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For Whom the Bell Tolls

The mathematics profession faces new and disturbing challenges. We must consider how to maintain and propagate our numbers. Fifty years ago the student who had a proclivity for strict analytical thinking naturally gravitated to a career in mathematics. The curriculum held few other choices that offered the rigor and the challenges of classical mathematics. The situation has now changed.

Today the student with mathematical talent can consider a career in bioinformatics, genomics, proteomics, financial derivatives, biostatistics, biomedical engineering, computer science, and—well, need I go on? Gone are the days when a student with mathematical training could only teach. The choices today are copious and baffling in their diversity and their myriad rewards (pecuniary and otherwise). Mathematics does not compete well in the marketplace of high-impact, money-driven pseudodiscourse. Couple this with the fact that we have never been any good at selling ourselves, and we clearly have a significant conundrum.

And the American students that we do attract do not seem to have the fire-in-the-guts that perhaps you and I had thirty-five years ago. When I went off to graduate school, I knew that this—getting a Ph.D. in mathematics—was something that I had to do. If I could not do mathematics, then I did not care what I did. I rarely see this sort of passion in today’s students. American students especially seem to be bewildered, and therefore their focus is diluted, by the plethora of life choices that they face.

Today’s students have grown up in an age of intellectual relativism that suggests that marketing software or cloning a gene has the same gravitas as proving a theorem. If people can think that chaos or data mining is actually a subject, then how are we to sell intersection theory or singular integral operators? The fact that mathematics builds vertically often works against us. It means that we have a hard time integrating students into our research programs. And it means that we have a difficult time showing our students—even our graduate students—the delights and compensations of the mathematical life.

Yet teaching and training graduate students remains one of the highest and finest things that we do. There is hardly anything more satisfying than bringing a student from the level of an ill-formed tyro to a polished scholar who is equipped to create mathematics and chart an independent path in the mathematical firmament. But we are not expert at this process. We know how to hand out thesis problems, we know how to answer questions, but how many of us really know how to mentor?

Today we have difficulties retaining students in our graduate programs. Every great religion has a vignette in which the prophet is tempted by mammon, and the prophet usually resists. Our graduate students do not come from such stern stuff, and their temptations are many. When faced with a future that consists of five years as a graduate student, six years as an assistant professor, another six years as an associate professor, and then a long slide toward the grave in a full professorship, the faint of heart will seek other rewards. When the economy is good, a student can major in computer science and get an M.B.A. in a total of about six years and then go off to a well-paying and reasonably rewarding career. Who needs the high-flown rodomontade of classical scholarship?

I, for one, would argue that scholarly work has intrinsic merit. The battle with ideas, the thrill of the pursuit of a new truth, the taming of a beautiful new proof are without parallel in human experience. Yet who among us can instill this euphoria and the passion for it in our youth? Laboratory sciences have much infrastructure, and they assist their students through each step of a graduate program. We mathematicians assign our students a great deal of independence (thinking they are like us), and as a result we lose many along the way.

The path to an established career as an academic mathematician is a long one, fraught with peril. But the rewards are many, it is a satisfying life, and there is frequent serendipity in the practice. It is challenging to find ways to present the old ideas to a new generation of students, it is gratifying to see their eyes light up when they encounter a new idea, and training new scholars works symbiotically with the process of conducting one’s own research program.

One of the comforts of my life is that I have many choices. I do not have to remain a university mathematician. I have other skills. But I cannot think of anything I would rather do. I enjoy being a recognized expert in several areas of mathematics, I enjoy being consulted for my erudition, and I enjoy being a leader in my profession. I am pretty good at what I do, and I like doing something at which I excel and that is recognized by others. This rapture is what we must teach our graduate students. The point of our profession is the sheer joy of being a mathematician. If we cannot communicate that to our progeny, then what good are we?

—Steven G. Krantz
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Letters to the Editor

The Financial Industry

I have worked on Wall Street for over twenty years, and I have been a regular reader of the Notices for many years. It was therefore with interest that I began to read an article on the recent accounting scandals by Mary Poovey in the January 2003 issue. The article ostensibly sets out to criticize the financial industry's use of numbers. In reality, the article takes random potshots at various financial instruments and practices. As I read it I found so many innuendos, unwarranted conclusions, and fantastical elements that I had trouble selecting just a few examples for special criticism; here are three:

1. "At the time Enron was doing all this, of course, all of these instruments, including derivatives, were perfectly legal. Derivatives were developed, in fact, specifically to take advantage of deregulation, which also permitted creative accounting to flourish."

2. "Because of their notional quality and because of the secrecy in which they are typically traded, the volume of derivatives is difficult to measure..."

3. "They are not and never were illegal. Furthermore, derivatives were not developed to take advantage of deregulation, which also permitted creative accounting to flourish."

These statements seem crafted to give the impression that derivatives and such instruments were once illegal but are now legal because of deregulation. They are not and never were illegal. Furthermore, derivatives were not developed to take advantage of deregulation. They were developed and sold as a means to reduce investment risk. Far from requiring deregulation, the trading of derivatives demanded orderly markets, which is possible only with regulation. Options trading is regulated via the exchanges which trade them and via the Options Clearing Corporation (OCC; see www.optionsclearing.com), which acts as a clearinghouse and as a licensing authority over exchanges. All these in turn are tightly regulated by the Securities and Exchange Commission (SEC; see www.sec.gov). Commodity futures are directly regulated by the Commodities Futures Trading Commission (CFTC; see www.cftc.gov), a federal agency.

The human genome has been described, as have the genomes of the fruit fly, yeast, and hundreds of bacteria. Many research centers are extending these results and interpreting the resulting data. In view of the fundamental importance of DNA sequences, it is remarkable that mathematicians have not made more of an effort to introduce and study models of the genetic code.

DNA sequences which perform a function—protein sequences are an important example—are generated by enzymes and hence by a chemical rule. The notion of recursiveness is very broad and surely can describe any sequence of chemicals. Protein sequences, and other DNA sequences, must be recursive. What recursions occur?

What is the linear structure of the genetic code?

The four-letter code for DNA consists of $T = thymine, A = adenine, G = guanine, and C = cytosine. We can model these with any of the rings with four elements: $Z_4, Z_2 \times Z_2, GF(4)$, or $Z_2[t]$ with $t^2 = 0$.

If we choose $Z_4$ as a model, we can set $T = 1, A = 3, G = 0, C = 2$. The involution $x \mapsto x + 2$ models Chargaff's Rules, $T = A, G = C$, which say that in the double helix thymine is always paired with adenine, and guanine is always paired with cytosine.

Computer codes are often constructed by taking a linear recursive sequence (shift register output) and modifying it. Does the cell do this? Which of the four rings above gives the best model for DNA sequences?

The linear structure of the genetic code is Terra Incognita.

—Sherwood Washburn
Seton Hall University
washbush@shu.edu
(Received June 3, 2003)

Models for the Genetic Code

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—Sherwood Washburn
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washbush@shu.edu
(Received June 3, 2003)
The Carnegie Initiative on the Doctorate: The Case of Mathematics

Hyman Bass

The Carnegie Foundation commissioned a collection of essays as part of the Carnegie Initiative on the Doctorate (CID). Essays and essayists represent six disciplines that are part of the CID: chemistry, education, English, history, mathematics, and neuroscience. Intended to engender conversation about the conceptual foundation of doctoral education, the essays are a starting point and not the last word in disciplinary discussions. Those faculty members, students, and administrators who work in the discipline are the primary among multiple audiences for each of these essays. © 2003 by the Carnegie Foundation for the Advancement of Teaching, reprinted with permission.

Comments on the essays and on the CID are welcome and may be sent to cid@carnegiefoundation.org. Further information may be found at the website http://www.carnegiefoundation.org/cid and in the article “The Carnegie Initiative on the Doctorate”, by Allyn Jackson, Notices, May 2003, pages 566-8.

The other Carnegie essay about mathematics, by Tony Chan, will appear in the September 2003 issue of the Notices.

—Allyn Jackson

Introduction

Mathematics is a discipline—a domain of knowledge, an intellectual heritage with ancient roots, with language and methods for analysis and understanding of aspects of the worlds that we inhabit and experience. And mathematics is now as well a profession—an intellectual community dedicated to knowledge generation, application, conservation, and transmission, interacting with other domains and institutions of learning and with the larger society. My thesis here is that, historically, the disciplinary perspective of mathematics has dominated and largely shaped the design of doctoral programs. The professional aspects of mathematics have gradually come into prominence over the past half-century, sometimes haltingly, and with mostly ad hoc adjustments in education and practice. Mathematics departments have mainly responded to immediate environmental pressures—of resource availability and the professional marketplace—without much broad reflection on the proper meaning and purpose of the mathematics doctorate in today’s world. I argue here that we should build on the proven strength of the discipline-focused doctoral training and develop scholars who are also professionals with a sense of calling that I shall begin to elaborate below. It is this view rather than transient market and resource pressures that can best guide our rethinking of the doctorate in mathematics.\(^1\) The ideas advanced here are less conclusions than

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\(^1\) Mathematicians are the primary among multiple audiences for this essay. This is my excuse for occasional use of technical terms of the field in an essay otherwise intended for a broad intellectual audience concerned with doctoral programs.

\(^2\) In the COSEPUP (Committee on Science, Engineering, and Public Policy) Report, “Reshaping the Graduate Education of Scientists and Engineers”, (National Academy Press, 1995) [2], a related distinction was made between preparation for academic research within the discipline and preparation for applied research in industry, government labs, etc. That report similarly proposed a better-integrated and more versatile preparation for these two kinds of career trajectories. (See [6].) Earlier discussions of the mathematics doctorate can be found, for example, in [8], [3], and [5].
prompts for a broad-based professional conversation about the doctorate in mathematics.

What is driving the need for change? Partly responsible is the intellectual growth in the discipline, as new ideas, methods, and instruments open up unexplored mathematical landscapes of both theory and application. But at least as important are demographic and economic pressures. Mathematics and science undergird the growth and development of modern technology and industry. Everything from security to commerce to health now rests inextricably on scientific foundations. This involves mathematics both as a direct producer of marketable ideas and applications and as an enabling discipline for all of the other sciences: physical, life, and social. As the whole scientific enterprise thus expands and intertwines with economic and social needs, there is a corresponding growth in the building of human capital and thus of the professional communities webbed in this complex system. The professional mathematics community has fully participated in this growth. Moreover, it has been not only a protagonist but, more intensively than the other sciences, a primary resource and agent for quantitative education at all levels.

The human expression of this growth and evolution is, first of all, a long-term increase in the sheer number of persons who characterize themselves as mathematicians or as involved in mathematically intensive professions. Second, the variety of professional environments in which substantial mathematics is practiced has greatly expanded well beyond the academic settings—themselves now more diverse—that historically employed the vast majority of mathematics doctorates. This demographic change alone already calls for increased professional infrastructure and function (e.g., expanded instructional mission, more publications and journals, more conferences, new institutes, more robust professional organizations, greater

3 From 1862 to 1933 there were about 1,300 U.S. mathematics Ph.D.'s earned. Only 16 percent of these published more than five papers, and more than half published none [8]. During the 1950s Ph.D. production increased sevenfold; during the post-Sputnik 1960s it increased from 500 to 1,250 annually. In the 1970s and 1980s there was re-trenchment in response to funding reductions and a saturated academic marketplace. About 25 percent of the Ph.D.'s found positions in doctoral-granting departments; the others in liberal arts colleges and nonacademic settings. There was brief but aborted consideration of a non-research Doctor of Arts degree. In 1999-2000, 1,127 mathematics Ph.D.'s were earned. Barely half of these were U.S. citizens, and many of these were Asian. The number of women is still too small but has been growing. There are hardly any Blacks or Hispanics. (See [5] and [3]).
Wigner's evocation of the means of mathematical proof. The discipline of mathematics as a discipline. This perspective, whose validity endures but whose incompleteness for doctoral preparation is increasingly evident, has historically dominated thinking about the doctorate. Following that I discuss the profession of mathematics as it has currently evolved. With this background I then propose one vision of "stewardship" of mathematics. I deliberately choose not to say "of the discipline of mathematics," since I intend this concept (of stewardship) to embrace the professional as well as disciplinary aspect of the field. In a final section I outline some implications of this perspective for the design of doctoral programs in mathematics.

