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Steve Batterson

By the start of the second decade of the twentieth century, the mathematics department at Harvard University was arguably the strongest in the United States. Yet this rise to mathematical prominence of America's oldest university was remarkably recent and rapid. The author tells the history of this transformation and the people who brought it about.

931 Invariant Theory of Tensor Product Decompositions of *U(N)* and Generalized Casimir Operators

William H. Klink and Tuong Ton-That

The representations of the $n \ge n$ unitary group have important applications in quantum physics. In particular, it is important to be able to compute the decompositions into irreducible factors of tensor powers of irreducible representations. The authors review the physics, the groups, and their representations, and discuss how the decompositions can be calculated.



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Opinion

Strikes Sweep French Universities

Sunday, March 15, 2009, was a fine sunny day in Paris, and the Jardin Luxembourg was full of people. On the park's bandstand was an unusual sight: Before an audience of about seventy-five people, Gérard Besson of the Université de Grenoble was delivering a Bourbaki lecture ("Le théorème de la sphère différentiable [d'après S. Brendle, R. Schoen]"). In a gesture of solidarity with the strikes that were sweeping French universities, the organizers of the Bourbaki seminar had asked Besson to give his lecture outside the usual venue, the Amphithéâtre Hermite at the Institut Henri Poincaré, which is located in the Université Pierre et Marie Curie. They brought along a two-sided whiteboard, and by the time Besson had filled both sides, the police had arrived. The officers explained that, because the park is owned by the senate, it is not a public place, and public lectures are thus forbidden. They suggested moving the lecture to the forecourt of the nearby Panthéon, but the mathematicians ruled out that option, knowing they would likely encounter there more policemen jumpy about the many demonstrations recently carried out in the area. In the end the mathematicians repaired to the amphitheater. A 4-minute video showing Besson's encounter with the police was posted on YouTube. "I am not sure that the outcome of this revolutionary act is important," Besson said, "but my kids were happy to see me on the video."

This somewhat lighthearted story points to a more serious reality: the extraordinary outpouring of discontent among French university faculty and students that since early 2009 has led to widespread strikes and demonstrations across the country. Lectures have been canceled, faculty have refused to perform administrative duties, chairs have been removed from lecture halls so that classes cannot be held. One of the most widely used tactics has been mass public readings, especially from the seventeenth-century classic *La Princesse de Clèves*. The book has become a symbol of protest against the French president, Nicholas Sarkozy, who has made several public statements deriding the book and whose administration has pushed the government policies that sparked the strikes.

Causes of the Unrest

Although different people and groups are striking for different reasons, most of the dissatisfactions have centered on a law—"Loi relative aux libertés et responsabilités des universités", or LRU—that the government intended as a way to give French universities more autonomy. Although the law was passed in August 2007, its implementation began in earnest only in 2009; all universities must implement the reforms by 2012. Another bone of contention has been the government's proposals for revamping training of secondary school teachers, proposals that many believe will be disastrous for an already ailing French school system. Another issue at the back of the minds of many of the protestors, though perhaps playing a less direct role, is the changes in the Centre National de la Recherche Scientifique (CNRS) that the government has been carrying out over the past couple of years.

The French mathematical community has responded in various ways. Many French university mathematics departments have posted notices on their Web pages saying they are on strike and describing their reasons and demands, and there has been a huge amount of discussion and exchanging of information among them. The concrete steps taken have varied-some departments canceled courses entirely, some temporarily; some taught part of their courses and advised students about how to catch up on the missed material; some held lectures outside of the university buildings. Through such actions, "people can say they are striking, but they are not doing something irreversible to the students," remarked Stephan Jaffard of the Université de Paris 12, who is the current president of the Société Mathématique de France (SMF). "The situation [for mathematics students] is under control, and there should not be too many bad consequences." In other academic areas, by early summer 2009 coursework interruptions had been so extensive that the upcoming examinations posed a serious problem, and it was not clear whether students would be able to progress towards their degrees.

The over eighty public universities in France are all centrally controlled by the French government. As many of them struggle with overcrowding, crumbling infrastructure, and a lack of funds, there is little disagreement that some kind of reform is needed. In fact, reforms of the type outlined in the LRU have been discussed for years in France and predate the Sarkozy administration. What has aroused the recent ire of French academics is the exact nature of the implementation of the LRU reforms. Writing in the Oxford Magazine after an April 2009 trip to France [1], Robin Briggs, Senior Research Fellow and Special Lecturer in Modern History at the University of Oxford, summed up the situation this way: "The model now being advocated is the classic competitive one derived from the business world, and is spectacularly ill-suited to generate academic excellence."

Deep Dismay Over Reforms

In this climate, faculty in the humanities feel more threatened than those in mathematics and science. But French mathematicians too have expressed deep dismay over at least two aspects of the implementation of the LRU. The first is a change in the way French mathematics departments are funded. Previously, department heads dealt directly with the Ministry of Higher Education and Research, which would provide the money, and the CNRS, which evaluated mathematics departments. In consultation with these two government bodies, a mathematics department head would make decisions about how to distribute the funds within the department. While perhaps not universally loved, this system was seen as impartial and fair. Now, under the LRU, funding for departments will flow through the hands of university presidents, who will have a great deal of control over how the money is spread around. Many French mathematicians fear that decisions might be made on the basis of favoritism and local politics—already a problem in French universities—and that university departments will have to compete against each other for funds.

The second concern centers on changes in the definition of the duties of university faculty. Previously, government regulations stipulated, for example, how much time a mathematics professor was supposed to spend on teaching and how much on research. The LRU reforms aim to give more control over such matters to the universities themselves. so that university presidents would have discretion to, say, shift around teaching loads, rewarding those who are productive in research by assigning them fewer teaching hours and upping the teaching loads of those doing less research. The buzzwords are "autonomy" and "local control", which sound reasonable and perhaps even desirable. But French academics are more comfortable basing such decisions on government regulations, which are seen as impartial and even-handed. They also believe the new organizational scheme does not provide enough discussion by and input from the rank and file faculty. In most universities in the United States, provision is made for discussion and input by an administrative layer-usually consisting of deans, who are themselves academics-that sits between departments and the upper university administration. In the reforms outlined in France, it is not clear there would be such an intermediate body.

One of the most volatile issues fueling the strikes is the government's efforts to change the structure of degree programs that prepare secondary school teachers. These changes have unified a powerful and vocal bloc of faculty and students in both universities and secondary schools. Previously, students who advanced through the teacher preparation programs obtained paid positions to do two years of practice teaching under the supervision of experienced teachers. This component of teacher training will now be replaced by study of teaching theory rather than actual practice. "There are fears that secondary school teachers will have less technical knowledge of their subjects and less practice interacting with students," Jaffard explained. In his article Briggs pointed to another disturbing possibility: "There is widespread perception that the real purpose behind many of the changes is a reduction in the number of properly qualified and fully employed teachers, in both schools and universities, and a greatly expanded use of various forms of casual labor."

Another component of the dispute, and one that can be difficult for outsiders to understand, is the role of the *grands écoles*. Briggs wrote, "These institutions are the crucible in which generation after generation of the French ruling class is formed; they only take 4 percent of the annual student intake, with a massive bias towards the children of the rich and powerful." Entrance into a *grande école* requires special preparatory classes after secondary school and ensures the graduate will enjoy privileges and connections throughout his or her career. Entrance into a French university offers none of these advantages and is seen as a poor second choice. "The French ruling élites, largely formed in the Grandes Ecoles, usually have little understanding of the universities and are markedly prone to their own subtler forms of hostility to 'pure' intellectual pursuits," Briggs wrote. "As a group their chief interest is in the maintenance of the Grandes Ecoles, through which they hope to pass their own children and grandchildren, so it is no surprise that the changes leave these institutions untouched."

Similar views, expressed in more blunt language, were voiced in a widely read editorial by Gérard Courtois that appeared in *Le Monde* in May 2009 [2]. Courtois wrote that, beyond all of the noisy unrest, the "true winners" of the conflict are the *grandes écoles*. The selective mechanisms that promote *grandes écoles* graduates intensify social hierarchies "to an absurd degree", he wrote. "This is what the university is suffering from, first of all. This is what the 'reform' under way is concealing."

For Mathematicians, Positive Signs, But Worries Too

Another development that has unsettled French mathematicians is the establishment of the Agence National de la Recherche, which gives research grants in a way similar to the U.S. National Science Foundation (NSF). This development has further complicated the climate in mathematics departments. "Now individual groups can ask for money for specific programs—and they can ask for quite large amounts," noted Frank Pacard of the Université de Paris 12, who also works part-time as an expert consultant on mathematics for the Ministry of Higher Education and Research. The division into "haves" and "have-nots" created by NSF grants have long been a fact of life in mathematics departments in the United States. "But people in France are not used to it," Pacard said. "The change has a good effect because it puts money into mathematics, but it could be a drawback because the system is not as even-handed as it used to be. So there are mixed feelings."

Over the past couple of years, the French government also mandated reforms of the CNRS that are intended to make the agency less centralized and to give each subject funded under the CNRS more autonomy. The reforms were greeted with some wariness by French mathematicians, for in mathematics, the CNRS has played a crucial role, by providing young mathematicians with research positions that ensure a good deal of job security (though not especially good pay) before they found permanent academic positions. It is true that the CNRS positions have not always been used as they were intended: A few mathematicians have remained for their entire careers in CNRS positions and have done little research. But these are exceptions, and it is clear that the CNRS has made an enormous contribution to the strength of French mathematics today. Indeed, six of the eight French Fields Medalists held CNRS positions at some point in their careers.

The changes to the CNRS that the government mandated have benefited mathematics in some ways. For one thing, the government has promised to provide more funding for mathematics through the CNRS. In addition, mathematics is now overseen by a single mathematical institute within the CNRS; before, the field was somewhat uncomfortably lumped into a section with physics. French mathematicians are generally happy with this change, Jaffard said. Nevertheless, he noted, "there is a fear that, if the CNRS is split into several independent blocks, then if the government wants to eliminate the CNRS, it will be easier to eliminate the blocks one by one."

Speech Galvanizes Opposition

Concerns about the government's policies had been simmering for months before a January 22, 2009, speech by President Sarkozy [3] sent shock waves through the academic community and galvanized many groups to strike. The speech was intended to lay out a new vision for a more modern and dynamic policy to support science and technology. Instead, it ended up alienating many of the people who work in these areas. Sarkozy painted a picture of "weak" universities led by "nitpicking" central administrations and an "infantilizing" system of research that "paralyzes" creativity and innovation. He pointed to mathematics, physics, and engineering sciences as some of the very few areas of excellence in France and suggested that they serve primarily to cover up the generally deteriorating condition of French science. Academics objected as much to what they saw as misconceptions and errors of fact as they did to the demeaning, chiding tone of the speech. For example, after criticizing the publication output of French researchers in some areas, Sarkozy took a preemptive strike against possible disagreement: "Pardon me, I don't want to be disagreeable.... This is a reality, and if the reality is disagreeable it is not because I say it, it is disagreeable because it is the reality."

Reactions to the speech within the scientific community were nearly uniformly negative. At one point in the speech, Sarkozy suggested that Albert Fert, a French physicist and recipient of the 2007 Nobel Prize, supported the ideas set forth in the speech; soon afterward Fert publicly came out opposed. Although they were among the few groups singled out for praise in the speech, mathematicians nevertheless found it infuriating. One of the most prominent voices raised was that of Fields Medalist Wendelin Werner of the Université de Paris-Sud, Orsay, who wrote an open letter to Sarkozy that appeared in Le Monde in February 2009 [4]. "Your speech contained flagrant untruths, abusive generalities, extreme simplifications, dubious rhetorical effects, which left all of science perplexed," Werner wrote. "I believe we are numerous, those of us who could not believe our ears." He also wrote that some very good colleagues and students were so revolted by the speech that they expressed a newfound desire to leave the country. Asked about the response to his letter, Werner wrote in an email message, "Basically everybody (including members of the government) understood that the 22 January speech did damage the situation and made it difficult to move forward," he wrote. "Since then, things have not really gone better."

The SMF, together with its counterpart organizations in physics and chemistry, also registered its opposition to the speech in a February 9, 2009, letter to the French minister for higher education and research, Valérie Précresse. Jaffard, together with the presidents of the other two societies, met with Précresse in April 2009 in an attempt to build a constructive dialogue. During that meeting, it became clear that Précresse was unaware that Sarkozy had planned to give such a speech. Indeed, the speech seemed to catch many in the government by surprise, leading to speculation that it was the work of a small handful of advisors to Sarkozy.

Together with the physics and chemistry societies, the SMF has written several letters to the government and articles that have appeared in Le Monde. "We have tried not to say that everything is good or everything is bad, but to make recommendations," Jaffard said. They have had constructive discussions about science policy with Précresse and others within the government. However, when the three societies joined a large group of other organizations across the academic spectrum to write a letter to the education minister Xavier Darcos opposing the changes in the preparation of secondary school teachers, the reaction was dead silence. "[Darcos] wants to do it his own way," Jaffard said. "He is not listening to others." But that letter had an indirect effect: Soon afterward, the association of French university presidents, which was initially strongly in favor of the changes, reversed its position and registered its opposition.

"The situation is fluid," Jaffard said in early summer 2009. It is clear that some of the developments that have generated the most controversy, such as the reforms made in response to the LRU, are here to stay. In other cases, the government has backed off from some proposed policies that met with opposition. The sheer number of changes the government has made, the rapid pace at which they are to be carried out, and the lack of provision for input from those whose lives will be affected have caused almost as much dissatisfaction as the specifics of the reforms themselves. But, as Jaffard pointed out, a clear consensus about alternatives has not emerged from the academic community. He said, "It is easier to be dissatisfied than to be united in what to do."

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—Allyn Jackson Notices Senior Writer and Deputy Editor axj@ams.org

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Representations of U(n)

The cover illustrates the Gelfand-Tsetlin scheme associated to one of the irreducible representations of U(3), and was suggested by the article in this issue with authors William Klink and Tuong Ton-That.

An irreducible finite-dimensional complex representation π of U(3) decomposes into a direct sum of eigenspaces on which the group D of diagonal elements act by a character:

$$\pi \begin{pmatrix} t_1 & 0 & 0 \\ 0 & t_2 & 0 \\ 0 & 0 & t_3 \end{pmatrix} : \quad \nu \mapsto t_1^{m_1} t_2^{m_2} t_3^{m_3} \nu \,.$$

The integral vectors (m_i) are called the **weights** of the representation. The dimension of the space on which D acts by a given weight is called its **multiplicity**, and in spite of many years of investigation the problem of computing this multiplicity in general has not found a clearly optimal solution.

The 3×3 permutation matrices normalize the diagonal group, so the set of weights is invariant with respect to permutation. Under the assumption of irreducibility, the weights are the lattice points in the convex hull of the permutations of a unique **dominant** weight with $m_1 \ge m_2 \ge m_3$.

Something similar is valid for all U(n). In particular, an irreducible representation of U(2) with dominant weight (m_1, m_2) is the direct sum of one-dimensional spaces with weights

$$(m_1, m_2), (m_1 - 1, m_2 + 1), \ldots, (m_2, m_1).$$

Hermann Weyl described the restriction of an irreducible representation of U(n) to U(n-1), which turns out to be relatively simple. Around 1950, Gelfand and Tsetlin pointed out that if Weyl's result were applied recursively it would allow an interesting geometric interpretation of weights. For U(3) their observation is that the one-dimensional eigenspaces of the diagonal group are parametrized by diagrams:

$$egin{array}{cccc} m_1^{(3)} & m_2^{(3)} & m_3^{(3)} \ m_1^{(2)} & m_2^{(2)} \ m_1^{(1)} & m_1^{(1)} \end{array}$$

where $m_i^{(3)} = m_i$, and the interlace conditions

$$m_1^{(3)} \ge m_1^{(2)} \ge m_2^{(3)} \ge m_2^{(2)} \ge m_3^{(3)}$$
$$m_1^{(2)} \ge m_1^{(1)} \ge m_2^{(2)}$$

are satisfied. The $m_i^{(3)}$ are fixed for a given representation, so the parametrization is by three independent integer

variables $x = m_1^{(2)}$, $y = m_2^{(2)}$, $z = m_1^{(1)}$ satisfying the six linear inequalities

$$m_2 \le x \le m_1$$
$$m_3 \le y \le m_2$$
$$y \le z$$
$$z \le x.$$

This is a rectangular cylinder sliced by top and bottom planes $x - z \le 0$, $z - y \ge 0$:



A decomposition into one-dimensional eigenspaces thus corresponds to lattice points inside the **Gelfand-Tsetlin polytope**, and these are what the cover shows for dominant weight (5, 0, -5).

The map from points $(m_i^{(j)})$ to weights (n_i) is according to the formulas

$$n_1 + n_2 + n_3 = m_1^{(3)} + m_2^{(3)} + m_3^{(3)}$$
$$n_1 + n_2 = m_1^{(2)} + m_2^{(2)}$$
$$n_1 = m_1^{(1)}$$

The cover shows in red the lines of *m* corresponding to a given weight, for the particular weights (n, 0, -n). The symmetry of the set of weights with respect to \mathfrak{s}_3 is skewed because of the choice of coordinate system but nonetheless apparent.

The literature on these matters is huge, but I have found especially useful the recent M.I.T. thesis of Étienne Rassart, which can be found on the Internet. It shows that the geometry of Gelfand-Tsetlin polytopes is extremely useful in analyzing weight multiplicities.

> —Bill Casselman Graphics Editor (notices-covers@ams.org)



Bôcher, Osgood, and the Ascendance of American Mathematics at Harvard

Steve Batterson

he year 1888 is notable to members of the American Mathematical Society (AMS) for the founding of their organization under the name The New York Mathematical Society. In this same year Maxime Bôcher received his A.B. in mathematics from Harvard. The university also awarded Bôcher a fellowship that enabled him to travel to Göttingen for graduate study. At the time, knowledgeable American mathematics students with means went to Germany to pursue a Ph.D. Opportunities for course work and thesis direction in the United States were vastly inferior. The country's only significant mathematical scholars were the nonacademically employed George William Hill, the part-time professor Simon Newcomb, and the reclusive scientist J. Willard Gibbs. Over the 1890-1894 interval just two American universities would confer more than two mathematics Ph.D.'s [1], and neither of these programs was on a favorable trajectory. Johns Hopkins was in a decline that had begun with the recent departure of J. J. Sylvester. Clark University, after a promising first three years, underwent devastating turmoil and lost many of its best staff [2], [3].

Yet by 1913 the American mathematical brand was appreciated in Europe. E. H. Moore, Maxime

Bôcher, W. F. Osgood, Leonard Dickson, and G. D. Birkhoff were internationally respected mathematicians. Graduate programs at Chicago, Harvard, and Princeton offered European-level training that had been unavailable in the United States when Bôcher completed his undergraduate studies a quarter century earlier. The advancement on American campuses began in the early 1890s.

Most significant was the opening of the University of Chicago in 1892. Under the leadership of E. H. Moore, Chicago recruited European emigrés to implement a high-level mathematics curriculum [2]. A steady stream of talented American students thrived in the scholarly environment. Moore's Ph.D. students Dickson (1896), Oswald Veblen (1903), and Birkhoff (1907) would each go on to deliver plenary addresses to the International Congress of Mathematicians.

Compare the Chicago ascendance with contemporaneous developments at Harvard [4], [5], [2]. After obtaining their Ph.D.'s in Germany, Osgood and Bôcher became Harvard instructors in 1890 and 1891 respectively. None of their departmental colleagues were engaged in mathematical research. Together Bôcher and Osgood steadily changed the culture, publishing their scholarly work and invigorating the graduate program. Birkhoff joined the Harvard faculty in 1912 and then discovered his famous proof of Poincaré's Geometric Theorem. With Bôcher, Osgood, and Birkhoff, Harvard was the strongest department in the United States. Given the 1890 state of American mathematics. the rise of Harvard was remarkable, even if overshadowed by the more rapid advances at Chicago. This article traces these developments, focusing on the vital roles of Bôcher, Osgood, and the Harvard traveling fellowships.

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Mathematics at Harvard Prior to 1880

In 1636 Harvard became the first college to be established in the North American British colonies. To fulfill its mission of providing the educational essentials to prospective Puritan ministers, the curriculum featured Latin, Greek, Hebrew, rhetoric, and philosophy. The small presence of mathematics was restricted to some arithmetic and geometry in the final year. During Harvard's first century mathematics was often taught by minimally trained instructors who held the title of tutor [6], [7].

The year 1727 marked the endowment of the Hollis Professorship of Mathematics and Natural Philosophy. The first holder was Isaac Greenwood. Greenwood, being knowledgeable in Newton, substantially elevated the Harvard faculty's level of scientific competence. Unfortunately his tenure ended prematurely when he was dismissed over repeated incidents of drunkenness. Greenwood's successor was his former student John Winthrop.

Serving from 1738 to 1779, Winthrop covered the broad span of mathematics and the physical sciences. Harvard historian Samuel Morison characterized Winthrop as "the first important scientist or productive scholar in the teaching staff of Harvard College" [6, page 92]. Winthrop took the then-novel initiative of setting up an experimental physics laboratory. His lectures included the topic of electricity. Winthrop's astronomical observations of the solar system earned him membership in the Royal Society.

When the nineteenth century began, no American professors were doing mathematical research. At both Harvard and Yale, scholarship in the subject meant the production of textbooks. By this time mathematics was front loaded into the Harvard curriculum. Tutors handled arithmetic and geometry in the freshman year. Subsequent topics included algebra, logarithms, trigonometry, surveying, and spherical geometry.

In 1806 the Hollis chair was offered to Nathaniel Bowditch, the author of an important handbook on navigation. Possessing only a rudimentary formal education, the self-taught Bowditch was an interesting choice. Following a maritime career, he had entered the insurance business, all the time studying mathematics on his own. Bowditch turned down the professorship but became an influential member of the Harvard Corporation, which governed the university. Meanwhile, he took on the ambitious project of translating and elucidating Laplace's multivolume work on celestial mechanics. Its successful completion was arguably the most impressive American mathematical accomplishment up to that time.

In place of Bowditch, the Hollis chair was filled by John Farrar. Farrar was a charismatic lecturer. His contribution to American mathematics was to translate French textbooks and introduce the superior continental mathematics to students in the United States. In 1824 Harvard juniors began studying Farrar's adaptation of Bezout's calculus [7].

The following year a brilliant sixteen-yearold freshman enrolled at Harvard. Benjamin Peirce had already received mathematical training from Nathaniel Bowditch, whose son, Ingersoll, was Peirce's classmate at the Salem Grammar School. Peirce supplemented his Harvard studies by assisting Bowditch with the Laplace translation. In addition, Peirce was an avid reader of The Mathematical Diary, solving problems posed in this early American journal [8].

Peirce completed his A.B. in 1829. Despite his ample mathematical gifts, Peirce's opportunities for further study were severely limited; Ph.D. programs did not then exist in the United States. Over the prior decade several Harvard students had returned to campus from advanced work at Göttingen and other European institu-

tions [6]. Their presence offered evidence and testimony to the benefits of study abroad. Yet Peirce remained in Massachusetts to teach at a prep school. His biographer speculates that recent family financial reversals forced Peirce to forgo European study and begin earning an income [8, page 52].

Peirce taught at the prep school for just two years. Then a mathematics tutorship opened up for him when Farrar's health began to fail. The 1831 Harvard appointment of Peirce was the beginning of an historic tenure for American science. Within months he submitted an original theorem for publication in *The Mathematical Diary*. It was known that if $2^{n+1} - 1$ is prime, then $(2^{n+1} - 1)2^n$ is perfect. Peirce proved that if a perfect number *M* does not have the above form, then *M* must have at least four distinct prime factors [9]. Later,



Maxime Bôcher.



W. F. Osgood.

a posthumously published paper of Euler showed that any even perfect number has the form stipulated above. Thus Peirce's result established that any odd perfect number has at least four distinct prime factors.

It is unclear whether the Harvard administration had any appreciation for this worthy demonstration of mathematical scholarship. Shortly afterward, however, President Josiah Quincy steered Peirce in a more traditional direction, the writing of textbooks. Peirce sought a clarification of priorities. He asked whether the Harvard Corpora-



tion wanted him to "undertake a task that must engross so much time and is so elementary in its nature and so unworthy of one that aspires to anything higher in science" [8, page 69]. Advised that it did, Peirce would publish seven textbooks over the next ten years and no further papers in number theory.

Harvard apparently was satisfied with Peirce's performance. As Farrar's health continued to deteriorate, Peirce took on increasing responsibility. In 1833 Peirce was

promoted to professor of mathematics and natural philosophy. Nine years later he became the first Perkins Professor of Astronomy and Mathematics.

Astronomy was the discipline of Peirce's first international notoriety. In 1846 the planet Neptune was discovered by an innovative technique. Neptune was spotted after its location was predicted from inferences about perturbations to the orbit of Uranus. The mathematical calculations had been performed independently by John Couch Adams of England and Urbain Le Verrier of France. A great deal of fascination accompanied the identification of a planet by means other than direct observation. Peirce closely followed these events and did his own calculations. He found aspects of Neptune's orbit that called into question Le Verrier's original prediction. When Peirce characterized the planet's discovery as a "happy accident", it did not sit well with Le Verrier [8].

In the ensuing dispute, Peirce was up against more than an eminent astronomer. Their countries represented the scientifically undeveloped and elite respectively. That Peirce held his own gave standing to both the scholar and his country. The latter was important to him.

About this time Peirce became part of a small fraternity of scientists, known as the Lazzaroni, whose objective was to elevate American science while enjoying each other's company. The core of the group also included Smithsonian visionary Joseph Henry, Harvard professor of zoology and geology Louis Agassiz, and Coast Survey Superintendent Alexander Dallas Bache. Their individual scholarly prominence placed the Lazzaroni in a position to promote national science initiatives. Out of their efforts came the creation of the American Association for the Advancement of Science and the National Academy of Sciences.

Peirce himself continued to do research in astronomy and mathematics. His astronomical work gained him admission to the Royal Society. However, Peirce's magnum opus, *Linear Associative Algebra*, was in mathematics. Along the way he held key positions with two important government scientific agencies, The Coast Survey and The Nautical Almanac.

Peirce remained at Harvard until his death in 1880. As a teacher Peirce was generally depicted as incomprehensible to ordinary students. Two of the more complimentary assessments were made in reflections from former pupils who each rose to the presidency of the university. They portray Peirce as an inspirational, if opaque, lecturer. A perhaps more balanced view was given by a member of the next generation of the Harvard mathematics faculty, Julian Coolidge: "His great mathematical talent and originality of thought, combined with a total inability to put anything clearly, produced among his contemporaries a feeling of awe that amounted almost to dread" [4]. Through his government work and his half century at a leading university, Peirce exerted an influence on the most promising younger American mathematicians, including his son C. S. Peirce, Simon Newcomb, George William Hill, and William Story [8]. In terms of both accomplishment and impact, Peirce was the outstanding American mathematician of his time.

Graduate education was one area where Peirce missed an opportunity to advance his country. In 1860 Yale became the first American university to offer a Ph.D. Harvard was slow to embrace the higher degree, reluctantly establishing its graduate school in 1872 [6]. The first Harvard Ph.D. was awarded to William Byerly in mathematics the following year. He was the only student to earn a Ph.D. under Peirce's direction.

Mathematics at Harvard and Elsewhere in the 1880s

Peirce's death in 1880 left a void in mathematical research at Harvard. Surviving him in the department were his son James Mills Peirce and former Ph.D. student William Byerly. In 1881 a distant relative, mathematical physicist Benjamin O. Peirce, joined the faculty. As undergraduates all three had taken courses from the elder Benjamin Peirce. Each was an effective teacher and wrote textbooks for Harvard students [5]. B. O. Peirce published experimental physics papers both earlier and later in his career. The state of mathematical scholarship at Harvard in the 1880s, however, had reverted back to that at the beginning of the century. No one was proving new theorems. Meanwhile other Harvard departments were flourishing. A new age began in 1869 with the installation of Charles Eliot as president. Eliot had a vision for Harvard as a modern university. Moreover, he possessed the skills to implement his plans. By the midpoint of his forty-year tenure, research was issuing from virtually every Harvard department except mathematics [6, page 378].

Beyond Harvard the only post-Peirce American scholars utilizing substantial mathematics were J. Willard Gibbs, George William Hill, and Simon Newcomb. Gibbs was professor of mathematical physics at Yale. His groundbreaking theoretical work in chemistry and physics was hailed in Europe by James Clerk Maxwell and Wilhelm Ostwald. Appreciation for Gibbs's ideas in his own country was limited by a lack of scientific understanding. The temperamentally withdrawn Gibbs rarely left New Haven, working in quiet isolation and seeing few students.

Hill and Newcomb were acclaimed for their research in celestial mechanics. Both held positions at the Nautical Almanac Office. Pure mathematical research was then absent from United States campuses, with the following exception. The Johns Hopkins University opened in 1876 under a twofold mission of research and graduate education. With no Americans suited to lead such a mathematics program, J. J. Sylvester was imported from England [2]. On Peirce's recommendation, Harvard tutor William Story was chosen to be second in command. Story had completed a Ph.D. in Leipzig following his undergraduate work at Harvard.

The graduate program at Johns Hopkins offered mathematical opportunities not previously available in America. Sylvester produced quality research and inspired students to follow his lead. Story taught courses in geometry. Together they began *The American Journal of Mathematics*, the first significant mathematics periodical based in the United States.

Late in 1883 Sylvester returned to England to assume Oxford's Savilian chair. Succeeding him at Hopkins was Simon Newcomb. Primarily an astronomer, Newcomb was serving as the superintendent of the Nautical Almanac Office in Washington. Newcomb continued in this position, commuting to Hopkins two days a week to conduct classes in astronomy. It was not enough to make up for the loss of Sylvester [2]. Once again, there was no United States university providing mathematical training approaching what was available in Europe.

The next notable American educational event occurred in 1889 with the founding of Clark University. Story left Hopkins to lead the new mathematics department [3]. Joining him was the German emigré Oskar Bolza, who had recently obtained his Ph.D. under Felix Klein at Göttingen. The following year another Klein student, the American Henry White, provided an additional boost to the teaching staff. Unfortunately the Clark venture was undercapitalized and a victim of competing visions. By its third year the university was roiled by acrimony among the founder, president, and faculty. Bolza, White, and several colleagues moved on to other opportunities.

Study Abroad and the Harvard Fellowships

American students in the mid-1880s needed to look across the Atlantic Ocean for advanced math-

ematical training. Several found their way to Germany into the classroom of Felix Klein. These fortunate placements were hardly random. The students came from Princeton, Wesleyan, and especially Harvard, where there was knowledge of the opportunities abroad.

In prior years Harvard graduates had occasionally sailed to Europe for graduate study. Benjamin Gould arrived in 1845 after taking several courses as an undergraduate from Benjamin Peirce. Gould studied under Carl Friederich Gauss and earned his Ph.D. in astronomy from Göttingen. Returning to the United States, he became an influential astronomer and member of the Lazzaroni.

The Harvard class of 1871 included two future mathematicians who pursued different educational paths. William Byerly remained at Harvard, where the graduate program was begun a few months later. Byerly received his Ph.D. in 1873. Meanwhile, his classmate William Story was in Berlin and Leipzig continuing his study of mathematics and physics. Story returned to the United States early in 1874 without an advanced degree [3].

Graduate study in Germany posed many challenges. Young Americans needed a variety of assets to succeed. Language facility, mathematical background, and maturity were essential prerequisites for profiting from the lectures. Moreover, no European study was feasible unless the student possessed the wherewithal to pay for the voyage and for subsistence over an extended period. In 1873 Harvard began a remarkable program that eased this burden for Story and many others.

At this time, income from a \$50,000 bequest by the Boston merchant John Parker Jr. became available for Harvard graduates to continue their



J. Willard Gibbs



George William Hill



Simon Newcomb

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studies at home or abroad. In his will Parker stated, "My design is to establish a fund for the highest possible education and advancement of one or more of those minds of great intellectual power, having a special adaptation to some particular science, which occasionally arise in society, and

whose possessors, whether strictly

poor or not, are not blessed with

pecuniary means adequate to effect-

ing the high state of improvement

and advance in science for which

they seem to be destined by nature"

[10]. The term science was inter-

preted broadly, as the first Parker

Fellow studied modern languages

in Europe. Story and a philosophy

student were selected for the re-

maining \$1,000 annual fellowships,

which, with satisfactory progress,

were renewable for two additional

vears. The arrangements meant that

Story needed just one year to



Felix Klein



Frank Nelson Cole

Fellowships. Peirce obtained a physics Ph.D. at Leipzig, gained valuable postdoctoral experience in Helmholtz's Berlin laboratory, and soon thereafter was appointed to the Harvard faculty.

Frank Nelson Cole was awarded a Parker Fellowship after graduating second in the class of 1882. Cole studied at Harvard for an additional year and then went to Leipzig, where he first attended courses in physics. During the summer of 1884 Cole enrolled in a mathematics class of Felix Klein on elliptic functions. Klein, then in his mid-thirties, was one of the most highly regarded mathematicians in Europe. He had recently been offered the chair to succeed Sylvester at Johns Hopkins. Although the Baltimore negotiations had broken down, Klein remained intrigued by the prospects for science in the United States [2].

Joining Cole in Klein's course was Henry Fine of Princeton. Both Americans received thesis problems from Klein. With just American university preparation, Cole and Fine found the research to be extremely difficult. Their struggles resulted in different outcomes. A junior faculty member, Eduard

Study, gave Fine considerable help on a substitute problem [2]. After one year Fine had his Ph.D. to take back to Princeton.

Cole also returned to his home university in 1885. There he continued his thesis research while proselytizing Klein's mathematics in courses at Harvard and lectures at MIT. Cole worked hard on his thesis problem but was completely isolated from anyone who might help him. Discouraged by his lack of progress, Cole wrote Klein after a year that he didn't believe "that I will finish it during my lifetime using my present method" [11]. Nevertheless, Cole had done enough to obtain his Ph.D. from Harvard.

Cole's Harvard teaching career lasted just two years. Overwork caused a breakdown that forced him to withdraw from a tutorship. He resumed his academic career elsewhere after a therapeutic year of outdoor railroad work. As a promoter, however, Cole's impact was striking. Klein, who had moved to Göttingen, suddenly experienced a surge of students from the United States, particularly the Boston area. His 1887 pupils included Harry Tyler of MIT, both Mellen Haskell and William Osgood on Harvard traveling fellowships, Henry Thompson from Princeton, and Henry White from Wesleyan. The following year another Harvard traveling fellow, Maxime Bôcher, arrived.

Osgood and Bôcher

Osgood and Bôcher would earn their Ph.D.'s in Germany and then return to Harvard. Over their careers they would establish similar impressive vitae, differing most notably with the latter's premature death in 1918 [12]. Both were born in Boston: Maxime Bôcher on August 27, 1867, and William Fogg Osgood three and one half years earlier.

Bôcher grew up in a scholarly, international household. The ancestry of his mother. Caroline. went back to the Plymouth Colony. Maxime's father, Ferdinand, was born in New York during a business trip of Maxime's grandfather from France. Ferdinand Bôcher became a Harvard French professor. He was among the early hires of President Eliot, coming from MIT, where the two had been colleagues. Ferdinand Bôcher revered Eliot, perhaps accounting in part for his son's devotion to the university and its president.

Osgood was also descended from early residents of Massachusetts. He came to Harvard as an undergraduate in 1882. Excelling in mathematics, physics, and Latin, Osgood graduated second in his class four years later. He remained at Harvard for an A.M. Then, inspired by classes from Cole, Osgood applied for a traveling fellowship to study under Klein at Göttingen.

By this time Parker Fellowship stipends had been reduced to \$700, but there were four of these grants in the rotation. Another traveling fellowship, the Harris, from a smaller endowment, carried a \$500 award under similar conditions. In 1887 one Parker and the Harris were vacated. The new Parker went to a law student who would later become a professor at the University of Chicago and a judge on the United States Court of Appeals. Osgood got the Harris. In his second year Osgood was upgraded to the Parker, making the Harris available again in 1888.

Bôcher had just turned sixteen when he began his undergraduate work at Harvard in 1883. It is unclear why it took him five years to complete his A.B. During the regime of President Eliot, Harvard students had substantial freedom to select elective courses. Bôcher took advantage of this opportunity in his senior year to fashion a diverse program that consisted of mathematics, Roman art, music, and an advanced course in geology [13]. He was awarded highest honors in mathematics for *A thesis on three systems of parabolic coordinates* and a second prize for the meteorological essay he entered in Harvard's long-standing Bowdoin Prize competition.

With Osgood's promotion to a Parker Fellowship, only one other Parker was available in 1888. This went to future Nobel chemistry laureate Theodore Richards for postdoctoral work in Germany. Bôcher was awarded the Harris Fellowship. He arrived in Göttingen September 1888, one year after Tyler, Osgood, and White.

The impression made by the Göttingen faculty on an American student was conveyed in a letter from Tyler to his parents following his first week of classes:

> After some 16 students are assembled, the door opens hastily, the Prof. enters, there is a slight scraping and stumping-to assure him we're glad he's no later-he deposits his tall hat and cane, and within 5 seconds of his appearance with no other preface than a hurried "meine Herren" he is in the midst of his lecture. It should not be inferred that he is a hasty instructor. Too much the contrary; he is one of the slowest men I ever heard lecture. This however later-My first impressions are that he is a large, stout dignified, fine-looking gentleman perhaps 55 years old, with full slightly gray beard and gold spectacles. In the next place he spoke with admirable distinctness, and I am agreeably surprised to find myself understanding almost every word—though it is very difficult at the same time to follow the lecture and to take notes either in English. German. or a mixture of the two...Please remember that the gentleman just introduced is Prof. Schwarz, senior professor of Mathematics in "der hiesigen Univer

sität". He has unfortunately not the reputation, and presumably not nearly the ability of his junior Prof. Klein, and his classes are not large.

Wednesday I attended the initial lecture of a course on the "higher plane curves" by Dr. Schoenflies-a Privat Docent-. It was almost beyond description, but I'll try. Dr. S. is a good-looking business like young man (30-35 perhaps) with dark hair and full beard. He talks very rapidly and somewhat indistinctly, though otherwise clear and very interesting. But he marched back and forth along the small platform, falling off 3-4 times in his apparent excitement, leaned against the desk or the black board, squinted up his eyes and wrinkled his nose, then dashed at the black board talking steadily with his back towards us...

Not till Thursday did I hear and see the great Klein (so to speak) whose fame as the greatest mathematical teacher in Germany (consequently in the world) has attracted me to Göttingen. He is a tall slender man of about 40, his hair is light brown, his eyes blue, keen and alert; the strength of his face lies chiefly in his large nose and high forehead. He speaks rather quickly and with a somewhat high voice, but clearly enough, and methodically, enunciating frequently statements to be taken down verbatim. He lays much stress upon the notes taken, and has one student write up the lectures which after his own revision are put in the reading room for general reference. His subject was Potential—a subject of mathematical physics, in which I have no interest. In spite of my first disinclination, I am gradually concluding to take this course-4 lectures a week-partly for the sake of the Mathematics involved, mainly to hear the man [14].

A significant feature of the traveling fellowships was their renewability. Unlike Osgood and Bôcher, who could expect three years of study abroad, Tyler was bound by a two-year leave from his faculty position at MIT. The extra year could be decisive in completing the requirements for a Ph.D. Further compounding the time limitations was Klein's course scheduling. In the fall of 1887 Klein's advanced offering was the second term of a course on hyperelliptic functions. Lacking the prerequisites Tyler, Osgood, and White took the intermediate-level potential theory. Not until their second semester, when Klein started a sequence on Abelian functions, could the three Americans begin the sort of instruction which had drawn them to Göttingen. Two other Americans and one or two Germans were also enrolled. Osgood received an unwelcome surprise on the first day of class. He was asked by Klein to serve as the course scribe. The duties included substantial revisions and rewriting. Up to this point Osgood had not been taking careful notes. While he dreaded assuming the new responsibility, he could not say no to Klein. After two lectures Osgood was



overwhelmed and prevailed upon the more clerically oriented Tyler to take over the duties.

The revision process gave Tyler more interaction with Klein than he would have otherwise had. Occasionally they discussed future plans. While Tyler had come to Göttingen with some hopes of obtaining his Ph.D., he had doubted whether the degree was possible under his twoyear constraint. To make the most of his time abroad, Tyler intended to study for a semester in some other

German city and another in Paris. As the first year drew to a close, Klein began encouraging Tyler to remain at Göttingen for his Ph.D.

Tyler went back and forth over where to spend his second year. At the last moment, with Klein's approval, Tyler moved to Erlangen. The particular attraction of Erlangen were its two strong mathematicians, Paul Gordan and Max Noether, and few students. Tyler's plan was to continue work on a thesis problem from Klein while receiving individual instruction from Gordan and Noether.

Both Gordan and Noether were generous with their time, offering personal attention that was not available in Göttingen. Tyler was especially drawn to Gordan, who, rather than discussing the problem from Klein, set Tyler to work on resultants. Then, as Tyler wrote Osgood, "A month or six weeks later he told me to my unbounded surprise he would accept this as a Ph.D dissertation if I chose" [15]. The plans for Paris were scrapped. Tyler spent the remainder of the second year in Erlangen, writing up his thesis and preparing for the required supplementary topics in physics and chemistry. After two years in Germany, Tyler returned to MIT with his Ph.D.

Tyler remained in touch with Osgood and White, with whom he had become close during their classes together. Back at Göttingen Klein was finishing a three-term sequence on Abelian functions. In the fall of 1889 he would begin a program in mathematical physics. Osgood sought advice from Tyler over whether to remain in Göttingen for a third year. Tyler's nine-page response, excerpted below, was both thoughtful and incisive, carefully analyzing the advantages and disadvantages of the people and venues.

I think in the first place that it's much better for you or anyone else who has 3 years abroad not to spend the whole time in Göttingen unless for reasons of great importance...I have much admiration for Klein personally, I know of nobody who can approach him as a lecturer...He's certainly acute, fertile in resource, not only understands other people, but makes them understand him, and seems to me to have a very firm grasp of the philosophical relations and bearings of different subjects, as well as great versatility and acquaintance with literature.

But quite in keeping with some of these good qualities are drawbacks that seem to me somewhat serious. So busy a man can not and will not give a student a very large share of his time and attention; so too he will not study out or interest himself especially in the painstaking elaboration of details, preferring to scatter all sorts of seed continually and let other people follow after to do the hoeing...it would seem ridiculous to claim—what he certainly would not claim for himself—that he does not sacrifice completeness of detail, and that this is not a real sacrifice...

Still anyone coming here from Klein would be sure to look at mathematical things from a new standpoint and as matters are now would be practically certain of a degree of interest and attention about out of the question in Göttingen, and especially valuable when one is beginning original work. I have been and am still embarrassed by the opportunities. I might have gained a great deal from Noether had I not been so occupied with Gordan. In the present semester Noether will probably have but one student besides myself and will probably give us anything we like...The chief advantage in being here in general depends upon cultivating personal relations with Gordan and Noether. I wouldn't advise anybody to come for the lectures alone. Both men are so peculiar and so irreconcilable that the p.r. must be cultivated with some tact especially if one tries to divide his attention about equally...G. is outspoken, irascible, exasperating, violent; N. is taciturn, serious, equable, patient... If G. is absolutely unrestrained N. is quite the contrary; but it's restraint not constraint. He may forbear from saying disagreeable things, but he doesn't go out of his way to say the other kind....

Now as to your plans, I would advise you unhesitatingly to come here if you want detailed work in pure mathematics. If you want to work especially with Gordan I wouldn't suggest any preparation unless the first volume of his book. If you had anything underway very likely it would not interest him. For Noether on the other hand I think it would be worth while to have something to propose—in Abelian Functions if you like or in any of his subjects that you know from the Annalen as well as I could tell you. I wouldn't advise you to come unless you feel sure your tastes will lie in these directions. I do not see the least reason to doubt your being able to make the Ph.D. in two semesters here, or even one if necessary [16].

Osgood followed the second branch. He went to Erlangen for his third year, bringing a problem from Klein on Abelian functions. One year later he had an Erlangen Ph.D. under Noether. For the fall of 1890 Osgood returned to Harvard with the title of instructor of mathematics.

Bôcher remained in Göttingen his entire 1888– 1891 period abroad. The lectures on mathematical physics, begun by Klein in 1889, suited Bôcher nicely. In his second year Bôcher took up a substantial piece of Klein's program.

Potential functions for many partial differential equation problems in mathematical physics could be obtained by series methods after employing an orthogonal change of coordinates and separation of the new variables. Bôcher had dabbled with a few of these coordinate systems in his undergraduate thesis. Now he sought to develop series solutions under general cyclidic coordinate transformations. The ordinary differential equation and other issues that arose from the technique required difficult analysis. Klein arranged for a prize to be awarded for a general development of this theory. Bôcher's success earned him the prize and his Ph.D.

In 1891 Bôcher returned to Harvard. Like Osgood, who arrived one year earlier, he was an instructor of mathematics with a German bride.

Mathematics at Harvard 1890-1913

Bôcher immediately experienced the conflict between a desire to continue his research and the overwhelming teaching obligations of a beginning instructor. As with new Ph.D.'s throughout time, this led to another dilemma. Bôcher wanted to stay in touch with his advisor but was embarrassed by having no great results to report. He delayed writing for fear that Klein might attribute the lack of progress to laziness. These emotions are vividly displayed, along with the 1891 Harvard teaching load, in this New Year's letter.

Dear Professor,

I apologize that you have not heard from me. The main reason for my silence is my work. I wanted to have something to write about, and I did not want you to think that I abandoned the research entirely. Since the end of September I have been very busy with my lectures. I have to give lectures 12 hours each week. Half of that time I devote to little foxes [Füchsen] to whom I teach elementary algebra. Of course I do not have to do much preparation for this, therefore I have more time. The students have to write assignments on a daily basis, which I have to correct. In addition I teach a second 3 hour lecture on analytical geometry. Here I discuss primarily the projective geometry of the two dimensional plane, mostly through homogeneous coordinates, etc., but partly through pure geometric methods. This lecture gives me a lot of pleasure although the audience could be better. Finally I lecture for 3 hours on Lamé's functions, the linear development of the potential theory, etc. Here I have two listeners. I would be happy with the numbers, also with the individuals but they do not find the time to work on the project as one of them gives elementary lectures at the Polytechnic in Boston [MIT] and the other has to do much work at the physics laboratory. Therefore it is almost impossible to go into details in this lecture. The penta-spherical coordinates, for example, have to be left out entirely.

Up to the Christmas break I have had practically no time for my own research. But I have managed to improve on some small points...

Over the Christmas holidays I did further research on the Bessel functions. I used the time when I did not have to do work for the university. I did the research in preparation for the definitive formula of those parts to be given for the prize for the composition that dealt with the degenerate cases, etc. I am happier with this formula and hope to send you the printed results of these functions in the spring.

As you can see it is impossible to finish the definitive reduction of the equation of the potential theory during this winter. As far as next summer goes, I would like to visit Goettingen; this is for a number of reasons. I think you agree with me that it is better I stay here at the university and work at my own pace on the research. I will have three months; in that time I can work, without interruptions, and can complete the work if I remain in good health. After that I can come to Göttingen.

The situation is such that one can do little research, in particular in the first few years of employment. You have to believe me that in the last few months I have tried to do as much work as possible [17].

Osgood, a second-year instructor, was in a similar position to Bôcher. Both were earning \$1,250 on one-year contracts. If all went well, they could expect annual renewals to serve as instructors for



three years and then be promoted to an assistant professorship on a five-year term. As Bôcher and Osgood were adjusting to their circumstances at Harvard, a significant development was taking place for mathematics in the United States. Staffing was under way for the opening of the University of Chicago in the fall.

Chicago's president, William Rainey Harper, was working with Rockefeller funding to establish a new university model emphasizing research and graduate education. Still, in 1892, no American math-

E. H. Moore

ematician possessed the credentials to lead such a venture. Harper elected to take a chance on E. H. Moore to be professor and acting head of mathematics. Moore had received his Ph.D. at Yale under Hubert Newton in 1885 [2], [18]. Newton had then lent Moore the money for a year of postdoctoral study in Berlin. Over the following six years Moore had held lower-level positions at Yale and Northwestern while publishing four papers.

Moore's first task was to recruit a junior faculty member to work with him in realizing Harper's ideals. The offer of an associate professorship went to Bôcher as he was approaching the end of his second semester at Harvard. The teaching load was to be ten hours and the salary \$2,500, twice what he was making at Harvard. Bôcher discussed the offer with President Eliot, who made no commitments but indicated that the chances were good for promotion to assistant professor in two years. Bôcher declined the offer from Chicago [19].

Moore subsequently hired Oskar Bolza and Heinrich Maschke, German mathematicians who had studied with Felix Klein. The results were almost magical. Moore immediately blossomed into an important mathematician. He teamed with Bolza and Maschke to give Chicago the first American graduate program offering training comparable to what was available in Europe [2]. Over the next fifteen years Dickson, Veblen, and Birkhoff received their Ph.D.'s, going on to become the next generation of American mathematical leaders.

Progress at Harvard was more gradual but sustained over a longer period. As a preface to these developments, consider the following retrospective analysis given by Bôcher in 1912:

> When Chicago was founded, Osgood and I were just beginning as young instructors, with far slighter mathematical equipments than it is easy to imagine now. I remember, during my first year of teaching, learning what uniform convergence of series means. For several years after that we were the only persons here who in any way represented modern mathematics or research. Many students of mathematics never took our courses at all, and those who did usually gave us only a small share of their time. These conditions changed only very slowly, whereas in Chicago the department was organized from the start on a thoroughly modern scientific basis [20].

Bôcher was hoping to expand his thesis into a book. During the 1892 spring break he got to work in earnest on the project, maintaining his momentum through the remainder of the semester. By the middle of the summer he was able to report substantial progress to Klein. Over the next two years Bôcher obtained deep new results that went beyond his thesis. The book was written in German and published in Leipzig. Klein was sufficiently impressed to provide the preface and to upgrade his Bôcher correspondence salutation from Doctor to Colleague. A byproduct of the publication, as it circulated among European mathematicians, was to demonstrate that strong scholarship existed in the United States.

Advancing through the ranks on schedule, Bôcher and Osgood became assistant professors after three years. They did their part to modernize the Harvard graduate offerings (for details see [5]) but continued to share teaching duties with Byerly and the Peirces. Bôcher's first Ph.D. student, James Glover, came from Michigan in 1892, where he had studied with Cole. The stories of two students who were awarded graduate fellowships in 1894 illustrates the challenges faced by the Harvard mathematics department in establishing its doctoral program. Leonard Dickson rescinded his acceptance when an offer arrived from Chicago. Charles Bouton came to Harvard, obtained his A.M., and then went to Leipzig as a Parker Fellow to study with Sophus Lie. Harvard was attracting notice but was not yet a destination school.

Nevertheless, Bôcher and Osgood were gaining stature in the nascent American mathematical community. In 1896 the AMS decided to experiment with colloquium lectures. Bôcher and James Pierpont were each selected to deliver a series of talks following the summer meeting in Buffalo. The thirteen attendees adjudged the experiment to be a success, and colloquium lectures became part of the program every two or three years. Osgood was chosen for the second offering. Then, as today, designation as a colloquium speaker was regarded as a prestigious mathematical recognition.

One factor in Bôcher's selection must have been that he was a lucid lecturer. The topic he chose for his colloquium series was *Linear differential equations and their applications*. Motivated by the inadequate treatment of existence and uniqueness theorems in contemporary texts, Bôcher gave a comprehensive theoretical development for second-order equations. He began with the case when the coefficients are analytic and then weakened the hypothesis to merely continuous. A careful uniqueness argument accompanied the presentation. With the foundation established he then went into applications and dependence of the solutions on parameters, issues that arose in his own work on potential theory.

Bôcher was a superb analyst with a broad command of mathematics. Quite a bit of his research involved aspects of linear differential equations. Representative of the work was a 1900 paper treating regular singular points in substantial generality. He considered points *a* where the coefficient functions have an isolated discontinuity that satisfies a weaker condition than becoming analytic when multiplied by (x - a) to the appropriate power. For example, Bôcher only required that the coefficient of the linear term in a second-order equation be expressed in the form $\frac{c}{x-a} + p(x)$, where |p| has an improper integral that converges on a neighborhood of a. Without analyticity of p the standard Frobenius Method is not applicable. Bôcher obtained solutions around *a* by using the method of successive approximations to develop a series with terms consisting of a power function times a continuous function.

The regular singular points article appeared in the first issue of the *Transactions of the AMS*. Bôcher was one of several younger AMS members who had provided the impetus for the creation of the *Transactions*. For the emerging American mathematical community the new journal was a source of pride as well as a vehicle for demonstrating its bona fides. Americans submitted their strongest work. The most definitive statement was made by Osgood with a seminal result in the third issue of the initial 1900 volume. He gave the first rigorous proof of the Riemann Mapping Theorem for arbitrary simply connected regions in the plane. In eliminating restrictions on the boundary, an American achieved the crowning position on a provenance that featured some of the greatest mathematicians of the nineteenth century.

Meanwhile, around the turn of the century, the Harvard mathematics department was bolstered by the hiring of Bouton, Julian Coolidge, and Edward Huntington (see [5]). Each was an alumnus who received his Ph.D. in Europe. More and better students were getting their doctorates at Harvard, mostly under Bôcher. Yet the mathematics faculty continued to encourage their best students to go to Europe for thesis work. Unlike at other universities, the traveling fellowships opened study-abroad opportunities to students of all financial means. One side effect of this marvelous resource was that the list of Harvard Ph.D.'s was less impressive than it otherwise would have been. E. R. Hedrick began graduate study in 1897 and then two years later, like Bouton, was awarded a Parker Fellowship. Hedrick studied with David Hilbert for his Ph.D. at Göttingen. He then returned to the United States, where he became a leading figure in the AMS and at UCLA.

That Harvard was closing the gap with Chicago can be seen from their competition in the graduate recruitment of G. D. Birkhoff. Birkhoff had entered Chicago in 1902 as an advanced undergraduate. He quickly came under the influence of E. H. Moore, who recognized a student of considerable potential. Surprisingly, Birkhoff transferred to Harvard in 1903. It is unclear why Birkhoff left Chicago after only sampling its scholarly resources, especially with Moore anxious to supervise him in research. The choice of Harvard is easily understood from the high esteem in which Moore held Bôcher and Osgood, but why did Birkhoff leave Chicago prematurely? Some notion of the reason possibly may be inferred from a summer letter by Moore offering Birkhoff advice on preparing for Cambridge. The first item was "to take much enough exercise this summer to come back to work in perfect trim in the autumn" [21] (emphasis included). After making some mathematical suggestions on a book and problem, Moore closed with the admonishment: "Don't forget no. 1: the rich red blood I want you to have for next year."

In his two years at Harvard, Birkhoff took courses from Bôcher and Osgood while obtaining A.B. and A.M. degrees. Early in 1905 Birkhoff contemplated whether to remain at Harvard or return to Chicago for his Ph.D. Both institutions offered graduate fellowships. Moore advised Birkhoff (and his father) that "except for two considerations" he should come to Chicago, where "we have a more catholic attitude towards mathematics in general



G. D. Birkhoff



Griffith Evans



Dunham Jackson

than they have at Harvard" [22]. One of the exceptions was if he were already engaged in an important research project that could best be prosecuted at Harvard. The second was to receive a guarantee that he would be awarded a traveling fellowship after remaining at Harvard for another year or two. Bôcher, who was also impressed by Birkhoff, tended to be less assertive with students, leaving it to them to choose their own path. Birkhoff decided to return to Chicago and work with Moore for his Ph.D.

Birkhoff had situated himself well. Over the first decade of the twentieth century, Bôcher, Osgood, and Moore were the foremost pure mathematicians in the United States. During this period each was inducted into the National Academy of Sciences and served a two-year term as president of the AMS. The Chicago graduate program peaked about the time of Birkhoff's Ph.D. in 1907. Maschke died the following year, and then Bolza returned to Germany. The homegrown Dickson and Gilbert Bliss were able replacements on the Chicago faculty, but Harvard began to turn out superior students.

The first outstanding mathematician to complete a Harvard Ph.D. was Griffith Evans. Bôcher supervised his 1910 thesis on integral equations. Evans then received a traveling fellowship to do postdoctoral work with Vito Volterra in Rome. Returning to the United States, Evans led the build-up of the mathematics departments at Rice and Berkeley.

Although Evans remained at Harvard for the entirety of his undergraduate and graduate education, other gifted students still took their Ph.D.'s in Europe. Dunham Jackson

entered Harvard one year after Evans. Jackson obtained a Harvard A.M. in 1909 and then went to Göttingen on a traveling fellowship. Bôcher was instrumental in connecting Jackson with Edmund Landau, under whom Jackson wrote an important thesis in approximation theory. Jackson completed his Ph.D. in 1911 and returned to Harvard as an instructor. His position was a new line that came about as a result of curricular changes that increased mathematics enrollments at Harvard. Jackson was not the first choice, but he was one of the three nominations put forward by the department. The others were Max Mason of Wisconsin and G. D. Birkhoff.

Bôcher had had his eye on Birkhoff since he left Harvard for Chicago. The two had maintained a correspondence on various mathematical matters. Their communication continued as Birkhoff held junior-level appointments at Wisconsin and Princeton. As a journal editor Bôcher came to rely on Birkhoff's taste and judgment. Meanwhile Birkhoff's theorems attracted offers from a number of institutions, including Princeton, which had begun its own mathematical ascendance a few vears earlier. At the end of 1910 Harvard offered Birkhoff an assistant professorship at a salary of \$2,500. Princeton countered with a promotion to full professor at \$3,500. The Harvard terms called for two 5-year contracts as an assistant professor, the salary for the second at \$3,000. This was the standard procedure at Harvard, where Bôcher and Osgood had each served as assistant professors for ten years.

Birkhoff attempted to leverage better terms from Harvard through a less than sympathetic Bôcher [23]. Harvard's only concession was a shortening of the first assistant professor term from five to three years, meaning that his Harvard salary in eight years would be \$500 less than what was immediately available at Princeton. After Birkhoff declined, Jackson was then hired to fill the new position at Harvard.

Over the following year Birkhoff came to regret his decision. He wrote Bôcher hinting at a desire for a renewed offer. Bôcher replied that another position might become available but that Birkhoff would have to guarantee his unconditional acceptance in advance of further efforts on his behalf [24]. Birkhoff promised to accept the assistant professorship of the previous offer, with only the modification of reducing the first contract from three years to two. The deal was completed and Birkhoff came to Harvard in 1912.

The addition of Birkhoff was the most significant development for Harvard mathematics since the hiring of Osgood and Bôcher just over two decades earlier. During the intervening period both Harvard and American mathematics had made impressive advances. While the German and French schools were still superior, American scholarship, especially at Harvard, was becoming appreciated in Europe. Both Osgood and Bôcher were invited to deliver plenary addresses to the 1912 International Congress of Mathematicians in England. By the end of 1912 Birkhoff had proved Poincaré's Geometric Theorem, the proof of which appeared in the January 1913 issue of the *Transactions*. According to Richard Courant, Birkhoff's result was the first piece of American mathematics to be admired by the Göttingen community [25].

The French mathematician Émile Borel invited Bôcher to serve as an exchange professor at the University of Paris for 1913–14. Osgood was recognized throughout Europe. His 1897 work on term-by-term integration for series of continuous functions was influential in Henri Lebesgue's development of integration theory [26]. Osgood's book *Funktionentheorie* was the leading primer on the subject both at home and abroad. In 1913 the Norwegian algebraist Ludwig Sylow expressed his high regard for the work of two Americans, Osgood and Leonard Dickson [27].

Birkhoff exerted an immediate impact on the Harvard graduate program. Marston Morse entered Harvard in 1914 and wrote his doctoral dissertation under Birkhoff. Birkhoff's presence was especially timely as Bôcher's health began to fail. The passing of the baton symbolically occurred through Joseph Walsh, who began his thesis with Bôcher and after his death in 1918 finished with Birkhoff. Over his first fifteen years at Harvard, Birkhoff supervised twenty-six Ph.D.'s, including that of Marshall Stone. During this period Birkhoff became regarded as the leading mathematician in the United States. Osgood, who was never active in thesis direction, remained an important presence at Harvard. Unfortunately his distinguished career was marred by a personal matter late in life. Osgood was ostracized by his colleagues and forced to retire in 1933 as a result of his relationship with the former wife of Marston Morse [28] and [29]. Morse had joined the department in 1926.

The 1913 Harvard mathematics faculty with Bôcher, Osgood, Birkhoff, and Jackson was the strongest that had ever been assembled in the United States. While the lopsided concentration in analysis has been noted, its effects were mitigated by several factors. Both Bôcher and Birkhoff were especially broad in their knowledge of mathematics. Moreover, Coolidge and Huntington added coverage to other areas. Finally, at a time when as many as four research mathematicians could be found on only a few university faculties, mathematical diversity was a different consideration than in more modern times.

A remarkable transformation occurred in the Harvard mathematics department from 1890 to 1913. Together, Bôcher and Osgood successfully installed research as the primary mission. Jackson would leave for Minnesota in 1919, but Birkhoff was firmly entrenched as the department's anchor. Harvard was on course to be a world mathematical power of the twentieth century.

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Invariant Theory of Tensor Product Decompositions of U(N) and Generalized Casimir Operators

William H. Klink and Tuong Ton-That

hat symmetries, invariance, and conservation laws are related has long been known. For example, Einstein exploited the relationship between the symmetry of Newton's equations and the (relativistic) symmetry of Maxwell's equations to develop a relativistic classical mechanics. But it is with quantum physics that the full power of symmetry, as expressed in the invariance of quantities under group operations, comes to the fore. This is particularly clear in the connection between the representation spaces of groups and the Hilbert spaces used in guantum mechanics on which the representations act. The first group symmetries of importance in quantum mechanics were those related to space-time symmetries; later, internal symmetries were introduced, and finally these symmetries were generalized to gauge symmetries. One of the main points of this paper is to show how the unitary groups have played a key role in all these different applications to quantum physics.

Historically one of the first applications of the unitary groups to quantum physics was with the group SU(2). Rotations in physical three-space can be generated from elements of SU(2) via the Cayley-Klein transformations. In particular the fundamental two-dimensional representation of SU(2) leads to a description of spin 1/2 objects such as electrons and protons. The Lie algebra of SU(2) leads to the angular momentum commutation relations, and shows that both orbital and spin

angular momentum is necessarily quantized, in contrast to classical mechanics. Further, when the theory of quantized angular momentum is applied to many-body systems, for example the many electrons in an atom, or the many nucleons (= protons and neutrons) in a nucleus, the relevant spin spaces are tensor products of irreducible representation spaces. If the Hamiltonian, the operator governing the time evolution of the many-body quantum system, commutes with the angular momentum operators (or, is invariant under SU(2)), the overall angular momentum of the system is conserved; it is then useful to choose a basis in the many-body representation space which is diagonal in the overall angular momentum. Basis dependent coefficients (called Clebsch-Gordan, or vector coupling, or Wigner coefficients), which transform between a tensor product basis and a direct sum basis, play a key role in the structure of many-body spin quantum systems; see for example reference [1].

One of the important ingredients in the analysis of spin in quantum systems concerns the notion of multiplicity, wherein an irreducible representation (irrep) occurs more than once in the decomposition of tensor products of single particle systems. SU(2) is unusual among the U(N) groups in that in the two-fold tensor product decomposition an irrep appears at most once. For *n*-fold tensor products, with $n \ge 3$ multiplicity does appear, and a fundamental issue is how to deal with the repeated appearance of the same irrep. For SU(2)this issue is dealt with by intermediate coupling labels; thus, if system 1 is coupled (tensored) to system 2, 1-2 to 3 and so forth, the multiplicity can be fixed by the value of the intermediate (1-2) value of the angular momentum. Such a solution only works when there is no multiplicity for two-fold

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products. One of the goals of this paper is to show that eigenvalues of generalized Casimir operators can be used to resolve the multiplicity problem, for arbitrary tensor products.

Though the multiplicity problem can be dealt with in a systematic fashion for SU(2) by stepwise coupling, it is clear that there are many different stepwise schemes. For three-fold tensor products electron 1 could be coupled first to electron 3 and then 1-3 coupled to 2. The multiplicity is then resolved by the 1-3 angular momentum rather than the 1-2 angular momentum. Coefficients that transform between different coupling schemes are called Racah (or recoupling or 3j, 6j...) coefficients and also play an important role in the quantum theory of angular momentum for manybody systems. Of particular importance is that Racah coefficients are basis independent; there are tables and computer programs for calculating these coefficients, which are usually obtained by summing over Clebsch-Gordan coefficients [1]. We will show how to compute such coefficients for the general U(N) groups using a procedure not tied to knowledge of the basis dependent Clebsch-Gordan coefficients.

All of the structural features that have been discussed with respect to the group SU(2) generalize to the other unitary groups. Our goal has been to find ways to compute the various coefficients that arise for general representations of the unitary groups, and in particular to generate computer programs that implement these operations. As is discussed in the following paragraphs, the U(N) groups and their representations play an important role in various subfields of physics, going well beyond angular momentum and SU(2).

The first application of the unitary groups not related to angular momentum occurred in the early 1930s when Heisenberg applied the known structure of SU(2) to the strong nuclear force. Early in the development of nuclear physics it was realized that the proton and (at the time the newly discovered) neutron behaved similarly with respect to the strong nuclear force. Where they differed was with respect to the electromagnetic force. For example, the neutron is uncharged whereas the proton is charged. Ignoring the weaker electromagnetic force and focusing on the strong nuclear force, Heisenberg introduced a two-dimensional complex space, the spin 1/2 space consisting of two basis elements, the proton and neutron. In this case the symmetry is called isospin (or isotopic spin) and has nothing to do with spin angular momentum discussed in previous paragraphs. Only the group is the same, namely SU(2); physical three-space is replaced by an "internal symmetry" space. Thus, to the extent it is possible to isolate the strong nuclear force from the other forces of nature, all strongly interacting particles fit into irreducible

representations of isospin SU(2). Well-known examples are the three pi mesons, π^+ , π^0 , π^- which all have spin 0 (the superscripts refer to the charge) and four Δ resonances, all of spin 3/2, which sit in the four-dimensional representation of isospin SU(2).

Once it is realized that the strong nuclear force is to a very good approximation invariant under isospin SU(2), it is possible to use the known machinery from spin SU(2) to analyze multiparticle nuclear systems. Nuclei are bound states of nucleons, and they carry an isospin quantum number; for example the alpha particle, the nucleus of the helium atom, consists of two protons and two neutrons and has isospin zero. When solving bound state problems the invariance of the nuclear Hamiltonian under isospin is exploited in calculating the bound state energies and wavefunctions. Moreover, since nucleons also interact electromagnetically, isospin invariance is broken. But it is broken in a systematic fashion, so that the electromagnetic part of the Hamiltonian may transform as a component of a tensor operator under isospin transformations. In such a situation matrix elements of physical interest are related to Clebsch-Gordan coefficients.

Wigner was one of the first to make use of higher dimensional unitary groups. In the so-called supermultiplet theory [2], spin SU(2) is embedded with isospin SU(2) into a larger SU(4) group. Bases for representation spaces are now indexed by isospin times spin multiplets and the strong nuclear Hamiltonian is supposed to have well-defined transformation properties under the larger group action. While such a supermultiplet model has not been particularly useful, as discussed in the following paragraphs, its generalization to particle physics has been quite successful.

The origins of such a generalization go back to the 1960s when a symmetry now called flavor SU(3) was introduced. In interactions involving pi mesons colliding with protons, new (or so-called strange) particles were observed, and to account for their production and decay properties, a new quantum number, called variously strangeness or hypercharge, was introduced. Combining the known isospin invariance with strangeness necessitated analyzing rank two compact groups. After investigating the representation structure of various rank two compact groups, it was seen that the group SU(3) was best able to accommodate the newly discovered strange particles. The two most important representations turned out to be the eight- and ten-dimensional representations. Actually the group of interest is U(3), but the U(1)subgroup, corresponding to the exact conservation of baryon number, is factored off. Then, for baryon number one, the eight-dimensional representation contains the proton and neutron, and six other newly discovered strange particles. For baryon

number zero the eight-dimensional multiplet is a meson multiplet which includes the three previously known pi mesons, along with five other strange mesons, including the four K mesons. The ten-dimensional representation for baryon number one contains the four Δ particles, along with six other strange particles. In fact at the time the flavor SU(3) model was being developed, the last particle in the ten-dimensional representation had not been discovered experimentally. Gell-Mann used tensor transformation properties of the mass operator under SU(3) transformations to predict the mass and other properties of the unknown particle. The discovery of the Ω^- was part of the reason the Nobel Prize was awarded to Gell-Mann in 1969.

A further development of flavor SU(3) deals with scattering, which in turn deals with tensor products of, in particular, the eight-dimensional representation with itself. It is well-known that the decomposition of two eight-dimensional representations involves multiplicity, in which the eight-dimensional representation occurs twice in the decomposition. The way in which the multiplicity was broken in the original applications was to make use of the fact that there is an underlying permutation symmetry on two numbers, the representations of which are either symmetric or antisymmetric.

In the 1960s when the flavor SU(3) model was being developed, it was known that unlike the electron, which seems to be a fundamental particle, not made out of more fundamental particles, the same was not the case for the proton and neutron. The reason for believing that the nucleons were not fundamental came from a variety of experiments, including the anomalous magnetic moments of the proton and neutron, the existence of excited states of the proton and neutron, and electron scattering experiments on the proton. A way to account for the nonfundamental character of the nucleons (and their associated strange counterparts) was to postulate the existence of guarks, entities that transformed under the threedimensional (fundamental) representation of flavor SU(3) (and correspondingly, antiquarks transforming under the complex conjugate representation, inequivalent to the fundamental representation). The three-fold tensor product of the fundamental representation with itself gave the eight- (with multiplicity 2) and ten-dimensional representations, along with a one-dimensional representation. That is, the physically observed particles occupying the eight- and ten-dimensional representations were thought to be "made out of" the fundamental (quark) representations [3]. Similarly the mesons in the eight-dimensional representation, with baryon number zero, were thought of as a two-fold tensor product of the fundamental with the conjugate representation. Or put differently, mesons were

thought to be bound states of quark-antiquark pairs.

The flavor SU(3) model was developed in a number of different ways, but for the purposes of this survey, it suffices to note that the Wigner supermultiplet theory was generalized to a supermultiplet SU(6) model, in which spin SU(2)times flavor SU(3) is embedded in SU(6) [4]. The main point to note is that while the particles in the various SU(3) representations do not all have the same mass (which would be the case if flavor SU(3) were an exact symmetry) the spin (and parity) of all the particles in a flavor irrep are the same. Therefore it makes sense to combine spin and flavor into a larger group. The irreps of SU(6) are used to select out those multiplets with the correct spin-flavor structure. In particular the fifty-six-dimensional representation of SU(6)contains the eight-dimensional representation of nucleons (since the spin is 1/2, this gives sixteen dimensions) along with the ten-dimensional resonances (the spins of which are 3/2, so that 4x10 =40), for a total of fifty-six dimensions. A number of physicists continue to develop the SU(6) model, in conjunction with a nonrelativistic or relativistic quantum mechanics which incorporates the spatial parts of the quark wavefunctions.

To conclude this brief overview of applications of the U(N) groups to quantum physics, we consider their use in quantum field theory. The starting point is fields defined over Minkowski space, which can be thought of as the manifold $\mathcal{P}/SO(1,3)$, the Poincaré group modulo the Lorentz group. Along with transformations under the Poincaré group, the fields also carry indices which transform under compact internal symmetry groups. Gauge groups are map groups from Minkowski space to the internal symmetry group, and interactions are generated from the requirement that the field theory be invariant under gauge transformations. The two most important internal symmetry groups in this context are color SU(3), which generates the quantum field theory for the strong nuclear force (the quantum field theory so generated is called quantum-chromodynamics, QCD) and SU(2)x U(1), the internal symmetry group for the electroweak interactions; see for example reference [5]. It is interesting to note that flavor SU(3) also appears as an internal symmetry in QCD, however not as a gauge symmetry. Finally it should be pointed out that attempts have been made to unify the strong and electroweak interactions, using among other possibilities the group SU(5).

After this brief introduction to applications of the U(N) groups in quantum physics, we can state mathematically the problems we wish to investigate. Let G denote the unitary group U(N) and $V^{(m)}$ a unitary irreducible G-module of signature (m). Form the r-fold tensor product $V^{(m)_1} \otimes ... \otimes V^{(m)_r}$ and give an explicit decomposition of this tensor

product G-module. This involves the following steps:

1. Give concrete realizations of $V^{(m)}$ and $V^{(m)_1} \otimes \dots \otimes V^{(m)_r}$ as subspaces of a common Hilbert space on which G acts unitarily.

2. Give a computationally effective formula to calculate the multiplicity $\mu(M) = \mu((M); (m)_1 \otimes ... \otimes (m)_r)$ of the equivalence class of irreps of signature (M) in the orthogonal direct sum decomposition of the tensor product representation.

3. Construct intertwining operators that map the G-modules $V^{(M)}$ into the G-module $V^{(m)_1} \otimes ... \otimes V^{(m)_r}$ for all (M) that occur in the orthogonal direct sum decomposition of the tensor product G-module. Most importantly, realize the steps above in the most general and "canonical" way; that is the method should work for all signatures (m), all ranks N, and arbitrary r-fold tensor products.

Here it should be noted that the analysis of tensor product decompositions of compact groups, especially the U(N) groups, has a long history, and a number of different methods have been deployed to deal with the problem; expressions for multiplicities in two-fold tensor products and Clebsch-Gordan and Racah coefficients of U(N) are investigated in great detail in reference [6] and references cited therein.