The Discipline of Mathematics

The discipline of mathematics as a deductive science has its roots mainly in Greek antiquity. Geometry for our Greek forebears was considered empirical in content, being a theory of the physical space that we inhabit, but deductive in method. Euclidean geometry took as a logical point of departure a small set of propositions (axioms) deemed to be "self-evident" and thence eschewing all reasoning making appeal to actual physical sense or measurement. The extent to which Euclidean geometry models physical reality is a scientific, not a mathematical, question. But the deductive axiomatic method modeled by the intellectual development of Euclidean geometry remains a cornerstone of the mathematical paradigm. Mathematics today includes deductive explorations of its own internal worlds in their own terms. The extent to which these mathematical worlds reflect, or model, some natural reality may account for the external utility of the mathematics but is not essential to the logical coherence or significance of the mathematics within the discipline. Nonetheless, most mathematical theories have their historical roots in problems arising from empirical science, and even the "purest" of mathematical theories often reconnect in unanticipated ways with the external world, constantly reinforcing Eugene Wigner's evocation of the "unreasonable effectiveness of mathematics" [10]. We are repeatedly reminded that mathematics seems to be the spring of Nature's idiom.

The characteristic that distinguishes mathematics from all other sciences is the nature of mathematical knowledge and its certification by means of mathematical proof. On the one hand, it is the only science that thus pretends to claims of absolute certainty. On the other hand, this certainty, which is self-referential, is gained at the cost of logical disconnection from the empirical world. As Einstein put it, "As far as the properties of mathematics refer to reality, they are not certain: and as far as they are certain, they do not refer to reality" [4]. This explains a fundamental contrast between mathematics and the scientific disciplines. Mathematics and the physical sciences honor very different epistemological gods. Mathematical knowledge tends much more to be cumulative. New mathematics builds on, but does not discard, what came before. The mathematical literature is extraordinarily stable and reliable. In science, in contrast, new observations or discoveries can invalidate previous models, which then lose their scientific significance. The contrast is sharpest in theoretical physics, which historically has been the science most closely allied with the development of mathematics. The mathematician I. M. Singer once compared the theoretical physics literature to a blackboard that must be periodically erased.

Some theoretical physicists—Richard Feynman, for instance—enjoyed chiding the mathematician's fastidiousness about rigorous proofs. For the physicist, if a mathematical argument is not rigorously sound but nonetheless leads to predictions that are in excellent conformity with experimental observation, then the physicist considers the claim validated by nature, if not by mathematical logic. For the physicist, nature is the appropriate authority. The physicist P. W. Anderson once remarked, "We are talking here about theoretical physics, and therefore of course mathematical rigor is irrelevant."

On the other hand, some mathematicians have shown a corresponding contempt for this free-wheeling approach of the theoretical physicists. The mathematician E. J. McShane once likened the reasoning in a "physical argument" to that of "the
woman who could trace her ancestry to William the Conqueror, with only two gaps.\footnote{This debate about the norms for mathematical claims based on sophisticated physical heuristics has been recently reawakened by the dramatic and paradigm-challenging commingling of fundamental particle physics with the most advanced levels of geometry. A remarkable record of views on this philosophical issue has been assembled in the Bulletin of the American Mathematical Society; see, for example, Vol. 29, No. 1, July 1993; and Vol. 30, No. 2, April 1994.}

The development of mathematics as a deductive science is more complex than my simple account suggests. Many central mathematical theories were first developed quite far largely on the basis of deep physical or other intuitions prior to being put on rigorous logical foundations. Moreover, even the foundations of mathematics and logic have weathered turbulent shocks and tensions, for example, from the work of Gödel and later the constructivist doctrines. But these foundational crises have not functionally undermined the basic deductive ethos of working mathematicians. The mathematician André Weil once characterized logic and foundations as the “hygiene” of mathematics, not its heart and soul.

A more recent development is the influence of technology and its essential use in the construction of some important mathematical proofs. The notion of mathematical proof is a precise theoretical construct, but it is quite formal, rule bound, and ponderous. Mathematicians typically do not produce such formal proofs, but rather convince expert colleagues essentially that such a proof exists, the presumption being that the conviction carries the belief that under duress and with sufficient time such a proof could be supplied by the proponent. Here we glimpse the boundary of mathematics as a discipline—as a set of theoretical ideas—on the one hand and as a profession—as a human practice—on the other. When a “proof” is reduced to checking a finite but large set of critical cases and this checking is within range of machine computation but beyond reasonable human capacity, what then is the standing of the computer-reliant argument? Notice that this question is not strictly a mathematical one, but one about the intellectual sociology, norms, and methodology of practice.\footnote{See \cite{9} for an insightful reflection on these issues.}

So much for the deductive methodology of mathematics. What about the content, the subject matter of the discipline? How has that changed? Many mathematicians hold deep convictions about the fundamental unity of the discipline. The grand themes—number, space, change, and (more prominently in recent times) chance—are often just different perspectives on or representations of the same phenomena, focusing on somewhat different kinds of questions. These themes are sometimes associated with the respective names—algebra, geometry, analysis, and probability/statistics. What has changed is the appearance of new or rejuvenated areas of investigation within the discipline and also vastly expanded interdisciplinary interaction with other domains of science and technology.

Much of this has been spurred by the availability of powerful computers and sophisticated mathematical software for computation, exploration, modeling, and simulation. The latter, which are founded on mathematically designed software, have become a fundamental paradigm in virtually all of science and industry. For example, aircraft prototypes are now virtually tested on computer screens, not physically built and tested in wind tunnels. It is easy to envisage the cost reductions and design leverage thus gained.

The new frontiers of mathematics investigation and application are too numerous to list, but we can mention a few noteworthy examples. The theory of dynamics and complex systems—studying the long-term evolution of systems governed by even relatively simple nonlinear laws—stalled in the 1920s for lack of computational capacity. The use of computers here, comparable with the introduction of telescopes into astronomy, has supported an explosive rebirth and expansion of the subject, including the visual discovery of stunning fractal geometries. Coding theory and cryptology, dealing with historic questions of reliability and security in the public transmission of information, now rests on the use of sophisticated tools from number theory and algebraic geometry. Theoretical computer science is founded on discrete mathematics and has given birth to the new mathematical domain of complexity theory which offers precise mathematical measures of the difficulty of certain classes of computations, which in turn is one of the foundations for the design of public key encryption systems. Quantum models of computation (not yet physically realized) are being theoretically developed and shown to support practical algorithms for problems known to be intractable by conventional computers. Methods of geometry and analysis have supported the design of noninvasive medical diagnostics. Signal and image processing have achieved dramatic applications using methods from analysis and statistics. Mathematical biology now incorporates tools from fields like topology and dynamics as well as traditional fields like fluid mechanics. Mathematics of finance has become a thriving field of application, providing widely used mathematical tools to Wall Street. And at the more theoretical end, there has been a virtual merger of fundamental particle physics with some of the most sophisticated branches of geometry and topology, with fascinating shifts in the traditional paradigms of knowledge generation.
The overriding message from all of these developments is that mathematics is much more “out in the world” than it was even a quarter of a century ago. There are more directions of exploration within mathematics, with a greater diversity of tools and methods; there are substantial interdisciplinary interventions of mathematics in a variety of fields; the utility of mathematics for many problems of science and society is increasingly evident; and mathematics has a growing presence in administrative and policy environments, both in universities and at the national level. Finally, the mathematics profession has a growing responsibility for helping to improve the quality of quantitative education in the nation’s schools, a task that can fruitfully be viewed as another site of interdisciplinary mathematics. Awareness of this outward reach must newly figure in the design of doctoral programs.

The Profession of Mathematics

Mathematics Work Environments

Historically, the doctoral program in mathematics was designed to be an apprenticeship into the research practice of an academic research mathematician. Its general form, if not the fine details of its structure, was remarkably similar across research-intensive universities. Foundational knowledge, typically gained in the first year or two of courses, covered algebra, analysis (real, complex, functional, and differential equations), and topology/geometry. This was certified by passage of qualifying examinations and often earned a master’s degree in passing. The next stage was more advanced elective course taking and seminar participation, leading to selection of an area of research and an advisor, perhaps following a second research preliminary examination. The final stage was framing a doctoral research project, carrying out the research, and writing the dissertation under the guidance of one’s advisor. In the past there were also requirements for reading knowledge of as many as two of the major languages of the mathematical literature. These have recently been considerably relaxed, if not eliminated. The final passage is the dissertation defense, typically at the conclusion of four to seven years of study.

Imagine that this newly minted doctoral student gains a faculty position in a similar doctorate-granting, research-intensive mathematics department. What are the components of her professional work, life, and responsibility? First and foremost in the culture of her professional formation is the active production and publication of original mathematics research. Second, and at least as demanding in time and effort, is teaching, mostly undergraduate and frequently calculus. Other aspects of her scholarly work might eventually include participating in and running research seminars; mentoring graduate students; writing mathematics papers; interacting with journal editors; peer reviewing of papers and research proposals of others; keeping up with the research literature related to her field; preparing and submitting research proposals for funding support; participating in research conferences, perhaps helping organize them; joining professional organizations; and writing reference letters for students and colleagues. She would be expected to serve on departmental or university committees and to work on committees of state or national organizations. At later stages of her career she might take on major administrative responsibility in the department as chair or director of the graduate or undergraduate program. She might also be enlisted as a journal editor or for work in policy environments or as staff in a federal research agency or as an officer of a professional organization.

It is interesting for us to consider along this spectrum of potential professional activities those for which her doctoral program provided explicit and substantial preparation. Foremost is the preparation for doing original research: selecting and framing research questions; assimilating the immediately relevant literature; strategizing the work; using imagination; diligently and productively enduring frustration; and finally, finding new results, organizing and clearly articulating them, and providing for them well-presented documentation and exposition. In the traditional value system of disciplinary mathematics, this performance of creative scholarship far outweighs all others combined. It is considered the most noble of professional achievements.

Teaching, which typically occupies about half of her working time, is belatedly gaining an improved status in the professional value system. But traditionally it was considered a professional duty (one spoke of “teaching loads” but not of “research burdens”) whose most dignified aspect was the instruction of mathematically talented and motivated students whom one tried to nurture and induct toward advanced mathematics study. Currently, the quality of mathematics instruction for all students is taken much more seriously, not least because of external pressures. Mathematics faculty members are now expected to provide high-quality mathematics instruction across the board, and they are held accountable for this in the prevailing hiring, promotion, and reward system. At the same time, it is often tacitly assumed that rigorous and deep understanding of disciplinary mathematics, coupled with injunctions to communicate it clearly and coherently to students, suffices to produce quality instruction. The “transfer model” of learning implicit in this Platonic way of thinking treats knowledge as a commodity that the professor carefully delivers to the student, considered as
a vessel expectantly waiting to be filled. Until recently it was hardly acknowledged that teaching entails knowledge and skills that are more than academic subject matter knowledge combined with formally lucid exposition and a sympathetic disposition toward students. In fact, it involves a kind of knowledge of mathematics itself that is distinct from what research mathematicians require for their research or typically know. Moreover, it is only recently recognized that this knowledge and skill can be taught and learned. Apart from a minimally mentored apprenticeship through teaching assistantships or graduate instructorships, scant professional development for the work of teaching has been provided to doctoral students in most mathematics departments. Similarly, the skills of mentoring graduate students are, like those of teaching, typically (and imperfectly) gained by imitating the observed models of one’s own mentors.

Beyond these two domains—research and teaching—what preparation was provided for the other aspects of our new Ph.D.’s professional life and work? A good initiation into tracking the research literature and participation in research seminars will have been provided. These activities, integral to the dissertation research, are among the vital practices of the ongoing intellectual life of a research mathematician. But there remain numerous other basic professional functions for which little or no mentoring may have been provided. These include the more refined skills of scientific writing, interaction with editors, preparing peer-review evaluations and letters of reference, and the preparation and submission of research proposals. Some mentoring for these activities may be picked up as part of a postdoctoral appointment, but unevenly so. Virtually no preparation, nor even consciousness-raising, is made for possible administrative or other leadership or public roles. Nor is there much cultivation of an expected participation in the larger mathematics community, for example, in the professional organizations or as staff in federal research agencies.

The preceding discussion was predicated on our new Ph.D. having joined a doctoral-granting, research-intensive mathematics department. Two other major kinds of career launches have to be considered as well: academic appointment in a less research-intensive mathematics department—for example, in a liberal arts college—or nonacademic appointment as a mathematics specialist in some industrial or other private sector setting. Moreover, her lifetime career trajectory may well include passages in a mix of such environments. They each place many of the same demands on our new Ph.D. that were discussed above, but perhaps with different emphases and priorities. In the first kind of example, research and intellectual vitality remain important to varying degrees, but much greater emphasis tends to be placed on teaching, interaction with students, and service to the department and to the university or college. In the second, nonacademic, types of settings, the mathematical activity tends to be interdisciplinary, and then of course there is need to gain some functional knowledge of one or more outside fields of mathematical application. This kind of work is often part of a collaborative team effort, so that relational skills come into play. Moreover, the demands of effective communication of technical knowledge among others with a very different professional culture and language present a major challenge. It is worth noting that these demands are not unlike those of effective teaching. Again, the doctoral program likely provided very little professional development for these kinds of skills, dispositions, and sensibilities.

**Mathematicians in the World at Large**

Our portrait of the professional life of a mathematics Ph.D. has consisted so far of a survey of the diverse demands and responsibilities of the kinds of work environments in which she would likely find herself. Missing from this is a sense of what is, or might be, the sense of personal agency and professional identity that our Ph.D. carries into the outside world at large. Neither our profession nor our doctoral departments have devoted much conscious reflection to these issues, and hence these have not been cultivated in our doctoral programs.

What professional identity does a traditionally trained mathematician Ph.D. carry, at least ideally? Being a mathematician incorporates a deep and expert knowledge of some significant domain of mathematics, including its epistemology and research methods. This is situated within a broader knowledge of the history and grand intellectual currents of the discipline, including their historic connections with the allied natural sciences, particularly physics. Today, more and more, the mathematician should have some functional knowledge of active interfaces with other disciplines and of important areas of application of mathematical methods. This ensemble of resources provides the mathematician with a rich cultural awareness of the discipline, with the tools and skills for the generation of new mathematical knowledge, and with the
skills and expert knowledge for selected interdisciplinary work environments or institutional settings. Finally, the mathematician should be a competent teacher in academic settings and communicator in interdisciplinary settings. This collectively describes a professional identity founded on a deep enculturation into the intellectual traditions of the discipline and, further expanded by the demands and vicissitudes of the job market, the mathematician serving as supplier of expert skill and communicator of technical knowledge to needy consumers.

This portrait includes some, but not all, of the roles which “stewardship of mathematics” might encompass. What significance does being a mathematician carry in the larger society and culture? In what ways does a mathematician function as a representative of the discipline in public arenas? What are its dimensions of social responsibility and of cultural and aesthetic expression? To prompt our thinking about these questions, we might consider other professions in which this sense of professional belonging, presence, and purpose is more easily recognized and appreciated. Medicine is a profession of health and healing guided by the Hippocratic Oath. While each physician pursues a specialized practice, this practice is situated in a larger sense of belonging to a professional community with a collective social mission of human betterment, of which each practitioner is a contributor, advocate, and representative. Law is similarly a profession of diverse expert practices but which carries with it a sense of stewardship of the political institutions on which our system of social organization and justice is founded. Architects provide expert technical and aesthetic skills, but these are expressions of an ancient legacy of the design and function of public and private physical environments to support and harmonize with human need and social purpose. And of course creative artists—writers, composers, performers—have a deep sense of how their well-honed craft serves large goals and needs of human social and cultural enrichment, of awakening emotions, and of elevating an awareness of the basic human condition.

What is the larger social and cultural significance of mathematics that the public should know and appreciate and that professional mathematicians could represent? Many current conditions beg for some compelling answers to this question: the existence and growing scale of our professional community, supported by public resources; the pervasive, though not highly visible, enabling roles of mathematics in every domain of science and technology; the many years of mathematics instruction as a basic literacy required of all school children. These conditions all speak to the implied importance of mathematics. Yet few mathematicians can furnish intrinsic explanations of this that would be compelling to most well-educated adults who, in the U.S., often boast of their mathematical weaknesses. Indeed, mathematicians may well be challenged even to provide convincing arguments to themselves, arguments that go much beyond the comfortable celebration of the beauty and depth of the core ideas and intellectual architecture of mathematics.

This relatively undeveloped sensibility and skill among professional mathematicians is not merely a matter of benign neglect of their social development and responsibility. It has a direct bearing on the overall long term well-being of the field and of the quality of mathematics education at all levels. It is at the root of the pressing problems of sustaining public resources and of enlisting more, and more diverse, domestic U.S. talent into mathematics and into mathematically intensive professions. It is certainly germane to any conception of “stewardship” of mathematics.

By what means could these larger senses of professional identity find expression beyond the routines of professional practice? In many ways. Op-ed pieces or other public writing and exposition. Public presentations or performances. Participation in civic enterprises such as school boards or cultural organizations. Contributing well-informed advice or service in policy environments and government agencies. And, perhaps above all, through teaching and communicating with the same professional attention and skill that we dedicate to our scholarly research. In each of these instances, one crucial resource is having deep and well-articulated expert knowledge and communicating clearly how this knowledge bears on the issues at hand. But much more skill and sensibility of a more subtle kind come into play. This includes a sense of audiences, of their knowledge and beliefs, and of the kind of language, contexts, and representations they can find comprehensible and persuasive. It includes a sense of norms for disciplined and respectful interaction with people very different from oneself. It includes an appreciation that in civil or cross-disciplinary (as opposed to some scholarly mathematical) discourse, adversarial postures are not a primary virtue but are a last recourse when constructive and collaborative approaches have failed.
Stewardship of Mathematics
As I emphasized at the outset, mathematics is both a discipline and a profession. The discipline of mathematics is a domain of knowledge, with finely developed methods of generation and validation of new knowledge, a noble intellectual heritage with ancient roots, and an unending source of language and concepts for quantitative description and understanding of the world. The profession of mathematics, on the other hand, is a community of human practice, one that generates, validates, synthesizes, conserves, and disseminates mathematical knowledge and practices. "Stewardship" of the field of mathematics must attend to both the strength and integrity of the disciplinary culture and to the health and integrity of the professional community. This may seem self-evident, since each essentially depends on and reinforces the other. However, a main purpose here is to give the professional face of this a visibility that has been largely lacking.

A steward of mathematics must have a deeply developed sense of intellectual and professional mission and community. This is operative in an expanding progression of spheres of professional life and activity.

At the most immediate and familiar level, a mathematician belongs to the community of research scholars in her area of specialization, colleagues with whom she intellectually identifies and communicates via correspondence, shared manuscripts, conferences, etc. This is situated within the larger mathematics research enterprise. Though any single mathematician is active in no more than a small number of sites of this work, mathematicians recognize the local cohesion and interdependence of the ensemble of this work, and this manifests itself in the lack of parochialism in the advocacy (for example, to federal agencies) of support for the field. One expression of this community participation is active membership in and support of the work of the professional organizations in the field.

In a similar vein, as a member of a university mathematics department, mathematicians face a different terrain of collective mission, this time embracing not only diverse mathematical specialties but also interdisciplinary connections with other units and programs, the immense teaching enterprise for which every mathematics department is responsible; and the larger intellectual, instructional, and administrative needs of the university environment. The individual mathematician is actively engaged with only a few components of this vast portfolio of responsibilities. A mathematics department is not a single purposeful agent with a focused agenda. What makes it a cohesive intellectual and professional community is that each member feels the collective responsibility for and commitment to the whole departmental mission, in the sense that each member respects and supports each aspect, whether directly involved in it or not.

Finally, the mathematician as scholar and teacher, may function within the larger society in diverse areas of policy and outreach—federal funding of research; education at all levels; technical legislation and regulatory policies; public communication about the nature, significance, and evolution of mathematics and its applications.

If doctoral programs are to produce "stewards of mathematics", then what are the capacities that comprise this? In the view that I have espoused here, the following should be prominent in that list:

- Mastery of the core foundational knowledge of the discipline, including a broad sense of its historical evolution.
- Command of the methods of mathematical inquiry and of certification of new knowledge.
- A deep and expert knowledge of at least one specialized area of mathematics at a level supporting the capacity for original research, including a knowledge of how this area is situated in the larger mathematical landscape in relation to other fields, and a thorough knowledge of the immediately relevant literature.
- A sense of discrimination and judgment of the significance and depth of new mathematical problems and results.
- Skills of scientific documentation and written exposition.
- Facility in the use of the mathematical literature, including an informed awareness of its scope, organization, and editorial and reviewing practices.
- Knowledge, and mastery in some cases, of some basic uses of technology in mathematics, including uses of the Web, electronic manuscript preparation, computationally supported research, and instructional uses of technology.
- The ability to frame and draft proposed programs of research for outside funding.
- Finely developed and adaptable skills for teaching mathematics at diverse levels, from introductory undergraduate courses to advanced graduate research courses and seminars.
- The ability and disposition to mentor research students and young faculty.
- A general cultural knowledge of the range of mathematically intensive fields and of the ways that mathematics is used in various human endeavors, and with what applications, perhaps including some in-depth knowledge in one or two cognate areas.
- Skills of communication of and about mathematics to diverse audiences.
The Design of Mathematics Doctoral Programs

What does all of this say or imply about the design of doctoral programs in mathematics? Let us summarize some of the main features proposed here.

The strength and soundness of the traditional research training in the core areas of the discipline should be preserved. This is training that emphasizes both a broad and unified global view of the discipline and the need for deep knowledge and original scholarship in some specialized area. In addition, opportunities for interdisciplinary learning and research should be available and sanctioned, if not required. Because of the increasing role of data analysis in applications of mathematics, some exposure to probability and statistics should now be a part of every mathematician's preparation.