U(N) Representation Theory

Let $C^{n\times N}$ denote the vector space of all $n \times N$ complex matrices. If $Z = (Z_{ij})$ is an element of $C^{n\times N}$, let Z^* denote its complex conjugate and write $Z_{ij} = X_{ij} + \sqrt{-1} Y_{ij}$; $1 \le i \le n$, $1 \le j \le N$. If dX_{ij} (resp. dY_{ij}) denotes Lebesgue measure on \mathcal{R} , we let dZ denote the Lebesgue product measure on \mathcal{R}^{2nN} . Define a Gaussian measure $d\mu$ on $C^{n\times N}$ by

(1)
$$d\mu(Z) = \pi^{-nN} \exp[-tr(ZZ^{\dagger})]dZ,$$

where *tr* denote the trace of a matrix and Z^{\dagger} is the transpose of Z^* . A function $f : C^{n \times N} \to C$ is holomorphic square

A function $f : C^{n \times N} \to C$ is holomorphic square integrable if it is holomorphic on the entire domain $C^{n \times N}$, and if

(2)
$$\int_{C^{n\times N}} |f(Z)|^2 d\mu(Z) < \infty.$$

Clearly the holomorphic square-integrable functions form a Hilbert space, the Bargmann-Segal-Fock space, with respect to the inner product

(3)
$$\langle f_1|f_2\rangle = \int_{C^{n\times N}} \overline{f_1(Z)} f_2(Z) d\mu(Z).$$

Let $\mathcal{F} \equiv \mathcal{F}(C^{n \times N})$ denote this Hilbert space. From [7] this inner product also can be defined by the following formula:

(4)
$$\langle f_1 | f_2 \rangle = f_1^*(D) f_2(Z) |_{Z=0}.$$

Thus if $f \in \mathcal{F}(C^{n \times N})$, then $f(Z) = \sum_{|(\alpha)|=0}^{\infty} C_{(\alpha)} Z^{(\alpha)}$, where $(\alpha) = (\alpha_{11}, \dots, \alpha_{nN})$, is an $n \times N$ -tuple of integers ≥ 0 , $|(\alpha)| = \alpha_{11} + \dots + \alpha_{nN}$, $C_{(\alpha)} \in C$, and $Z^{(\alpha)} = Z_{11}^{\alpha_{11}} \dots Z_{nN}^{\alpha_{nN}}$. Moreover, $C_{(\alpha)}$ must satisfy $\sum_{|(\alpha)|=0}^{\infty} (\alpha)! |C_{(\alpha)}|^2 < \infty, \text{ where } (\alpha)! = \alpha_{11}! \dots \alpha_{nN}!.$ For $f \in \mathcal{F}(C^{n \times N})$ define f^* by

(5)
$$f^*(Z) = \sum_{|(\alpha)|=0}^{\infty} C^*_{(\alpha)} Z^{(\alpha)}.$$

Then $f^*(D)$ is the differential operator obtained by formally replacing $Z_{\gamma j}$ by the partial derivative $\partial/\partial z_{\gamma j}$ $(1 \le \gamma \le n, 1 \le j \le N)$. If $f \in \mathcal{F}(C^{n \times N})$, then obviously $(f^*)^* = f$ and $f^* \in \mathcal{F}(C^{n \times N})$. Moreover, for all $f_1, f_2 \in \mathcal{F}(C^{n \times N})$

(6)
$$< f_1^*, f_2^* > = f_1(D)f_2^*(Z)|_{Z=0}$$

 $= \sum_{|(\alpha)|=0}^{\infty} (\alpha)!C_{(\alpha)}^1\overline{C}_{(\alpha)}^2$
 $= <\overline{f_1, f_2} > = < f_2, f_1 > .$

Therefore, $||f^*|| = ||f||$ for all $f \in \mathcal{F}(C^{n \times N})$. If $\mathcal{P}(C^{n \times N})$ denotes the subspace of $\mathcal{F}(C^{n \times N})$ of all polynomial functions in *Z*, then $\mathcal{P}(C^{n \times N})$ is dense in $\mathcal{F}(C^{n \times N})$. It is straightforward to show that the representation *R* of U(N) on \mathcal{F} defined by

(7)
$$(R(g)f)(Z) = f(Zg), g \in U(N)$$

is unitary.

Irreducible representations of GL(N, C) are realized on subspaces of \mathcal{F} defined by (8)

$$V^{(M)} := \{ f \in \mathcal{F}(C^{n \times N}) , f(bZ) = \pi^{(M)}(b)f(Z) \}$$

where $b \in B_n$, the subgroup of GL(n, C) of lower triangular matrices, and $\pi^{(M)}(b) \in C$ is a representation of B_n defined by

(9)
$$\pi^{(M)}(b) := d_1^{(M_1)} \cdots d_n^{M_n}$$

where $\begin{pmatrix} d_1 \\ \dots \\ d_n \end{pmatrix}$ is an element of the diagonal subgroup of B_n and (M) is an n-tuple of integers, M_1, \dots, M_n satisfying the dominant condition, $M_1 \ge \dots \ge M_n$, $n \le N$. We restrict ourselves to the case when the integers are nonnegative. In general $V^{(M)}$ can be realized as a subspace of \mathcal{F} with an additional condition ([8]). Then the Borel-Weil theorem implies that the representation of GL(N, C) obtained by right translation on $V^{(M)}$ is irreducible with signature (highest weight) (M). It follows from Weyl's "unitarian trick" that the restriction to U(N) remains irreducible.

Irreducible representations of GL(N, C) can also be realized on $\mathcal{F}(C^{N\times N})$ as follows: Let $W^{(M)} := \{ \phi \in \mathcal{F}(C^{N\times N}) | \phi(wb^T) = \pi^{(M)}(b)\phi(w) \}$, where $b \in B_N$ and $w \in C^{N\times N}$, and define the representation *L* of GL(N, C) on $W^{(M)}$ by $(L(g)\phi)(w) = \phi(g^Tw)$. Then the map $\Phi : W^{(M)} \to V^{(M)}$ defined by $(\Phi\phi)(Z) := \phi(Z^T)$ is a GL(N, C) module isomorphism. Hence the U(N)-modules $V^{(M)}$ and $W^{(M)}$ are unitarily equivalent and have the same highest weight vector. In reference [9], Theorem 3, section 5.6, Zelobenko gives an orthogonal direct sum decomposition of $\mathcal{F}(C^{n\times N})$ into irreducible $GL(n, C) \times GL(N, C)$ -modules of signature (M, M), where $(M) = (M_1, ..., M_k, 0, ..., 0), k = min(n, N)$. The *r*-fold tensor products of irreps of U(N) are also subspaces of an appropriate \mathcal{F} ; define

(10)
$$\mathcal{H}^{(m)} = V^{(m_1)} \otimes \cdots \otimes V^{(m_r)},$$

the subspace of $\mathcal{F}(C^{p \times N})$, as

$$\mathcal{H}^{(m)} = \{ f \in \mathcal{F}(C^{p \times N}) |$$

(11)
$$f(\beta Z) = \pi^{(m)}(\beta) f(Z)$$
$$= \pi^{(m_1)}(b_1) \cdots \pi^{(m_r)}(b_r) f(Z) \},$$

where $p = \sum_{i=1}^{r} p_i$ and β is an element of the product Borel group,

(12)
$$\beta = \begin{pmatrix} b_1 & 0 \\ \ddots \\ 0 & b_n \end{pmatrix}$$

with $b_i \in B_i$, the $p_i \times p_i$ lower triangular matrix. It follows that the outer product group $U(N) \times \cdots \times U(N)$, consisting of elements (g_1, \ldots, g_r) , $g_i \in U(N)$ is irreducible on $\mathcal{H}^{(m)}$, with irrep

(13)
$$(R_{(g_1...g_r)}f)\begin{pmatrix} Z_1\\ \vdots\\ Z_r \end{pmatrix} = f\begin{pmatrix} Z_1g_1\\ \vdots\\ Z_rg_r \end{pmatrix}, \quad f \in \mathcal{H}^{(m)}$$

 $(m) := (m_{11} \dots m_{1p_1}, m_{21} \dots m_{2p_2}, \dots, m_{rp_r})$, that is, all the zeros in (m_i) have been deleted.

If the elements of $U(N) \times \cdots \times U(N)$ are restricted to the diagonal subgroup of all elements $(g, g, \ldots, g), (g \in U(N))$ which is identified with U(N), the representation $R_{(g,g,\ldots,g)}$ of U(N) on $\mathcal{H}^{(m)}$ becomes reducible and decomposes into a direct sum of irreducible representations of U(N), with multiplicity $\mu(M)$:

(14)
$$\mathcal{H}^{(m)} = \sum_{(M)} \oplus \mu(M) V^{(M)}.$$

Rather than decomposing $\mathcal{H}^{(m)}$ directly, the strategy will be to adjoin the contragredient representation of (M), denoted by $(M)^{\vee}$ to $\mathcal{H}^{(m)}$ and find the invariant subspace of $\mathcal{H}^{(m)} \otimes V^{(M)^{\vee}}$, that is, the space of identity representations of U(N). This is possible since the multiplicity $\mu(M)$ is equal to the dimension of the U(N)-invariant subspace of $\mathcal{H}^{(m)} \otimes V^{(M)^{\vee}}$. (See [10].) References [11] and [14] show that the contragredient representation—defined with respect to linear functionals of the representation space $V^{(M)}$ —can be written in the following way; consider the irrep space defined in Eq.(8) and set

(15)
$$(R^{\vee}(g)f)(Z) = f(Zg^{\vee}),$$

 $f \in V^{(M)}, g \in GL(N, C), g^{\vee} := (g^{-1})^{T}.$

Then $R^{\sqrt{g}}$ is equivalent to the contragredient representation.

Now let
$$\underbrace{GL(N,C) \times \cdots \times GL(N,C)}_{r} \times GL(N,C)$$

act on $\mathcal{H}^{(m)}\otimes V^{(M)^{\checkmark}}$ via the outer tensor product.

If the signature (*M*) is $(M_1, \dots, M_q, 0, \dots, 0)$, set

$$n = p + q, Z = \begin{bmatrix} Z_1 \\ \vdots \\ Z_r \end{bmatrix} \in C^{p \times N}$$

and $W \in C^{q \times N}$, then the inner (or Kronecker) tensor product representation of GL(N, C) on $\mathcal{H}^{(m)} \otimes V^{(M)^{\vee}}$ can be defined as

(16)
$$\begin{bmatrix} R^{(m)} \otimes R^{(M)^{\vee}}(g)f \end{bmatrix} \begin{pmatrix} \begin{bmatrix} Z \\ W \end{bmatrix} = f \begin{pmatrix} \begin{bmatrix} Zg \\ Wg^{\vee} \end{bmatrix} \end{pmatrix}$$

for all $f \in \mathcal{H}^{(m)} \otimes V^{(M)^{\vee}} \subset \mathcal{F}(C^{n \times N})$ and $g \in GL(N, C)$. Then the restriction of $R^{(m) \otimes (M)^{\vee}}$ to U(N) is unitary.

In general, GL(N, C) acts on $\mathcal{P}(C^{n \times N}) \subset \mathcal{F}(C^{n \times N})$ via the representation

(17)

$$\begin{bmatrix} R(g)f \end{bmatrix} \begin{pmatrix} \begin{bmatrix} Z \\ W \end{bmatrix} \end{pmatrix} = f \begin{pmatrix} \begin{bmatrix} Zg \\ Wg^{\vee} \end{bmatrix} \end{pmatrix}, \quad \forall f \in \mathcal{P}(C^{n \times N}).$$

Then it follows from [12] that the ring of all polynomials in $\begin{bmatrix} Z \\ W \end{bmatrix}$ that are invariant under this action is generated by the constants and the pq algebraically independent polynomials $P_{a\alpha}$ defined by

(18)
$$P_{a\alpha}\left(\begin{bmatrix} Z\\ W\end{bmatrix}\right) = (ZW^T)_{a\alpha} = \sum_{i=1}^N Z_{ai}W_{\alpha i}, 1 \le a \le p, 1 \le \alpha \le q.$$

Set $X_{a\alpha} = P_{a\alpha}\left(\begin{bmatrix} Z \\ W \end{bmatrix}\right)$ and let *X* denote the $p \times q$ matrix with entries $X_{a\alpha}$. If \mathcal{J} denotes the ring of all GL(N, C)-invariants, it follows that an element of \mathcal{J} is a polynomial in the variable *X*, i.e., $f \in \mathcal{J}$ if and only if

(19)
$$f\left(\begin{bmatrix} Z\\ W\end{bmatrix}\right) = \phi_f(X), \quad X = ZW^T$$

for some polynomial $\phi_f \in \mathcal{P}(C^{p \times q})$. Note that by construction $q \leq \min(p, N)$ ([13]), and by abuse of language if $(M) = \underbrace{(M_1, \dots, M_q, 0, \dots, 0)}_{p}$ let $(M)_p$

(or simply (*M*) if there is no possible confusion) denote the signature of the equivalent class of irreducible representations of GL(p, C) with highest weight $(M_1, \ldots, M_q, 0 \ldots, 0)$. Let **W**^{(*M*)_{*p*} denote the</sup>}

vector space of all polynomial functions ϕ in *X* which also satisfy the covariant condition

0)
$$\phi(Xb^T) = \pi^{(M)}(b)\phi(X), \quad \forall b \in B_q.$$

(2

Define the representation $L^{(M)_p}$ of GL(p, C) on $\mathcal{P}(C^{p \times q})$ by the equation

(21)
$$L^{(M)_p}(\gamma)\phi(X) = \phi(\gamma^T X), \quad \gamma \in GL(p, C).$$

Then the Borel-Weil theorem together with Weyl's "unitarian trick" imply that the representation $L^{(M)_p}$ is irreducible with signature $(M)_p$ and its restriction to U(p) is an irreducible unitary representation of the same signature. The proof of the following theorem can be found in [14]:

Theorem 1. If $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ denotes the subspace of all GL(N, C)-invariant polynomials in $\mathcal{H}^{(m)\otimes(M)^{\checkmark}}$, then every element f in $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ can be uniquely identified with an element ϕ_f in $W^{(M)p}$ which also satisfies the covariant condition.

$$L^{(M)_p}(\beta^T)\phi_f = \pi^{(m)}(\beta)\phi_f,$$

where β and $\pi^{(m)}(\beta)$ are defined by Eqs.(11) and (12). In other words the ϕ_f 's constitute the subspace $(W^{(M)p};\pi^{(m)})$ of $W^{(M)p}$ of all highest weight vectors of the restriction

$$L^{(M)p}|GL(p_1,C)\times\cdots\times GL(p_r,C).$$

Corollary 1. Let G = U(N) and let $(R^{(M)}, \mathbf{V}^{(M)})$ denote the irreducible unitary G-module with signature $(M) = (M_1, ..., M_q, 0, ..., 0)$. Then the multi-

plicity of $R^{(M)}$ in $\mathcal{H}^{(m)}$ is equal to the dimension of the subspace $(W^{(M)p}; \pi^{(m)})$ defined in the Theorem.

Remark 1. *The conditions in Eq.(21) can be broken* into two parts: if β is unipotent, then $L^{(M)p}(\beta^T)\phi_f =$ ϕ_f , and if β is a diagonal matrix $\begin{pmatrix} d_1 & d_p \end{pmatrix}$, then $L^{(M)_p}(d)\phi_f = d_1^{m_1,p_1}\dots d_p^{m_r,p_r}\phi_f$. This means that ϕ_f are weight vectors of $(\mathbf{W}^{(M)\mathbf{p}})$. Now the Gelfand-*Cetlin tableaux provide a set of labels that can be* used to get the dimension of the subspace of $(\mathbf{W}^{(M)_p})$ with a definite weight. It follows that a bound on the dimension of $(W^{(M)p}; \pi^{(m)})$ is given by the number of Gelfand-Cetlin tableaux associated with irreducible representations of GL(p, C) of signature $(M)_{\nu}$ and with weight (m). A special case occurs when $\mathcal{H}^{(m)}$ is an r-fold tensor product of "symmetric" representations (a representation of GL(N, C) is called symmetric if its signature is of the form $(m, 0, \ldots, 0)$,

so-called because it is the space of symmetric tensors that occur in the m-fold tensor product of the vector representation (1, 0, ..., 0) in the Schur-Weyl

duality theorem, see ([12], Th. 4AD)). In this special case r = p and the elements β are reduced to the diagonal elements d. Thus we have also proven the following:

Corollary 2. If $\mathcal{H}^{(m)}$ is a p-fold tensor product of symmetric representations of GL(N, C), then $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ admits an orthogonal basis $\{f_{\mathcal{E}}\}$ where $f_{\mathcal{E}}$ corresponds to a Gelfand-Cetlin basis element φ_{ξ}

of $\mathcal{P}(C^{p \times q})$, and ξ ranges over all Gelfand-Cetlin tableaux of $(M)_p$ with weight (m), i.e.,

$$f_{\xi}\left(\begin{bmatrix} Z\\ W\end{bmatrix}\right) = \varphi_{\xi}(ZW^T)$$

To explicitly construct a basis of $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ we construct a basis of $(\mathbf{W}^{(M)_p}; \pi^{(m)})$. For this let $\{L_{\alpha\gamma}\}$ denote the basis of the infinitesimal operators of the left representation of GL(p,C) on $\mathcal{F}(C^{p\times q})$ given by $(L(h)f)(X) = f(h^T X)$. Then

(22)
$$L_{\alpha \gamma} = \sum_{i=1}^{q} X_{\alpha i} \frac{\partial}{\partial X_{\gamma i}}, \quad 1 \leq \alpha, \gamma \leq p$$

and the $L_{\alpha\gamma}$ generate a Lie algebra isomorphic to $Gl_p(C)$. Moreover $L_{\alpha\gamma}^{\dagger} = L_{\gamma\alpha}$, and the $L_{\alpha\gamma}$ with $\alpha < \infty$ γ are raising operators while the $L_{\alpha\gamma}$ with $\alpha > \gamma$ are lowering operators.

If ϕ is a weight vector of $(\mathbf{W}^{(M)_p})$ of weight (m)then (23)

$$L(d)\phi(X) = \phi(dX) = d_{11}^{m_1} \dots d_{pp}^{m_p}\phi(X) , \forall d \in D_p.$$

It follows that

It follows that

(24)
$$L(d)(L_{\alpha\beta}\phi) = d_{11}^{m_1} \dots d_{\alpha\alpha}^{m_{\alpha}+1} \dots d_{\beta\beta}^{m_{\beta}-1}\phi,$$

that is, $L_{\alpha\beta}\varphi$ is also a weight vector of weight $(m_1,\ldots,m_{\alpha}+1,\ldots,m_{\beta}-1,\ldots,m_p)$ if $\alpha < \beta$ and $(m_1,\ldots,m_\beta-1,\ldots,m_\alpha+1,\ldots,m_p)$ if $\alpha > \beta$. And in our ordering of the weights this justifies the claim that $L_{\alpha\beta}$ is a lowering operator if $\alpha > \beta$ and is a raising operator if $\alpha < \beta$. Among these infinitesimal operators we have the particular operators $L_{\alpha_{\nu}\beta_{\nu}}$, where $p = p_1, \ldots, p_r$, which correspond to the infinitesimal operators of the $GL(p_i, C)$ subgroup actions, $1 \le i \le r$. Thus the condition $L^{(M)_p}(\beta^T)\phi = \phi$, $\phi \in V^{(M)_p}, \beta$ unipotent, is equivalent to the condition

$$25) \quad L_{\alpha_p\beta_p}\phi=0, \quad \forall \, \alpha_p < \beta_p, \quad p=p_1,\ldots,p_r.$$

By exploiting the weight changing properties of the $L_{\alpha\beta}$ we construct a set of operators $\{\tilde{\Phi}_{\nu}\}$, where ν ranges from 1 to the number of Gelfand-Cetlin tableaux associated with $(M)_p$ of weight (m). Each operator $\widetilde{\Phi}_{\nu}$ is a product of lowering operators $L_{\alpha\beta}$, $\alpha < \beta$. By applying $\widetilde{\Phi}_{\nu}$ to the highest weight vector $\phi_{\max}^{(M)_p}$ in $\mathbf{W}^{(M)_p}$, where

(26)
$$\phi_{\max}^{(M)}(X) = \Delta_1(X)^{M_1 - M_2} \cdots \Delta_q^{M_q}(X)$$

we send $\phi_{\max}^{(M)}$ into

(27)
$$\mathcal{P}(C^{p \times q})^{(m)} = \{ f \in P(C^{p \times q} : f(dX) \\ = \pi^{(m)}(d)f(X), \quad \forall d \in D_p \}.$$

The systematic procedure for doing this, which can be implemented on a computer, makes use of the Gelfand-Cetlin tableaux for irreps $(M)_n$ and weight (m) of U(p) (see [14] for details.)

We thus have constructed a linearly independent subspace of $\mathcal{P}(C^{p \times q})$. In order that elements of this subspace belong to $(\mathbf{W}^{(m)}; \pi^{(m)})$, it must also satisfy the condition given in Eq.(27). This gives a set of basis elements of $(\mathbf{W}^{(m)}; \pi^{(m)})$ as well as the multiplicity $\mu(M)$. And this also gives us a basis for $\mathcal{J}^{(m)\otimes(M)^{\checkmark}}$. The problem of constructing an orthogonal basis for $\mathcal{J}^{(m)\otimes(M)^{\checkmark}}$ is considered in the next section.

Orthogonal Bases in $\mathcal{J}^{(m)\otimes(M)^{\vee}}$

In the previous section we have shown that the space of invariants $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ corresponds to the subspace $(\mathbf{W}^{(M)_p}; \pi^{(m)})$ of the irreducible U(p)-module $W^{(M)_p}$. We also showed how to construct a (nonorthogonal) basis of $(\mathbf{W}^{(M)_p}; \pi^{(m)})$, and hence of $\mathcal{J}^{(m)\otimes(M)^{\vee}}$, by exploiting properties of the Gelfand-Cetlin tableaux associated with the weight (m). The goal of this section is to generate orthogonal bases for $(\mathbf{W}^{(M)_p}; \pi^{(m)})$, or equivalently for $\mathcal{J}^{(m)\otimes(M)^{\vee}}$ by introducing generalized Casimir operators whose eigenvalues can be used as labels of orthogonal basis vectors.

First, we make the following observation. According to our theory of dual representations (see [7], [15]), the spectral decompositions of the pairs (U(p), U(q)) on $\mathcal{F}(C^{p \times q})$ and (U(p), U(N)) on $\mathcal{F}(C^{p \times N})$ are identical if $p \ge N$; for p < N there is a one-to-one correspondence between the isotypic components with signature (M_1, \ldots, M_p) in $\mathcal{F}(C^{p \times p})$ and those with signature $(M_1, \ldots, M_p, 0, \ldots, 0)$ in $\mathcal{F}(C^{p \times N})$. This observa-

tion applied to the pairs (U(p), U(q)) acting on $\mathcal{F}(C^{p \times q})$, (U(p), U(N)) acting on $\mathcal{F}(C^{p \times N})$ (recall that $q \leq min(p, N)$) implies that there is a correspondence between the dual modules $W^{(M)_p} \otimes V^{(M)_p}$, $W^{(M)_p} \otimes V^{(M)_q}$, and $W^{(M)_p} \otimes V^{(M)_N}$, which are the isotypic components with signature (M) in the corresponding Bargmann-Segal-Fock spaces. In particular, the highest weight vectors of the irreducible dual modules are identical if expressed in terms of the same dummy variable. It follows that the effect of the operators $\tilde{\Phi}_{v}$ on ϕ_{Max} , whether $\tilde{\Phi}_{v}$ are expressed in terms of the infinitesimal operators

$$L^{q}_{\alpha\beta} = \sum_{i=1}^{q} Z_{\alpha i} \frac{\partial}{\partial Z_{\beta i}}$$
 or $L^{N}_{\alpha\beta} = \sum_{i=1}^{N} Z_{\alpha i} \frac{\partial}{\partial Z_{\beta i}}$

is identical (in fact the global action L(h), $h \in U(p)$, is always the same on $\mathcal{F}(C^{p\times q})$, $\mathcal{F}(C^{p\times p})$, or $\mathcal{F}(C^{p\times N})$). But the operators $\widetilde{\Phi}_{\nu}$, if expressed in terms of the $L^{N}_{\alpha\beta}$, are exactly the linearly independent intertwining operators that map the U(N)irreducible module $\mathbf{V}^{(M)}$ into the tensor product $\mathcal{H}^{(m)}(C^{n\times N})$. This is exactly the problem we considered in [7].

The procedure by which generalized Casimir operators are used to break the multiplicity is quite general. Let (G', G) and (H', H) be two pairs of

dual (representation) modules acting on $\mathcal{F}(C^{n\times N})$ in such a way that *G* is a closed subgroup of *H* and *H'* is a closed subgroup of *G'*. Let $\mathcal{W}_{n\times N}$ denote the Weyl algebra of all differential operators with polynomial coefficients on $C^{n\times N}$. Let U_G , $U_{G'}$, U_H , and $U_{H'}$ denote the universal algebras of (the representations) of *G*, *G'*, *H*, and *H'*, respectively. Then all these algebras are subalgebras of $\mathcal{W}_{n\times N}$. If $\mathcal{Z}(\mathcal{U}_G; \mathcal{W}_{n\times N})$, $\mathcal{Z}(\mathcal{U}_{G'}; \mathcal{W}_{n\times N})$, $\mathcal{Z}(\mathcal{U}_H; \mathcal{W}_{n\times N})$, and $\mathcal{Z}(\mathcal{U}_{H'}; \mathcal{W}_{n\times N})$ denote the centralizers of \mathcal{U}_G , \mathcal{U}_G' , \mathcal{U}_H , and $\mathcal{U}_{H'}$ in $\mathcal{W}_{n\times N}$, then for many dual representations $\mathcal{Z}(\mathcal{U}_G; \mathcal{W}_{n\times N}) = \mathcal{U}_{G'}$, $\mathcal{Z}(\mathcal{U}_{G'}; \mathcal{W}_{n\times N}) = \mathcal{U}_G$, $\mathcal{Z}(\mathcal{U}_H; \mathcal{W}_{n\times N}) = \mathcal{U}_{H'}$, and $\mathcal{Z}(\mathcal{U}_{H'}; \mathcal{W}_{n\times N}) = \mathcal{U}_H$.

Definition 1. Let ρ_H be a unitary representation of a Lie group H on a Hilbert space \mathcal{H} , let G be a closed subgroup of H. Let \mathcal{U}_H (resp. \mathcal{U}_G) denote the universal enveloping algebra generated by the infinitesimal action of ρ_H (resp. $\rho_G = \rho_{H|G}$). An element $C \in \mathcal{U}_H$ that commutes with \mathcal{U}_G is called a generalized Casimir operator for the pair (ρ_H, ρ_G) or (simply (H, G)).

Such operators are useful not only for compact groups but also more general classes of groups, including semidirect product groups such as the Poincaré or Galilei groups, where it is known how to construct sets of generalized commuting operators whose eigenvalues label the invariant subspaces.

Theorem 2. Under the assumption that (H', H) and (G', G) are two dual (representations) modules acting on $\mathcal{F}(C^{n\times N})$ such that *G* is a closed subgroup of *H* and *H'* is a closed subgroup of *G'*, if $C_H(G)$ (resp. $C_{G'}(H')$) denotes the set of generalized Casimir operators for (H, G) (resp. (G', H')) then $C_H(G) = C_{G'}(H')$.

Now if λ_i denotes an equivalence class of the irreducible representation of the group *G* on the space V^{λ_i} , $1 \le i \le n$, then $V^{\lambda_1} \otimes \cdots \otimes V^{\lambda_n}$ is an irreducible $\underbrace{G \times \cdots \times G}_{n} = H$ -module. On the restriction to the

diagonal subgroup which is identified with *G*, the Kronecker tensor product *G*-module $V^{\lambda_1} \otimes \cdots \otimes V^{\lambda_n}$ becomes reducible and in general multiplicity occurs. Generalized Casimir operators may then be used to break this multiplicity.

In the context of our problem let

$$\underbrace{U(N)\times\cdots\times U(N)}_{\mathbf{r}},$$

or equivalently, $GL(N, C) \times \cdots \times GL(N, C) = H$ act on $\mathcal{H}^{(m)}$. Let G = GL(N, C) and let \mathcal{U}_H (resp. \mathcal{U}_G) denote the universal enveloping algebra of the infinitesimal action, then $\mathcal{U}_H = \mathcal{U}(G \times \cdots \times G) \cong$ $\mathcal{U}(G) \otimes \cdots \otimes \mathcal{U}(G)$, where G is the Lie algebra generated by the infinitesimal action of G on $\mathcal{H}^{(m)}$. The set of generalized Casimir operators $C_H(G)$ is generated by the differential operators of the form

(28)
$$tr[[R^{(p_1)}]^{d_1}\cdots [R^{(p_r)}]^{d_r}]$$

where the matrices $R^{(p_i)}$, $1 \le i \le r$, have (j,k) entry

(29)
$$R_{jk} = \sum_{\alpha=1}^{p} Z_{\alpha j} \frac{\partial}{\partial Z_{\alpha k}}, \quad 1 \le j, k, \le N;$$

the d_i are integers ≥ 0 (see [7] Prop. 3.3), and "tr" denotes the noncommutative trace operator. Moreover, as shown in [7], Prop. 3.5, these generalized Casimir operators are Hermitian.

To see how these generalized Casimir operators act on $\mathcal{J}^{(m)\otimes(M)^{\vee}}$, and also for computational purposes, it is more convenient to use the dual representation and the above Theorem to compute $C_H(G) = C'_G(H')$ in terms of the dual actions of H and G on $\mathcal{F}(C^{p\times N})$. The dual action of H on $\mathcal{F}(C^{p\times N})$ is defined by

(30)
$$L\begin{pmatrix} g'_1 & 0\\ \ddots \\ 0 & g'_r \end{pmatrix} f(X) = f(\begin{pmatrix} g'_1^T & 0\\ \ddots \\ 0 & g'_r^T \end{pmatrix} X)$$

for all $g'_i \in GL(p_iC)$, $1 \le i \le r$, and for all $f \in \mathcal{F}(C^{p \times N})$. The dual action of *G* on $\mathcal{F}(C^{p \times N})$, $p = p_1 + \cdots + p_r$, is given by

(31)
$$[L(g')f](X) = f((g')^T X), g' \in GL(p, C)$$

and thus $H' = GL(p_1, C) \times \cdots \times GL(p_r, C)$. The Lie algebra of the infinitesimal action of G' is generated by the vector fields

$$L_{\alpha\beta} = \sum_{i=1}^{N} Z_{\alpha i} \frac{\partial}{\partial Z_{\beta i}} \quad 1 \leq \alpha, \beta \leq p_j$$

and the universal enveloping algebra $\mathcal{U}_{G'}$ is particularly simple. If we write the matrix $[L] = (L_{\alpha\beta})$, $1 \le \alpha, \beta \le p_j$, in block form as

(32)
$$[L] = \begin{bmatrix} [L]_{11} & \dots & [L]_{1r} \\ \vdots & & \\ [L]_{r1} & \dots & [L]_{rr} \end{bmatrix},$$

then, as was shown in [16], $C_{G'}(H')$ is generated by the generalized Casimir operators of the form (33)

$$tr([L]_{u_1u_2}[L]_{u_2u_3}\dots [L]_{u_ku_1}), 1 \le u_j \le r, 1 \le j \le k.$$

The Hermitian operators formed from these generalized Casimir operators were used in [7] to break the multiplicity in the tensor product decomposition of $\mathcal{H}^{(m)}$. But as remarked earlier in this section, in the construction of a nonorthogonal basis ($\mathbf{W}^{(M)_p}$; $\pi^{(n)}$), this basis is obtained by applying the maps $\tilde{\Phi}_{\nu}$ to $\phi_{\text{Max}}^{(M)}$ and then requiring that they satisfy condition (27). Further, as remarked earlier, $\tilde{\Phi}_{\nu}$ can be expressed equivalently in terms of $L^{q}_{\alpha\beta}$ or $L^{N}_{\alpha\beta}$. And the condition (27) can be expressed as

(34) $L_{\alpha_p\beta_p}\varphi = 0$, $\forall \alpha_p < \beta_p$, $p = p_1, \dots, p_r$ where

(35)
$$L_{\alpha_p\beta_p} = \sum_{i=1}^{N} Z_{\alpha_p i} \frac{\partial}{\partial Z_{\beta_p i}}$$

instead of $\sum_{i=1}^{q} Z_{\alpha_{pi}} \partial/\partial Z_{\beta_{pi}}$. But these are part of the infinitesimal operators of the action of H'. It follows that if Φ_{μ} are obtained from $\widetilde{\Phi}_{\nu}$ by applying condition (27), then for $C \in C_{G'}(H') = C_H(G)$, C commutes with Φ_{μ} . Indeed, $\widetilde{\Phi}_{\nu}$ maps $V^{(M)}$ into $\mathcal{P}^{(m)}$, and C commuting with H' implies that C commutes with Φ_{μ} . We summarize the results above in the following

Proposition 1. *The generalized Casimir operators given by Eq.(33) leaves the subspace* $(W^{(M)_p}; \pi^{(m)})$, *or equivalently,* $\mathcal{J}^{(m)\otimes(M)^{\checkmark}}$, *invariant.*

Assume now that a set of generalized commuting Hermitian operators $\{C_t\}$ has been chosen such that

(36)
$$C_t \Phi_\mu \phi_{\text{Max}}^{(M)} = \Phi_\mu C_t \phi_{\text{Max}}^M;$$

that is, each C_t leaves the space $(\mathbf{W}^{(M)}; \boldsymbol{\pi}^{(m)})$ invariant. Since $\{C_t\}$ is a commuting set of Hermitian operators on $(\mathbf{W}^{(M)}; \boldsymbol{\pi}^{(m)})$ they can be simultaneously diagonalized; call the eigenvalues η , then the set $\{\eta\}$ may be used to label an orthogonal basis of $(\mathbf{W}^{(M)}; \boldsymbol{\pi}^{(m)})$, and hence of $\mathcal{J}^{(m)\otimes(M)^{\vee}}$. An example will be given in the next section.

Example

In this section we present an example to show the power of our procedures. Other examples are given in references [17] and [18]. We consider SU(3)Racah coefficients, in which we wish to find the embedding of the eight-dimensional representation in the three-fold tensor product of eight-dimensional representations. The eight-dimensional representations and their tensor products arise in applications of flavor and color SU(3) gauge theories of the strong interactions. The eight-dimensional irrep is entered into the computer as [4,3,2,0,0,0], while the three-fold tensor product of eight-dimensional irreps [[2,1,0],[2,1,0],[2,1,0]] is entered into the computer as [m] = [2, 1, 2, 1, 2, 1]. The programs then calculate $\vec{\Phi}$, which in this case has multiplicity 8.

In this example rather than focusing on coupling schemes, we find two sets of commuting Casimir operators. A first choice is [[1,2],[2,2],[2,1]] which has two 2-fold degeneracies. A second Casimir that commutes is [[[2,3],[3,3],[3,2]] + [[1,3],[3,3],[3,1]]] which then breaks the degeneracy. The resulting eigenvalues are
$$\eta = \begin{bmatrix} 42 & 30 \\ 30 & 36 \\ 36 & 42 \\ 6 & 66 \\ \frac{39}{2} - 3/2\sqrt{5} & \frac{105}{2} + 3/2\sqrt{5} \\ \frac{39}{2} + 3/2\sqrt{5} & \frac{105}{2} + 3/2\sqrt{5} \\ \frac{39}{2} + 3/2\sqrt{5} & \frac{105}{2} - 3/2\sqrt{5} \\ \frac{39}{2} - 3/2\sqrt{5} & \frac{105}{2} - 3/2\sqrt{5} \end{bmatrix}$$

A second Casimir operator that does not commute with the previous two is [[[2,3],[3,3],[3,2]] + [[1,2],[2,2],[2,1]]], for which there are no degenerate eigenvalues:

$$\eta' = \begin{bmatrix} 27.90\\ 38.30\\ 39.94\\ 48.57\\ 52.16\\ 53.42\\ 56.88\\ 66.84 \end{bmatrix}$$

Then the overlap between these two sets of noncommuting Casimir operators is

Conclusion

We have solved the following problems:

1. We give the most general (non-inductive) construction of the Gelfand-Cetlin basis of irreps of U(N) (or equivalently of GL(N, C)) as polynomial functions.

2. If $(M)^{\checkmark}$ denotes the signature of the contragredient representation of (M), we show the multiplicity $\mu(M)$ is equal to the dimension of the G-invariant subspace of $V^{(m)_1} \otimes \cdots \otimes V^{(m)_r} \otimes V^{(M)^{\checkmark}}$. Further we give a method for constructing an orthonormal basis in the G-invariant subspace.

3. We realize Casimir operators, and more importantly, generalized Casimir operators, as invariant differential operators which are intertwining operators of the G-modules $V^{(M)}$ and $V^{(m)_1} \otimes \cdots \otimes V^{(m)_r}$; thus we give a resolution of the important multiplicity problem in physics.

4. We present a general method for computing Clebsch-Gordan and Racah coefficients which are fundamental in quantum physics. A website (http://www.physics.uiowa.edu/wklink/ Racah/index.html) has been developed which makes it possible for users to compute Gelfand-Cetlin basis elements, Clebsch-Gordan and Racah coefficients by downloading the programs from the website.

	-0.094	$0.019 \\ -0.019$	$0.054 \\ 0.019$	0.019	0.019	-0.019	-
	0.00000069	$\begin{array}{c} 0.00000055 \\ -0.00000081 \end{array}$	$-0.00000031 \\ 0.0000013$	0.0000022	0.0000017	-0.0000013	
	-0.84	$\begin{array}{c} 0.99 \\ -0.99 \end{array}$	$0.99 \\ 0.99$	0.99	0.99	-0.99	
D	-0.27	$0.054 \\ -0.054$	$0.053 \\ 0.055$	0.055	0.055	-0.055	
$K_{\eta\eta'} =$	0.40	$\begin{array}{c} -0.080\\ 0.080\end{array}$	$-0.079 \\ -0.081$	-0.082	-0.081	0.081	
	-0.15	$0.031 \\ -0.031$	$\begin{array}{c} 0.030\\ 0.031\end{array}$	0.031	0.031	-0.031	
	0.059	-0.012 0.012	$-0.012 \\ -0.012$	-0.012	-0.012	0.012	
	-0.15	$0.031 \\ -0.031$	$\begin{array}{c} 0.030\\ 0.031\end{array}$	0.031	0.031	-0.031	_

The time needed for this Racah calculation is about five minutes.



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the Complex Dual to the Real Sphere?

Simon Gindikin

The observation of this note is connected with some modern considerations in integral geometry. At the same time it returns us back to the era of great projective geometry of Poncelet-Plücker and to the understanding that some phenomena of real geometry need a language of complex geometry. This era started with Poncelet's discovery that circles can be defined as ellipses passing through two universal imaginary points at infinity—the cyclic points. We consider here a canonical object dual to the real sphere $S = S^n$ that was not considered earlier, probably because it is complex.

Spherical and hyperbolic geometry are real forms of the same complex geometry, but in many respects hyperbolic geometry is richer than spherical geometry. In hyperbolic geometry, horospheres ("spheres of infinite radius") play an important role, but they have no analogues in spherical geometry. Our initial point is that it makes perfect sense to consider complex horospheres on the real sphere.

Let us start from the hyperbolic picture. We realize hyperbolic space as the hyperboloid $H = H^n \subset \mathbb{R}^{n+1}$,

$$x_1^2 - x_2^2 - \cdots - x_{n+1}^2 = 1$$
,

relative to the action of the pseudoorthogonal group O(1; n). The dual object is the cone \hat{H} ,

$$\xi_1^2 - \xi_2^2 - \cdots - \xi_{n+1}^2 = 0, \xi \neq 0,$$

without the vertex, where the group O(1; n) also acts transitively. Points $\xi \in \hat{H}$ parameterize the horospheres, which are intersections of *H* by the (isotropic) hyperplanes $\xi \cdot x = 1$. Here the

dot-product corresponds to the same quadratic form.

For the real sphere $S = S^n$

$$x_1^2 + x_2^2 + \cdots + x_{n+1}^2 = 1$$

we consider its complexification $\mathbb{C}S$,

 $z_1^2 + z_2^2 + \cdots + z_{n+1}^2 = 1, z = x + iy \in \mathbb{C}^{n+1}$

and complex horospheres $E(\zeta)$ —intersections of $\mathbb{C}S$ by the hyperplanes

$$\boldsymbol{\zeta}\cdot\boldsymbol{z}=\boldsymbol{\zeta}_1\boldsymbol{z}_1+\cdots+\boldsymbol{\zeta}_{n+1}\boldsymbol{z}_{n+1}=1, \boldsymbol{\zeta}\cdot\boldsymbol{\zeta}=0, \boldsymbol{\zeta}\neq 0.$$

So complex horospheres are parameterized by points of the complex cone $C \subset \mathbb{C}^{n+1}$ without the vertex. The crucial moment in such constructions comes when one selects from all horospheres some that have a special relation with the real sphere. We suggest considering horospheres $E(\zeta)$ that do not intersect the real sphere *S* and interpreting the manifold $\hat{S} \subset C$ of their parameters ζ as the dual object for the sphere *S*. Direct computation shows that the domain \hat{S} on the cone *C* is defined by the condition

$$\xi_1^2+\cdots+\xi_{n+1}^2<1, \xi=\Re\zeta.$$

This domain is invariant relative to the orthogonal group O(n+1) (but, of course, is inhomogeneous).

To support this interpretation we will state one analytic fact. Analytic dualities as consequences of geometric dualities are important components of such considerations (the Radon transform and projective duality is the classic example). Let Hyp(S)be the space of hyperfunctions on $S \subset \mathbb{C}S$ functionals on the space $\mathcal{O}(S)$ of holomorphic functions on $\mathbb{C}S$ in some neighborhoods of S and let $\mathcal{O}(\hat{S})$ be the space of holomorphic functions in \hat{S} .

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Theorem 1. There is an O(n)-isomorphism between Hyp(S) and $O(\hat{S})$.

The operators, which establish the isomorphism in both directions, are explicit. If $f \in Hyp(S)$ and $\zeta \in \hat{S}$, then the evaluation of this functional on the function $\varphi_{\zeta} = 1/(1 - \zeta \cdot z)$, which is holomorphic in a neighborhood of *S*, gives $\hat{f}(\zeta) \in \mathcal{O}(\hat{S})$. To construct the inverse operator we need an analogue of the Cauchy-Fantappie integral formula on $\mathbb{C}S$, which makes it possible to extend functionals from the functions of the form φ_{ζ} to all holomorphic functions in neighborhoods of *S*.

All regular functions and distributions are contained in Hyp(S). Let μ be the invariant form of maximal degree on $S: \mu \wedge d(z \cdot z) = dz$. Then for any function $\psi(z), z \in S$, we consider the hyperfunction-functional $(f[\psi], \phi) = \int_S \psi(z)\phi(z)\mu, \phi \in \mathcal{O}(S)$. We identify $\hat{f}[\psi](\zeta) = \hat{\psi}(\zeta)$. If ψ is holomorphic in some neighborhood of S, then in the integral defining $\hat{\psi}(\zeta)$ we can by deforming S extend $\hat{\psi}(\zeta)$ holomorphically outside of the domain \hat{S} . If ψ is holomorphic on $\mathbb{C}S$ then $\hat{\psi}$ holomorphically extends to the whole of C.

Theorem 2. There is an $O(n, \mathbb{C})$ -isomorphism between $O(\mathbb{C}S)$ and O(C) that identifies the spaces of polynomials on these manifolds.

This isomorphism is surprising since complex homogeneous manifolds $\mathbb{C}S$ and C are not isomorphic as homogeneous manifolds, nor are they isomorphic as complex ones. There are some intermediate isomorphisms for spaces of holomorphic functions on horospherically convex domains $D \subset \mathbb{C}S$ (their complements are unions of horospheres). This situation is similar to the complex linear convexity of Martineau. It is essential that the sphere *S* is horospherically convex compact. It would be interesting to investigate horospherically convex compacts inside *S* as an example of the influence of complex geometry on real geometry.

In the isomorphism of Theorem 2, homogeneous polynomials on *C* correspond to spherical polynomials on *S*. Spherical polynomials are eigenfunctions of the Laplace-Beltrami operator on the sphere. Similarly, we can consider spherical functions on the hyperbolic space *H*. In the latter case there is the Poisson integral reconstructing spherical functions through their boundary values (we transfer to the bounded model in the intersection of *H* by the hyperplane $x_1 = 1$).

Is there an analogue of the Poisson integral for spherical polynomials? Of course, *S* has no real boundary, but we can consider the complex boundary of $\mathbb{C}S$, which we will identify with the projectivization *B* of the cone *C*. We extend spherical polynomials f(x) on \mathbb{C}^{n+1} and take restrictions \hat{f} to the cone *C*. They are homogeneous polynomials on *C*—sections of line bundles on *B*. We

interpret \hat{f} as boundary values of f. The operator $f \to \hat{f}$ is compatible with the isomorphism in Theorem 2 above. Let C_z be the intersection of C by the hyperplane $\zeta \cdot z = 1$ and ω be a holomorphic (n-1)-form such that $d(\zeta \cdot z) \wedge \omega = \mu$. Let $\gamma \subset C_z$ be any cycle homological to the sphere S^{n-1} .

Theorem 3. We have

$$\int_{\gamma} \hat{f} \omega = c(m, n) f(z), m = \deg \hat{f}.$$

In this formula we reconstruct the extensions of spherical polynomials on the whole space. We do not give the explicit value of the constant c. To make this formula similar to the Poisson formula on H we need to use the homogeneity of \hat{f} to replace the integration in C_z by the integration in a fixed section of C. Doing so will add to the integrand a factor—a Poisson kernel. The new essential moment comes when we integrate not on the whole complex boundary but on any cycle there. Let us mention that the connections between spherical polynomials on S and homogeneous polynomials on the complex cone C were discovered by Maxwell although he considered a different isomorphism.

There are interesting complex constructions connecting with the hyperbolic geometry as well. Here is one example. Let H_+ be one sheet of the hyperboloid $H(x_1 > 0)$. Let us consider its complex neighborhood $Crown(H) = \{z = x + iy \in \mathbb{C}^{n+1}, z \cdot z = 1, x_1^2 - x_2^2 - \cdots - x_{n+1}^2, x_1 > 0\}$, which we will call the complex crown of H. It is biholomorphically equivalent to the future tube.

Theorem 4. All spherical functions on H_+ admit holomorphic extensions on Crown(H), and it is the maximal joint holomorphy domain for these functions.

All these constructions can be generalized to arbitrary compact symmetric spaces.

Further Reading

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Book Review

Strange Attractors: Poems of Love and Mathematics

Reviewed by J. M. Coetzee

Strange Attractors: Poems of Love and Mathematics Sarah Glaz and JoAnne Growney A K Peters, Ltd., 2008 US\$39.00, 250 pages ISBN 13: 978-56881-3417

The highest type of intelligence, says Aristotle, manifests itself in an ability to see connections where no one has seen them before, that is, to think analogically. The spark of true poetry—according to one influential school of poets—flashes when ideas are juxtaposed that no one has yet thought of bringing together. Scientific discoveries often start with a hunch that there is some connection between apparently unrelated phenomena.

So there are a priori grounds for thinking of poetry and mathematics together, as two rarefied forms of symbolic activity based on the power of the human mind to detect hidden analogies. In other words, an anthology like *Strange Attractors*, which brings together a hundred and fifty poems with some degree of mathematical content, makes more a priori sense than, say, a collection of famous speeches with some mathematical content.

There is a further, more mystical argument that poetry and mathematics belong together (have an analogical relation). Among poets there are some who believe that, the mind being part of nature, certain operations of the mind—not necessarily the most rational operations—allow us insights into nature that are essentially *true*. And in Western science there is a tradition going back at least two and a half millennia that sees mathematics ("Number")

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as inhering in the universe: when we speak mathematics, we speak *the* universal language.

The question of how exactly poetic thinking diverges from mathematical thinking has seldom been attacked by poets in their poetic work. Wordsworth treats the question glancingly in his long autobiographical poem "The Pre-

lude", where, as a creative person self-confessedly haunted by the question of how the creative mind works, he contrasts poetry, whose truths somehow inhere in the world, with mathematics as an "independent world, / Created out of pure intelligence".

A third parallel between poetry and mathematics has to do with elegance. Just as there are poets who will wrestle for months to get an insight down on paper in its most jewel-like form, because to them the truth of the poem is inseparable from its expression, so there are mathematicians who believe that, if a given proof is lengthy and messy, then, no matter how ironclad its logic, there must be a better proof—briefer, more elegant—waiting to be uncovered.

The subtitle of *Strange Attractors* is "Poems of Love and Mathematics", a phrase whose ambiguity is probably deliberate. In their brief introduction, the editors claim, not strictly accurately, that the common theme linking the poems they have selected is love; they interpret love broadly to include not only romantic love, familial love, love of nature,

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and love of life, but also "the love that focuses on mathematics and mathematicians."

The natural sympathies between love and mathematics are most easily felt if you are, say, a Christian poet with mystical leanings, like Dante. Dante is represented in the anthology by a passage from the end of the *Paradiso* in which he summons all his mental powers to comprehend the torrent of love pouring forth from a divine creative Mind whose order of intelligence is infinitely above his own. Failing in that attempt ("mine were not the wings for such a flight"), he turns away, only to be pierced, suddenly, with a great flash of light: for an instant he is at one with "the Love that moves the sun and the other stars."

An anthology is by definition not a unity. Though it inevitably expresses the tastes of its editors, it is not required to have an argument. Taken together, the poems in *Strange Attractors* make no unified statement about love, about mathematics, or about the relations between love and mathematics. The following comments thus deal not with the collection as a whole but with a handful of its more outstanding constituents.

The Israeli poet Yehuda Amichai writes a soberly moving poem based on the notion of our life story as a book of problems to be solved—for example, "A man…leaves from place A, / and a woman…leaves from place B. When will they meet, / will they meet at all, and for how long?" Only late in life, when we come to the end of the book, do we get to see the page of answers and discover "where I was right and where I went wrong."

In "The Accounting" Jon Davis contrasts the experience of completing a tax return, as a kind of bare-bones reliving of a year, with the vivifying allure of the erotic. Davis is only one of several poets, among them the Chilean Pablo Neruda, who see counting in general (not just accounting) as a way of imposing an artificial and even deathly order on reality. Thus, despite her whimsical tone, Mary Cornish is steely in her opposition to a Platonic realm of pure Number. Numbers can only be referential, says her poem "Numbers". Forty-seven divided by eleven leaves a remainder of three—not three in the abstract but "three boys beyond their mother's call, / two Italians off to the sea, / one sock that isn't anywhere you look."

Poems like these, hostile to the purity of pure mathematics, are counterbalanced by what one might call Pythagorean poems, in which mathematical entities belong to a higher reality. The prime numbers in particular seem to follow mysterious laws of their own, laws to which human beings have no access (see Helen Spalding's "Let Us Now Praise Prime Numbers").

Len Roberts writes a powerful piece about children in a third-grade arithmetic class, learning to manipulate numbers, unaware that those very numbers, manifested in seconds ticking by, will rule their destinies.

In "Mathematician" Alissa Valles explores a character type not uncommon in the profession: wary or even timid in its emotional dealings, limiting its energies to scanning the life around it for regularities. Can such people be rescued, Valles implicitly asks, or are they simply not wired for human connection?

Roald Hoffman, a Nobel prizewinner in chemistry, is also a notable poet. In one image after another he identifies a subtle phenomenon in our psychological life: the moment, abstracted from the passage of present time, that holds in potential a future that will unfold as soon as the ticking of the seconds resumes. He gives to the poem that collects these images—some ecstatic, some menacing—the title, only partly ironic, "Why Does Disorder Increase in the Same Direction of Time as That in Which the Universe Expands?"

In the epigraph to a much lighter poem, "Sex and Mathematics", Jonathan Holden quotes Wittgenstein: "About that of which we cannot speak we have to be silent." Holden sets forth a poetic argument for the experience of orgasm having the shape of the graph y = 1/x. Wittgenstein does not get it quite right, he suggests: it is only at the asymptote, at the paradoxical moment when we attain the never-to-be-attained ultimate ecstasy, that language must fall silent.

Several other poems in the anthology are based on the mise en abyme that we encounter in the paradoxes—like the paradoxes of Zeno—involving infinite recursion. In "Yes" the Australian poet David Brooks asks: What if, in my last moment on earth, the whole of my life were to flash before my eyes, including this last moment when the whole of my life flashes before my eyes, and so forth to infinity? Would my life stand up to being infinitely re-viewed? His answer: Yes, because you (the beloved) are in it.

One philosophical theme that comes back again and again is the disjunction between our personal sense that we are free agents and our objective knowledge that we are behaving according to laws that can be formulated with great precision. Thus in "Figures of Thought" Howard Nemerov reminds us that, as he closes in exultantly for the kill, the fighter pilot follows the same logarithmic spiral course as the heliotropic bug drawn to the candle flame.

Among the finest poems in the book is Ronald Wallace's "Chaos Theory", which reflects a sensibility genuinely shaped by—rather than merely playing with—the world-view (or universe-view) of present-day cosmology. What is the point of the Socratic enterprise of trying to discern the laws governing one's private life, Wallace asks, when in our thinking about the universe, at every level from



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the subatomic to the galactic, we have abandoned the idea of determinacy?

During the 1950s and 1960s an art movement named concrete art, with a branch called concrete poetry, flourished in Europe and Latin America (it was less strong in the Anglosphere). Affiliated with these concrete poets were followers of the Surrealists of the 1930s.

The Surrealists had held that, since our deepest creative forces are unconscious, images that rise up unbidden from the unconscious may reveal deep poetic truths. The concrete poets asked themselves: If deep images are dictated by unconscious associations so outré as to seem random, then may we not be able to fabricate equally deep—or at least equally striking—images by collocating words randomly, using randomizing procedures within the rules of natural-language syntax (with perhaps some semantic constraints superadded)?

Concrete poetry never made much headway: it was the musicians rather than poets who were best able to exploit mathematical procedures and the new cybernetic technology. But concrete music and concrete poetry were only one manifestation of a wider Zeitgeist in the years around 1960. In the plays of Beckett and Ionesco, with their formulaic patter; in the poetry of the early John Ashbery, with its loopy, dreamlike logic; in the general enthusiasm among intellectuals for structuralism, that is, for systems of thought that seemed to run themselves without need for intervention, we can detect an underlying scepticism and even despair about what human agency can achieve.

That phase in the history of poetry—a phase in which mathematical models had real prestige—is underrepresented in *Strange Attractors*. Carl Andre's poem "On the Sadness" is the sole substantial example. Readers intrigued by Andre's poem which does not lend itself to being excerpted because its force depends on giving an impression of endlessness—may want to look at *Against Infinity*, an anthology of "mathematical poetry" edited by Ernest Robson and Jet Wimp (Primary Press, 1979), and in particular at the work of the American poet Emmett Williams.

If there is a bias among the poets of *Strange Attractors*, it is toward number theory, the infinitesimal calculus, and the mathematics of indeterminacy. There is not much about geometries, Euclidean or otherwise: the territory of strange spaces and eerie topologies is in effect abandoned to filmmakers like David Lynch. Though it makes nods towards a few of the big names (Catullus, John Donne, Emily Dickinson), the book concentrates on the contemporary English-language poetry scene. Two-thirds of the poets represented are still alive; half of these are women. There are no duds among the poems, but overall they tend to be witty rather than profound. Included is a useful set of biographical notes.

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Proving Yourself: How to Develop an Interview Lecture

John Swallow

You've applied, you've waited, and now you've been invited for a campus interview—and, no doubt, you'll be giving a lecture. Your hosts have provided a few details about the lecture format, and you've given some thought to a topic—perhaps a result from your research. At this point you wonder: have I done enough? Is the problem of the interview lecture essentially solved?

If you're in that most special of cases, when your appointment is a done deal and all that's required is a passable lecture, then yes, you needn't do any more—and congratulations!

If you're in the general case, though, then read on. Positions can be won or lost with a lecture, and the goal of this article is to help you land your desired position. If you've been working on your job talk for quite a while, then this article will help you assemble a good set of questions for your hosts so that you can maximize the effectiveness of what you have already prepared. If you're just getting started on your interview lecture, the article will help you start and plan the process efficiently. Either way, don't let what follows overwhelm you. Even the most experienced lecturers can improve, and your hosts surely understand that you're just starting out.

Boundary Conditions

When you ask your hosts the natural question what sort of lecture you should give—you'll almost surely be told one datum: the type of lecture. That is, you're to give a colloquium, a seminar, an undergraduate lecture, or some variant. You might also be told a second datum: how much of the talk should be related to your recent research results. What you should realize is that these data hardly answer the question. In fact, your hosts have done no more than set boundary conditions—and they know that. You'll probably want to prepare a few more questions to ask so that you'll know how to hit the mark more closely—and we'll mention these later on. Still, the answers to even these questions will be only boundary conditions, and it will be up to you to construct a lecture meeting the boundary conditions and differentiating you, positively, as much as possible. Let's start, however, with how to interpret the two data.

Understanding the Constraints

Most often the type indicates the audience. For instance, a colloquium is usually meant to introduce an area of mathematics, or perhaps a significant theorem or counterexample, to mathematicians who are not specialists in the area. Such a lecture should certainly be accessible to the graduate students in the audience for at least n minutes and almost surely the n you assume is too low. A seminar lecture, by contrast, is for specialists—not from your precise subfield, of course, but from a recognized subdiscipline: algebra, or differential geometry.

An undergraduate lecture could suggest one of several sorts of potential audiences: math majors, all students in math courses, or even all undergraduates. If you're asked to give an undergraduate talk, be sure to determine the audience as closely as you can. How many students will likely attend, and with what background? Will everyone in the audience have had a course in linear algebra?

After the determination of the audience, the next most important boundary condition is the topic. For positions at research universities, this will be your research, or at least something from your work that would suit the audience.

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For positions at other institutions, however, potential topics can be quite variable, and it would be well worth your time to explore your options with your hosts. Some may prefer that you provide a context for your own work, instead of results from it, say by explaining fundamental ideas in your research area: an introduction to a subdiscipline. Others may ask you for a hybrid exposition-research lecture: present your own work, but only after spending the first *m* minutes in a manner sufficiently elementary for a certain audience.

Still others may ask you to teach a class, either on a topic of your own choosing or of theirs, something called a class lecture. Watch out for this last sort: they may be the hardest lectures to give. It is far too easy to become overconfident about presenting "trivial" material—and what, after all, could be worse than showing your potential colleagues that you have trouble preparing to teach calculus or linear algebra?

One tricky part of these boundary conditions is that the actual audience will very likely diverge from the stated audience. Your colloquium could be attended by some specialists, your undergraduate talk by many faculty. Be aware of this discrepancy, particularly when you deliberately describe a concept or a proof intuitively but not precisely: those who know what you're talking about will scrutinize that intuition closely.

Now let's move on to what should be the heart of the lecture—the mathematics.

First Principles

Of prime importance: your talk must communicate some compelling mathematics. Select a theorem or two that you can comprehensibly state and convincingly motivate. Don't be a slave to the advice that all good mathematics talks contain at least one proof; many wonderfully fine lectures don't even give a sketch. If you do plan to explain the result, be sure that the proof or sketch can be clearly broken into a few significant and accessible ideas.

Having made these choices, then lay out the pieces of the mathematics: definitions, possible examples, equivalent statements of the theorem, ideas in the proof, applications. Once you see them, consider how you can order them to tell a compelling story.

It may be that you want an example first, in order to motivate a theorem. Or you may want an example afterwards, to illustrate the statement of the theorem—and you might work the example out in a way that prefigures the general method of the proof.

Given a choice between greater clarity or greater completeness in presenting a proof, always choose clarity. It is for this reason that many excellent lecturers give sketches in place of proofs. Your audience can always ask how some details would be filled in, and if they do so they'll be giving you just the sort of question you'd like to answer. Remember that the objective is not to show that you can work out all of the details of a hard problem surely your hosts assume this, since they brought you to campus—but to show that you can share some compelling mathematics with others, generating excitement and enthusiasm in the process. (Beware confusing clarity with teaching to the least knowledgeable person in the audience. It serves no purpose for your lecture to be too vague.)

In general, less is more. It is far better to end a bit early, with the possibility of answering some great questions, than to finish in a rush, running roughshod over your conclusion. Similarly, a couple of well-explained ideas will be far more valuable to your audience than a fully-detailed proof.

If you're to give a class lecture, take extra care in preparation. Especially if you're to introduce an elementary concept, be sure you know exactly what definition you will state, exactly what diagram you will draw, exactly what example will illustrate the precise point you want to make. We're all harsh critics of things we've taught many times.

Conventions and Convolutions

Now that you've got the pieces of the talk set out and organized, consider the means at your disposal. Will you have a blackboard or a whiteboard, colored markers, or an overhead projector? A projection system driven by a desktop or laptop, with or without sound? A podium, with a microphone at the podium or a lapel mike? What will be available—and what most people tend to use—should be among the information you find out from your hosts. Once these are known, you can consider your options, and decide whether to follow the local conventions of that particular department.

If you can give your talk in the traditional way, writing on the board using chalk or colored markers, legibly and in straight lines, then you probably should. In this way you'll be able to show off your experience managing the challenge of delivering a lecture while choosing, as judiciously as possible, what to write on the board.

You've seen the mistakes of inexperienced lecturers: beginning to write a sentence, only to break off because it's taken too long; writing that sentence in a line—but not a line of slope zero; spelling words using a script of size proportional to the distance from the edge. Your hosts will want to know, for their students' sake, that you've worked to avoid these mistakes, and the best way to allay their fears is to demonstrate your competence during the interview lecture.

You may feel a temptation to give a PowerPointstyle lecture, by, for instance, using the beamer LAT_EX package to prepare a pdf file that you can click your way through. Be very careful, however, before deciding to do so. First and foremost, you'll be passing up the opportunity to demonstrate your ability to give a traditional lecture, and so you'll place yourself at an initial disadvantage, something you'll need to compensate for by crafting an especially rhetorical presentation.

Moreover, for every mistake of a beginning lecturer at the board, there is a mistake of a beginning lecturer stepping through a prepared file. These mistakes include reading the lecture directly off the slides, thereby revealing a dependence on the script; cramming too much text or technical material on a slide; and clicking too quickly from one slide to another, without regard for whether the audience is assimilating the material. For all the faults of blackboards and whiteboards, they have one great benefit: they force you to make hard decisions about what to write. If you do decide to give a PowerPoint-style presentation, be sure to see the "Rhetoric and Taste" section below.

If your work involves computing, then your lecture may require a computer demonstration, and you'll need to work to make this portion of your presentation as seamless as possible. You'll want to be able to recover from errant key presses or button clicks, so know your software intimatelyand be sure to find out whether you'll be able to use your computer or instead an unfamiliar one at the institution. It's wise to ask your hosts to schedule sufficient time for you to run through the technological portion at least a half-day before the talk. If it turns out that something's amiss-you can't connect your laptop to their secured Internet network, their projection system, or their sound system; or you finally realize that you'll have to use their computer, which doesn't have the software vou need installed—the likelihood of finding a remedy will be much greater if there's a half-day to find someone to troubleshoot the situation.

You can certainly consider combining two or more ways of delivering your talk—board work, beamer presentation, computer simulations, something yet unnamed. But be prepared to handle the transitions well. If all you genuinely need is a diagram or section of a proof that requires a lot of time to write, you could ask if the lecture room has movable boards. Writing on a board before the lecture and covering it up may be a better strategy than depending on technology.

Finally, if possible, avoid being tied to a podium. Doing so restricts your ability to move around, to engage the audience, and perhaps even to get up close to a student and ask a question. If a microphone is necessary, try to use a wireless one. If you need to click through your presentation, procure a wireless clicker as well.

Great Expectations

Having chosen and organized the mathematics well, now it's time to think about how you'll be presenting yourself. You want to appear confident and relaxed, both friendly and engaging: show your best self—and smile.

The folks in the audience will be asking themselves who you are: who you are as a teacher, who you are as a mathematician, and who you would be as a colleague.

Don't be overly modest or self-deprecating. The interview lecture is not the time to express eternal gratitude to your advisor, or to admit that your work hasn't been all that impressive. Show what you've got and stand by it. At the other extreme, don't try to impress with your mathematical ennui—this trivially follows from that, which obviously implies the following result. If you're not excited about the mathematics, your audience won't be either—not to mention that you'll likely be making them feel inferior.

Engage the audience, yes, but don't go overboard by asking every two minutes if everyone's with you, or by too-earnestly soliciting questions. Don't be surprised that some faculty simply don't intend to be with you. They've heard it all before, and they're simply watching how you go about the task.

Choose what you will highlight in the talk based on your audience. If you're speaking to mathematicians, bring out an interesting subtlety, emphasizing that you're a mathematician's mathematician. If you're speaking to undergraduates, bring out a detail of the discovery or the surprise of a generalization, emphasizing that you're a student's teacher.

Whatever you do, don't become defensive in taking and fielding questions. Instead, prepare for lots of possible questions, viewing the opportunity of answering them as an opportunity to introduce material in a different way.

Theory and Practice

With all of this planning behind you, now practice! Rehearse the beginning especially, figuring out how you'll start off with the right expressions and tone of voice. Give the talk to some friends or family members. If you're reluctant, at least deliver it a couple of times to an empty room and then see if you can ask others to observe and evaluate.

Either way, find a way to time the different portions of the talk. It's a great help to see how long each portion takes, particularly if you find that the talk is a bit short or a bit long; you'll be able to spend more time with a proof, or eliminate an unnecessary remark.

Once you feel ready for prime time, see if you can give the talk as a regularly scheduled seminar at your current institution, or even as a lecture in some course, finding an audience somewhat like the audience you plan to encounter. (Of course, this requires starting the process of lecture development far in advance of your actual interviews!)

Rhetoric and Taste

If you've gotten this far, you have a fairly complete recipe for developing an interview lecture that should be entirely satisfactory. However, particularly if the competition is stiff, you may need a lecture that reaches beyond satisfactory—all the way to memorable. At one level, lectures are about making meaning, to be sure. But making that meaning truly memorable is what will cause that search committee to keep thinking about you.

To make your lecture memorable, you must do something different and do it well. The novelty might certainly be using the latest technology (audio, video from film, or flash presentations you developed yourself), but it needn't be. In our society of mathematicians, it can sometimes be considered novel to engage the audience by making eye contact with each person. The ways of breaking the mold are limited only by your creativity and your diligence in perfecting a technique, making your personality work for you—and your sense of mathematical taste.

One especially effective approach is to use a rhetorical strategy in your talk. That is, consciously present the mathematics in a way that elicits some emotional reaction: laughter, surprise, or even a bit of anxiety. You could choose among the following:

• Produce a surprise: show how an example or result generalizes, but not in the expected fashion.

• Explore—or manufacture—a paradox.

• Make visible some concepts or phenomena that were previously invisible even though the objects are well-known.

• Add a joke or two to lighten up some tough technical moments.

• Deliberately omit a case, or tumble over a subtle point, and get the audience to ferret it out.

Of course, some of these are riskier than others, and the more you have a sense of the faculty at the host institution—who may be quite different from those whom you met earlier—the better. Note that the last strategy requires special care to carry off: your audience must believe by the end that the strategy was your plan all along!

Other methods for making meaning memorable are matters more of style than of rhetoric, and they might be used together with a strategy:

• Provide historical details or motivation about the mathematical results you give.

• Use the available division of the boards carefully, cleverly hiding certain results behind some boards and bringing them out just in time. (No doubt you'll need to take a few moments before the talk to figure out how to do this.)

• Get some members of your audience to stand up and somehow represent a mathematical concept or technique.

Whichever rhetorical strategies or stylistic components you use, the very fact that you'll have

decided upon them means that you'll have crafted a truly individual—and distinguished—lecture.

Quod Erat Faciendum

Don't forget: when you're done, smile and say "Thank you." The interview won't be over, but it will feel different. Your hosts will have experienced first-hand how you can communicate mathematics—and the better you've prepared for that moment, the more they'll want you to join them.

Acknowledgments

I am grateful to all who critiqued drafts of this article, including Tim Chartier, Della Fenster, Helen Grundman, David Leep, Nicole Lemire, Ján Mináč, and Andrew Schultz, as well as all those who answered a query on what advice they would give to candidates giving interview lectures: Steve Benson, Richard Cleary, David Cox, Douglas Ensley, David Finn, John Holcomb, Judy Holdener, Judith Roitman, Carol Schumacher, and Tamara Veenstra.

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Donaldson and Taubes Receive 2009 Shaw Prize





On June 16, 2009, the Shaw Foundation announced that it would award its annual Shaw Prize in Mathematical Sciences to SIMON K. DONALDSON and CLIFFORD H. TAUBES "for their many brilliant contributions to geometry in three and four dimensions". The prize carries a cash award of US\$1 million.

The Shaw Prize in Mathematical Sciences committee made the following statement:

"Geometry and physics have been closely related from Simon K. Donaldson the earliest times, and the differential calculus of Newton and Leibniz became the common mathematical tool that connected them. The geometry of two-dimensional surfaces was fully explored by these techniques in the nineteenth century. It was closely related to algebraic curves and also to the flow of fluids. Extending our understanding to threedimensional space and fourdimensional space-time has been fundamental for both geometers and physicists in Clifford H. Taubes the twentieth and twenty-first centuries.

"Simon K. Donaldson and Clifford H. Taubes are the two geometers who have transformed the whole subject by pioneering techniques and ideas originating in theoretical physics, including quantum theory.

"Electromagnetism is governed by the famous differential equations of Clerk Maxwell, and these equations were used in the early twentieth century by William Hodge as geometric tools. They were particularly useful in the geometry associated with algebraic equations, extending the work of the nineteenth-century mathematician Bernhard Riemann.

"The physical forces involved in the atomic nucleus are governed by the Yang-Mills equations, which generalize Maxwell's equations but, being nonlinear, are much deeper and more difficult. It was these equations which Donaldson used, basing himself on analytical foundations of Taubes, to derive spectacular new results. These opened up an entirely new field in which more and more subtle geometric results have been established by Donaldson, Taubes, and their students. The inspiration has frequently come from physics, but the methods are those of differential equations.

"A key strand of this newly developing theory is the close relation that has been found between solutions of the Yang-Mills equations and the geometry of surfaces embedded in four dimensions. A definitive result in this direction is a beautiful theorem of Taubes, which essentially identifies certain 'quantum invariants' with others of a more classical nature. Many old conjectures have been settled by these new techniques, but many more questions still pose a challenge for the future. Donaldson and Taubes between them have totally changed our geometrical understanding of space and time."

Simon K. Donaldson, born in 1957 in Cambridge, United Kingdom, is currently the Royal Society Research Professor of Pure Mathematics and President of the Institute for Mathematical Sciences at Imperial College, London. He received his B.A. from Pembroke College of Cambridge University in 1979 and his Ph.D. from Oxford University in 1983. In 1986 he was elected a Fellow of the Royal Society.

Clifford H. Taubes, born in 1954 in Rochester, New York, is currently the William Petschek Professor of Mathematics at Harvard University. He did his undergraduate studies at Cornell University and received his Ph.D. in Physics from Harvard in 1980. He is a member of the National Academy of Sciences.

The Shaw Prize is an international award established to honor individuals who are currently active in their respective fields and have achieved distinguished and significant advances, who have made outstanding contributions in culture and the arts, or who have achieved excellence in other domains. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilization. Preference is given to individuals whose significant work was recently achieved.

The Shaw Prize consists of three annual awards: the Prize in Astronomy, the Prize in Life Science and Medicine, and the Prize in Mathematical Sciences. Each prize carries a monetary award of US\$1 million. Established under the auspices of Run Run Shaw in November 2002, the prize is managed and administered by the Shaw Prize Foundation based in Hong Kong.

Previous recipients of the Shaw Prize in Mathematics are Vladimir Arnold and Ludwig Faddeev (2008), Robert Langlands and Richard Taylor (2007), David Mumford and Wen-Tsun Wu (2006), Andrew Wiles (2005), and Shiing-Shen Chern (2004).

—From Shaw Foundation announcements



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Applications received on or before 31 December 2009 will be given full consideration for appointment in 2010. Applications received afterwards will be considered subject to availability of positions. Applicants should send a curriculum vitae and at least three research references and one teaching reference to the Human Resources Office, HKUST, Clear Water Bay, Kowloon, Hong Kong, (Fax (852) 2358 0700). Applicants for positions above the Assistant Professor rank should send a curriculum vitae and the names of at least three research referees to the Human Resources Office. More information about the University is available on the University's homepage at http://www.ust.hk.

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What Is New in \PTEX? III. Formatting References

G. Grätzer

Dedicated to the Memory of Michael Downes



Oxford, 2000.

And the Evening and the Morning Were the Fifth Day

Having created T_EX for himself and other knowledgeable users, Donald Knuth eagerly awaited convenient work environments to be built, more suitable for the average user to work with. Two such platforms emerged in the early 1980s: A_MS - T_EX by the AMS (with Michael Spivak in charge) and ET_EX by Leslie Lamport.

 A_{MS} -T_EX provided many features needed by the mathematical community, including

- Sophisticated math typesetting capabilities complete with the formatting of multiline formulas
- Flexible bibliographic references

LATEX also provided many features, including

- The use of logical units to separate the logical and the visual design of an article
- Automatic numbering and symbolic crossreferencing

Both $\mathcal{A}_{\mathcal{M}}S$ -T_EX and \mathbb{A} T_EX became very popular, causing a split in the mathematical community, as some chose one system over the other.

In February of 1995 the AMS released version 1.2 of $\mathcal{A}_{\mathcal{M}}S$ -ET_EX built on top of the newly redesigned ET_EX. **Michael Downes** was the project leader.

How to Format References

 $\ensuremath{\text{ET}_{E}}\xspace{X's}$ approach was simple: "hardwire" the references, format each one separately. So a typical reference

[3] Ernest T. Moynahan, On a problem of M. Stone,

Acta Math. Acad. Sci. Hungar. 8 (1957), 455–460. would appear in the $\[mathscrewtex]$ source of the references, for instance, as

\bibitem{eM57}

Ernest^T. Moynahan, \emph{On a problem of M. Stone}, Acta Math. Acad. Sci. Hungar. \textbf{8} (1957), 455--460.

Of course, $\ensuremath{\mathbb{E}}\xspace{TE}\!x$ users were free to use bibtex. In a bibtex database, the above reference would be coded, for instance, as

```
@ARTICLE(eM57,
```

```
author = "Ernest T. Moynahan",
title = "On a Problem of
{M. Stone}",
journal = "Acta Math. Acad. Sci.
Hungar.",
```

G. Grätzer is Distinguished Professor of Mathematics at the University of Manitoba. His email address is gratzer @me.com.

```
pages = "455--460",
volume = 8,
year = 1957,
```

)

Michael told me that one of the difficulties in coding the bibliographic commands for $\mathcal{A}_{\mathcal{M}}S$ -TEX was to find where a reference stops and the next one starts. In the new $\mathbb{E}T_{E}X$ setup, each reference would become an environment, so this difficulty would not arise. Little did I know that Michael had plans far more ambitious than recoding the amsmath reference formatting commands.

We talked about implementing formatted references as an AMS package on and off for quite a few years. In the late 1990s, I received the good news: Michael got the green light to proceed with the project.

The AMS released <code>amsrefs</code> at its annual meeting in January 2002. (After Michael Downes passed away, David M. Jones took over the project, and released version 2.0 in June 2004. The current version is 2.03.) The presentation was made by Michael Downes, who designed and coded the package. Iwas very excited to hear his lecture—bibliographic management was the last block needed to complete the rebuilding of $\mbox{ET}_{\rm E}^{\rm X}$.