Doctoral programs should further recognize the critical role of teaching in a mathematician's career. For this it does not suffice to provide graduate teaching experience. Much more serious attention needs to be paid to professional development for this work, and this is an area where involvement of expertise from mathematics education would be useful and appropriate.

Development of competencies with the diverse uses of technology for document preparation, for research, and for instruction should be provided. Attention should be given to the development of skills in scientific documentation and written exposition. Students should learn to navigate and use the mathematical literature and the protocols of scientific publication and reviewing. Mentoring should be provided for the process of framing a research program and of preparing and submitting a proposal to a funding agency for its support.

Students should be given more explicit awareness of the infrastructure of their diverse professional environments, and of the resources and services that sustain them. This includes the mathematics department within the university environment and, on the outside, the disciplinary community, its organized activities, and the organizations and institutions that sponsor them. Students should be able to anticipate and appreciate the professional roles that they will eventually play in these spheres.

Finally, doctoral programs should more self-consciously and creatively confer a strong sense of cultural awareness in students of the significance of their discipline in the larger worlds of science and society and of the expectation that they will serve as emissaries of their discipline in the outside world. One concrete way that this might be done is in the form of a professional development seminar. The themes of the seminar could include questions in education—for example, a serious inquiry into the nature of teaching, learning, and assessment—or critical evaluation of some curriculum materials. Or the seminar might examine some current area of public policy of concern to mathematicians, in which assignments might include composition of an op-ed piece or a letter to a congressman.

This ambitious list poses a challenging task of program design. Some, but not all, of the items can be treated in a curricular framework, through appropriate course or seminar development. Other aspects might more appropriately be addressed through other professional development kinds of formats. Possibilities include special supervised projects or brief internships, perhaps in the context of a one-credit professional development seminar. These might take such forms as immersion in an interdisciplinary project; time spent in an industrial setting or in a school mathematics program; or a small project of analysis and writing about some policy area, for example, in education, in research funding, or about the infrastructure of the profession.

At this point we must confront an obvious and fundamental dilemma. Reform agendas, of which this essay represents one, typically know how to add but not subtract. To an already demanding model of the mathematics doctorate, we have proposed added conditions of performance. Yet the traditional model has already been criticized for the excessive time required. This is a major design challenge. No simple solution exists. This difficulty cannot, however, be an excuse for inaction. The challenge merits broad discussion in the professional community, with perhaps the development of diverse models emphasizing different kinds of orientation. We can likely profit from study of how other fields manage within a fixed time frame to prepare doctoral candidates to enter the profession as well as earn admission to the practice of the discipline.

Conclusion

This essay argues that the traditional doctorate in mathematics has been fashioned almost exclusively on a disciplinary view of the field and that the strength of that model needs to be expanded to encompass the modern evolution of mathematics as a profession. Stewards of mathematics must attend not only to the traditional disciplinary missions of knowledge generation, validation, representation, and dissemination but also to the needs and infrastructure of the professional community of mathematicians, and to the responsibilities of that community to the discipline, to the

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8 Phillip Griffiths has suggested that we have something to learn here from the design of programs in the professional schools.
Surveys in Number Theory
Presented and compiled by a group of experts, these papers provide a current view of the state of the art and an outlook into the future of the subject.

Surveys in Number Theory... collects only those papers that might be of interest to a wider range of readers. There are several very nice things in the book. Some of the topics covered are the Riemann Hypothesis, normal numbers, automorphic forms, Iwasawa theory, diophantine approximation, and Waring's Problem. Bjorn Poonen's article on how to compute rational points on curves is particularly good.

— Fernando Q. Gouvêa,
MAA Online Book Review, March 2003

Works Cited
Teaching Mathematics in the United States

Al Cuoco

This article is a "prequel" to the author's article that appeared in the February 2001 issue of the Notices. That article was reprinted subsequently in Italian translation as "La matematica per l'insegnamento", Bollettino della Unione Mathematica Italiana, Sezione A (Decembre 2002), 473-490.

The author wrote the present article for the Bollettino in order to give Italian readers background about the U.S. system of mathematics education. Many U.S. mathematicians themselves have little contact with the public schools. Therefore this article, originally written for a foreign audience, is reprinted here in the expectation that it will also be enlightening to U.S. readers.

This is a companion to my article Mathematics for Teaching. In it I'll set the context for the complex situation in the United States and go on to describe some of the ways in which teachers here are prepared.

One of the most striking features about the U.S. education system at every level is its decentralization. Precollege education (grades kindergarten through 12) is publicly supported through taxes and is compulsory through age sixteen. But there is no national curriculum. Each of the fifty states is free to design its own program, and, while there are state "curriculum frameworks", in most of these states, that freedom is passed on to each city and town. There are several "adoption states" (California and Texas are the largest) in which the state has a list of admissible texts, but they are exceptions; curriculum is largely a purely local choice. In fact, almost everything about schooling seems to be determined locally. For example, each town's teachers have their own union (affiliated with state and national organizations), and each local union negotiates the salaries of its members directly with its town government.

This decentralization is due to the way precollege education is funded. Although the federal government does funnel money to states, most funding for education is raised at the state and local level. My state (Massachusetts) is one of the most extreme in this regard—most public education is funded by taxes on one's property that are paid to the town government. This gives rise to huge differences in education spending, with wealthier towns having much better facilities, teacher salaries, and services. Using Massachusetts as an example again, per-pupil per-annum expenditures range across the cities and towns from about $6,000 to $12,000 if one ignores outliers [16]. Not surprisingly, these figures correlate well with the percentage of graduates who enroll in college—from less than 50 percent to over 95 percent.

The system of undergraduate education is even more complex. For the most part, admission to four-year programs is competitive, and students have to apply to individual institutions. There are private colleges and universities, supported completely by tuition, grants, and private endowments. And there is a parallel system of state colleges and universities, partially supported by tax dollars. All these institutions charge tuition, ranging from about $10,000 per year (including room and board) for state colleges to something close to $35,000 for private universities. These tuitions impose severe financial hardships on students and their families. In many cases where a family has more than one
college-age student, tuition and fees exceed the family's annual income. As a result, there is a vast array of loan programs and scholarships available for needy students. It is not uncommon for a student to graduate facing a $50,000 debt for college loans.

In addition to four-year schools, there is a system of two-year colleges. These usually have open admission, are publicly supported, and attract a wide array of students: students who want preparation for a profession that does not require a four-year degree, students who need some developmental work before transferring to a four-year program, and students who simply cannot afford the expenses of a four-year college. Since most two-year colleges are not residential, tuition is per course, and that averages $300 for a one-semester three-hour course. Many students who attend these schools also hold full-time jobs (more than a few support families), so even this tuition poses a hardship. An estimated 40 percent of teachers take some of their mathematics preparation at two-year schools [24].

Given this organizational patchwork, there is a surprising uniformity in American education. National forces, some of them having little to do with educational principles, tend to smooth out the irregularities of local control.

At the precollege level, one of these forces is the economics of textbook publishing. Publishers invest heavily in meeting the criteria of Texas, California, and other adoption states. As a result, the tables of contents in most major texts closely resemble the union of the curriculum frameworks in these key states. Because state curriculum frameworks have become essentially lists of specific and low-level topics to be covered (e.g., "combining fractions with unlike denominators"), mainstream commercial texts are a collection of loosely related chapters each treating one such topic. As one moves up the grades, the effects of this topic-driven design principle compound. By the time one reaches the fourth year of high school, we find 18-chapter, 700-page compendia of topics that range from triangle trigonometry to data analysis to complex numbers. The de facto national curriculum therefore consists of locally chosen subsets of topics from these texts.

Economic and social forces have, in other ways, always played an important role in public precollege education in this country [1]. On the one hand, working-class parents see schooling for their children as "the great equalizer" and education as a ticket to upward mobility in American society. On the other hand, there are subtle but substantial forces on schools to act as enculturation mechanisms (building "good citizenship"), to maintain economic inequity among various classes, and to produce graduates who fit into a work force that is based on hierarchy. This tension plays out in American classrooms every day: on the one hand, teachers work very hard to help their students become creative thinkers and problem solvers and to build their skills and their self-confidence. On the other hand, a great deal of time is spent ensuring that students learn to submit to authority and to obey an elaborate system of school rules that governs everything from punctuality to personal attire to when one can go to the lavatory.

An extremely potent smoothing force has taken root over the past decade. It is a phenomenon that might be more common in other countries than it has previously been here: the high-stakes exam. Taxpayers, through elected officials, are demanding accountability on the part of what they see as autonomous school departments. So all over the country students are required to pass certain exams before they can move on to the next level of schooling. Typically, there are three such exams in each discipline. In Massachusetts the mathematics exams are given at the fourth, eighth, and tenth grades. Students who do not pass the tenth-grade exam will not graduate from high school until they do pass it. What may be unusual in the U.S. system is that, true to the spirit of local control, every state makes up its own sets of "standards" (usually lists of topics that will be tested at each grade; see [2] for a critique of these documents) and designs its own exams. Proponents of various particular educational philosophies are therefore lobbying in different states to gain influence over those who are in control of the standards and exams. Teachers are under enormous pressure to prepare their students to pass these exams. Students who fail the exams are put into "test-prep" classes that concentrate on the fine points of taking tests. Scores are published in the newspapers, schools are judged by the percentage of students who pass the tests, and the scores of a town's school system have an impact on the real estate values in that town; property values go up in districts with high scores (so they end up with even more resources to spend on education), and underperforming schools experience a drop in real estate values and hence a decline in the tax revenue that can be used to support education.2

Finally, many professional societies are filling the void left by the absence of an official national curriculum. In 1989, in response to a growing dissatisfaction among mathematics teachers in the U.S., the National Council of Teachers of Mathematics

2 Added in May 2003. New federal legislation (the "No Child Left Behind Act") has strengthened both traditions of local control and high-stakes accountability: more of the federal education budget is being distributed to individual states, and in return states are being required to greatly increase their testing programs and to provide (quantitative) evidence of success for funded programs.
(NCTM) published its *Curriculum and Evaluation Standards* [20]. While not a curriculum, this publication called for more student-centered, activity-based programs for children and a diminished emphasis on rote memorization and technical drill. The *Standards* spurred an enormous amount of activity in curriculum development, in teacher preparation, and in professional development programs for practicing teachers, and it became the model for state frameworks and standards. The National Science Foundation (NSF) invested heavily in innovative curricula that gave specificity to the NCTM *Standards*. The *Standards* also spurred a substantial backlash to some of the more extreme interpretations of the report; more about this in the section on politics. A recent and extensive revision [21] attempts to fine-tune some of the recommendations and address some of the excesses that were carried out in the name of the original.

The American Mathematical Association of Two-Year Colleges produced a similar set of guidelines [3], and the Conference Board of the Mathematical Sciences, an umbrella organization for sixteen professional societies, has just published a set of recommendations [4] for the mathematical preparation of teachers. We will look more carefully at that in the section on teacher preparation.

Even though there is no national curriculum, federal agencies, especially the National Science Foundation and the U.S. Department of Education, are heavily involved in improving mathematics education across the country. NSF supports the development of curricula, professional development programs for practicing teachers, and innovations at the teacher-preparation level, and it is especially interested in increasing the mathematical competence of the teaching profession. Both agencies fund research aimed at finding more effective teaching methods and at obtaining better understanding of how young students come to understand mathematics.

So, overlaid on the collage of local decision making and control is a web of forces that tend to blur distinctions and to make the effect of education fairly uniform. That is why, for example, in *Mathematics for Teaching* I can point to what seems to be pervasive phenomena in the mathematics classrooms of teachers who, on the surface, seem to have had preparations that are quite varied. In the following sections I will elaborate a bit more on these similarities, especially as they pertain to mathematics teaching and teacher preparation.

It goes without saying that what follows is just the perspective of one person, clouded by a rather idiosyncratic (and therefore, by the above remarks, rather typical) indoctrination into mathematics education. Other perspectives abound (see [9], for example).

### The Profession

The structures and forces described in the previous section tend to shape the teaching profession in several ways. In this section I will concentrate on teaching at the high school (grades 9–12) level, because that is the level with which I am most familiar.

The tradition of local funding for education has a direct impact on teachers' working conditions and salaries. With notable exceptions (in wealthy suburbs), starting mathematics teachers can expect to earn 50–75 percent of the starting salaries for the other professions that attract mathematics majors. Salary increments are a function of both years on the job and postgraduate courses. These postgraduate increments are for any kind of course taken, and a whole industry has grown up that provides teachers with convenient workshops, day-long seminars, or weekend courses that advance them on the salary scale. These courses vary widely in quality and intensity, and they are often devoted to teaching techniques, use of technology, or classroom management. The professional development courses in mathematics that I describe in *Mathematics for Teaching* are among the rare exceptions to this statement.

In Massachusetts yearly salary increments are negotiated between the local unions and the local school boards, so they have to compete with similar negotiations with other unions and with the local operating budget and tax base, both of which are constrained by law (in Massachusetts a town’s budget cannot increase more than 2.5 percent per year without a very-difficult-to-obtain “override”). It is not uncommon for negotiations to produce no raise at all for several years in a row.

A typical school day starts between 7:00 and 8:00 a.m. and runs through midafternoon. Teachers teach four to six classes each day, usually in three or four different courses. Classes last almost an hour. In addition to their teaching duties, teachers usually spend one class a day “supervising” a study hall or a lunchroom and are given one “free” period to plan lessons and to grade papers. In most districts teachers are required to remain in the
school for the entire school day, even during their free periods. Typical class size is 25-35 students.

Many teachers have developed substantial expertise in the use of technology. There was a period in the 1980s when schools invested heavily in microcomputers, but the educational use of technology has become almost completely confined to the use of calculators: numerical calculators in early grades and scientific (graphing) calculators in later grades. A small percentage of teachers uses dynamic geometry environments, spreadsheets, statistical packages, and even computer algebra systems (CAS). But until these media are available on handheld devices (as several now are), their use in education will remain confined to a small number of enthusiasts. Most uses of these computational environments are as replacements for paper-and-pencil calculations and, especially in the case of geometry, as a means for justifying conjectures. This poses a quandary for many teachers who question the usefulness of many topics they teach in light of the capabilities of mathematical software. This is especially true for the use of CAS technology. I have heard many teachers worry out loud that the existence of CAS environments on handheld devices makes a good deal of the current algebra curriculum obsolete. It is no coincidence that CAS technology has been slow to take root in high schools.

Although some schools use an “integrated” curriculum, the typical high school program still follows the American tradition of four courses: elementary algebra, geometry, advanced algebra, and “precalculus” (a mix of trigonometry, analytic geometry, and function graphing). Students who manage to start the sequence a year early can opt for a calculus course in their last year. Recent trends have infused some of the standard courses with statistics, probability, and combinatorics. As uniform as this sounds, there is wide variation among schools and even within a school. The differences among schools can be related again to the financial resources communities are able and willing to devote to education. The differences within a school are another matter.

There is a widespread belief in the U.S. that the ability to succeed at mathematics is somehow an innate “all or nothing” affair: either you are destined to be a scientist, engineer, or mathematician or you will never be able to understand anything about mathematics. Young children who do not catch on to mathematics (typically arithmetic) at an early age are often deemed mathematically “slow” and are gradually moved into the group of students who “can’t do math”. By the time these students get to high school, many find themselves in the low tier of a tracking system that has as many as five different “ability levels” for each course. While the top few levels usually do a fine job preparing students for college (and even sometimes of giving them a glimpse of what mathematics is about), the lower levels are abysmal rehashes of elementary school low-level topics: the algebra is little more than drill in numerical and symbolic calculations, and the geometry is devoid of proof and consists mainly of vocabulary and practice applying area formulas. Many students in these tracks fail one of these courses and either have to repeat it or drop out of mathematics altogether.

Although students are placed in these low tracks for all kinds of reasons, children from dysfunctional families almost always end up here. These are precisely the students who feel most oppressed by the enculturation function of schools, and, with little support at home and no intellectual satisfaction from their courses, many act out and become difficult to control, a phenomenon that tends to spread outside the classroom. This is the underbelly of American education; it is a primary source of the disengagement from learning that affects too many adults, and it is a breeding ground for a great deal of the violence one reads about in American schools.

I am afraid I have painted a pretty bleak picture of the teaching situation in American high schools. In fact, low pay, oppressive workloads, rigid rules of behavior for students, and extensive sorting of students into tracks by no means exhaust the collection of challenges teachers face. I did not mention the low esteem in which much of the American public holds teachers (Mark Twain had a saying that is very popular in the U.S.: “Those who can, do; those who can’t, teach”), nor did I discuss the fact that many teachers need to hold a second job (usually having nothing to do with education) in order to make ends meet. As I said in Mathematics for Teaching, while the mathematical preparation of teachers is essential to improving American mathematics education, it is in no way the only problem facing our schools, and in many ways it is not the most difficult one.

Nevertheless, there is an attraction to teaching for many of us. I know and work with hundreds of high school teachers, and the vast majority of them are extremely dedicated to their students and view their work as something very important. I have seen some pretty weak mathematics in classes I have visited, and I know a great many teachers who think that their primary job is to help students build “good” values and develop respect for authority, but I have seldom known a teacher who did not care about her students or work very hard to help them succeed.

And, oddly enough, some of the very things that make teaching in this country so frustrating contribute to the attraction of the profession. Let me cite one example from my own background. The administration in my school and the teachers in my department (in a working-class city outside Boston),
in spite of wide differences in philosophies and values, were dedicated to the well-being and advancement of our students. By the time students in the bottom track of the system got to high school, there was little we could do to help them catch up so that they could take upper-level courses. But many of my colleagues and I found it extremely gratifying to work with these students. Because we had the trust of the administration and because, for the most part, we were not preparing these students for college, we could more or less do anything we wanted with them. So, many of the "low-level" courses at my high school turned into problem-solving experiences in which students designed and executed projects, often using the Logo computer language. It caused quite a shift in my approach to teaching when I realized that these students, the ones who "couldn't do math", were every bit as able to think in characteristically mathematical ways as students in my advanced courses. And although these students did not have the technical backgrounds necessary to advance in the usual curriculum, many did take more mathematics, and a few ended up in our advanced "independent study" elective. Furthermore, as my own mathematics education progressed, I began to see ways to circumvent the horrible texts that were dominant in the 1970s and 1980s, and I realized that while frontline research problems in mathematics are out of reach for most secondary students, many, if given the chance, are capable of understanding and using methods common among research mathematicians. This led to an approach to teaching and learning that kept me in the classroom for over twenty years and that has been the cornerstone of my subsequent work in education [7].

The Politics of Mathematics Education

If you have not been following the situation in the U.S., it may come as a surprise to hear that there is a furious debate here over the most effective ways to teach mathematics. Indeed, a Google search on "math wars" will turn up thousands of newspaper articles and websites arguing for or against this or that approach to teaching mathematics. Some of these involve interviews with eminent mathematicians or high government officials; others are written by parents, teachers, or business people. There have been television programs devoted to mathematics education, and on several occasions people have testified before Congress on the topic.

This math wars phenomenon is an extremely complex one; to do a good job of documenting and analyzing the events would take us too far afield (and such an account should be carried out by sociologists and anthropologists). As someone who feels part of several of the communities who are so angry with each other, let me give the briefest sketch of the landscape at a level of abstraction that will leave out many important details. The point that I want to make is that in the U.S., mathematicians and mathematics educators live in different worlds: they have different cultures, different standards of rigor, and even different languages for talking about mathematics and mathematics learning. At most universities, mathematics educators (people specializing in teacher preparation, epistemology, or curriculum design) are not part of the mathematics department; they belong to "schools of education", departments whose members are scholars in education first and disciplinary specialists second. And, at least for the past few years, significant numbers of people from these two cultures—mathematicians and mathematics educators—have been struggling to gain influence over each other and to wrest control of mathematics education in the U.S.

In the previous section I mentioned the poor curricula that were in place during the late 1970s and 1980s. These were in reaction to the excesses of the "new math" reform movement a decade earlier, a movement that was led by many prominent mathematicians and that tried to help children learn mathematics through deduction, logic, and mathematical structure. The emphasis in curriculum design was on logical precision, careful definitions, and polished presentations. In fact, there were some lasting benefits from the movement; the stylized caricatures of some of the most extreme aspects of the program mask the fact that there were some solid ideas here. But reaction to the curricula and philosophy grew into a movement that is sometimes called "back to basics", a slogan for an approach to mathematics that kept the topical organization and the vocabulary of the reform texts but eschewed abstraction and proof, emphasizing "basic skills". Far from basic, this approach evolved into a program full of arcane exercises that had little to do with basic skills or with mathematics. I can still find, in a very popular algebra book of that era, a page entitled "Factoring $x^2 + bx + c$; c Positive".

The page was filled with forty identical (and trivial) exercises. You can guess the title of the next page. Most high school classrooms followed a predictable format: the teacher would carefully work out an example of how to, say, add rational expressions. The students would try another similar example at their seats. The work would be checked, and then students would work on a practice set that continued on for homework that night.

By the mid 1980s the situation had gotten intolerable for teachers and students. Teachers (even those with weak mathematical preparation) were very uncomfortable with the technique-driven curriculum; students were dropping out of
mathematics, mainly from sheer boredom, and even those who stuck with it, taking four years of high school mathematics, had no sense for what the discipline is about or what it is for. Advances in technology were making obsolete most of what was in the curriculum: numerical and symbolic calculations for the sole purpose of arriving at answers to pointless exercises.

At the same time, a critical mass of education researchers was adopting a neo-Piagetian philosophy of learning ("constructivism") that held that learning takes place when (and only when) learners build mathematical ideas in their own minds through a process of reflective abstraction. A corollary of this philosophy is that the kind of rote drill in computational technique that had become the staple of precollege mathematics would never produce robust mathematical understanding. This dovetailed perfectly with the years of anecdotal evidence built up in the teaching profession, where every teacher told stories of students who could imitate and execute all the routines but had no idea how to use them. It also flew in the face of the common sense of many mathematicians who believe that mathematics is best learned by first setting solid foundations and then advancing via precise explanations and ample practice.

In 1989, after considerable feedback from teachers in the field, the National Council of Teachers of Mathematics produced its Standards documents. I am leaving out a great deal of detail here; the NCTM leadership, largely a group of volunteers, had been working on policy documents for at least a decade, trying to reform precollege mathematics education into something that was more meaningful for students. Emerging from the NCTM deliberations was a vision of classroom organization that looked quite different from the classical lecture and recitation model. A notion was evolving among educators that perhaps one should not teach in the way one was taught. It was common during these times to look back with disdain at the experiment of the new math as overly pedantic and even as a stifling influence on children's mathematical development; people mocked the "Bourbaki influence" on precollege education. For these and other complex reasons, resentment among educators for mathematicians (especially those with no experience in precollege education) was growing.3

The timing of the release of the NCTM Standards was perfect. Teachers had just graduated a generation of students that was baffled by mathematics. Teachers saw this document—one that called for emphases on sense making, on looking at the utility of mathematics in other fields, on listening to and taking seriously students' ideas, and on reasoning and communication—as something that was speaking for them, telling people outside education that things had to change.