My excitement was shared by Michael and by very few others. Two minutes before the start of the presentation, there were only the two of us in the lecture hall.

Michael's Vision

Michael combined the best of both worlds:

- (1) An amsrefs entry is very much like a
 bibtex entry.Forinstance, the above entry
 in amsrefs form is
 \bib{eM57}{article}{
 author={Moynahan, Ernest~T.},
 title={On a problem of M. Stone},
 journal={Acta Math. Acad. Sci.
 Hungar.},
 volume={8},
 date={1957},
 pages={455--460},
 }
 - }
- (2) The bibliographic entries could be placed into the document, in a separate (MTEX) document, in an amsrefs database (a MTEX document), or in a bibtex database.
- (3) The entries are put together and shaped by a bibliography style file. Developing a format for a journal is very easy. For instance, to format an article as above, you specify

```
\BibSpec{article}{%
+{}{\PrintAuthors} {author}
+{,}{ \textit} {title}
+{,}{ } {journal}
+{}{ \textbf} {volume}
+{}{ \parenthesize} {date}
+{,}{ } {pages}
}
```

To write a **bibtex** style file, you have to learn an esoteric programming language. Michael's style files are $\[mathbb{E}T_EX\]$ files, and they can be written in a few minutes.

- (4) The bibliographic data files are also $\[Mathbb{E}T_{E}X\]$ files, so you can print them within $\[Mathbb{E}T_{E}X\]$, making it easy to maintain them.
- (5) amsrefs allows you to use your bibtex database files seamlessly.

Real Nice Features

- **Citation labels:** By default, the items in your bibliography are numbered. Four other label styles are supported:
 - **alphabetic:** First letter(s) of each author name with the year of publication (two digits).
 - **shortalphabetic:** First letter(s) of each author name.
 - **author-year:** The popular author-year format, as described in *The Chicago Manual of Style.*
 - **y2k:** Same as alphabetic, but with fourdigit year.
- Section title for a bibliography: The bibliography is in the bibdiv environment, which formats it as a section or as a chapter, as appropriate. Three more commands are provided for maximum flexibility: \bibdiv, \bibsection, \bibchapter.
- **Elegant handling of names:** Since you input names in the form

von Lastname, Firstname, Jr.

most name related complications of bibtex disappear. You are also free to use most accents and special characters. The initials option uses initials for first names.

Citing: The <code>FTEX \cite</code> command does not properly function if citations are grouped together. So now <code>amsrefs</code> recommends that the \cite command be used only for single citations (such as [13] or [13, Theorem 9]) and it provides the \citelist command that can easily and logically produce grouped citations, such as [12, page 9; 14; 19, Theorem 8]. For author-year citations, there are many complications that the <code>ETEX \cite</code> command cannot handle. Is the author part of the sentence or part of the reference? A few new variants of \cite handle this problem elegantly.

Abbreviations: can be provided for names, journals, and publishers.

This is just a sampler to whet your appetite. For a complete listing of all the features, see the two manuals in the references.

Mathematical Bibliographic Databases

You can easily build your own amsrefs mathematical databases with MathSciNet from the AMS. Do a search. When the result page comes up, go to the pulldown menu next to Batch Download and select Citations (AMSRefs). Now you can checkmark the items you want by clicking on the little squares and then click on Retrieve Marked next to the pulldown menu or click on Retrieve First 50. For the latter to work well, before your search, click on the Preferences button and click on the circle next to 50, so you get at most 50 items per result page. The Retrieve First 50 then retrieves them all.

Of course, if you select Citations (BibTeX), you get the references in bibtex format.

Transition

Mathematicians are a conservative lot. $\mathcal{A}_{\mathcal{M}}S$ -TEX was superseded by the new $\mathbb{E}T_{E}X$ with the AMS packages almost twenty years ago, and still many authors use it. How long would it take for amsrefs to be adopted by the majority of mathematicians, journals, and publishers?

Although the third edition of my ETEX book was out less than two years, to help in the transition, with Michael's encouragement, I started to write a brand new chapter on amsrefs for the next edition; see http://www.maths.umanitoba.ca /homepages/gratzer.html/amsrefs.pdf. This was fun, and a systematic way to find a lot of bugs.

Then a serious obstacle emerged in the transition plans.

bibtex produces from the database file(s) the bbl file, the LATEX source file for the bibliography. You can copy and paste it into your article for submission. If you need a different format, you just change the name of the style file and run bibtex again.

amsrefs also creates a bbl file (entirely incompatible with the bibtex bbl file), which it uses to create the typeset file. So if the journal you want to submit your article to does not have an amsrefs style file, then you have to redo the amsrefs entries by hand in the format the journal would accept, a major—and very unpleasant—undertaking.

So who should build an amsrefs database? Since only the AMS journals have amsrefs style files, only those should do it who know that they intend to submit to an AMS journal and *know that* *their article will be accepted for publication,* a tall order.

When I first called Michael with this problem, he suggested that I call back the next day; he wanted to think this problem over. Next day he started out by saying that the evening before he started coding the option to produce a $\[mathbb{ETE}\]$ source file for the bibliography. He said this was a chicken and egg problem. Journals will not produce amsrefs style files unless many contributors demand it, but mathematicians will be reluctant to use amsrefs unless many journals can accommodate it. This option will allow the use of amsrefs, while the journals ready their style files.

We continued the debugging process and Michael was telling me that the option was being thought through. Soon he was on sick leave, and we never talked again.

Where Are You Going, and What Do You Wish?

I think <code>amsrefs</code> is the nicest reference formatting tool ever devised for $\Join_{TE}X$. After twenty years, the mathematical community deserves to complete the transition from \mathcal{A}_{MS} -TEX to the new $\Join_{TE}X$ and the AMS packages.

To facilitate the transition, to help the mathematical community, and to respect Michael's memory, the AMS should complete the work on the option Michael started coding.

Acknowledgement

Special thanks to Barbara Beeton for her constant help, in general, and useful criticisms of this article, in particular. Thanks are also due to Karl Berry, R. Padmanabhan.

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Ask Professor Nescio

Editor's Note: Graduate students, early career faculty, and other mathematicians may have professional questions that they are reluctant to pose to colleagues, junior or senior. The *Notices* advice column, "Ask Professor Nescio", is a place to address such queries. Nomen Nescio is the pseudonym of a distinguished mathematician with wide experience in mathematics teaching, research, and service. Letters to Professor Nescio are redacted to eliminate any details which might identify the questioner. They are also edited, in some cases, to recast questions to be of more general interest and so that all questions are first person. Some letters may be edited composites of several submitted questions. Query letters should be sent to notices@math.ou.edu with the phrase "A question for Professor Nescio" in the subject line.

-Andy Magid

Dear Professor Nescio,

I began a tenure-track position about 1.5 years ago. I will soon be coming up for reappointment and am worried about my publication rate. How do I know if what I've done is enough?

-Counting

Dear Counting,

Professor Nescio regrets to inform you that there is no answer to your question. First, different departments have different attitudes about this with the more enlightened ones deciding that numbers of papers are irrelevant. Perhaps a more accurate statement is that enlightened departments have a core of professors who don't believe in counting, but even in such a department there will be faculty who are of the opposite persuasion. The variety that adorns humanity is such that even where there are majorities of one inclination or the other, the opposite approach will have significant representation. Second, at such an early stage in your career almost all faculty are looking at a variety of other factors to judge you rather than a "rate". (Actually, in my book you haven't been around long enough to establish a publication rate.)

My best advice is to talk to a tenured faculty member about this. Professor Nescio is certain there was some faculty member who wanted the department to hire you in the first place and undoubtedly you know who that is. Believe me, you were not hired out of the blue. If that person occupies the ranks of the socially or verbally challenged, seek someone else to discuss it with. If there is another colleague you have grown comfortable with, discuss it with him/her. I also wouldn't hesitate to ask the chair, though chairs might be somewhat guarded in this situation unless you are on good terms with him/her. Whomever you approach, ask them this question. Perhaps you might not focus on the publication rate but ask how your case for renewal looks. Ask how your publications measure up to previous cases at your stage of the career.

Surely two good papers in your 1.5 years will get you renewed in most departments, provided the other aspects of your professional life are acceptable—perhaps 1.5 papers or even one. It really depends on how good the papers are. Realize that no one but the most brilliant has more than one good idea in a year, and if you are strict in your definition of "good idea" it might be that one every 5 or 6 years is a sign of excellence. Ask yourself, are 10 two-page notes better than a 40-page paper? Of course not, so don't go that route.

In the final analysis I am afraid it is impossible to give you solace in this situation. Whenever we place ourselves in a situation where we are to be judged, we are bound to be insecure and worry. Even Professor Nescio faced this when his tenure decision approached. Memories of unprecedented headaches are quite vivid in his mind and lead him to empathize with your plight.

If it does comfort you, it is my experience that unless you have really made a botch of your teaching or done no research since you arrived or have physically attacked a respected member of the faculty or any student, the department is likely to renew you. That renewal may come with a warning, but I think most mathematicians will allow you to have a fair shot at getting tenure.

> -Good luck, Professor Nescio

Professor Nomen Nescio is a pseudonym for the Notices advice columnist. Questions for the Professor may be sent to notices@math.ou.edu.

Dear Professor Nescio,

I am in my first year of a postdoc at a large university. My teaching load seems to be quite heavy compared to the tenure-track faculty. For example, I am teaching very large sections of calculus while I see others are teaching upper-level classes to a handful of students. Is there anything I can do to make my teaching load better for next year?

-Burdened

Dear Burdened,

Your letter touches a special place in Professor Nescio's heart—the plight of the recent Ph.D. It saddens him that there are those in our noble profession who would make life difficult for the novice in order to make their lives easier. Perhaps he should be more generous and only compare this to a variant of the fraternity initiation where the newcomer is subjected to a ritualistic hazing before being accepted into the clan. Perhaps this is an intellectual version of what street gangs do before admitting someone-the whole gang indulges in beating and kicking the applicant. Surely this does not reflect well on our profession. As a young man Professor Nescio certainly encountered those who seemed to delight in making the path of the newcomer painful and even then he wondered at what went into the making of such mean-spirited personalities. Had it not been for ample counterweights, his view of this profession would certainly have suffered. On the other hand there might be an innocent explanation such as the advanced courses were assigned before you were hired. But Professor Nescio has railed enough about the abuse of the young and the prostitution of the term "postdoc" in a previous column for him to continue in this line in the present missive. So he must now take a deep breath, overcome his irritation, and focus on your question.

My primary advice is that you should speak up. I would talk to your mentor at this department, assuming that you have acquired such a relationship. I would also talk to the chair. (Usually it is the chair or a faculty committee that determines who will teach the advanced courses.) In most departments with which I am familiar a request is made of the faculty to submit teaching requests and you should certainly complete this, though do not assume this will suffice. In each case the approach can be the same: I have paid my dues by teaching large sections of calculus and would like to teach something close to my expertise and at a more advanced level. Do this diplomatically—in other words do not say it as though you are owed this (as my phrasing would seem to suggest) but that this would be a great help in your development as a mathematician.

One hopes that this approach works and with most mathematicians it should. Everyone wants to develop the next generation (well, almost everyone) and teaching an advanced course as well as calculus is definitely part of that evolutionary process that allows the species to advance.

Good luck and happy career.

-Professor Nescio

Dear Professor Nescio,

I am studying for my preliminary exams. When looking at old exams, I'm struck by how easy they are some years and how difficult they are other years. My school has a policy that one must obtain a certain percentage on the exam in order to pass. I'm worried about the seeming randomness of the difficulty and about how this may impact my ability to stay in the program.

-Unsettled

Dear Unsettled,

What you describe does not surprise Professor Nescio. Exams are written by human beings or possibly a committee. If the author(s) of the exam change from one year to the next, a likely event, the nature of the exam is likely to change as well. The instructions to the authors are likely to consist of a mandate to adhere to the syllabus established for the exam, though this mandate is likely to be more implicit than explicit. Again the variations in the human species come into play here and some will take this task more seriously than others and therefore there will be a wide variation in the difficulty of different exams. By the way, this variation may be paltry when compared to the way the grading of the exams changes from year to year. The point is that even though more is at stake in this exam than a typical Calculus I exam, the effort to assure uniformity in Calculus I is far greater. So what to do?

Study! Study hard. Prepare for the worst. Expect the most difficult problems. Also you might take some comfort that in Professor Nescio's experience this is an area where student perception is often skewed by what they know. You could try to nose around to discover who will be the author. The best bet is that the person(s) who taught the most recent course that closely parallels the exam syllabus will be the exam's author. Perhaps it will be a committee of all those who work in the general area—an unlikely event if the exams do vary in degree of difficulty. But that's the general idea.

The important thing, however, is to not get caught up playing a game of "Guess the author." Just work your hardest, get a good night's sleep before the exam, and hope for the best.

> -Good luck and happy problem solving, Professor Nescio

Dear Professor Nescio,

I am currently a senior undergraduate math major applying to graduate school in mathematics. How do I start finding schools that would be good? How many schools should I apply to?

—Ready for the Next Step

Dear Ready,

If ever there was a problem that lacks a unique solution, this is it. Be cautious when you read Professor Nescio's reply. It has been many years since I went through this process. On the other hand I have advised many undergraduates in exactly your situation. So the overriding advice here is to temper the advice in this letter, or from wherever else you get it, with your own instincts and inclinations.

First, be aware that the world of mathematics is vast. You may have been enraptured by your analysis or topology course, but there are many fields in mathematics and the worst thing you can do is to select a school solely because of its reputation in a single area of research. In fact I would advise that you expose yourself to as much mathematics during your first two years of graduate school as is possible. Attend colloquia to become acquainted with other areas. Broadening your horizon is good for many reasons—helping to choose an area for research, preparing you for undergraduate teaching after the degree, and acquainting yourself with areas that might help you in whatever research you do.

Second, be aware that many of your professors may recommend schools that were good when they were in school and possibly have lost their luster. Third, understand that both large departments and small ones have virtues. A large department will offer a far greater variety of courses and expose you to competition with a greater cross-section of mathematical talent. Small departments will spend far greater time with you as an individual—don't feel self-conscious admitting that is important. Fourth, forget about geography. You aren't deciding where to raise a family and sink roots; you are going to school and you will only be there a short time. If another factor is important to you, use it in making your decision. If that something else is music, art, girlfriend, family, let it influence you but don't let it override all else.

As for the number of schools to apply to, I haven't an iota of advice. I would pick a spectrum of departments, however. Try to be as candid as you can about your ability—a trusted faculty adviser might be helpful here, as I have yet to meet a student who had an accurate view of their position in the mathematics world—I have met some who were too humble and some too haughty. Then apply to schools at a slightly higher level than you judge yourself, some at a lower level, and somewhere you feel you will belong.

If you can, visit some schools. If you are accepted and given an offer of support, they may have funds to help defray the cost of the visit—don't hesitate to ask about this. The competition for good graduate students in mathematics is heated. When you visit be sure to talk to the graduate students to get a feel for the place. Ask who their favorite professor is and their worst and why they arrived at that judgment. Ask about the Ph.D. exams, the social life, the advising, everything. This is not a time to be shy. You might also ask these questions of the faculty and compare the answers.

Though Professor Nescio is happy with his place in this profession, there is a part of him that would love to be where you are. It's the start of a grand adventure. Make the most of it.

> -Good luck, Professor Nescio

Dear Professor Nescio,

I am in a tenure-track position and will be going up for tenure next year. I have just finished a paper that I think is quite strong. There is a prestigious journal that I think I may be able to get into, but the backlog is quite long. Would it be better for me to publish in a lesser known journal so that I can declare the paper as accepted when I submit my tenure dossier?

-Ready to Submit

Dear Ready,

Submit to the strong journal; in the long run this will benefit you the most. In addition, if your department is typical, that paper as a preprint will be sent to your reference writers for review and, if your assessment of it is correct, they will see it is quality work. Further, acceptance of a paper is usually independent of the quality of a journal and so the acceptance may occur before you are up for tenure; that acceptance is more important than the actual appearance.

Understand that it is impossible to predict the reaction of different mathematicians to the same piece of evidence. We are, after all, human beings with different histories and different libraries of experiences. All of your colleagues, like you, would undoubtedly prefer that the paper had appeared. Certainly your dean will feel that way. Some of the faculty in your department may even discount to some extent the fact that it remains a preprint. (This should be very few. We have all had our problems with backlogs.) But true experts, such as your references, will recognize quality when they see it and this will dictate what they write. Your tenured colleagues will then accept their assessment as superior to the assessment of a published paper. It is then up to the department chair to explain to the dean that the references are to be taken seriously and that the nonappearance of the paper is a detail to be overlooked.

Professor Nescio wants to indulge in a bit of circumspection here. Being judged for tenure is a stressful time both for you and your department. Realize that should you not get tenure this will constitute a failure on the part of the department. The department has invested considerably in you. They invested financially in recruiting you and they have invested many dollars and several years nurturing you and developing your talents. This is part of the process of advancing the department. Should you not get tenure they are back to square one. Therefore there is a natural inclination for the department to want to tenure you. Unless you have committed some egregious sin against professionalism, they will not be looking for a reason to deny you tenure.

> —Good luck, Professor Nescio

Dear Professor Nescio,

I submitted a paper eleven months ago but still have not heard whether or not it has been accepted. Is it reasonable for me to contact the editor?

-Timed Out

Dear Timed,

By all means. In fact Professor Nescio will go a step further and say the referee of your paper has been negligent; this judgment also applies to the editor unless he/she has already nudged the referee to move towards a conclusion. To be sure refereeing a paper is one of the more onerous tasks in the profession; from my perspective maybe it's only second from the bottom to grading papers. Unless the paper is squarely in the mathematician's bailiwick, doing a good job of reading a paper and making helpful comments is tiring and bothersome. Nevertheless it is a job we are all called on to do and one needed to make the profession prosper.

So by all means write the editor a polite letter giving the details needed to easily locate the paper. Hopefully this will strike the correct degree of guilt in the referee and produce a quick response. Professor Nescio also hopes this teaches you a lesson for future service to the profession. I hope you prosper and at some time are asked to referee a paper that is in the ballpark of your interests but not exactly there. At that point recall your experience with this paper as well as Professor Nescio's advice and do a conscientious and timely review.

> -Good luck, Professor Nescio

THE CHINESE UNIVERSITY OF HONG KONG

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Department of Mathematics

Professor / Associate Professor / Assistant Professor / Research Associate Professor /

Research Assistant Professor (one to two openings) (*Ref. 0809/345(576)/2) (Closing date: March 15, 2010)*

Applicants should have a relevant PhD degree in geometry, algebra, PDE, or probability and analysis. Those with excellent qualifications in other areas will also be considered. Applicants for <u>Research Assistant Professorship</u> should have good potential for research and teaching. Applicants for <u>Assistant Professorship</u> should have outstanding profile in research and teaching; and those for <u>Professorship</u> should have established scholarship of international reputation in their specialties.

Appointment(s) will normally be made on contract basis for up to three years initially commencing August 2010, leading to longer-term appointment or substantiation later subject to mutual agreement.

Salary and Fringe Benefits

Salary will be highly competitive, commensurate with qualifications and experience. The University offers a comprehensive fringe benefit package, including medical care, and a contract-end gratuity for appointment(s) of two years or longer, plus housing benefits for eligible appointee(s).

Further information about the University and the general terms of service for appointments is available at *http://www.cuhk.edu.hk/personnel*. The terms mentioned herein are for reference only and are subject to revision by the University.

Application Procedure

Please send full resume, copies of academic credentials, a publication list and/ or abstracts of selected published papers together with names, addresses and fax numbers/e-mail addresses of three referees to whom the applicants' consent has been given for their providing references (unless otherwise specified), to the Personnel Office, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong (Fax: (852) 2603 6852) by the closing date. The Personal Information Collection Statement will be provided upon request. Please quote the reference number and mark 'Application - Confidential' on cover.

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NSF Fiscal Year 2010 Budget Request

This article is the 37th in a series of annual reports outlining the president's request to Congress for the budget of the National Science Foundation. Last year's report appeared in the June/July 2008 issue of the *Notices*, pages 711-14.

In May 2009 the National Science Foundation (NSF) released its budget request for fiscal year 2010, which begins October 1, 2009. The request calls for a total budget of US\$7.0 billion, an increase of more than 8 percent above the fiscal 2009 level. Congress appropriated US\$6.5 billion for the NSF for fiscal 2009, an increase of 6.7 percent over the fiscal 2008 level. On top of the fiscal 2009 increase,

the NSF will gain an additional US\$3 billion as part of the American Recovery and Reinvestment Act (ARRA). ARRA is one component of the Obama Administration's effort to stimulate the flagging U.S. economy. With the ARRA money spread across the foundation, the Division of Mathematical Sciences (DMS) stands to receive an estimated US\$98.0 million on top of its appropriated budget of US\$226.2 million. ARRA funds must be spent within two years.

What follows is the NSF news release about the fiscal year 2010 budget request, which provides highlights of the foundation's plans. After the news release is the section of the fiscal 2010

Table 1: National Science Foundation (Millions of Dollars)

	2006 Actual	Change	2007 Actual	Change	2008 Actual	Change	2009 Estimate*	Change	2010 Request
(1) Mathematical Sciences									* * * * *
Research Support	\$ 199.5	3.1%	\$ 205.7	2.9%	\$ 211.7	6.8%	\$ 226.2 (98.0)	8.9%	\$ 246.4
(2) Other Research	4492 5	F 20/	4710.0	1.0%	4808.2	C 20/	5108.0	0.70/	5604.1
Support (Note a)	4483.5	5.2%	4718.9	1.9%	4808.3	6.2%	(2802.0)	9.7%	5604.1
(3) Education and Human	700.2	0.6%	EDE E	10.2%	766.2	10.2%	945 2	1 60/	0570
Resources (Note D)	700.5	-0.0%	095.0	10.2%	700.5	10.5%	(100.0)	1.5%	037.0
(4) Salaries and Expenses									
(Note c)	262.5	0.6%	264.1	12.7%	297.7	4.1%	310.0 (2.0)	8.6%	336.7
(5) Totals	\$5645.8	4.2%	\$5884.4	3.4%	\$6084.0	6.7%	\$6490.4 (3002.0)	8.5%	\$7045.0
(6) (1) as a % of the sum									
of (1) and (2)	4.26%		4.18%		4.22%		4.24%		4.21%
(7) (1) as a % of (5)	3.53%		3.50%		3.48%		3.48%		3.50%

Tables prepared by Notices staff. Totals may not add up due to rounding. Note a: Support for research and related activities in areas other than the mathematical sciences. Includes scientific research facilities and instrumentation. Note b: Support for education in all fields, including the mathematical sciences. Note c: Administrative expenses of operating the NSF, including the National Science Board and the Office of the Inspector General. budget request that describes the plans of the DMS. Further details may be found on the NSF website at http://www.nsf.gov/about/budget/fy2010/. Accompanying this NSF-prepared information are the tables that traditionally appear in the *Notices* each year. (In the tables, the amounts in parentheses indicate the additional funds appropriated under ARRA.)

Mathematics departments might be especially interested in the increased funding for the NSF Graduate Research Fellowship Program. The participation of mathematics in this program has historically been low. In fiscal 2008, just 23 mathematics students received these fellowships, the smallest number for all areas in which the fellowships are given, including psychology, which had 69 fellowships, and the social sciences, which had 98. Just over 300 fellowships went to students in engineering. The distribution of these fellowships among the various areas is determined by the number of applications received, so the low participation in mathematics is due to the NSF receiving few applications from mathematics students. In fiscal 2009 these prestigious fellowships provide stipends of US\$30,000 per year for three years of graduate study. For further information, consult the website http://www.nsf.gov/grfp.

-Allyn Jackson

News Release: National Science Foundation Requests \$7.045 Billion for Fiscal Year 2010

May 14, 2009

National Science Foundation (NSF) Director Arden L. Bement Jr. today presented the agency's proposed \$7.045 billion budget for fiscal year (FY)

Table 2: Directorate for Mathematical and P	ysical Sciences (Millions of Dollars)
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	2	006	2 0	07	2 0	2008		2009		10
	Actual	% of Total	Actual	% of Total	Actual	% of Total	Estimate*	% of Total	Request	% of Total
(1) Mathematical Sciences	\$ 199.5	18.4%	\$ 205.7	17.9%	\$ 211.7	18.1%	\$ 226.2 (98.0)	18.0%	\$ 246.4	17.8%
(2) Astronomical Sciences	199.7	18.4%	215.4	18.7%	217.9	18.6%	228.6	18.2%	250.8	18.2%
(3) Physics	234.1	21.5%	248.5	21.6%	251.6	21.5%	274.5	21.8%	296.1	21.5%
(4) Chemistry	180.7	16.6%	191.2	16.6%	194.6	16.6%	211.3	16.8%	238.6	17.3%
(5) Materials Research	242.6	22.3%	257.3	22.4%	262.5	22.4%	(103.0) 282.1 (106.9)	(21.0%) 22.5% (21.8%)	309.0	22.4%
(6) Office of Multidisciplinary Activities	29.9	2.7%	32.6	2.8%	32.7	2.8%	33.2 (0.0)	2.6% (0.0%)	39.1	2.8%
(7) Totals	\$1086.6	100.0%	\$1150.7	100.0%	\$1171.3	100.0%	\$1256.0 (490.0)	100.0%	\$1380.0	100.0%

Table 3: Compilation of NSF Budget, 2002–2008 (Millions of Dollars)

		2004 Actual	2005 Actual	2006 Actual	2007 Actual	2008 Actual	2009 Estimate*	2010 Request	2004-2008 Change	2004-2010 Change
(1)	Mathematical Sciences									
	Research Support	\$ 200.3	\$ 200.2	\$ 199.5	\$ 205.7	\$ 211.7	\$ 226.2	\$ 246.4	5.7%	23.0%
	Constant Dollars	106.0	102.5	99.0	99.2	98.3			-7.3%	
(2)	Other Research Support (Note a)	4277.0	4199.7	4483.5	4718.9	4808.3	5108.9	5604.1	12.4%	31.0%
	Constant Dollars	2264.2	2150.4	2224.0	2275.9	2233.3			-1.4%	
(3)	Education and Human									
	Resources (Note b)	944.1	843.5	700.3	695.6	766.3	845.3	857.8	-18.8%	-9.1%
	Constant Dollars	499.8	431.9	347.4	335.5	355.9			-28.8%	
(4)	Salaries and Expenses (Note c)	230.6	237.3	262.5	264.1	297.7	310.0	336.7	29.0%	46.0%
	Constant Dollars	122.1	121.5	130.2	127.4	138.3			13.3%	
(5)	Totals	\$5652.0	\$5480.8	\$5645.8	\$5884.4	\$6084.0	\$6490.4	\$7045.0	7.6%	24.6%
	Constant Dollars	2992.0	2806.3	2800.5	2838.0	2825.8			-5.5%	

Current dollars are converted to constant dollars using the Consumer Price Index (based on prices during 1982-84). For Notes a, b, and c, see Table 1.

2010, an 8.5 percent increase over its planned expenditures for FY 2009. The additional \$555 million would increase funding for major investments in the scientific infrastructure, research endeavors, and human capital.

"With this budget, the president makes it absolutely clear that science and engineering research and education are vital to the nation's future," Bement said in a presentation to the National Science Board. "NSF has a long history of success in supporting research with far-reaching impacts on the U.S. economy and the well-being of Americans."

The requested budget will also put the agency on a path to doubling its budget from FY 2006 to FY 2016, as envisioned in the president's Plan for Science and Innovation, which is designed to sustain the momentum for investing in science and innovation that was generated by the American Recovery and Reinvestment Act (ARRA) of 2009.

Several prominent initiatives and other key investments outlined by President Obama will receive increased support under the requested budget:

Potentially Transformative Research. Transformative research involves ideas, discoveries, or tools that radically change our understanding of existing scientific or engineering concepts or educational practices. Such research is risky but can be high-reward if it leads to breakthroughs or creates new paradigms or fields. NSF explicitly recognizes the critical importance of transformative research in its merit review process. In FY 2010, each research division will set aside a minimum of \$2.0 million (\$92.0 million Foundation-wide) to explore methodologies and leverage ongoing activities that foster transformative research.

New Faculty and Young Investigators. (11.6 percent increase to \$203.8 million). NSF's Foundation-wide Faculty Early Career Development (CAREER) program supports junior faculty who integrate top-notch education with outstanding research and will receive an 11.6 percent increase, to \$203.8 million. The five-year awards emphasize exploring new approaches and pursuing potentially transformative activities.

Graduate Research Fellowship Program. The prestigious program is the flagship for the federal government in supporting advanced education in a broad array of science and engineering disciplines as well as international research activity. To launch the presidential initiative of tripling the number of new fellowships awarded annually by FY 2013, the request supports 1,654 new fellowships in FY 2010.

Advanced Technological Education (ATE). Focusing on two-year colleges, ATE supports partnerships between academic institutions and employers to improve the education of science and engineering technicians. Career pathways between secondary schools, two-year, and four-year colleges are supported, as are curriculum and professional development activities. Increasing the program's budget by 24 percent to \$64.0 million in FY 2010 is the beginning of a growth trajectory reaching \$100.0 million in FY 2013.

Climate Change Education Program. This new program, which will be funded at \$10.0 million each in FY 2009 and FY 2010, will catalyze activity at the national level and help develop the next generation of environmentally engaged scientists and engineers by supporting awards in the following educational areas: increasing public understanding and engagement; development of resources for learning; informing local and national science, technology, engineering and mathematics (STEM) education policy; and preparing a climate science professional workforce.

Science education and workforce development is also a priority in the requested budget, reflecting the profound impact that scientific knowledge and training can have on the career options of individuals, the economic well-being of families and community, as well as the nation's competitiveness.

Integrative Graduate Education and Research Training (IGERT). This program, which will see a nine percent increase to \$68.88 million, helps prepare doctoral students by integrating research and education in innovative ways that are tailored to the unique requirements of newly emerging interdisciplinary fields and new career options.

Discovery Research K–12. This program, which will receive \$108.5 million under the proposed budget, develops more effective tools and resources for teachers and students that will support inquiry-based classroom practices and a more intensive scientifically-based assessment of the efficacy of these resources.

Robert Noyce Teacher Scholarship Program. This program, funded at \$55.0 million under the proposed budget, enables institutions to develop and implement programs to prepare STEM undergraduate majors—and mid-career STEM professionals—to become K-12 science and mathematics teachers.

The Math and Science Partnership (MSP). Linking K-12 teachers with their colleagues in higher education, this program will receive \$58.2 million in FY 2010, and will continue to build capacity while integrating the work of higher education with that of K-12 to strengthen and reform science and mathematics education. In addition to these initiatives and priorities, the proposed budget will also ensure that NSF is able to continue to make other crucial investments that are integral to NSF's mission and vision.

Climate Change Science Program (CCSP). This interagency program coordinates climate research across 13 departments and agencies, and will receive a 36.6 percent increase under the proposed budget. NSF's role is to provide a comprehensive scientific foundation for CCSP through support of a broad and basic research portfolio, which can provide insight into the fundamental processes underlying climate.

Climate Research. The FY 2010 request includes \$197.3 million for a Foundation-wide investment that builds upon CCSP and previous NSF efforts. It focuses on multidisciplinary research that deepens our current understanding of complex interactions that influence climate, through expanded observing capabilities, modeling and simulation, and fundamental research on ways to mitigate and adapt to the impacts of a changing climate. Investments will address smart adaptation and mitigation science, regional and decadal-scale climate modeling, ecosystem vulnerability, the carbon and water cycles, ocean acidification, abrupt climate change, and weather extremes.

Cyber-enabled Discovery and Innovation (CDI). (44.7 percent increase to \$102.6 million) CDI supports transformative, multidisciplinary science and engineering research outcomes made possible by innovations and advances in computational concepts, methods, models, algorithms, and tools. CDI breakthroughs advance one or more of the three themes: From Data to Knowledge; Understanding Complexity in Natural, Built, and Social Systems; Building Virtual Organizations.

Cybersecurity. The FY 2010 request includes \$126.7 million for cybersecurity research and education, with \$40.0 million specifically devoted to research in usability, theoretical foundations, and privacy in support of the Comprehensive National Cybersecurity Initiative.

Experimental Program to Stimulate Competitive Research (EPSCoR). NSF remains a leader in efforts to broaden participation in science and engineering in all states and regions. Funding for EPSCoR increases by 10.6 percent to \$147.1 million.

Homeland Security Activities. NSF programs apply to homeland security priorities in two areas: protecting critical infrastructure and key assets and defending against catastrophic threats. The proposed budget will increase that funding 2.2 percent to \$385.5 million.

Networking and Information Technology R&D (NITRD). NITRD coordinates networking and information technology investments across agencies. Major funding increases for FY 2010 are in such areas as large-scale networking, high-end computing research, human-computer interaction, and research on social, economic, and workforce aspects of advanced computing and communications technologies. The proposed budget will increase funding for the program by a 10.6 percent increase to \$1,110.8 million.

National Nanotechnology Initiative. This multiagency initiative seeks systematic understanding, organization, manipulation, and control of atomic, molecular, and supramolecular levels of matter in the size range of 1–100 nanometers. The initiative will receive a 6.5 percent increase to \$423.0 million under the proposed budget, which will also provide a \$2.0 million increase for the Environmental, Health, and Safety area to support decision analysis research.

Major Research Equipment and Facilities Construction. (\$117.29 million)

• Advanced Laser Interferometer Gravitational Wave Observatory: \$46.30 million.

· Atacama Large Millimeter Array: \$42.76 million.

· IceCube Neutrino Observatory: \$950,000.

· Advanced Technology Solar Telescope: \$10.0 million.

Ocean Observatories Initiative: \$14.28 million.
 Judgment Fund: \$3.0 million.

Regaining Our Energy Science and Engineering Edge (RE-ENERGYSE). This set of investments, part of the president's New Energy for America plan, focuses on preparing students for careers related to research and education on clean energy. NSF, working with the Department of Energy, will leverage existing programs and partnerships to train scientists and technicians, educate K-12 and undergraduate students, and inform the public.

Science and Engineering Beyond Moore's Law. In 10 to 20 years, current silicon technology will reach the limits of Moore's Law—the empirical observation that computing power doubles roughly every 18 months. Activities in FY 2010, funded at \$46.7 million, will encourage transformational activities as well as creating partnering opportunities with the private sector and national laboratories to accelerate innovation.

Science and Technology Centers (STC). STCs integrate cutting-edge research, excellence in education, targeted knowledge transfer, and development of a diverse workforce across all disciplines of science and engineering. STCs conduct research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations, as appropriate. With funding set at \$57.8 million, up to five new STCs are expected to be funded in FY 2010, for a total of 17.

Stewardship. To manage the growing and increasingly complex workload being experienced throughout the Foundation, the request includes an 8 percent increase for Agency Operations and Award Management.

Bement ended his remarks to the [National Science Board] by stating that the nation needs "research and education in every scientific field to resolve America's greatest challenges. With a steady eye on the frontier, NSF will continue to support basic research across all fields and education at all levels to ensure that America remains a global leader in science and technology."

Budget Request: Mathematical Sciences

The Division of Mathematical Sciences (DMS) supports research at the frontiers of fundamental, applied, and computational mathematics and statistics and enables discovery in other fields of science and engineering. In turn, advances in science and engineering that are driven by powerful computing environments and that routinely generate large datasets require development of ever more sophisticated mathematical tools. DMS plays a key role in training the nation's scientific and engineering workforce. In general, 53 percent of the DMS portfolio is available for new research grants. The remaining 47 percent is used primarily to fund continuing grants made in previous years.

DMS supports research programs in algebra, number theory, and combinatorics; analysis; applied mathematics; computational mathematics; foundations; geometry and topology; mathematical biology; probability and statistics. In addition, DMS supports national mathematical sciences research institutes; postdoctoral, graduate and undergraduate training opportunities; and infrastructure, such as workshops, conferences, and equipment.

NSF plays a critical role in the mathematical sciences, as it provides more than 60 percent of all federal support for basic research in the nation's colleges and universities. In certain areas of the mathematical sciences this percentage is even higher, since NSF supports a broader range of fundamental and multidisciplinary research topics than other federal agencies.

In FY 2008, DMS received 2,181 research proposals and made 678 awards for a funding rate of 31 percent.

Changes by Activity

Mathematical Sciences Research Institutes (+\$6.0 million, to a total of \$26.0 million). These institutes are supported in 10-year cycles. The current funding cycle for four of the institutes ends in FY 2009. They are eligible to re-compete in a FY 2010 institutes solicitation with other projects. The FY 2010 budget can accommodate an increase in the number and size of institute awards. Four to six awards are expected.

Cyber-enabled Discovery and Innovation (CDI) (+\$5.20 million, to a total of \$10.40 million). CDI uses the mathematical sciences to provide new ways of obtaining insight into the nature of complex phenomena in science and engineering.

Science and Engineering Beyond Moore's Law (SEBML) (+\$2.0 million, to a total of \$2.75 million). In parallel with Moore's Law for hardware, SEBML continues the algorithmic "Moore's Law", i.e., the exponential increase in speed of basic computations due to innovative new algorithms, and develops new mathematical frameworks for computation.

Solar Energy Research (SOLAR) (+\$1.70 million, to a total of \$2.40 million). SOLAR will support multidisciplinary teams engaged in potentially transformative research on the efficient harvesting, conversion, and storage of solar energy.

Climate Research (CR) will start in FY 2010 at \$1.85 million. CR will support development of mathematical methods and effective computational techniques needed for simulation and analysis of climate models.

Mathematical Sciences Funding

(Dollars in Millions)

	FY 2008	FY2009 Current	FY2009 ARRA	FY 2010	Chang FY 200	e Over 19 Plan
	Actual	Plan	Estimate	Request	Amount	Percent
Total, DMS	\$211.75	\$226.18	\$98.00	\$246.41	\$20.23	8.9
Major Components:						
Research and Education Grants	211.37	226.08	98.00	246.21	20.13	8.9%
Centers	0.38	0.10	-	0.20	0.10	1.0%
Ctrs. for Analysis & Synthesis	-	0.10	-	0.10	-	-
Nanoscale Science & Engr. Centers	0.38		-	0.10		N/A

Mathematics People

Reingold, Vadhan, and Wigderson Awarded Gödel Prize

OMER REINGOLD of the Weizmann Institute of Science, SALIL VADHAN of Harvard University, and AVI WIGDER-SON of the Institute for Advanced Study, Princeton University, were named recipients of the Gödel Prize of the Association for Computing Machinery (ACM) at the ACM Symposium on the Theory of Computing (STOC) held May 31–June 2, 2009, in Bethesda, Maryland. The Gödel Prize for outstanding papers in the area of theoretical computer science is sponsored jointly by the European Association for Theoretical Computer Science (EATCS) and the Special Interest Group on Algorithms and Computing Theory of the ACM (SIGACT). The prize carries a cash award of US\$5,000.

Reingold, Vadhan, and Wigderson were recognized for their development of "a new type of graph that enables the construction of large expander graphs, which play an important role in designing robust computer networks and constructing theories of error-correcting computer codes. Using the new zig-zag graph, this technique was able to solve one of the most intriguing open problems in computational complexity theory, that of detecting a path from one node to another in very small storage for undirected graphs (in which the nodes are connected by lines with no direction)." In a paper titled "Entropy Waves, the Zig-Zag Graph Product and New Constant Degree Expanders", the authors presented their research on a rich family of expander graphs, which are used for critical computer theory applications. These sparse but highly connected graphs were constructed using the zig-zag graph product. This new tool makes it possible to construct large expanders from smaller expanders while preserving degree and connectivity.

In a paper titled "Undirected Connectivity in Log-Space", Reingold proved that connectivity in undirected graphs can be solved in logarithmic storage (i.e., enough storage to hold a constant number of pointers or counters stored elsewhere in the computer). The author's key observation is that any connected graph is a very weak expander, but applying the zig-zag product makes it possible to turn the graph into an expander of only moderately large size. This solution had been possible using randomness but had not been accomplished with a deterministic algorithm, as Reingold demonstrated. The findings of Reingold, Vadhan, and Wigderson were published in the *Annals of Mathematics* in 2002. The subsequent findings of Reingold on undirected connectivity in log-space were published in the *Journal of the Association for Computing Machinery* in 2007.

Reingold received the ACM Grace Murray Hopper Award in 2005 for "the outstanding young computer professional of the year". He completed a Ph.D. and pursued a short period of postdoctoral studies at the Weizmann Institute. He received his B.Sc. in mathematics from Tel Aviv University.

Vadhan received his Ph.D. in applied mathematics from the Massachusetts Institute of Technology and won the 2000 ACM Doctoral Dissertation Award. He has earned a Certificate of Advanced Study in Mathematics from Churchill College, Cambridge University, and received his A.B. in mathematics and computer science from Harvard University. Wigderson received the 1994 Nevanlinna Prize from the International Congress of Mathematicians in Zurich.

The Gödel Prize is named in honor of Kurt Gödel, an Austrian-American mathematician and philosopher who had a major impact on scientific and philosophical thinking in the twentieth century. The award recognizes his major contributions to mathematical logic and the foundations of computer science.

-From an ACM announcement

AMS Menger Awards at the 2009 ISEF

The 2009 Intel International Science and Engineering Fair (ISEF) was held May 10–15, 2009, in Reno, Nevada. This was the fifty-ninth year of the ISEF competition. More than fifteen hundred students in grades 9 through 12 from over fifty countries participated in the fair. Student finalists who competed at the ISEF went through a multistep process to qualify and won an all-expense-paid trip to the fair. They qualified by winning local, regional, and state fairs in the United States or national science fairs abroad. In addition to numerous grand awards presented by the ISEF, sixty-seven federal agencies and professional and educational organizations, including the American Mathematical Society (AMS), participated by giving special awards. Prizes given by the AMS included cash, certificates, books, and tote bags.



AMS Menger Award winners. Front row, left to right: Alicia Zhang, Sohini Sengupta, Almas Abdulla, Yale Fan. Back row, left to right: Sameer Deshpande, Jeffrey Chan, Sarah Sellers, Joshua Vekhter, Andrei Triffo, and Ed Connors, committee chair.

For the AMS, this was the twenty-second year of participation, and it was the twentieth year of presentation of the Karl Menger Awards. The members of the 2008-2009 AMS Menger Prize Committee and AMS Special Awards Judges were Edward Connors, University of Massachusetts (chair); Doron Levy, University of Maryland; and David Scott, University of Puget Sound. The panel of judges reviewed all fifty-seven projects in mathematics, as well as mathematically oriented projects in computer science, physics, and engineering. From these entries they interviewed several students selected for further consideration for a Menger Award. In the mathematics category forty-five entries were individuals, and twelve were submitted by teams of two or three students. The AMS gave awards to one first-place winner, two second-place winners, and four third-place winners (including one team of three students), and honorable mentions to five others.

The Karl Menger Memorial Prize winners are as follows: *First-Place Award* (US\$1,000): "Graph Crossings and Cyclic Permutations: Towards a Proof of Zarankiewicz's Conjecture", JOSHUA VEKHTER, 17, Williamsville East High School, East Amherst, New York.

Second-Place Awards (US\$500): "Infinite Sums of Zeta Functions and Other Dirichlet Series", ANDREI TRIFFO, 17, Synge Street CBS Secondary School, Dublin, Ireland; and "A Quantum Algorithm for Molecular Dynamics Simulation", YALE WANG FAN, 17, The Catlin Gabel School, Portland, Oregon.

Third-Place Awards (US\$250): "Universal Law for the Distribution of Odd Periodic Cycles within Chaos in Nonlinear Dynamical Systems: An Analysis of Rigid Bifurcation", ALMAS ABDULLA, 15, West Shore Junior/Senior High School, Melbourne, Florida; "Dirichlet Prime Magic Square", SARAH L. SELLERS, 18, Hedgesville High School, Hedgesville, West Virginia; "Controlling HIV from Transformation into AIDs: Mathematical Modeling of HIV Dynamics", SOHINI SENGUPTA, 17, Ocean Lakes High School, Virginia Beach, Virginia; and "Survival Analysis of Gene Expression Data Using a Hybrid Dimension Reduction Technique", SAMEER K. DESHPANDE, 18, Texas Academy of Mathematics and Science, Denton, Texas, JEFFREY CHAN, 16, William P. Clements High School, Sugar Land, Texas; and ALICIA ZHANG, 17, Liberal Arts and Science Academy High School, Austin, Texas.

Honorable Mention Awards: "Sequences of Reducible 0,1 Polynomials", MARTIN A. CAMACHO, 13, Central High School, St. Paul, Minnesota; "Convergence Acceleration for the Power Series Representation of the Exponential Integral", MICHAEL C. YURKO, 15, Detroit Catholic Central High School, Novi, Michigan; "MatheMagical' Pool", WENHAN CUI, 14, Cookeville High School, Cookeville, Tennessee; "An Analysis of Erdős's

Conjecture", MATTHEW H. STOFFREGEN, 18, Woodland Hills High School, Pittsburgh, Pennsylvania; and "A Relativistic Generalization of the Navier-Stokes Equations to Quark-Gluon Plasmas", NILESH TRIPURANENI, 18, Clovis West High School, Fresno, California.

The Society for Science and the Public (SSP), a nonprofit organization based in Washington, D.C., owns and has administered the ISEF since 1950. Intel became the title sponsor of ISEF in 1996.

The panel of judges was impressed both by the quality, breadth and originality of the work and the dedication and enthusiasm of the students. The projects covered a wide range of topics, as indicated by the titles of the awardwinning projects.

In all, fifty-one male and twenty-one female students entered the competition. Of the monetary award winners (first, second, and third place), four are female and five are male. Sarah Sellers (third place) was the only 2009 winner to have also placed in 2008 (honorable mention).

The AMS's participation in the Intel-ISEF is supported in part by income from the Karl Menger Fund, which was established by the family of the late Karl Menger. For more information about this program or to make contributions to this fund, contact the AMS Development Office, 201 Charles Street, Providence RI, 02904-2294, or send email to development@ams.org, or phone 401-455-4151.

-Ed Connors, University of Massachusetts

Mathematical Sciences Awards at the 2009 ISEF

The 2009 Intel International Science and Engineering Fair (ISEF) was held May 10–15, 2009, in Reno, Nevada.

More than fifteen hundred students in grades 9 through 12 from over fifty countries participated in the fair. The Society for Science and the Public, in partnership with the Intel Foundation, has honored the following mathematics students with Grand Awards, which consist of cash and other prizes.

Best of Category Award (US\$5,000) and *First Award* (US\$3,000): "The Classification of Certain Fusion Categories", ERIC K. LARSON, 17, South Eugene High School, Eugene, Oregon.

Second Awards (US\$1,500): "Universal Law for the Distribution of Odd Periodic Cycles within Chaos in Nonlinear Dynamical Systems: An Analysis of Rigid Bifurcation, Year II", ALMAS ABDULLA, 15, West Shore Junior/Senior High School, Melbourne, Florida; "Forcing a Draw in K-ina-Row Games", SHENG-HAO CHIANG, 18, National Experimental High School at Hsinchu Science Park, Hsinchu City, Chinese Taipei; "On G-Difference: A Property of Permutations and Words", KRISTIN R. CORDWELL, 18, Manzano High School, Albuquerque, New Mexico.

Third Award (US\$1,000): "Sequences of Reducible 0,1 Polynomials", MARTIN A. CAMACHO, 13, Central High School, St. Paul, Minnesota; "Matching Preclusion for the (*n*,*k*)-Bubble-Sort Graphs", DAVID A. SHERMAN, 18, Wylie E. Groves High School, Beverly Hills, Michigan; "An Analysis of Erdős's Conjecture", MATTHEW H. STOFFREGEN, 18, Woodland Hills High School, Pittsburgh, Pennsylvania; "Infinite Sums of Zeta Functions and Other Dirichlet Series", ANDREI TRIFFO, 17, Synge Street CBS Secondary School, Dublin, Ireland.

Fourth Award (US\$500): "An Investigation of the Closure of the Set of Singleton Sets of Natural Numbers under Union, Intersection, Complement, Addition, Multiplication", JASON S. GROSS, 17, Commack High School, Commack, New York; "Approximation of the Size of Distorted Spherical Objects, and a New Algorithm for Precisely Estimating the Size of Spherical Fullerene Molecules", JUN SUP LEE, 15, Langley High School, McLean, Virginia; "Parameterizing Knots with Chebyshev Polynomials", Jenna K. Freudenburg, 18, Kalamazoo Area Math and Science Center, Kalamazoo, Michigan; "Graph Crossings and Cyclic Permutations: Towards a Proof of Zarankiewicz's Conjecture", JOSHUA VEKHTER, 17, Williamsville East High School, East Amherst, New York; "MicroRNA Expression Patterns in Mouse Lung Development and Cancer", KEVIN KYLE HAWKINS, 17, Glen Oak High School, Canton, Ohio.

The Seaborg SIYSS Award was presented to Larson for "The Classification of Certain Fusion Categories". He will receive an all-expense-paid trip to attend the Stockholm International Youth Science Seminar (SIYSS) during the Nobel Prize Ceremonies in December 2009. The award is named for the late Glenn T. Seaborg, Nobel Laureate in chemistry.

—Elaine Kehoe

Crowdy Receives CMFT Young Researcher Award

DARREN CROWDY of Imperial College, London, has been awarded the 2009 CMFT Young Researcher Award at the Computational Methods and Function Theory (CMFT) conference held in Ankara, Turkey, June 8–12, 2009. He was honored for his work in developing mathematical techniques for solving engineering problems involving complicated geometries. His research in conformal mapping led to his updating of the Schwarz-Christoffel formula so it could be used for more complicated shapes and, therefore, in more diverse applications in physics and engineering.

The CMFT Young Researcher Award is given every four years for outstanding scientific contributions in the fields of mathematics associated with the CMFT conference. These fields include the interaction of complex variables and scientific computation, including related topics from function theory, approximation theory, and numerical analysis. The award consists of a cash prize of 1,000 euros (approximately US\$1,400) and the opportunity to give a plenary address at the CMFT 2009 conference.

-From an Imperial College announcement

Ford Foundation Diversity Fellowships Awarded

The Ford Foundation has named the recipients of its Diversity Fellowships for 2008. The Ford Foundation's predoctoral, dissertation, and postdoctoral fellowship programs seek to increase the presence of underrepresented minorities on college faculties. Awardees later serve as role models and mentors for a new generation of scholars. Two awardees in the mathematical sciences received Predoctoral Fellowships of US\$20,000 a year for up to three years. TANIECEA A. ARCENEAUX of Princeton University is a student in applications of mathematics. ANTHONY M. FRANKLIN of North Carolina State University is a student in the field of statistics.

-From a Ford Foundation announcement

Korchmáros Receives Euler Medal

GÁBOR KORCHMÁROS of the University of Basilicata has been chosen to receive the 2008 Euler Medal, awarded annually by the Institute of Combinatorics and Its Applications (ICA). The medal is given to mathematicians who have made distinguished lifetime contributions to combinatorial research and who are still active in research. According to the prize citation, Korchmáros has made "important contributions to combinatorial geometry and applications to the theory of codes and cryptography."

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beyond the bounds of plausible conversation, and she is presented as a woman of substance who cared little for the trappings of style and pomp."

-Charles Aschbacher, MAA Reviews

The Prince of Mathematics Carl Friedrich Gauss M. B. W. Tent

"For teachers who value the impact that historical studies in mathematics can have on their students, who incorporate literature into their teaching, or who want to open up a world of mathematics often inaccessible to middle school students, this is an excellent source."



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Mathematics People

He is "a leading representative of the theory of ovals and their generalizations in higher dimensional spaces over finite fields." His current research also includes the known embedding problem of arcs in an oval, which has relevant applications to coding theory, and algebraic curves defined over a finite field and their automorphism groups. His work is characterized by a variety of methods borrowed from combinatorial geometry, the theory of groups and graphs, and algebraic geometry.

-From an ICA announcement

Royal Society of London Elections

The following mathematical scientists have been elected to the Royal Society of London: MICHAEL BATTY, University College London; JONATHAN P. KEATING, University of Bristol; and BURT J. TOTARO, University of Cambridge. Elected as a foreign member was YAKOV SINAI, Princeton University and Landau Institute of Theoretical Physics, Academy of Sciences of Russia.

-From a Royal Society of London announcement

Mathematics Opportunities

American Mathematical Society Centennial Fellowships

Invitation for Applications for Awards for 2010-2011 Deadline December 1, 2009

Description: The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Society supplements contributions as needed. One fellowship will be awarded for the 2010–2011 academic year. A list of previous fellowship winners can be found at http:// www.ams.org/prizes/centennial-fellowship.html.

Eligibility: The eligibility rules are as follows. The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or National Science Foundation Postdoctoral Fellowship. Under normal circumstances, the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award (that is, received between September 1, 1998, and September 1, 2007). Applications will be accepted from those currently holding a tenured, tenure-track, postdoctoral, or comparable position (at the discretion of the selection committee) at an institution in North America. Applications should include a cogent plan indicating how the fellowship will be used. The plan should include travel to at least one other institution and should demonstrate that the fellowship will be used for more than reductions of teaching at the candidate's home institution. The selection committee will consider the plan in addition to the quality of the candidate's research and will try to award the fellowship to those for whom the award would make a real difference in the development of their research careers. Work in all areas of mathematics, including interdisciplinary work, is eligible.

Grant amount: The stipend for fellowships awarded for 2010–2011 is expected to be US\$77,000, with an additional expense allowance of about \$7,700. Acceptance of the fellowship cannot be postponed.

Deadline: The deadline for receipt of applications is **December 1, 2009**. Awards will be announced in February 2010 or earlier if possible.

Application information: Application forms are available via the Internet at http://www.ams.org/employment/ centflyer.html. For paper copies of the form, write to the Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; or send electronic mail to prof-serv@ams. org; or call 401-455-4105.

-AMS announcement

AMS Scholarships for "Math in Moscow"

The Independent University of Moscow runs a program called "Math in Moscow", which offers foreign students (undergraduate or graduate students specializing in mathematics and/or computer science) the chance to spend a semester in Moscow studying mathematics. The AMS provides a small number of scholarships to students to attend the program.

Math in Moscow provides students with a fifteen-week program similar to the Research Experiences for Undergraduates programs that are held each summer across the United States. Math in Moscow draws on the Russian tradition of teaching mathematics, which emphasizes creative approaches to problem solving. The focus is on developing in-depth understanding of carefully selected material rather than broad surveys of large quantities of material. Discovering mathematics under the guidance of an experienced teacher is the central principle of Math in Moscow. Most of the program's teachers are internationally recognized research mathematicians, and all of them have considerable teaching experience in English, typically in the United States or Canada. All instruction is in English.

With funding from the National Science Foundation (NSF), the AMS awards five US\$7,500 scholarships each semester to U.S. students to attend the Math in Moscow program. To be eligible for the scholarships, students must submit *separate* applications to *both* the Math in Moscow program and the AMS. An applicant should be an undergraduate mathematics or computer science major enrolled at a U.S. institution. **September 30, 2009**, is the deadline for the spring 2010 semester; **April 15, 2010**, is the deadline for scholarship applications for the fall 2010 semester.

Information and application forms for Math in Moscow are available on the Web at http://www.mccme.ru/ mathinmoscow, or by writing to Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax: +7095-291-65-01; email:mim@mccme.ru. Information and application forms for the AMS scholarships are available on the Web at http://www.ams.org/employment/mimoscow.html, or by writing to Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email: student-serv@ams.org.

-AMS announcement

Call for Nominations for Chern Medal

The International Mathematical Union (IMU) and the Chern Medal Foundation (CMF) have established a major new prize in mathematics, the Chern Medal Award, in memory of the outstanding mathematician Shiing-Shen Chern. The Chern Medal will be awarded every four years in conjunction with the International Congress of Mathematicians (ICM) to an individual whose accomplishments warrant the highest level of recognition for outstanding achievements in the field of mathematics.

The medal will be awarded for the first time at ICM 2010 in Hyderabad, India. The award carries a cash prize of US\$250,000. In addition, each awardee may nominate one or more organizations to receive Organization Awards, funding totaling US\$250,000, for the support of research, education, or other outreach programs in the field of mathematics.

Nominations should ideally be sent by **December 15**, **2009**, electronically or on paper, to Phillip A. Griffiths, Institute for Advanced Study, Einstein Drive, Princeton, NJ, 08540, email: huguenin@ias.edu. For more details about the award, the nomination process, and the selection criteria, see http://www.mathunion.org/fileadmin/IMU/Prizes/Chern/Chern_Medal_Program_Guidelines.pdf.

Shiing-Shen Chern (1911–2004) devoted his life to mathematics, both in active research and education. He obtained fundamental results in all the major aspects of modern geometry and founded the area of global differential geometry. Chern's work exhibited keen aesthetic tastes in his selection of problems, and in its breadth it exemplified the interconnectiveness of modern geometry and all of its aspects. The Chern Medal Award is funded by CMF.

-From an IMU announcement

NRC–Ford Foundation Diversity Fellowships

The National Research Council (NRC) administers the Ford Foundation Diversity Fellowships program. The program seeks to promote the diversity of the nation's college and university faculties by increasing their ethnic and racial diversity, to maximize the educational benefits of diversity, and to increase the number of professors who can and will use diversity as a resource for enriching the education of all students. Predoctoral fellowships support study toward a Ph.D. or Sc.D.; dissertation fellowships offer support in the final year of writing the Ph.D. or Sc.D. thesis; postdoctoral fellowships offer one-year awards for Ph.D. recipients. Applicants must be U.S. citizens or nationals in research-based fields of study and members of one of the following groups: Alaska Native (Eskimo or Aleut), Black/African American, Mexican American/Chicana/ Chicano, Native American Indian, Native Pacific Islander (Polynesian/Micronesian), or Puerto Rican.

Approximately sixty predoctoral fellowships will be awarded for 2010. The awards provide three years of support and are made to individuals who, in the judgment of the review panels, have demonstrated superior academic achievement, are committed to a career in teaching and research at the college or university level, show promise of future achievement as scholars and teachers, and are well prepared to use diversity as a resource for enriching the education of all students. The annual stipend is US\$20,000, with an insitutional allowance of US\$2,000. The deadline for applying online is **November 2, 2009**.

Approximately thirty-five dissertation fellowships will be awarded for 2010 and will provide one year of support for study leading to a Ph.D. or Sc.D. degree. The stipend for one year is US\$21,000. The deadline for applying online is **November 9, 2009**.

Approximately twenty postdoctoral fellowships will be awarded for 2010. These fellowships provide one year of support for individuals who have received their Ph.D. or Sc.D. degrees no earlier than November 30, 2002, and no later than November 9, 2009, in an eligible research-based field from a U.S. educational institution. The stipend is US\$40,000 with an employing institution allowance of US\$1,500. The deadline for applying online is **November 9, 2009**.

More detailed information and applications are available at the website http://sites.nationalacademies. org/pga/FordFellowships/index.htm. The postal address is: Fellowships Office, Keck 576, National Research Council, 500 Fifth Street, NW, Washington, DC 20001. The telephone number is 202-334-2872. The email address is infofell@nas.edu.

-From an NRC announcement

NSF International Research Fellow Awards

The objective of the International Research Fellowship Program (IRFP) of the National Science Foundation (NSF) is to introduce scientists and engineers in the early stages of their careers to research opportunities abroad. The program provides support for postdoctoral and junior investigators to do research in basic science and engineering for nine to twenty-four months in any country in the world. The goal of the program is to establish productive, long-term relationships between U.S. and foreign science and engineering communities. Applicants must be U.S. citizens or permanent residents who have earned their doctoral degrees within two years before the date of application or who expect to receive their degrees by the date of the award.

The deadline for full proposals is **September 8, 2009**. For further information contact the program officer, Susan Parris, 703-292-7225, sparris@nsf.gov; or visit the website http://www.nsf.gov/funding/pgm_summ. jsp?pims_id=5179&org=NSF.

-From an NSF announcement

AWM Travel Grants for Women

The National Science Foundation (NSF) and the Association for Women in Mathematics (AWM) sponsor travel grant programs for women mathematicians.

AWM Travel Grants enable women to attend research conferences in their fields, thereby providing scholars valuable opportunities to advance their research activities and their visibility in the research community. A Mathematics Travel Grant provides full or partial support for travel and subsistence for a meeting or conference in the grantee's field of specialization. The Mathematics Education Research Travel Grants provide full or partial support for travel and subsistence in math/math education research for mathematicians attending a math education research conference or math education researchers attending a math conference.

AWM Mentoring Travel Grants are designed to help junior women develop long-term working and mentoring relationships with senior mathematicians. A mentoring travel grant funds travel, subsistence, and other expenses for an untenured woman mathematician to travel to an institute or a department to do research with a specified individual for one month.

The final deadline for the Travel Grants program for 2009 is October 1, 2009; the deadlines for 2010 are February 1, 2010; May 1, 2010; and October 1, 2010. For the Mentoring Travel Grants program the deadline is February 1, 2010. For further information and details on applying, see the AWM website, http://www.awm-math.org/travelgrants.html; telephone: 703-934-0163; or email: awm@awm-math.org. The postal address is: Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

-From an AWM announcement

Call for Nominations for Clay Research Fellows

The Clay Mathematics Institute (CMI) solicits nominations for its competition for the 2010 Clay Research Fellowships. Fellows are appointed for a period of two to five years. They may conduct their research at whatever institution or combination of institutions best suits their research. In addition to a generous salary, the Fellow receives support for travel, collaboration, and other research expenses.

The selection criteria are the quality of the candidate's research and promise to make contributions of the highest level. At the time of their selection, most recent appointees were graduating Ph.D. students. However, mathematicians within three years of the Ph.D. are sometimes appointed. Selection decisions are made by CMI's Scientific Advisory Board: Jim Carlson, Simon Donaldson, Gregory Margulis, Richard Melrose, Yum-Tong Siu, and Andrew Wiles.

To nominate a candidate, please send the following items by **September 16, 2009**: (1) letter of nomination; (2) names and contact information of two other references; (3) curriculum vitae for the nominee; and (4) publication list for the nominee.

Nominations should be sent to the attention of Alagi Patel, Clay Mathematics Institute, One Bow Street, Cambridge, MA 02138. Electronic submissions are also accepted at nominations@claymath.org.

Information about the Clay Research Fellows is available on the CMI website at http://www.claymath.org/ research_fellows. Additional information may be obtained by calling Alagi Patel at 617-995-2602 or emailing her at patel@claymath.org.

Current and alumni Clay Research Fellows are Mohammed Abouzaid, Spyridon Alexakis, Artur Avila, Roman Bezrukavnikov, Manjul Bhargava, Daniel Biss, Alexei Borodin, Maria Chudnovsky, Dennis Gaitsgory, Soren Galatius, Daniel Gottesman, Ben Green, Sergei Gukov, Adrian Ioana, Bo'az Klartag, Elon Lindenstrauss, Ciprian Manolescu, Davesh Maulik, Maryam Mirzakhani, Sophie Morel, Mircea Mustata, Sam Payne, Igor Rodnianski, Sucharit Sarkar, David Speyer, Terence Tao, Andras Vasy, Akshay Venkatesh, Teruyoshi Yoshida, Xinyi Yuan.

-Clay Mathematics Institute announcement

Graduate Student Travel Grants to 2010 JMM

The AMS, with funding from a private gift, is accepting applications for partial travel support for graduate students attending the Joint Mathematics Meetings in San Francisco, CA, January 13–16, 2010. The awards, not to exceed US\$500, must be matched by travel funds from the student's institution. It is expected that awards will be made late in November 2009. Funding is provided on a reimbursement basis.

The deadline for submitting applications is **October 28, 2009**. Awards or decline notifications will be made by email in late November 2009. Information can be found at http://www.ams.org/employment/ student-JMM.html. This travel grant program is being administered by the AMS Membership & Programs Department. You can reach the department at student-JMM@ams.org, or 800-321-4267, ext. 4060, or 401-455-4060.

-AMS announcement

News from the Fields Institute

Edward Bierstone of the University of Toronto assumed the post of director of the Fields Institute for Research in the Mathematical Sciences on July 1. He succeeds Barbara Lee Keyfitz, who retired from the directorship on December 31 to assume a professorship at the Ohio State University in Columbus, Ohio, and Juris Steprans of York University, who served as acting director in the interim.

Thematic Programs. The fall 2009 thematic program will be *Foundations of Computational Mathematics.* Three workshops will be held: *Discovery and Experimentation in Number Theory,* September 22–26 (held at the Interdisciplinary Research in the Mathematical and Computational Sciences [IRMACS] Centre, Simon Fraser University); the *Fields Institute Workshop on Complexity of Numerical Computation,* October 20–24; and *Computational Differential Geometry, Topology, and Dynamics,* November 16–21.

Hendrik Lenstra (Universiteit Leiden) will deliver the *Distinguished Lecture Series*, September 16–18, and Éva Tardos (Cornell University) will deliver the *Coxeter Lecture Series* on a date to be announced.

More information can be found at http://www.fields.utoronto.ca/programs/scientific/09-10/FoCM.

Future thematic programs include the following:

Winter/Spring 2010: Quantitative Finance: Foundations and Applications

Fall 2010: Asymptotic Geometric Analysis

Winter/Spring 2011: Dynamics and Transport in Disordered Systems

Fall 2011: Discrete Geometry and Applications *Winter/Spring 2012:* Galois Representations

Activities in the fall of 2009 include:

September 10–13: Workshop on Adaptive Movement of Interactive Species

September 24–26: Workshop on Modeling Indirectly or Imprecisely Observed Data

October 1: CRM-Fields-PIMS Prize Lecture. Lecturer: Martin Barlow, University of British Columbia.

October 3-4: Southern Ontario Groups and Geometry Workshop

October 31-November 1: Workshop on Algebraic Varieties

November 25: IFID Conference on Retirement Income Analytics

See the Fields Institute website, http://www.fields. utoronto.ca/programs/scientific/, for information on all activities at the Institute.

-Fields Institute announcement

PIMS Postdoctoral Fellowships

The Pacific Institute for the Mathematical Sciences (PIMS) invites nominations of outstanding young researchers in the mathematical sciences for Postdoctoral Fellowships for the year 2010–2011. Candidates must be nominated by one or more scientists affiliated with PIMS or by a department or departments affiliated with PIMS. The fellowships are intended to supplement support made available through such a sponsor. The Institute supports fellowships tenable at any of its Canadian member universities: Simon Fraser University, the University of Alberta, the University of British Columbia, the University of Calgary, the University of Saskatchewan, as well as at the University of Lethbridge (a PIMS affiliate).

For the 2010–2011 competition, to be held in January of 2010, the amount of the award will be CA\$20,000 (approximately US\$17,500), and the sponsor(s) is (are) required to provide additional funds to finance a minimum stipend of \$40,000 (approximately US\$35,000).

Award decisions are made by the PIMS PDF Review Panel based on the excellence of the candidate, potential for participation in PIMS programs, and potential for involvement with PIMS partners. PIMS Postdoctoral Fellows will be expected to participate in all PIMS activities related to the Fellow's area of expertise and will be encouraged to spend time at other sites. To ensure that PIMS Postdoctoral Fellows are able to participate fully in Institute activities, they may not teach more than two single-term courses per year.

Nominees must have a Ph.D. or equivalent (or expect to receive a Ph.D. by December 31, 2010) and be within three years of the Ph.D. at the time of the nomination (i.e., the candidate must have received her or his Ph.D. on or after January 1, 2007). The fellowship may be taken up at any time between September 1, 2010, and January 1, 2011. The fellowship is for one year and is renewable for at most one additional year.

The nomination/application process will take place entirely online this year, utilizing the MathJobs service provided by the American Mathematical Society (AMS). Having selected their nominees, sponsors direct them to apply online at mathjobs.org/jobs/PIMS. Nominees are required to upload two letters of reference, a curriculum vitae, and a statement of research interests. Sponsors must also upload their own reference letters (these are in addition to the two reference letters mentioned above) and statements of anticipated support to MathJobs; they will receive instructions as to how to proceed from their nominees via email from MathJobs. Detailed instructions regarding all aspects of the MathJobs application procedure may be found in the online MathJobs user guides. Please note that application is by nomination only; unsolicited applications will not be considered.

Complete applications must be uploaded to MathJobs by **December 15, 2009**. For further information, visit the website http://www.pims.math.ca/scientific/postdoctoral.

-PIMS announcement
Inside the AMS

From the AMS Public Awareness Office

A Guide to Online Resources for High School Math Students brochure. The Office is undertaking a project to promote awareness of AMS resources of interest to high

a guide to online resources for high school math students		
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school math students: the central list of summer math programs, Who Wants to Be a Mathematician, Arnold Ross lectures, career information, Headlines & Deadlines for Students email service, Mathematical Imagery, Math in the Media, online math articles and essays, and posters. The brochure and other materials are mailing this fall to 9,000 members of the National Council of Teachers of Mathematics. Additional copies may be requested by email to paoffice@ ams.org with "AMS-hs brochure" in the subject line.

AMS Posters. Download to print or request via email printed copies of posters of the Fall 2009 AMS Sectional Meetings, *Notices* covers, and others at http://www.ams. org/posters.

This Mathematical Month. Read

about the International Topology Conference that was held September 1935 in Moscow. In reminiscences published in Russian in the journal *Uspehi Mat. Nauk* in 1966, the Swiss topologist Heinz Hopf called the year of 1935 "an especially important landmark in the evolution of topology" and singled out this meeting as holding particular significance. More about this and other notable events in the month of September are at http://www.ams.org/ thismathmonth.

> -Annette Emerson and Mike Breen AMS Public Awareness Officers paoffice@ams.org

JOHN DAUNS, professor, Tulane University, died on June 4, 2009. Born on June 11, 1937, he was a member of the Society for 45 years.

FREDERIK J. DE JONG, from Hebron, CT, died on April 8, 2009. Born on June 1, 1955, he was a member of the Society for 24 years.

ALBERTO M. DOU, from Barcelona, Spain, died on April 18, 2009. Born on December 21, 1915, he was a member of the Society for 50 years.

LAZAR DRAGOS, University of Bucharest, Romania, died on April 2, 2009. Born on November 21, 1930, he was a member of the Society for 14 years.

CHARLES J. A. HALBERG JR., emeritus professor, University of California Riverside, died on June 1, 2009. Born on September 24, 1921, he was a member of the Society for 56 years.

RICHARD K. JUBERG, professor emeritus, University of California Irvine, died on October 15, 2006. Born on May 14, 1929, he was a member of the Society for 51 years.

RAJEEV MOTWANI, professor, Stanford University, died on June 5, 2009. Born on March 26, 1962, he was a member of the Society for 6 years.

NORMAN SCHAUMBERGER, professor emeritus, Bronx Community College, CUNY, died on July 10, 2008. Born on May 28, 1929, he was a member of the Society for 44 years.

WILLIAM TRANSUE, professor emeritus, Binghamton University, State University of New York, died on February 3, 2009. Born on November 30, 1914, he was a member of the Society for 70 years.

MAVINA K. VAMANAMURTHY, professor, University of Auckland, died on April 6, 2009. Born on September 5, 1934, he was a member of the Society for 41 years.

SERGEY VIKTOROVICH VINNICHENKO, professor, from Chita, Russia, died on March 29, 2008. Born on March 7, 1958, he was a member of the Society for 9 years.

JOHN W. WRENCH JR., from Frederick, MD, died on February 27, 2009. Born on October 13, 1911, he was a member of the Society for 73 years.

ALLEN D. ZIEBUR, from Binghamton, NY, died on April 1, 2009. Born on May 1, 1923, he was a member of the Society for 60 years.

Deaths of AMS Members

KLAUS D. BIERSTEDT, professor, University of Paderborn, Germany, died on May 23, 2009. Born on May 4, 1945, he was a member of the Society for 36 years.

Reference and Book List

The **Reference** section of the Notices is intended to provide the reader with frequently sought information in an easily accessible manner. New information is printed as it becomes available and is referenced after the first printing. As soon as information is updated or otherwise changed, it will be noted in this section.

Contacting the Notices

The preferred method for contacting the *Notices* is electronic mail. The editor is the person to whom to send articles and letters for consideration. Articles include feature articles, memorial articles, communications, opinion pieces, and book reviews. The editor is also the person to whom to send news of unusual interest about other people's mathematics research.

The managing editor is the person to whom to send items for "Mathematics People", "Mathematics Opportunities", "For Your Information", "Reference and Book List", and "Mathematics Calendar". Requests for permissions, as well as all other inquiries, go to the managing editor.

The electronic-mail addresses are notices@math.ou.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 405-325-7484 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

Upcoming Deadlines

August 15, 2009: Nominations for SASTRA Ramanujan Prize. See http://www.math.ufl.edu/ sastra-prize/nominations-2008. html.

August 15, 2009: Applications for National Academies Research Associateship Programs. See http://www7. nationalacademies.org/rap/ or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: rap@nas.edu.

August 21, 2009: Letters of intent for NSF Focused Research Groups (FRG). See at http://www.nsf.gov/

Where to Find It

A brief index to information that appears in this and previous issues of the Notices. AMS Bylaws—November 2007, p. 1366 AMS Email Addresses—February 2009, p. 278 AMS Ethical Guidelines—June/July 2006, p. 701 AMS Officers 2008 and 2009 Updates—May 2009, p. 651 AMS Officers and Committee Members—October 2008, p. 1122 **Conference Board of the Mathematical Sciences**—September 2009, p. 977 IMU Executive Committee—December 2008, p. 1441 Information for Notices Authors—June/July 2009, p. 749 Mathematics Research Institutes Contact Information—August 2009, p. 854 National Science Board—January 2009, p. 67 New Journals for 2008—June/July 2009, p. 751 NRC Board on Mathematical Sciences and Their Applications-March 2009, p. 404 NRC Mathematical Sciences Education Board—April 2009, p. 511 NSF Mathematical and Physical Sciences Advisory Committee—February 2009, p. 278 **Program Officers for Federal Funding Agencies**—October 2008, p. 1116 (DoD, DoE); December 2007, p. 1359 (NSF); December 2008, p. 1440 (NSF Mathematics Education) Program Officers for NSF Division of Mathematical Sciences-November 2008, p. 1297

funding/pgm_summ.jsp?pims_
id=5671.

September 1-November 15, 2009: Applications for travel grants to ICM 2010. See the AMS website, http://www.ams.org/employment/ icm2010.html, or contact Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; telephone: 800-321-4267, ext. 4170, or 401-455-4170; email: ICM2010@ams.org.

September 8, 2009: Full proposals for NSF International Research Fellow Awards. See "Mathematics Opportunities" in this issue.