No one could have predicted what would happen over the next few years, and although hindsight provides some explanations, I still find much of it quite amazing. The different cultures of mathematics and mathematics education supported completely different interpretations of the same recommendations (and even sometimes of the same word). The "vertical disconnect" between the mathematics of the undergraduate and precollege curricula that I describe in Mathematics for Teaching contributed to some strange developments: given the license to downplay the silly treatment of topics in many texts and having never experienced, as part of undergraduate studies, the central position of school topics in the larger mathematical landscape, some teachers and educators proposed to stop children from memorizing multiplication facts, to eliminate the study of computational algorithms (some people even called them "dangerous"), to avoid the quadratic formula at all costs, to eliminate the study of conic sections, and to move algebra away from the study of formal calculations and toward the study of continuous variation. Of course, none of these was an explicit recommendation of the Standards, but the gates seemed to open for all kinds of recommendations, especially those advocating the abandonment of technical fluency and memorization, all in the name of reform.

As just one example, look at the role of proof in precollege mathematics. For mathematicians, the activity of constructing a proof is a research technique. In school mathematics, especially during the 1980s, deduction had nothing to do with discovery, insight, or experiment. Indeed, proof was taught and practiced almost exclusively in the yearlong geometry course as a post-facto ritual for establishing facts, most of which seemed obvious in the first place. In an attempt to help students construct stylized proofs of already established facts, texts and curricula encouraged the organization of statements and reasons in a two-column format (statements in one column, reasons in the other). This device had been used in the U.S. for decades, but it gradually evolved from a system for organizing one's work to a method for constructing proofs. This seems to be a recurring pattern in U.S. education (due again, in part, to the vertical disconnect and to the way university courses are organized): the way results and insights are presented becomes identical with how they allegedly are conceived. When "writing" a proof, many students in geometry would write the "given" on the top line of a two-column set-up (called a "T-bar

3At the 1988 ICME in Budapest, I attended a long talk given by a prominent education researcher, who opened with "We're finally getting the arrogant mathematicians out of education."
I have seldom known a teacher who did not care about her students or work very hard to help them succeed.

template" by many teachers, write what they were told to prove on the bottom statement line, put "Side-Angle-Side" or "Corresponding Parts of Congruent Triangles Are Congruent" beside it as a reason (usually one of these was right), and fill in the rest with random statements and reasons, hoping for the best.

So when the 1989 Standards called for reduced attention to the two-column proof and increased emphasis on developing the skills needed to write proofs and to record the results of deductive arguments in an understandable narrative form, many of us applauded. But within months I began hearing people in education claim that proof was an obsolete topic for school geometry, especially since geometry software experiments provided such convincing evidence. More than a few teachers were saying, "We don't do proofs anymore." Proof had already been eliminated from the low tracks of geometry; it was now about to disappear at every level.

This infuriated many mathematicians. And the story was the same with algebraic and numerical calculations, factoring to solve equations, plotting points by hand, establishing trigonometric identities, completing the square, and a host of other topics. The "reform movement", as it had become known, called for reduced attention to how these topics had been corrupted in school mathematics. Because these corruptions had become the topics in the minds of many (the vertical disconnect again), these statements were interpreted as calls to eliminate the topics themselves. And what was heard by those not familiar with schools and education, being completely oblivious to the existence of the corruptions, was a call for the gutting of a great deal of core mathematics from the precollege curriculum.

Several prominent mathematicians mobilized to stop what they saw as the demise of mathematics in K–12 education, and they did this with the tools that mathematicians know best: piercing arguments that tore apart the "reduced emphasis" recommendations by showing how the topics that were allegedly on the chopping block were prerequisites for further study in mathematics, science, and engineering. This piqued the attention of many parents, who wanted no part of programs that put their children at a disadvantage for getting into college or succeeding in advanced courses. There were also searing attacks on mathematics educators, pointing out mathematical errors and misunderstandings in published articles and poking fun at the language used by education researchers to describe their work. Educators replied in kind, mocking naïve public statements about education made by mathematicians.

This acrimony has existed for close to a decade, and, like other conflicts of this type, as it matures the public pronouncements get less strident and more conciliatory. The authors of the revised Standards [21] went to great lengths to include professional organizations such as the AMS and the MAA (Mathematical Association of America), as well as individual mathematicians, in the revision. Most mathematicians now realize that mathematical expertise is a necessary but not sufficient prerequisite for quality teaching and that teachers and educators have important expertise to offer the effort to improve mathematics education. Conversely, published reports on teaching and learning [4], [8], [14], [17], [18], [19] and guidelines for federally funded professional development programs for teachers place a great deal of emphasis on the importance of content knowledge for teachers. An especially hopeful development is a consensus document for K–8 mathematics [23], written by a team of mathematicians, educators, and teachers, that shows in a concrete way how the expertise distributed across the entire mathematics community can be synthesized in extremely effective ways.

But in private I still hear a great deal of distrust and dislike on all sides. I worry that the fight has become an end in itself. If I am right, the real casualties of the math wars will be another generation of students that will be subjected to the kind of mathematical nonsense that can only be fixed if the adults who know how to fix it stop arguing.

**Teacher Preparation**

The previous two sections describe some of the forces influencing U.S. precollege education. These same forces exert influence over the programs at universities that prepare teachers. In this section I will describe how some of these forces play out. Again, I will restrict myself to the preparation and professional development of high school teachers. For a description of and recommendations for teacher preparation programs in grades K–8, see [4], [13], [23], [24], [25].
Most states require that high school teachers meet certain formal certification requirements. True to the topic-driven curriculum, these requirements amount to a list of courses to be taken: the equivalent of an undergraduate major in mathematics (35–40 semester hours of mathematics courses) combined with several courses in education.

The mathematics courses are usually not designed specifically for prospective teachers. This is not necessarily a drawback: there are many benefits to studying mathematics for its own sake, and there is a great deal of effort among many undergraduate instructors (especially around the use of technology) to make these generic courses appealing to a wide audience of students. And there are special courses for prospective teachers, usually in geometry or "capstone" courses that make connections among topics in the undergraduate curriculum or to high school mathematics. But because most of the mathematics courses taken by prospective teachers must meet the needs of a wider clientele (including future mathematicians), discussions of teaching, learning, and the precollege curriculum hardly ever occur. Indeed, many college students majoring in mathematics do not decide to become high school teachers until late in their undergraduate careers. This often forces them into an extra year of college in which they take the necessary education courses to obtain state certification.

The split between mathematics departments and schools of education translates into a split in the mathematical preparation of teachers. Education courses are taken in education departments, separate from mathematics, but like the mathematics courses, many of these are generic courses—like adolescent psychology and the history of education—not aimed at prospective mathematics teachers. There is usually a "methods" course that concentrates specifically on methods for teaching high school mathematics. These courses often use the NCTM documents [21] as a basis for studying effective techniques for getting students involved in mathematical activities, techniques that are seldom used in the undergraduate mathematics courses themselves. There are some truly exceptional education courses that I know about in the Boston area, courses in problem solving or in the teaching of algebra and geometry, that are every bit as mathematical as courses offered in mathematics departments, but these are not common across the country.

So the short story is that prospective high school teachers are given a set of mathematics courses and a set of education courses. Putting the two together is essentially the job of the student, not the university.

Mathematicians and mathematics educators alike realize that this structure is not working. At AMS, MAA, and NCTM meetings all over the country, people are giving talks about the need to integrate mathematics and education, to connect undergraduate mathematics and school mathematics, and to make undergraduate teaching a model for what we want high school teaching to be. Evidence exists ([15], for example) that other countries are able to bridge these divides, but it remains to be seen if U.S. education will be able to overcome the traditions and hostilities that make progress along these lines difficult.

A good example of a thoughtful attempt to bring some coherence and purpose to the mathematical education of teachers is a recent report with exactly this name [4]. Known as the "MET report", it makes some recommendations that show an intimate knowledge of the problems in teacher preparation. These include (see http://www.maa.org/cbms for the exact wording in [4]):

- Prospective teachers need to develop a deep understanding of the mathematics they will teach.
- Prospective high school teachers of mathematics should major in mathematics and in their last year take a two-semester course connecting their college mathematics courses with high school mathematics.
- Courses designed for prospective teachers should develop careful reasoning and mathematical "common sense".
- Mathematics courses for prospective teachers should develop the habits of mind of a mathematical thinker and demonstrate flexible, interactive styles of teaching.
- More mathematicians should consider becoming deeply involved in K–12 mathematics education.
- The mathematical education of teachers should be seen as a partnership between mathematics faculty and mathematics education faculty.
- There needs to be greater cooperation between two-year and four-year colleges in the mathematical education of teachers.
- There needs to be more collaboration between mathematics faculty and mathematics teachers.

*For two reactions to the report, see the October 2001 issue of the Notices, pages 985–91.*
• Teachers need the opportunity to develop their understanding of mathematics and its teaching throughout their careers.

The report gives many more insightful details of the difficulties facing reform in teacher preparation, and it takes seriously the structural problems faced by universities—the necessary inclusion of prospective teachers in courses designed to meet the needs of students preparing for other careers, for example. It offers concrete suggestions for meeting its recommendations. MET promises to be very influential in teacher preparation, setting the course for reform over the next few years.

Unfortunately, the specific content recommendations in MET are influenced by the topic-driven nature of U.S. curricula, and while MET gets the statement of the problem exactly right, I am afraid its blueprint for a solution, at least at the high school level, is lacking. For example, its recommendations around abstract algebra have to do with justifying the rules of elementary algebra. Yes, abstract algebra gives an axiomatic foundation for the algebraic transformations involved in precollege algebra, but it does so much more than that. Its major themes—decomposition, extension, and representation [12]—underlie and connect huge segments of the precollege curriculum. Algebra shows why polynomial algebra, one of the few universal objects in mathematics, occupies such a central role in formal calculation. Similarly, number theory does help one understand unique factorization, but, more importantly, major themes like reduction and localization give one a theoretical framework for bringing out the importance of many topics in elementary arithmetic. And Gauss’s brilliant breakthrough theory of cyclotomy ties together more topics from school mathematics than almost any other theory in undergraduate mathematics. Number theory is also a basic tool in the craft of teaching, especially in the often neglected mathematical techniques of task design [6].

And so it goes. Extension by linearity is central to linear algebra and finds applications in everything from high school geometry to trigonometry, but is never mentioned in [4]. Nor is extension by continuity, completion, or other basic themes in analysis that underlie many topics in school mathematics. The deep applications of multilinear algebra to almost every topic in the secondary curriculum that involves geometric or algebraic symmetry (see [5], for example) would help teachers see genuine uses of determinants in a curriculum that makes almost no mention of them anymore.

This is not the carping of someone interested in trading one set of recommendations for another. Everything I mention above turned out to have frequent, almost weekly, utility in my high school teaching (with every level of course)—this was, for me, mathematics for teaching. And none of it was ever highlighted in my undergraduate courses as a theme worth considering. Some of these things were mentioned in my undergraduate courses, but in the same breath the discussion turned to a low- level pedantic proof of something like the fact that 0 = 1 (this is the undergraduate version of the “flatness syndrome” that I describe in Mathematics for Teaching). It was not until graduate school that I realized that there are central themes in mathematics and, not coincidentally, that these themes are essential tools in the teaching of mathematics. At the right level of abstraction and in the right contexts, mathematical themes like these would be ideal organizers for courses for prospective teachers.