September 14, 2009: Full proposals for NSF Integrative Graduate Education and Research Training (IGERT). See http://www.nsf.gov/ pubs/2009/nsf09519/nsf09519. htm.

September 15, 2009: Nominations for Alfred P. Sloan Foundation Fellowships. Contact Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, New York 10111-0242, or consult the foundation's website: http://www.sloan.org/programs/ fellowship_brochure.shtml.

September 16, 2009: Nominations for Clay Research Fellowships. See "Mathematics Opportunities" in this issue.

September 18, 2009: Full proposals for NSF Focused Research Groups (FRG). See http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5671.

September 30, 2009: Applications for spring 2010 semester of Math in Moscow. See "Mathematics Opportunities" in this issue.

September 30, 2009: Nominations for 2009 Sacks Prize. See http:// www.aslonline.org/Sacks_ nominations.html.

October 1, 2009: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

October 15, 2009: Proposals for NSA Grants for Research in Mathematics. See http://www.nsa.gov/ research/math_research/index. shtml.

October 15, 2009: Nominations for Emanuel and Carol Parzen Prize for Statistical Innovation. See http:// www.stat.tamu.edu/events/
parzenprize/nominations.pdf.

October 21, 2009: Proposals for NSF Postdoctoral Research Fellowships. See http://www.nsf.gov/ pubs/2008/nsf08582/nsf08582. htm.

October 28, 2009: Applications for graduate student travel grants to JMM. See "Mathematics Opportunities" in this issue.

November 1, 2009: Nominations for Vasil Popov Prize. See http:// www.math.sc.edu/~popov/.

November 1, 2009: Applications for the January program of the Christine Mirzayan Science and Technology Policy Graduate Fellowship Program of the National Academies. See http://www7.nationalacademies. org/policyfellows; or contact The National Academies Christine Mirzayan Science and Technology Policy Graduate Fellowship Program, 500 Fifth Street, NW, Room 508, Washington, DC 20001; telephone: 202-334-2455; fax: 202-334-1667; email: policyfellows@nas.edu.

November 2, 2009: Applications for NRC-Ford Foundation Predoctoral Fellowships. See "Mathematics Opportunities" in this issue.

November 9, 2009: Applications for NRC-Ford Foundation Dissertation and Postdoctoral Fellowships. See "Mathematics Opportunities" in this issue.

November 12, 2009: Full proposals for NSF Project ADVANCE Institutional Transformation (IT) and Institutional Transformation Catalyst (IT-Catalyst) awards. See http://www.nsf.gov/pubs/2009/nsf09504/nsf09504.htm.

November 15, 2009: Applications for National Academies Research Associateship Programs. See http:// www7.nationalacademies.org/ rap/ or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: rap@nas.edu.

December 1, 2009: Applications for AMS Centennial Fellowships. See "Mathematics Opportunities" in this issue.

December 4, 2009: Entries for 2009 Ferran Sunyer i Balaguer Prize. See http://ffsb.iec.cat.

December 15, 2009: Nominations for PIMS Postdoctoral Fellowships. See "Mathematics Opportunities" in this issue.

December 15, 2009: Nominations for the International Mathematical Union (IMU) Chern Medal Award. See "Mathematics Opportunities" in this issue.

February 1, 2010: Applications for AWM Travel Grants and Mentoring Travel Grants. See "Mathematics Opportunities" in this issue.

April 15, 2010: Applications for fall 2010 semester of Math in Moscow. See "Mathematics Opportunities" in this issue.

May 1, 2010: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

October 1, 2010: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

Conference Board of the Mathematical Sciences

1529 Eighteenth Street, NW Washington, DC 20036 202-293-1170 http://www.cbmsweb.org/

Ronald C. Rosier Director 202-293-1170 Fax: 202-293-3412

Lisa R. Kolbe Administrative Coordinator 202-293-1170 Fax: 202-293-3412

Member Societies:

American Mathematical Association of Two-Year Colleges (AMATYC) American Mathematical Society

- (AMS)
- American Statistical Association (ASA)

Association for Symbolic Logic (ASL)

Association for Women in

Mathematics (AWM)

Association of Mathematics Teacher Educators (AMTE)

Association of State Supervisors of Mathematics (ASSM)

Benjamin Banneker Association (BBA)

Institute for Operations Research and the Management Sciences (INFORMS)

Institute of Mathematical Statistics (IMS)

Mathematical Association of America (MAA)

National Association of Mathematicians (NAM)

National Council of Supervisors of Mathematics (NCSM)

National Council of Teachers of Mathematics (NCTM)

Society for Industrial and Applied Mathematics (SIAM)

Society of Actuaries (SOA)

TODOS: Mathematics for ALL

Book List

The Book List highlights books that have mathematical themes and are aimed at a broad audience potentially including mathematicians, students, and the general public. When a book has been reviewed in the Notices, a reference is given to the review. Generally the list will contain only books published within the last two years, though exceptions may be made in cases where current events (e.g., the death of a prominent mathematician, coverage of a certain piece of mathematics in the news) warrant drawing readers' attention to older books. Suggestions for books to include on the list *may be sent to* notices-booklist@ ams.org.

*Added to "Book List" since the list's last appearance.

An Abundance of Katherines, by John Green. Dutton Juvenile Books, September 2006. ISBN-13:978-0-5254-7688-7. (Reviewed October 2008.)

The Annotated Turing: A Guided Tour Through Alan Turing's Historic Paper on Computability and the Turing Machine, by Charles Petzold. Wiley, June 2008. ISBN-13: 978-04702-290-57.

The Archimedes Codex: How a Medieval Prayer Book Is Revealing the True Genius of Antiquity's Greatest Scientist, by Reviel Netz and William Noel. Da Capo Press, October 2007. ISBN 978-03068-1580-5. (Reviewed September 2008.)

The Best of All Possible Worlds: Mathematics and Destiny, by Ivar Ekeland. University of Chicago Press, October 2006. ISBN-13: 978-0-226-19994-8. (Reviewed March 2009.)

The Book of Numbers: The Secret of Numbers and How They Changed the World, by Peter J. Bentley. Firefly Books, February 2008. ISBN-13: 978-15540-736-10.

The Calculus of Friendship: What a Teacher and Student Learned about Life While Corresponding about Math, by Steven Strogatz. Princeton University Press, August 2009. ISBN-13: 978-06911-349-32.

The Calculus Wars: Newton, Leibniz, and the Greatest Mathematical Clash of All Time, by Jason Socrates Bardi. Thunder's Mouth Press, April 2007. ISBN-13: 978-15602-5992-3. (Reviewed May 2009.)

The Cat in Numberland, by Ivar Ekeland. Cricket Books, April 2006. ISBN-13: 978-0-812-62744-2. (Reviewed January 2009.)

Chez les Weils (French), by Sylvie Weil. Buchet-Chastel, January 2009. ISBN-13: 978-22830-236-93.

Crossing the Equal Sign, by Marion D. Cohen. Plain View Press, January 2007. ISBN-13: 978-18913-866-95.

Crocheting Adventures with Hyperbolic Planes, by Daina Taimina. A K Peters, March 2009. ISBN-13: 978-15688-145-20.

Decoding the Heavens: A 2,000-Year-Old Computer—and the Century-Long Search to Discover Its Secrets, by Jo Marchant. Da Capo Press, February 2009. ISBN-13: 978-03068-174-27.

Digital Dice, by Paul J. Nahin. Princeton University Press, March 2008. ISBN-13: 978-06911-269-82.

Dimensions, by Jos Leys, Etienne Ghys, and Aurélien Alvarez. DVD, 117 minutes. Available at http://www. dimensions-math.org.

The Drunkard's Walk: How Randomness Rules Our Lives, by Leonard Mlodinow. Pantheon, May 2008. ISBN-13: 978-03754-240-45.

Einstein's Mistakes: The Human Failings of Genius, by Hans C. Ohanian. W. W. Norton, September 2008. ISBN-13: 978-0393062939.

Embracing the Wide Sky: A Tour Across the Horizons of the Human Mind, by Daniel Tammet. Free Press, January 2009. ISBN-13: 978-14165-696-95. *Emmy Noether: The Mother of Modern Algebra*, by M. B. W. Tent. A K Peters, October 2008. ISBN-13: 978-15688-143-08.

Ernst Zermelo: An Approach to His Life and Work, by Heinz-Dieter Ebbinghaus. Springer, April 2007. ISBN-13 978-3-540-49551-2. (Reviewed August 2009.)

Euler's Gem: The Polyhedron Formula and the Birth of Topology, by David S. Richeson. Princeton University Press, September 2008. ISBN-13: 97-80691-1267-77.

Fifty Mathematical Ideas You Really Need to Know, by Tony Crilly. Quercus, 2007. ISBN-13: 978-18472-400-88.

Fighting Terror Online: The Convergence of Security, Technology and the Law, by Martin Charles Golumbic. Springer, 2008. ISBN: 978-0-387-73577-1.

Five-Minute Mathematics, by Ehrhard Behrends (translated by David Kramer). AMS, May 2008. ISBN-13: 978-08218-434-82.

Gaming the Vote (Why Elections Aren't Fair and What We Can Do About It), by William Poundstone. Hill and Wang, February 2009. ISBN-13: 978-08090-489-22.

Geekspeak: How Life + Mathematics = Happiness, by Graham Tattersall. Collins, September 2008. ISBN-13: 978-00616-292-42.

Geometric Folding Algorithms: Linkages, Origami, Polyhedra, by Erik D. Demaine and Joseph O'Rourke. Cambridge University Press, July 2007. ISBN-13: 978-05218-57574.

Geometric Origami, by Robert Geretschläger. Arbelos, October 2008. ISBN-13: 978-09555-477-13.

The Golden Section: Nature's Greatest Secret (Wooden Books), by Scott Olsen. Walker and Company, October 2006. ISBN-13: 978-08027-153-95.

Group Theory in the Bedroom, and Other Mathematical Diversions, by Brian Hayes. Hill and Wang, April 2008. ISBN-13:978-08090-521-96. (Reviewed February 2009.)

Hexaflexagons, Probability Paradoxes, and the Tower of Hanoi: Martin Gardner's First Book of Mathematical Puzzles and Games, by Martin Gardner. Cambridge University Press, September 2008.ISBN-13:978-0-521-73525-4. *The Housekeeper and the Professor*, by Yoko Ogawa. Picador, February 2009. ISBN-13: 978-03124-278-01.

How Math Explains the World: A Guide to the Power of Numbers, from Car Repair to Modern Physics, by James D. Stein. Collins, April 2008. ISBN-13: 978-00612-417-65.

How to Think Like a Mathematician: A Companion to Undergraduate Mathematics, by Kevin Houston. Cambridge University Press, March 2009. ISBN-13: 978-05217-197-80.

The Indian Clerk, by David Leavitt. Bloomsbury USA, September 2007. ISBN-13: 978-15969-1040-9. (Reviewed September 2008.)

Is God a Mathematician? by Mario Livio. Simon & Schuster, January 2009. ISBN-13: 978-07432-940-58.

Kiss My Math: Showing Pre-Algebra Who's Boss, by Danica McKellar. Hudson Street Press, August 2008. ISBN-13: 978-1594630491.

The Last Theorem, by Arthur C. Clarke and Frederik Pohl. Del Rey, August 2008. ISBN-13: 978-0345470218.

Leonhard Euler and His Friends: Switzerland's Great Scientific Expatriate, by Luis-Gustave du Pasquier (translated by John S. D. Glaus). CreateSpace, July 2008. ISBN: 978-14348-332-73.

Lewis Carroll in Numberland: His Fantastical Mathematical Logical Life: An Agony in Eight Fits, by Robin Wilson. W. W. Norton & Company, ISBN-13: 978-03930-602-70.

Logic's Lost Genius: The Life of Gerhard Gentzen, by Eckart Menzler-Trott, Craig Smorynski (translator), Edward R. Griffor (translator). AMS-LMS, November 2007. ISBN-13: 978-0-8218-3550-0.

The Map of My Life, by Goro Shimura. Springer, September 2008. ISBN-13: 978-03877-971-44.

Mathematical Omnibus: Thirty Lectures on Classic Mathematics, by Dmitry Fuchs and Serge Tabachnikov. AMS, October 2007. ISBN-13: 978-08218-431-61. (Reviewed December 2008).

The Mathematician's Brain, by David Ruelle. Princeton University Press, July 2007. ISBN-13 978-0-691-12982-2. (Reviewed November 2008.)

Mathematicians of the World, Unite!: The International Congress of Mathematicians: A Human Endeavor, by Guillermo P. Curbera. A K Peters, March 2009. ISBN-13: 978-15688-133-01.

Mathematics and the Aesthetic: New Approaches to an Ancient Affinity, edited by Nathalie Sinclair, David Pimm, and William Higginson. Springer, November 2006. ISBN-13: 978-03873-052-64. (Reviewed February 2009.)

Mathematics and Common Sense: A Case of Creative Tension, by Philip J. Davis. A K Peters, October 2006. ISBN 1-568-81270-1. (Reviewed June/ July 2009.)

Mathematics and Democracy: Designing Better Voting and Fair-Division Procedures, by Steven J. Brams. Princeton University Press, December 2007. ISBN-13: 978-0691-1332-01.

Mathematics at Berkeley: A History, by Calvin C. Moore. A K Peters, February 2007. ISBN-13: 978-1-5688-1302-8. (Reviewed November 2008.)

Mathematics Emerging: A Sourcebook 1540–1900, by Jacqueline Stedall. Oxford University Press, November 2008. ISBN-13: 978-01992-269-00.

Mathematics in Ancient Iraq: A Social History, by Eleanor Robson. Princeton University Press, August 2008. ISBN-13: 978-06910-918-22.

Mathematics in India, by Kim Plofker. Princeton University Press, January 2009. ISBN-13: 978-06911-206-76.

Mathematics in 10 Lessons: The Grand Tour, by Jerry P. King. Prometheus Books, May 2009. ISBN: 978-1-59102-686-0.

The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Sourcebook, by Victor J. Katz et al. Princeton University Press, July 2007. ISBN-13: 978-0-6911-2745-3.

More Mathematical Astronomy Morsels, by Jean Meeus. Willmann-Bell, 2002. ISBN 0-943396743.

Number and Numbers, by Alain Badiou. Polity, June 2008. ISBN-13: 978-07456-387-82.

The Numbers Behind NUMB3RS: Solving Crime with Mathematics, by Keith Devlin and Gary Lorden. Plume, August 2007. ISBN-13: 978-04522-8857-7. (Reviewed March 2009.)

The Numbers Game: The Commonsense Guide to Understanding Numbers in the News, in Politics, and in Life, by Michael Blastland and Andrew Dilnot. Gotham, December 2008. ISBN-13: 978-15924-042-30.

The Numerati, by Stephen Baker. Houghton Mifflin, August 2008. ISBN-13: 978-06187-846-08.

One to Nine: The Inner Life of Numbers, by Andrew Hodges. W. W. Norton, May 2008. ISBN-13: 978-03930-664-18.

Origami, Eleusis, and the Soma Cube: Martin Gardner's Mathematical Diversions, by Martin Gardner. Cambridge University Press, September 2008. ISBN-13: 978-0-521-73524-7.

Our Days Are Numbered: How Mathematics Orders Our Lives, by Jason Brown. McClelland and Stewart, to appear April 2009. ISBN-13: 978-07710-169-67.

Out of the Labyrinth: Setting Mathematics Free, by Robert Kaplan and Ellen Kaplan. Oxford University Press, January 2007. ISBN-13: 978-0-19514-744-5. (Reviewed June/July 2009.)

A Passion for Discovery, by Peter Freund. World Scientific, August 2007. ISBN-13: 978-9-8127-7214-5.

Picturing the Uncertain World: How to Understand, Communicate, and Control Uncertainty through Graphical Display, by Howard Wainer, Princeton University Press, April 2009. ISBN-13: 978-06911-375-99.

Plato's Ghost: The Modernist Transformation of Mathematics, by Jeremy Gray. Princeton University Press, September 2008. ISBN-13: 978-06911-361-03.

The Princeton Companion of Mathematics, edited by Timothy Gowers (June Barrow-Green and Imre Leader, associate editors). Princeton University Press, November 2008. ISBN-13: 978-06911-188-02.

Professor Stewart's Cabinet of Mathematical Curiosities, by Ian Stewart. Basic Books, December 2008. ISBN-13: 978-0-465-01302-9.

Pythagoras' Revenge: A Mathematical Mystery, by Arturo Sangalli. Princeton University Press, May 2009. ISBN-13: 978-06910-495-57.

Pythagorean Crimes, by Tefcros Michalides. Parmenides Publishing, September 2008. ISBN-13: 978-19309-722-78. (Reviewed January 2009.)

Recountings: Conversations with MIT Mathematicians, edited by Joel Segel. A K Peters, January 2009. ISBN-13: 978-15688-144-90.



Turning 40?



Turning 50?



Turning 60?

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Call your Member and Customer Services representative at 800-321-4267 or email amsmem@ams.org

www.ams.org

Reference and Book List

Reminiscences of a Statistician: The Company I Kept, by Erich Lehmann. Springer, November 2007. ISBN-13: 978-0-387-71596-4.

Rock, Paper, Scissors: Game Theory in Everyday Life, by Len Fisher. Basic Books, November 2008. ISBN-13: 978-04650-093-81.

Roots to Research: A Vertical Development of Mathematical Problems, by Judith D. Sally and Paul J. Sally Jr. AMS, November 2007. ISBN-13: 978-08218-440-38. (Reviewed December 2008.)

Sacred Mathematics: Japanese Temple Geometry, by Fukagawa Hidetoshi and Tony Rothman. Princeton University Press, July 2008. ISBN-13: 978-0-6911-2745-3.

The Shape of Content: An Anthology of Creative Writing in Mathematics and Science, edited by Chandler Davis, Marjorie Wikler Senechal, and Jan Zwicky. A K Peters, November 2008. ISBN-13: 978-15688-144-45.

Souvenirs sur Sofia Kovalevskaya (French), by Michèle Audin. Calvage et Mounet, October 2008. ISBN-13: 978-29163-520-53.

*Strange Attractors: Poems of Love and Mathematics, edited by Sarah Glaz and JoAnne Growney. A K Peters, November 2008. ISBN-13: 978-15688-134-17. (Reviewed in this issue.)

Super Crunchers: Why Thinkingby-Numbers Is the New Way to Be Smart, by Ian Ayres. Bantam, August 2007. ISBN-13: 978-05538-054-06. (Reviewed April 2009.)

Symmetry: The Ordering Principle (Wooden Books), by David Wade. Walker and Company, October 2006. ISBN-13: 978-08027-153-88.

Tools of American Math Teaching, 1800–2000, by Peggy Aldrich Kidwell, Amy Ackerberg-Hastings, and David Lindsay Roberts. Johns Hopkins University Press, July 2008. ISBN-13: 978-0801888144.

The Unfinished Game: Pascal, Fermat, and the Seventeenth-Century Letter That Made the World Modern, by Keith Devlin. Basic Books, September 2008. ISBN-13: 978-0-4650-0910-7.

The Unimaginable Mathematics of Borges' Library of Babel, by William Goldbloom Bloch. Oxford University Press, August 2008. ISBN-13: 978-01953-345-79.

What Is a Number?: Mathematical Concepts and Their Origins, by Robert Tubbs. Johns Hopkins University Press, December 2008. ISBN-13: 978-08018-901-85.

What's Happening in the Mathematical Sciences, by Dana Mackenzie. AMS, 2009. ISBN-13: 978-08218-447-86.

*Why Does E=mc*²? (*And Why Should We Care*?), by Brian Cox and Jeff Forshaw. Da Capo Press, July 2009. ISBN-13: 978-03068-175-88.

The Wraparound Universe, by Jean-Pierre Luminet. A K Peters, March 2008. ISBN 978-15688-130-97. (Reviewed December 2008.)

Zeno's Paradox: Unraveling the Ancient Mystery behind the Science of Space and Time, by Joseph Mazur. Plume, March 2008 (reprint edition). ISBN-13: 978-0-4522-8917-8.

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*Nominees are individuals appointed by the department of mathematics of member institutions and are considered regular individual members of the Society who do not pay dues during the period they are nominees.

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From the AMS Secretary

ATTENTION ALL AMS MEMBERS

Voting Information for 2009 AMS Election

AMS members who have chosen to vote online will receive an **email message** on or shortly after August 17, 2009, **from the AMS Election Coordinator, Survey & Ballot Systems**.

The From Line will be "AMS Election Coordinator".

The Sender email address will be amsvote@directvote.net.

The Subject Line will be "AMS 2009 Election—login information below".

The body of the message will provide your unique voting login information and the address (URL) of the voting website. If you use a spam filter, you may want to use the above address or subject information to configure your spam filter to ensure this email will be delivered to you.

AMS members who have chosen to vote by paper should expect to receive their ballot by the middle of September. Unique voting login information will be printed on the ballot should you wish to vote online.

At midnight (U.S. Eastern Standard Saving Time) on November 6, 2009, the website will stop accepting votes. Paper ballots received after this date will not be counted.

Additional information regarding the 2009 AMS Election is available on the AMS website, http://www.ams.org/ secretary/election-info.html, or by contacting the AMS: election@ams.org, 800-321-4267 (U.S. & Canada), 401-455-4000 (worldwide).

Thank you and please remember to vote.

—Robert J. Daverman

SPECIAL SECTION

2009 American Mathematical Society Election

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2009 AMS Elections Special Section

List of Candidates-2009 Election

President

(one to be elected) Eric M. Friedlander Wilfried Schmid

Vice President (one to be elected)

Sylvain Cappell Peter Li

Board of Trustees *(one to be elected)*

Mark L. Green Robion Kirby

Member at Large of the Council

(five to be elected) Alejandro Adem James H. Curry Richard Hain Evans M. Harrell Alexander R. Its Venkatramani Lakshmibai Jennifer Schultens Janet Talvacchia Christoph Thiele Maciej Zworski

Nominating Committee

(three to be elected) William Beckner Richard T. Durrett Dorian Goldfeld Brian Marcus Carla D. Savage Julius L. Shaneson

Editorial Boards Committee *(two to be elected)*

Diego Ernesto Dominici Anatoly Libgober Simon Tavener Pham Huu Tiep

Ballots

AMS members will receive email with instructions for voting online by August 24, or a paper ballot by September 20. If you do not receive this information by that date, please contact the AMS (preferably before October 1) to request a ballot. Send email to ballot@ams.org or call the AMS at 800-321-4267 (within the U.S. or Canada) or 401-455-4000 (worldwide) and ask to speak with Member Services. The deadline for receipt of ballots is November 6, 2009.

Write-in Votes

It is suggested that names for write-in votes be given in exactly the form that the name occurs in the *Combined Membership List* (www.ams.org/cml). Otherwise the identity of the individual for whom the vote is cast may be in doubt and the vote may not be properly credited.

Replacement Ballots

For a paper ballot, the following replacement procedure has been devised: A member who has not received a ballot by September 20, 2009, or who has received a ballot but has accidentally spoiled it, may write to ballot@ams.org or Secretary of the AMS, 201 Charles Street, Providence, RI 02904-2294, USA, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or airmail. Although a second ballot will be supplied on request and will be sent by first class or airmail, the deadline for receipt of ballots cannot be extended to accommodate these special cases.

Biographies of Candidates

The next several pages contain biographical information about all candidates. All candidates were given the opportunity to provide a statement of not more than 200 words to appear at the end of their biographical information.

Description of Offices

The **president** of the Society serves one year as president elect, two years as president, and one year as immediate past president. The president strongly influences, either directly or indirectly, most of the scientific policies of the Society. A direct effect comes through the president's personal interactions with both members of the Society and with outside organizations. In addition, the president sits as member of all five policy committees, (Education, Meetings and Conferences, Profession, Publications, and Science Policy) is the chair of the Council's Executive Committee, and serves ex officio as a trustee. Indirect influence occurs as the president appoints chairs and members of almost all committees of the Society, including the policy committees. The president works closely with all officers and administrators of the Society, especially the executive director and the secretary. Finally, the president nominates candidates for the Nominating Committee and the Editorial Boards Committee. Consequently, the president also has a long-term effect on Society affairs.

The vice president and the members at large of the AMS Council serve for three years on the Council. That body determines all scientific policy of the Society, creates and oversees numerous committees, appoints the treasurers and members of the Secretariat, makes nominations of candidates for future elections, and determines the chief editors of several key editorial boards. Typically, each of these new members of the Council also will serve on one of the Society's five policy committees.

The **Board of Trustees**, of whom you will be electing one member for a five-year term, has complete fiduciary responsibility for the Society. Among other activities, the trustees determine the annual budget of the Society, prices of journals, salaries of employees, dues (in cooperation with the Council), registration fees for meetings, and investment policy for the Society's reserves. The person you select will serve as chair of the Board of Trustees during the fourth year of the term.

The candidates for vice president, members at large, and trustee were suggested to the Council either by the Nominating Committee or by petition from members. While the Council has the final nominating responsibility, the groundwork is laid by the **Nominating Committee**. The candidates for election to the Nominating Committee were nominated by the current president, George E. Andrews. The three elected will serve three-year terms. The main work of the Nominating Committee takes place during the annual meeting of the Society, during which it has four sessions of face-to-face meetings, each lasting about three hours. The Committee then reports its suggestions to the spring Council, which makes the final nominations.

The **Editorial Boards Committee** is responsible for the staffing of the editorial boards of the Society. Members are elected for three-year terms from a list of candidates named by the president. The Editorial Boards Committee makes recommendations for almost all editorial boards of the Society. Managing editors of *Journal of the AMS, Mathematics of Computation, Proceedings of the AMS, and Transactions of the AMS;* and Chairs of the *Collquium, Mathematical Surveys and Monographs,* and *Mathematical Reviews* editorial committees are officially appointed by the Council upon recommendation by the Editorial Boards Committee. In virtually all other cases, the editors are appointed by the president, again upon recommendation by the Editorial Boards Committee.

Elections to the **Nominating Committee** and the **Editorial Boards Committee** are conducted by the method of approval voting. In the approval voting method, you can vote for as many or as few of the candidates as you wish. The candidates with the greatest number of the votes win the election.

A Note from AMS Secretary Robert J. Daverman

The choices you make in these elections directly affect the direction the Society takes. If the past election serves as a reliable measure, about 13 percent of you will vote in the coming election, which is comparable with voter participation in other professional organizations which allow an online voting option. This is not mentioned as encouragement for you to throw the ballot in the trash; instead, the other officers and Council members join me in urging you to take a few minutes to review the election material, fill out your ballot, and submit it. The Society belongs to its members. You can influence the policy and direction it takes by voting.

Also, let me urge you to consider other ways of participating in Society activities. The Nominating Committee, the Editorial Boards Committee, and the Committee on Committees are always interested in learning of members who are willing to serve the Society in various capacities. Names are always welcome, particularly when accompanied by a few words detailing the person's background and interests. Self-nominations are probably the most useful. Recommendations can be transmitted through an online form (www.ams.org/committee-nominate) or sent directly to the secretary (secretary@ams.org) or Office of the Secretary, American Mathematical Society, Department of Mathematics, 302C Aconda Court, University of Tennessee, 1534 Cumberland Avenue, Knoxville, TN 37996-0612.

PLEASE VOTE.

Nominations for President

Nomination of Eric Friedlander

John Franks

I am very pleased to support the nomination of Eric Friedlander for the position of president of the American Mathematical Society. Eric has had an extremely distinguished career in our profession spanning almost four decades. Beyond a sterling research record his career is characterized by numerous and wide-ranging contributions to the mathematical enterprise. In my opinion his contributions to mathematics and his past experience serving the mathematical community make him exceptionally qualified for the role of president of the Society.

Eric received his doctorate in mathematics in 1970 from MIT, where he studied with Michael Artin. After spending some years at Princeton University, he went to Northwestern University in 1975 as an associate professor. He was promoted to professor in 1980 and became the Henry S. Noyes Professor of Mathematics in 1999. Subsequently, he succumbed to the allure of Southern California and starting in September of 2008 he became Dean's Professor of Mathematics at the University of Southern California.

Beginning with his thesis and throughout his career, Eric developed a unique blend of algebraic geometry and algebraic topology that made him a leader in a number of diverse fields, especially algebraic *K*-theory, cohomology of algebraic groups, representation theory, and cohomology theories for algebraic varieties. He is the author of numerous papers and monographs, including three papers in the *Annals of Mathematics*, ten papers in *Inventiones Mathematicae*, and two books in the *Annals of Mathematical Studies*. For this work, Eric has earned a number of important honors, including a Humboldt prize and invitations to speak at the International Congress

John Franks is chair of the Mathematics Department and professor of mathematics at Northwestern University. His email address is john@math.northwestern.edu.

of Mathematicians. In 2005, he became a Fellow of the American Academy of Arts and Sciences.

The president plays many crucial roles in the governance of the Society. He or she presides over the Executive Committee and Board of Trustees which sets our policy and has the fiduciary responsibility for the financial wellbeing of the AMS. Eric's years of exemplary service on the Board (which I have had the opportunity to observe firsthand) have prepared him well to accept this responsibility. The president is also called on to enhance our presence in Washington, in conjunction with our Washington office, and to represent the mathematical research community to members of Congress and other government officials. Eric's past service on the Committee on Science Policy of the AMS has familiarized him with this aspect of the Society's activities and his outgoing nature leads me to believe he will perform extremely well in discharging this task.

Another important responsibility of the president is to represent the Society, and indeed American mathematics generally, in international mathematical circles. This is a role for which Eric is exceptionally well qualified. He has interacted with the mathematical community at an international level to an extent rarely matched by others in our profession. He has been a research fellow at Trinity College, Cambridge, and New College, Oxford, a Professor Associé in Paris, a visiting fellow at the Max Planck Institute in Germany, ETH in Zurich, and the Institut Henri Poincaré in Paris. He has held a visiting professorship at Heidelberg and been a visiting member at the IHES multiple times. He is prominent in the activities of the "Friends of the IHES" and he has served on the Scientific Advisory Panel of the Fields Institute in Toronto.

Eric has directed the theses of fourteen Ph.D. students. He spends enormous amounts of time with each of his students and many have written very fine theses. Throughout his career he has also had a number of very productive collaborations, developing important and separate lines of research. In all Eric has had nearly twenty-five coauthors, including a number of postdocs and new Ph.D.s with whom he generously shared ideas and his experience. During his years at Northwestern, Eric served the department and the university with enormous dedication and enthusiasm. He was chair of the Mathematics Department twice (1987–1990 and 1999–2003), Academic Associate Dean for Science (1995–1998), and served on a number of important college and university committees. As a member of the department, he was part of a very strong group in algebraic topology, and he helped organize numerous emphasis years and large conferences, including one of the landmark conferences in the field which saw a cascade of solutions to long-standing and important problems.

Eric is known by his colleagues and, indeed, throughout the mathematical world, for his inexhaustible energy. Those who know him well can attest how much of his time is devoted to students, his department, and to the mathematical community in general. Election to its presidency is one of the highest honors the Society bestows, and one Eric richly merits. But, beyond honoring past achievements, the presidency is an office which carries a great responsibility for the stewardship of the Society. For all the reasons cited above—his contributions to mathematics, his experience both within the Society and in the broader world mathematical community, and his dedication to the goals of the AMS—I believe that Eric is an outstanding choice to be our next president.

Nomination of Wilfried Schmid

Roger Howe

It is my pleasure and honor to nominate Wilfried Schmid for president of the American Mathematical Society.

What qualifications should a president of AMS have? Certainly, one would want the AMS president to be an excellent mathematician. Also, our president should have a strong sense of mathematics as an enterprise—a broad view of the subject, a keen appreciation of its value and its values, and ideas about how to help mathematicians achieve their best. Moreover, and perhaps most importantly, our president should be able to communicate with nonmathematicians, to promote the value of mathematics, and to help the many people who can affect mathematics for better or worse, understand why better is better.

Wilfried Schmid easily satisfies all these criteria. To take the second one first, anyone who has been to one of Wilfried's talks knows that he is a superb expositor of mathematics. A lecture by Wilfried is like a three ring circus. He always has a lot to say, and his talks always involve a large cast of ideas and several death-defying feats. But he orchestrates his players—definitions, techniques, and results—so deftly, and weaves in history and motivations so skillfully that nobody falls off the trapeze, and a listener goes away with a sense of enlightenment and even awe. His expository skill has been recognized by invitations to deliver series of lectures in North and South America, Europe, India, and China. He has also spoken three times at ICMs, including a plenary lecture.

Moreover, Wilfried's sense of mathematics goes well beyond technical mastery. He values the depth and the variety and the vitality of mathematics in all its manifestations. The following quotation shows this better than I can. This is from the foreword to the volume *Mathematics Unlimited: 2001 and Beyond*, edited by Wilfried and Björn Engqvist.

At the dawn of the 20th century, it was possible for one sage individual to survey the whole of mathematics: Hilbert's presentation of twentythree problems in 1900 not only gave a sense of the direction of mathematics, but also helped it move forward.

The scope of mathematics has expanded tremendously over the last hundred years.

Scientific and technological advances, in particular, the explosive growth of computing power, have created numerous opportunities for mathematics and mathematicians. The core areas did not suffer as a result of the proliferating areas, quite to the contrary, "pure mathematics" is thriving, with the invention of powerful theories, the solution of celebrated problems, and the emergence of unforeseen connections between different areas of mathematics and mathematical physics.

Can one eminent mathematician, or a small group of eminent mathematicians, afford an overview of the breadth of today's mathematics? We think not—we present a composite of many individual views, both out of necessity and conviction.... We hope to provide the reader with a glimpse of the great variety and the vitality of mathematics as we enter the new millennium.

Wilfried has also served the mathematics community as an editor of several journals. In particular, he was a founding editor of the *Journal of the AMS*, and managing editor from 1991 to 1994. I can testify from direct experience, that as editor he was not a passive recipient of manuscripts, but also was on the lookout for promising articles that might not otherwise have found their way to *JAMS*.

There is no question, then, that Wilfried embodies a strong sense of mathematics and that he can communicate well with mathematicians. What about with the wider public? One would not expect this to be an issue, since Wilfried's expository skills reflect a clarity and thoroughness of thought that he brings to everything he does. However, it is not necessary to speculate. Wilfried has a well-established track record, through his involvement in issues of mathematics education.

As probably with many of us, Wilfried's attention to mathematics education started when his daughter expressed deep unhappiness with her second grade

Roger Howe is professor of mathematics at Yale University. His email address is howe@math.yale.edu.

mathematics experience. Unlike most of us, however, he did not leave things with a visit to the school or the purchase of some supplementary books. He quickly became involved in math education issues at the state level. In 2000, he was invited by the Massachusetts Department of Education to help with the editing of the state mathematics standards, and he played a major role in shaping their final form. This version of the Massachusetts standards is still in force, a remarkably long life for a document of this sort. Anyone who has taken time to read state mathematics standards knows what mind-numbing documents they can be. The readability of the Massachusetts standards is in notable contrast to the standards of most other states.

After his work in Massachusetts Wilfried was invited to participate in several projects at the national level. He served on the steering committee to develop the framework for the mathematics section of NAEP (National Assessment of Educational Progress—aka, "the nation's report card"—a statistical sampling of mathematics achievement in each state and nationally). He served on review panels for the SAT and for NAEP. He was a member of the program committee for the 10th International Congress on Mathematics Education. He was part of the Common Ground committee, convened to promote cooperation between mathematicians and mathematics educators toward common goals. Most recently, he served on the National Mathematics Panel. In all these situations, he worked productively with people from a variety of backgrounds, and advocated for the integrity of mathematics and for strong content. As mathematics education continues to heat up as a policy issue, with increased attention from the Obama administration, expertise in this area will be especially valuable for the president of AMS.

I should round out this discussion with some description of Wilfried's research. This has been mostly in representation theory, broadly construed. This subject has roots in physics, where it has several striking applications. It is also linked with classical topics such as Fourier analysis, the theory of spherical harmonics, and many other aspects of special functions. It is strongly interwoven with symplectic geometry and microlocal analysis. Somewhat serendipitously, it has turned out also to have applications to ergodic theory, to geometric integration theory, and probably most significantly, to number theory, through the theory of automorphic forms, including the Langlands Program, and the theory of theta functions.

A drawback to representation theory is the high entrance fee. It is notorious for the level of technicality needed to start talking about it, and the technical proficiency needed to practice it. Although it has recently become much better known, especially in connection with the Langlands Program, representation theory, especially infinite-dimensional representations, is still not part of a general mathematical background to the extent that complex analysis or measure theory is. Even among representation theorists, Wilfried is known for his technical power, and many of his papers are technical tours de force. Our brief descriptions will elide most of the technicalities.

The representation theory of finite groups on complex vector spaces is frequently seen in graduate study, and we

will assume that the reader is familiar with it. The basic problems are

i) Given a group *G*, describe the irreducible representations of *G*.

ii) Given a representation of *G*, describe its decomposition into a direct sum of irreducible representations.

One can think of representation theory of Lie groups as being the representation theory of finite groups on steroids. The basic problems are the same, but the typical irreducible representation will be infinite dimensional, and in decomposing representations, one must consider direct integrals (aka, continuous direct sums) as well as the conventional algebraic direct sums.

I will briefly describe three items from Wilfried's research.

1. Proof of the Kostant-Langlands conjecture on construction of models for the discrete series for semisimple Lie groups, and proof of Blattner's formula.

2. Analysis of possible degenerations of Hodge structures.

3. Proof of the Barbasch-Vogan conjecture on asymptotic invariants of representations.

1. After pioneering work by physicists and the Gelfand school, representation theory of semisimple groups was studied systematically by Harish-Chandra. He found that in some cases (for example, for the indefinite orthogonal groups $O_{p,q}$ if at least one of p or q is even), the regular representation of G on $L^2(G)$ contained some irreducible subspaces. These became known as the *discrete series*. Harish-Chandra showed that the discrete series were the essential ingredient in the Plancherel formula-the explicit decomposition of the regular representation. (Later, Langlands and others showed that the discrete series were also key to constructing all irreducible representations of G.) Harish-Chandra had classified the discrete series, but his approach was indirect, and did not provide explicit realizations for them. Kostant and Langlands suggested a method for constructing them, by means of a non-compact analog of the Bott-Borel-Weil construction of irreducible representations of compact Lie groups, on cohomology of vector bundles. In a series of papers in the 1970s, Wilfried established the Kostant-Langlands conjecture. At the same time, he (jointly with Henryk Hecht) established a formula conjectured by R. Blattner describing the multiplicities of the irreducible representations of K, a maximal compact subgroup of G, in the restriction to K of a discrete series representation.

2. This has little to do with representation theory. It is about algebraic geometry, and emphasizes Wilfried's expertise in this area (which he often uses in doing representation theory). Hodge theory shows that the cohomology of a compact Kähler manifold has a bigraded structure known as a *Hodge structure*. The Hodge structure is not a topological invariant of the manifold—it reflects the complex structure. As an approach to describing the moduli of higher-dimensional algebraic varieties, Griffiths proposed looking at how the Hodge structure varies in families of algebraic varieties. Wilfried's original paper concerns the case of a one-dimensional family of Kähler varieties, which may degenerate at one point. Locally, this means

From the AMS Secretary-Election Special Section

that one is studying a family of varieties parametrized by the punctured disk $D^* = \{z \in \mathbb{C} : 0 < |z| < 1\}$. In this context, Wilfried shows that the limit at the origin of the Hodge structures of the varieties in the family is a mixed Hodge structure that in some sense would be the Hodge structure of the fiber over 0, if that existed. The review of this paper in *Math Reviews* finishes with the opinion that "this paper must surely play a key role in future work on Hodge theory." In a pair of papers with Eduardo Cattani and Aroldo Kaplan, Wilfried later generalized this to families of higher dimension.

3. In their work on the classification of representations, Dan Barbasch and David Vogan attached two geometric invariants with analogous structure to an irreducible representation. One invariant reflected the structure of the restriction of the representation to K. The other reflected the analytic behavior of the character (in the sense of Harish-Chandra) of the representation. Barbasch and Vogan conjectured that the two invariants were related in a precise way (known as the Kostant-Sekiguchi correspondence). In a series of papers with Kari Vilonen, Wilfried showed that this was correct.

THE FEATURE COLUMN *monthly essays on mathematical topics*



www.ams.org/featurecolumn

Each month, the Feature Column provides an online in-depth look at a mathematical topic. Complete with graphics, links, and references, the columns cover a wide spectrum of mathematics and its applications, often including historical figures and their contributions. The authors—David Austin, Bill Casselman, Joe Malkevitch, and Tony Phillips—share their excitement about developments in mathematics.

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Penrose Tilings Tied up in Ribbons

Topology of Venn Diagrams



AMS members: Sign up for the AMS members-only *Headlines & Deadlines* service at www.ams.org/enews to receive email notifications when each new column is posted.

Biographies of Candidates 2009

Biographical information about the candidates has been supplied and verified by the candidates.

Candidates have had the opportunity to make a statement of not more than 200 words (400 words for presidential candidates) on any subject matter without restriction and to list up to five of their research papers.

Candidates have had the opportunity to supply a photograph to accompany their biographical information. Candidates with an asterisk (*) beside their names were nominated in response to a petition.

Abbreviations: American Association for the Advancement of Science (AAAS); American Mathematical Society

(AMS); American Association for the Advancement of Science (AAAS); American Mathematical Society (AMS); American Statistical Association (ASA); Association for Computing Machinery (ACM); Association for Symbolic Logic (ASL); Association for Women in Mathematics (AWM); Canadian Mathematical Society, Société Mathématique du Canada (CMS); Conference Board of the Mathematical Sciences (CBMS); Institute for Advanced Study (IAS), Institute of Mathematical Statistics (IMS); International Mathematical Union (IMU); London Mathematical Society (LMS); Mathematical Association of America (MAA); Mathematical Sciences Research Institute (MSRI); National Academy of Sciences (NAS); National Academy of Sciences/National Research Council (NAS/NRC); National Aeronautics and Space Administration (NASA); National Council of Teachers of Mathematics (NCTM); National Science Foundation (NSF); Society for Industrial and Applied Mathematics (SIAM).

President Eric M. Friedlander



Dean's Professor of Mathematics, University of Southern California. **Born:** January 7, 1944, Santurce, Puerto Rico.

Ph.D.: Massachusetts Institute of Technology, 1970.

AMS Offices: Board of Trustees, 2000–2010.

AMS Committees: Member of Committee on Summer Institutes, 1985–1987; Committee on the Publication Program, 1989–1992;

Committee on Science Policy, 1991–1993, 2000–2005; Nominating Committee, 1995–1998 (Chair, 1997); Chair, Committee on Committees, 2005–2007; Committee on Publications, 2005–2008; Chair, University Lecture Series, 2005–2011; Selection Committee for Cole Prize; Task Force for AMS Prizes (2009–); Committee on the Profession (2009–); Past member of the editorial boards of the *Bulletin* and the *Proceedings of the AMS*.

Selected Addresses: Invited Address, AMS Sectional Meeting, 1985; International Congress of Mathematicians, 1986 (surrogate for Andrei Suslin's plenary lecture); Invited Address, International Congress of Mathematicians, 1998; Plenary Addresses, AMS-Mexico international meeting, 2001, Morelia (Mexico); Plenary Addresses, AMS-Spain international meeting, 2003, Sevilla (Spain).

Additional Information: U.S.-France Exchange of Scientists Fellow, 1974; Senior Visiting Fellow, U.K. Science Research Council, 1977–1978; Chair, Northwestern University Department of Mathematics, 1987–1990, 1999–2003; Associate Dean of Science, Northwestern University, 1995–1998; Humboldt Senior Scientist Research Prize, 1996–1998; Noyes Professor of Mathematics, Northwestern University, 1999–2008; Currently, co-Managing Editor of *Journal of Pure and Applied Algebra*; member of editorial boards of *Algebra and its Applications, American Journal of Mathematics*, and *Journal of K-Theory*; Visiting Member: E.T.H.-Zurich, Fields Inst-Toronto, I.A.S.-Princeton, I.H.E.S.-Bures-sur-Yvette, I.H.P.-Paris, M.P.I.-Bonn, M.S.R.I.-Berkeley, Mittag-Leffler-Stockholm, Newton Inst-Cambridge, Tata Inst-Mumbai; Fellow of American Academy of Arts & Sciences, 2005–.

Selected Publications: 1. with H. B. Lawson, A theory of algebraic cocycles, Ann. of Math. (2), 136 (1992), No. 2, 361-428. MR1185123 (93g:14013); 2. with C. Bendel and A. Suslin, Infinitesimal 1-parameter subgroups and cohomology, J. Amer. Math. Soc., 10 (1997), No. 3, 693-728. MR1443546 (98h:14055b); 3. with V. Franjou, A. Scorichenko, and A. Suslin, General linear and functor cohomology over finite fields, Ann of Math. (2), 150 (1999), No. 2, 663-728. MR1726705 (2001b:14076); 4. with M. Walker, Rational isomorphisms between K-theories and cohomology theories, Invent. Math., 154 (2003), No. 1, 1-61. MR2004456 (2004j:19002); 5. with J. Pevtsova and A. Suslin, Generic and maximal Jordan types, *Invent, Math.*, 168 (2007), No. 3, 485-522. MR2299560 (2008e:20072). **Statement:** It is a great honor to be nominated for the position of President of the American Mathematical Society, especially since my mathematical grandfather Oscar Zariski and mathematical father Michael Artin led the society in earlier years. The many activities of the AMS well serve the mathematical community: disseminating mathematics through its journals and books; promoting mathematics by organizing meetings at regional, national, and international venues; encouraging public awareness and support of mathematics; improving the conditions, fairness, and diversity of the profession; reaching out to other disciplines as well as the general public; and advancing mathematical education. I have been fortunate to participate in some of these activities, to watch as the AMS has grown in strength and impact, and to serve as a member of the Board of Trustees overseeing the financial well-being of the Society.

Thanks to the efforts of many within the AMS, our Society benefits all of us mathematicians. The Executive Director and the professional staff in Providence/Washington do an excellent job in efficiently and cost-effectively realizing the objectives articulated by the membership. The staff of Math Reviews, as well as the journal/book publication program, provides marvelous resources for us all. Direction is provided by the officers and the Council of the AMS, informed by AMS policy committees. The President of the AMS serves as a constructive spokesperson for the mathematical community and helps to prioritize the many efforts of our Society.

Here are a few of the topics which we in the AMS must continue to address: i.) the impact upon our profession of the stresses of academic financing and external funding; ii.) the necessity to diversify our profession in order to assure its long-term relevance; iii.) the ever-present need to promote mathematics and its vital links to other disciplines; iv.) the changing business and intellectual landscape of mathematics publications; v.) the encouragement of international ties and cooperation; and vi.) the constructive involvement in mathematical education. I would welcome the opportunity to serve as President of the AMS to work with and for the members of the AMS to advance our Society's diverse goals.

Wilfried Schmid



Dwight Parker Robinson Professor of Mathematics, Harvard University.

Born: May 28, 1943, Hamburg, Germany.

Ph.D.: University of California, Berkeley, 1967.

AMS Offices: Member of the Council ex officio, 1991–1994. AMS Committees: Editorial Com-

mittee, *Journal of the AMS*, 1987–1994 (Chair, 1991–1994); Commit-

tee on Education, 2006-2009.

Selected Addresses: Invited Addresses, International Congress of Mathematicians, Nice, 1970, Vancouver, 1974, Plenary Address, Helsinki, 1978; Invited Address, International Congress of Mathematical Physics, Berlin, 1980; Morningside Lecture, International Congress of Chinese Mathematics, Hong Kong, 2004.

Additional Information: Alfred P. Sloan Fellowship, 1968-1970; Simon F. Guggenheim Memorial Fellowship, 1975-1976, 1988-1989; Prix Scientifique de l'UAP, 1986; Honorary Professor, University of Cordoba (Argentina), 1989; American Academy of Arts and Sciences 2003-; National Mathematics Advisory Panel, 2006-2008.

Selected Publications: 1. On a conjecture of Langlands, *Ann of Math. (2)*, 93 (1971), 1-42. MR0286942 (44 #4149);

2. Variation of Hodge structure: The singularities of the period map, *Invent. Math.*, **22** (1973), 211–319. MR**0382272** (**52** #**3157**); 3. with Michael F. Atiyah, A geometric construction of the discrete series for semisimple Lie groups, *Invent. Math.*, **42** (1977), 1–62. MR**0463358** (**57** #**3310**); 4. with Kari Vilonen, Characteristic cycles and wave front cycles of representations of reductive Lie groups, *Ann of Math.* (*2*), **151** (2000), No. 3, 1071–1118. MR**1779564** (**2001j:22017**); 5. with Stephen Miller, Automorphic distributions, *L*-functions, and Voronoi summation for GL₃, *Ann of Math.* (*2*), **164** (2006), 423–488. MR**2247965** (**2007j:11065**).

Statement: The academic world around us has changed since the last election of an AMS President. Budgets are being slashed, at both public and private universities. Mathematics is not immune to this process of retrenchment. Under conditions like these, the AMS needs to vigorously defend the interests of our profession. In 1996, then AMS President Arthur Jaffe intervened when the University of Rochester announced plans to reduce its mathematics department to a mere provider of service teaching; in cooperation with others, he managed to get the decision reversed. The next AMS President may have to deal with similar emergencies. I am prepared to act energetically if elected.

The current economic conditions are accelerating a trend that started years ago: the role of refereed journals is gradually eroding. A number of universities are instituting open access policies, at least in part to defend against the rapid escalation of journal costs. We do not yet know how the commercial publishers will react. It seems inevitable, however, that the pattern of publication of mathematical research will change significantly in the medium term. The tenure and promotion process at many universities relies on publications in refereed journals, and elite journals in particular, as an important measure of a candidate's research. What else can serve this function if and when journals fade from the scene? I have no ready answer, but want to make sure that the question is thoroughly examined.

On a less gloomy note, I would like to strengthen the influence of the AMS in K-12 mathematics education. Ten years ago I personally became intensely interested, in response to my daughter's experiences with elementary school mathematics. I recently served on the National Mathematics Advisory Panel (NMP). Among its main recommendations, it asked for a greater involvement of mathematicians on many levels. Curriculum guidelines, textbooks, teacher licensure requirements, state and national assessment tests need to be examined thoroughly, not just by administrators and educators, but also by mathematicians. Anyone who doubts this need should look through a typical high school mathematics textbook! When I first became active in mathematics education, I sensed a general reluctance to let mathematicians participate in the process. That has definitely changed—our expertise is now really welcome. The AMS, through its Committee on Education, can help to establish contacts between interested mathematicians and those who seek our advice.

Vice President Sylvain Cappell



Silver Professor of Mathematics, Courant Institute of Mathematical Sciences, New York University. **Born:** September 10, 1946, Brussels,

Belgium. **Ph.D.:** Princeton University, 1969. **AMS Offices:** Member at Large of the Council, 2004–2010.

AMS Committees: Contemporary Mathematics Editorial Committee, 1989–1992; Member and Chair, Steele Prize Committee, 1990–

1993; Nominating Committee, 1996–1998; Committee on Professional Ethics, 1999–2002; Committee on Education, 2005–2007; Executive Committee, 2006–2010; Long Range Planning Committee, 2007–2009; Nominating Committee of Executive Committee and Board of Trustees, 2008–2009. **Selected Addresses:** Invited Address, International Congress of Mathematicians, Helsinki, 1978; Invited Address, American Mathematical Society, 1980; Principal Speaker, Conference Board of the Mathematical Sciences lectures, Blacksburg, VA, 1987; AMS-MAA Invited Address, Seattle, August, 1996; Kervaire Memorial Conference, Geneva, Switzerland, 2009. **Additional Information:** Sloan Foundation Fellow, 1972– 1973; Member, Editorial Board of *Communications in Pure and Applied Math.*, 1988-; Guggenheim Foundation Fellow, 1989–1990; Chair of NYU Faculty Senate, 2007–.

Selected Publications: 1. A splitting theorem for manifolds, *Invent. Math.*, 33 (1976), No. 2, 69–170. MR0438359 (55 #11274); 2. with J. Shaneson, Nonlinear similarity, *Ann. of Math.*, 113 (1981), No. 2, 315–355. MR0607895 (83h:57060); 3. with A. Ranicki and J. Rosenberg, C. T. C. Wall's contributions to the topology of manifolds. Surveys on surgery theory, Vol. 1, 3–15, *Ann. of Math. Stud.*, 145, Princeton Univ. Press, Princeton, NJ, 2000. MR1747526; 4. with S. Weinberger, Surgery theoretic methods in group actions. Surveys on surgery theory, Vol. 2, 285–317, *Ann. of Math. Stud.*, 149, Princeton Univ. Press, Princeton, NJ, 2001. MR1818776 (2002a:57046); 5. with L. Maxim and J. Shaneson, Hodge genera of algebraic varieties. I, *Comm. Pure Appl. Math.*, 61 (2008), No. 3, 422–449. MR2376848.

Statement: The American Mathematical Society should both maintain its great role in supporting and advancing mathematical research across the spectrum and its educational efforts, as well as make special efforts advocating for the mathematical community in the present economic environment. In my current work on the AMS Council and its Executive Committee, I've had the opportunity to learn from extraordinary colleagues about the distinctive contributions of the AMS to mathematical life, both nationally and internationally, and its future projects and hope to see these carried forward, enhanced and made ever more inclusive, even through challenging times.

Peter Li



Chancellor's Professor, University of California, Irvine.

Born: April 18, 1952, Hong Kong, China.

Ph.D.: University of California, Berkeley, 1979.

AMS Offices: Member at Large of the Council, 1993–1996.

AMS Committees: AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences, 1990–1993;

Progress in Mathematics Committee, 1991–1993; Editor, *Proc. Amer. Math. Soc.*, 1991–1992; Coordinating Editor, *Proc. Amer. Math. Soc.*, 1992–1999; Committee on Committees, 1993–1995; Policy Committee on Meetings and Conferences, 1993–1996, Committee on Accessibility for Handicapped (Chair), 1994–1996; Committee on Special Donations of Publications, 1996; Committee to Select the Winner of the Veblen Prize for 1996; Panel for ICM-98 Travel Grants, 1997; Program Committee for the Joint AMS-HKMS meeting in Hong Kong (Chair), 2000; Books and Journal Donations Steering Committee, 2001–2004; Panel for ICM-2002 Travel Grants (Chair), 2001; Committee on Human Rights of Mathematicians, 2002–2005 (Chair, 2003–2004); Committee on Publications, 2005–2008.

Selected Addresses: Hour Address, AMS Regional Meeting, Logan, 1986; Plenary Speaker, First International Congress of Chinese Mathematicians, Beijing, 1998; International Congress of Mathematicians, Beijing, 2002; Plenary Speaker, Third International Congress of Chinese Mathematicians, Hong Kong, 2004.

Additional Information: Alfred P. Sloan Fellowship, 1982; John Simon Guggenheim Fellowship, 1989; Fellow, American Academy of Arts and Sciences, 2007; Faculty Mentor Award, Department of Mathematics, UCI, 2008.

Selected Publications: 1. with S.-T. Yau, On the parabolic kernel of the Schrödinger operator, Acta Math., 156 (1986), No. 3-4, 153-201. MR0834612 (87f:58156); 2. with L.-F. Tam, Harmonic functions and the structure of complete manifolds, J. Differential Geom., 35 (1992), No. 2, 359-383. MR1158340 (93b:53033); 3. Harmonic sections of polynomial growth, Math. Res. Lett., 4 (1997), No. 1, 35-44. MR1432808 (98i:53054); 4. with J. Wang, Weighted Poincaré inequality and rigidity of complete manifolds, Ann. Sci. École Norm. Sup. (4), 39 (2006), No. 6, 921-982. MR2316978 (2008d:53053); 5. with L. Ji and J. Wang, Ends of locally symmetric spaces with maximal bottom spectrum, J. Reine Angew. Math. (Crelles J.), to appear. Statement: I will be honored to serve as Vice President of the American Mathematical Society. This will be a valuable opportunity to help promote mathematical research as well as mathematical education. As one of the most influential professional organizations of its kind, it is important for the AMS to take a worldwide leadership role in the fostering of the profession.

Trustee Mark L. Green



Professor of Mathematics and Director Emeritus, Institute for Pure and Applied Mathematics, University of California, Los Angeles. **Born:** October 1, 1947.

Ph.D.: Princeton University, 1972. **AMS Committees:** Committee on the Profession, 2000–2003 (Chair, 2002–2003).

Selected Addresses: CIME Lecture Series (8 lectures), Torino, Italy, 1993; Invited talk (45 min.), International Congress of Math-

ematicians, Berlin, Germany, 1998; AMS Invited Address, Joint Mathematics Meetings, New Orleans, 2001; Plenary Speaker, Abel Bicentennial, Oslo, 2002; Plenary Speaker, Hodge Centennial, Edinburgh, 2003.

Additional Information: Alfred P. Sloan Fellowship, 1976; Director, Institute for Pure and Applied Mathematics, 2001–2008.

Selected Publications: 1. Quadrics of rank four in the ideal of a canonical curve, *Invent. Math.*, **75** (1984), No. 1, 85–104. MR0728141 (85f:14028); 2. Griffiths' infinitesimal invariant and the Abel-Jacobi map, *J. Differential Geom.*, **29** (1989), No. 3, 545–555. MR0992330 (90c:14006); 3. with R. Lazarsfeld, Higher obstructions to deforming cohomology groups of line bundles, *J. Amer. Math. Soc.*, **4** (1991), No. 1, 87–103. MR1076513 (92i:32021); 4. Higher Abel-Jacobi maps, Proceedings of the International Congress of Mathematicians, Vol. II (Berlin, 1998). *Doc. Math.* 1998, Extra Vol. II, 267–276 (electronic). MR1648077 (99k:14012); 5. with P. Griffiths, *On the Tangent Space to the Space of Algebraic Cycles on a Smooth Algebraic Variety*, Annals of Mathematics Studies, Princeton University Press, Princeton (2005). MR2110875 (2005m:14013).

Statement: A Trustee needs to be a good listener, have an open mind, be committed to serving the needs of the entire mathematical community, and believe passionately in the importance of Mathematics as a discipline. The central role of a Trustee is to look out for the financial interests of the AMS and to ensure that its funds are used wisely, so as to maximize the positive impact that it can have on the mathematical community. My experience as Director of a start-up institute, the Institute for Pure and Applied Mathematics (IPAM), has given me considerable experience with balancing a budget, managing an organization, and with how to assess new programs and figure out how much funding they will need. The AMS has an enviable record of developing new programs and activities and of extending public awareness of Mathematics, and continuing to move forward will be especially challenging in the present difficult fiscal environment. Starting with attending an AMS summer meeting shortly after receiving my Ph.D., I have been the beneficiary of many of the AMS's important activities, and I would be honored to have an opportunity to give something back to this excellent organization.

Robion Kirby

Professor of Mathematics, University of California, Berkeley.

Born: February 25, 1938.

Ph.D.: University of Chicago, 1965.

AMS Offices: Member at Large of the Council, 1974–1976, 1988–1991; Executive Committee, 1976–1977.

AMS Committees: Veblen Prize Committee, 1975-1976, 1999-2000; *Graduate Studies in Mathematics* Editorial Committee, 1993-1995; Committee on Education, Subcommittee on Graduate and Postdoctoral Affairs, 1996-1997; *Notices* Editorial Board Committee, 2001-2009; Library Committee, 2005-2008; Program Committee for National Meetings, 2007-2010 (Chair, 2009-2010).

Selected Addresses: AMS Hour speaker, August, 1969; International Congress of Mathematicians, Nice, 1970.

Additional Information: Deputy Director, MSRI, 1985-1987; Member, National Academy of Sciences, 2001-; cofounder, *Geometry & Topology*; co-founder, Mathematical Sciences Publishers.

Selected Publications: 1. Stable homeomorphisms and the annulus conjecture, *Ann. of Math. (2)*, **89** (1969), 575–582. MR0242165 (**39** #3499); 2. with L. C. Siebenmann, On the triangulation of manifolds and the Hauptvermutung, *Bull. Amer. Math. Soc.*, **75** (1969), 742-749. MR0242166 (**39** #3500); 3. A calculus for framed links in *S*³, *Invent. Math.*, **45** (1978), No. 1, 35–56. MR0467753 (**57** #7605); 4. with Paul Melvin, The 3-manifold invariants of Witten and Reshetikhin-Turaev for sl(*2,C*), *Invent. Math.*, **105** (1991), No. 3, 473–545. MR1117149 (**92e:57011**); 5. with D. Gay, Constructing Lefschetz-type fibrations on four-manifolds, *Geom. Topol.*, **11** (2007), 2075–2115. MR2350472 (**2009b:57048**).

Statement: Given the current financial crunch, of uncertain duration, the AMS is likely to have at least some financial difficulties in the coming years. The AMS relies considerably on income from its publications, both journals and books, and libraries are being hard hit by cutbacks which must impact the AMS. My experience in co-founding and running Mathematical Sciences Publishers, a non-profit company that publishes over 10,000 pages of excellent mathematics at very low prices, should help me understand the difficulties that the AMS is facing. The publication business is a peculiar one in which great savings can be made, although the AMS is already outdoing almost all other publishers in low-cost, excellent math journals. The AMS serves the math community very well, and it is the duty of the Trustees to make sure that the AMS remains financially healthy so that it can continue to serve us well.

Member at Large Alejandro Adem



Professor of Mathematics, Department of Mathematics, University of British Columbia.

Born: November 24, 1961, Mexico City, Mexico.

Ph.D.: Princeton University, 1986. **AMS Committees:** Selection Committee for Summer Research Conferences, 1997–2000; Committee on the Profession (Chair), 2008–. **Selected Addresses:** Plenary Address, AMS Central Section, Co-

lumbia, Missouri, 1996; Plenary Address, Mexican Mathematical Society, Guadalajara, 1999; Bourbaki Seminar, Paris, 2001; Special Lecture, Latin American Congress, Cancun, 2004; Plenary Address, Korean Mathematical Society, Jeju, 2008.

Additional Information: A. P. Sloan Doctoral Dissertation Fellowship, 1985; NSF Young Investigator Award, 1992; Wisconsin Alumni Research Foundation Romnes Fellowship, 1995; NSERC Canada Research Chair (Tier I), 2004; Chair, Department of Mathematics, University of Wisconsin-Madison, 1999–2002; Co-Chair, Scientific Advisory Committee, MSRI, 2003–2007; Director, Pacific Institute for the Mathematical Sciences, 2008–; Visiting Professor: ETH, 1994, Princeton, 2004; Editor, *Trans. Amer. Math. Soc.*, 2004–.

Selected Publications: 1. with W. Browder, The free rank of symmetry of $(S^n)^k$, Invent. Math., 92 (1988), No. 2, 431-440. MR0936091 (89e:57034); 2. Characters and K-theory of discrete groups, Invent. Math., 114 (1993), No. 3, 489-514. MR1244911 (95j:55006a); 3. with R. J. Milgram, *Cohomology of finite groups*, Grundlehren Math. Wiss., 309, Springer-Verlag, Berlin, 1994. viii+324 pp. MR1317096 (96f:20082); 4. with J. H. Smith, Periodic complexes and group actions, Ann. of Math. (2), 154 (2001), No. 2, 407-435. MR1865976 (2002i:57031); 5. with J. Leida and Y. Ruan, Orbifolds and stringy topology, Cambridge Tracts in Mathematics, 171, Cambridge University Press, Cambridge, 2007. xii+149 pp. MR2359514 (2009a:57044). Statement: In my view the AMS is the most important mathematical organization in the world. Through its collective efforts it has fostered the development of the mathematical sciences in the United States as well as internationally. As someone who has worked and studied at a variety of institutions in the United States, Canada, and Mexico, I have a broad perspective on how the AMS can contribute to strengthening our community. In addition my administrative experience as department chair at Wisconsin and now as director of a research institute have made me aware of many issues as well as opportunities that require our attention, especially given the current highly uncertain financial situation which we are facing. I would be honored to serve the mathematics community as a Member at Large of the Council if elected.

James H. Curry

J. R. Woodhull/Logicon Teaching Professor of Applied Mathematics, Chair of the Department of Applied Mathematics, University of Colorado at Boulder.

Born: 1948, Oakland, California, USA.

Ph.D.: University of California, Berkeley, 1976.

AMS Committees: Committee on Exemplary Mathematics Departments, 2005–2007; Morgan Prize Selection Committee, 2005–2011; Committee on the Profession, 2006–2009. Additional Information: David Blackwell Lecture, 1995; Lectures in Vietnam (2005, 2007); SIAM Committee on Education; National Research Council (NRC) Fellowship Advisory Panel; NRC, Vietnam Education Foundation Fellowship Selection Committee.

Selected Publications: 1. with L. Billings and E. Phipps, Lypunov exponents, singularities and a riddling bifurcation, *Phys. Rev. Lett.*, Vol. 79, No. 6, 1997; 2. with L. Billings and E. Phipps, Symmetric functions and exact Lyapunov exponents, *Phys. D*, **121** (1998), No. 1–2, 44–64. MR1644390 (99h:58132); 3. with S. Wild and A. Dougherty, Seeding non negative matrix factorization, *Pattern Recognition* (2004), vol. 37; 4 with B. J. Klingenberg and A. Dougherty, On the ill-posedness of non negative matrix factorization, *Pattern Recognition* (2009).

Statement: During my six-year tenure as Chair a major goal has been in promoting the excellence of the faculty so that it achieves its expectations of research growth and its goal of becoming a world class mathematical sciences enterprise. Promoting faculty excellence to the administration and better educating students in the subtleties, opportunities and possibilities present in the mathematical sciences and at all levels, is part of the AMS' mission. As an AMS Member at Large I would continue to promote excellence in research and excellence in teaching, but at a national and international level. The Mathematical Sciences community must prepare its constituents for the world stage. I believe that this is an imperative! I further understand that while teaching our students well is vital, it is not the only imperative we have to embrace. We must also educate the campus, state and national administration on the importance of excellence in the mathematical sciences: teaching, service and most importantly research.

Richard Hain



Professor of Mathematics, Duke University.

Born: August 15, 1953, Sydney, Australia.

Ph.D.: University of Illinois, 1980. **AMS Committees:** Centennial Fellowship Committee, 1991–1993; Southeastern Section Program Committee, 2000–2001; Program Committee for National Meetings, 2003–2006 (Chair, 2005–2006); Nominating Committee, 2003–

2005; AMS-MAA Joint Program Committee, 2004–2005; Advisory Board for Employment Services, 2009–2011. **Selected Addresses:** Two plenary talks, International Conference on Algebraic Topology, Evanston, 1988; Arbeitstagung, Bonn, 1988; AMS Invited Hour Address, Memphis, TN, 1997; Frontiers in Mathematics Lectures, Texas A&M University, 1997; Current Developments in Mathematics, Harvard-MIT, 2002.

Additional Information: Member, Institute for Advanced Study (1985–1986, Fall 1994), MSRI (Spring, 2009); AMS Research Fellowship, 1987; Japan Society for the Promotion of Science Fellow, May, 1998; Organizer of the first *Math Day for High School Students*, University of Washington, March, 1991; Organizer of a conference on mapping class groups and moduli spaces of curves, Seattle, August, 1991; Special session organizer, AMS meeting, Memphis, 1997; Co-organizer of *Duke Mathematical Journal* Conferences, 1998, 2001, 2004; Special session co-organizer, AMS meeting, Melbourne, Australia, 1999; Department Chair (Duke University), 1999–2002, 2004–2006; Editor, *Illinois Journal of Mathematics*, 2002-2006; Director, IAS/Park City Mathematics Institute, September 2009–.

Selected Publications: 1. with S. Zucker, Unipotent variations of mixed Hodge structure. Invent. Math., 88 (1987). No. 1, 83-124. MR0877008 (88i:32035); 2. Infinitesimal presentations of the Torelli groups, J. Amer. Math. Soc., 10 (1997), No. 3, 597-651. MR1431828 (97k:14024); 3. with E. Looijenga, Mapping class groups and moduli spaces of curves, Algebraic Geometry-Santa Cruz 1995, Proc. Sympos. Pure Math., vol. 62, part 2, Amer. Math. Soc, Providence, RI, 1997, 97-142. MR1492535 (99a:14032); 4. with M. Matsumoto, Weighted completion of Galois groups and Galois actions on the fundamental group of $\mathbb{P}^1 - \{0, 1, \infty\}$, Compositio Math., 139 (2003), No. 2, 119-167. MR2025807 (2005c:14031); 5. Relative weight filtrations on completions of mapping class groups, in Groups of Diffeomorphisms, Advanced Studies in Pure Mathematics, 52 (May, 2008), 309–368, Mathematical Society of Japan.

Statement: This is a critical time for the AMS and the profession. Shrinking budgets and declining endowments have resulted in constrained university budgets and a shortage of jobs, both academic and non-academic, particularly for younger mathematicians. It is important that the AMS provide tools to help those seeking employment and graduate support to available funding. It is also important that the AMS not lose sight of its long-term goals, such as the publishing of high quality and affordable books and journals, the support of mathematics research through quality meetings, its advocacy for increased funding of the mathematical sciences, and the continuation of its outreach and educational activities.

IN.

Evans M. Harrell



Professor of Mathematics and Associate Dean of Sciences, Georgia Institute of Technology. **Born:** July 26, 1950, Indianapolis,

Ph.D.: Princeton University, 1976. **AMS Committees:** Member of AMS Liaison Committee with American Association for the Advancement of Science, 1995–2001 (Chair, 1998–2001). **Selected Addresses:** Spectral Theory and Mathematical Physics, California Institute of Technology, Pasadena, 2006; Operator Theory and Quantum Mechanics, Prague, Czech Republic, 2006; CIMPA-UNESCO Morocco School on Riemannian Geometry, Pseudo-Riemannian Geometry and Mathematical Physics, Marrakech, Morocco, 2008; International Conference on Global Analysis and Differential Geometry, Saga, Japan, 2009.

Additional Information: NSF National Needs Fellow, Massachusetts Institute of Technology, 1978-1979; Sloan Fellow, 1983-1985; Chercheur du C.N.R.S., 1998-1999; Eichholz Fellow (a teaching award), 2006; Fellow of American Association for the Advancement of Science, 2006; Scholar visits: University of Vienna, 1977-1978; Luminy, France, 1993; Schrödinger Institute, Vienna, 1993, 1998, 2009; Rennes, France, 1998; Toulouse, France, 1998-1999; University of Tokyo, 2003; Tours, France, 2004; Tata Institute for Fundamental Research, Bangalore, 2004. Memberships: International Association of Mathematical Physics, American Physical Society (Elected to Executive Committee of the Forum on Physics and Society, 1986-1988), American Association for the Advancement of Science. Service on scientific assessment panels for National Science Foundation, Department of Energy, Science Foundation Ireland, and various universities.

Selected Publications: 1. with J. Stubbe, On trace identities and universal eigenvalue estimates for some partial differential operators, Trans. Amer. Math. Soc., 349 (1997), No. 5, 1797-1809. MR1401772 (97i:35129); 2. A direct proof of a theorem of Blaschke and Lebesgue, J. Geom. Anal., 12 (2002), No. 1, 81-88. MR1881292 (2002k:52009); 3. Commutators, eigenvalue gaps, and mean curvature in the theory of Schrödinger operators, Comm. Partial Differential Equations 32 (2007), No. 1-3, 401-413. MR2304154 (2008i:35041); 4. Perturbation theory and atomic resonances since Schrödinger's time, Spectral theory and mathematical physics: A Festschrift in honor of Barry Simon's 60th Birthday, pp. 227-248. Proc. Sympos. Pure Math., 76, Part 1, Amer. Math. Soc., Providence, RI, 2007. MR2310205 (2008c:81200); 5. with L. Hermi, Differential inequalities for Riesz means and Weyl-type bounds for eigenvalues, J. Funct. Anal., 254 (2008), No. 12, 3173-3191. MR2418623. Statement: The community of mathematicians has two important needs that the Council of the AMS can help to address. One of these is to maintain the high level of our intellectual product. As an interdisciplinary mathematician with wide contacts in the scientific community and experience developing and overseeing research and graduate educational programs at Georgia Tech, I am well positioned to connect mathematicians with research in other disciplines and to help gather the resources needed for research programs to succeed. The second great need is for society to better understand mathematics and how to benefit from it. An important part of this is to ensure the continued entry into mathematics of young talent, drawn from diverse populations. I have been an innovator in college curricula and in ways of delivering education. My experience with other scientific societies, with the recruitment and mentoring of graduate students, and my extensive contacts with mathematics in developing

countries have further informed my perspectives on this need. I welcome the challenge of serving on the Council and will devote the time and effort it will take. I can be a forceful and articulate advocate for mathematics.

Alexander R. Its



Distinguished Professor of Indiana University, Indiana University-Purdue University, Indianapolis. **Born:** January 1, 1952, Leningrad, USSR.

Ph.D.: Leningrad State University, USSR, 1977.

Selected Addresses: Invited Address, Joint Mathematics Meetings, Washington, DC, 2000; Invited Speaker, British Mathematical Colloquium, Leeds, UK, 2000; Hardy

Lecture, London Mathematical Society, London, UK, 2002; Hardy Lecture, Edinburgh Mathematical Society, Edinburgh, UK, 2002; Plenary Talk, 2008 Conference on Foundations of Computation Mathematics, Hong Kong, 2008. Additional Information: Co-Editor-in-Chief, Mathematical Physics, Analysis and Geometry; Member of the Editorial Board, Nonlinearity. Awards: The Prize of Moscow Mathematical Society, 1976, The Prize of the Leningrad Mathematical Society, 1981, 2002 Hardy Fellow of the London Mathematical Society, 2009 Batsheva de Rothschild Fellow of the Israel Academy of Sciences and Humanities. Visiting Positions: Visiting Professor, Rennes University, France, 1995; Visiting Professor, Department of Mathematics, Imperial College, London, UK, 2000, 2002, 2007-2008; Visiting Faculty, Department of Mathematics, University of Pennsylvania, 2000; Visiting Professor, Université Louis Pasteur, Strasbourg, France, 2001, 2007; Visiting Professor, Université de Bourgogne, Dijon, France, 2003; Member, Isaac Newton Institute, 2004, 2007; Visiting Professor, Université Paris VII, Paris, France, 2005; Visiting Professor and Research Fellow, Brunel University, West London, UK, 2007-2008. Conference Co-organizer (selected): AMS-SIAM-IMS Summer Research Conference on Random Matrices, Statistical Mechanics, and Painlevé Transcendents, Mt. Holyoke College, MA, 1996 (Co-Chair); MSRI semester on Random Matrix Models and Their Applications, Berkeley, Spring, 1999 (Co-Chair); International Congress in Mathematical Physics, Rio de Janeiro, 2006 (Member of the International Scientific Committee); Workshop on the Theory of Highly Oscillatory Problems, Isaac Newton Institute, 2007; Associate Member of the CRM Math Phys Lab, Montreal, Canada; Honorary Visiting Professor of the Imperial College, London, UK, 2006-2009; Honorary Visiting Professor of Brunel University, London, UK, 2008–2009. Selected Publications: 1. with A. S. Fokas and A. V. Kitaev, The isomonodromy approach to matrix models in 2D quantum gravity, Comm. Math. Phys., 147 (1992), 395-430.

MR1174420 (93h:81115); 2. with P. A. Deift and X. Zhou, A Riemann-Hilbert approach to asymptotic problems arising in the theory of random matrix models, and also in the theory of integrable statistical mechanics, *Ann. of Math.* (2), **146** (1997), No. 1, 149–235. MR1469319 (98k:47097);

3. with P. Bleher, Semiclassical asymptotics of orthogonal polynomials, Riemann-Hilbert problem, and universality in the matrix model, *Ann. of Math.* (2), **150** (1999), No. 1, 185-266. MR**1715324** (2000k:42033); 4. The Riemann-Hilbert problem and integrable systems, *Notices Amer. Math. Soc.*, **50** (2003), No. 11, 1389–1400. MR**2011605** (2004m:30065); 5. with P. A. Deift and I. Krasovsky, Asymptotics of the Airy-kernel determinant, *Comm. Math. Phys.*, **278** (2008), No. 3, 643–678. MR**2373439** (2008m:47061).

Statement: A striking aspect of the unity of mathematics is the remarkable fact that the most fundamental breakthroughs in the development of mathematics very often result from the fusion of ideas and techniques from different mathematical areas. Hence the importance of the old but somewhat under-appreciated idea that it is extremely advantageous for a mathematician to understand the basic goals, results and techniques of areas outside of the "epsilon-neighborhood" of his'r field. I think that the strengthening of this idea should be one of the key objectives of scientific policy at AMS. The fulfillment of this objective is impossible without simultaneous and coordinated efforts in the field of education. It is my strong belief that the AMS should (1) promote research and educational activities (e.g., summer workshops), (2) encourage relevant NSF funding and postdoctoral fellowships (3) promote undergraduate and graduate mathematical curriculum development, all of the kind that would help to build a new generation of American mathematicians imbued with the truly universal character of mathematical research. Due to the strong interdisciplinary nature of my own research field, I am already been involved in such activities and, if elected, I will strive to further such activities as a Member at Large of the Council.

Venkatramani Lakshmibai



Professor of Mathematics, Northeastern University.

Born: December 15, 1944, Trichy, India.

Ph.D.: Tata Institute, India, 1976. **Selected Addresses:** 1-hour invited address, AMS meeting, Stillwater, OK, 1994; C. M. S. Conference on "Representations of Groups", Banff, Alberta, Canada, 1994; Conference on "Algebraic Groups", Oberwolfach, Germany,

1995; Conference on "Algebraic Groups & their Representations", Cortona, Italy, 1995; A prime speaker (5 lectures on "Flag Variety"), *Women and Mathematics*, Institute for Advanced Study, Princeton, 2007.

Selected Publications: 1. Singular loci of Schubert varieties, *Bull. Amer. Math. Soc. (N.S.)*, **16** (1987), No. 1, 83–90. MR**0866020 (87m:14059)**; 2. with N. Reshetikhin, Quantum deformations of SL_n/B and its Schubert varieties, *Special Functions*, ICM-90, Satellite Conference Proceedings, Springer-Verlag, Tokyo, 1991, pp. 149–168. MR**1166816 (93g:17028)**; 3. Tangent spaces to Schubert varieties, *Math. Res. Lett.*, **2** (1995), No. 4, 473–477. MR**1355708**

Statement: It is beyond anybody's doubt that AMS has been doing an excellent service to the mathematical community in U. S. as well as all over the world in various capacities and has become an indispensable mathematical organization for the global mathematical community. It would be a great honor for me to serve the mathematical community in the capacity as a Member at Large of the AMS council, if elected.

Jennifer Schultens



Professor, University of California, Davis.

Born: January 26, 1965, Goettingen, Germany.

Ph.D.: University of California, Santa Barbara, 1993.

AMS Committees: Western Section Program Committee, 2007–2010. Selected Addresses: PIMS, Banff Research Centre, Canada, 2003; Topology seminar, University of California, Berkeley, 2004; Wa-

satch Topology Conference, Park City, UT, 2005; Oberseminar Topologie, MPIM-Bonn, Germany, 2006; Workshop on 3-manifold geometry and topology, University of Warwick, 2007.

Selected Publications: 1. The stabilization problem for Heegaard splittings of Seifert fibered spaces, *Topology Appl.*, **73** (1996), No. 2, 133–139. MR1416756 (97h:57039); 2. with M. Scharlemann, The tunnel number of the sum of *n* knots is at least *n*, *Topology*, **38** (1999), No. 2, 265–270. MR1660345 (2000b:57013); 3. Heegaard splittings of graph manifolds, *Geom. Topol.*, **8** (2004), 831–876. MR2087071 (2005f:57031); 4. with R. Weidman, On the geometric and the algebraic rank of graph manifolds, *Pacific J. Math.*, **231** (2007), No. 2, 481–510. MR2346507 (2009a:57030); 5. Width complexes for knots and 3-manifolds, *Pacific J. Math.*, **239** (2009), No. 1, 135–156. MR2449015.

Statement: The AMS plays an important role in the safeguarding of the professional interests of mathematicians. It is uniquely positioned to act on behalf of individual mathematicians and groups of mathematicians. On an individual level, mathematicians require very little to operate. Nevertheless, the institutions that employ mathematicians play a crucial role in shaping the profession. Institutional policies can inhibit the work of individual mathematicians or allow them to flourish. Institutional policies can create troubled departments or allow them to blossom. The current economic situation brings the usual challenges, especially for budding mathematicians. Not all news is dire, however, for as the fat is trimmed off of our universities, they will be called upon to focus on their core mission. This means that departments of mathematics, a core academic discipline, have a chance to become more involved in policy decisions. The AMS is in a position to foster a discussion of the institutional role of departments of mathematics and to advocate on behalf of mathematics departments and individual mathematicians within and outside of academia.

Janet Talvacchia

Professor of Mathematics, Swarthmore College.

Ph.D.: University of Pennsylvania. 1989.

AMS Committees: Pi Mu Epsilon, 1996-1999.

Additional Information: Visiting Positions: Bunting Institute of Harvard University, 1992–1993; Institute for Advanced Study, Princeton, 1997–1998, 2001–2002; General Member, Mathematical

Sciences Research Institute, Berkeley, 2003, 2006; The Fields Institute for Research in the Mathematical Sciences, 2005–2006.

Selected Publications: 1. with D. DeTurck and H. Goldschmidt, Connections with prescribed curvature and Yang-Mills currents: The semi-simple case, Ann. Sci. École Norm. Sup. (4), 24 (1991), No. 1, 57-112. MR1088271 (92a:53034); 2. with D. DeTurck and H. Goldschmidt, Local existence of connections with prescribed curvature, Differential geometry, global analysis, and topology (Halifax, NS, 1990), pp. 13-25, CMS Conf. Proc., 12, Amer. Math. Soc., Providence, RI, 1991. MR1158466; 3. with D. DeTurck and H. Goldschmidt, Existence of connections with prescribed Yang-Mills currents, Differential geometry: Geometry in mathematical physics and related topics (Los Angeles, CA, 1990), pp. 173-182, Proc. Sympos. Pure Math., 54, Part 2, Amer. Math. Soc., Providence, RI, 1993. MR1216536 (94c:53037); 4. with L. Sibner, The existence of nonminimal solutions of the Yang-Mills-Higgs equations over R^3 with arbitrary positive coupling constant, *Comm. Math.* Phys., 162 (1994), 331-351. MR1276551 (95b:58041); 5. with S. Singer and N. Watson, Nontoric Hamiltonian circle actions on four-dimensional symplectic orbifolds, Proc. Amer. Math. Soc., 127 (1999), No. 3, 937-940. MR1487340 (99f:57043).

Statement: The role of the AMS is to support research and education in the mathematical sciences as well as to foster awareness and appreciation of mathematics in the society at large. I believe that the integration of these activities is crucial and that the AMS council can play a helpful role in facilitating this. To achieve its goals, the AMS must engage a broad audience. This is vital in order to train a diverse population as the next generation of mathematicians, encourage sophisticated and creative uses of mathematics in a broad spectrum of applied fields, and help convey the value and relevance of mathematics to the general population. Outreach to underrepresented groups is key and as is outreach to areas not traditionally partnered with mathematics.

Christoph Thiele



Professor of Mathematics and Chair, Department of Mathematics, University of California, Los Angeles.

Born: September 10, 1968, Darmstadt, Germany.

Ph.D.: Yale University, 1995.

Selected Addresses: Invited speaker, International Congress of Mathematicians, Beijing, 2002; Invited address, AMS Western Sectional Meeting, University of

Southern California, 2004; Principal speaker, Conference Board of the Mathematical Sciences Conference, Atlanta, 2004.

Additional Information: Salem Prize, 1996.

Selected Publications: 1 with M. Lacey, *L^p* estimates for the bilinear Hilbert transform for 2 ,*Ann. of Math.*(2),**146**(1997), No. 3, 693–724. MR1**491450**(**99b:42014**); 2. A uniform estimate,*Ann. of Math.*(2),**156**(2002), No. 2, 519–563. MR1**933076**(**2003i:47036**); 3. with T. Tao, Nonlinear Fourier Analysis, Lecture notes to appear IAS Park City Mathematics, Series 2003, Vol 13; 4. with C. Muscalu and T. Tao, A Carleson theorem for a Cantor group model of the scattering transform,*Nonlinearity*,**16**(2003), No. 1, 219–246. MR1**950785**(**2004i:34227**); 5. with C. Demeter, M. Lacey, and T. Tao, Breaking the duality in the return times theorem,*Duke Math. J.*,**143**(2008), No. 2, 281–355. MR2**420509**.

Statement: The AMS is an outstanding organization that offers superb services to the mathematics community. It affects mathematicians' daily lives and is a public face of the profession. If elected Member at Large of the Council, I would view my service as a chance to give back to this wonderful organization and to help extend its mission in to the future. Building on its strong programs, and wisely following new initiatives, I envision a bright future for the AMS, and a critical role for mathematics as an ever growing and increasingly vital component of modern life.

Maciej Zworski



Professor of Mathematics, University of California, Berkeley.

Born: October 8, 1963, Wroclaw, Poland.

Ph.D.: Massachusetts Institute of Technology, 1989.

AMS Committees: National Meetings Committee, 2005–2007.

Statement: The organization of mathematical research seems to be moving in the direction of "big science". In my view, this under-

mines the special role that our subject should play. Among other things, this direction is reflected in funding trends with more institutes and more group initiatives taking up a larger share of available research funds. I am all for interdisciplinary research and interaction with other fields but big initiatives might not be the best way to achieve this. In the current economic situation we are in danger of losing a generation of young researchers and they, as individuals, need our support. The AMS should stand up for the role of independent research.

Nominating Committee William Beckner



Montgomery Professor of Mathematics and Chair, Department of Mathematics, University of Texas at Austin.

Born: September 15, 1941, Kirksville, Missouri, USA.

Ph.D.: Princeton University, 1975. **AMS Offices:** Member at Large of the Council, 2000–2005.

AMS Committees: Committee on the Profession, 1999–2003.

Selected Addresses: AMS Annual Meeting, St. Louis, 1977; International Congress of Mathematicians, Helsinki, 1978; Centre Emile Borel, Institut Henri Poincaré, Paris, 1998; British Mathematics Colloquium, Swansea, 2007.

Additional Information: Salem Prize, 1975; Sloan Fellow, 1977–1979; Managing Editor, *Trans. Amer. Math. Soc.*, 2000–2005.

Selected Publications: 1. Inequalities in Fourier analysis, *Ann. of Math.* (2), **102** (1975), 159–182. MR0385456 (52 #6317); 2. Sharp Sobolev inequalities on the sphere and the Moser-Trudinger inequality, *Ann. of Math.* (2), **138** (1993), 213–242. MR1230930 (94m:58232); 3. Geometric inequalities in Fourier analysis, *Essays on Fourier analysis in honor of Elias M. Stein, Princeton, NJ*, 1991, Princeton Math. Ser., 42, Princeton University Press, Princeton, NJ (1995), 36–68. MR1315541 (95m:42004); 4. Geometric asymptotics and the logarithmic Sobolev inequality, *Forum Math.*, **11** (1999), 105–137. MR1673903 (2000a:46049); 5. On the Grushin operator and hyperbolic symmetry, *Proc. Amer. Math. Soc.*, **129** (2001), 1233–1246. MR1709740 (2001g:35009).

Statement: The American Mathematical Society is an important voice in representing our mathematical community at large. It's essential that we continually draw new representatives for our committees and our administrative structures that reflect the diversity of the Society.

Richard T. Durrett



Professor, Department of Mathematics, Cornell University. **Born:** August 17, 1951, Anniston, Alabama, USA.

Ph.D.: Stanford University (Operations Research), 1976.

AMS Committees: Centennial Fellowship, 1998–2000, 2007–2009; Associate Editor, *Notices Amer. Math. Soc.*, 2001–2006.

Selected Addresses: One hour lecture, Joint Mathematics Meet-

ings, San Antonio, 1987; 45 minute address, International

Congress of Mathematicians, 1990; Wald Lectures (Institute of Mathematical Statistics), 2008.

Additional Information: Guggenheim Fellowship, 1988– 1989; Elected to American Academy of Arts and Sciences, 2002; Elected to National Academy of Science, 2007.

Selected Publications: 1. Stochastic Calculus: A Practical Introduction, CRC Press, Boca Raton, FL, 1996. MR1398879 (97k:60148); 2. Essentials of Stochastic Processes, Springer Texts in Statistics, Springer-Verlag, New York, 1998. MR1703359 (2002i:60001); 3. Probability: Theory and Example, third edition, Duxbury Press, Belmont, California, 2004; 4. Random Graph Dynamics, Series in Statistical and Probabilistic Mathematics, Cambridge University Press, Cambridge, 2006. MR2271734 (2008c:05167); 5. Probability Models for DNA Sequence Evolution, Springer-Verlag, New York, second edition, 2008. MR2439767.

Statement: The Nominating Committee must be concerned with diversity: not just of gender and ethnicity, but also to make sure that nominees represent the broad spectrum of AMS members, pure and impure.

Dorian Goldfeld



Professor of Mathematics, Columbia University, New York, NY. **Born:** January 21, 1947, Marburg,

Germany. Ph.D.: Columbia University, 1969. Selected Addresses: One Hour Address, AMS Annual Meeting, 1985; Forty Five Minute Address, International Congress of Mathematicians, 1986; AMS/DMV Joint International Meeting, Mainz, Germany, 2005; Distinguished Lecture

Series, Brown University, 2007; Third Ramanujan Colloquium, University of Florida, 2008.

Additional Information: Sloan Fellow, 1977–1979; Vaughn Prize, 1985; Cole Prize in Number Theory, 1987; Editor: *Acta Arithmetica, Ramanujan Journal*; American Academy of Arts and Sciences, 2009.

Selected Publications: 1. with A. Diaconu and J. Hoffstein, Multiple Dirichlet series and moments of zeta and L-functions, Compositio Math., 139 (2003), No. 3, 297-360. MR2041614 (2005a:11124); 2. The Gauss class number problem for imaginary quadratic fields, Heegner points and Rankin L-series, Math. Sci. Res. Inst. Publ., 49, H. Darmon, S.-W. Zhang (eds.), Cambridge Univ. Press (2004). MR2083209 (2005f:11251); 3. with A. Lubotzky, N. Nikolov, and L. Pyber, Counting primes, groups, and manifolds, Proc. Nat. Acad. Sci. USA, 101 (2004), No. 37, 13428-13430. MR2226643 (2007b:11144); 4. with X. Li, The Voronoi formula for $GL(n, \mathbf{R})$, *IMRN*, 2008, Article ID rnm144 (2008). MR2418857 (2009b:11077); 5. Automorphic forms and L-functions for the group $GL(n, \mathbf{R})$, Cambridge Studies in Advanced Mathematics, Vol. 99 (2006), Cambridge University Press. MR2254662 (2008d:11046). **Brian Marcus**



Professor of Mathematics, University of British Columbia, Vancouver.

Born: August 29, 1949, Los Angeles, California.

Ph.D.: University of California, Berkeley, 1975.

AMS Offices: Member at Large of the Council, 2003–2006.

AMS Committees: Committee to Monitor Problems in Communication, 1993.

Selected Addresses: AMS Short Course Lecture on Constrained Coding, 1995; Plenary Lecture, IEEE International Symposium on Information Theory, 1995; Short course on Symbolic Dynamics, University of Padova, 2001; AMS Short Course Lecture on Symbolic Dynamics, 2002; Plenary Lecture, Workshop on Symbolic Dynamics and Coding, Université Marne la Vallée, Paris, 2007.

Additional Information: IBM Almaden Research Staff Member, 1984–2002; shared with P. Siegel and J. Wolf, Leonard G. Abraham Prize Paper Award, IEEE Communications Society, 1993; 12 U. S. patents; Consulting Associate Professor of Electrical Engineering, Stanford University, 2000–2003; Mathematics Department Head, University of British Columbia (2002–2007).

Selected Publications: 1. Ergodic properties of horocycle flows for surfaces of negative curvature, *Ann. of Math.* (2), 105 (1977), 81–105. MR0458496 (56#16696); 2. with S. Tuncel, Matrices of polynomials, positivity, and finite equivalence of Markov chains, *J. Amer. Math. Soc.*, 6 (1993), 131–147. MR1168959 (93e:28022); 3. with D. Lind, *An Introduction to Symbolic Dynamics and Coding*, Cambridge University Press, Cambridge, 1995. MR1369092 (97a:58050); 4. with P. Chaichanavong, Stabilization of block-type-decodability properties for constrained systems, *SIAM J. Discrete Math.*, 19 (2005), 321–344. MR2178106 (2006i:94112); 5. with G. Han, Asymptotics of input-constrained binary symmetric channel capacity, to appear in *Ann. Appl. Probab.*, 2009.

Statement: My broad experience in academia, industry and administration, has given me a solid understanding of the skills needed for strong leadership. I would use the networks that I have established to identify and recruit mathematicians, who have these skills, to serve the AMS.

Carla D. Savage



Professor, North Carolina State University.

Born: November 11, 1951, Baltimore, MD.

Ph.D.: University of Illinois, Urbana-Champaign, 1977.

AMS Committees: Southeastern Section Program Committee, 2000–2002.

Selected Addresses: Invited Talk, Twentieth Clemson Mini-Conference on Discrete Mathematics,

Clemson University, 2005; Invited Talk, Harvey Mudd

Conference on Enumerative Combinatorics, Harvey Mudd College, 2006; Invited Hour Address, AMS Southeastern Section Meeting, Murfreesboro, Tennessee, 2007; Invited Talk, 20th Annual International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC 08), Valparaiso, Chile, 2008; Invited Talk, MAA Mathfest, Madison, Wisconsin, 2008.

Additional Information: Chair, Steering Committee, ACM/ SIAM Symposium on Discrete Algorithms, 1995-1999; Editorial Board, SIAM *Journal on Discrete Mathematics*, 1995-; Chair, Program Committee, Tenth SIAM Conference on Discrete Mathematics, Minneapolis, 2000; Chair, SIAM Activity Group on Discrete Mathematics, 2008-2010; Program Chair, Second Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM), Montreal, 2009.

Selected Publications: 1. A survey of combinatorial Gray codes, *SIAM Rev.*, **39** (1997), No. 4, 605–629. MR1491049 (98m:94052); 2. with S. Corteel, B. Pittel, and H. S. Wilf, On the multiplicity of parts in a random partition, *Random Structures Algorithms*, **14** (1999), No. 2, 185–197. MR1667320 (2000g:05017); 3. with J. Griggs and C. E. Killian, Venn diagrams and symmetric chain decompositions in the Boolean lattice, *Electron. J. Combin.*, **11** (2004), No. 1, Research Paper 2 (electronic). MR2034416 (2004j:06004); 4. with S. Corteel, Lecture hall theorems, *q*-series and truncated objects, *J. Combin. Theory Ser. A* **108** (2004), No. 2, 217–245. MR2098842 (2005h:05018); 5. with A. J. Yee, Euler's partition theorem and the combinatorics of *l*-sequences, *J. Combin. Theory Ser. A*, **115** (2008), No. 6, 967–996. MR2423343 (2009c:05019).

Statement: The current political and economic climate presents unique challenges and opportunities for mathematicians and for mathematics research. Through its activities and committees, the AMS is strategically positioned to utilize this climate to promote public awareness of the critical importance of mathematics; to identify scientific challenges requiring a mathematical breakthrough; to secure increased funding for mathematical research; and to improve mathematics education. If elected, I will strive to recruit candidates with talent, energy, and imagination, who will pursue these goals.

Julius L. Shaneson

Class of 1939 Professor, Mathematics Department, University of Pennsylvania.

Born: July 24, 1944, Richmond, Virginia.

Ph.D.: University of Chicago, 1968.

AMS Committees: Joint Summer Research Conference Committee, 1980–1982; Chair, Committee on Committees, 1989–1990; Committee to Select Winner of Steele Prizes, 2006–2009 (Chair, 2008–2009).

Selected Addresses: AMS Annual Meeting, Biloxi, MS, 1979; International Congress of Mathematicians, Warsaw, 1983; Indiana University Distinguished Lecture Series, 1991; International Congress of Mathematicians, Zurich, 1994; Namboodiri Lecture Series, University of Chicago, 1994.

Additional Information: A. P. Sloan Foundation Fellowship, 1971-1973; J. S. Guggenheim Foundation Fellowship, 1981–1982; Chair, Department of Mathematics, University of Pennsylvania, 2002–2006.

Selected Publications: 1. Wall's surgery obstruction groups for $Z \times G$, Ann. of Math. (2), 90 (1969), 296-334. MR0246310 (39#7614); 2. with S. Cappell, The codimension two placement problem and homology equivalent manifolds, Ann. of Math. (2), 99 (1974), 277-348. MR0339216 (49#3978); 3. with S. Cappell, Nonlinear similarity, Ann. of Math. (2), 113 (1981), No. 2, 315-355. MR0607895 (83h:57060); 4. with S. Cappell, Stratifiable maps and topological invariants, *J. Amer. Math. Soc.*, 4 (1991), 521-551. MR1102578 (92d:57024); 5. with S. Cappell and L. Maxim, Hodge genera of algebraic varieties. I. *Comm. Pure Appl. Math.*, 61 (2008), No. 3, 422-449. MR2376848.

Statement: The elected officers of the AMS represent American Mathematics to the public at large, and help the Math community to identify and address many issues in the pursuit of research and education. The nominating committee should seek out the most talented individuals for the many tasks involved, keeping in mind the need for officers that can address the needs of different components of the community of mathematicians and can speak to different parts of the wider public.

Editorial Boards Committee

Diego Ernesto Dominici



Assistant Professor, SUNY New Paltz, New Paltz, New York. **Born:** February 18, 1972, Buenos

Aires, Argentina.

Ph.D.: University of Illinois at Chicago, 2003.

Selected Addresses: Invited Speaker, 9th Conference on Orthogonal Polynomials Special Functions and Applications (OPSFA07), Marseille, France, 2007; Chair, Session on Asymptotics, 6th International Congress

on Industrial and Applied Mathematics (ICIAM07), Zurich, Switzerland, 2007; Co-organizer (with S. Cooper and S. Ole Warnaar), Special Session on Special Functions and Orthogonal Polynomials, Joint Meeting of the AMS-NZMS, 2007, Victoria University of Wellington, New Zealand, 2007; Invited Speaker, Workshop on Asymptotic Analysis, Foundations of Computational Mathematics, City University of Hong Kong, Hong Kong, China, 2008; Co-organizer (with R. Paris), Minisymposium on Asymptotic Analysis, The European Consortium For Mathematics In Industry (ECMI 2008), University College London, London, UK, 2008. Additional Information: Richard C. DiPrima Prize for outstanding research in applied mathematics, SIAM, 2004; Humboldt Research Fellowship for experienced researchers, Alexander von Humboldt Foundation, 2008-2011. Editorial boards: Associate Editor, Journal of Mathematics, Statistics and Allied Fields, 2008-; Advisory Board Member, Scientific Journals International (SJI), 2006-; Co-Editor, The Electronic News Net of the SIAM Activity Group on Orthogonal Polynomials and Special Functions (OP-SF NET),

2006-; Associate Editor, International Journal of Applied Mathematics & Statistics (IJAMAS), 2005-. Member, SIAM. Selected Publications: 1. with C. Knessl, Geometrical optics approach to Markov-modulated fluid models, Stud. Appl. Math., 114 (2005), No. 1, 45-93. MR2117327 (2005h:34011); 2. with C. Knessl, Ray solution of a singular perturbed elliptic PDE with applications to computer network models, SIAM J. Appl. Math., 66 (2006), No. 6, 1871-1894. MR2262956 (2008e:35046); 3. Asymptotic analysis of the Krawtchouk polynomials by the WKB method, Ramanujan J., 15 (2008), No. 3, 303-338. MR2390273; 4. Asymptotic analysis of generalized Hermite polynomials, Analysis (Munich), 28 (2008), No. 2, 239-261. MR2401156 (2009c:33020); 5. with C. Knessl, Asymptotic analysis of a fluid model modulated by an *M/M/1* gueue, *Adv. Appl.* Prob., 40 (2008), No. 3, 856-881. MR2454036.

Statement: The publication of articles in scientific areas, especially in mathematics, is about to enter a new era. Modern typesetting software, electronic journals and e-print archives are revolutionizing the way in which we write and share our mathematical ideas. I believe that in order to keep up with these changes a review of the roles of publisher, editor and referee is needed. As a member of the AMS Editorials Board Committee, I will put all my energy into creating a bridge between the wonderful traditions that the AMS publications represent and the new challenges that the future will bring.

Anatoly Libgober



Professor, University of Illinois at Chicago.

Born: March 24, 1949, Moscow, Russia.

Ph.D.: Tel-Aviv University, 1977. **Selected Addresses:** Summer School on Algebraic Geometry, Seattle, Washington, 2005; Course in School on Singularities, ICTP, Trieste, Italy, 2005; ICM Satellite Conference on Algebraic Geometry, Segovia, Spain, 2006; Lecture

series, Hangzhou University, Hangzhou, China, 2007; Lecture, Workshop of Topology of Stratified Spaces, MSRI, 2008.

Additional Information: Editor, *Journal of Knot Theory and its Ramifications*; Co-editor, *Trends in Singularities* (with M. Tibar), Birkhäuser; Co-editor, *Algebraic Geometry* (with P. Wagreich), Springer-Verlag, 1981; Co-editor, *Braids* (with J. Birman), Contemporary Mathematics, vol. 78, Amer. Math. Soc., 1988; Co-editor, *Singularities and Complex Geometry* (with S. Yau and Q. K. Lu), AMSIP Studies in Advanced Mathematics, vol. 5, Amer. Math Soc., 1997; Fulbright Scholar, 2001.

Selected Publications: 1. Invariants of plane algebraic curves via representations of the braid groups, *Invent. Math.*, **95** (1989), No. 1, 25–30. MR**0969412 (90a:14038)**; 2. Homotopy groups of the complements to singular hypersurfaces. II, *Ann. of Math.* (2), **139** (1994), No. 1, 117–144. MR**1259366 (95d:14023)**; 3. with S. Yuzvinsky, Cohomology of the Orlik-Solomon algebras and local

systems, *Compositio Math.*, **121** (2000), No. 3, 337–361. MR**1761630** (2001j:52032); 4. with L. Borisov, Elliptic genera of toric varieties and applications to mirror symmetry, *Invent. Math.*, **140** (2000), No. 2, 453–485. MR**1757003** (2001j:58037); 5. with L. Borisov, McKay correspondence for elliptic genera, *Ann. of Math.* (2), **161** (2005), No. 3, 1521–1569. MR**2180406** (2008b:58030).

Statement: Communicating, documenting and disseminating mathematical knowledge is crucial for successful development of mathematics. AMS has a tradition of being very creative in finding new ways in finding, improving and using new capabilities in its publication processes. Identifying the best people to advance the quality and effectiveness of its publications is a challenge to which I hope to contribute if elected. I see excellence and diversity as the top criteria in recommending members to editorial boards.

Simon Tavener



Professor and Chair, Department of Mathematics, Colorado State University.

Born: August 31, 1960, Barnet, England.

Ph.D.: University of Oxford, 1986. **Selected Publications:** 1. with J.-H. Chen and W.G. Pritchard, Bifurcation for flow past a cylinder between parallel planes, *J. Fluid Mech.*, **284** (1995), 23–41. MR**1317889**; 2. with K. A. Cliffe and A. Spence, The

numerical analysis of bifurcation problems with application to fluid mechanics, *Acta Numerica* (2000), 39–131. MR1883627 (2003b:37125); 3. with K. A. Cliffe, Two-fluid Marangoni-Bénard convection with a deformable interface, *J. Comput. Phys.*, 182 (2002), No. 1, 277–300. MR1936808 (2003i:76090); 4. with V. Carey and D. Estep, A posteriori analysis and adaptive error control for multiscale operator decomposition solution of elliptic systems I: Triangular systems, *SIAM J. Numer. Anal.*, 47 (2009), 740–761. 5. with E. Allgower and S.-G. Cruceanu, Application of numerical continuation to compute all solutions of semilinear elliptic equations (2009), to appear in *Adv. Geom.*

Statement: I like to think that a journal can instill a sense of expectation and excitement as the reader glances through the titles and abstracts of the latest issue. Achieving such a standard consistently is possible only through the perspective, ingenuity and diligence of the editorial board. As a member of the EBC I would strive to identify mathematicians who can help to continue this tradition throughout the AMS journals and book series.

AMERICAN MATHEMATICAL SOCIETY



техтвоок)

Mathematics and Music

David Wright, *Washington University*, *St. Louis*, *MO*

This introduction to the interrelationships between mathematical reasoning and musical creativity shows how both subjects appeal to the same set of skills and instincts. The text explores the common foundations of the two subjects, which are developed side by side. The use of musical topics allows for the introduction of important mathematical concepts such as modular arithmetic and equivalence relations to early undergraduates.

Mathematical World, Volume 28; 2009; 161 pages; Softcover; ISBN: 978-0-8218-4873-9; List US\$35; AMS members US\$28; Order code MAWRLD/28

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American Mathematical Society



Professor, Department of Mathematics, University of Arizona. Born: 1963, Hanoi, Vietnam. Ph.D.: Moscow State University, Moscow, Russia, 1989. Selected Addresses: Twelve conferences on Representations of Finite Groups, Groups and Geometries, Lattices and Applications, and Permutation Groups, at Mathematisches Forschungsinstitut Oberwolfach, 1991–2009; Harvard

Number Theory Seminar, 1999; Conference on Algebraic Groups and Finite Reductive Groups, Bernoulli Center, EPFL, Lausanne, Switzerland, 2005; Department Colloquium, University of Wisconsin, Madison, 2006; Caltech Geometry and Topology Seminar, 2008; Group Theory, Geometry and Representation Theory: Abel Prize 2008; London Algebra Colloquium, Imperial College, London, 2009; Newton Institute, Cambridge, UK, 2009.

From the AMS Secretary—Election Special Section

Additional Information: International Mathematical Olympiad, Silver Medal, London, 1979; Alexander von Humboldt Fellow, Germany, 1993-1995; Teacher of the Year Award, College of Liberal Arts and Sciences, University of Florida, 2001-2002: Visiting Professor, Bernoulli Center, EPFL, Lausanne, Switzerland, 2005; Member, Mathematical Sciences Research Institute (MSRI), Berkeley, 2008; Editorial Boards: Communications in Algebra, Acta Math. Vietnamica; Conference organizer, "Group Representations and Combinatorics", Gainesville, FL, 2007; Co-organizer: Special Year in Algebra 2002–2003, University of Florida; "Finite Groups 2003", Gainesville, FL, 2003; "Quadratic Forms, Sums of Squares, Theta Functions and Integral Lattices" and "Higher Degree Forms", Gainesville, FL, 2009. Selected Publications: 1. with A. I. Kostrikin, Orthogonal Decompositions and Integral Lattices, Walter de Gruyter & Co., Berlin, 1994. MR1308713 (96f:17001); 2. with A. E. Zalesskii, Mod *p* reducibility of unramified representations of finite groups of Lie type, Proc. London Math. Soc., 84 (2002), 439-472. MR1881398 (2002m:20027); 3. with G. Navarro, Rational irreducible characters and rational conjugacy classes in finite groups, Trans. Amer. Math. Soc., 360 (2008), No. 5, 2443-2465. MR2373321 (2008k:20014); 4. with R. M. Guralnick, Symmetric powers and a problem of Kollár and Larsen, Invent. Math., 174 (2008), 505-554. MR2453600; 5. with A. S. Kleshchev, Representations of finite special linear groups in non-defining characteristic, Adv. Math., 220 (2009), 478-504.

Statement: If elected, I will work with other members of the committee to identify and nominate the best qualified mathematicians for the editorial boards of the AMS publications, to help maintain their high standards and to further promote the role of mathematics in science, engineering, education, and in the society as a whole.



2010 AMS Election Nominations by Petition

Vice President or Member at Large

One position of vice president and member of the Council *ex officio* for a term of three years is to be filled in the election of 2010. The Council intends to nominate at least two candidates, among whom may be candidates nominated by petition as described in the rules and procedures.

Five positions of member at large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate at least ten candidates, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

Prior to presentation to the Council, petitions in support of a candidate for the position of vice president or of member at large of the Council must have at least fifty valid signatures and must conform to several rules and procedures, which are described below.

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee.

The President will name at least four candidates for these two places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and procedures, described below, should be followed.

Nominating Committee

Three places on the Nominating Committee will be filled by election. There will be six continuing members of the Nominating Committee.

The President will name at least six candidates for these three places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on

the ballot. In addition, several other rules and procedures, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice president, member at large, member of the Nominating or Editorial Boards Committees.

- 1. To be considered, petitions must be addressed to Robert J. Daverman, Secretary, American Mathematical Society, 302C Aconda Court, University of Tennessee, Knoxville, TN 37996-0612 USA, and must arrive by 25 February 2010.
- 2. The name of the candidate must be given as it appears in the *Combined Membership List* (www.ams.org/cml). If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices*. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or by the candidate contacting the AMS headquarters in Providence (amsmem@ams.org).
- 3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.
- 4. On the next page is a sample form for petitions. Petitioners may make and use photocopies or reasonable facsimiles.
- 5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.
- 6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the *CML*. A name neither in the *CML* nor on the mailing lists is not that of a member. (Example: The name Robert J. Daverman is that of a member. The name R. Daverman appears not to be.)
- 7. When a petition meeting these various requirements appears, the secretary will ask the candidate to indicate willingness to be included on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving consent.

Nomination Petition for 2010 Election

The undersigned members of the American Mathematical Society propose the name of

as a candidate for the position of (check one):

□ Vice President

□ Member at Large of the Council

- □ Member of the Nominating Committee
- □ Member of the Editorial Boards Committee

of the American Mathematical Society for a term beginning 1 February, 2011

Return petitions by 26 February 2010 to:

Secretary, AMS, 302C Aconda Court, University of Tennessee, Knoxville, TN 37996-0612 USA

Name and address (printed or typed)



From the AMS Secretary

Report of the Treasurer (2008)

I. Introduction

One of the most important duties of the Treasurer is to lead the Board of Trustees in the oversight of financial activities of the Society. This is done through close contact with the executive staff of the Society, review of internally generated financial reports, review of audited financial statements, and meeting with the Society's independent auditors. Through these and other means, the Trustees gain an understanding of the finances of the Society and the important issues surrounding its financial reporting and planning. The Report of the Treasurer is presented annually and discusses the financial condition of the Society as of the immediately preceding fiscal year end, and the results of its operations for the year then ended. This report contains summary information regarding the operating results and financial condition of the Society for 2008, a review of 2008 operations, and, in light of the economic events of 2008 that have affected all of us, a review of how the current economic recession is likely to affect the Society and the Society's ability to weather what is yet to come. Finally, in the last part of the Report, there are financial statements derived principally from the Society's audited financial statements, which present the balance sheet, statement of activities (akin to an income statement in a for-profit organization), and information regarding the Society's invested funds.

The Society segregates its net assets, and the activities that increase or decrease net assets, into three types. Unrestricted net assets are those that have no requirements as to their use placed on them by donors outside the Society. A substantial majority of the Society's net assets and activities are in this category. Temporarily restricted net assets are those with donor-imposed restrictions or conditions that will lapse upon the passage of time or the accomplishment of a specified purpose. Examples of the Society's temporarily restricted net assets and related activities include gifts to be entirely spent on a specified project or activity, grant awards, and the accreted return in excess of spendable income, as well as any unspent spendable income, from prize and other income-restricted true endowment funds. In 2008, due to a change in the governing law in the District of Columbia and related new accounting guidelines, temporarily restricted net assets now also includes the accreted unspent return on income-unrestricted true endowment funds. This change required a reclassification of approximately \$5,065,000

from unrestricted net assets to temporarily restricted net assets as of the beginning of 2008. The temporary restriction is considered to be a time restriction, as the Board has not yet actually appropriated the accreted excess for expenditure. Permanently restricted net assets are those that must be invested in perpetuity per donor instruction and are commonly referred to as endowment funds. The Society's permanently restricted net assets are stated at fair value at the time the gift(s) were made. The accompanying financial information principally relates to the unrestricted net assets, as this category includes the operating activities of the Society.

II. Overview of 2008

Operating activities provided slightly over \$759,000 in operating revenues in excess of operating expenses. However, the total change in unrestricted net assets for the year ended December 31, 2008 was a decrease of approximately \$24,781,000, with the unrestricted portion of the loss on the long-term investment portfolio being the largest component of the decrease at almost \$20,332,000. The overall return on the Society's long-term investment portfolio was a loss of (29.5%) in 2008 versus a positive 5.4% in 2007 and a positive 13.6% in 2006. The problems with sub-prime mortgage loans that first came to light in August 2007 led, in part, to the most severe domestic and global economic crisis since the Great Depression. The effects of the global economic crisis and current recession on the Society and other matters are discussed in more detail later in this report. The accounting reclassification discussed above reduced unrestricted net assets by approximately \$5,065,000, with post-retirement health benefit changes other than periodic cost providing the remainder of the decrease in unrestricted net assets of \$143.000.

Temporarily restricted net assets increased by approximately \$2,146,000 in 2008, with the reclassification from unrestricted net assets of \$5,065,000 partially offset by the restricted portion of the loss on the long-term investment portfolio of approximately \$2,540,000. Donor contributions in this category increased in 2008 to \$178,000, due both to the generosity of an anonymous donor who funded three programs over the next few years and to the final distribution from an estate whose beneficiary was the temporarily restricted Centennial Fellowship fund. Under the new accounting guidance resulting from a change in the governing law in the District of Columbia, the use of spendable income from both the restricted and unrestricted use of income true endowment funds is now considered to be a release of restrictions on the accreted spendable

Editor's note: All dollar figures are given in US\$Dollars.

income (purpose and time restrictions for the income-restricted spendable income and time restrictions on the income-unrestricted spendable income). Accordingly, assets released from restrictions, a reduction in temporarily restricted net assets and a simultaneous increase in unrestricted net assets where the related expenses are recorded, increased in 2008 to almost \$557,000.

Permanently restricted net assets increased by slightly over \$757,000 in 2008, due principally to the generosity of an anonymous donor whose gifts funded some new activities of the Society. In addition, these gifts brought the Epsilon and various prize funds to a then current value sufficient to fund the current prize amounts and frequency. Unfortunately, the economic crisis and market meltdown occurred subsequent to the receipt of these gifts. While the market value of certain true endowment funds was less than the fair value of the endowment fund at December 31, 2008, the amount recorded as permanently restricted net assets is not adjusted for such deficits. The initial deficit arose due to investment losses and was recorded in temporarily restricted net assets. The Society's operations (unrestricted net assets) then transferred the amount necessary (\$615,140) to keep each true endowment fund at the fair value of the gifts made to them (at the time the gifts were made) via a transfer to temporarily restricted net assets. In the financial statements, this transfer increased the unrestricted loss and decreased the restricted loss on the long-term investment portfolio. When the long-term investment portfolio recovers and these true endowment funds' values are in excess of the fair value of the gifts received, operations can recover the \$615,140 so transferred. This type of transfer last occurred during the period 2001-2002, and it took the following four years to fully recover the total \$230,814 transferred from operations

to keep the true endowment funds "whole". Recovery of this market downturn is currently expected to take much longer than the previous "dot-com" bubble burst.

Although the Society's unrestricted net assets, which are similar to retained earnings in a for-profit corporation, decreased by almost \$24,800,000 in 2008, the Society remains on solid financial footing. Between cash and the operating investment portfolio, the Society had over \$17,000,000 in liquid assets at its disposal at the end of 2008. Further, the Society carries no debt other than trade accounts payable and accruals incurred in the normal course of its operations. In addition to the longterm investment portfolio, of which only 15.5% is related to true endowment funds, the Society owns valuable real property free and clear of encumbrances.

The ratio of its current assets to current liabilities, after removing deferred income from both the numerator and denominator so the result is comparable to most other enterprises, is 2.45 to 1. This is a very healthy current ratio in any economic environment, and indicative of the





Society's financial strength at what may be the beginning of a long and difficult economic period. Furthermore, the Board-designated Economic Stabilization Fund (ESF) was maintained at its target level of the sum of 75% of annual operating expenses plus 100% of the post-retirement health benefit liability. It is interesting to note that this fund's predecessor was almost entirely used during the early 1980's, which is an economic period similar in effects on the Society to what we are beginning to see now in mid-2009 (significant cutbacks in university funding which led to significant attrition in the subscriber and membership base in the early 1980's). The Board-designated Operations Support Fund (OSF), while diminished, still has a value of approximately \$20,000,000 and will continue to provide funding for operations in the form of spendable income.

III. Review of 2008 Operations

As indicated in the graph above, the four years prior to 2008 were very good years, financially, for the Society. Had the operating investment portfolio produced an av-





erage amount of income in 2008 instead of the \$100,000 loss, the 2008 operating income would have looked quite normal in the middle of the graph below, despite the highest average annual inflation (which is the inflation actually felt/incurred assuming goods and services are purchased evenly throughout the year) for the period presented below.

The returns on long-term investments have been volatile over this period, with the average annual rate of return for the three, five, and ten year periods ending December 31, 2008, at (5.44%), 0.06%, and 1.10%, respectively.

Since 2002, the Board of Trustees has appropriated investment income from the OSF, as well as those true endowment funds with income whose use is unrestricted, to support operations. The total amounts of such appropriations that have been included in operating revenue are \$1,336,778 in 2008, \$1,007,069 in 2007, \$899,630 in 2006, \$847,225 in 2005, and \$792,870 in 2004.

The graph on the preceding page showing operating income as a percentage of total operating revenue has been relatively stable in the preceding eleven years compared to the first seventeen years, which is a positive financial indicator. The results for 2008 are expected given the economic crisis that took place, and is an indicator of a period of volatility to come. One of the key factors that will keep the bar above the baseline or to push it below in the future will be inflation. Should we find ourselves in a period of "stagflation" (experienced from the late 1970's through the latter 1980's with low or no growth combined with high inflation), the "red" will return as adjustments are made to the Society's operating structure.

Sales Trends.

The graphs on this page show sales trends from 1996 through 2008, first in historical dollars and second in constant dollars (using 2008 as the base year and adjusting other years for inflation using Dec-Dec CPI figures).

The trends shown in historical dollars above are in general mildly upward, and this is partly due to pricing strategies that are intended to help counter the effects of inflation and attrition. When shown in constant dollars below, most sources of revenue are fairly flat or declining over this period.

During the ten-year period from the end of 1998 through 2008, the average annual inflation was 2.52%. During this same period, the Society's average annual expense growth was 2.44%, indicating that the Society was able to keep its expense growth at about the overall

rate of inflation for this ten-year period. At the same time, the average annual growth in revenue was only 2.04%. The revenue growth did not keep up with either inflation or the nominal expense growth during this period. This is the first year (in the five-year period we have been tracking this) that we have seen the difference in growth rates of expenses and revenues over the most recent ten-year time period be negative, and this is likely due to the significant effects of increased petroleum costs seen in 2008. Expenses grew over 8.5% in 2008 over 2007, while revenues grew only 0.17%. This reversal in the differential growth rates must be carefully monitored during the current financial crisis, as it is not sustainable.

Revenues in 2008 came in very much on target, with the exception of the return on the operating portfolio. A moderate return is generally budgeted each year, but a loss was incurred in 2008. The overall loss occurred because the investments in convertible securities and corporate bond funds, while a relatively small portion of

	20	06	20	07	20	800
Personnel Costs	\$15,471	67%	\$15,607	68%	\$16,537	67%
Building and equipment related	1,359	6%	1,453	6%	1,648	6%
Postage	904	4%	982	4%	999	49
Outside printing, binding, and mailing	g 876	4%	654	3%	705	3%
Travel: staff, volunteers, grant suppo	rted 1,131	5%	735	3%	874	49
All other expenses	3,371	14%	3,400	16%	4,037	16%
TOTAL	\$23,112	100%	\$22,831	100%	\$24,800	1009

the portfolio, incurred significant losses due to the crisis that occurred in the latter part of 2008. The yields on bank certificates of deposits were already quite low, and money market yields plummeted; accordingly, the interest income on these funds could not compensate for the losses on the mutual funds.

Major Expense Categories

The table above shows the major expenses for 2006, 2007 and 2008, in thousands of dollars. There has not been much change from year to year in the types of expenses incurred by the Society, which is expected as there have been no major changes in the way the Society operates.

Operating expenses can also be associated with the various activities of the Society, and this is similar to our audited financial statements (see Section 4). The Society has accounting systems in place to capture the identifiable direct costs of its publishing and member and professional services activities, as well as indirect costs associated with these two major functions. General and administrative

costs are those that cannot be directly associated with either of its two main functions or any activity therein. The following is a summary presentation that matches the revenue and costs of the major activities of the Society.

Some points worth noting in the above presentation are that the *Mathematical Reviews* activities and the Providence publications produce similar margins (in dollars) after identifiable direct costs associated with these products. The indirect costs associated with the overall publishing activities of the Society (taking orders, shipping and storing goods, marketing and sales efforts, etc.) reduces this margin by 37%. If general and administrative costs were allocated to the publishing activities, this margin would be reduced even further. But there would still be significant margin from the Society's publishing activities, resulting from by *Mathematical Reviews* and the journals, available to spend on services and outreach activities.

The member and professional services activities use resources of the Society, which are then supported, or "paid for" by member dues, spendable income from board-

2008 Operating Revenue and Expenses by Major Activity, in Thousands of Dollars								
	Revenue	Expense	Net					
Publications:		-						
Mathematical Reviews	\$10,230	\$ 6,569	\$ 3,661					
Providence publications (books, journals, etc.)	8,821	5,322	3,499					
Publications indirect (customer services, marketing,								
distribution and warehousing, etc.)		2,663	(2,663)					
Total publications	19,051	14,554	4,497					
Member and professional services:								
Services and outreach programs	1,117	3,699	(2,582)					
Grants, prizes and awards	657	797	(140)					
Meetings	995	1,050	(55)					
Divisional indirect		581	(581)					
Governance		454	(454)					
Total before spendable income and dues revenue	2,769	6,581	(3,812)					
Spendable income from investments	1,337		1,337					
Dues	2,360		2,360					
Total member and professional services	6,466	6,581	(115)					
Other	42	229	(187)					
General and administrative		3,435	(3,435)					
Total	\$25,559	\$24,799	<u>\$ 760</u>					

designated and true endowment funds, and the margin from publishing activities. While the various activities in this functional area do have revenue streams, such as fees, grant support, prize fund spendable income, etc., the costs incurred by these activities are significantly greater than the revenues generated.

Investing Activities in 2008

The Society has almost completed a multi-year replacement project for all the old heating and ventilation equipment and controls in the Providence and Pawtucket facilities. There is one unit left to replace in 2009. The north wing roof of the headquarters building was redone in 2008, and office furniture conversion to modular workstations in the Ann Arbor office began in 2008. This will continue over the next few years until all departments have modern, efficient workspaces. The capital acquisitions in 2008 totaled just over \$1,046,000, principally due to the financial software implementation. While not all modules are fully installed and running as yet, the Society has converted from its 1988 Ross Systems software to current day financial software that is better integrated among the modules and has far more capabilities. The investments in facilities in Rhode Island and Michigan should be complete in 2009, with 2009 a relatively normal year with a capital budget of about \$543,000. In late 2010 or early 2011, more technological investments may come on line, as the implementation of Association Management Software is currently scheduled to be complete by that time (payments will have been ongoing, but the capital addition does not get recorded as such until the system is placed in service). There are also planned improvements to our technology hardware, although not nearly so costly as replacing the Ross software and in-house developed membership, sales and distribution systems.

The other obvious area of investing activities is the long-term investment portfolio, which supports the Society's Board-designated and true endowment funds. The Society's endowment is managed under the "total return concept". Under this management policy, an investment strategy or asset allocation policy is developed for the portfolio's investments that matches the risk profile of the organization with the objectives for the investment portfolio. An expected average annual return is determined, although it should be remembered that since the life of the funds that own the investment portfolio is perpetual, as hopefully is the Society's, even the time horizon of a 20-something putting money aside for retirement may be too short a horizon to keep in mind when thinking about the Society's long-term investment portfolio.

The total return of the portfolio—income, dividends, transaction gains and unrealized gains and losses, are combined and lose their originating nature. Absent requirements to the contrary (law, regulation, specific donor language in the gift instrument), the entire return is available for spending. The Board of Trustees then determines the amount of return that is reasonable or prudent to spend, balancing the perpetual nature of the gift and investment and the donor's desire to support the activities of the Society. Currently this reasonable amount is 5% applied to the three-year moving average of the annual value of the portfolio. Any return in excess of this amount stays associated with the fund (classified in temporarily restricted net assets for those funds created by donors) and assists in maintaining the purchasing power value of the original gift. In years where losses are incurred by the portfolio, such as 2008, there are still earnings available to be spent via the 5% spending rate established by the Board, as long as the value of each fund stays at or above the original gift amounts. The effects on spendable income of any significant swing in the market value of the portfolio—up or down—are felt gradually, since the three year moving average is used as the base to which to apply the 5% rate.

The large market decline of 2008 did have some immediate effects. The true endowment funds created after 1997 or which received significant additions after 1997 all had preliminary allocated values less than their original gift amounts. The Society's unrestricted net assets had to make up for this shortfall of \$615,140, which may be recovered in the future when market conditions improve and the affected funds' values exceed their original gift amounts. The OSF, established to provide a sources of revenue for operations, which might then take some economic pressure off the Society when pricing its products and services, decreased by over half its value, from \$40,831,000 it the end of 2007 to \$20,083,000 at the end of 2008. This occurred because not only did it suffer its share of the investment portfolio's 29.5% loss for the year, it had to transfer funds to the ESF so that fund would remain at its target level. The OSF's share of the 2008 investment loss was \$11,945,000, the transfer out to the ESF was \$7,881,000, and spendable income used was \$1,039,000. Finally, operations added \$117,000 to the OSF at year end.

IV. How the Economic Recession/Financial Markets Crisis Will Affect the Society

There are five key ways in which the current economic conditions can affect organizations like the Society:

- 1. Inability to borrow money.
- 2. Loss of value in financial assets.
- 3. Loss of income to support operations.

4. Loss of customers or inability of customers to pay for products and services already provided.

5. Inability of vendors to meet their obligations to AMS, such as warranties or prepaid services.

Because of the financial strength built up by the Society over many years, it remains well-positioned to weather the current crisis, despite the 29.5% loss on its long-term investments and an overall loss on the operating investment portfolio in 2008. To confirm this conclusion, let us look at the five ways this crisis can affect the Society.

There are many unknowns; most importantly we do not know how bad this will get and how long will it last. We know this is a global economic recession the likes of which has not been seen since the 1930's. There could be many profound outcomes, such as the U.S. losing its preeminence in the global financial world, which could in turn severely hamper its ability to maintain its political standing in the world. Unprecedented actions have al-
ready been taken by the U.S. and other governments, and continued government action likely will be needed for some number of years before the global recession turns around. It is prudent to assume that the "bottom" has not yet been found in the U.S. or global economy (unemployment continues to rise, auto companies in bankruptcy, foreclosures about to start up again) and that recovery, particularly in the U.S. with certain unique and systemic problems, will be slow.

The inability to borrow money should not directly affect the Society. Currently, the Society has no debt other than to its suppliers and employees in the ordinary course of its operations. Further, the Society is nearing the end of a period of significant investments in its infrastructure (physical condition of its buildings and their various systems, computing infrastructure, etc.), which should serve its needs for quite some time to come. While significant capital outlays remain to be made in the next few years to complete the planned investments, the operating investment portfolio has sufficient funds, invested conservatively, to meet these needs. Once these are completed, there should be no further investment required in the Society's plant, fixtures and equipment, other than general repairs, upgrades and maintenance in the ordinary course of business, until after the recovery is solidly in place (assume about 6-8 years from now).

In the last two decades, the Society's operations have provided cash flow sufficient to fund its operations and, on a regular basis, cash flow to add to Board-designated "reserve" funds in the form of long-term investments. We expect the cash flow to decrease during the crisis and recovery period as sales of products and services are negatively affected over the next few years, but there should be sufficient time provided by the operating investment portfolio and, if necessary, the value of the long-term investment portfolio owned by the Economic Stabilization Fund (ESF), for the Society to adjust its operations to the new economic circumstances and thus minimize any years with a negative operating cash flow. In short, the evidence to date indicates the Society should be able to avoid having to incur debt while the credit markets are frozen or the rates charged for the funds are not to its advantage.

Loss in value of financial assets—the Society has already incurred the most obvious and immediate effects of this financial crisis in the performances of the operating and long-term investment portfolios. Yield on bond funds are low, as the flight to quality instruments in the wake of Wall Street's disasters have raised the values of high quality bonds to the extent that real yields are close to -0- or sometimes negative. Investments in anything other than high quality debt securities (read that as U.S. government and guaranteed Agency securities and FDIC insured deposit accounts) have significantly deteriorated in value, and money market investments are considered more at risk than at any time since their creation, although they appear to have stabilized for the moment with only one such fund having fallen below the \$1.00 per share value.

The performance of the operating portfolio was also an overall loss for 2008, due primarily to the performance of the two corporate bond funds and the convertible securities fund. Interest rates on the money market funds and the certificates of deposits were so low in 2008 that the return on these and the government bond funds could not overcome the losses on the other investments. Once the credit markets start to thaw, the corporate bond funds should recover their value and we don't foresee any need to liquidate these investments in the near term for cash flow needs. The convertible securities fund follows more closely the domestic equity market than the bond market, so it will likely be some time before recovery of market losses occurs. It is also likely that we will not need to liquidate these investments before recovery of value occurs.

The long-term investment portfolio suffered a decline of 29.5% for the year ended December 31, 2008, with losses continuing into 2009 (8.4% through March). However, as discussed in a previous section, this overall significant loss in the value of the portfolio will not have an immediate negative effect on the Society's operating results. Return from the long-term investment portfolio continues to make its way into operations in the form of spendable income and assets released from restrictions, even when the portfolio suffers actual losses. This occurs due to the use of the total return concept and a spending rate to determine the amount available to spend each year.

Given the actual significant decline in the long-term investment portfolio's value in 2008, with recovery not currently expected to begin (at the earliest) until late in 2010, the spendable income included in operating revenue (from the OSF, and both the income-restricted and incomeunrestricted true endowment funds) will decline in future years. The spendable income streams associated from the true endowment funds and linked to specific costs of activities may reach a level where, in the absence of some other action(s), they no longer cover all the previously covered costs of the activities. However, the declines in these revenue streams will not occur precipitously, due to the smoothing effect of the use of the three-year moving average of invested balances to determine the base investment value to use for the determination of spendable income. This gives the Society time to plan and adjust should it be likely that fewer (or more) dollars of spendable income will be available to fund operating activities for some number of years to come.

Under the Society's current long-term financial planning assumptions, the Society's income from these revenue streams will decline to some "bottom" level in the next four (plus) years and will stay at or near this lower amount for a few more years until it slowly starts climbing again when recovery gets going.

Absent any significant changes in the behaviors of its customers and members, and assuming the Society maintains or only slightly modifies its various pricing policies and procedures, the operations of the Society provide sufficient cash flow to fund all required payments, and should continue to do so despite the expected decreases in spendable income over time. However, depending upon the length and breadth of the global economic recession, and any other currently unknown factors that may come to bear on the Society, it may be necessary to suspend the required target level for the ESF and actually use some of its funds to support operations during this period. Reserve funds were used in this manner during the early 1980's when the Society lost many subscribers, so it is possible this may be necessary again should the current severe recession be deep and long.

Loss of income to support operations, loss of customers, inability of customers to pay—the financial health of the Society's customers will likely be put more at risk by this financial crisis than that of the Society itself. This, in turn, will add significant risk to the Society's revenue streams. The lack of availability of credit could affect the ability of the Society's commercial customers and subscription agents to pay the Society in a timely manner. Some could face significant business difficulties if necessary credit lines are not renewed and/or additional cash investments are not secured, which could lead to significant reductions in orders from these channels for books and journals, respectively, or, even worse, another subscription agent failure similar to divine/Rowecom a few years back. These relationships and the credit levels of commercial customers and their payment patterns must be monitored closely.

Finally, battered state and federal coffers, losses on endowment funds and rising costs could lead to a significant decrease in subscriptions in the next few years, as well as membership. It is not out of the question that a situation similar to that of the late 1970's-early 1980's could present itself again, where over the span of 3 or 4 years there was a precipitous drop in revenues from these sources. The losses incurred in the subscriber and member bases were never fully recovered, and it took quite some time for the Society to adjust to the new reality. Recovering was not without pain and risk back then, nor will it be now.

Inability of vendors to provide goods and servicesshould our vendors not be able to provide goods or services already paid for, the Society would be in the position of having to pay a second time for those that are absolutely necessary for operations (such as servicing or repairing equipment). We do not prepay for many things and use corporate credit cards when we do so for goods (so that the charge can be reversed if they are never received). For service contracts and similar services that must be prepaid, we use only highly rated vendors and will continue to monitor them to minimize this risk. In the critical area of publishing, paper, outside printing, mailing costs and the like are all paid for after the goods and services are delivered, so there is little risk to the Society's ability to produce and deliver its promised products. This area of risk should not significantly affect the Society.

With the operating investment portfolio, relatively stable spendable income from the OSF over the next few years and the availability of funds (over \$22,000,000) in the ESF should the need arise, the Society has the time over the next year or two to monitor the financial effects of the recession and consider the actions it should take should significant adjustments in its operations be deemed necessary. Note that the financial health of the Society negates the risk of acting precipitously; it does not negate the need to act in the face of these economic challenges. In summary, while it will not be pleasant or easy to do, the Society is in a very good position to continue carrying on its mission in the face of the current financial crisis and a relatively dire set of assumptions for the next 5 to 10 years.

V. Summary Financial Information

The following Balance Sheets and Statements of Activities are from the audited annual financial statements of the Society, and the Statement of Invested Funds is from the internal financial records of the Society. Each year, the Audit Committee of the Board of Trustees meets with the Society's auditors to review the conduct of the audit, the Society's financial statements, and the auditors' report on the financial statements. Pursuant to the recommendation of the Audit Committee, the Board of Trustees has accepted the audited financial statements. A copy of the Society's audited financial statements, as submitted to the Trustees and the Council, will be sent from the Providence Office to any member who requests it from the Treasurer. The Treasurer will be happy to answer any questions members may have regarding the financial affairs of the Society.

-Respectfully submitted,

John M. Franks Treasurer

BALANCE SHEETS

December 31, 2008, and 2007

Assets	2008	2007
Cash and cash equivalents	\$ 1,263,610	\$ 921,425
Short-term investments	16,007,397	16,387,716
Receivables, less allowances		
of \$260,000	1,023,032	817,901
Deferred prepublication costs	568,308	608,723
Completed books	1,271,938	1,153,060
Prepaid expenses and		
deposits	1,612,107	1,323,430
Land, bldgs. and equipment, les	S	
accumulated depreciation	4,532,533	4,270,952
Long-term investments	52,202,609	74,065,208
Total assets	<u>\$78,481,615</u>	<u>\$99,548,415</u>
Liabilities and Net Assets		
Liabilities:		
Accounts payable		
and accrued expenses	\$ 2,902,068	\$ 2,614,560
Severance and study		
leave pay	972,311	1,213,114
Deferred revenue	12,243,494	11,744,369
Postretirement benefit		
obligation	4,344,865	4,079,327
Total liabilities	20,462,738	19,651,370
Net assets:		
Unrestricted	49,371,817	74,152,965
Temporarily restricted	4,054,666	1,908,841
Permanently restricted	4,592,394	3,835,239
Total net assets	<u>58,018,877</u>	79,897,045
Total liabilities and		
net assets	<u>\$78,481,615</u>	<u>\$99,548,415</u>

STATEMENTS OF ACTIVITIES

Years Ended December 31, 2008, and 2007

Changes in unrestricted net assets:

Operating Revenue	2008	2007					
Publication:							
Mathematical Reviews and							
related activities	\$10,230,303	\$ 9,658,217					
Journals (excluding MR)	4,707,481	4,481,903					
BOOKS Other publications related	3,616,900	3,093,828					
revenue	496 852	538 547					
Dues, services and outreach	3,774,473	3.620.377					
Grants, prizes and awards	657,044	550,202					
Meetings	994,808	908,836					
Long-term investment earning							
available for spending	1,039,300	1,007,069					
Short-term investment incom	e						
(loss)	(105,508)	895,022					
Other	<u>147,466</u>	<u>161,156</u>					
Total operating revenue	<u>25,559,119</u>	<u>25,515,157</u>					
Operating expenses:							
MR and related activities	6,569,210	6,115,797					
Journals (excluding MR)	1,668,099	1,351,788					
Books	3,212,074	2,957,073					
Publications indirect	923,463	955,416					
Customer services, warehous	ing						
and distribution	1,739,938	1,704,588					
Other publications-related	442,312	491,439					
Membership, services and	2 600 120						
outreach Crants, prizes and awards	3,699,129	3,350,117					
Meetings	1 0/0 852	7 54,105 940 853					
Covernance	453 805	400 390					
Member and professional	455,005	400,550					
services indirect	581,135	554,806					
General and administrative	3,435,371	3,196,735					
Other	<u>228,556</u>	57,384					
Total operating expenses	<u>24,799,683</u>	<u>22,830,489</u>					
Excess of operating revenue							
over operating expenses	759,436	2,684,668					
Long-term investment earnings		, ,					
in excess of (less than)							
investment earnings available	2						
for spending	(20,332,683)	2,420,182					
Effect of adoption of SFAS 158	-	750,728					
Post-retirement health benefit-							
related changes other than	(142.024)						
Adjustment required under the	(142,934)						
District of Columbia's enacted	d						
Version of the Uniform Prude	nt						
Management of Institutional Funds Act and the provisions of Financial Accounting Standards Board Staff							
					Position 117-1	<u>(5,064,967)</u>	
					Change in unrestricted net		
assets	(\$24,781,148)	\$5.855.578					
	<u>, = = ,,, 0,,, 10/</u>	<u>+++++++++++++++++++++++++++++++++++++</u>					

	2008	2007			
Changes in temporarily					
restricted net assets:					
Contributions and grants	178,340	53,952			
Long-term investment					
(loss) income	(2,540,675)	200,215			
Net assets released from					
restrictions	(556,807)	(310,704)			
Adjustment required under the					
District of Columbia's enacte	d				
Version of the Uniform Prude	ent				
Management of Institutional					
Funds Act and the provisions	of				
financial Accounting Standar	financial Accounting Standards				
Board Staff Position 117-1 (5,064,967)					
Change in temporarily					
restricted net assets	<u>(2,145,825)</u>	<u>(56,537)</u>			
Change in permanently					
restricted net assets-					
Contributions	<u>757,155</u>	<u>157,800</u>			
Change in net assets	(21,878,168)	5,956,841			
Net assets, beginning of year	<u>79,897,045</u>	73,940,204			
Net assets, end of year	<u>\$58,018,877</u>	<u>\$79,897,045</u>			

STATEMENTS OF INVESTED FUNDS

As of December 31, 2008, and 2007

Original Gift(s)Market ValueMarket ValueTrue Endowment Funds:Prize Funds: Steele\$ 145,009 \$ 435,797 \$ 654,511	rue Endowment Fu e Funds: teele irkhoff eblen (iener	Original Gift(s) unds: \$ 145,009 49,959	Market Value \$ 435,797	Market Value
True Endowment Funds: Prize Funds: Steele \$ 145,009 \$ 435,797 \$ 654,511	rue Endowment Fu e Funds: teele irkhoff eblen (iener	unds: \$ 145,009 49,959	\$ 435,797	\$ 654 511
Prize Funds: Steele \$ 145,009 \$ 435,797 \$ 654,511	e Funds: teele irkhoff eblen /iener	\$ 145,009 49,959	\$ 435,797	\$ 654 511
Steele \$ 145,009 \$ 435,797 \$ 654,511	teele irkhoff eblen /iener	\$ 145,009 49,959	\$ 435,797	\$ 654 511
	irkhoff eblen /iener	49,959		J 0J7,JII
Birkhoff 49,959 54,606 70,675	eblen /iener		54,606	70,675
Veblen 29,773 29,773 13,372	/iener	29,773	29,773	13,372
Wiener 29,773 29,773 13,372	nenei	29,773	29,773	13,372
Bôcher 32,557 32,557 9,725	ôcher	32,557	32,557	9,725
Conant 9,477 29,063 43,650	onant	9,477	29,063	43,650
Cole Prize in Number	ole Prize in Numb	er		
Theory 32,275 32,275 11,483	heory	32,275	32,275	11,483
Cole Prize in	ole Prize in			
Algebra 32,275 32,275 11,482	lgebra	32,275	32,275	11,482
Satter 43,212 43,437 34,764	atter	43,212	43,437	34,764
Morgan 25,000 31,629 47,502	lorgan	25,000	31,629	47,502
Whiteman 63,468 63,468 71,837	/hiteman	63,468	63,468	71,837
Doob Book Prize 45,000 45,000 50,867	oob Book Prize	45,000	45,000	50,867
Robbins Prize 41,000 41,000 46,719	obbins Prize	41,000	41,000	46,719
Eisenbud 40,000 40,000 43,920	isenbud	40,000	40,000	43,920
Arnold Ross	old Ross			
Lectures 70,000 79,932 79,932	ectures	70,000	79,932	79,932
Triitzinsky	zinsky	,	,	,
Scholarships 196.030 526.243 526.243	cholarships	196.030	526.243	526.243
C V Newsom 100,000 244,885 244,885	Newsom	100,000	244 885	244 885
Centennial	tennial	100,000	211,005	211,005
Fellowship 56 100 125 561 125 561	ellowshin	56 100	125 561	125 561
Menger 250 12 288 12 288	der	250	12 288	12 288
Ky Fan (China) 366 757 387 085 387 085	an (China)	366 757	387 085	387 085
Finstein Lecture 100.000 100.000 -	tein Lecture	100,000	100 000	
Exemplary Program 100,000 100,000		100,000	100,000	

AMERICAN MATHEMATICAL SOCIETY

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From the AMS Secretary

STATEMENTS OF INVESTED FUNDS, CON'T.

As of December 31, 2008, and 2007

	Dec. 31, 2008		Dec. 31, 2007		
	Origir Gift	nal (s)	Marke Valu	et e	Market Value
Mathematical Art	20,0	00	20,00	0	-
Epsilon	1,302,2	1,302,298		8 1,1	1,167,541
Total Income Restricted					
Funds	<u>\$3,027,2</u>	<u>13</u>	<u>\$3,594,00</u>	<u>5</u> <u>\$3,6</u>	67,414
Endowment	100,2	80	537,80	78	05,476
Morita	100,0	00	100,00	0 1	43,694
Henderson	548,2	23	2,881,95	5 4,3	16,561
Schoenfeld/					
Mitchell	573,4	47	573,44	78	09,829
Laha	189,3	09	189,30	92	73,133
Ritt	51.3	47	171,70	32	57,174
Moore	2,5	75	16,18	5	24,242
Total Income				_	
Unrestricted					
Funds	1.565.18	1	4.470.406	6.6	30.110
Total True			_,,		
Endowment					
Funds	<u>\$4,592,39</u>	4	<u>\$8,064,411</u>	<u>\$10,2</u>	<u>97,523</u>
Board-Restricted	l Funds:				
Iournal Archiv	۵		523 142	6	77 039
Young Schola			484 565	6	80 014
Economic Stak	silization	2	2 870 386	213	26 7/2
Operations Su	nport	2	0.082.678	21,3	20,742
Total Poard Pos	pport	2	0,002,070	40,0	50,015
Funds	incleu	<u>4</u>	3,969,771	<u>63,5</u>	23,608
Total Funds		<u>\$5</u>	2,034,182	<u>\$73,8</u>	<u>21,130</u>

Mathematics Calendar

Please submit conference information for the Mathematics Calendar through the Mathematics Calendar submission form at http://www.ams.org/cgi-bin/mathcal-submit.pl. The most comprehensive and up-to-date Mathematics Calendar information is available on the AMS website at http://www.ams.org/mathcal/.

September 2009

* 2-4 **9th International Workshop on Differential Geometry and its Applications**, Iasi University, Iasi, Romania.

Organizers and Information: The Institute of Mathematics of the Romanian Academy (Bucharest), the Alexandru Ioan Cuza University (Iasi), and the Institute of Mathematics of Iasi with the financial support of CNCSIS through the Exploratory Workshop program. Mihai Anastasiei (Iasi), email: anastas@uaic.ro; Radu Iordanescu (Bucharest), email: radu.iordanescu@imar.ro; Sergiu Moroianu (Bucharest), email: sergiu.moroianu@imar.ro.http://www.imar.ro/~sergium/iasi09/Iasi.html.

Invited Speakers: Dorin Andrica (Cluj-Napoca), Dan Burghelea (Columbus), Marius Buliga (Bucharest), Florin Damian (Chisinau), Liana David (Bucharest), Josef Dorfmeister (Munich), Graziano Gentili (Florence), Sylvain Golenia (Erlangen), Colin Guillarmou (Paris), Stefan Haller (Vienna), Wilhelm Kaup (Tübingen), Yuri Kordyukov (Ufa), Paul Loya (Binghamton), Stefano Marchiafava (Rome), Marian Munteanu (Iasi), Cezar Oniciuc (Iasi), Daniele Otera (Palermo), Jinsung Park (Seoul), Vladimir Slesar (Craiova), Laszlo Stacho (Szeged), Nicolae Teleman (Ancona).

2–4 **Workshop in Nonlinear Elliptic PDEs**, Université Libre de Bruxelles, Brussels, Belgium. (Feb. 2009, p. 310)

Description: The workshop is organized on the occasion of the 65th birthday of Jean-Pierre Gossez.

Speakers: The following lecturers have confirmed their participation: Henri Berestycki (Paris), Philippe Clément (Delft), Djairo G. de Figueiredo (Campinas), François de Thélin (Toulouse), Pavel Drabek (Pilsen), Ivar Ekeland (Vancouver), Jesús Hernández (Madrid), Bernd Kawohl (Köln), Pierre-Louis Lions (Paris), Jean Mawhin (Louvain-la-Neuve), Petru Mironescu (Lyon), Mark Peletier (Eindhoven), Frédéric Robert (Nice), Bernhard Ruf (Milano), Michael Struwe (Zurich), Charles Stuart (Lausanne), Juan Luis Vazquez (Madrid).

Information: http://wnpde09.ulb.ac.be/.

2-6 **The 9th Balkan Conference on Operational Research (BALCOR 2009)**, Constanta, Romania. (Jun./Jul. 2009, p. 767)

Description: The University of Bucharest, Naval Academy Mircea cel Batran Constanta, The Romanian Academy, The Technical University of Civil Engineering Bucharest, are honored to invite everyone engaged in research, teaching, business, or public services related to Operational Research to attend. The general aim of the conference is to facilitate the exchange of scientific and technical information related to Operational Research and to promote international co-operation especially among the Balkan countries.

Information: http://civile.utcb.ro/balcor/.

3–5 **Complex and Harmonic Analysis 2009**, Archanes, Crete, Greece. (Jun./Jul. 2009, p. 767)

Description: At the Department of Mathematics of the University of Crete we are organizing a small meeting in the broad areas of Complex and Harmonic Analysis. The meeting will take place in the village of

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.

An announcement will be published in the *Notices* if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

In general, announcements of meetings and conferences carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. If there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the *Notices* in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.

In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **eight months** prior to the scheduled date of the meeting.

The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. The March, June/July, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.

The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: http://www.ams.org/.

Archanes, 15km southeast of the city of Iraklio. We are hoping that a similar meeting will be taking place every two years alternating in Greece and Spain.

Invited Speakers: Dimitris Betsakos, Univ. of Thessaloniki; Oscar Blasco, Univ. de Valencia; Joaquim Bruna, Univ. Autonoma de Barcelona; Daniel Girela, Univ. de Malaga; Antonios Melas, Univ. of Athens; Vassilis Nestoridis, Univ. of Athens; Artur Nicolau*, Univ. Autonoma de Barcelona; Aristomenis Siskakis, Univ. of Thessaloniki; Dragan Vukotic. Univ. Autonoma de Madrid. * Beyond the invited speakers there will be some shorter contributed talks. Financial support: there will be some support for junior participants.

Information: http://fourier.math.uoc.gr/ch2009.

3-5 International Conference on Modern Mathematical Methods in Science and Technology (M3ST '09), Poros Image Hotel, Poros Island, Greece. (May 2009, p. 657)

Topics: Differential equations and mathematical models, numerical analysis, mathematics of computation, applications of mathematics in economy, stochastic analysis, modelling optimization, control theory, image and signal processing.

Invited Speakers: H. Ammari (CNRS, France), G. Bellettini (Roma, Tor Vergata, Italy), N. Bouleau (ENPC, France), G. Dassios (Patras, Greece), P. Imkeller (Humbolt University, Berlin, Germany), O. A. Karakashian (Tennessee, Knoxville, U.S.A.), L. Kirousis Patras, Greece), D. J. N. Limebeer (Imperial College, U.K.), F. Murat (Paris VI, France), E. M. Ouhabaz (Bordeaux, France), G. Papanicolaou (Stanford, U.S.A.), J.-C. Saut (Paris Sud 11, France), A. Tertikas (Heraklion, Crete, Greece), A. E. Tzavaras (Heraklion, Crete, Greece).