I find another aspect of [4] disappointing. The recommendation “Mathematics courses for prospective teachers should develop the habits of mind of a mathematical thinker...” is extremely important for many of the reasons I describe in Mathematics for Teaching, especially since teaching high school involves fielding questions, picking at germs of insight in students’ ideas, and redirecting classroom discussion on the fly. But I am convinced that topic-driven survey courses of the kind most undergraduates take (mainstream linear algebra courses, for example) are not the vehicle for doing this. It is not that they are bad courses, but they are designed for another purpose—that of exposing students to an established mathematical theory. To meet this recommendation, students need an immersion experience in mathematics similar to the one I describe for practicing teachers (PROMYS) in Mathematics for Teaching. For all the reasons described there, a sustained immersion in a focused part of the discipline is one of the most valuable experiences a prospective teacher can have. It is a shame that this was not an explicit recommendation in [4].

So far I have described the “typical” path to teaching in a high school via a teacher preparation program in college. In fact, many teachers find their way into classrooms via other routes.

The economics of the job market have put in motion a pendulum that swings from an oversupply of teachers to a teacher shortage. I did not go through a teacher preparation program as an undergraduate, but when I finished college in 1969, the pendulum was in the shortage state, so I got a job with little difficulty. During the 1980s declining enrollments and property tax revolts across the country caused massive layoffs of teachers and other public employees, and all of a sudden there was an overabundance of teachers looking for jobs. Many teacher preparation programs came close to closing down, and mathematics majors and laid-off teachers saw much more opportunity in the high tech industry than in education. Schools went
for years without taking on new staff. When I started teaching, I was the youngest person in my department. When I left twenty-four years later, I was still almost the youngest member. Teachers of my generation are now starting to retire, and enrollment is going up again. So we are now in a period of severe teacher shortages. Coupled with the downturn in high tech, many people with technical backgrounds are looking to fill the void in schools, and schools are taking them in droves.

There is evidence [19] that as many as 50,000 inadequately prepared teachers enter the profession each year. By one report [11], 33 percent of the practicing mathematics teachers have neither a major nor a minor in undergraduate mathematics, and these teachers teach 26 percent of the country’s mathematics students. To make matters worse, large numbers of qualified teachers leave the profession within five years.

People with many kinds of backgrounds are filling mathematics teaching openings. Some are engineers or scientists with significant mathematics backgrounds that are quite different from the typical undergraduate mathematics major. Some are teachers from other fields—science or computer science and sometimes history and elementary education—who take open mathematics positions looking for more job security. There are even out-of-work mathematicians, trained as researchers in pure or applied mathematics, looking for teaching positions in high schools.

Whereas these “through the back door” entries into the profession are more numerous now than a decade ago, there have always been people who come to teaching from outside teacher preparation programs. Although the efforts to reform undergraduate teacher preparation are crucial, they are invisible to these teachers who enter the profession via other routes. To compensate for this and for the shortcomings of current teacher preparation programs, local districts, states, and the federal government have had to invest heavily in ongoing professional development programs for practicing teachers.

Professional development has become big business in the U.S. Millions of dollars are spent on programs every year, and many large cities have special departments in the central administration devoted to funding and implementing professional development programs. Most states require participation in such programs in order to maintain certification, and many universities and school districts provide alternative certification programs to help people gain the qualifications they need to teach while holding teaching positions via “provisional” certification.

The needs of the teaching force vary so widely that most systems opt for an eclectic menu of professional development offerings ranging from after-school classes to one-day workshops to organized sequences of such experiences. The content varies widely, too, covering everything from cooperative learning techniques, the use of graphing calculators, and seminars on how to implement a particular curriculum, to what has come to be known as “make and take” workshops, where teachers spend an afternoon or a day working through activities that they can use directly with their students. Because the programs are either one-day seminars or a set of such seminars separated by many weeks, it is very difficult to do any significant mathematics in these programs.

Concluding Remarks

Mathematics as a scientific discipline is quite healthy in the U.S.: each year graduate schools produce a new corps of highly talented Ph.D.’s, many of whom join a research establishment that is among the most productive in the world. And, in addition to mathematical research, my country makes essential contributions to profound advances in technology, science, and finance. All these contributions rest on a bedrock of mathematical expertise that is as solid as any in the world. How then can an educational establishment that produces some of the best minds have so many weaknesses? One answer lies in the huge scale of the educational enterprise. Even if our mathematics programs lost half of our students for each of the twelve years of precollege education (as claimed in [22]), there would still be a large pool of young adults with the preparation needed to major in mathematics in undergraduate school. In fact, many argue that U.S. mathematics education has evolved into a system designed precisely to nurture, from the earliest grades, the talent that will eventually take leading roles in science and technology, often at the expense of a greater mathematical literacy for all high school graduates. Although I do not agree with this assessment, it is certainly true that the upper-level tracks in high school are often taught by the most mathematically expert teachers, and the curricula used in such programs are usually quite traditional, emphasizing the technical expertise needed to succeed in university majors in mathematics and science. And for the truly precocious students who show a knack for mathematics at a young age, there are many extra-curricular opportunities, from summer “math camps” to mentoring programs. The teacher counterpart for one such program (PROMYS) is described in Mathematics for Teaching. PROMYS (Program in Mathematics for Young Scientists) for students has been in existence for over ten years.
in Boston; it works with about sixty very advanced high school students each year, many of whom eventually specialize in mathematics or a related field. Similar programs exist at Ohio State and at other universities around the country.

So, preparation for students in the "top end" of the mathematics education spectrum seems to be working quite well. Indeed, the efforts of many of us to improve mathematics education for the rest of the spectrum can be thought of as an attempt to make the top end more inclusive, to awaken the nascent interest in mathematics that almost all students show when given a chance, and to prepare and develop mathematics teachers with the same success as that with which we prepare and develop mathematicians researchers.

This sets a bit of the stage for my comments in Mathematics for Teaching. Public education in the U.S. is an extremely complex enterprise, and others in my country would have completely different perspectives about what would be important and interesting (see [9], [10], [26] for example). If I have conveyed a glimpse of the complexity of the system, then I have accomplished what I set out to do.

References
WHAT IS...

a Dessin d’Enfant?

Leonardo Zapponi

A dessin d’enfant (“child’s drawing”) is a connected graph with two extra bits of structure:

• at each vertex is given a cyclic ordering of the edges meeting it;
• each vertex is assigned one of two colors, conventionally black and white, and the two ends of every edge are colored differently.

These structures were introduced, at least in the context about to be described, by Alexandre Grothendieck in about 1984. There is an amazing relationship between these dessins and deep arithmetical questions.

Dessins and Complex Geometry

Dessins arise naturally from finite coverings $X \to \mathbb{P}^1(\mathbb{C})$ by a Riemann surface $X$ unramified outside the points $0, 1, \infty$. Here $\mathbb{P}^1(\mathbb{C})$ is just the Riemann sphere $\mathbb{C} \cup \{\infty\}$. To such a covering a dessin is associated in the following way: the black nodes are the inverse images of $0$, the white ones the inverse images of $1$, and the edges of the dessin are the components of the inverse image of the line segment $(0, 1)$. The cyclic order arises from local monodromy around the vertices—i.e., winding around the local sheets of the covering containing a common point. Thus, we get not only a dessin but along with it an embedding into a Riemann surface. We also get a cellular decomposition of the surface. The faces of this decomposition are the connected components of the inverse image of the complement of $[0, 1]$.

Monodromy associates to each path in the fundamental group of $\mathbb{P}^* = \mathbb{P}^1 - \{0, 1, \infty\}$ with respect to $1/2$ a permutation of the edges in the dessin: a closed path starting and ending at $1/2$ will lift to a path in the covering starting at one edge of the dessin and ending at another.

This idea allows one to see, conversely, a simple way to construct a covering from a dessin. The fundamental group of $\mathbb{P}^*$ with respect to $1/2$ is a free group on two generators $\sigma_0$ and $\sigma_1$, loops around $0$ and $1$. Associated to each of these is a permutation of the edges of a dessin. The one associated to $\sigma_0$ rotates the edges around each black node in accord with the cyclic ordering at that node, and similarly $\sigma_1$ rotates around the white nodes. This extends to a permutation representation of the whole free group. This group acts transitively on the edges, since the dessin is connected, and the isotropy subgroup of any edge is therefore a subgroup of index equal to the number of edges, hence is associated to a finite covering of $\mathbb{P}^*$. Different isotropy subgroups are conjugate. But the finite coverings of $\mathbb{P}^*$ are also the coverings of $\mathbb{P}^1(\mathbb{C})$ unramified except at $0, 1, \infty$. Thus the dessin determines such a covering.

Grothendieck wrote of this relationship: “This discovery, which is technically so simple, made a very strong impression on me, and it represents a decisive turning point in the course of my reflections, a shift in particular of my centre of interest in mathematics, which suddenly found itself strongly focussed. I do not believe that a mathematical fact has ever struck me quite so strongly as this one, nor had a comparable psychological impact. This is surely because of the very familiar, non-technical nature of the objects considered, of which any child’s drawing scrawled on a bit of

Figure 1. The dessins with three edges. The cyclic ordering at each vertex is indicated geometrically. The last two are distinct because of different cyclic orders at the bottom vertex—$(1, 3, 2)$ against $(1, 2, 3)$.

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paper (at least if the drawing is made without lifting the pencil) gives a perfectly explicit example. To such a dessin we find associated subtle arithmetic invariants, which are completely turned topsy-turvy as soon as we add one more stroke."

**Arithmetic and Algebraic Geometry**

Any finite cover of $\mathbb{P}^1(\mathbb{C})$ has an algebraic structure defined over $\mathbb{C}$. That is to say, the Riemann surface and the projection are both defined by polynomials in $\mathbb{C}$. In the following table we give the explicit list for the dessins we have already seen.

<table>
<thead>
<tr>
<th>Dessin</th>
<th>$\hat{X}$</th>
<th>Equation for the cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Dessin 1" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_1(x) = x^3$</td>
</tr>
<tr>
<td><img src="image2.png" alt="Dessin 2" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_2(x) = 1 - \beta_1(x) = 1 - x^3$</td>
</tr>
<tr>
<td><img src="image3.png" alt="Dessin 3" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_3(x) = \frac{(4-x)(1+2x)^2}{27x}$</td>
</tr>
<tr>
<td><img src="image4.png" alt="Dessin 4" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_4(x) = 1 - \beta_3(x)$</td>
</tr>
<tr>
<td><img src="image5.png" alt="Dessin 5" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_5(x) = x^3 + 3x^2$</td>
</tr>
<tr>
<td><img src="image6.png" alt="Dessin 6" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_6(x) = \frac{x^3}{x^3 - 1}$</td>
</tr>
<tr>
<td><img src="image7.png" alt="Dessin 7" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$y^2 = x^3 + 1$</td>
</tr>
<tr>
<td><img src="image8.png" alt="Dessin 8" /></td>
<td>$\mathbb{P}^1(\mathbb{C})$</td>
<td>$\beta_7(x, y) = \frac{1}{2}(1 + y)$</td>
</tr>
</tbody>
</table>

We can see easily now that there are three faces for the next to last dessin, which sits in a sphere, but only one for the last, which is embedded in a torus (Figure 2).