Information: http://www.math.uoa.gr/M3ST09/index.html.

3-6 International Conference on Theory and Applications in Mathematics and Informatics, "1 Decembrie 1918" University of Alba Iulia, Alba Iulia, Romania. (May 2009, p. 657)

Description: The aim of the conference is to bring together mathematicians and informaticians from all over the world and to attract original papers on the following topics: algebra, analysis and complex analysis, topology and geometry, differential equations, probability and statistics, applied mathematics, computer science, intelligence computation, product and process modelling, embedded systems, knowledge engineering, e-education.

Information: http://www.uab.ro/ictami.

4–9 **2nd Dolomites Workshop on Constructive Approximation and Applications (DWCAA09)**, Alba di Canazei, Trento, Italy. (Jan. 2009, p. 73)

Description: DWCAA09 proposes 8 main invited lectures, 4 sessions of contributed talks and a poster session.

Keynote speakers: C. de Boor (Madison, USA); N. Dyn (Tel-Aviv, IL); G. Meurant (Paris, F); R. Schaback (Goettingen, D); I. H. Sloan (Sydney, AU); N. Trefethen (Oxford, UK); H. Wendland (Brighton, UK); Y. Xu (Eugene OR, USA).

Information: http://www.math.unipd.it/~dwcaa09; email: marcov@math.unipd.it.

5–10 **9th Conference on Geometry and Applications**, Hotel Joliot Curie, resort St. Constantine and Helena, Varna, Bulgaria. (Jun./ Jul. 2009, p. 767)

Organizer: The Geometrical Society Bojan Petkanchin in Bulgaria. **Topics:** The following fields are included: Differential geometry, finite groups and inzident geometries, application of computer methods in geometry, algebra and analysis, school geometry.

Information: http://www.fmi.uni-sofia.bg.

7-8 **CETL-MSOR Conference 2009**, Open University, Milton Keynes, England. (Apr. 2009, p. 524)

Description: The Maths, Stats & OR Network will be running its fourth annual learning and teaching conference in conjunction with the related Centres of Excellence in Teaching and Learning (CETLs). The 2009 conference will be hosted by the Centre for Open Learning of Mathematics, Science, Computing and Technology (COLMSCT). The

aim of this conference is to promote, explore, and disseminate emerging good practice and research findings in mathematics and statistics support, teaching, learning, and assessment.

Information: http://mathstore.ac.uk/index.php?pid=253.

7-10 **A Harmonic Map Fest**, University of Cagliari, Italy. (Jun./ Jul. 2009, p. 767)

Description: This conference is in honour of Prof. John C. Wood, on the occasion of his 60th birthday and 35 years of involvement in harmonic maps. While the scientific content will undoubtably reflect J. C. Wood's predilection for harmonic maps and harmonic morphisms and be a good opportunity to review the state of the art, other topics in Differential Geometry will be most welcome.

Main speakers: P. Baird (Brest), F. Burstall (Bath), S. Dragomir (Potenza), F. Helein (Paris), D. Kotschick (Munich), E. Musso (Aquila), Y. Ohnita (Osaka), L. Ornea (Bucharest), F. Pedit (Tuebingen and Amherst), M. Rigoli (Milan) and H. Urakawa (Tohoku. There will also be some 30 minute talks.

Information: http://www.matematik.lu.se/JCW-60/.

7-11 Third International Conference on Geometry and Quantization GEOQUANT, Mathematics Research Unit, University of Luxembourg, Luxembourg. (Apr. 2009, p. 524)

Topics: The scientific program of the conference is concentrated around the following main topics: algebraic-geometric and complexanalytic-geometric aspects of quantization; geometric quantization and moduli space problems; asymptotic geometric analysis; infinitedimensional geometry; relations with modern theoretical physics.

Speakers (preliminary list): Andersen, Jorgen, Aarhus (TBC); Charles, Laurent, Paris; Domrin, Andrei, Moscow; Englis, Mirek, Prague; Foth, Tatyana, Western Ontario; Fujita, Hajime, Tokyo; Gorodentsev, Alexey, Moscow; Huebschmann, Johannes, Lille; Kaledin, Dmitry, Moscow (TBC); Karabegov, Alexander, Abilene; Kobayashi, Ryoishi, Nagoya; Mano, Toshiyuki, Kyoto; Marinescu, George, K¹n; Natanzon, Sergey, Moscow; Nohara, Yuichi, Nagoya; Osipov, Denis, Moscow; Paoletti, Robert, Milano; Talalaev, Dmitry, Moscow; Tate, Tatsuja, Nagoya; Trechev, Dmitry, Moscow; Tyurin, Nikolai, Dubna; Ueno, Kenji, Kyoto; Upmeier, Harald, Marburg; Zhang, Weiping, Nankai, China.

Information: http://math.uni.lu/geoquant.

7–11 **XXIst Rolf Nevanlinna Colloquium**, Kyoto University, Kyoto, Japan. (Jun./Jul. 2009, p. 767)

Information: To join the mailing list for further information, please send an empty mail to: join@nevanlinna.jp; Contact address: http://www.nevanlinna.jp.

7-12 Advanced School on Homotopy Theory and Algebraic Geometry, Mathematical Research Institute, University of Sevilla (IMUS), Sevilla, Spain. (May 2009, p. 657)

Description: The school is addressed to Ph.D. students and young post-doc researchers working on Algebraic Geometry and related areas. There will be three main minicourses: (1) Derived Algebraic Geometry. (2) Model Categories and Derivators. (3) Cartan-Eilenberg Categories and Descent Categories.

Speakers: Francisco Guillén Santos, University of Barcelona; Bernhard Keller and Georges Maltsiniotis, University of Paris 7; Vicente Navarro Aznar, University of Barcelona; Beatriz Rodríguez González, CSIC-Madrid; Bertrand Toën and Michel Vaquié, University of Toulouse; Gabriele Vezzossi, University of Bologna.

Information: http://congreso.us.es/htag09.

* 8–10 International Conference on Mathematics and Informatics ICMI 2 (2009), Faculty of Science (Department of Mathematics and Computer Science), University of Bacau, Bacau, Romania. (Aug. 2009, p. 862)

Description: The aim of the conference is to bring together mathematicians and computer scientists from all over the world and to attract original papers on the following topics: Algebra, Analysis and Complex Analysis, Topology and Geometry, Differential Equations, Probability and Statistics, Applied Mathematics, Theoretical Computer Science, Artificial Intelligence, Software Systems, Knowledge Engineering, E-Education. The Scientific Programme of the conference will consist of invited 30-minute plenary lectures and contributed 15-minute papers on the related topics.

Information: http://www.stiinte.ub.ro/cercetare/ c-conferinte/103; email: mihaitalmaciu@yahoo.com.

8–12 IV International Conference on Mathematical Analysis in Andalucia, University of Cadiz, Jerez de la Frontera, Spain. (May 2009, p. 657)

Description: This edition will be dedicated to the memory of Professor Antonio Aizpuru Tomas, full professor in Mathematical Analysis of Cadiz University, who suddenly passed away on May 1, 2008. He was mainly responsible for the development of the studies of mathematics in Cadiz and in the research activities on functional analysis in this university. He was also a beloved person and friend. We kindly invite you to participate in this scientific event which we hope will be of interest to you.

Information: http://cidama.uca.es.

8-December 11 Long Program: Combinatorics: Methods and Applications in Mathematics and Computer Science, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jan. 2009, p. 73)

Overview: Combinatorics studies discrete objects and their properties. This program will focus specifically on several major research topics in modern Discrete Mathematics and puts an emphasis on the exchange of ideas, approaches and techniques between various areas of Discrete Mathematics and Computer Science and on the identification of new tools from other areas of mathematics which can be used to solve combinatorial problems.

Organizing Committee: Noga Alon, Gil Kalai, Janos Pach, Vera Sos, Angelika Steger, Benjamin Sudakov, Terence Tao.

Application/Registration: An application and registration form is available at http://www.ipam.ucla.edu/programs/cma2009. Applications received by July 27, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/ cma2009/; email: sbeggs@ipam.ucla.edu.

9–16 Combinatorics: Methods and Applications in Mathematics and Computer Science, Tutorials, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jan. 2009, p. 73) Overview: Tutorials provide an introduction to several major research topics in modern discrete mathematics, including probabilistic methods, extremal problems for graphs and set systems, Ramsey theory, additive number theory, combinatorial geometry, discrete harmonic analysis and more.

Goal: The goal is to familiarize the prospective participants with the techniques which were developed in combinatorics in the last few decades. Registration for tutorials is free.

Organizing Committee: Noga Alon, Gil Kalai, Janos Pach, Vera Sos, Angelika Steger, Benjamin Sudakov, Terence Tao.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmatut. Applications received by July 29, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

10–12 **Quantum topology and Chern-Simons theory**, Institut de Recherche Mathématique Avancée, Université de Strasbourg, 7 rue René Descartes, Strasbourg, France. (Jan. 2009, p. 73)

Description: The meeting is No. 84 in the series "Encounter Between Mathematicians and Theoretical Physicists". The focus is on quantum

topology and Chern-Simons theory. There will be survey lectures and specialized talks.

Invited speakers: A. Alekseev (Geneva), J. E. Andersen (Aarhus), F. Costantino (Strasbourg), V. Fock (Strasbourg), S. Garoufalidis (Georgia Tech), R. Kashaev (Geneva), G. Masbaum (Paris 7), K. Noui (Tours), N. Reshetikhin (Amsterdam), B. Schroers (Edinburgh), Teschner (Hamburg), G. Thompson (Trieste).

Organization and information: Gwenael Massuyeau and Athanase Papadopoulos; email: massuyea@math.u-strasbg.fr; papadopoulos@math.u-strasbg.fr.

Information: http://www-irma.u-strasbg.fr/article744. html; email: papadopoulos@math.u-strasbg.fr.

11–13 **Algebra and Topology in Interaction**, University of California, Davis, California. (May 2009, p. 657)

Description: In honor of Professor Dmitry Fuchs' 70th Anniversary. **Theme:** The main theme of the conference is the interplay of algebra and topology over the past 40 years, since the birth of Gelfand Fuchs cohomology.

Topics: Include current exciting developments in symplectic field theory, representations of infinite dimensional Lie algebras, topological quantum field theory, topological applications of cohomology of infinite dimensional Lie algebras, characteristic classes of foliations, contact homology, Chekanov Eliashberg differential graded algebra, and Legendrian knot theory.

List of speakers: B. Feigin, E. Frenkel, S. Gindikin, A. Givental, M. Khovanov, A. Kirillov, S. Novikov, V. Retakh, C. Roger, G. Segal, S. Tabachnikov, and O. Viro. Mathematicians at all levels are invited to attend. An important goal of the conference is to provide an opportunity for a diverse group of mathematicians including postdoctoral researchers, those with traditionally underrepresented background, graduate students, and faculty from primary undergraduate institutions, to meet and discuss mathematics with the invited leading experts of the field.

Deadline: Those interested in receiving funding for travel should apply by July 31, 2009. This conference is supported by the NSF, MSRI, and UC Davis.

Information: email: cdani@math.ucdavis.edu; http://www. math.ucdavis.edu/research/algetopcon.

11-17 (NEW DATE) **Models in Developing Mathematics Education**, Dresden University of Applied Sciences, Dresden, Germany. (Apr. 2007, p. 498)

Description: 10th International Conference of The Mathematics Education into the 21st Century Project Our project was founded in 1986 and is dedicated to the planning, writing and disseminating of innovative ideas and materials in Mathematics and Statistics Education.

Program: Papers are invited on all innovative aspects of mathematics education. There will be an additional social programme for accompanying persons. Our conferences are renowned for their friendly and productive working atmosphere. They are attended by innovative teachers and mathematics educators from all over the world, 25 countries were represented at our last conference for example! **Information:** email: alan@rogerson.pol.pl.

14–18 **2009 Workshop on Algebraic Geometry and Physics: Representations, Lie Theory and Physics**, Maresias Beach Hotel, Maresias, Brazil. (Jun./Jul. 2009, p. 767)

Description: The workshop will bring together mathematicians and physicists working on several aspects of Lie theory (Lie groups, Lie algebras, algebraic groups, representations) and their applications (including gauge theory, deformation theory, automorphic representations, partial differential equations, integrable systems, symmetries in physics, among others). The programme will include minicourses by A. Kleshchev, D. E. Diaconescu, R. Donagi, and about 15 one-hour talks by invited speakers. It is possible to submit a proposal of a communication; please send a title and a short abstract. Inclusion into the programme will be decided by the scientific committee. If you are in-

terested in participating, please write to: jardim@ime.unicamp.br, futorny@ime.usp.br or henrique@impa.br by April 30, 2009. Information: http://people.sissa.it/~bruzzo/wagp09/ index.htm.

* 14-18 **Conference on Probabilistic Techniques in Computer Science**, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona, Spain.

Description: Probabilistic Techniques in Computer Science constitutes a well developed and very active area of research that combines Theoretical Computer Science, Discrete Mathematics, Probability Theory, and Combinatorics. The main goal of the conference is to gather a large number of world-renowned experts and young researchers of the area for the dissemination of novel results, exchange of scientific ideas among the participants, and cross-fertilization between the different subareas of probabilistic techniques in computer science. **Information:** http://www.crm.cat/ccomputer.

14–18 **IMA Workshop: Flowing Complex Fluids: Rheological Measurements and Constitutive Modeling**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 524)

Description: Fluids with nontrivial small-scale inhomogeneities (microstructure) include suspensions, emulsions, foams, polymer melts and solutions, surfactant solutions and liquid crystals. Flows of these complex fluids display features that are not found in simple fluids, including interfacial and bulk instabilities, texture formation and evolution and other novel flow phenomena that all can be traced back to the influence the fluid microstructure has on the stresses that develop within the flow. This workshop will focus on the experimental motivation and the constitutive modeling of complex fluids at all scales. Topics to be discussed include modeling from microscopic to mesoscopic to macroscopic, closures, constitutive model predictions including shear thinning and thickening regimes, inhomogeneities in flow including transient and steady state shearbanding, and shear induced phase transitions.

Information: http://www.ima.umn.edu/2009-2010/ W9.14-18.09/.

* 14–18 **MSRI Upcoming Workshops: Black Holes in Relativity**, Mathematical Sciences Research Institute, Berkeley, California.

Organizers: Mihalis Dafermos (University of Cambridge) and Igor Rodnianski (Princeton).

Information: http://www.msri.org.

14–19 Dictionary of Atoms: New Trends in Advanced Signal Processing in Functional Brain Imaging, Centre de recherches mathématiques, Université de Montréal, Montréal, Québec, Canada. (Jun./ Jul. 2009, p. 768)

Description: During the last decade, sparse representations of signals have been intensively studied in the domain of functional brain imaging and electrophysiology. This workshop will present various aspects of this "wavelet heritage" in this domain of signal processing, applied in fMRI and electrophysiological signals. Analysis of signals and inverse problems in sparse representations will be highly focussed during the week.

Information: http://www.crm.umontreal.ca/Atoms09/
index_e.php.

15–18 **Bogolyubov Kyiv Conference: "Modern Problems of Theoretical and Mathematical Physics"**, Bogolyubov Institute for Theoretical Physics, Kyiv, Ukraine. (Nov. 2008, p. 1319)

Description: The National Academy of Sciences of Ukraine, the Bogolyubov Institute for Theoretical Physics and the Institute of Mathematics organize the Bogolyubov Kyiv Conference: "Modern Problems of Theoretical and Mathematical Physics" on the occasion of the 100th anniversary of Nikolai Bogolyubov.

Topics: Mathematical methods in theoretical physics, Particles and quantum field theory, Statistical physics and kinetic theory, Nuclei theory and nuclear reactions, Solid-state theory.

Information: http://www.bitp.kiev.ua/bogolyubov2009/; email: bogolyubov2009@bitp.kiev.ua.

* 17–19 **The 5th William Rowan Hamilton Geometry and Topology Workshop on Computational and Algorithmic Geometry**, The Hamilton Mathematics Institute, Trinity College, Dublin, Ireland.

Description: A workshop on Computational and Algorithmic Geometry.

Information: Sponsored by Boston College, and the HMI; http:// www.hamilton.tcd.ie/events/gt/gt2009.htm.

21–25 **Convex algebraic geometry, optimization and applications**, American Institute of Mathematics, Palo Alto, California. (Apr. 2009, p. 524)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to the study of "Convex Algebraic Geometry" and some of its numerous applications.

Information: http://aimath.org/ARCC/workshops/ convexalggeom.html.

* 24–25 **4th International Workshop on Data Privacy Management (DPM09)**, Co-located with ESORICS 2009, Saint Malo, Britany, France. **Description:** DPM 2009 Workshop aims at discussing and exchanging ideas related to privacy data management. We invite papers from researchers and practitioners working in privacy, security, trustworthy data systems and related areas to submit their original papers in this workshop.

Information: For more information, please see: http://dpm09. dyndns.org/.

 $24\mathchar`-26$ Variational and Topological Methods in Nonlinear Analysis,

University of Texas at San Antonio (UTSA). (Jun./Jul. 2009, p. 768) **Description:** International conference dedicated to the 60th birthday of Vieri Benci.

Information: http://www.dm.uniba.it/nonlinear09/.

24–30 6th International Conference on Functional Analysis and Approximation Theory -FAAT 2009, Acquafredda di Maratea, Italy. (Apr. 2009, p. 525)

Description: The meeting will be devoted to some significant aspects of contemporary mathematical research on functional analysis, operator theory and approximation theory including the applications of these fields in other areas such as partial differential equations, integral equations, numerical analysis. It is expected that the Proceedings of the Conference will be published.

Plenary speakers: J. Appell (Würzburg), G. Godefroy (Paris), N. Jacob (Swansea), M. Kato (Kitakyushu), L. Maligranda (Lulea), F. Marcellan (Madrid), G. Milovanovic (Serbia), G. Monegato (Torino), B. de Pagter (Delft), L.E. Persson (Lulea), D. Potts (Chemnitz), I. Raaa (Cluj-Napoca), B. Silbermann (Chemnitz), V. Totik (Szeged), J. Szabados (Budapest), P. Vertesi (Budapest).

Organizing Committee: F. Altomare, A. Attalienti, M. Campiti, M. Cappelletti Montano, L. D'Ambrosio, M. C. De Bonis, S. Diomede, V.Leonessa, G. Mastroianni, D. Occorsio, M. G. Russo.

Information: http://www.dm.uniba.it/faat2009; email:faat2009@dm.uniba.it.

27-29 **Symposium on Engineered & Natural Complex Systems**, Toronto, Ontario, Canada. (May 2009, p. 658)

Topics: Include, but are not limited to, the following: Structure, function and dynamics of complex systems, i.e. data communication networks, cyberspace, transportation networks, organizational networks, power grids, biological, physical, social, ecological, epidemiological and other complex systems & networks; Emergence, multiscale phenomena, self-organization, self-similarity, long range dependence, phase transition, pattern formation, synchronization, robustness, reliability, fragility, interdependence, cooperation, adaptation, evolution; Analysis & control techniques of dynamics & performance, mean field & information theory of complex systems & networks; Cellular automata, agent based & individually based and other models of complex systems & networks and their simulations.

Information: http://toronto.ieee.ca/tic-sth2009/cfps/ IEEE_TIC-STH09_CFP-ENS.pdf.

October 2009

* 1-2 **Finitely Presented Groups: Where Do We Go From Here**, The City College of New York/CUNY, New York, New York.

Description: Senior mathematicians will join early-career researchers to discuss new directions of study, research and investigation of finitely presented groups. The conference aims to disseminate the most current research in group theory, engender an active interest among newer researchers, and point the way to possible new developments. **Sponsored:** National Science Foundation and The City College of New York/CUNY.

Speakers: Gilbert Baumslag and Alexei Miasnikov will lecture on the first day, primarily to graduate and postdoctoral students. The plenary session on the second day will be addressed by Mladen Bestvina, Jim Cannon, Peter Kropholler, Zlil Sela and Bill Thurston.

Information: Registration and participaton are free, and some funding is available. Olga Mikhlina at omikhlina@cs.ccny.cuny.edu; http://rio.sci.ccny.cuny.edu/caissny.org/events-1/ GroupsConference.

* 2-3 Ninth Annual Prairie Analysis Seminar, Kansas State University, Manhattan, Kansas.

Description: Emmanuele DiBenedetto, Vanderbilt University, will give two one-hour talks. Ugo Gianazza of the University of Pavia and Vincenzo Vespri of the University of Florence will each give a one-hour talk. There is time scheduled for contributed talks; all participants, especially mathematicians early in their careers, are encouraged to contribute a 20-minute talk.

Organizers: Marianne Korten, Charles Moore, Kansas State University; and Estela Gavosto, Rodolfo Torres, University of Kansas.

Information: Some support for travel is available. The organizers have applied for further support.

* 2–3 **"Why Knot?: A Knot Theory Workshop"**, University of Central Oklahoma, Edmond, Oklahoma.

Description: This is a workshop for undergraduates that introduces the fascinating mathematics of knots. Knot theory is particularly exciting as there are lots of pictures and open problems can be discussed without the need for much background. The lecturer for the workshop will be Colin Adams, author of the highly praised "The Knot Book". Dr. Adams is the author of numerous research articles on knot theory and the receipient of a 1998 MAA Haimo Distinguished Teaching Award. He is widely recognized as an expositor of mathematics and is notorious for giving mathematical lectures in the guise of sleazy real estate agent Mel Slugbate. This workshop is funded by the NSF and limited travel funds are available to deter the expenses of participants. Women, minorities, and persons with disabilities are especially encouraged to participate and to apply for support.

Information: Contact Charlotte Simmons at cksimmons@uco.edu.

5-8 **2009 SIAM/ACM Joint Conference on Geometric Design and Solid & Physical Modeling**, Hilton San Francisco Financial District, San Francisco, California. (Dec. 2008, p. 1451)

Description: The 2009 Joint Conference on Geometric and Solid & Physical Modeling seeks high quality, original research contributions that strive to advance all aspects of geometric and physical modeling, and their application in design, analysis and manufacturing, as well as in biomedical, geophysical, digital entertainment, and other areas. A shared objective of both the SIAM GD and ACM SPM communities is a desire to highlight work of the highest quality on the problems of greatest relevance to industry and science.

Information: http://www.siam.org/meetings/gdspm09/.

5-9 **Combinatorics: Probabilistic Techniques and Applications**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Dec. 2008, p. 1451)

Description: The probabilistic approach has been successful in combinatorics, graph theory, combinatorial number theory, optimization and theoretical computer science. This workshop will focus on several main research directions of probabilistic combinatorics, including the application of probability to solve combinatorial problems, the study of random combinatorial objects and the investigation of randomized algorithms.

Organizing Committee: Alan Frieze, Nathan (Nati) Linial, Angelika Steger, Benjamin Sudakov, Prasad Tetali.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmaws1. Applications received by August 24, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information:http://www.ipam.ucla.edu/programs/cmaws1/; email:sbeggs@ipam.ucla.edu.

* 5-9 **Frobenius Lifts**, Lorentz Center, Leiden, The Netherlands. (Aug. 2009, p. 862)

Description: A workshop on the role of commuting Frobenius lifts in arithmetic algebraic geometry. Important roles are played by schemes of Witt vectors, arithmetic jet spaces, and the spectra of lambdarings. There will be four expository lecture series: Pierre Cartier (IHES): Lambda-rings and Witt vectors; Lars Hesselholt (Nagoya): The de Rham-Witt complex; Alexandru Buium (Albuquerque): Arithmetic differential equations; James Borger (Canberra): Lambda-algebraic geometry. There will also be a number of individual talks about relations with nearby fields. We welcome workers and students in all fields of number theory and algebraic geometry. Some monetary support is available to Ph.D. students and postdocs.

Information: http://www.lorentzcenter.nl/lc/ web/2009/342/info.php3?wsid=342.

5-9 International Conference "Kolmogorov readings. General control problems and their applications (GCP-2009)", Tambov State University named after G.R. Derzhavin, Institute of Mathematics, Physics, and Computer sciences, Tambov, Russia. (May 2009, p. 658)

Description: The conference is the 4th one in the series "Kolmogorov readings" gathering international scientists in the city where the outstanding mathematician, A.N. Kolmogorov, was born. Traditionally the conference will mainly focus on general control problems and their applications in natural and human sciences, optimization theory, differential equations and inclusions. There are planned plenary (40 min.) and sectional (20 min.) talks, as well as a school on optimal control aimed to Ph.D students and young researches.

Information: http://www.tambovopu2009.narod.ru/.

5–9 Rational curves and A^1 -homotopy theory, American Institute of Mathematics, Palo Alto, California. (Jun./Jul. 2009, p. 768)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to studying recent interactions between rational connectivity and the newly developing theory of A^1 -algebraic topology.

Information: http://aimath.org/ARCC/workshops/alhomotopy.html.

* 8-11 The International Conference of Differential Geometry and Dynamical Systems (DGDS-2009), University Politehnica of Bucharest, Bucharest, Romania.

Description: The Conference main topics are: 1. Applications of Riemannian and Finsler-Lagrange-Hamilton structures; 2. Dynamical systems and jet space theory; 3. Multitime evolutions and optimal control problems; 4. Magnetic dynamical systems; antennas theory; 5. Mathematical models in Physics and in Engineering; 6. Mathemati-

cal statistics; 7. Chaos and fractals. Graduate students and postdocs interested in these rapidly developing fields are warmly welcome. **Information:** http://www.mathem.pub.ro.

9–11 SIAM Conference on Mathematics for Industry: Challenges and Frontiers (MI09), Hilton San Francisco Financial District, San Francisco, California. (Feb. 2009, p. 310)

Description: The SIAM conferences on Mathematics for Industry focus attention on the many and varied opportunities to promote applications of mathematics to industrial problems. From the start of planning for these conferences, the major objective has been the development and encouragement of industrial, government, and academic collaboration. The format of this conference continues to provide a forum for industrial and government engineers and scientists to communicate their needs, objectives, and visions, to the broad mathematical community. In 2009 an all-electronic proceedings will be introduced providing a unique and convenient opportunity for the SIAM community to publish applications of and research in applied mathematics. The major themes continue to fit the important categories of Challenges, Frontiers, and Industrial Academic Collaborations. **Information**: http://www.siam.org/meetings/calendar.php.

9-11 Southeastern Lie Theory Workshop on Combinatorial Lie Theory and Applications, North Carolina State University, Raleigh, North Carolina. (Jun./Jul. 2009, p. 768)

Description: The main focus of this workshop will be on combinatorial representation theory, both algebraic and geometric. Professor Masaki Kashiwara will give a series of three lectures at this workshop. This is the first of three annual workshops on Lie Theory to be held in the southeastern region of USA, funded by the National Science Foundation; organized by Kailash Misra (email: misra@math. ncsu.edu), Daniel Nakano, and Brian Parshall. Partial support would be available to junior researchers and graduate students. Please see the conference web page for further details. Priority for funding will be given to applicants from minority and underrepresented groups. Information: http://www.math.virginia.edu/ lieworkshops/.

12-14 The 6th annual International New Exploratory Technologies Conference (NEXT 2009), Fudan University, Shanghai, China. (May 2009, p. 658)

Description: This year's NEXT focuses on four special themes: Productization and Commercialization, Productization of Embedded Software in Products and Services, Renewable Energy Technology, and Exploratory Materials and Technology.

Organizers: Fudan university and University of Turku.

Information: http://next.utu.fi/2009.

12-16 **Algebra, Geometry, and Mathematical Physics**, The Bedlewo Mathematical Research and Conference Center, Bedlewo, Poland. (Dec. 2008, p. 1451)

Description: Contemporary hot trends in algebra, geometry, and mathematical physics.

Organizing Committee: V. Abramov, J. Fuchs, J. Grabowski, E. Paal (Vice-Chair), A. Stolin, A. Tralle (Chair), P. Urbanski.

Information: http://www.agmf.astralgo.eu/bdl09/.

* 12–16 Asymptotics in Dynamics, Geometry and PDEs; Generalized Borel Summation, CRM Ennio de Giorgi, Pisa, Italy.

Description: A one-week international conference centered on asymptotic analysis and its applications to dynamics, geometry, physics, etc., putting emphasis on the theories developed by Jean Ecalle. **Scientific Themes:** Local analytic dynamics. Small denominator problems. Divergent series, transseries, summability theories. Resurgent functions, alien calculus, mould calculus. Analytic PDEs. Classification of singular geometric structures. Applications to semi-classical quantum mechanics and perturbative Quantum Field Theory. **Scientific Committee:** L. Boutet de Monvel (Univ. Paris 6), D. Cerveau (Univ. Rennes 1), T. Kawai (Kyoto Univ.), S. Marmi (SNS Pisa).

Information: http://www.crm.sns.it/cgi-bin/pagina.pl?I
d=117&Tipo=evento&Sezione=Aims.

12-16 **IMA Workshop: Flowing Complex Fluids: Fluid Mechanics-Interaction of Microstructure and Flow**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 524)

Description: Fluids with nontrivial small-scale inhomogeneities (microstructure) include suspensions, emulsions, foams, polymer melts and solutions, surfactant solutions and liquid crystals. Flows of these complex fluids display features that are not found in simple fluids, including interfacial and bulk instabilities, texture formation and evolution and other novel flow phenomena that all can be traced back to the influence the fluid microstructure has on the stresses that develop within the flow. This workshop focuses on these fluid mechanical phenomena and their origins in the complex nature of the fluid. Topics include free surface flows and extensional rheometry, instabilities and flow induced phase transitions, turbulence and drag reduction in polymer and surfactant solutions, coating and extrusion, some microfluidic flows of complex fluids, and multiscale computational methods.

Information: http://www.ima.umn.edu/2009-2010/
W10.12-16.09/.

* 12–16 **MSRI Upcoming Workshops: Tropical Geometry in Combinatorics and Algebra**, Mathematical Sciences Research Institute, Berkeley, California.

Organizers: Federico Ardila (San Francisco State University), David Speyer (MIT), Jenia Tevelev (U. Mass Amherst), Lauren Williams (Harvard).

Parent Program(s): Tropical Geometry. Information: http://www.msri.org.

14-16 **The 9th Conference Shell Structures Theory and Applications**, Neptun Hotel, Hel Peninsula, Baltic Sea, Jurata, Poland. (Dec. 2008, p. 1451)

Description: The aim of the SSTA 2009 Conference is to bring together scientists, designers, engineers and other specialists of shell structures in order to discuss important results and new ideas in this broad field of activity. The previous one - 8th SSTA 2005 - was attended by 109 participants from 16 countries.

Conference Topics: The theory and analysis of shells, numerical analysis of shell structures and elements, design and maintenance of shell structures, special surface-related mechanical problems. The conference program will include general lectures and contributed oral presentations. The main language of the conference will be English.

Publications and Deadline: All accepted papers (full-length article in English) will appear in the hard-cover volume of Proceedings published by CRC Press/Balkema, Taylor & Francis Group. Deadline for submission of the full paper is February 28, 2009.

14–17 **Integers Conference 2009**, University of West Georgia, Carrollton, Georgia. (Apr. 2009, p. 524)

Description: The Editors of Integers: Electronic Journal of Combinatorial Number Theory are pleased to announce the Integers Conference 2009. The Integers conferences are international conferences in combinatorial number theory, held for the purpose of bringing together mathematicians, students, and others interested in combinatorics and number theory. The Integers Conference 2009 will also be honoring Professors Melvyn Nathanson and Carl Pomerance on the occasions of their 65th birthdays. The proceedings of the conference will be published as a special volume of the Integers journal. The conference will feature six plenary speakers and many other invited talks. **Information:** http://www.westga.edu/~math/IntegersConference2009.

16-17 Twenty-Ninth Southeastern Atlantic Regional Conference on Differential Equations (SEARCDE), Mercer University, Macon, Georgia. (Jun./Jul. 2009, p. 768) **Plenary Speakers:** Howard (Howie) Weiss (Georgia Institute of Technology), H.T. Banks (North Carolina State University), Irena Lasiecka (University of Virginia). In addition to the plenary speakers, there will be sessions of twenty-minute contributed talks. Pending funding from the National Science Foundation, travel support funds will be available for advanced graduate students and recent Ph.D. recipients (2004 or later). Women and minorities are especially encouraged to participate in this conference and to apply for support.

Deadline: For abstracts in contributed session is October 2, 2009.

Information: http://www.mercer.edu/math/searcde/ for information on registration, lodging, submission of abstracts, and application for support.

16–18 **AMS Central Section Meeting**, Baylor University, Waco, Texas. (Aug. 2008, p. 872)

Information: http://www.ams.org/amsmtgs/sectional.html.

19–22 International Conference "Discrete Mathematics, Algebra, and their applications" (DIMA09), Belarus State University, Minsk, Belarus. (May 2009, p. 658)

Description: The conference is dedicated to the 80th birthday of Professor Regina Tyshkevich. The research activity of Regina Tyshkevich is connected with two fields: discrete mathematics (graph theory, combinatorics) and algebra (permutation groups, linear groups, matrix algebras). She is the founder of the Belarus school in graph theory, that has gained a worldwide recognition. Professor Tyshkevich was awarded the Belarus State Prize and the title of a Distinguished Worker of Education. The conference topics include (but are not restricted to): Graph theory, combinatorics, discrete optimization, algorithms, data structures and computational complexity, applications of discrete mathematics in computer science, operations research, algebra, topology, probability theory, permutation groups, linear groups and representations, Brauer groups of varieties and algebraic groups. **Information:** http://dima09.bsu.by.

19–23 **Combinatorics: Combinatorial Geometry**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Dec. 2008, p. 1451)

Organizing Committee: Alexander Barvinok, Gil Kalai, Janos Pach, Jozsef Solymosi, Emo Welzl.

Overview: Combinatorial geometry deals with the structure and complexity of discrete geometric objects and is closely related to computational geometry, which deals with the design of efficient computer algorithms for manipulation of these objects. The focus of this workshop will be on the study of discrete geometric objects, their combinatorial structure, stressing the connections between discrete geometry and combinatorics, number theory, analysis and computer science.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmaws2. Applications received by Sept. 7, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/cmaws2; email: sbeggs@ipam.ucla.edu.

19–23 **Higher Reidemeister Torsion**, American Institute of Mathematics, Palo Alto, California. (Dec. 2008, p. 1451)

Description: This workshop, sponsored by AIM and the NSF, will focus on connections between different constructions for invariants of fiber bundles.

Information: http://aimath.org/ARCC/workshops/ reidemeister.html; email: ebasor@aimath.org.

* 19–23 **Quantum Dynamic Imaging**, Centre de recherches mathématiques, Université de Montréal, Quebec, Canada.

Description: Studying and using light or "photons" to image and then to control and transmit molecular information is amongst the most challenging and significant research fields to emerge in recent years.

One of the fastest growing areas involves research in the temporal imaging of quantum phenomena, molecular dynamics from the femtosecond (10*15) time regime for atomic motion to the attosecond (10*18) time scale natural to electron motion. In fact the attosecond "revolution" is now internationally recognized as one of the most important recent breakthroughs and innovations in the science of the 21st century.

Information: http://www.crm.umontreal.ca/Quantum09/
index_e.php.

* 19–24 Advanced Course on Shimura Varieties and L-functions, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona, Spain. **Description:** The Advanced Course consists of two series of lectures, delivered by S. W. Zhang (Columbia) and by Bas Edixhoven (Leiden University) and Andrei Yafaev (University College London), respectively. The aim of the lectures of S. W. Zhang is to give a comprehensive description of some recent work of the author and his students on generalisations of the Gross-Zagier formula, Euler systems on Shimura curves and rational points on elliptic curves. The aim of the course delivered by B. Edixhoven and A. Yafaev is to give an introduction to the proof (under the generalised Riemann hypothesis) of the so-called Andre-Oort conjecture by Yafaev, Klingler and Ullmo.

Information: http://www.crm.cat/acshimura.

20–22 International Conference in Modeling Health Advances 2009, UC Berkeley, San Francisco Bay Area, California. (Mar. 2009, p. 416) **Description:** A host of new diseases, like HIV/AIDS, BSE, Avian Flu, West Nile Virus and others have appeared on the scene during the last twenty five years and undoubtedly, more will come in the coming years. To tackle these illnesses, the cooperation of modelers, mathematicians, statisticians, computer scientists, and others, and of researchers from the medical community is absolutely essential. Modeling is important because it gives important insight into the method of treatment. In the case of HIV/AIDS, for example, mathematical modeling indicated that a combination of both protease inhibitors and reverse transcriptase inhibitors would be far more effective than any one of these two drugs. The purpose of this conference is to bring all the people working in the area of epidemiology under one roof and encourage mutual interaction.

Information: http://www.iaeng.org/WCECS2009/ICMHA2009. html; email: publication@iaeng.org.

21–23 The 4th International Conference on Research and Education in Mathematics 2009 (ICREM09), Kuala Lumpur, Malaysia. (Apr. 2009, p. 525)

Description: Mathematics, applications of mathematics, statistics, operation research, innovation in teaching mathematics, mathematics education and other related to mathematics and statistics. **Information:** http://www.inform.upm.edu.my.

22-24 Partial Differential Equations and Applications International Workshop for the 60th birthday of Michel Pierre, Club Med, Vittel, France. (Apr. 2009, p. 525)

Description: The scope of this meeting is to gather international scientists to discuss recent advances in the fields studied by Michel Pierre, professor at ENS Cachan O'Antenne de Bretagne. His contributions are very important in non-linear analysis and applications to partial differential equations. More precisely, he is interested in one of the following topics : non-linear semi-groups, non-linear parabolic and elliptic partial differential equations with L1 or measure data, global existence for reaction-diffusion systems, shape optimization problem, in particular regularity of optimal shapes, control of PDE. **Information:** http://edpa2009.iecn.u-nancy.fr/.

24–25 **AMS Eastern Section Meeting**, Pennsylvania State University, University Park, Pennsylvania. (Aug. 2008, p. 872)

Information: http://www.ams.org/amsmtgs/sectional.html.

25-30 **Mathematical Methods in Emerging Modalities of Medical Imaging**, Banff International Research Station, Banff, Canada. (Jun./ Jul. 2009, p. 769)

Description: The workshop will assemble researchers from mathematics, physics, engineering and medicine interested in developing and implementing mathematical methods of novel medical diagnostic imaging. Among the techniques to be discussed are, in particular, optical tomography, electron tomography, phase contrast CT, thermo/photoacoustic tomography, elastography, ultrasound modulated optical tomography, and acousto-electric tomography. These new modalities of imaging involve challenging problems on crossroads of mathematics, physics, and engineering. The goal is to formulate the mathematical problems that must be resolved to meet outstanding challenges of this young and fast developing area and to assess and facilitate the current progress in these directions.

Information: http://www.birs.ca/birspages.
php?task=displayevent&event_id=09w5017

26–28 **SAGA 2009, Fifth Symposium on Stochastic Algorithms, Foundations and Applications,** Hokkaido University, Sapporo, Japan. (May 2009, p. 658)

Description: The symposium offers the opportunity to present original research on the analysis, implementation, experimental evaluation, and real-world application of stochastic algorithms. The focus of SAGA'09 is on new algorithmic ideas involving stochastic decisions and the design and evaluation of stochastic algorithms within realistic scenarios. Thus, the symposium wants to foster the co-operation between practitioners and theoreticians from this research area.

Topics: Original research papers (including significant work-in-progress and work identifying and exploring directions of future research) or state-of-the-art surveys are invited on all aspects of algorithms employing stochastic components.

Information:http://www-alg.ist.hokudai.ac.jp/~thomas/ SAGA09/saga09.html.

26–30 **Implementing algebraic geometry algorithms**, American Institute of Mathematics, Palo Alto, California. (May 2009, p. 658)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to developing three packages, algebraic statistics, numerical algebraic geometry, toric algebraic geometry, for the computer algebra system Macaulay 2. Macaulay 2 is a widely used computer algebra system for research and teaching in algebraic geometry and commutative algebra and is one of the leading computer algebra programs for performing such computations.

Information: Visit http://aimath.org/ARCC/workshops/
agalgorithms.html.

26–31 Autumn School: "Towards a p-adic Langlands Correspondence", Mathematical Research Institute, University of Sevilla (IMUS), Sevilla, Spain. (May 2009, p. 658)

Description: The school is addressed to Ph.D. students and young post-doc researchers working on number theory, arithmetic algebraic geometry and related areas. There will be four main minicourses: (1) Introduction to the theory of representations of p-adic groups. (2) Modular forms, automorphic forms and GL(2). (3) The Langlands program. (4) Towards a modular Langlands correspondence.

Speakers: James Cogdell, Ohio State University; Jean François Dat, Université Paris 6; Guy Henniart, Université Paris Sud; Ariane Mézard Université de Versailles; Vincent Sécherre, Université de Marseille; Shaun Stevens, University of East Anglia; Jose M. Tornero Sánchez, Universidad de Sevilla.

Information: http://congreso.us.es/planglands09.

* 28-29 **The 5th Central and Eastern European Software Engineering Conference in Russia 2009 (CEE-SECR 2009),** Moscow, Russia. (Aug. 2009, p. 862)

Description: This conference is aimed to consolidate the local software professional community and to integrate it into the international software society. The Software Engineering Conference in Russia at-

tracts speakers from 15+ countries, over 500 participants from all over the world. The list of keynote speakers from previous SEC(R) conferences includes Michael Cusumano, Larry Constantine, Claudia Dent, Michael Fagan, Bill Hefley, Ivar Jacobson, Rick Kazman, Steve Masters, Mark Paulk and Michel Speranski, Erich Gamma, Stephen Mellor and many others. This conference is targeted at software professionals, such as Project Managers, Software Architects, Process Engineers, Software Engineering Process Group Directors, HR Specialists, Business Analysts, Team Leaders, IT Managers, CIO/CTO, QA Managers, Senior Developers, etc. from Russia, Ukraine, Belarus, Kazakhstan, Armenia, the Baltic, other CIS countries, Europe, and the U.S. Information: http://cee-secr.org/.

* 29-31 The 9th Red Raider Mini-Symposium: Non-linear Analysis, PDEs and Applications, Texas Tech University, Lubbock, Texas.

(Aug. 2009, p. 862)

Description: This is the 9th edition of the Annual Red Raider Mini-Symposium organized by the Department of Mathematics and Statistics, Texas Tech University. The Red Raider Mini-Symposium now has an established tradition of bringing in a range of distinguished scientists and promising early-career researchers in a particular area of modern mathematical importance. The theme for this year's minisymposium is the mathematical analysis of non-linear problems in physics, engineering, and technology. This multidisciplinary research area spans nonlinear PDE, analysis, geometry, and scientific computing. The selection of conference speakers will emphasize interactions among these subject areas, applications of mathematics to other sciences, and important open problems. Additionally, the mutual interaction among speakers and attendees will lead to new opportunities for multi-disciplinary collaborations.

Information: http://www.math.ttu.edu/redraider2009/.

30-November 1 **AMS Southeastern Section Meeting**, Florida Atlantic University, Boca Raton, Florida. (Aug. 2008, p. 872)

Information: http://www.ams.org/amsmtgs/sectional.html.

November 2009

1-6 **23rd Large Installation System Administration Conference (LISA '09)**, Baltimore Marriott Waterfront, 700 Aliceanna Street, Baltimore, Maryland. (Mar. 2009, p. 416)

Description: Over 1,000 system administrators of all specialties and levels of expertise meet at LISA to exchange ideas, sharpen old skills, learn new techniques, debate current issues, and meet colleagues, vendors, and friends. Talks, presentations, posters, WiPs, and BoFs address a wide range of administration specialties, including system, network, storage, and security administration on a variety of platforms including Linux, BSD, Solaris, and OS X.

Information: http://usenix.org/events/lisa09/.

1-December 31 **Financial Mathematics**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Jan. 2009, p. 73) **Description:** This program will be focusing on, but not limited to, the following three areas: 1) the pricing and hedging of environmental and energy-related financial derivatives; 2) risk and robust optimization; 3) optimal stopping and singular stochastic control problems in finance. These areas form the substance of 3 workshops in the twomonth long program. The workshops are intended for researchers working in the specific areas to congregate, cross-pollinate ideas, exchange knowledge, and together advance the mathematical frontiers in publishing and disseminating rigorous pieces of scholastic work. **Information:** http://ims.nus.edu.sg/Programs/financialm09/index.htm; email: imscec@nus.edu.sg.

2-6 **Combinatorics: Topics in Graphs and Hypergraphs**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jan. 2009, p. 74)

Overview: The workshop will focus on several research directions in modern graph and hypergraph theory including Ramsey theory, extremal problems for graphs and hypergraphs and in particular Turan-type questions, extremal set theory and its applications to information theory, computer science and coding theory, algebraic methods in extremal combinatorics, Szemeredi's regularity lemma for graphs and hypergraphs and its application to number theory and property testing.

Organizing Committee: Penny Haxell, Dhruv Mubayi, Vera Sos, Benjamin Sudakov, Jacques Verstraete.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmaws3/. Applications received by Sept. 21, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/cmaws3/; email: sbeggs@ipam.ucla.edu.

2-6 **The Cuntz Semigroup**, American Institute of Mathematics, Palo Alto, California. (Apr. 2009, p. 525)

Description: This workshop, sponsored by AIM and the NSF, will explore the Cuntz semigroup; an invariant of C*-algebras inspired by *K*-theory and recently shown to be important for classification.

Information: http://aimath.org/ARCC/workshops/ cuntzsemigroup.html.

* 2–7 **DNA Topology Course-Workshop 2009**, Okinawa Institute of Science and Technology, Okinawa, Japan.

Organizers: Robert Sinclair, OIST, Japan Nafaa Chbili, UAE University, United Arab Emirates.

Confirmed Speakers: De Witt Sumners, Patrick Forterre, Jun O'Hara, Javier Arsuaga, Dorothy Buck, Isabel Darcy, Christian Laing, Jennifer K. Mann, Koya Shimokawa, Andrzej Stasiak, Mariel Vazquez, and Lynn Zechiedrich.

Information: http://web.me.com/oist_mbu/DNA_Topology_ Course/Home.html.

6-10 XV International Conference on Mathematics, Informatics and Related Fields, Hotel Energetyk, Naleczow, Poland. (Jun./Jul. 2009, p. 769)

Topics: Mathematical analysis, probability and statistics, computer science, applied mathematics and mathematical didactics.

Scientific Committee: Bogdan Bojarski, Theodor Bulboaca, Stanisława Kanas, Jacek Kluska, Józef Korbicz, Piotr Liczberski, Dariusz Partyka, Wiesław Pleśniak, Arkadiusz Płoski, Dymitr Prokhorov, Zdzisław Rychlik, Józef Siciak, Hari M. Srivastava, Jan Stankiewicz, Toshiyuki Sugawa, Zbigniew Suraj, Józef Zajc, Jarosław Zemanek.

Organizing Committee: Stanisława Kanas, Beata Fałda, Zdzisław Rychlik, Anna Szpila, Katarzyna Wilczek.

Information: http://ptm.prz.rzeszow.pl/konferencja/.

7–8 **AMS Western Section Meeting**, University of California, Riverside, California. (Aug. 2008, p. 872)

Information: http://www.ams.org/amsmtgs/sectional.html.

9–13 **Cyclic homology and symplectic topology**, American Institute of Mathematics, Palo Alto, California. (Apr. 2009, p. 525)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to the incarnations of cyclic homology in symplectic topology. **Information:** http://aimath.org/ARCC/workshops/cyclichomology.html.

* 13–15 International Conference on Mathematics and Information Security, Sohag University, Sohag, Egypt.

Description: The aim of the conference is to bring together the teachers, researchers, and scientists working in the field of Mathematics, Theoretical Physics, Statistics and Applied Statistics including Operation Research and Computer Sciences. The ICMIS organized by the Department of Mathematics, Faculty of Science, Sohag University, is being held in Sohag, Egypt. The gathering of distinguished mathematicians, statisticians, researchers, and academicians from around the

whole world is expected to provide a unique opportunity to share their latest research and discoveries and thought provoking ideas with their fellow scientists on various disciplines of mathematics and its allied subjects.

Information: http://www.icamis2009.tk/.

16–20 **MSRI Upcoming Workshops: Algebraic Structures in the Theory of Holomorphic Curves**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 862)

Organizers: Mohammed Abouzaid (Clay Mathematics Institute), Yakov Eliashberg (Stanford University), Kenji Fukaya (Kyoto University), Eleny Ionel (Stanford University), Lenny Ng (Duke University), Paul Seidel (MIT).

Parent Program(s): Symplectic and Contact Geometry and Topology. Information: http://www.msri.org.

19–21 **2nd meeting on Optimization Modelization and Approximation Moma 2009**, Hassania School, Public Works Département de Mathématiques et Informatique Km 7, Route d'El Jadida, B.P 8108, Oasis-Casablanca, Morocco. (May 2009, p. 658)

Description: The scope of this second meeting covers a range of major topics in numerical analysis, optimization, also in approximation and engineering and related disciplines, ranging from theoretical developments to industrial applications and modelling of problems. The themes of the conference include, but are not limited to: Optimization, computational optimization frameworks, optimization modeling, approximation theory, radial basis functions, scattered data approximation, learning machine theory, meshless methods, numerical analysis, modelization. Applications: Image processing, financial computation, medicine and biology.

Information: http://www-lmpa.univ-littoral.fr/MOMA09/.

23-27 Mathematics and Astronomy: A Joint Long Journey, CSIC, Madrid, Spain. (Jun./Jul. 2009, p. 769)

Description: Mathematics and Astronomy walked together for thousands of years. Ptolemy, Copernicus, Galileo, Kepler, Newton are good examples of this fruitful interaction between both disciplines. In medieval educational theory, the "quadrivium" consisted of arithmetic, geometry, music, and astronomy, which prove their common past in the development of science. More recently, the extraordinary works by Einstein with the General Theory of Relativity give new insights to our vision of the universe, in a wonderful cooperation of geometry and physics. The proposed symposium wants to show and stress these links with the occasion of the celebration of the International Year of Astronomy IYA2009.

Information: http://www.astromath2009.com.

29-December 4 Southern Right Delta ($\Sigma P \Delta$ '09) Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics, Gordon's Bay, Western Cape, South Africa. (Feb. 2009, p. 310)

Description: Mathematics and Astronomy walked together for thousands of years. Ptolemy, Copernicus, Galileo, Kepler, Newton are good examples of this fruitful interaction between both disciplines. In medieval educational theory, the "quadrivium" consisted of arithmetic, geometry, music, and astronomy, which prove their common past in the development of science. More recently, the extraordinary works by Einstein with the General Theory of Relativity give new insights to our vision of the universe, in a wonderful cooperation of geometry and physics. The proposed symposium wants to show and stress these links with the occasion of the celebration of the International Year of Astronomy IYA2009.

Information: http://www.astromath2009.com.

30-December 4 **International Conference on Elliptic and Parabolic Equations**, Weierstrass Institute for Applied Analysis and Stochastics (WIAS), Berlin, Germany. (Aug. 2009, p. 862)

Description: Elliptic and parabolic PDE's have been powerful models of problems in science and engineering for more than a quarter millennium. The classical solution theory of these equations assumes "perfect" spatial domains and coefficients. However, to deal with

real world problems today, one has to take into account vertices and edges of three-dimensional spatial domains, discontinuous coefficient functions, and various mixed boundary conditions. Suitable regularity for such linear elliptic problems is crucial for the solution theory of corresponding nonlinear elliptic and parabolic equations. This conference will examine the progress in this direction, and elliptic and parabolic equations in real space at large. One day of the conference will be specifically devoted to Navier-Stokes equations.

Information: http://www.wias-berlin.de/workshops/epe09.

30–December 4 **MSRI Upcoming Workshops: Tropical Structures in Geometry and Physics**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 863)

Organizers: Mark Gross (University of California San Diego), Kentaro Hori (University of Toronto), Viatcheslav Kharlamov (Université de Strasbourg (Louis Pasteur)), Richard Kenyon (Brown University). **Parent Program(s):** Tropical Geometry.

Information: http://www.msri.org.

December 2009

1–4 (NEW DATE) **Combinatorics: Analytical Methods in Combinatorics, Additive Number Theory and Computer Science**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Dec. 2008, p. 1452)

Overview: This workshop will focus on the interplay between combinatorics, discrete probability, additive number theory and computer science with emphasis on a wide spectrum of analytical tools that are used there. One of the workshop's aims is to foster interaction between researchers in these areas, discuss recent progress and communicate new results and ideas. We would also like to utilize this forum to make the state-of-the-art analytical techniques accessible to a broader audience.

Organizing Committee: Irit Dinur, Ben Green, Gil Kalai, Alex Samorodnitsky, Terence Tao, Van Vu.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmaws4. Applications received by Oct. 5, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/cmaws4/; email: sbeggs@ipam.ucla.edu.

7–9 **SIAM Conference on Analysis of Partial Differential Equations (PD09)**, Hilton Miami Downtown, Miami, Florida. (Feb. 2009, p. 310) **Overview:** This workshop will focus on the interplay between combinatorics, discrete probability, additive number theory and computer science with emphasis on a wide spectrum of analytical tools that are used there. One of the workshop's aims is to foster interaction between researchers in these areas, discuss recent progress and communicate new results and ideas. We would also like to utilize this forum to make the state-of-the-art analytical techniques accessible to a broader audience.

Organizing Committee: Irit Dinur, Ben Green, Gil Kalai, Alex Samorodnitsky, Terence Tao, Van Vu.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/cmaws4. Applications received by Oct. 5, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/cmaws4/;
email: sbeggs@ipam.ucla.edu.

7-11 **IMA Workshop: Microfluidics: Electrokinetic and Interfacial Phenomena**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 525) **Description:** Microfluidics is the science of fluid motion on microscopic scales, roughly 100 nanometers to 100 microns. In this regime inertial effects are negligible and interfacial effects, i.e., surface tension, capillarity, electrostatic charge, etc. dominate. The subject has emerged as an area of intense interest in the applied sciences because of applications in nanotechnology and bio-analytical chemistry. The workshop will focus on topics in the basic science of ionic fluids: zeta potentials, Debye Layers, electroosmosis and electrophoresis; interfacial effects and applications such as controlled droplet motion by electrowetting, and the Brownian hydrodynamics of macromolecules and polymers.

Information: http://www.ima.umn.edu/2009-2010/
W12.7-11.09/.

* 9-12 Advanced Course on Algebraic Cycles, Modular Forms, and Rational Points on Elliptic Curves, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona, Spain.

Description: The theme of this course is the construction of algebraic points on elliptic curves from special points and higher-dimensional cycles on Shimura varieties and closely related objects. The lecturers will provide background for, explain, and, time permitting, expand further on the results that are proven in the two works in progress: 1.- M. Bertolini, H. Darmon, and K. Prasanna, "Generalized Heegner cycles and p-adic Rankin L-series"; 2.- M. Bertolini, H. Darmon, and K. Prasanna, "Chow-Heegner points on CM elliptic curves and values of p-adic L-series".

Information: http://www.crm.cat/accycles.

14–18 AMSI Workshop: New Directions in Geometric Group Theory, The University of Queensland, Brisbane, Australia. (Aug. 2009, p. 863) **Description:** This workshop will examine the influx of new ideas, trends, and advances in geometric group theory with focus on: (1) analysis (Baum-Connes conjecture, Kazhdan's property, amenability, soficity, rapid decay); (2) statistics (random walks, random subgroups, percolation, generic properties of groups); and (3) geometry (Cannon conjecture, boundaries, BNS invariants, bounded (co)-homology of groups, isoperimetric functions). We gratefully acknowledge support of the Australian Mathematical Sciences Institute, the Australian Mathematical Society, and the School of Mathematics and Physics at the University of Queensland.

Information:http://sites.google.com/site/ggtbrisbane/ Home.

14–18 **Brownian motion and random matrices**, American Institute of Mathematics, Palo Alto, California. (May 2009, p. 659)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to beta-generalizations of the classical ensembles in random matrix theory. These are certain tridiagonal and unitary Hessenberg matrices, with an eigenvalue p.d.f. generalizing that of Gaussian Hermitian matrices and Haar distributed unitary matrices.

Information: http://aimath.org/ARCC/workshops/ brownianrmt.html.

16-18 **The 4th Indian International Conference on Artificial Intelligence: (IICAI-09)**, Tumkur (near Bangalore), India. (Dec. 2008, p. 1452) **Description:** The conference consists of paper presentations, special workshops, sessions, invited talks and local tours, etc. and it is one of the biggest AI events in the world. We invite draft paper submissions. **Information:** For details visit: http://www.iiconference.org.

17-21 **The 14th Asian Technology Conference in Mathematics (ATCM 2009)**, Beijing Normal University, Beijing, China. (Apr. 2009, p. 525)

Description: Conference Theme "Journey to discover more mathematics". The ATCM 2009 is an international conference to be held in China that will continue addressing technology-based issues in all mathematical sciences. The aim of this conference is to provide a

forum for educators, researchers, teachers and experts in exchanging information regarding enhancing technology to enrich mathematics learning, teaching and research at all levels. English is the official language of the conference. There will be over 400 participants coming from over 33 countries around the world. Deadlines for abstract and full paper are June 15 and July 30 respectively.

Information: http://atcm.mathandtech.org.

19-21 International Conference on Current Trends in Mathematics, Allahabad, Uttar Pradesh, India. (May 2009, p. 659)

Description: The aim of the conference is to introduce undergraduate and Ph.D. students in mathematics as well as post-doctoral researchers to recently emerged trends of mathematics.

Deadline: Submit abstracts with full-length paper to: complexgeometry18@yahoo.com: October 20, 2009. Acknowledgement of accepted papers by email: October 25, 2009. For registration: November 15, 2009. All submitted papers will be under peer review and accepted papers will be published in the conference proceedings. **Information:** complexgeometry18@yahoo.com; Sushil Shukla (email: ss123a@rediffmail.com); http://sites.google.com/ site/educationalconferenceorg/ss.

21–22 Mathematical Sciences for Advancement of Science and Technology (MSAST 2009), IMBIC Hall, Salt Lake City, Kolkata, (Calcutta), West Bengal, India. (Aug. 2009, p. 863)

Description: The 3rd International Conference organized by the Institute for Mathematics, Bioinformatics, Information Technology and Computer Science (IMBIC) on "Mathematical Sciences for Advancement of Science and Technology" (MSAST 2009) will be held during December 21–22, 2009, at IMBIC Hall, Kolkata, India. Authors are requested to submit the full original papers for presentation and publication in the Proceedings of the conference related to the theme of the conference: "Mathematical Sciences for Advancement of Science and Technology" indicating the motivation of the problem, its method of solution, and important results to the Secretary of IMBIC.

Information: All correspondences in respect of the conference are to be addressed to Dr. Avishek Adhikari, Secretary, IMBIC, AH 317, Salt Lake City, Sector II, Kolkata 700091, West Bengal, India, email: avishek.adh@gmail.com; http://imbic.org/forthcoming. html.

28-31 Seventh International Triennial Calcutta Symposium on Probability and Statistics, Department of Statistics, University of Calcutta, 35 Ballygunge Circular Road, Kolkata- 700019, West Bengal, India. (Aug. 2009, p. 863)

Description: The Seventh International Triennial Calcutta Symposium, following the previous six symposia, will bring together researchers engaged in theoretical, methodological, and applied aspects of statistics and probability on a common platform. A large number of researchers from all over the world are expected to attend. There will be invited and technical sessions and poster sessions for students and young researchers. The best posters will be awarded. The Department of Statistics, Calcutta University, is the oldest post-graduate department in Asia offering a course in statistics. It is recognized as one of the prime departments of Statistics in India. Calcutta Statistical Association is an international learned society closely associated with the department. The Association publishes an internationally circulated journal of its own besides organizing lectures, seminars, workshops, and symposia.

Information:

http://triennial.calcuttastatisticalassociation.org.

January 2010

2-4 International Convention on Mathematical Sciences, Allahabad, India. (May 2009, p. 659)

Description: The aim of the conference is to introduce undergraduate and Ph.D. students in mathematics as well as post-doctoral researchers in recently emerged trends of mathematics.

Deadlines: The deadline for submitting abstracts with full-length paper to complexgeometry18@yahoo.com: October 20, 2009. Ac-knowledgement of accepted papers by email: October 25, 2009. For registration: November 15, 2009. All submitted papers will be under peer review and accepted papers will be published in the conference proceedings.

Information: Contact: complexgeometry18@yahoo.com.

* 4–July 2 Stochastic Partial Differential Equations, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Organizers: Z. Brzezniak (York), M. Hairer (Warwick), M. Röckner (Universität Bielefeld), P. Souganidis (Chicago), and R. Tribe (Warwick). **Description:** Stochastic Partial Differential Equations are used to model many physical systems subjected to the influence of internal, external or environmental noise. They also arise when considering deterministic models from random initial conditions, or as tractable approximations to complex deterministic systems. In many cases the presence of noise leads to new phenomena with many recent examples in the physical sciences, biology and financial modelling. The goal of the program is to bring together the world leaders in Stochastic Partial Differential Equations working on various aspects of the theory, numerical approximations and applications, as well as in related scientific areas. A number of workshops will take place during the programme.

Information: http://www.newton.ac.uk/programmes/SPD/
ws.html.

5-9 **New Directions in Financial Mathematics**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Aug. 2009, p. 863)

Overview: The workshop will introduce researchers and mathematicians to two fields of research: environmental emissions markets and mathematical models for financial markets. Among other talks, there will be a short course on the challenge of the environment and the attempts to use financial markets to control emissions of greenhouse gases in the most efficient way, and a short course on agent-based models for financial markets.

Organizing Committee: Rene Carmona, Jaska Cvitanic, Nicole El Karoui, George Papanicolaou, Eduardo Schwartz, Ronnie Sircar, Thaleia Zariphopoulou.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/fin2010. Applications received by Nov. 9, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/ fin2010/.

* 11-July 2 **Stochastic Processes in Communication Sciences**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Organizers: V. Anantharam, F. Baccelli, D. Denisov, S. Foss, P. W. Glynn, and T. Konstantopoulos.

Description: Probability theory and communications have developed hand in hand for about a century. The research challenges in the latter field (from telephone networks to wireless communications and the Internet) have spurred the development of the mathematical theory of stochastic processes, particularly in the theory of Markov processes, point processes, stochastic networks, stochastic geometry, stochastic calculus, information theory, and ergodic theory. Conversely, a large number of applications in communications would not have been possible without the development of stochastics. This program aims at the exposition of the latest developments in mathematical sciences lying on the boundary between stochastics and communications. Several workshops will take place during the program. Information: http://www.newton.ac.uk/programmes/SPD/
ws.html.

* 13-16 Joint Mathematics Meetings, San Francisco, California. Information: http://www.ams.org/amsmtgs/national.html.

17–19 **ACM-SIAM Symposium on Discrete Algorithms (SODA10)**, Hyatt Regency Austin, Austin, Texas. (Apr. 2009, p. 525)

Description: This symposium focuses on research topics related to efficient algorithms and data structures for discrete problems. In addition to the design of such methods and structures, the scope also includes their use, performance analysis, and the mathematical problems related to their development or limitations. Performance analyses may be analytical or experimental and may address worst-case or expected-case performance. Studies can be theoretical or based on data sets that have arisen in practice and may address methodological issues involved in performance analysis.

Information: http://www.siam.org/meetings/da10/.

24–26 International Conference on Analysis and Applications (ICAA10), Sultan Qaboos University, Muscat, Oman. (May 2009, p. 659) **Description:** The aim of this conference is to reflect the current state of the art in the study of analysis with the hope to promote scientific exchange among analysts all over the world. The main goal of this conference is to discuss new developments and future directions in analysis. Its particular focus is on the active participation of all who attend to promote a spirit of training, learning and communicating. The conference will consist of plenary talks and contributed talks of 25 minutes (20 + 5 for discussion) in parallel special sessions. All areas of analysis-related mathematics, especially topology, complex analysis, real and functional analysis, numerical analysis, and applications of analysis to other areas of mathematics and the sciences, will be covered. For any inquiries please contact us at: http://icaa10@ squ.edu.om.

Information: http://www.squ.edu.om/Portals/87/ Conference/ICAA10/conference2010/ICAA10.htm.

* 25–29 **III Internacional Conference on the Anthropological Theory of the Didactic**, The Vilar Rural Hotel, Sant Hilari Sacalm, Catalonia, Spain.

Description: The Anthropologic Theory of the Didactic constitutes a development of the didactic transposition theory born in 1985 with the publication of Chevallard's book "La transposition didactique: du savoir savant au savoir enseigné". The main goal of the Conference is to gather researchers working to present empirical studies carried out in the educational systems of different countries, to discuss and spread the results obtained, and to agree on a common programme of research and development for the coming years.

Information: http://www.crm.cat/cdidactic.

25–29 **Metamaterials: Applications, Analysis and Modeling**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2009, p. 769)

Overview: This workshop brings together three groups of people: physicists and engineers working on metamaterials and their applications; mathematicians who are studying homogenization in high contrast materials and are providing a greater understanding of the mathematics of metamaterials; and numerical analysts interested in the solving the microscopic and macroscopic equations governing the behavior of metamaterials.

Organizing Committee: Robert Kohn, Graeme Milton, Susanne Brenner, Maria-Carme Calderer, Tatsuo Itoh, Jichun Li, Chi-Wang Shu, Richard Ziolkowski.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/meta2010. Applications received by November 30, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

* 25–30 **International School on Combinatorics "Pilar Pisón-Casares"**, Facultad de Matemáticas, Universidad de Sevilla, Spain.

Description: The School is addressed to Ph.D. students and young post-doc researchers working on Algebraic Geometry, Combinatorics, Commutative Algebra and related areas, introducing the participants to research, beginning from a basic level with a view towards the applications and to the most recent results.

Organizers: A. Castaño Domínguez, M. C. Fernández Fernández, Jaime Lugo Gómez, José Navarro Garmendia.

February 2010

* 2-4 **3rd Global Conference on Power Control and Optimization PCO 2010**, Courtyard Surfers Paradise Resort, Gold Coast, Queensland, Australia.

Description: It is our great pleasure to announce the third Global Conference on Power Control and Optimization PCO 2010, which will be held in Courtyard Surfers Paradise Resort, Gold Coast, Australia, from 2–4 February 2010. Scope of the conference is contemporary and original research and educational development in the area of electrical power engineering, control systems and methods of optimization. Prospective authors from universities or institutes and industries are invited to submit the full paper by email before the deadline. All papers will be peer-reviewed by independent specialists. Conference proceeding will be published online by AIP.

Information: Please kindly contact Conference Chairman Professor Dr. Nader Kisho at icpco.20@gmail.com, tel:+6085443821, fax: +6085443837 and Conference Secretary General Pandian Vasant at vasantglobal@gmail.com.

8–11 The International Symposium on Stochastic Models in Reliability Engineering, Life Sciences, and Operations Management, Sami Shamoon College of Engineering, Bialik/Basel Sts., Beer Sheva, 84100, Israel. (May 2009, p. 659)

Description: The SMRLO'Ò10 will serve as a forum for discussing different issues of Stochastic Models and Methods in Reliability Engineering, Life Sciences, and Operations Management and their applications. The idea of the symposium is to assemble researchers and practitioners from universities, institutions, industries, businesses and government, working in these fields. Theoretical issues and applied case-studied, presented on the symposium, will range from academic considerations to operational applications. There will be invited talks, plenary sessions, parallel sessions, posters and exhibitions. The talks will be selected by the program committee and will be included in the symposium proceedings. Selected papers after review and revision will be published in special issues of international journals.

Information: Tel: +972-8-6475-642; fax: +972-8-6475-643; http:// info.sce.ac.il/i/SMRL010.

8–12 Mathematical Problems, Models and Methods in Biomedical Imaging, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2009, p. 770)

Overview: The workshop's topics will include some of the current major technologies and emerging mathematical problems in biomedical imaging. The emphasis will be on the interface between Mathematics and Biomedical Imaging to promote new ideas and research at the frontiers of interdisciplinary studies.

Organizing Committee: Hongkai Zhao, Yair Censor, Steve Jiang, Belinda Seto, Lei Xing.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/bmed2010. Applications received by Dec. 14, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

* 8-12 **PIA 2010** — **The Arithmetic of Fundamental Groups**, Mathematics Center Heidelberg (MATCH), Heidelberg, Germany.

Description: The conference PIA 2010 will cover different approaches to the arithmetic of fundamental groups that have been successful recently and remain promising in the focus of current and future developments. PIA 2010 intends to bring together knowledge in the area of anabelian geometry, pro-finite etale fundamental groups, tannakian/motivic algebraic fundamental groups, p-adic fundamental groups, and in the interplay between fundamental groups and special objects like the polylogarithm.

Description: http://www.pia2010.mathi.uni-heidelberg. de/.

18–19 **February Fourier Talks 2010**, Norbert Wiener Center, University of Maryland, College Park, Maryland. (Jun./Jul. 2009, p. 770)

Description: Each year the two-day February Fourier Talks, organized by the Norbert Wiener Center in the Department of Mathematics at the University of Maryland, College Park, feature a diverse array of invited talks in the field of Harmonic Analysis and Applications. A single track of presentations from top academic, industry, and government researchers is scheduled, allowing ample time for interaction with other participants. The conference will feature a talk in our Distinguished Lecturer Series by Elias Stein of Princeton University, and the Norbert Wiener Lecture, delivered by Charles Fefferman of Princeton University.

Information: http://www.norbertwiener.umd. edu/FFT/FFT10/index.html.

22–26 **IMA Workshop: Analysis and Computation of Incompressible Fluid Flow**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 525) **Description:** The mathematical and numerical analysis of incompressible flows is of paramount importance for understanding basic nonlinear phenomena in science and engineering. The subject contains some of the most challenging nonlinear partial differential equations of mathematical physics, posing problems for both analysis and computation. This workshop will address modern developments in the core analytical issues of existence and uniqueness of smooth solutions, as well as of weak solutions and statistical solutions. Additional topics will include geophysical flows, analysis of complex fluid models, free surface problems, vanishing viscosity limits, and numerical methods for scientific computation of complex flows.

Information: http://www.ima.umn.edu/2009-2010/ W2.22-26.10/.

22-26 **Statistical and Learning-Theoretic Challenges in Data Privacy**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2009, p. 770)

Overview: The workshop's goal is to establish a coherent theoretical foundation for research on data privacy. This implies work on how the conflicting goals of privacy and utility can or should be formulated mathematically, and how the constraints of privacy affect the accuracy of statistical inference and machine learning.

Organizing Committee: Adam Smith, Cynthia Dwork, Stephen Fienberg, Aleksandra Slavkovic.

Application/Registration: An application and registration form is available at http://www.ipam.ucla.edu/programs/data2010. Applications received by December 21, 2009, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

24–26 SIAM Conference on Parallel Processing and Scientific Computing (PP10), Hyatt Regency Seattle, Seattle, Washington. (Apr. 2009, p. 525)

Description: This conference organized by the SIAM Activity on Supercomputing.

Information: http://www.siam.org/meetings/pp10/
index.php.

March 2010

8–12 AIM Workshop: Mock Modular Forms in Combinatorics and Arithmetic Geometry, American Institute of Mathematics, Palo Alto, California. (Jun./Jul. 2009, p. 770)

Description: This workshop, sponsored by AIM and the NSF, will focus on mock modular forms as they occur in combinatorics and arithmetic geometry and explore some other potential applications. **Information:** http:// www.aimath.org/ARCC/workshops/mockmodular.html.

8–June 11 Long Program: Model and Data Hierarchies for Simulating and Understanding Climate, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Apr. 2009, p. 526) **Overview:** Simulation has advanced climate science, but not sufficiently to the profit of theory and understanding. Our hypothesis is that the development of climate science will be best served by focusing computational and intellectual resources on model and data hierarchies. By bringing together physicists, mathematicians, statisticians, engineers, and climate-scientists to focus on themes across scales and scientific methodologies, our program will provide a framework for advancing our use of hierarchical methods in our attempt to understand the climate system.

Organizing Committee: Amy Braverman, Rupert Klein, Andrew Majda, Olivier Pauluis, Bjorn Stevens.

Application and Information: Information and an application form is available at: http://www.ipam.ucla.edu/programs/CL2010. Applications for individual workshops will be posted on individual workshop home pages. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications.

15-19 **Localization techniques in equivariant cohomology**, American Institute of Mathematics, Palo Alto, California. (May 2009, p. 659) **Description:** This workshop, sponsored by AIM and the NSF, will be devoted to localization techniques in equivariant cohomology. Localization techniques in equivariant cohomology are a powerful tool in computational algebraic topology in the context of a topological space with the action of a Lie group.

Information: Visit http://aimath.org/ARCC/workshops/ localization.html.

17-19 **IAENG International Conference on Operations Research 2010**, Regal Kowloon Hotel, Hong Kong, China. (Aug. 2009, p. 863) **Organizers:** The conference ICOR'10 is held under the International MultiConference of Engineers and Computer Scientists 2010. The IMECS 2010 is organized by the International Association of Engineers (IAENG).

Important Dates: Draft Manuscript submission deadline: December 8, 2009; Camera-Ready Papers Due & Registration Deadline: January 10, 2010; ICOR 2010: March 17–19, 2010.

Topics: ICOR'10 include, but not limited to, the following: Management Science Managerial economics Systems thinking and analysis Optimization Integer programming Linear programming Nonlinear programming Assignment problem Transportation network design Simulation Statistical Analysis Stochastics Modelling Reliability and maintenance Queueing theory Game theory Graph theory OR algorithms and software developments OR applications and case studies. **Information:** http://www.iaeng.org/IMECS2010/ICOR2010. html.

* 18–20 **44th Spring Topology and Dynamics Conference 2010**, Mississippi State University, Starkville, Mississippi.

Description: The 44th Annual Spring Topology and Dynamics Conference regularly attracts 150–200 particpants and offers a healthy mixture of invited and contributed talks. Special sessions are organized in General and Set Theoretic Topology, Continuum Theory, Dynamical Systems, Geometric Topology and Geometric Group Theory. **Information:** http://www2.msstate.edu/~fabel/sptop10a.

18-21 First International Conference on Mathematics and Statistics, AUS-ICMS '10, American University of Sharjah (AUS), Sharjah, United Arab Emirates. (Jun./Jul. 2009, p. 770)

Description: The main objective of the conference is to bring together researchers and scientists working in all areas of mathematics and statistics from academia and industry to exchange research ideas, discuss the most recent advancements in all fields of mathematics and sciences, and to promote interaction between our faculty and researchers from the region and worldwide.

Topics: To be covered include, but are not limited to: Algebra, analysis, applied mathematics, applied statistics, differential equations, discrete mathematics, financial mathematics, mathematics education, number theory, numerical analysis, probability theory, statistics, stochastic differential equations, and topology and geometry.

Information: http://www.aus.edu/conferences/icms10/.

* 22–26 **Equation Hierarchies for Climate Modeling**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.

Overview: This workshop will focus the discussion on problems such as: 1) the development of new balanced systems of equations using techniques such as multiple scales asymptotics, 2) the use of simplified sets of equations as models of the Earth or other planetary climates, 3) balance dynamics and the breakdown of balance, and 4) the role of latent heating in the dynamics of the tropical and extra-tropical atmosphere and simplified ways to account for condensation in models.

Application/Registration: An application and registration form is available at http://www.ipam.ucla.edu/programs/clws1.Applications received by Jan. 25, 2010, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

Organizing Committee: Simona Bordoni, Dargan Frierson, Andrew Majda, Jonathan Mitchel.

* 27–28 AMS Southeastern Section Meeting, University of Kentucky, Lexington, Kentucky.

Information: http://www.ams.org/amsmtgs/sectional.html.

29–April 2 AIM Workshop: Computational optimization for tensor decompositions, American Institute of Mathematics, Palo Alto, California. (Jun./Jul. 2009, p. 770)

Description: This workshop, sponsored by AIM and the NSF, will be devoted to facilitating the development of new decomposition methods and to provide fundamentally new insights into both tensor decompositions and numerical optimization.

Information: http://aimath.org/ARCC/workshops/comptensor.html.

April 2010

* 10-11 AMS Central Section Meeting, Macalester College, St. Paul, Minnesota.

Information: http://www.ams.org/amsmtgs/sectional.html.

12-16 Climate Modeling: Numerical Hierarchies for Climate Modeling, Introduction for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Aug. 2009, p. 863)

Overview: This workshop will focus on advanced computational techniques which allow us to cover a wide range of spatio-temporal scales in a single simulation, and which operate reliably at various resolutions. Of particular interest will be mechanisms for selecting non-resolved scale parameterizations as a function of grid resolution and for controlling the interplay of numerical truncation with subgrid scale process representations.

Organizing Committee: Francis Giraldo, Christiane Jablonowski, Rupert Klein, Sebastian Reich.

Application/Registration: An application and registration form is available at: http://www.ipam.ucla.edu/programs/clws2.

Applications received by Feb. 15, 2010, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

Information: http://www.ipam.ucla.edu/programs/clws2/.

12-16 IMA Workshop: Transport and Mixing in Complex and Turbulent Flows, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 526) **Description:** Enhanced mixing and transport properties are distinguishing characteristics of both turbulent and more structured complex flows. The concepts of eddy diffusion and eddy viscosity, for example, were introduced as attempts to "parameterize" these effects to produce reduced models for theoretical analysis and simulations. At the same time turbulent mixing and transport is the focus of significant attention from a fundamental point of view, based in some cases on the Navier-Stokes equations and in other cases on models or special flows amenable to more thorough analytical investigations. This workshop is concerned with modern mathematical approaches to the study of transport and mixing in turbulence and other complex flows, including transitional flows with significant attention to applications from the applied sciences, predominantly geophysics. Information: http://www.ima.umn.edu/2009-2010/ W4.12-16.10/.

14–17 **International Workshop on Multivariate Risks and Copulas**, Mohamed Khider University of Biskra, Algeria. (Aug. 2009, p. 863) **Description:** The first edition of the International Workshop on Multivariate Risks and Copulas which will be held April 14–17, 2010, at Mohamed Khider University of Biskra, Algeria. The workshop will serve as a forum for discussing different issues of risks, copulas, and related topics. The main goal of this scientific event is to gather researchers and practitioners from universities, institutions, industries, and government, working in these fields. The tools and methodologies in progress in probability, statistics, mathematics, and economics that are closely relevant for Univariate and Multivariate Risks will be embraced as well. We are proud to organize this workshop and look forward to welcoming you in Biskra.

Information: http://www.univ-biskra.dz/manifestations/
math/stat_2010/.

15-17 **35th Spring Lectures Series, 2010 "Minimal Surfaces and Mean Curvature Flow"**, University of Arkansas, Fayetteville, Arkansas. (Aug. 2009, p. 864)

Speakers and Talks: The main speaker is William Minicozzi (Johns Hopkins University). The title of the conference is "Minimal Surfaces and Mean Curvature Flow". Professor Minicozzi will deliver a total of five lectures. There will be ten talks by the following invited speakers: Maria Calle, Julie Clutterbuck, Tobias Colding, Camillo De Lellis, Lei N, Felix Schulze, Natasa Sesum, Mu-Tao Wang, Matthias Weber, Michael Wolf.

Information: Applications for contributed talks by junior mathematicians are strongly encouraged. Titles and abstract should be received by the organizers not later than March 15th, 2010. For further questions please contact Andy Raich araich@uark.edu; http://www.math.uark.edu.

* 17–18 **AMS Western Section Meeting**, University of New Mexico, Albuquerque, New Mexico.

Information:http://www.ams.org/amsmtgs/sectional.html.

May 2010

* 3-7 Advanced Course on Foliations: Dynamics-Geometry-Topology, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona, Spain.

Description: One advanced course will present the fundaments of foliation theory, and the other advanced courses will introduce some of its most active areas, like dynamics of foliations, classifying spaces, index theory for foliations and group actions, or rigidity and leafwise ohomology. These courses should provide the audience with the necessary tools to work on some of the most important unsolved problems on foliation theory.

Information: http:// www.crm.cat/acfoli.

* 3–7 **Simulation Hierarchies for Climate Modeling**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.

Overview: The objective of this workshop is to increase our understanding of the climate system through developments of better consistent simulation model hierarchies. It will explore to what extent more simplified models and theories can be useful in reproducing, interpreting and conceptualizing the complex dynamics of the climate system. This will include models, theories, and simulation techniques that have emerged from statistical physics and mathematics.

Application/Registration: An application and registration form is available at http://www.ipam.ucla.edu/programs/clws3.Applications received by Mar. 8, 2010, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

Organizing Committee: Markos Katsoulakis, Alan Kerstein, Boualem Khouider, Olivier Pauluis, Ole Peters, Pier Siebesma.

17-20 **25th Annual Shanks Lecture and Conference: Optimal Configurations on the Sphere and Other Manifolds**, Vanderbilt University, Nashville, Tennessee.

Description: The aim of this conference is to bring together mathematicians and scientists for the purpose of gaining a better understanding of the structure of particle systems under a variety of physical constraints. These include, for example, classical ground states for interacting particle systems, best-packing, random packings, jammed states, granular and colloidal systems, as well as minimal discrete and continuous energy problems for general kernels.

Information: http://www.math.vanderbilt.edu/
~shanks2010.

* 22-23 AMS Eastern Section Meeting, New Jersey Institute of Technology, Newark, New Jersey.

Information: http://www.ams.org/amsmtgs/sectional.html.

23-26 **SIAM Conference on Mathematical Aspects of Materials Science (MS10)**, Doubletree Hotel Philadelphia, Philadelphia, Pennsylvania. (Aug. 2009, p. 864)

Description: This conference is sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science.

Information: http://www.siam.org/meetings/ms10/.

24–28 **Applied Linear Algebra**—in Honor of Hans Schneider, Department of Mathematics, Faculty of Science, Novi Sad, Serbia. (Aug. 2009, p. 864)

Description: Inspired by the success of two previous conferences Applied Linear Algebra—in honor of Richard Varga, 2005, Palić; and Applied Linear Algebra—in honor of Ivo Marek, 2008, Novi Sad we will continue in the same fashion by organizing a conference Applied Linear Algebra—in honor of Hans Schneider. ALA 2010 has the similar aim as ALA 2005 and ALA 2008—to review numerous contributions of Hans Schneider and to report and discuss recent progress through the participation of international leaders in the field, who will gather in his honor. We are pleased to announce the 10th GAMM Workshop Applied and Numerical Linear Algebra with special emphasis on Positivity which will be organized as a part of ALA 2010. A special issue of Linear Algebra and its Applications will be devoted to selected papers presented during the conference.

Information: http://www.dmi.uns.ac.rs/events/ala2010.

* 24–28 **Data Hierarchies for Climate Modeling**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.

Description: This workshop will examine 1) basic paradigms for modeling hierarchical relationships, 2) the application of these paradigms

to facilitate the formulation of hierarchies for understanding climate processes, 3) their application to equation, model, and simulation hierarchies given a priori, 4) quantification and propagation of databased modeling errors and uncertainties through the hierarchies, 5) interdisciplinary issues arising from the data collected or generated in climate science.

Application/Registration: An application and registration form is available at http://www.ipam.ucla.edu/programs/clws4. Applications received by Mar. 29, 2010, will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. You may also simply register and attend without IPAM funding.

Organizing Committee: Amy Braverman, Illia Horenko, Luis Kornblueh, Robert Pincus.

25-28 8th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Dresden, Germany. (Jun./Jul. 2009, p. 770)

Plenary Speakers: Luis Caffarelli, Emmanuel Candes, Kuo-Chang Chen, Barbara Gentz, Louis Nirenberg, Masaharu Taniguchi, Gunther Uhlmann, Lai-Sang Young

Organizers: The American Institute of Mathematical Sciences, Dresden University of Technology.

Information: Stefan Siegmund, stefan.siegmund@tu-dresden. de; Shouchuan Hu, shu@missouristate.edu; Xin Lu, lux@uncw. edu; http://aimsciences.org/AIMS-Conference/2010/.

25-29 **BALWOIS 2010: Fourth International Scientific Conference**, Ohrid, Republic of Macedonia. (Jun./Jul. 2009, p. 771)

Description: Conference on Water Observation and Information System for Decision Support. Scientific presentations, Forum exchange, Workshops, Exhibition, Social program, etc.

Main topics: Climate and hydrology, environment and human activities, water related risks, integrated water resouces management, ecohydrology, computing and technologie.

Deadlines: Submission of Abstract: November 15, 2009. Author Notification of Abstract Acceptance: December 15, 2009. Submission of Full Paper: February 15, 2010. Author Notification of Full Paper Acceptance: March 15, 2010.

Supporters: Ministry of Environment of Republic of Macedonia, French Ministry of Ecology, French Embassy in Macedonia, and International Association of Hydrological Sciences

Information: email: secretariat@balwois.com; http://www. balwois.com/2010.Projectwebsite: http://www.balwois.com.

June 2010

1–5 **IMA Workshop: Natural Locomotion in Fluids and on Surfaces: Swimming, Flying, and Sliding**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2009, p. 526)

Description: Natural locomotion in fluids includes the swimming of fish and microorganisms and the flying of birds and insects. Other creatures employ similar movements on solid and fluid surfaces, e.g., snails, snakes, and water striders. Nature has exploited the complex fluid dynamics of time-dependent three-dimensional flows over a wide range of Reynolds numbers to evolve a variety of interesting mechanisms of locomotion. This workshop will focus on the mechanics of these behaviors and the current state of theoretical and experimental work in the field. The scope will cover the dynamics from low to high Reynolds numbers, emphasizing the links between the fluid dynamics and the nature of the evolved mechanisms. The inclusion of movement over solid and fluid surfaces introduces new phenomena involving surface stresses and complex fluid layers.

Information: http://www.ima.umn.edu/2009-2010/ W6.1-5.10/. 2-5 Number Theory and Representation Theory—A conference in honor of Dick Gross' 60th birthday, Science Center, Harvard University, Cambridge, Massachusetts. (Jun./Jul. 2009, p. 771)

Description: A conference focusing on the many exciting interactions between number theory and representation theory.

Speakers: Manjul Bhargava, Henri Darmon, Samit Dasgupta, Noam Elkies, Wee-Teck Gan, Joe Harris, Mike Hopkins, Nick Katz, Curt McMullen, Steve Kudla, Dipendra Prasad, Mark Reeder, Gordan Savin, Doug Ulmer, Marie-France Vigneras, Jiu-Kang Yu, Don Zagier, and Shou-Wu Zhang. On the evening of June 4th, 2010, there will be a dinner in honor of Dick Gross' 60th birthday.

Information: http://www.math.harvard.edu/conferences/
gross_10/index.html.

17–19 **Coimbra Meeting on 0-1 Matrix Theory and Related Topics**, Department of Mathematics, University of Coimbra, Portugal. (Jun./ Jul. 2009, p. 771)

Description: Matrices with entries consisting only of zeros and ones, whose entry sums of rows and columns are constrained, play an active role in modern mathematics and its applications, extending far beyond their natural context of Matrix Theory, Combinatorics, or Graph Theory. The purpose of this meeting is to bring together mathematicians from different areas with a view to exploring a number of new properties on the set A(R,S), whose insertion tableau has a previously-fixed shape, and identifying fruitful avenues for further research. In spite of their extremely demanding nature, recent developments and procedures have evidenced a remarkable elegance and beauty, strengthening the interdisciplinary approach of the issue. It is the purpose of this meeting to attract more mathematicians to this exciting and important area, and to foster collaborations with other scientific users. This meeting is endorsed by the International Linear Algebra Society–ILAS.

Information: http://www.mat.uc.pt/~cmf/01MatrixTheory.

18–August 15 **Geometry, Topology, and Dynamics of Character Varieties**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Aug. 2009, p. 864)

Description: This program concerns character varieties of representations in a Lie group G of a discrete group π , for example, the fundamental group of a surface. These varieties have rich geometry and are related to interesting topological objects such as locally homogeneous geometric structures on manifolds, and moduli spaces arising in gauge theory. When π is the fundamental group of a surface group S, the mapping class group acts with a complicated and mysterious dynamics.

Information: http://www.ims.nus.edu.sg/
Programs/010geometry/index.htm.

21-26 **"Alexandru Myller" Mathematical Seminar Centennial Conference**, "Al. I. Cuza" University of Iaşi, Romania. (Jun./Jul. 2009, p. 771)

Description: The Conference is a centennial celebration of the "Alexandru Myller" Mathematical Seminar of the "Al. I. Cuza" University of Iaşi. This celebration is also part of the anniversary of 150 years from the founding of the University of Iaşi. The Mathematical Seminar was founded in 1910 by the late Professor A. Myller, who obtained his Ph.D. degree at Göttingen in 1907. Besides a general session dedicated to the history of the Mathematical Seminar, there will be several sessions on the basic branches of mathematics listing both invited and contributed presentations.

Organizing Committee: Professors Viorel Barbu (chairman), Radu Miron, Constantin Corduneanu, Ovidiu Cârjă, Răzvan Litcanu, Marius Durea. All current and former members of the "A. Myller" Mathematical Seminar are invited to participate. The invitation is also extended to all interested persons from the international mathematical community.

Information: http://www.math.uaic.ro/~Myller2010.

26-30 **2010 International Conference on Topology and its Applications**, Nafpaktos, Greece. (Jun./Jul. 2009, p. 771)

Description: The Department of Mathematics of the University of Patras and the Department of Telecommunication Systems and Networks of the T.E.I. of Messologhi with the hospitality of the city of Nafpaktos organize the 2010 International Conference on Topology and its Applications. All areas of Topology and its Applications are included (General topology, set-theoretic topology, geometric topology, algebraic topology, applied topology. In particular, topological groups, dimension theory, dynamical systems and continua theory, computational topology, history of topology). The conference is the continuation of the 2006 International Conference on Topology and its Applications (see http://www.math.upatras.gr/~aegion). **Organizing Committee:** S. D.Iliadis (Chairman), D. N. Georgiou, I. E. Kougias, Th. Papathanasis.

Information: http://www.math.upatras.gr/~nafpaktos/; email: nafpaktos@math.upatras.gr.

28-July 2 **The Józef Marcinkiewicz Centenary Conference (JM 100)**, A. Mickiewicz University, Faculty of Mathematics and Computer Science, Poznańoznań, Poland. (Aug. 2009, p. 864)

Description: On the occasion of the upcoming centenary of birth of Józef Marcinkiewicz (1910–1940) the Faculty of Mathematics and Computer Science of Adam Mickiewicz University is organizing a scientific conference to commemorate one of the most eminent Polish mathematicians. The meeting will be devoted to some significant aspects of contemporary mathematical research related to Marcinkiewicz's scientific interests (real, complex and functional analysis, probability theory) including their applications.

Confirmed Plenary Speakers: Krzysztof Bogdan, Michael Cwikel, Tadeusz Iwaniec, Jean-Pierre Kahane, Nigel Kalton, Michael Lacey, Rafal Latala, Tomasz Luczak, Lech Maligranda, Gilles Pisier, Andreas Seeger, Marc Yor, and Bernard Roynette.

Information: http://www.jm100.amu.edu.pl.

July 2010

* 12-August 6 **Statistical Challenges Arising from Genome Resequencing**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Organizers: D. Balding (Imperial College London), C. Holmes (Oxford), G. McVean (Oxford) and M. Stephens (Chicago).

Description: The current generation of high-throughput genetic and genomic platforms, has had a great impact on biomedical research, and given new impetus to studies of molecular mechanisms of genetic disease, and to systems biology. The next big technological step forward is the advent of cheap, fast, sequencing platforms that will allow near-complete genome sequences to be quickly and affordably obtained from individual members of any species. Individual genomes from humans, their pathogens and model organisms will have an enormous impact on population genetics and evolutionary theory, as well as on epidemiology, particularly our understanding of infectious disease. We plan to discuss the most pressing open problems and the most promising avenues of future research necessary to deliver the full benefits of genome resequencing.

Information: http://www.newton.ac.uk/programmes/CGR/.

12-15 **SIAM Conference on the Life Sciences (LS10)**, The David L. Lawrence Convention Center, Pittsburgh, Pennsylvania. (Apr. 2009, p. 526)

Description: This conference is organized by the SIAM Activity Group on the Life Sciences.

Information: http://www.siam.org/meetings/ls10/.

12–16 **2010 SIAM Annual Meeting (AN10)**, The David L. Lawrence Convention Center, Pittsburgh, Pennsylvania. (Apr. 2009, p. 526)

Description: SIAM's Annual Meeting provides a broad view of the state of the art in applied mathematics, computational science, and

their applications through invited presentation, prize lectures, minisymposia, and contributed papers and posters.

Information: http://www.siam.org/meetings/an10/index.
php.

* 19–August 13 **Gyrokinetics in Laboratory and Astrophysical Plasmas**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Organizers: W. Dorland (Maryland), S. Nazarenko (Warwick) and A. Schekochihin (Oxford).

Description: In the last 25 years, a new mathematical approach, gyrokinetics, has been developed to treat low-frequency fluctuations in plasmas. In this approach, the fast orbital "gyromotion" is averaged to produce kinetic equations for rings of charge. This is a mathematically rigorous description that is far more tractable than the full kinetic theory. Despite some practical successes in code-building and simulations, the mathematical properties and physical implications of gyrokinetics are insufficiently well understood. In space and astrophysics, the wide applicability and power of the gyrokinetic theory has yet to be fully recognised and exploited. To realise the benefits of this approach, it is essential that gyrokinetics be put on a firm mathematical and physical footing. This program will include several workshops.

Information: http://www.newton.ac.uk/programmes/GYP/
ws.html.

26–30 **6th International Conference on Lévy Processes: Theory and Applications**, Technical University of Dresden, Dresden, Germany. (Apr. 2009, p. 526)

Description: The focus is on recent developments in the theory of Lévy and jump processes and their applications. There will be invited talks and poster sessions.

Scientific Committee: Jean Bertoin (Paris VI, France), Serge Cohen (Toulouse, France), Davar Khosnevisan (Utah, USA), Andreas Kyprianou (Bath, UK), Alexander Lindner (Braunschweig, Germany), Makoto Maejima (Keio, Japan), Thomas Mikosch (Copenhagen, Denmark), Victor Pérez-Abreu (CIMAT, Mexico), Jan Rosinski (U. Tennessee, USA), Réne Schilling (Dresden, Germany).

Information: http://www.math.tu-dresden.de/levy2010; email: levy2010@tu-dresden.de. It is also possible to contact: Réne Schilling (TU Dresden) or Alexander Lindner (TU Braunschweig) directly.

26-August 6 Winter School on Topics in Noncommutative Geometry, Departamento de Matematica, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina. (Apr. 2009, p. 526) Description: The school will cover different topics in non-commutative geometry and its connections with other areas of mathematics and physics, such as operator index theory, strings, representations, operator algebras, and K-Theory. As of December 2008, the following people have agreed in principle to come and give a course: Henrique Bursztyn, Joachim Cuntz, Pavel Etingof, Victor Ginzburg, Victor Kac, Max Karoubi, Henri Moscovici, Holger Reich, Nicolai Reshetikhin, Marc Rieffel, Jonathan Rosenberg, Georges Skandalis, Boris Tsygan.

Organizers: G. Cortiñas, M. Farinati, J. A. Guccione, J. J. Guccione, M. Graña.

Scientific Committee: G. Cortiñas, J. Cuntz, B. Tsygan.

Information: http://cms.dm.uba.ar/Members/gcorti/
workgroup.GNC/3EILS.

August 2010

8–11 **Functional Analysis and Operator theory**, Indian Statistical Institute, Bangalore, India. (Aug. 2009, p. 864)

Local Organizing Committee: T. S. S. R. K. Rao (ISI, Bangalore), G. Misra (IISc, Bangalore), S. H. Kulkarni (IIT, Chennai), P. Bandyopadhyay (ISI, Kolkata), T. Bhattacharya (IISc, Bangalore), N. Namboodiri (CUSAT, Cochin), S. Dutta (IIT, Kanpore).

Information: Conference email: ramanuj@isibang.ac.in; http://www.isibang.ac.in/~statmath/conferences/ icmfasat/icm.htm. Registration fee: 100 Euros.

* 11-December 22 Mathematical and Statistical Approaches to Climate Modelling and Prediction, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Description: Our best estimates of future climate are based on the use of complex computer models that do not explicitly resolve the wide variety of spatio-temporal scales making up Earth's climate system. The non-linearity of the governing physical processes allows energy transfer between different scales, and many aspects of this complex behaviour can be represented by stochastic models. However, the theoretical basis for so doing is far from complete. Many uncertainties remain in predictions derived from climate models, yet governments are increasingly reliant on model predictions to inform mitigation and adaptation strategies. An overarching aim of climate scientists is to reduce the uncertainty in climate predictions and produce credible assessments of model accuracy. Several workshops will take place during this program.

Information: http://www.newton.ac.uk/programmes/CLP/
ws.html.

12-15 International Conference on Recent Trends in Graph Theory and Combinatorics, ICRTGC-2010, Cochin, India. (Jun./Jul. 2009, p. 771)

Information and Location: This conference is a Satellite Conference of the International Congress of Mathematicians to be held at Hyderabad, India, from August 19–27, 2010, http://www.icm2010.in. **Programme:** The academic programme will consist of plenary and invited talks by eminent researchers in the field of Graph theory, Combinatorics and related topics, contributed presentations and mini symposia/special sessions on specific themes such as Algebraic Graph Theory, Metric Graph Theory and Graph Products, Graph Labeling and Graph Operators.

Contact: Ambat Vijayakumar, Convener ICRTGC-2010, Department of Mathematics, Cochin University of Science and Technology, Cochin-682 022 India. Email: icrtgc 2010 at gmail dot com; icrtgc2010 at cusat dot ac dot in.http://icrtgc2010. cusat.ac.in/.

16-December 17 **MSRI Future Scientific Programs: Inverse Problems and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864)

Information: http://www.msri.org.

16-December 17 MSRI Future Scientific Programs: Random Matrix Theory, Interacting Particle Systems and Integrable Systems, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864)

Information: http://www.msri.org.

* 16-December 22 **Partial Differential Equations in Kinetic Theories**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.

Organizers: J. A. Carrillo (Barcelona), S. Jin (Wisconsin) and P. A. Markowich (Cambridge).

Description: The main objective of this program is aimed at advancing Partial Differential Equations (PDEs) research in kinetic theories and its impact in the applied sciences highlighting selected modern application areas. This effort has to be understood from a global perspective of research in PDEs bringing together mathematical modelling, analysis, numerical schemes, and simulation in a feedback loop of synergies. The three selected newly emerging application areas of kinetic theories are kinetic modelling in biology, coupled fluid-particle models, and PDE Models for quantum fluids. Several workshops will take place during the program.

Information: http://www.newton.ac.uk/programmes/KIT/
ws.html.

20-25 Third International Conference on Boundary Value Problems, Integral Equations and Related Problems, Beijing and Baoding, Hebei, China. (Aug. 2009, p. 864)

Topics: The conference will be about the following six subjects: 1) Various boundary value problems for partial differential equations and functional equations; 2) The theory and methods of integral equations and integral operators including singular integral equations; 3) Applications of boundary value problems and integral equations to mechanics and physics; 4) Numerical methods of integral equations and boundary value problems; 5) Theory and methods for inverse problems of mathematical physics; 6) Clifford analysis and some related problems with above subjects.

Information: More detailed information can be found at http:// www.math.pku.edu.cn/3inter.conf-bvp.ie.rps or please contact G. C. Wen, School of Math. Sci., Peking Univ., Beijing 100871, China; tel:008610-62755937; fax: 008610-62751801; email: wengc@ pku.edu.cn or wengc@math.pku.edu.cn.

23-27 **International Workshop on Geodesics**, Chern Institute of Mathematics, Nankai University, Tianjin, China. (Jun./Jul. 2009, p. 771) **Description:** This joint workshop of the American Institute of Mathematics (AIM) and the Chern Institute of Mathematics (CIM), sponsored by AIM, CIM, and the NSF, will be devoted to the study of the behavior of geodesics in the large. Although this is an old subject, with important contributions first made by J. Hadamard and H. Poincare, many of the fundamental problems are still open.

Information: http://aimath.org/ARCC/workshops/
geodesics.html.

31-September 4 **Permanents and modeling probability distributions**, American Institute of Mathematics, Palo Alto, California. (Jun./ Jul. 2009, p. 771)

Description: This workshop, sponsored by AIM and the NSF, will study the problem of estimating a probability distribution from a small data sample it generates. The workshop will investigate consolidating a theoretical and algorithmic framework for this topic.

Information: http://aimath.org/ARCC/workshops/
permanents.html.

The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.

October 2010

* 2-3 AMS Eastern Section Meeting, Syracuse University, Syracuse, New York.

Information:http://www.ams.org/amsmtgs/sectional.html.

* 9–10 **AMS Western Section Meeting**, University of California, Los Angeles, California.

Information: http://www.ams.org/amsmtgs/sectional.html.

26–29 **SIAM Conference on Applied Linear Algebra (LA09)**, Embassy Suites Hotel, Monterey Bay-Seaside, California.

Description: Linear algebra is an important area of mathematics and it is at the heart of many scientific, engineering, and industrial applications. Research and development in linear algebra include theoretical studies, algorithmic designs and implementations on advanced computer architectures, and applications to various disciplines. The SIAM Conferences on Applied Linear Algebra, organized by SIAM every three years, are the premier international conferences on applied linear algebra, which bring together diverse researchers and practitioners from academia, research laboratories, and industries all over the world to present and discuss their latest work and results on applied linear algebra.

Information: http://www.siam.org/meetings/la09/.

* 29–31 **AMS Central Section Meeting**, Notre Dame University, Notre Dame, Indiana.

Information: http://www.ams.org/amsmtgs/sectional.html.

November 2010

* 6–7 AMS Southeastern Section Meeting, University of Richmond, Richmond, Virginia.

Information: http://www.ams.org/amsmtgs/sectional.html.

December 2010

25-27 **International Conference on Current trends in Mathematics**, Allahabad, Uttar Pradesh, India. (May 2009, p. 659)

Description: The aim of the conference is to introduce undergraduate and Ph.D. students in mathematics as well as post-doctoral researchers in recently emerged trends of mathematics.

Deadline: For submitting abstracts with full-length paper to complexgeometry18@yahoo.com: October 20, 2010. Acknowledgement of accepted papers by email: October 25, 2010. For registration: November 15, 2010. All submitted papers will be under peer review and accepted papers will be published in the conference proceeding. **Information:** Contact: complexgeometry18@yahoo.com.

January 2011

10–May 20 **MSRI Future Scientific Programs: Arithmetic Statistics**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864)

Information: http://www.msri.org.

10-May 20 **MSRI Future Scientific Programs: Free Boundary Problems, Theory and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864) **Information:** http://www.msri.org.

New Publications Offered by the AMS

To subscribe to email notification of new AMS publications, please go to http://www.ams.org/bookstore-email.

Algebra and Algebraic Geometry



Tropical and Idempotent Mathematics

G. L. Litvinov, *Independent University of Moscow, Russia*, and **S. N. Sergeev**, *University of Birmingham, United Kingdom*, Editors

This volume is a collection of papers from the International Conference on Tropical and Idempotent Mathematics, held in Moscow, Russia in August 2007. This is a relatively new branch of mathematical sciences that has been rapidly developing and gaining popularity over the last decade.

Tropical mathematics can be viewed as a result of the Maslov dequantization applied to "traditional" mathematics over fields. Importantly, applications in econophysics and statistical mechanics lead to an explanation of the nature of financial crises. Another original application provides an analysis of instabilities in electrical power networks.

Idempotent analysis, tropical algebra, and tropical geometry are the building blocks of the subject. Contributions to idempotent analysis are focused on the Hamilton-Jacobi semigroup, the max-plus finite element method, and on the representations of eigenfunctions of idempotent linear operators. Tropical algebras, consisting of plurisubharmonic functions and their germs, are examined. The volume also contains important surveys and research papers on tropical linear algebra and tropical convex geometry.

This item will also be of interest to those working in applications.

Contents: M. Akian, S. Gaubert, and **A. Guterman**, Linear independence over tropical semirings and beyond; **M. Akian**, **S. Gaubert**, and **V. Kolokoltsov**, The optimal assignment problem for a countable state space; **D. Alessandrini**, Dequantization of real convex projective manifolds; **M. Ansola** and **M. J. de la Puente**, Tropical conics for the layman; **A. Avantaggiati** and **P. Loreti**, Idempotent aspects of Hopf-Lax type formulas; **P. Butkovič** and **K. P. Tam**, On some properties of the image set of a max-linear mapping; **V. I. Danilov**, **A. V. Karzanov**, and **G. A. Koshevoy**, Tropical Plücker functions and their bases; N. Farhi, A class of periodic minplus homogeneous dynamical systems; Z. Izhakian, Basics of linear algebra over the extended tropical semiring; M. Joswig, Tropical convex hull computations; B. K. Kirshtein, Complex roots of systems of tropical equations and stability of electrical power networks; V. Maslov, Dequantization, statistical mechanics and econophysics; D. McCaffrey, Graph selectors and the max-plus finite element method; W. M. McEneaney, Complexity reduction, cornices and pruning; A. Rashkovskii, Tropical analysis of plurisubharmonic singularities; S. Sergeev, Multiorder, Kleene stars and cyclic projectors in the geometry of max cones; G. B. Shpiz and G. L. Litvinov, A tropical version of the Schauder fixed point theorem; E. Wagneur, L. Truffet, F. Faye, and M. Thiam, Tropical cones defined by max-linear inequalities; C. Walsh, Minimal representing measures in idempotent analysis.

Contemporary Mathematics, Volume 495

October 2009, 382 pages, Softcover, ISBN: 978-0-8218-4782-4, LC 2009011257, 2000 *Mathematics Subject Classification*: 06-06, 06F07, 14A99, 15-06, 16Y60, 46N99, 46T99, 49L99, 81P05, 91B70, **AMS members US\$84**, List US\$105, Order code CONM/495

Applications



Imaging Microstructures

Mathematical and Computational Challenges

Habib Ammari, Ecole Polytechnique, Palaiseau, France, and Hyeonbae Kang, Inha University, Incheon, Korea, Editors

This book contains the proceedings of the research conference, "Imaging Microstructures: Mathematical and Computational Challenges", held at the Institut Henri Poincaré, on June 18–20, 2008.

The problems that appear in imaging microstructures pose significant challenges to our community. The methods involved come from a wide range of areas of pure and applied mathematics. The main purpose of this volume is to review the state-of the-art developments from analytic, numerical, and physics perspectives.

Contents: D. Holcman, Diffusion in cellular microdomains: application to synapses; G. Bao and Y. Sun, Modeling and computation of the scattering by a nano optical medium; Y. Otani and N. Nishimura, Behaviour of periodic fast multipole boundary integral equation method for Maxwell's equations near Wood's anomalies; R. Griesmaier and M. Hanke, An asymptotic factorization method for inverse electromagnetic scattering in layered media II: a numerical study; D. Volkov, Faults in elastic half space: direct and inverse problem; E. Bonnetier and F. Triki, Asymptotics in the presence of inclusions of small volume for a conduction equation: a case with a non-smooth reference potential; K. Kilgore, S. Moskow, and J. C. Schotland, Inverse Born series for diffuse waves; V. Isakov, On identification of doping profile in semiconductors; W. Lionheart and V. Sharafutdinov, Reconstruction algorithm for the linearized polarization tomography problem with incomplete data; R. G. Novikov, An effectivization of the global reconstruction in the Gel'fand-Calderón inverse problem in three dimensions; G. Dassios and J. C.-E. Sten, The image system and Green's function for the ellipsoid.

Contemporary Mathematics, Volume 494

October 2009, 195 pages, Softcover, ISBN: 978-0-8218-4745-9, LC 2009009824, 2000 *Mathematics Subject Classification*: 34A55, 35R30, 35A20, 35B40, 44A12, 78M05, 78M25, 78A45, **AMS members US\$55**, List US\$69, Order code CONM/494



The Shortest Path Problem

Ninth DIMACS Implementation Challenge

 Andrew V. Goldbson

 David S. Johnson

 David S. Johnson

 Litors

 Camil Demetrescu, Sapienza

 Universitá di Roma, Rome,

 Italy, Andrew V. Goldberg,

 Microsoft Research - Silicon

 Valley, Mountain View, CA, and David S. Johnson,

AT&T Labs - Research, Florham Park, NJ, Editors

Shortest path problems are among the most fundamental combinatorial optimization problems with many applications, both direct and as subroutines. They arise naturally in a remarkable number of real-world settings. A limited list includes transportation planning, network optimization, packet routing, image segmentation, speech recognition, document formatting, robotics, compilers, traffic information systems, and dataflow analysis. Shortest path algorithms have been studied since the 1950's and still remain an active area of research.

This volume reports on the research carried out by participants during the Ninth DIMACS Implementation Challenge, which led to several improvements of the state of the art in shortest path algorithms. The infrastructure developed during the Challenge facilitated further research in the area, leading to substantial follow-up work as well as to better and more uniform experimental standards. The results of the Challenge included new cutting-edge techniques for emerging applications such as GPS navigation systems, providing experimental evidence of the most effective algorithms in several real-world settings. *This item will also be of interest to those working in discrete mathematics and combinatorics.*

Co-published with the Center for Discrete Mathematics and Theoretical Computer Science beginning with Volume 8. Volumes 1–7 were co-published with the Association for Computer Machinery (ACM).

Contents: I. L. Santos. Real-world applications of shortest path algorithms; U. Lauther, An experimental evaluation of point-to-point shortest path calculation on road networks with precalculated edge-flags; M. Hilger, E. Köhler, R. H. Möhring, and H. Schilling, Fast point-to-point shortest path computations with arc-flags; D. Delling, M. Holzer, K. Müller, F. Schulz, and D. Wagner, High-performance multi-level routing; A. V. Goldberg, H. Kaplan, and R. F. Werneck, Reach for A*: shortest path algorithms with preprocessing; D. Delling, P. Sanders, D. Schultes, and D. Wagner, Highway hierarchies star; H. Bast, S. Funke, and D. Matijevic, Ultrafast shortest-path queries via transit nodes; P. Sanders and D. Schultes, Robust, almost constant time shortest-path queries in road networks; N. Edmonds, A. Breuer, D. Gregor, and A. Lumsdaine, Single-source shortest paths with the parallel boost graph library; K. Madduri, D. A. Bader, J. W. Berry, and J. R. Crobak, Parallel shortest path algorithms for solving large-scale instances; D. Ajwani, U. Meyer, and V. Osipov, Breadth first search on massive graphs; C. L. Barrett, K. Bisset, M. Holzer, G. Konjevod, M. V. Marathe, and D. Wagner, Engineering label-constrained shortest-path algorithms; C. Demetrescu, A. V. Goldberg, and D. S. Johnson, Bibliography.

DIMACS: Series in Discrete Mathematics and Theoretical Computer Science, Volume 74

August 2009, 319 pages, Hardcover, ISBN: 978-0-8218-4383-3, LC 2009012805, 2000 *Mathematics Subject Classification*: 05C90, 05C12, 05C38, 05C85, 68-06, 68W05, 68W40, 90B20, 90B18, **AMS members US\$83**, List US\$104, Order code DIMACS/74



Models of Conflict and Cooperation

Rick Gillman, Valparaiso University, IN, and David Housman, Goshen College, IN

Models of Conflict and Cooperation is a comprehensive, introductory, game theory text for general undergraduate students. As a textbook, it provides a new and distinctive experience for students

working to become quantitatively literate. Each chapter begins with a "dialogue" that models quantitative discourse while previewing the topics presented in the rest of the chapter. Subsequent sections develop the key ideas starting with basic models and ending with deep concepts and results. Throughout all of the sections, attention is given to promoting student engagement with the material through relevant models, recommended activities, and exercises. The general game models that are discussed include deterministic, strategic, sequential, bargaining, coalition, and fair division games. A separate, essential chapter discusses player preferences. All of the chapters are designed to strengthen the fundamental mathematical skills of quantitative literacy: logical reasoning, basic algebra and probability skills, geometric reasoning, and problem solving. A distinctive feature of this book is its emphasis on the process of mathematical modeling.

This item will also be of interest to those working in probability.

Contents: Deterministic games; Player preferences; Strategic games; Probabilistic strategies; Strategic game cooperation; Negotiation and arbitration; Coalition games; Fair division; Epilogue; Answers to selected exercises; Bibliography; Index.

October 2009, approximately 419 pages, Hardcover, ISBN: 978-0-8218-4872-2, LC 2009014906, 2000 *Mathematics Subject Classification:* 00A06, 91-01, 91A10, 91A12, 91A40, 91B08, **AMS members US\$55**, List US\$69, Order code MBK/65

Differential Equations



Nonlinear Dispersive Equations

Existence and Stability of Solitary and Periodic Travelling Wave Solutions

Jaime Angulo Pava, IME-USP, São Paulo, Brazil

This book provides a self-contained presentation of classical and new methods

for studying wave phenomena that are related to the existence and stability of solitary and periodic travelling wave solutions for nonlinear dispersive evolution equations. Simplicity, concrete examples, and applications are emphasized throughout in order to make the material easily accessible. The list of classical nonlinear dispersive equations studied include Korteweg-de Vries, Benjamin-Ono, and Schrödinger equations. Many special Jacobian elliptic functions play a role in these examples.

The author brings the reader to the forefront of knowledge about some aspects of the theory and motivates future developments in this fascinating and rapidly growing field. The book can be used as an instructive study guide as well as a reference by students and mature scientists interested in nonlinear wave phenomena.

This item will also be of interest to those working in mathematical physics.

Contents: *History, basic models, and travelling waves:* Introduction and a brief review of the history; Basic models; Solitary and periodic travelling wave solutions; *Well-posedness and stability definition:* Initial value problem; Definition of stability; *Stability theory:* Orbital stability—the classical method; Grillakis-Shatah-Strauss's stability approach; *The Concentration-Compactness Principle in stability theory:* Existence and stability of solitary waves for the GBO equations; More about the Concentration-Compactness Principle; Instability of solitary wave solutions; *Stability of periodic travelling waves:* Stability of cnoidal waves; *Appendices:* Sobolev spaces and elliptic functions; Operator theory; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 156

October 2009, approximately 258 pages, Hardcover, ISBN: 978-0-8218-4897-5, 2000 *Mathematics Subject Classification:* 76B25, 35Q53, 35Q55, 37K45, 76B15, 45M15; 76B55, 35B10, 34D20, 35A15, 47A10, 47A75, **AMS members US\$63**, List US\$79, Order code SURV/156

Discrete Mathematics and Combinatorics



Inevitable Randomness in Discrete Mathematics

József Beck, Rutgers, The State University of New Jersey, Piscataway, NJ

Mathematics has been called the science of order. The subject is remarkably good for generalizing specific cases to create

abstract theories. However, mathematics has little to say when faced with highly complex systems, where disorder reigns. This disorder can be found in pure mathematical arenas, such as the distribution of primes, the 3n + 1 conjecture, and class field theory.

The purpose of this book is to provide examples—and rigorous proofs—of the complexity law:

(1) discrete systems are either simple or they exhibit advanced pseudorandomness;

(2) a priori probabilities often exist even when there is no intrinsic symmetry.

Part of the difficulty in achieving this purpose is in trying to clarify these vague statements. The examples turn out to be fascinating instances of deep or mysterious results in number theory and combinatorics.

This book considers randomness and complexity. The traditional approach to complexity—computational complexity theory—is to study very general complexity classes, such as P, NP and PSPACE. What Beck does is very different: he studies interesting concrete systems, which can give new insights into the mystery of complexity.

The book is divided into three parts. Part A is mostly an essay on the big picture. Part B is partly new results and partly a survey of real game theory. Part C contains new results about graph games, supporting the main conjecture. To make it accessible to a wide audience, the book is mostly self-contained.

Contents: *Reading the shadows on the wall and formulating a* vaque conjecture: Complex systems; Collecting data: Apparent randomness of digit sequences; Collecting data: More randomness in number theory; Laplace and the principle of insufficient reason; Collecting proofs for the SLG conjecture; More evidence for the SLG conjecture: Exact solutions in real game theory: Ramsey theory and games; Pratice session (I): More on Ramsey games and strategies; Practice session (II): Connectivity games and more strategies; What kind of games?; Exact solutions of games: Understanding via the equiprobability postulate; Equiprobability postulate with constraints (endgame policy); Constraints and threshold clustering; Threshold clustering and a few bold conjectures; New evidence: Games and graphs, the surplus, and the square root law: Yet another simplification: Sparse hypergraphs and the surplus; Is surplus the right concept? (I); Is surplus the right concept? (II); Working with a game-theoretic partition function; An attempt to save the variance; Proof of theorem 1: Combining the variance with an exponential sum; Proof of theoem 2: The upper bound; Conclusion (I): More on theorem 1; Conclusion (II): Beyond the SLG conjecture; Dictionary of phrases and concepts; References.

University Lecture Series, Volume 49

September 2009, approximately 257 pages, Softcover, ISBN: 978-0-8218-4756-5, LC 200901127, 2000 *Mathematics Subject Classification:* 60-02, 05-02, 91A46; 05D40, 11K38, **AMS members US\$47**, List US\$59, Order code ULECT/49

General and Interdisciplinary



Famous Puzzles of Great Mathematicians

Miodrag S. Petković, University of Nis, Serbia

This entertaining book presents a collection of 180 famous mathematical puzzles and intriguing elementary problems that great mathematicians have posed, discussed, and/or solved. The selected problems do not require

advanced mathematics, making this book accessible to a variety of readers.

Mathematical recreations offer a rich playground for both amateur and professional mathematicians. Believing that creative stimuli and aesthetic considerations are closely related, great mathematicians from ancient times to the present have always taken an interest in puzzles and diversions. The goal of this book is to show that famous mathematicians have all communicated brilliant ideas, methodological approaches, and absolute genius in mathematical thoughts by using recreational mathematics as a framework. Concise biographies of many mathematicians mentioned in the text are also included.

The majority of the mathematical problems presented in this book originated in number theory, graph theory, optimization, and probability. Others are based on combinatorial and chess problems, while still others are geometrical and arithmetical puzzles.

This book is intended to be both entertaining as well as an introduction to various intriguing mathematical topics and ideas. Certainly, many stories and famous puzzles can be very useful to prepare classroom lectures, to inspire and amuse students, and to instill affection for mathematics.

Contents: Recreational mathematics; Arithmetics; Number theory; Geometry; Tiling and packing; Physics; Combinatorics; Probability; Graphs; Chess; Miscellany; Appendices A–D; Biographies; Bibliography; Name index.

September 2009, 324 pages, Softcover, ISBN: 978-0-8218-4814-2, 2000 *Mathematics Subject Classification:* 00A08, 97A20, 01A05, 01A70, 05A05, 05C45, 05C90, 11D04, 11D09, 51E10, 51M16, 52C15, 52C22, 97D40, **AMS members US\$29**, List US\$36, Order code MBK/63



Poincaré's Legacies, Part I

pages from year two of a mathematical blog

Terence Tao, University of California, Los Angeles, CA

There are many bits and pieces of folklore in mathematics that are passed down from advisor to student, or from collaborator

to collaborator, but which are too fuzzy and non-rigorous to be discussed in the formal literature. Traditionally, it was a matter of luck and location as to who learned such folklore mathematics. But today, such bits and pieces can be communicated effectively and efficiently via the semiformal medium of research blogging. This book grew from such a blog.

In 2007, Terry Tao began a mathematical blog to cover a variety of topics, ranging from his own research and other recent developments in mathematics, to lecture notes for his classes, to non-technical puzzles and expository articles. The articles from the first year of that blog have already been published by the AMS. The posts from 2008 are being published in two volumes.

This book is Part I of the second-year posts, focusing on ergodic theory, combinatorics, and number theory. Chapter 2 consists of lecture notes from Tao's course on topological dynamics and ergodic theory. By means of various correspondence principles, recurrence theorems about dynamical systems are used to prove some deep theorems in combinatorics and other areas of mathematics. The lectures are as self-contained as possible, focusing more on the "big picture" than on technical details.

In addition to these lectures, a variety of other topics are discussed, ranging from recent developments in additive prime number theory to expository articles on individual mathematical topics such as the law of large numbers and the Lucas–Lehmer test for Mersenne primes. Some selected comments and feedback from blog readers have also been incorporated into the articles.

The book is suitable for graduate students and research mathematicians interested in broad exposure to mathematical topics.

Contents: Expository articles; Ergodic theory; Lectures in additive prime number theory; Bibliography; Index.

August 2009, 293 pages, Softcover, ISBN: 978-0-8218-4883-8, LC 2009009832, 2000 *Mathematics Subject Classification*: 00A99, AMS members US\$31, List US\$39, Order code MBK/66



Poincaré's Legacies, Part II

pages from year two of a mathematical blog

Terence Tao, University of California, Los Angeles, CA

There are many bits and pieces of folklore in mathematics that are passed down from advisor to student, or from collaborator

to collaborator, but which are too fuzzy and non-rigorous to be discussed in the formal literature. Traditionally, it was a matter of

luck and location as to who learned such folklore mathematics. But today, such bits and pieces can be communicated effectively and efficiently via the semiformal medium of research blogging. This book grew from such a blog.

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This book is Part II of the second-year posts, focusing on geometry, topology, and partial differential equations. The major part of the book consists of lecture notes from Tao's course on the Poincaré conjecture and its recent spectacular solution by Perelman. The course incorporates a review of many of the basic concepts and results needed from Riemannian geometry and, to a lesser extent, from parabolic PDE. The aim is to cover in detail the high-level features of the argument, along with selected specific components of that argument, while sketching the remaining elements, with ample references to more complete treatments. The lectures are as self-contained as possible, focusing more on the "big picture" than on technical details.

In addition to these lectures, a variety of other topics are discussed, including expository articles on topics such as gauge theory, the Kakeya needle problem, and the Black–Scholes equation. Some selected comments and feedback from blog readers have also been incorporated into the articles.

The book is suitable for graduate students and research mathematicians interested in broad exposure to mathematical topics.

Contents: Expository articles; The Poincaré conjecture; Bibliography; Index.

September 2009, 292 pages, Softcover, ISBN: 978-0-8218-4885-2, LC 2009009832, 2000 *Mathematics Subject Classification*: 00A99, **AMS members US\$31**, List US\$39, Order code MBK/67



Mathematics and Music

David Wright, *Washington University, St. Louis, MO*

Many people intuitively sense that there is a connection between mathematics and music. If nothing else, both involve counting. There is, of course, much more to the association. David Wright's book is an investigation of the interrelationships

between mathematics and music, reviewing the needed background concepts in each subject as they are encountered. Along the way, readers will augment their understanding of both mathematics and music.

The text explores the common foundations of the two subjects, which are developed side by side. Musical and mathematical notions are brought together, such as scales and modular arithmetic, intervals and logarithms, tone and trigonometry, and timbre and harmonic analysis. When possible, discussions of musical and mathematical notions are directly interwoven. Occasionally the discourse dwells for a while on one subject and not the other, but eventually the connection is established, making this an integrative treatment of the two subjects.

The book is a text for a freshman level college course suitable for musically inclined or mathematically inclined students, with the intent of breaking down any apprehension that either group might have for the other subject. Exercises are given at the end of each chapter. The mathematical prerequisites are a high-school level familiarity with algebra, trigonometry, functions, and graphs. Musically, the student should have had some exposure to musical staffs, standard clefs, and key signatures, though all of these are explained in the text.

This item will also be of interest to those working in applications.

Contents: Basic mathematical and musical concepts; Horizontal structure; Harmony and related numerology; Ratios and musical intervals; Logarithms and musical intervals; Chromatic scales; Octave identification and modular arithmetic; Algebraic properties of the integers; The integers as intervals; Timbre and periodic functions; The rational numbers as musical intervals; Tuning the scale to obtain rational intervals; Bibliography; Index.

Mathematical World, Volume 28

September 2009, 161 pages, Softcover, ISBN: 978-0-8218-4873-9, LC 2009014813, 2000 *Mathematics Subject Classification*: 00-01, 00A06, **AMS members US\$28**, List US\$35, Order code MAWRLD/28

Geometry and Topology



New Perspectives and Challenges in Symplectic Field Theory

Miguel Abreu, Instituto Superior Técnico, Lisbon, Portugal, François Lalonde, Université de Montréal, QC, Canada, and Leonid Polterovich, Tel Aviv University, Israel, Editors

This volume, in honor of Yakov Eliashberg, gives a panorama of some of the most fascinating recent developments in symplectic, contact and gauge theories. It contains research papers aimed at experts, as well as a series of skillfully written surveys accessible for a broad geometrically oriented readership from the graduate level onwards. This collection will serve as an enduring source of information and ideas for those who want to enter this exciting area as well as for experts.

Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: P. Biran and **O. Cornea**, A Lagrangian quantum homology; **F. Bourgeois**, A survey of contact homology; **Y. Chekanov**, **O. van Koert**, and **F. Schlenk**, Minimal atlases of closed contact manifolds; **K. Cieliebak** and **J. Latschev**, The role of string topology in symplectic field theory; **R. L. Cohen** and **M. Schwarz**, A Morse theoretic description of string topology; **T. Ekholm**, A version of rational SFT for exact Lagrangian cobordisms in 1-jet spaces; **K. Fukaya**, **Y.-G. Oh**, **H. Ohta**, and **K. Ono**, Canonical models of filtered A_{∞} -algebras and Morse complexes; **R. E. Gompf**, Constructing Stein manifolds after Eliashberg; **S. Hohloch**, **G. Noetzel**, and **D. A. Salamon**, Floer homology groups in hyperkähler geometry; **M. Hutchings**, The embedded contact homology index revisited; **F. Laudenbach**, Positive Legendrian regular homotopies; **T.-J. Li** and **Y. Ruan**, Symplectic birational geometry; **R. Lipshitz**, Heegaard Floer homology, double points and nice diagrams.

CRM Proceedings & Lecture Notes, Volume 49

September 2009, approximately 345 pages, Softcover, ISBN: 978-0-8218-4356-7, LC 2009022007, 2000 *Mathematics Subject Classification:* 53D40, 53D45, 53D05, 53D10, 53D12, 53D35; 37J05, 58J05, 58J20, 34C25, **AMS members US\$92**, List US\$115, Order code CRMP/49



Manifolds and Differential Geometry

Jeffrey Lee, Texas Tech University, Lubbock, TX

Differential geometry began as the study of curves and surfaces using the methods of calculus. In time, the notions of curve and surface were generalized along with associated notions such as length, volume, and curvature. At the same time the topic

has become closely allied with developments in topology. The basic object is a smooth manifold, to which some extra structure has been attached, such as a Riemannian metric, a symplectic form, a distinguished group of symmetries, or a connection on the tangent bundle.

This book is a graduate-level introduction to the tools and structures of modern differential geometry. Included are the topics usually found in a course on differentiable manifolds, such as vector bundles, tensors, differential forms, de Rham cohomology, the Frobenius theorem and basic Lie group theory. The book also contains material on the general theory of connections on vector bundles and an in-depth chapter on semi-Riemannian geometry that covers basic material about Riemannian manifolds and Lorentz manifolds. An unusual feature of the book is the inclusion of an early chapter on the differential geometry of hypersurfaces in Euclidean space. There is also a section that derives the exterior calculus version of Maxwell's equations.

The first chapters of the book are suitable for a one-semester course on manifolds. There is more than enough material for a year-long course on manifolds and geometry.

Contents: Differentiable manifolds; The tangent structure; Immersion and submersion; Curves and hypersurfaces in Euclidean space; Lie groups; Fiber bundles; Tensors; Differential forms; Integration and Stokes' theorem; De Rham cohomology; Distributions and Frobenius' theorem; Connections and covariant derivatives; Riemannian and semi-Riemannian geometry; The language of category theory; Topology; Some calculus theorems; Modules and multilinearity; Bibliography; Index.

Graduate Studies in Mathematics, Volume 107

November 2009, approximately 675 pages, Hardcover, ISBN: 978-0-8218-4815-9, LC 2009012421, 2000 *Mathematics Subject Classification:* 58A05, 58A10, 53C05, 22E15, 53C20, 53B30, 55R10, 53Z05, **AMS members US\$71**, List US\$89, Order code GSM/107



Collected Papers of John Milnor

IV. Homotopy, Homology and Manifolds

John McCleary, Vassar College, Poughkeepsie, NY, Editor

The development of algebraic topology in the 1950's and 1960's was deeply influenced by the work of Milnor. In this

collection of papers the reader finds those original papers and some previously unpublished works. The book is divided into four parts: Homotopy Theory, Homology and Cohomology, Manifolds, and Expository Papers. Introductions to each part provide some historical context and subsequent development. Of particular interest are the articles on classifying spaces, the Steenrod algebra, the introductory notes on foliations and the surveys of work on the Poincaré conjecture.

Together with the previously published volumes I-III of the Collected Works by John Milnor, volume IV provides a rich portion of the most important developments in geometry and topology from those decades.

This volume is highly recommended to a broad mathematical audience, and, in particular, to young mathematicians who will certainly benefit from their acquaintance with Milnor's mode of thinking and writing.

Contents: Part 1: Homotopy theory: Introduction to Part 1: homotopy theory; Construction of universal bundles, I; Construction of universal bundles, II; The geometric realization of a semi-simplicial complex; On spaces having the homotopy type of a CW-complex; On the construction of FK; Part 2: Cohomology and homology: Introduction to Part 2: cohomolgy and homology; The Steenrod algebra and its dual; On the Steenrod homology theory; On axiomatic homology theory; (with M. G. Barratt), An example of anomalous singular homology; (with G. Lusztig and F. P. Peterson), Semi-characteristics and cobordism; On the homology of Lie groups made discrete; Part 3: Manifolds: Introduction to Part 3: Manifolds; On the immersion of *n*-manifolds in (n+1)-space; On simply connected 4-manifolds; (with M. Kervaire), On 2-spheres in 4-manifolds; (with E. Spanier), Two remarks on fiber homotopy type; Microbundles and differentiable structures; Topological manifolds and smooth manifolds; Microbundles. I; On characteristic classes for spherical fibre spaces; *Part 4: Expository papers:* Introduction to Part 4: Expository papers; The work of J. H. C. Whitehead; Foliations and foliated vector bundles; The work of M. H. Freedman; Towards the Poincaré conjecture and the classification of 3-manifolds; The Poincaré conjecture one hundred years later; Fifty years ago: topology of manifolds in the 50's and 60's; Bibliography; Index.

Collected Works, Volume 19

October 2009, approximately 357 pages, Hardcover, ISBN: 978-0-8218-4475-5, 2000 *Mathematics Subject Classification:* 55-XX, 57-XX, **AMS members US\$63**, List US\$79, Order code CWORKS/19.4

Logic and Foundations



Categoricity

John T. Baldwin, University of Illinois at Chicago, IL

Modern model theory began with Morley's categoricity theorem: A countable first-order theory that has a unique (up to isomorphism) model in one uncountable cardinal (i.e., is categorical in cardinality) if and only if the same holds in all uncountable cardinals. Over the last 35 years Shelah made great strides in

extending this result to infinitary logic, where the basic tool of compactness fails. He invented the notion of an Abstract Elementary Class to give a unifying semantic account of theories in first-order, infinitary logic and with some generalized quantifiers. Zilber developed similar techniques of infinitary model theory to study complex exponentiation.

This book provides the first unified and systematic exposition of this work. The many examples stretch from pure model theory to module theory and covers of Abelian varieties. Assuming only a first course in model theory, the book expounds eventual categoricity results (for classes with amalgamation) and categoricity in excellent classes. Such crucial tools as Ehrenfeucht–Mostowski models, Galois types, tameness, omitting-types theorems, multi-dimensional amalgamation, atomic types, good sets, weak diamonds, and excellent classes are developed completely and methodically. The (occasional) reliance on extensions of basic set theory is clearly laid out. The book concludes with a set of open problems.

Contents: Part 1. Quasiminimal excellence and complex exponentiation: Combinatorial geometries and infinitary logics; Abstract quasiminimality; Covers of the multiplicative group of C; Part 2. Abstract elementary classes: Abstract elementary classes; Two basic results about $L_{\omega_1,\omega}(Q)$; Categoricity implies completeness; A model in N2; Part 3. Abstract elementary classes with arbitrarily large models: Galois types, saturation, and stability; Brimful models; Special, limit and saturated models; Locality and tameness; Splitting and minimality; Upward categoricity transfer; Omitting types and downward categoricity; Unions of saturated models; Life without amalgamation; Amalgamation and few models; Part 4. Categoricity in $L_{\omega_1,\omega}$: Atomic AEC; Independence in ω -stable classes; Good systems; Excellence goes up; Very few models implies excellence; Very few models implies amalgamation over pairs; Excellence and *-excellence; Quasiminimal sets and categoricity transfer; Demystifying non-excellence; Appendix A. Morley's omitting types theorem; Appendix B. Omitting types in uncountable models; Appendix C. Weak diamonds; Appendix D. Problems; Bibliography; Index.

University Lecture Series, Volume 50

August 2009, 235 pages, Softcover, ISBN: 978-0-8218-4893-7, LC 2009018740, 2000 *Mathematics Subject Classification:* 03C30, 03C45, 03C52, 03C60, 03C75, 03C95, 03C98, **AMS members US\$44**, List US\$55, Order code ULECT/50

Number Theory



Those Fascinating Numbers

Jean-Marie De Koninck, *Université Laval, Quebec, QC, Canada* Translated by Jean-Marie De Koninck

Who would have thought that listing the positive integers along with their most remarkable properties could end up being

such an engaging and stimulating adventure? The author uses this approach to explore elementary and advanced topics in classical number theory. A large variety of numbers are contemplated: Fermat numbers, Mersenne primes, powerful numbers, sublime numbers, Wieferich primes, insolite numbers, Sastry numbers, voracious numbers, to name only a few. The author also presents short proofs of miscellaneous results and constantly challenges the reader with a variety of old and new number theory conjectures.

This book becomes a platform for exploring new concepts such as the index of composition and the index of isolation of an integer. In addition, the book displays several tables of particular families of numbers, including the list of all 88 narcissistic numbers and the list of the eight known numbers which are not prime powers but which can be written as the sum of the cubes of their prime factors, and in each case with the algorithm used to create them.

Contents: Those fascinating numbers; Appendix: The prime numbers < 10000; Bibliography; Index.

August 2009, 426 pages, Softcover, ISBN: 978-0-8218-4807-4, LC 2009012806, 2000 *Mathematics Subject Classification:* 11-00, 11A05, 11A25, 11A41, 11A51, 11K65, 11N05, 11N25, 11N37, 11N56, **AMS members US\$39**, List US\$49, Order code MBK/64

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Recent Developments in Algebra and Related Areas

Chongying Dong, *University of California, Santa Cruz, CA*, and **Fu-an Li**, *Chinese Academy of Sciences, Beijing, China*, Editors

This volume contains fifteen articles presented at the International Conference on Algebra and Related Areas held at

Tsinghua University, Beijing, in August 2007. Some are surveys and others are research papers on topics including algebraic geometry, combinatorics, coding theory, Lie algebras, representation theory of finite groups and algebraic groups, and vertex operator algebras, with their applications. This volume is intended for researchers and graduate students in algebra and related areas.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: Eiichi and Etsuko Bannai, Spherical designs and Euclidean designs; Y. Chen, Minimal representation degree of affine Kac-Moody groups; H. Chu, S.-J. Hu, and M.-C. Kang, A rationality problem of certain A₄ action; Z. Dai, K. Wang, and D. Ye, Characterization of multi-continued fractions for multi-formal Laurent series: Y. Fang and Z. Lin. Eulerian trails and Hamiltonian paths in digraphs with anti-involutions; R. Feng and H. Wu, Efficient pairing computation on curves; W. Guo, Some ideas and results in group theory; T. Huang, L. Huang, and M.-I. Lin, On a class of strongly regular designs and quasi-semisymmetric designs; H. Li, **F**-leading homogeneous algebras and Gröbner bases; J. Liu and K. Zhao, Automorphism groups of Lie algebras from quantum tori; Y. Su, Quasifinite representations of some Lie algebras related to the Virasoro algebra; G. Szeto and L. Xue, On Galois extensions with an inner Galois group; N. Xi, Representations of algebraic groups: Some basics and progresses; J. Zhang and Z. Zhang, Broué's conjecture for finite groups with abelian Sylow p-subgroups; S. Zhou and D. Lin, An interesting member ID-based group signature; Curriculum vitae and publications of Zhexian Wan.

International Press

February 2009, 317 pages, Softcover, ISBN: 978-1-57146-135-3, 2000 *Mathematics Subject Classification:* 03-XX, **AMS members US\$46**, List US\$58, Order code INPR/79

Analysis



Variational Principles for Discrete Surfaces

Junfel Dai, Zhejiang University, China, Xianfeng David Gu, SUNY at Stony Brook, NY, and Feng Luo, Rutgers University, New Brunswick, NJ, Editors

This volume introduces readers to some of the current topics of research in the geometry of polyhedral surfaces, with

applications to computer graphics. The main feature of the volume is a systematic introduction to the geometry of polyhedral surfaces based on the variational principle. The authors focus on using analytic methods in the study of some of the fundamental results and problems of polyhedral geometry: for instance, the Cauchy rigidity theorem, Thurston's circle packing theorem, rigidity of circle packing theorems, and Colin de Verdiere's variational principle. This book is the first complete treatment of the vast, and expansively developed, field of polyhedral geometry.

This item will also be of interest to those working in geometry and topology.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: Introduction; Spherical geometry and Cauchy rigidity theorem; A brief introduction to hyperbolic geometry; The cosine law and polyhedral surfaces; Spherical polyhedral surfaces and Legendre transformation; Rigidity of Euclidean polyhedral surfaces; Polyhedral surfaces of circle packing type; Non-negative curvature metrics and Delaunay polytopes; A brief introduction to Teichmüller space; Parameterizations of Teichmüller spaces; Surface Ricci flow; Geometric structure; Shape acquisition and representation; Discrete Ricci flow; Hyperbolic Ricci flow; Reference; Index.

International Press

August 2008, 146 pages, Hardcover, ISBN: 978-1-57146-172-8, 2000 *Mathematics Subject Classification:* 52C99, **AMS members US\$34**, List US\$42, Order code INPR/77



Handbook of Geometric Analysis

Number 1

Lizhen Ji, University of Michigan, Ann Arbor, MI, Peter Li, University of California, Irvine, CA, and Richard Schoen and Leon Simon, Stanford University, CA, Editors

This handbook of geometric analysis—the first of two to be published in the Advanced Lectures in Mathematics series—presents introductions and survey papers treating important topics in geometric analysis, with their applications to related fields. It can be used as a reference by graduate students and by researchers in related areas.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: R. S. Bunch and S. K. Donaldson, Numerical approximations to extremal metrics on toric surfaces: S. K. Donaldson, Kähler geometry on toric manifolds, and some other manifolds with large symmetry; M. Haskins and N. Kapouleas, Gluing constructions of special Lagrangian cones; J. Jost, Harmonic mappings; P. Li, Harmonic functions on complete Riemannian manifolds; F. H. Lin, Complexity of solutions of partial differential equations; F. Luo, Variational principles on triangulated surfaces; T. Mabuchi, Asymptotic structures in the geometry of stability and extremal metrics; W. H. Meeks III, J. Pérez, and A. Ros, Stable constant mean curvature surfaces; L. Simon, A general asymptotic decay lemma for elliptic problems; L.-F. Tam, Uniformization of open nonnegatively curved Kähler manifolds in higher dimensions; T. Toro, Geometry of measures: Harmonic analysis meets geometric measure theory; M.-T. Wang, Lectures on mean curvature flows in higher codimensions; S. Zelditch, Local and global analysis of eigenfunctions on Riemannian manifolds: K. Zuo. Yau's form of Schwarz lemma and Arakelov inequality on moduli spaces of projective manifolds.

International Press

August 2008, 676 pages, Hardcover, ISBN: 978-1-57146-130-8, 2000 *Mathematics Subject Classification:* 01-02, **AMS members US\$78**, List US\$97, Order code INPR/78



Algebraic Analysis and Around

In Honor of Professor Masaki Kashiwara's 60th Birthday

Tetsuji Miwa, *Kyoto University*, *Japan*, **Atsushi Matsuo**, *University of Tokyo, Japan*, **Toshiki Nakashima**, *Sophia*

University, Tokyo, Japan, and **Yoshihisa Saito**, *University of Tokyo, Japan*, Editors

This volume is the proceedings of the conference "Algebraic Analysis and Around", in honor of Professor Masaki Kashiwara's 60th birthday. The conference was held in Kyoto in June 2007.

Most of the papers are based on talks given at the conference, and the subjects discussed include *D*-modules, micro-local analysis, representation theory, integrable systems, to which Kashiwara's contribution and influence are really profound. The readers may find groundbreaking materials for the future in mathematics.

This item will also be of interest to those working in algebra and algebraic geometry.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: P. Schapira, Masaki Kashiwara and algebraic analysis; **T. Tanisaki**, Masaki Kashiwara and representation theory; **T. Aoki**, **T. Kawai**, and **Y. Takei**, The Bender–Wu analysis and the Voros theory. II; **A. Boysal** and **S. Kumar**, A conjectural presentation of fusion algebras; **B. Feigin**, **E. Feigin**, **M. Jimbo**, **T. Miwa**, and **E. Mukhin**, Principal $\widehat{sl_3}$ subspaces and quantum Toda Hamiltonian; **E. Frenkel** and **D. Gaitsgory**, Local geometric Langlands correspondence: The spherical case; **K. Kato**, **C. Nakayama**, and **S. Usui**, Classifying spaces of degenerating mixed Hodge structures, I: Borel-Serre spaces; **T. Mochizuki**, Good formal structure for meromorphic flat connections on smooth projective surfaces; **P.-E. Paradan** and **M. Vergne**, Quillen's relative Chern character; **C. Sabbah**, Wild twister \mathcal{D} -modules; **M. Saito**, On *b*-function, spectrum and multiplier ideals.

Advanced Studies in Pure Mathematics, Volume 54

February 2009, 379 pages, Hardcover, ISBN: 978-4-931469-51-8, 2000 *Mathematics Subject Classification:* 32C38; 17B67, 17B80, 32S35, **AMS members US\$49**, List US\$61, Order code ASPM/54



Handbook of Teichmüller Theory Volume II

Athanase Papadopoulos, *Université de Strasbourg, France*, Editor

This multi-volume set deals with Teichmüller theory in the broadest sense, namely, as the study of moduli space of

geometric structures on surfaces, with methods inspired or adapted from those of classical Teichmüller theory. The aim is to give a complete panorama of this generalized Teichmüller theory and of its applications in various fields of mathematics. The volumes consist of chapters, each of which is dedicated to a specific topic.

The volume has 19 chapters and is divided into four parts:

- The metric and the analytic theory (uniformization, Weil– Petersson geometry, holomorphic families of Riemann surfaces, infinite-dimensional Teichmüller spaces, cohomology of moduli space, and the intersection theory of moduli space).
- The group theory (quasi-homomorphisms of mapping class groups, measurable rigidity of mapping class groups, applications to Lefschetz fibrations, affine groups of flat surfaces, braid groups, and Artin groups).
- Representation spaces and geometric structures (trace coordinates, invariant theory, complex projective structures, circle packings, and moduli spaces of Lorentz manifolds homeomorphic to the product of a surface with the real line).
- The Grothendieck-Teichmüller theory (dessins d'enfants, Grothendieck's reconstruction principle, and the Teichmüller theory of the solenoid).

This handbook is an essential reference for graduate students and researchers interested in Teichmüller theory and its ramifications, in particular for mathematicians working in topology, geometry, algebraic geometry, dynamical systems and complex analysis.

The authors are leading experts in the field.

This item will also be of interest to those working in geometry and topology.

A publication of the European Mathematical Society. Distributed within the Americas by the American Mathematical Society.

Contents: A. Papadopoulos, Introduction to Teichmüller theory, old and new; *Part A. The metric and the analytic theory, 2:*

S. A. Wolpert, The Weil-Petersson metric geometry; A. Fletcher and V. Markovic, Infinite dimensional Teichmüller spaces; Y. Imayoshi, A construction of holomorphic families of Riemann surfaces over the punctured disk with given monodromy; R. Silhol, The uniformization problem; G. Mondello, Riemann surfaces, ribbon graphs and combinatorial classes; N. Kawazumi, Canonical 2-forms on the moduli space of Riemann surfaces; Part B. The group theory, 2: K. Fujiwara, Quasi-homomorphisms on mapping class groups; M. Korkmaz and A. Stipsicz, Lefschetz fibrations on 4-manifolds; Y. Kida, Introduction to measurable rigidity of mapping class groups; M. Möller, Affine groups of flat surfaces; L. Paris, Braid groups and Artin groups; Part C. *Representation spaces and geometric structures, 1:* **D. Dumas**, Complex projective structures; S. Kojima, Circle packing and Teichmüller space; R. Benedetti and F. Bonsante, (2 + 1) Einstein spacetimes of finite type; W. M. Goldman, Trace coordinates on Fricke spaces of some simple hyperbolic surfaces; S. Lawton and **E. Peterson**, Spin networks and $SL(2, \mathbb{C})$ -character varieties; *Part* D. The Grothendieck-Teichmüller theory: F. Luo, Grothendieck's reconstruction principle and 2-dimensional topology and geometry; F. Herrlich and G. Schmithüsen, Dessins d'enfants and origami curves; D. Šarić, The Teichmüller theory of the solenoid; List of contributors; Index.

IRMA Lectures in Mathematics and Theoretical Physics, Volume 13

March 2009, 883 pages, Hardcover, ISBN: 978-3-03719-055-5, 2000 *Mathematics Subject Classification:* 30-00, 32-00, 32G15, 30F60, **AMS members US\$102**, List US\$128, Order code EMSILMTP/13

General and Interdisciplinary



Current Developments in Mathematics, 2004

Barry Mazur, Wilfried Schmid, and Shing-Tung Yau, Harvard University, Cambridge, MA, and David Jerison, Tomasz Mrowka, and Richard P. Stanley, Massachusetts Institute of

Technology, Cambridge, MA, Editors

The Current Developments in Mathematics (CDM) conference is an annual seminar, jointly hosted by Harvard University and the Massachusetts Institute of Technology, and devoted to surveying the most recent developments in mathematics. In choosing speakers, the hosts take a broad look at the field of geometry and select geometers who transcend classical perceptions within their field. All speakers are prominent specialists in the fields of algebraic geometry, mathematical physics, and other areas. International Press is pleased to present the full contents of these proceedings in the CDM book series.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: H. Hofer, A general Fredholm theory and applications; **L. Caffarelli**, A homogenization method for nonvariational problems; **W. Meeks III**, Applications of minimal surfaces to the topology of three-manifolds; **E. Lindenstrauss**, Adelic dynamics and arithmetic quantum unique ergodicity; **C. Skinner**, Main conjectures and modular forms.

International Press

June 2006, 161 pages, Hardcover, ISBN: 978-1-57146-105-6, 2000 *Mathematics Subject Classification:* 00Bxx, **AMS members US\$55**, List US\$69, Order code INPR/80



Current Developments in Mathematics, 2005

Barry Mazur, Wilfried Schmid, and Shing-Tung Yau, Harvard University, Cambridge, MA, and David Jerison, Tomasz Mrowka, and Richard P. Stanley, Massachusetts Institute of

Technology, Cambridge, MA, Editors

The Current Developments in Mathematics (CDM) conference is an annual seminar, jointly hosted by Harvard University and the Massachusetts Institute of Technology, and devoted to surveying the most recent developments in mathematics. In choosing speakers, the hosts take a broad look at the field of geometry and select geometers who transcend classical perceptions within their field. All speakers are prominent specialists in the fields of algebraic geometry, mathematical physics, and other areas. International Press is pleased to present the full contents of these proceedings in the CDM book series.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: E. D. Hoker and **D. H. Phong**, Complex geometry and supergeometry; **D. Sullivan**, String topology: Background and present state; **E. H. Lieb**, The stability of matter and quantum electrodynamics; **J.-Y. Cai**, Holographic algorithm; **S. DeBacker**, The fundamental lemma: What is it and what do we know?; **P. W. Shor**, The additivity conjecture in quantum information theory; **M. Kisin**, Modularity of 2-dimensional Galois representations.

International Press

January 2008, 230 pages, Hardcover, ISBN: 978-1-57146-166-7, 2000 *Mathematics Subject Classification:* 00Bxx, **AMS members US\$55**, List US\$69, Order code INPR/81

Geometry and Topology



Computational Conformal Geometry

Xianfeng David Gu, SUNY at Stony Brook, NY, and Shing-Tung Yau, Harvard University, Cambridge, MA, Editors

Computational conformal geometry is an emerging inter-disciplinary field, with applications to algebraic topology, differential geometry and Riemann

surface theories applied to geometric modeling, computer graphics, computer vision, medical imaging, visualization, scientific computation, and many other engineering fields.

This volume presents thorough introductions to the theoretical foundations—as well as to the practical algorithms—of computational conformal geometry. These have direct applications to engineering and digital geometric processing, including surface parameterization, surface matching, brain mapping, 3-D face recognition and identification, facial expression and animation, dynamic face tracking, mesh-spline conversion, and more.

This item will also be of interest to those working in applications.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: *Introduction:* Overview of theories; Algorithms for computing conformal mappings; Applications; Further readings; *Part I. Theories:* Homotopy group; Homology and cohomology; Exterior differential calculus; Differential geometry of surfaces; Riemann surface; Harmonic maps and surface Ricci flow; Geometric structure; *Part II. Algorithms:* Topological algorithms; Algorithms for harmonic maps; Harmonic forms and holomorphic forms; Discrete Ricci flow; Appendix A: Major algorithms; Appendix B: Acknowledgement; Reference; Index.

International Press

July 2008, 295 pages, Hardcover, ISBN: 978-1-57146-171-1, 2000 *Mathematics Subject Classification:* 68U05, **AMS members US\$71**, List US\$89, Order code INPR/76

Mathematical Physics



Superstring Theory

Kefeng Liu, University of California, Los Angeles, CA, Shing-Tung Yau, Harvard University, Cambridge, MA, and Chongyuan Zhu, Chinese Academy of Sciences, Beijing, China, Editors

Interest in string theory is driven largely by the hope that it will evolve to be the

ultimate "Theory of Everything". Work on string theory has led to advances in many branches of mathematics. This rapidly developing subject is one of the mainstream topics of mathematics in the 21st century.

This volume presents lectures from the important String Theory International Conference held in 2002 in Hangzhou, China. These include talks given by several mathematicians of particular prominence in the field, among them Stephen Hawking and Edward Witten.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: S. Hawking, Brane new world; E. Witten, Gauge theory and gravity; E. Witten, Easing into OFT; A. Strominger, Open string creation by S-brane; S. Ferrara, Duality, gauging and superHiggs effect in string and M-theory; T. Eguchi and K. Sakai, Seiberg-Witten curve for the E-string theory; L. Dolan and C. R. Nappi, Strings and noncommutativity; E. D'Hoker and D. H. Phong, Lectures on two-loop superstrings; E. D'Hoker, I. Krichever, and D. H. Phong, Seiberg-Witten theory, symplectic forms, and Hamiltonian theory of solitons; Z.-Z. Xing, Quark mass hierarchy and flavor mixing in orbifold models; S. Gukov, M-theory on manifolds with exceptional holonomy; R. P. Thomas, Stability conditions and the braid group; R.-G. Cai, Some remarks on constant curvature spaces; S. Hosono, Fourier-Mukai partners and mirror symmetry of K3 surfaces; S. Hosono, Counting BPS states via holomorphic anomaly equations; Y.-H. Gao, Symmetries, matrices, and de sitter gravity; M. Li, Correspondence principle in a PP-wave background; B. Wang, Support of dS/CFT correspondence from spacetime perturbations; C.-J. Gao and Y.-G. Shen, Quintessence cosmology in the Brans-Dicke theory; X.-H. Ge and Y.-G. Shen, Entropy in the NUT-Kerr-Newman black holes due to an arbitrary spin field.

International Press

August 2008, 348 pages, Hardcover, ISBN: 978-1-57146-131-5, 2000 *Mathematics Subject Classification:* 83E30, **AMS members US\$36**, List US\$45, Order code INPR/75

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UNIVERSITY OF CALIFORNIA, LOS ANGELES Department of Mathematics Faculty Positions Academic Year 2010-2011

The Department of Mathematics, subject to administrative approval, will consider tenure-track/tenure appointments in a wide range of possible fields with emphasis on applied mathematics. We also plan to make temporary and visiting appointments in the following categories 2–5. Depending on the level, candidates must give evidence of potential or demonstrated distinction in scholarship and teaching.

(1) Tenure Track/Tenured Faculty Positions. Salary is commensurate with level of experience.

(2) E. R. Hedrick Assistant Professorships. Salary is \$61,200 and appointments are for three years. The teaching load is four quarter courses per year.

(3) Computational and Applied Mathematics (CAM) Assistant Professorships. Salary is \$61,200, and appointments are for three years. The teaching load is normally reduced to two or three quarter courses per year by research funding as available.

(4) Program in Computing (PIC) Assistant Adjunct Professorships. Salary is \$65,500. Applicants for these positions must show very strong promise in teaching and research in an area related to computing. The teaching load is four one-quarter programming courses each year and one seminar every two years. Initial appointments are for one year and possibly longer, up to a maximum service of four years.

(5) Assistant Adjunct Professorships and Research Postdocs. Normally appointments are for one year, with the possibility of renewal. Strong research and teaching background required. The salary range is \$53,200-\$59,500. The teaching load for adjuncts is six quarter courses per year.

If you wish to be considered for any of these positions you must submit an application and supporting documentation electronically via http://www.mathjobs. org.

For fullest consideration, all application materials should be submitted on or before December 9, 2009. Ph.D. is required for all positions.

UCLA and the Department of Mathematics have a strong commitment to the achievement of excellence in teaching and research and diversity among its faculty and staff. The University of California is an Equal Opportunity/Affirmative Action Employer. The University of California asks that applicants complete the Equal Opportunity Employer survey for

Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

The 2009 rate is \$110 per inch or fraction thereof on a single column (oneinch minimum), calculated from top of headline. Any fractional text of 1/2 inch or more will be charged at the next inch rate. No discounts for multiple ads or the same ad in consecutive issues. For an additional \$10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: October 2009 issue–July 29, 2009; November 2009 issue–August 28, 2009; December 2009

issue-September 28, 2009; January 2010 issue-October 28, 2009; February 2010 issue-November 25, 2009; March 2010 issue-December 28, 2009.

U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the U.S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U.S. laws. Details and specific wording may be found on page 1041 (vol. 55).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to classads@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 20904. Advertisers will be billed upon publication.

Letters and Science at the following URL: http://cis.ucla.edu/ facultysurvey. Under Federal law, the University of California may employ only individuals who are legally authorized to work in the United States as established by providing documents specified in the Immigration Reform and Control Act of 1986.

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KENTUCKY

WESTERN KENTUCKY UNIVERSITY **Department of Mathematics and Computer Science**

The Department of Mathematics and Computer Science at Western Kentucky University invites applications for 4 tenure-track positions. Three of these Assistant Professor positions will begin January 1, 2010. The fourth Assistant Professor position will begin August 15, 2010. Candidates must have a Ph.D. in mathematics or related area. Preference will be given to those who have at least 3 years primary teaching experience at the university level and postdoctoral experience. Candidates must have grant writing experience and a collaborative research record closely related to research areas currently existing in the department.

Western Kentucky University (WKU) is located in Bowling Green, KY, and is a research institution with over 20,000 students. WKU is conveniently located just 50 miles from the metro Nashville, TN, area. Western Kentucky University is committed to the promotion of stewardship and student engagement.

The application materials required for each position include an AMS coversheet, letter of application, vita, 3 letters of recommendation, and a research statement.

One position is in the areas of Graph Theory, Extremal Combinatorics, Probabilistic Methods and Theoretical Computer Science. This position will begin January 1, 2010. Application materials are to be sent to: Dr. Claus Ernst, Search Committee Chair, Department of Mathematics and Computer Science, Western Kentucky University, 1906 College Heights Blvd. #11078, Bowling Green, KY 42101-1078.

One position is in the area of Combinatorics and Graph Theory. Candidates with interest in convex sets. finite geometries and their applications, and related computational problems are particularly welcomed. This position will begin January 1, 2010. Application materials are to be sent to: Dr. David Erbach. Search Committee Chair, Department of Mathematics and Computer Science, Western Kentucky University, 1906 College Heights Blvd. #11076, Bowling Green, KY 42101-1076.

One position is in the area of Statistics. This position will begin January 1, 2010. Candidates must hold a Ph.D. in statistics by the time of appointment. Candidates must have experience in data mining, statistical computing, bioinformatics, and survival analysis. Successful candidates must also have interest in creating new statistics courses and in developing a statistics program. Candidates should exhibit enthusiasm and a strong commitment to teaching at all levels of undergraduate and graduate statistics, directing undergraduate research projects and master's-level theses, and contributing to the department and university service missions. Candidates should also have grant-writing experience, as well as experience in interdisciplinary research. Application materials are to be sent to Dr. David Neal, Search Committee Chair, Department of Mathematics and Computer Science. Western Kentucky University. 1906 College Heights Blvd. #11078, Bowling Green, KY 42101-1078.

A second position in the area of Statistics has the begin date of August 15. 2010. Candidates must hold a Ph.D. in statistics, in mathematics, or in a related discipline by the time of appointment. Candidates whose research area would complement that of current faculty are especially encouraged to apply. Candidates should exhibit enthusiasm and a strong commitment to teaching at all levels of undergraduate and graduate mathematics and statistics, directing undergraduate research projects and master's-level theses, continuing a program of high-quality research, and contributing to the department and university service missions. Successful candidates must also have interest in creating new statistics courses and in developing a statistics program. Application materials are to be sent to Dr. Melanie Autin, Search Committee Chair, Department of Mathematics and Computer Science, Western Kentucky University, 1906 College Heights Blvd. #11078, Bowling Green. KY 42101-1078.

Each committee will begin reviewing applications on September 1, 2009. All qualified individuals are encouraged to apply including women, minorities, persons with disabilities, and disabled veterans. 000037

TEXAS

TEXAS A&M UNIVERSITY Department of Mathematics

The Department of Mathematics anticipates several openings for tenured, tenure-eligible, and visiting faculty positions beginning fall 2010. The field is open, but we particularly seek applications from individuals whose mathematical interests would augment and build upon existing strengths both within the Mathematics Department as well as other departments in the university. Salary, teaching loads and start-up funds are competitive. For a tenured position the applicant should have an outstanding research reputation and would be expected to fill a leadership role in the department. An established research program, including success in attracting external funding and supervision of graduate students, and a demonstrated ability and interest in teaching are required. Informal inquiries are welcome. For an Assistant Professorship, we seek strong research potential and evidence of excellence in teaching. Research productivity beyond the doctoral dissertation will normally be expected. We also have several visiting positions available. Our Visiting Assistant Professor positions are three-year appointments and carry a three course per year teaching load. They are intended for those who have recently received their Ph.D. and preference will be given to mathematicians whose research interests are close to those of our regular faculty members. Senior Visiting Positions may be for a semester or one year period. A complete dossier should be received by December 15, 2009. Early applications are encouraged since the department will start the review process in October 2008.

Applicants should send the completed "AMS Application Cover Sheet", a vita, a summary statement of research and teaching experience, and arrange to have letters of recommendation sent to: Faculty Hiring, Department of Mathematics, Texas A&M University, College Station, Texas 77843-3368. Further information can be obtained from: http://www.math.tamu. edu/hiring.

Texas A&M University is an Equal Opportunity Employer. The University is dedicated to the goal of building a culturally diverse and pluralistic faculty and staff committed to teaching and working in a multicultural environment and strongly encourages applications from women, minorities, individuals with disabilities, and veterans. The University is responsive to the needs of dual career couples.

000039

Mathematical Sciences Employment Center

Moscone West Center, San Francisco, CA January 13–16, 2010

2010 Employment Center Schedule:

November 2, 2009-Suggested deadline for electronic forms submission to allow for advanced scheduling.

December 22, 2009–Advance registration deadline for JMM. Meeting badge will be required for admittance.

After this date, meeting registration fees go up and meeting registration can only happen on site in San Francisco.

OPEN HOURS:

Wednesday, January 13, 2010–8:00 a.m.–7:00 p.m. Do not schedule interviews before 9:00 a.m. on this day.

Thursday, January 14, 2010-8:00 a.m.-7:00 p.m.

Friday, January 15, 2010-8:00 a.m.-7:00 p.m.

Saturday, January 16, 2010-9:00 a.m.-12:00 noon

Note: Computer scheduling is no longer provided at the Employment Center. When deciding on travel dates, keep in mind that employers may wish to conduct interviews during any of the hours listed above.

The Employment Center offers a convenient, safe, and practical meeting place for employers and applicants attending the Joint Meetings. The focus of the Employment Center is on Ph.D.-level mathematical scientists and those that seek to hire them from academia, business, and government.

Employment Center Now Fully Electronic

This year all forms will be submitted and accessed electronically on the Web. In addition, registered attendees will be able to utilize a basic scheduling tool in advance on the Web. The website and all information will be available



beginning in September 2009 and will remain accessible through the period of the Employment Center. The same applicant and job information available on the Employment Center/EIMS website during the months preceding the event in San Francisco will be accessible during the JMM on computer terminals available at the Employment Center.

There will be no printed books or paper forms. Also, there will be no paper message center since the new electronic system allows for interview arrangements. As of 2009, the on-site computer-scheduling program was discontinued. The new electronic system represents a significant enhancement of the Employment Center.

No Admittance Without a JMM Badge

All applicants and employers planning to enter the Employment Center—even just for one interview—must present a 2010 Joint Meeting Registration badge or they will be denied admittance. This is not a new policy, but it will now be strictly enforced. Meeting badges are obtained by registering for the Joint Mathematics Meetings. See the JMM website at: http://www.ams.org/amsmtgs/2124_intro.html for registration instructions and rates.


Employers: Choose a Table

There are two table types available for employers, based on the number of interviewers who will be present at any one time:

• one or two interviewers per table in the "Quiet Area": before 11/2/09 (US\$145), after 11/2/09 (US\$185), additional table (US\$85).

• three to six interviewers per table in the "Committee Table" area: before 11/2/09 (US\$230), after 11/2/09 (US\$270), additional table (US\$135).

In addition to the table fees, appropriate ad fees must be paid at the time the ad is submitted. Please note that the traditional advertising site on the AMS website, EIMS, now also serves as the ad placement site for the Employment Center. An existing EIMS ad can be earmarked for Employment Center use, and the table fee will be paid at that time.

All fees are to be paid at the EIMS ad website; fees are no longer paid through the JMM registration form. However, individual registration for the JMM is required for all interviewers and no admittance is possible without a JMM badge.

Employers: How to Register

Registration begins September 1, 2009, at the following website: http://eims.ams.org.

Use of the EIMS website is through password-accessible accounts, one per employer. Please place your ad and select your table type, paying all fees on the website. Whoever places the ad will want to make careful note of the account access password in case faculty or other personnel need to access the resume review and scheduling features in the months leading up to the Employment Center.

Once registered, employers will gain access to applicant data as it is submitted to the site. There will be applicant resumes on the site, but employers will want to notice especially the resumes marked "Employment Center". Also, employers can review and sort the requests for interviews submitted by applicants on the system. To respond to a request, employers will be able to access the applicant's pre-approved schedule and fill in the desired slot or slots. In this way, employers will build their own schedule, which is also viewable after logging in on the system.

To participate in the interviewing program by using a Table Only (not posting an ad or accessing applicant data) purchase a table ON SITE (fee will be US\$300) in San Francisco at the JMM registration desk. It is not possible to gain access to applicant data without placing an ad. Also, it is not possible to purchase a Table-Only in advance of the meeting, but availability of tables on site is guaranteed in San Francisco. To display an ad on site, and use no Employment Center services at all, submit your one-page paper ad on site to the Employment Center staff. There is no fee for this service.

For complete information, visit http://www.ams.org/
emp-reg/.

Applicants: Making the Decision to Attend

For those who are currently on the job market, the Employment Center is a central meeting place for employers and applicants who are attending the Joint Meetings. After submitting information and a limited number of documents on the Employment Center/EIMS website, applicants will review the jobs ads marked "Employment Center" and, if desirable, mark a box indicating interest. They will also mark hours of availability on their personal schedule screen. Employers may, at any time, respond by filling in an interview slot on the applicant's schedule.

All information is available on the website in advance, and now that this electronic service is in place, there is no other messaging conducted on paper. Computer workstations will be available for brief use on site. The only difference between information available in advance, and what is available on site would be the addition of possible

Employment Center



on-site employer registrations and any last minute scheduling done by employers.

There will ordinarily be no research-oriented postdoctoral positions listed or discussed at the Employment Center. In the current job market, the majority of Employment Center employers are academic departments of mathematical sciences seeking to meet a short list of applicants who applied for their open positions during the fall. Opportunities to meet employers with whom no previous contact was made are becoming quite rare. Each year, a few government or industry employers are present. Often, they are seeking U.S. citizens only due to existing contracts.

If timely registration, following the website instructions, and marking each appropriate employer (thereby seeking interview invitations) does not produce interviews, then there will be little to no opportunity to attract the interest of employers on site. Through the new software the Employment Center intends to become increasingly arranged in advance, predictable, and calm.

Most appointments will go to applicants who applied to jobs during the fall and are now being sought out by the institutions for in-person meetings during the JMM. Applicants should understand that the Employment Center offers no guarantees of interviews or jobs. Hiring decisions are not made during or immediately following such interviews. A good outcome, in the following weeks or months, would be an invitation for a campus visit.

In a recent survey, fifty percent of applicants responding reported being invited for at least one on-campus visit to an employer they had interviewed with at the Employment Center.

Applicants: How to Register

There are no Employment Center fees for applicants; however, admission to the Employment Center room requires a 2010 JMM badge, obtainable by registering (and paying a fee) for the Joint Mathematics Meetings.

Registration is possible beginning September 1, 2009, at http://eims.ams.org and continuing through Day One of the Employment Center in San Francisco. Early registration is vital since most employers will finalize schedules before arriving in San Francisco.

To register for a badge, go to http://www.ams.org/ amsmtgs/2124_intro.html.

It is possible to attend one or more privately arranged interviews without official Employment Center registration, however, a meeting badge is required to access the interview room.

For complete information, visit http://www.ams.org/
emp-reg/.

Questions about the Employment Center registration and participation can be directed to Steve Ferrucci, AMS Membership and Programs Department, at 800-321-4267, ext. 4113, or by email to emp-info@ams.org.

AMERICAN MATHEMATICAL SOCIETY

AMS Sectional Meetings – Fall 2009



Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See http://www.ams.org/meetings/. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL and in an electronic issue of the *Notices* as noted below for each meeting.

Waco, Texas

Baylor University

October 16-18, 2009

Friday – Sunday

Meeting #1051

Central Section

Associate secretary: Susan J. Friedlander Announcement issue of *Notices*: August 2009 Program first available on AMS website: September 3, 2009 Program issue of electronic *Notices*: October 2009 Issue of *Abstracts*: Volume 30, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: August 25, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

David Ben-Zvi, University of Texas at Austin, *Title to be announced*.

Alexander A. Kiselev, University of Wisconsin, *Title to be announced*.

Michael C. Reed, Duke University, *Title to be announced*. Igor Rodnianski, Princeton University, *Title to be announced*.

Special Sessions

Applicable Algebraic Geometry (Code: SS 12A), **Luis David Garcia-Puente**, Sam Houston State University, and **Frank Sotille**, Texas A&M University.

Commutative Algebra: Module and Ideal Theory (Code: SS 4A), Lars W. Christensen, Texas Tech University, Louiza Fouli, University of Texas at Austin, and David Jorgensen, University of Texas at Arlington.

Contemporary Complex and Special Function Theory (Code: SS 14A), **Roger W. Barnard** and **Kent Pearce**, Texas Tech University, **Kendall Richards**, Southwestern University, and **Alexander Solynin** and **Brock Williams**, Texas Tech University.

Dynamic Equations on Time Scales: Analysis and Applications (Code: SS 1A), John M. Davis, Ian A. Gravagne, and Robert J. Marks, Baylor University.

Formations of Singularities in Geometric Flows (Code: SS 15A), **Maria-Cristina Caputo**, University of Texas at Austin, and **Natasa Sesum**, Columbia University.

Fusion Categories and Applications (Code: SS 7A), **Deepak Naidu** and **Eric Rowell**, Texas A&M University.

Global Analysis on Homogeneous Spaces (Code: SS 13A), **Ruth Gornett**, University of Texas at Arlington, and **Ken Richardson**, Texas Christian University.

Harmonic Analysis and Partial Differential Equations (Code: SS 8A), **Susan Friedlander**, University of Southern California, **Natasa Pavlovic**, University of Texas at Austin, and **Nikolaos Tzirakis**, University of Illinois at Urbana-Champaign.

Interdisciplinary Session on Stochastic Partial Differential Equations (Code: SS 11A), **M. Chekroun**, ENS-Paris and University of California Los Angeles, and **Shouhong Wang** and **Nathan Glatt-Holtz**, Indiana University.

Lie Groups, Lie Algebras, and Representations (Code: SS 6A), **Markus Hunziker, Mark Sepanski**, and **Ronald Stanke**, Baylor University.

Mathematical Aspects of Spectral Problems Related to Physics (Code: SS 10A), Klaus Kirsten, Baylor University, Gregory Berkolaiko and Stephen Fulling, Texas A&M University, Jon Harrison, Baylor University, and Peter Kuchment, Texas A&M University.

Mathematical Models of Neuronal and Metabolic Mechanisms (Code: SS 3A), **Janet Best**, Ohio State University, and **Michael Reed**, Duke University.

Numerical Solutions of Singular or Perturbed Partial Differential Equation Problems with Applications (Code: SS 2A), **Peter Moore**, Southern Methodist University, and **Qin Sheng**, Baylor University.

Recent Developments on Turbulence (Code: SS 9A), **Eleftherios Gkioulekas**, University of Texas-Pan American, and **Michael Jolly**, Indiana University. *The Topology of Continua* (Code: SS 16A), **David Ryden**, Baylor University, **Chris Mouron**, Rhodes College, and **Sergio Macias**, Universidad Nacional Autonoma de Mexico.

Topological Methods for Boundary Value Problems for Ordinary Differential Equations (Code: SS 5A), **Richard Avery**, Dakota State University, **Paul W. Eloe**, University of Dayton, and **Johnny Henderson**, Baylor University.

University Park, Pennsylvania

Pennsylvania State University

October 24-25, 2009

Saturday - Sunday

Meeting #1052

Eastern Section

Associate secretary: Steven H. Weintraub

Announcement issue of *Notices*: August 2009

Program first available on AMS website: September 10, 2009

Program issue of electronic *Notices*: October 2009 Issue of *Abstracts*: Volume 30, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: September 1, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Michael K. H. Kiessling, Rutgers University, *N*-body problems in relativity.

Kevin R. Payne, Universita degli di Milano, *PDE of mixed type: The twin challenges of globalization and diversity.*

Laurent Saloff-Coste, Cornell University, *Subelliptic heat kernel measures and holomorphic functions on complex Lie groups.*

Robert C. Vaughan, Pennsylvania State University, *Title to be announced*.

Special Sessions

Algebraic Combinatorics (Code: SS 6A), **Peter McNamara**, Bucknell University, and **Mark Skandera**, Lehigh University.

Analytic Number Theory (Code: SS 16A), **Angel V. Kumchev**, Towson University, **Michael P. Knapp**, Loyola College, and **Robert C. Vaughan**, Pennsylvania State University.

Arithmetic and Profinite Groups (Code: SS 19A), Alireza Salehi-Golsefidy, Princeton University, Martin D.

Kassabov, Cornell University, and **Mikhail V. Ershov**, University of Virginia.

Automorphisms of Riemann Surfaces and Related Topics (Code: SS 15A), **S. Allen Broughton**, Rose-Hulman Institute of Technology, **Anthony Weaver**, Bronx Community College, the City University of New York, and **Aaron D. Wootton**, University of Portland.

Combinatorial and Homological Aspects of Commutative Algebra (Code: SS 3A), **Amanda I. Beecher**, United States Military Academy, and **Alexandre B. Tchernev**, University at Albany.

Commutative Algebra and Applications to Algebraic Geometry (Code: SS 11A), **Janet Striuli**, Fairfield University, and **Jooyoun Hong**, Southern Connecticut State University.

Difference Equations and Applications (Code: SS 2A), **Michael A. Radin**, Rochester Institute of Technology.

Function Fields and Their Applications (Code: SS 20A), **Mihran Papikian** and **Kirsten Eisentrager**, Pennsylvania State University.

Geometry of Integrable and Non-Integrable Dynamics (Code: SS 5A), **Boris Khesin**, University of Toronto, and **Mark Levi** and **Sergei Tabachnikov**, Pennsylvania State University.

Heat Kernel Analysis (Code: SS 8A), **Maria Gordina**, University of Connecticut, and **Laurent Saloff-Coste**, Cornell University.

Homotopy Theory (Code: SS 1A), **James Gillespie** and **Mark W. Johnson**, Pennsylvania State University, Altoona, **Simona Paoli**, University of Haifa, and **Donald Yau**, Ohio State University.

Integrable Systems and Related Areas (Code: SS 4A), **Sam Evans** and **Michael Gekhtman**, University of Notre Dame, and **Luen-Chau Li**, Pennsylvania State University.

Microlocal Analysis and Spectral Theory on Singular Spaces (Code: SS 14A), **Juan B. Gil** and **Thomas Krainer**, Pennsylvania State University, Altoona.

New Trends in Triangulated Categories and their Associated Cohomology Theories (Code: SS 12A), **Sunil Kumar Chebolu**, Illinois State University and **Keir H. Lockridge**, Wake Forest University.

Nonlinear Waves (Code: SS 13A), **Bernard Deconinck**, University of Washington, **Diane Henderson**, Pennsylvania State University, **J. Douglas Wright** and **David Ambrose**, Drexel University.

Partial Differential Equations of Mixed Elliptic-Hyperbolic Type and Applications (Code: SS 18A), **Barbara Lee Keyfitz**, Ohio State University, and **Kevin Ray Payne**, Universitá di Milano.

Random Dynamics: Where Probability and Ergodic Theory Meet (Code: SS 21A), **Manfred Denker**, Pennsylvania State University, and **Wojbor A. Woyczynski**, Case Western Reserve University.

Symplectic, Contact, and Complex Structures on Manifolds (Code: SS 7A), **Philippe Rukimbira, Tedi C. Draghici**, and **Gueo V. Grantcharov**, Florida International University.

Topics in Mathematical Finance (Code: SS 10A), Nick Costanzino, Anna L. Mazzucato, and Victor Nistor, Pennsylvania State University.

n-Body Problems in Relativity (Code: SS 17A), **Michael K. H. Kiessling**, Rutgers University, **Pavel B. Dubovski**,

Stevens Institute of Technology, and **Shadi Tahvildar-Zadeh**, Rutgers University

q-Series and Related Areas in Enumerative Combinatorics and Number Theory (Code: SS 9A), **David Little, James Sellers**, and **Ae Ja Yee**, Pennsylvania State University

Boca Raton, Florida

Florida Atlantic University

October 30 - November 1, 2009

Friday – Sunday

Meeting #1053

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: August 2009

Program first available on AMS website: September 17, 2009

Program issue of electronic *Notices*: October 2009 Issue of *Abstracts*: Volume 30, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: September 8, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Spyridon Alexakis, Massachusetts Institute of Technology, *Global conformal invariants: A conjecture of Deser and Schwimmer*.

Kai-Uwe Bux, University of Virginia, *Arithmetic groups in positive characteristic.*

Dino J. Lorenzini, University of Georgia, *The index of an algebraic variety.*

Eduardo D. Sontag, Rutgers University, *Title to be announced*.

Special Sessions

Applied Partial Differential Equations (Code: SS 10A), **Shar Sajjadi** and **Timothy A. Smith**, Embry Riddle Aeronautical University.

Arithmetic Geometry (Code: SS 16A), **Pete L. Clark** and **Dino Lorenzini**, University of Georgia.

Commutative Ring Theory (Code: SS 3A), Alan Loper, Ohio State University, and Lee C. Klingler, Florida Atlantic University.

Concentration, Functional Inequalities, and Isoperimetry (Code: SS 2A), **Mario Milman**, Florida Atlantic University, **Christian Houdre**, Georgia Institute of Technology, and **Emanuel Milman**, Institute for Advanced Study.

Constructive Mathematics (Code: SS 1A), **Robert Lubarsky**, **Fred Richman**, and **Martin Solomon**, Florida Atlantic University. *Dynamical Systems* (Code: SS 6A), **William D. Kalies** and **Vincent Naudot**, Florida Atlantic University.

Enumerative Combinatorics (Code: SS 4A), **Christian Krattenthaler**, University of Vienna, and **Aaron D. Meyerowitz**, **Heinrich Niederhausen**, and **Wandi Wei**, Florida Atlantic University.

General Relativity and Related Partial Differential Equations (Code: SS 18A), **Spyridon Alexakis**, Massachusetts Institute of Technology, and **Gilbert Weinstein**, University of Alabama Birmingham.

Geometry and Topology (Code: SS 20A), Alexander N. Dranishnikov and Yuli B. Rudyak, University of Florida.

Graded Resolutions (Code: SS 13A), **Christopher Francisco**, Oklahoma State University, and **Irena Peeva**, Cornell University.

Graph Theory (Code: SS 11A), **Zixia Song** and **Yue Zhao**, University of Central Florida.

Harmonic Analysis (Code: SS 5A), **Galia D. Dafni**, Concordia University, and **J. Michael Wilson**, University of Vermont, Burlington.

Homological Aspects of Module Theory (Code: SS 7A), **Andrew R. Kustin**, University of South Carolina, **Sean M. Sather-Wagstaff**, North Dakota State University, and **Janet Vassilev**, University of New Mexico.

Hypercomplex Analysis (Code: SS 12A), **Craig A. Nolder**, Florida State University, and **John Ryan**, University of Arkansas at Fayetteville.

Invariants of Knots and Links (Code: SS 9A), **Heather A. Dye**, McKendree University, **Mohamed Elhamdadi**, University of South Florida, and **Louis H. Kauffman**, University of Illinois at Chicago.

Inverse Problems and Signal Processing (Code: SS 14A), **M. Zuhair Nashed** and **Qiyu Sun**, University of Central Florida.

Lattices, Coxeter Groups, and Buildings (Code: SS 19A), **Kai-Uwe Bux**, University of Virginia, **Jon McCammond**, University of California Santa Barbara, and **Kevin Wortman**, University of Utah.

Mathematical Models in Biology (Code: SS 17A), **Patrick de Leenheer**, University of Florida, and **Yuan Wang**, Florida Atlantic University.

Modular Forms and Automorphic Forms (Code: SS 21A), **Jonathan P. Hanke**, University of Georgia.

Partial Differential Equations from Fluid Mechanics (Code: SS 15A), **Chongsheng Cao**, Florida International University, **Jiahong Wu**, Oklahoma State University, and **Baoquan Yuan**, Henan Polytechnic University.

Recent Advances in Probability and Statistics (Code: SS 8A), **Lianfen Qian** and **Hongwei Long**, Florida Atlantic University.

Riverside, California

University of California

November 7-8, 2009

Saturday – Sunday

Meeting #1054

Western Section

Associate secretary: Michel L. Lapidus Announcement issue of *Notices*: September 2009 Program first available on AMS website: September 24,

2009 Program issue of electronic *Notices*: November 2009 Issue of *Abstracts*: Volume 30, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: September 15, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Christopher Hacon, University of Utah, *Classification of algebraic varieties*.

Birge Huisgen-Zimmerman, University of California Santa Barbara, *Representations of quivers with relations. Geometric Aspects.*

Jun Li, Stanford University, Toward high genus GWinvariants of quintic Calabi-Yau threefolds.

Joseph Teran, University of California Los Angeles, *Title to be announced*.

Special Sessions

Algebraic Geometry (Code: SS 1A), **Christopher Hacon**, University of Utah, and **Ziv Ran**, University of California Riverside.

Algebraic Structures in Knot Theory (Code: SS 17A), **Alissa S. Crans**, Loyola Marymount University, and **Sam Nelson**, Claremont McKenna College.

Arithmetic Combinatorics (Code: SS 16A), **Mei-Chu Chang**, University of California Riverside, and Alex Gamburd, University of California Santa Cruz and Northwestern University.

Calabi-Yau Manifolds (Code: SS 15A), **Owen Dearricott**, University of California Riverside, **Jun Li**, Stanford University, and **Bun Wong** and **Yat-Sun Poon**, University of California Riverside.

Dynamical Systems (Code: SS 18A), **Nicolai Haydn**, University of Southern California, and **Huyi Hu**, Michigan State University.

Fluid Mechanics (Code: SS 5A), **James Kelliher** and **Qi Zhang**, University of California Riverside.

Fractal Geometry, Dynamical Systems, Number Theory and Analysis on Rough Spaces (Code: SS 6A), Michel L. **Lapidus**, University of California Riverside, **Hung Lu**, Hawaii Pacific University, and **Erin P. J. Pearse**, University of Iowa.

Global Riemannian Geometry (Code: SS 14A), **Fred Wilhelm**, University of California Riverside, and **Peter Petersen**, University of California Los Angeles.

History and Philosophy of Mathematics (Code: SS 4A), **Shawnee L. McMurran**, California State University San Bernardino, and **James J. Tattersall**, Providence College.

Homotopy Theory and Higher Algebraic Structures (Code: SS 8A), **John Baez** and **Julie Bergner**, University of California Riverside.

Interactions Between Algebraic Geometry and Noncommutative Algebra (Code: SS 9A), Kenneth R. Goodearl, University of California Santa Barbara, Daniel S. Rogalski, University of California San Diego, and James Zhang, University of Washington.

Knotting Around Dimension Three: A Special Session in Memory of Xiao-Song Lin (Code: SS 11A), Martin Scharlemann, University of California Santa Barbara, and Mohammed Ait Nouh, University of California Riverside.

Noncommutative Geometry (Code: SS 2A), **Vasiliy Dolgushev** and **Wee Liang Gan**, University of California Riverside.

Operator Algebras (Code: SS 13A), **Marta Asaeda** and **Aviv Censor**, University of California Riverside, and **Adrian Ioana**, Clay Institute and Caltech.

Representation Theory (Code: SS 3A), **Vyjayanthi Chari**, **Wee Liang Gan**, and **Jacob Greenstein**, University of California Riverside.

Representations of Finite Dimensional Algebras (Code: SS 7A), **Frauke Bleher**, University of Iowa, **Birge Huisgen-Zimmermann**, University of California Santa Barbara, and **Markus Schmidmeier**, Florida Atlantic University.

Research Conducted by Students (Code: SS 10A), **Robert G. Niemeyer** and **Jack R. Bennett**, University of California Riverside.

Stochastic Analysis and Applications (Code: SS 12A), **Michael L. Green, Alan C. Krinik**, and **Randall J. Swift**, California State Polytechnic University Pomona.

Accommodations

Participants should make their own arrangements directly with a hotel of their choice. Rates quoted do not include sales tax. The AMS is not responsible for rate changes or for the quality of the accommodations. When making a reservation, participants should state they are with the American Mathematical Society group (AMS Meeting) and/ or UC Riverside Math Department. Cancellation and early checkout policies vary; be sure to check when you make your reservation.

Mission Inn, 3649 Mission Inn Ave., Riverside, CA, 92501; 951-784-0300. Rates are US\$120/single and US\$135/double plus tax. **Deadline for reservations is October 5, 2009**.

Riverside Marriott, 3400 Market Street, Riverside, CA 92501; 888-236-2427. Rates are US\$99 single/double plus tax. **Deadline for reservations is October 13, 2009**.

Courtyard by Marriott, 1510 University Ave., Riverside, CA 92507; 951-781-2844. Rates are US\$99 single/double plus tax. Deadline for reservations is October 15, 2009.

Dvnastv Suites. 3735 Iowa Ave., Riverside, CA 92507: 951-369-8200. Rates are US\$83 single/double plus tax. Deadline for reservations is October 5, 2009.

Extension Center, 1200 University Avenue, Riverside, CA 92507; 951-827-1708. Rates are US\$65 single/double plus tax. Deadline for reservations is October 15, 2009.

Food Service

The Stacked Deli is located on campus and is open on Saturday for lunch only from 11:00 a.m.-3:00 p.m. A list of additional restaurants will be available at the registration desk.

Local Information

Please visit the websites maintained by University of California Riverside at http://www.ucr.edu, the Department of Mathematics at http://math.ucr.edu, and the site maintained by the Riverside Convention and Visitors Bureau at http://www.riversidecb.com/.

Other Activities

AMS Editorial Activity: An acquisitions editor from the AMS book program will be present to speak with prospective authors. If you have a book project that you would like to discuss with the AMS, please stop by the book exhibit located in the Surge building.

Book Sales: Stop by the on-site AMS Bookstore located in the Surge Building and review the newest titles from the AMS, enjoy up to 25% off all AMS publications, or take home an AMS t-shirt! Complimentary coffee will be served courtesy of AMS Membership Services.

Parking

There are two Information Kiosk booths located at the UCR campus entrances. Kiosk services provide information, direction, permits, and maps to our guests. Parking is available in Lots 1, 19, and 24 for a fee of \$5 per day on Saturday and Sunday. For parking information please visit http://www.parking.ucr.edu/index. php?content3Dservices/event_services.html.

Registration and Meeting Information

The registration desk will be located in the Surge Building, and will be open from 7:30 a.m. to 4:00 p.m. on Saturday, and 8:00 a.m. to noon on Sunday. Special Session talks will take place in the Surge Building, Bourns Hall, the HUB, and the Physics Building. The Invited Addresses will take place in the University Lecture Hall located next to the Surge Building.

Registration fees are US\$40 for AMS or CMS members. US\$60 for nonmembers; and US\$5 for students, unemployed mathematicians, and emeritus members. Fees are payable on site by cash, check, or credit card.

Travel Information and Campus Map

Both Ontario International Airport (ONT) and Los Angeles International Airport (LAX) serve the city of Riverside

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with Ontario International Airport the closest to campus. SuperShuttle: Call 1-800-258-3826 for reservations or SuperShuttle vans are outside of Departures.

By Car: From Los Angeles County

From the 91 freeway: Take the 91 freeway east to the 60 freeway east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From the 10 freeway: Take the 10 freeway east to Interstate 15 south and then to the 60 freeway east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From the 60 freeway: Take the 60 freeway east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From Orange County

Take the 91 freeway east to the 60 freeway east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From Ontario Airport

From the 10 freeway: Take the 10 freeway east, to the 15 south and then to the 60 east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From the 60 freeway: Take the 60 freeway east. Exit at University Avenue and turn left. Go to the second light and make a right onto Campus Drive.

From Palm Springs

Take the 10 freeway west to the junction with the 60 freeway and go west. Exit at University Avenue and turn left. Go to the first traffic signal and turn right onto Campus Drive.

From San Bernardino

Take the 215 freeway south to the junction with the 60 freeway and go east. Exit at University Avenue and turn left. Go to the second traffic signal and turn right onto Campus Drive.

From San Diego County

Take the 15 freeway north to the 215 north and then the 60 freeway west. Exit at University Avenue and turn left. Go to the first light and make a right on Campus Drive.

Please visit http://campusmap.ucr.edu/campusMap. php for a campus map.

Car Rental

Avis Rent A Car is the official car rental company for the meeting. Depending on variables such as location, length of rental, and size of vehicle, Avis will offer participants the best available rate which can range from 5%–25% discount off regular rates. Participants must use the assigned Meeting Avis Discount Number (**J098887**) and meet Avis rate requirements to receive the discount. (Rate discounts are available at all corporate and participating licensee locations.) Reservations can be made by calling 1-800-331-1600 or online at http://www.avis.com.

All car rentals include unlimited free mileage and are available to renters 25 years and older. Renters must also meet Avis's driver and credit requirements. Return to the same rental location or additional surcharges may apply.

Rates do not include any state or local surcharges, tax, optional coverages, or gas refueling charges.

Weather

During the month of November temperatures range from an average low of 45° Fahrenheit to an average high of 75° Fahrenheit.

Special Travel Information for International Participants

Please see the links to international travel information at www.ams.or/amsmtgs/sectional.html for the Riverside meeting. International participants should view the important information about traveling to the U.S. found at http://www.nationalacademies.org/visas/ Traveling_to_US.html and http://travel.state.gov/visa/index.html.

Seoul, South Korea

Ewha Womans University

December 16-20, 2009

Wednesday - Sunday

Meeting #1055

First Joint International Meeting of the AMS and the Korean Mathematical Society.

Associate secretary: Georgia Benkart

Announcement issue of *Notices*: August 2009 Program first available on AMS website: Not applicable Program issue of electronic *Notices*: Not applicable Issue of *Abstracts*: Not applicable

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: October 31, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ internmtgs.html.

Invited Addresses

Young Ju Choi, Pohang University of Science and Technology, *Title to be announced*.

Bumsig Kim, Korea Institute for Advanced Study, *Title to be announced*.

Minhyong Kim, University College London, *Title to be announced*.

Ki-ahm Lee, Seoul National University, *Title to be announced*.

James T. McKernan, Massachusetts Institute of Technology, *Title to be announced*.

Frank Morgan, Williams College, *Title to be announced*. **Hee Oh**, Brown University, *Title to be announced*.

Terence Tao, University of California Los Angeles, *Title to be announced*.

Van Vu, Rutgers University, Title to be announced.

Special Sessions

Algebraic Combinatorics, **Dongsu Kim**, Korea Advanced Institute of Science & Technology, **Soojin Cho**, Ajou University, and **Bruce Sagan**, Michigan State University.

Algebraic Geometry, **Yongnam Lee**, Sogang University, **Ian Morrison**, Fordham University, and **James McKernan**, Massachusetts Institute of Technology.

Arithmetic of Quadratic Forms, **Myung-Hwan Kim**, Seoul National University, and **Wai Kiu Chan**, Wesleyan University.

Combinatorial Matrix Theory, **Suk-Geun Hwang**, Kyungpook National University, and **Bryan Shader**, University of Wyoming.

Computational Science and Engineering, **Jeehyun Lee**, Yonsei University, and **Max Gunzburger**, Florida State University.

Creativity, Giftedness, and Talent Development in Mathematics, **Kyeong-Hwa Lee**, Seoul National University, and **Bharath Sriraman**, University of Montana.

Cryptography, **Hyang-Sook Lee**, Ewha Womans University, and **Alice Silverberg**, University of California Irvine.

Differential and Integral Geometry, Young Jin Suh, Kyungpook National University, Byung Hak Kim, Kyung Hee University, Yongdo Lim, Kyungpook National University, Gaoyong Zhang, Polytechnic University of NYU, and Jiazu Zhou, Southwest University.

Ergodic Theory and Dynamical Systems, **Keonhee Lee**, Chungnam National University, **Jeong-Yup Lee**, Korea Institute for Advanced Study, and **Jane Hawkins**, University of North Carolina.

Financial Mathematics, **Hyejin Ku**, York University, **Hyunggeon Koo**, Ajou University, and **Kiseop Lee**, University of Louisville.

Geometric Structures and Geometric Group Theory, **In Kang Kim**, Korea Advanced Institute of Science & Technology, and **Seonhee Lim**, Cornell University.

Geometry of Syzygies and Computations, **Sijong Kwak**, Korea Advanced Institute of Science & Technology, **Hyungju Park**, Korea Institute for Advanced Study, and **Jerzy Weyman**, Northeastern University.

Harmonic Analysis and Its Applications, **Sunggeum Hong**, Chosun University, and **Andreas Seeger**, University of Wisconsin.

Inverse Problems and Imaging, **Hyeonbae Kang**, Inha University, and **Gunther Uhlmann**, University of Washington.

Knot Theory and Related Topics, **Jae Choon Cha**, Pohang University of Science & Technology, and **Kent Orr**, Inidana University.

Lie Symmetries and Solitons, **Woo-Pyo Hong**, Catholic University of Daegu, **Anjan Biswas**, Delaware State University, and **Chaudry M. Khalique**, North-West University.

Mathematical Analysis in Fluid, Gas Dynamics, and Related Equations, Minkyu Kwak, Chonnam National University, Hyeong-Ohk Bae, Ajou University, Seung-Yeal Ha, Seoul National University, and Simon Seok Hwang, LaGrange College. *Mathematical Biology*, **Eunok Jung**, Konkuk University, and **Jae-Hun Jung**, SUNY at Buffalo.

Mathematical Logic and Foundation, **Byunghan Kim**, Yonsei University, and **Ivo Herzog**, Ohio State University.

Modular Forms and Related Topics, Youn-Seo Choi, Korea Institute for Advanced Study, YoungJu Choie, Pohang University of Science & Technology, and Wen-ching Winnie Li, Pennsylvania State University.

Noncommutative Ring Theory, **Yang Lee**, Pusan National University, **Nam Kyun Kim**, Hanbat National University, and **Pace P. Nielsen**, Brigham Young University.

Nonlinear Elliptic Partial Differential Equations, **Jaeyoung Byeon**, Pohang University of Science & Technology, and **Zhi-Qiang Wang**, Utah State University.

Nonlinear Partial Differential Equations and Viscosity Solutions, **Ki-ahm Lee**, Seoul National University, and **Inwon Kim**, University of California Los Angeles.

Operator Theory and Operator Algebras, **11 Bong Jung**, Kyungpook National University, **Ja A Jeong**, Seoul National University, **George Exner**, Bucknell University, and **Ken Dykema**, Texas A&M University.

Operator Theory in Analytic Function Spaces, **Hyung Woon Koo** and **Boo Rim Choe**, Korea University, and **Kehe Zhu**, SUNY at Albany.

Spectral Geometry and Global Analysis, **Jinsung Park**, Korea Institute for Advanced Study, and **Maxim Braverman**, Northeastern University.

Symplectic Geometry and Mirror Symmetry, Jae-Suk Park, Yonsei University, Cheol-Hyun Cho, Seoul National University, and Yong-Geun Oh, University of Wisconsin.

San Francisco, California

Moscone Center West and the San Francisco Marriott

January 13-16, 2010

Wednesday - Saturday

Meeting #1056

Joint Mathematics Meetings, including the 116th Annual Meeting of the AMS, 93rd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society of Industrial and Applied Mathematics (SIAM).

Associate secretary: Matthew Miller

Announcement issue of Notices: October 2009

Program first available on AMS website: November 1, 2009 Program issue of electronic *Notices*: January 2010 Issue of *Abstracts*: Volume 31, Issue 1

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: September 22, 2009

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ national.html.

AMS Invited Addresses

James G. Glimm, Stony Brook University, *Title to be announced* (AMS Retiring Presidential Address).

Olga Holtz, University of California Berkeley, *Title to be announced*.

Richard W. Kenyon, Brown University, *Title to be announced*.

Igor Y. Rodnianski, Princeton University, *Title to be announced*.

Peter W. Shor, Massachusetts Institute of Technology, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

Richard P. Stanley, MIT, *Title to be announced* (AMS Colloquium Lectures).

Amie Wilkinson, Northwestern University, *Title to be announced*.

AMS Special Sessions

Some sessions are cosponsored with other organizations. These are noted within the parenthesis at the end of each listing, where applicable.

Algebraic Aspects of Cryptology (Code: SS 2A), **Jintai Ding**, University of Cincinnati, and **Chris Christensen**, Northern Kentucky.

Algebraic Methods in Signal Processing (Code: SS 3A), Shamgar Gurevich, University of California Berkeley, Ronny Hadani, University of Chicago, Olga Holtz, University of California Berkeley and Technical University Berlin, Oded Schwartz, Technical University Berlin, and Nir Sochen, Tel Aviv University.

Analysis and Control Under Uncertainty (Code: SS 4A), Xioaming Wang, Florida State University, Yanzhao Cao, Auburn University, and Catalin Trenchea, University of Pittsburgh.

Applications of Algebraic Geometry (Code: SS 5A), **Frank Sottile**, Texas A&M University, and **Luis Garcia-Puente**, Sam Houston State University.

Applications of Graph Theory (Code: SS 6A), **Richard Low**, San Jose State University, and **Ralucca M. Gera**, Naval Postgraduate School.

Applications of Time Scales to Biology, Economics, and Engineering (Code: SS 7A), Martin Bohner, Missouri University of Science and Technology, Billur Kaymakcalan, Southern University-Statesboro, and Allan Peterson, University of Nebraska-Lincoln.

Arithmetic Geometry (Code: SS 9A), **Bo-Hae Im**, Chung-Ang University, **Jennifer Johnson-Leung**, University of Idaho, and **Jennifer Paulhus**, Kansas State University.

Arithmetic and Nonarchimedean Dynamics (Code: SS 8A), **Joseph Silverman**, Brown University, **Michelle Manes**, University of Hawaii, and **Raphael Jones**, College of the Holy Cross.

Arithmetic of Function Fields (Code: SS 10A), Allison Pacelli, Williams College, and Michael Rosen, Brown University.

Biomathematics: Modeling in Biology, Ecology, and Epidemiology (Code: SS 12A), **Olcay Akman**, Illinois State University, **Linda Allen**, Texas Tech University, **Timothy D. Comar**, Benedictine University, and **Sophia Jang** and **Lih-Ing Roeger**, Texas Tech University.

Categorical and Algebraic Methods in Representation Theory (Code: SS 13A), **Jon Brundan**, University of Oregon, **Julia Pevtsova**, University of Washington, and **Eric Fried lander**, University of Southern California.

Commutative Algebra (Code: SS 15A), **Susan Cooper**, University of Nebraska-Lincoln, **Graham Leuschke**, Syracuse University, and **Sean M. Sather-Wagstaff**, North Dakota State University.

Degenerate and Singular Elliptic Partial Differential Equations (Code: SS 16A), **Marian Bocea** and **Cristina Popovici**, North Dakota State University.

Difference Equations and Applications (Code: SS 17A), **Michael Radin**, Rochester Institute of Technology.

Differential Galois Theory and Group Representations: A Tribute to Andy Magid (Code: SS 19A), James Carrell, University of British Columbia, Lourdes Juan, Texas Tech University, Alex Lubotzky, Hebrew University, Brian Parshall, University of Virginia, and Marius van der Put, University of Groningen.

Enumerative Combinatorics (Code: SS 18A), **Brian Miceli**, Trinity University, and **Jeff Remmel**, University of California San Diego.

Geometric Aspects of Link and 3-manifold Invariants (Code: SS 20A), **Oliver Dasbach**, Louisiana State University, and **Effie Kalfagianni**, Michigan State University.

Graph Algebras in Analysis and Algebra (Code: SS 21A), **Gene Abrams**, University of Colorado at Colorado Springs, and **Mark Tomforde**, University of Houston.

Harmonic Analysis (Code: SS 22A), **Kabe Moen**, Washington University, **Richard Oberlin** and **Betsy Stovall**, University of California Los Angeles (a Mathematics Research Communities session).

Harmonic Analysis and Representations of Reductive p-adic Groups (Code: SS 23A), **Robert Doran**, Texas Christian University, **Paul Sally**, University of Chicago, and **Loren Spice**, Texas Christian University.

History of Mathematics (Code: SS 24A), **Craig Fraser**, University of Toronto, **Deborah Kent**, Hillsdale College, and **Sloan Despeaux**, Western Carolina University (AMS-MAA).

Integrability of Dynamical Systems and Solitons Equations (Code: SS 25A), **Zhijun Qiao**, University of Texas-Pan American, **Taixi Xu**, Southern Polytechnic State University, and **Wenxiu Ma**, University of South Florida.

Interactions of Inverse Problems, Signal Processing and Imaging (Code: SS 26A), M. Zuhair Nashed, University of Central Florida.

Inverse Problems: Analysis and Computations (Code: SS 27A), Gaik Ambartsoumian, University of Texas at Arlington, Raluca Felea, Rochester Institute of Technology, Hongyu Liu, University of Washington, Kui Ren, University of Texas at Austin, and Michael VanValkenburgh, University of California Berkeley (a Mathematics Research Communities session).

L-Functions and Analytic Number Theory (Code: SS 28A), **Alina Bucur**, Massachusetts Institute of Technology, **Chantal David**, Concordia University, and **Matilde Lalin**, University of Alberta.

Markov Chains and Their Statistical Applications (Code: SS 33A), **James Flegal**, University of California Riverside, **Radu Herbei**, Ohio State University, and **Jessica Zuniga**, Stanford University (a Mathematics Research Communities session).

Mathematical Challenges of Relativity (Code: SS 29A), **Paul T. Allen**, Lewis & Clark College, **Michael Eichmair**, MIT and Monash University, and **Jared Speck** and **Willie W. Wong**, University of Cambridge (a Mathematics Research Communities session).

Mathematics and Physical Experiment (Code: SS 30A), **Roger Thelwell, Anthony Tongen**, and **Paul Warne**, James Madison University.

Mathematics of Computation (Code: SS 31A), **Susanne Brenner**, Louisiana State University, and **Chi-Wang Shu**, Brown University (AMS-SIAM).

Nonlinear Hyperbolic Equations and Control Systems in Physics and Engineering (Code: SS 11A), **Petronela Radu** and **Daniel Toundykov**, University of Nebraska-Lincoln.

Optimal Frames and Operator Algebras (Code: SS 35A), **David Larson**, Texas A&M University, **Deguang Han**, University of Central Florida, and **Shidong Li**, San Francisco State University.

Parabolic Geometries, Integrable Systems, and Twistor Theory (Code: SS 36A), **Dana Mihai**, Carnegie Mellon University, and **Jonathan Holland** and **George Sparling**, University of Pittsburgh.

Recent Advances in Evolution Equations and Applications (Code: SS 38A), **Guoping Zhang** and **Gaston N'Guerekata**, Morgan State University, **Yi Li**, University of Iowa, **Wen-Xiu Ma**, University of South Florida, and **Michael Goldberg**, Johns Hopkins University.

Representation Theory and Nonassociative Algebras (Code: SS 40A), **Andrew Douglas**, City University of New York.

Research in Mathematics by Undergraduates (Code: SS 41A), **Darren Narayan** and **Bernard Brooks**, Rochester Institute of Technology, **Jacqueline Jensen**, Sam Houston State University, **Carl V. Lutzer**, Rochester Institute of Technology, **Vadim Ponomarenko**, San Diego State University, and **Tamas Wiandt**, Rochester Institute of Technology (AMS-MAA-SIAM).

Spectral Problems on Compact Riemannian Manifolds (Code: SS 43A), Carolyn Gordon, Dartmouth College, Ruth Gornet, University of Texas at Arlington, and Craig Sutton, Dartmouth College (AMS-AWM).

Surreal Numbers (Code: SS 45A), **Lou van den Dries**, University of Illinois, and **Philip Ehrlich**, Ohio University (AMS-ASL).

The Mathematics of Information and Knowledge (Code: SS 46A), **Naoki Saito**, University of California Davis, **Ronald R. Coifman**, Yale University, **James G. Glimm**, SUNY at Stony Brook, **Peter W. Jones**, Yale University, **Mauro**

Maggioni, Duke University, and **Jared Tanner**, University of Edinburgh.

Use of Technology in Modern Complex Analysis Research (Code: SS 47A), **Beth Schaubroeck**, U.S. Air Force Academy, **Michael Dorff**, Brigham Young University, and **James Rolf**, U.S. Air Force Academy.

Voting Theory (Code: SS 48A), **Michael Jones**, Mathematical Reviews, **Brian Hopkins**, Saint Peter's College, and **Tommy Ratliff**, Wheaton College.

Zonotopal Algebra and Its Applications (Code: SS 49A), **Olga Holtz**, University of California Berkeley and Technical University Berlin, and **Amos Ron**, University of Wisconsin.

Lexington, Kentucky

University of Kentucky

March 27-28, 2010

Saturday - Sunday

Meeting #1057

Southeastern Section Associate secretary: Matthew Miller Announcement issue of *Notices*: January 2010 Program first available on AMS website: February 11, 2010 Program issue of electronic *Notices*: March 2010 Issue of *Abstracts*: Volume 31, Issue 2

Deadlines

For organizers: August 28, 2009 For consideration of contributed papers in Special Sessions: December 8, 2009 For abstracts: February 2, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Percy A. Deift, Courant Institute–New York University, *Title to be announced*.

Irina Mitrea, University of Virginia, *Title to be announced*.

Bruce Reznick, University of Illinois at Urbana Champaign, *Title to be announced*.

Bernd Ulrich, Purdue University, *Title to be announced*. **Doron Zeilberger**, Rutgers University, *Title to be announced* (Erdős Memorial Lecture).

Special Sessions

Advances in Algebraic Coding Theory (Code: SS 6A), **Heide Gluesing-Luerssen**, University of Kentucky, and **Jon-Lark Kim**, University of Louisville.

Advances in Algebraic Statistics (Code: SS 2A), **Sonja Petroviá**, University of Illinois, Chicago, and **Ruriko Yoshida**, University of Kentucky.

Combinatorial Algebra (Code: SS 7A), **Juan C. Migliore**, University of Notre Dame, and **Uwe Nagel**, University of Kentucky. *Commutative Algebra* (Code: SS 1A), **Alberto Corso**, University of Kentucky, **Claudia Polini**, University of Notre Dame, and **Bernd Ulrich**, Purdue University.

Complex Analysis and Potential Theory (Code: SS 4A), **James E. Brennan** and **Vladimir Eiderman**, University of Kentucky.

Function Theory, Harmonic Analysis, and Partial Differential Equations (Code: SS 5A), **Joel Kilty**, Centre College, **Irina Mitrea**, Worcester Polytechnic Institute, and **Katharine Ott**, University of Kentucky.

Geometric Function Theory and Analysis on Metric Spaces (Code: SS 3A), John L. Lewis, University of Kentucky, and Nageswari Shanmugalingam, University of Cincinnati.

Partial Differential Equations in Geometry and Variational Problems (Code: SS 8A), **Luca Capogna**, University of Arkansas, and **Changyou Wang**, University of Kentucky.

St. Paul, Minnesota

Macalester College

April 10-11, 2010

Saturday – Sunday

Meeting #1058

Central Section Associate secretary: Georgia Benkart Announcement issue of *Notices*: February 2010 Program first available on AMS website: February 25, 2010 Program issue of electronic *Notices*: April 2010 Issue of *Abstracts*: Volume 31, Issue 2

Deadlines

For organizers: September 10, 2009 For consideration of contributed papers in Special Sessions: December 22, 2009 For abstracts: February 16, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Charles Doering, University of Michigan, *Title to be announced*.

Vladimir Touraev, University of Indiana, *Title to be announced*.

Peter Webb, University of Minnesota, *Title to be announced*.

Special Sessions

Probabilistic and Extremal Combinatorics (Code: SS 2A), **Ryan Martin** and **Maria Axenovich**, Iowa State University.

Quantum Invariants of 3-manifolds and Modular Categories (Code: SS 1A), **Thang Le**, Georgia Institute of Technology, **Eric Rowell**, Texas A&M University, and **Vladimir Touraev**, Indiana University.

Albuquerque, New Mexico

University of New Mexico

April 17–18, 2010 Saturday – Sunday

Meeting #1059

Western Section Associate secretary: Michel L. Lapidus Announcement issue of *Notices*: February 2010 Program first available on AMS website: March 4, 2010 Program issue of electronic *Notices*: April 2010 Issue of *Abstracts*: Volume 31, Issue 3

Deadlines

For organizers: September 17, 2009 For consideration of contributed papers in Special Sessions: December 29, 2009 For abstracts: February 23, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Kenneth Bromberg, University of Utah, *Title to be announced*.

Danny Calegari, California Institute of Technology, *Title to be announced*.

Ioana Dumitriu, University of Washington, *Title to be announced*.

Steffen Rhode, University of Washington, *Title to be announced*.

Special Sessions

Topics in Geometric Group Theory (Code: SS 1A), **Matthew Day**, California Institute of Technology, **Daniel Peter Groves**, University of Illinois at Chicago, **Jason Manning**, SUNY at Buffalo, and **Henry Wilton**, University of Texas.

Newark, New Jersey

New Jersey Institute of Technology

May 22-23, 2010

Saturday – Sunday

Meeting #1060

Eastern Section

Associate secretary: Steven H. Weintraub Announcement issue of *Notices*: March 2020 Program first available on AMS website: April 8, 2010 Program issue of electronic *Notices*: May 2020 Issue of *Abstracts*: Volume 31, Issue 3

Deadlines

For organizers: November 23, 2009 For consideration of contributed papers in Special Sessions: February 2, 2010 For abstracts: March 30, 2010

Berkeley, California

University of California Berkeley

June 2-5, 2010

Wednesday – Saturday

Meeting #1061

Eighth Joint International Meeting of the AMS and the Sociedad Matemáica Mexicana. Associate secretary: Susan J. Friedlander Announcement issue of Notices: February 2010 Program first available on AMS website: April 22, 2010 Program issue of electronic Notices: June 2010 Issue of Abstracts: Volume 31, Issue 3

Deadlines

For organizers: November 3, 2009For consideration of contributed papers in Special Sessions: February 16, 2010For abstracts: April 13, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ internmtgs.html.

Invited Addresses

Alejandro Adem, University of British Columbia and PIMS, *Title to be announced*.

Peter W-K Li, University of California Irvine, *Title to be announced*.

Ernesto Lupercio, CINVESTAV, Title to be announced. Victor Perez Abreu, CIMAT, Title to be announced. Alberto Verjovsky, IM-UNAM, Title to be announced. Maciej Zworski, University of California Berkeley, Title to be announced.

Special Sessions

Analytic Aspects of Differential Geometry (Code: SS 2A), **Lizhen Ji**, University of Michigan, and **Jiaping Wang**, University of Minnesota.

Harmonic Analysis, Microlocal Analysis, and Partial Differential Equations (Code: SS 1A), **Gunther Uhlmann**, University of Washington, and **Salvador Perez Esteva**, UNAM.

Syracuse, New York

Syracuse University

October 2-3, 2010

Saturday – Sunday

Meeting #1062

Eastern Section Associate secretary: Steven H. Weintraub Announcement issue of *Notices*: To be announced Program first available on AMS website: August 19, 2010 Program issue of electronic *Notices*: October Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: March 2, 2010For consideration of contributed papers in Special Sessions: June 15, 2010For abstracts: August 10, 2010

Los Angeles, California

University of California Los Angeles

October 9-10, 2010

Saturday – Sunday

Meeting #1063

Western Section Associate secretary: Michel L. Lapidus Announcement issue of *Notices*: August 2010 Program first available on AMS website: August 26, 2010 Program issue of electronic *Notices*: October 2010 Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: March 10, 2010For consideration of contributed papers in Special Sessions: June 22, 2010For abstracts: August 17, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Greg Kuperberg, University of California Davis, *Title to be announced*.

Cris Moore, University of New Mexico, *Title to be announced*.

Stanley Osher, University of California Los Angeles, *Title to be announced*.

Terence Tao, University of California Los Angeles, *Title to be announced* (Einstein Public Lecture in Mathematics).

Special Sessions

Large Cardinals and the Continuum (Code: SS 2A), **Matthew Foreman**, University of California Irvine, **Alekos Kechris**, California Institute for Technology, **Itay Neeman**, University of California Los Angeles, and **Martin Zeman**, University of California Irvine.

Topology and Symplectic Geometry (Code: SS 1A), **Robert Brown** and **Ciprian Manolescu**, University of California Los Angeles, and **Stefano Vidussi**, University of California Riverside.

Notre Dame, Indiana

Notre Dame University

October 29-31, 2010

Friday – Sunday

Meeting #1064

Central Section Associate secretary: Georgia Benkart Announcement issue of *Notices*: August 2010 Program first available on AMS website: September 16, 2010 Program issue of electronic *Notices*: October 2010 Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: February 19, 2010 For consideration of contributed papers in Special Sessions: July 20, 2010 For abstracts: September 7, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Invited Addresses

Laura DeMarco, University of Illinois at Chicago, *Title to be announced*.

Jordan Ellenberg, University of Wisconsin, *Title to be announced*.

David Fisher, Indiana University, *Title to be announced*. **Jared Wunsch**, Northwestern University, *Title to be announced*.

Richmond, Virginia

University of Richmond

November 6-7, 2010

Saturday – Sunday

Meeting #1065

Southeastern Section Associate secretary: Matthew Miller Announcement issue of *Notices*: September Program first available on AMS website: September 23, 2010 Program issue of electronic *Notices*: November

Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: March 8, 2010For consideration of contributed papers in Special Sessions: July 27, 2010For abstracts: September 14, 2010

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 5-8, 2011

Wednesday – Saturday

Joint Mathematics Meetings, including the 117th Annual Meeting of the AMS, 94th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Steven H. Weintraub Announcement issue of *Notices*: October 2010 Program first available on AMS website: November 1, 2010 Program issue of electronic *Notices*: January 2011 Issue of *Abstracts*: Volume 32, Issue 1

Deadlines

For organizers: April 1, 2010 For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Statesboro, Georgia

Georgia Southern University

March 12-13, 2011

Saturday – Sunday Southeastern Section Associate secretary: Matthew Miller Announcement issue of *Notices*: To be announced Program first available on AMS website: To be announced Program issue of electronic *Notices*: To be announced Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 12, 2010 For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

Iowa City, Iowa

University of Iowa

March 18-20, 2011

Friday – Sunday Central Section Associate secretary: Georgia Benkart Announcement issue of *Notices*: To be announced Program first available on AMS website: To be announced Program issue of electronic *Notices*: To be announced Issue of *Abstracts*: To be announced

Deadlines

For organizers: July 16, 2010 For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

Worcester, Massachusetts

College of the Holy Cross

April 9-10, 2011

Saturday – Sunday Eastern Section Associate secretary: Steven H. Weintraub Announcement issue of *Notices*: To be announced Program first available on AMS website: To be announced Program issue of electronic *Notices*: To be announced Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 9, 2010 For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

Las Vegas, Nevada

University of Nevada

April 30 - May 1, 2011

Saturday – Sunday Western Section Associate secretary: Michel L. Lapidus Announcement issue of *Notices*: To be announced Program first available on AMS website: To be announced Program issue of electronic *Notices*: To be announced Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/ sectional.html.

Special Sessions

Geometric PDEs (Code: SS 1A), **Matthew Gursky**, Notre Dame University, and **Emmanuel Hebey**, Universite de Cergy-Pontoise.

Pucon, Chile

December 15-18, 2011

Thursday – Sunday

First Joint International Meeting between the AMS and the Sociedad de Matematica de Chile. Associate secretary: Robert J. Daverman Announcement issue of *Notices*: June 2011 Program first available on AMS website: To be announced Program issue of electronic *Notices*: To be announced Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced For consideration of contributed papers in Special Sessions: To be announced For abstract: To be announced

For abstracts: To be announced

Boston, Massachusetts

John B. Hynes Veterans Memorial Convention Center, Boston Marriott Hotel, and Boston Sheraton Hotel

January 4-7, 2012

Wednesday - Saturday Joint Mathematics Meetings, including the 118th Annual Meeting of the AMS, 95th Annual Meeting of the Math-

SEPTEMBER 2009

ematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM). Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: October 2011 Program first available on AMS website: November 1, 2011 Program issue of electronic *Notices*: January 2012 Issue of *Abstracts*: Volume 33, Issue 1

Deadlines

For organizers: April 1, 2011

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

San Diego, California

San Diego Convention Center and San Diego Marriott Hotel and Marina

January 9-12, 2013

Wednesday - Saturday

Joint Mathematics Meetings, including the 119th Annual Meeting of the AMS, 96th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Georgia Benkart

Announcement issue of *Notices*: October 2012 Program first available on AMS website: November 1, 2012 Program issue of electronic *Notices*: January 2012 Issue of *Abstracts*: Volume 34, Issue 1

Deadlines

For organizers: April 1, 2012 For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

For abstracts: To be announced

Baltimore, Maryland

Baltimore Convention Center, Baltimore Hilton, and Marriott Inner Harbor

January 15-18, 2014

Wednesday - Saturday

Joint Mathematics Meetings, including the 120th Annual Meeting of the AMS, 97th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM). Associate secretary: Matthew Miller

Announcement issue of *Notices*: October 2013

Program first available on AMS website: November 1, 2013 Program issue of electronic *Notices*: January 2013 Issue of *Abstracts*: Volume 35, Issue 1

Deadlines

For organizers: April 1, 2013 For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

San Antonio, Texas

Henry B. Gonzalez Convention Center and Grand Hyatt San Antonio

January 10-13, 2015

Saturday – Tuesday

Joint Mathematics Meetings, including the 121st Annual Meeting of the AMS, 98th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Steven H. Weintraub Announcement issue of *Notices*: October 2014 Program first available on AMS website: To be announced Program issue of electronic *Notices*: January 2015 Issue of *Abstracts*: Volume 36, Issue 1

Deadlines

For organizers: April 1, 2014 For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

Seattle, Washington

Washington State Convention & Trade Center and the Sheraton Seattle Hotel

January 6-9, 2016

Wednesday – Saturday

Joint Mathematics Meetings, including the 122nd Annual Meeting of the AMS, 99th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM). Associate secretary: Michel L. Lapidus Announcement issue of *Notices*: October 2015 Program first available on AMS website: To be announced Program issue of electronic *Notices*: January 2016 Issue of *Abstracts*: Volume 37, Issue 1

Deadlines

For organizers: April 1, 2015

For consideration of contributed papers in Special Sessions: To be announced For abstracts: To be announced

Atlanta, Georgia

Hyatt Regency Atlanta and Marriott Atlanta Marquis

January 4-7, 2017

Wednesday - Saturday

Joint Mathematics Meetings, including the 123rd Annual Meeting of the AMS, 100th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Georgia Benkart

Announcement issue of *Notices*: October 2016 Program first available on AMS website: To be announced Program issue of electronic *Notices*: January 2017 Issue of *Abstracts*: Volume 38, Issue 1

Deadlines

For organizers: April 1, 2016

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

Central Section: Susan J. Friedlander, Department of Mathematics, University of Illinois at Chicago, 851 S. Morgan (M/C 249), Chicago, IL 60607-7045; e-mail: susan@math.nwu.edu; telephone: 312-996-3041. **Georgia Benkart** (after January 31, 2010), University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. **Information in this issue may be dated. Up-to-date meeting and conference information can be found at www.** ams.org/meetings/.

Meetings:

2009		
October 16-18	Waco, Texas	p. 1049
October 24-25	University Park,	
	Pennsylvania	p. 1050
October 30-Nov. 1	Boca Raton, Florida	p. 1051
November 7-8	Riverside, California	p. 1052
December 6-20	Seoul, Korea	p. 1054

2010

January 13–16	San Francisco, California	p. 1055
	Annual Meeting	
March 27-28	Lexington, Kentucky	p. 1057
April 10-11	St. Paul, Minnesota	p. 1057
April 17-18	Albuquerque, New Mexico	p. 1058
May 22-23	Newark, New Jersey	p. 1058
June 2-5	Berkeley, California	p. 1058
October 2-3	Syracuse, New York	p. 1059
October 9-10	Los Angeles, California	p. 1059
October 29-31	Notre Dame, Indiana	p. 1059
November 6-7	Richmond, Virginia	p. 1060
2011		
January 5-8	New Orleans, Louisiana Annual Meeting	p. 1060
March 12-13	Statesboro, Georgia	p. 1060
March 18-20	Iowa City, Iowa	p. 1060

Eastern Section: Steven H. Weintraub, Department of Mathematics, Lehigh University, Bethlehem, PA 18105-3174; e-mail: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: Matthew Miller, Department of Mathematics, University of South Carolina, Columbia, SC 29208-0001, e-mail: miller@math.sc.edu; telephone: 803-777-3690.

2009 Seoul, Korea Meeting: Georgia Benkart, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

April 9-10 April 30-May 1 December 15-18	Worcester, Massachusetts Las Vegas, Nevada Pucon, Chile	p. 1060 p. 1061 p. 1061
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January 4-7	Boston, Massachusetts Annual Meeting	p. 1061
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January 10–13	San Antonio, Texas Annual Meeting	p. 1062
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January 6-9	Seattle, Washington Annual Meeting	p. 1062
2016		
January 4–7	Atlanta, Georgia Annual Meeting	p. 1062

Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 89 in the January 2009 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of LATEX is necessary to submit an electronic form, although those who use LATEX may submit abstracts with such coding, and all math displays and similarily coded material (such as accent marks in text) must be typeset in LATEX. Visit http://www.ams.org/cgi-bin/ abstracts/abstract.pl. Questions about abstracts may be sent to abs-info@ams.org. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

Conferences: (see http://www.ams.org/meetings/ for the most up-to-date information on these conferences.) Co-sponsored conferences:

March 18-21, 2010: First International Conference on Mathematics and Statistics, AUS-ICMS '10, American University of Sharjah, Sharjah, United Arab Emirates (please see http://www.aus.edu/conferences/icms10/ for more information). June 17-19, 2010: Coimbra Meeting on 0-1 Matrix Theory and Related Topics, University of Coimbra, Portugal (for more information please see http://www.mat.uc.pt/~cmf/01MatrixTheory).

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Model and Data Hierarchies for Simulating and Understanding Climate

Los Angeles, California

March 8 – June 11, 2010

MMITTEE: BJORN STEVENS (Max Planck Institut für Meteorologie/ UCLA), RUPERT KLEIN (Freie Universität Berlin), AMY BRAVERMAN (Jet Propulsion Laboratory), OLIVIER PAULUIS, (Courant Institute), ANDREW J. MAJDA (Courant Institute)

Scientific Overview

Simulation has greatly advanced climate science, but not sufficiently to the profit of theory and understanding. How can simulation better advance climate science and what mathematical issues does this raise?

Our hypothesis is that the development of climate science (i.e., theory and understanding) will be best served by focusing computational and intellectual resources on model and data hierarchies. Where "model and data hierarchies" refer to successively more complex models, or data structures, and the relations among them. Classic examples are the equations that emerge at different order in an asymptotic expansion; or microscopic, mesoscopic, macroscopic representations of systems that emerge in statistical physics and material science. In the atmosphere/ocean system such approaches lead to familiar families of equation sets used to explore specific phenomena, and the statistical theories (parameterizations) used to close the systems which emerge at different orders; but such ideas are also relevant to the data used to test such systems.

Workshop Schedule

- Tutorials: March 9 12, 2010
- Workshop 1: Equation Hierarchies for Climate Modeling, March 22 26, 2010
- Workshop 2: Numerical Hierarchies for Climate Modeling, April 12 16, 2010
- Workshop 3: Simulation Hierarchies for Climate Modeling, May 3 7, 2010
- Workshop 4: Data Hierarchies for Climate Modeling, May 24 28, 2010
- Culminating Workshop at Lake Arrowhead, June 6 11, 2010

Participation

This long program will involve a community of senior and junior researchers, including mathematicians, physicists, engineers, statisticians and climate scientists. The intent is for participants to learn about new mathematical developments in the area of simulating and understanding climate, to meet a diverse group of people, and have ample opportunities to form new collaborations.

Full and partial support for long-term participants is available. We are especially interested in applicants who intend to participate in the entire program, but will consider applications for shorter periods. Funding is available for participants at all academic levels, though recent PhDs, graduate students, and researchers in the early stages of their careers are especially encouraged to apply. Encouraging the careers of women and minorities is an important component of IPAM's mission and we welcome their applications. More information and an application is available online.

www.ipam.ucla.edu/programs/cl2010





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For access check with your librarian

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2009. Approx. 430 p. 21 illus. (Undergraduate Texts in Mathematics) Hardcover ISBN 978-0-387-79147-0 ► Approx. \$59.95

Mathematica in Action The Power of Visualization

S. Wagon

This is not only an introduction to Mathematica 6.0, but also a tour of modern mathematics. Wagon explores some of the most important areas of modern mathematics with new chapters on optimization and linear and integer programming. Connections are also made to computer science with new material on graphs and networks.

3rd ed. 2010. XVI, 658 p. 531 illus., 16 in color. With CD-ROM. Softcover ISBN 978-0-387-75366-9 ► Approx. \$69.95



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