In Figure 3 these faces can be read off directly from the dessin as the connected components of a thickened dessin.

But now we enter into the realm of arithmetic algebraic geometry with this pleasant observation: Any dessin arises from a finite covering of $\mathbb{P}^1$ that can be defined over the field $\mathbb{Q}$ of algebraic numbers. This is essentially a consequence of Weil's descent theory.

**Figure 3. Three faces on the left, one on the right.**

**Belyi's Theorem**

Everything so far is elementary, and yet...the manner in which "squishy" combinatorial objects (clay) turn out to possess canonical rigid structures (crystal) remains astonishing. At this point we have seen that dessins correspond to certain finite coverings of $\mathbb{P}^1$ defined over $\mathbb{Q}$, but we do not know what algebraic curves arise in this way. Grothendieck was amazed by this famous and remarkably simple theorem due to G. V. Belyi, first announced in Helsinki in 1978: Every algebraic curve defined over $\mathbb{Q}$ can be represented as a covering of $\mathbb{P}^1$ ramified over at most three points. In other words, every algebraic curve defined over $\mathbb{Q}$ contains an embedded dessin.

**Galois Action**

Dessins correspond to covers of $\mathbb{P}^1$ defined over $\mathbb{Q}$. The covers are permuted by the Galois group $\text{Gal}(\overline{\mathbb{Q}}/\mathbb{Q})$, so this group also acts on the set of dessins, and one consequence of Belyi's theorem is that the action is faithful. The deepest open question in the theory of dessins is this: Can the Galois orbits of dessins be distinguished by combinatorial or topological invariants? That is, is there an effective way to tell whether two dessins belong to the same Galois orbit? There are several obvious invariants, such as genus, valency lists, etc., but it is known that they are insufficient to answer this question. Other more delicate invariants have been discovered, but whether a complete list exists—and, if so, whether finite or infinite—remains a mystery.

**References**


Mathematics and the Roots of Postmodern Thought  
Vladimir Tasić  
Oxford University Press, 2001  
200 pages, $29.95  
ISBN 0-195-13967-4

**Chairs, Tables, Beer Mugs**

Three number theorists—one American, one French, one German—were sitting in a restaurant, and after a few beers they began to debate the ontological status of the continuum. The Frenchman (who was actually drinking wine, not beer) opted for the radical position that the real numbers do not exist, though he confessed that this belief had never stopped him from using them when convenient. The German allowed that real numbers might not exist individually, but claimed that the set of real numbers nevertheless existed as a “totality”—for emphasis he also used the German word Gesamtheit. The American asserted that real numbers not only exist but that he could and often did compute them on his computer to as many digits as you like.

To illustrate his thesis, the Frenchman proposed a Diophantine variant of Gregory Chaitin’s “maximally unknowable” real number $\Omega$, the probability that a randomly generated program will halt on a universal Turing machine. The American cheerfully replied that this was not the kind of real number he had in mind.

The punch lines, if any, will be a long time coming. The three mathematicians, all distinguished specialists, actually held this conversation in my presence during a conference in Münster. My sole contribution was to ask whether the “existence” of which they spoke had anything to do with the axioms of set theory, axioms which all three participants claimed not to know. What the incident seems to demonstrate is that, under the right circumstances, long dormant memories of the “crisis of foundations”, which agitated mathematicians during the period roughly bounded by Russell’s paradox (1901) and Goedel’s theorem (1931), can resurface to surprising effect. The right circumstances must be relatively rare: two of the participants, colleagues in close proximity for the better part of two decades, had never before discussed ontology. But the claim by Bourbaki co-founder Jean Dieudonné that “the young mathematicians said to be ‘formalist’ no longer even know that there had once been a ‘crisis of foundations’” is patently false, as Dieudonné himself would have realized if he had given his students

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1 That evening I was mainly engrossed in another discussion, concerning a controversial program to prove a famous conjecture in number theory using nonstandard analysis, among other ingredients.

enough to drink. "No longer even care" would be more accurate, though who can say what repressed anxieties were seeking an unexpected outlet under an apparently untroubled expression of opinion? The most one can say is that differences of opinion of this sort do not seem to matter, at least from the viewpoint of the mathematics itself, if one can imagine such a thing, abstracted from the activities of the mathematicians in creating and in understanding each other's work.

The basic premise of Vladimir Tasić's unusual book Mathematics and the Roots of Postmodern Thought (MRPT) is that the "crisis of foundations", more or less distorted, does continue to matter in the most unlikely setting of so-called postmodern thought, as practiced mainly in France. Tasić seeking an alternative to the rhetorical violence of the "science wars", wants to answer the following question: Why would postmodern intellectuals bother invoking mathematics in their theories at all? (Tasić, p. 3)

His thoroughly original solution, obtained at the end of a breathless excursion through the history of Western philosophy and much of the history of mathematics, is ...

... to view postmodern theory as a deeply divided edifice: first, as a revival, or a reinvention in somewhat different terms, of a challenge that mathematicians who were influenced by romanticism once issued to logical reductionism; and second, as an extraordinary radical dismissal of romantic humanism, a dismissal whose roots can in part be traced to mathematics, and which in its postmodern edition becomes a rather extreme form of formalism (Tasić, pp. 5–6).

Or, more diagnostically, the "postmodern Oedipus...has a formalist daddy and an intuitionist mommy" (p. 99).

There is no doubt in my mind that Tasić's question is the right one, the only genuinely interesting question to arise from Fashionable Nonsense, the book by physicists Alan Sokal and Jean Bricmont that revealed to the world the proclivity of some (mainly) French philosophers for ill-advised use of mathematical terminology. Jacques Bouveresse, a no-nonsense French philosopher and supporter of Sokal and Bricmont, can find no better explanation than to evoke the "oligarchic, hierarchical, clannish, even...Mafia-esque" nature of the current French literary scene and to ask "If we were deprived of the right to say more or less whatever we like about things that are difficult to understand and that we don't want to understand, where would be the pleasure and interest?" Tasić emphasizes, rightly, that "Mathematics has been part of the Western tradition, inseparable from its culture and philosophy" (p. 4), and that the roots of the "nonsense", if that's what it is, must be sought in the history of that tradition.

The answers Tasić proposes are more problematic than the question, as the author is himself aware. The reader of MRPT, and of this review, should bear in mind that Tasić, in addition to being a mathematics professor (at the University of New Brunswick) and an active researcher in a core branch of mathematics (group theory), is a highly regarded author of fiction in his native Serbia; his novel Oprostajni dar (koncerto) won the Radio Belgrade 2 prize in 2001. Recognizing that the full ramifications of the problem he poses vastly exceed the scope of his book, he invites the reader to "think of this book as a story—a speculative reconstruction of a story—and as an invitation to a polemic" (p. 6). Not surprisingly, Tasić tells a good story, which I will try to re-reconstruct. "Let us, as philosophers, welcome fantasy," Ian Hacking once wrote. Philosophically minded mathematicians arguably need fantasy even more. The polemic can wait.

Dramatis Personae

In a narrative extending over a period of several centuries, it is natural that there will be abstract protagonists alongside the merely human characters, limited by their "relatively short shelf life," as Tasić puts it. We have already encountered some of the former, conveniently introduced in binary oppositions whose borders, however, they rapidly overflow. The couple "intuitionism/formalism" is familiar from the early twentieth century crisis of foundations. For Tasić it is important to view this couple as a peculiarly mathematical species of the larger opposition between "romanticism" and what romantics viewed as the excesses of determinism, variously identified with Kantian categories, with objectivity, with logic, and with science in general. Tasić's list of romantics in the sciences contains a few surprises. Of course there are Poincaré and Brouwer, cast as the lucid Jekyll and the radical Hyde of intuitionism, and Weyl. But there are also Einstein; Sapir and Whorf, famous for their thesis on the culture-dependency of language; and, perhaps inadvertently, Wittgenstein. Among other minor characters, Delenze and Guattari, quoted to much humorous effect by Sokal and Bricmont, are here identified as romantics, though their relation

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Living between Two Worlds—The Fiction of Vladimir Tasić

Tasić’s fictional works include two books of short stories in Serbian—Pseudologia Fantastica (Matica Srpska, 1995) and The Joy of a Shipwrecker (Svetovi, 1997) (which were translated into English and published together as Herbarium of Souls (Broken Jaw Press, 2001)—and one novel, The Farewell Gift (Svetovi, 2000).

We mathematicians are particularly fond of duality theorems; translating mathematical statements from one category to another often gives us new and unexpected insight. Tasić the fiction writer explores duality, albeit of a different kind, the one between the rational world of science and logic and the mystical and metaphysical world of emotions, beliefs, and spirituality. He invites us to take an exhilarating journey to the plane where those worlds intersect, yielding sometimes wonderful but often fatal outcomes. His stories are carefully constructed, like a well-thought-out mathematical proof, and his style is glazed by a thin layer of the melancholy of one living in exile. It is therefore not surprising that Tasić is already considered one of the rising stars of Serbian literature.

Herbarium of Souls is a collection of four stories exploring the relation between myth and knowledge, the exotic and esoteric, inspiration and delusion, and the search for the ineffable truth. They bear strong resemblance to Borges’s Ficciones both in style and in subject and can be considered an homage to the great master. There is a story about a student struggling to publish the findings of his deceased mentor on Solov’ev’s eschatology and at the same time falling in love with the late professor’s wife. In another one, a painter, whose reputation rested on his mastery of color, is left color-blind after an accident and tries to remember the world. The allegorical tale “Secrets of an Argonaut” explores the limits of modern science in the search for the meaning of our existence. But the most interesting for a mathematician is “Herr Doktor’s Wondrous Smile”, in which the narrator, a mathematician professor, decides as a prank to give a talk at a joint symposium of scientists and occultists in search of the hidden meaning of numbers. In his lecture on Chaitin’s number \( \Omega \), he mixes mathematical logic and mysticism, randomness and religion, computability and the cabala. It is all intended to be a parody, a sort of reductio ad absurdum of the occultists’ project, but alas the joke goes awry, and he unwillingly gets drawn into the world of one of the mystics, who is in search of his own spiritual \( \Omega \) through art and sculpture. The scientific community does not forgive such transgressions, and the narrator’s academic career is ruined by his conspiring colleagues. In the end, having lost everything, he himself starts sliding into mysticism and numerology.

The novel Farewell Gift, which is written in the form of a concerto, is certainly Tasić’s most accomplished work. It is a melancholic but also humorous and ironic story of a generation of Yugoslav immigrants who, fleeing the Balkan inferno, find themselves facing the impossibility of integrating into the New World. But the novel is also a counterpoint between two opposing views of the world: the scientific reductionist view of genetics and computers, and the holistic spiritual one of art and handicraft. The narrator, an engineer working in a medical institute, misplaces the ashes of his deceased brother, who is depicted as a perfect being, an angel. The ashes are left in the pottery studio of the narrator’s wife, who mistakenly uses them as a glaze and in this way achieves the missing artistic touch in her ceramics. Tasić seems to be asking: Is our essence to be found in our ashes or in the complete recording of our genes on a computer? The title and indeed the novel itself is a metaphor about farewell both from one’s home country and from life itself and about overcoming the horror of leaving by making the gift of our own essence to the world, be it our genes, our ashes, our literature, or our mathematics.

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to the German romantic tradition, exemplified for Tasić by Herder and Fichte, is unclear.

A second couple, difficult to articulate with the first and not really developed systematically in MRPT, opposes “anthropocentrism” to “logocentrism”. Kant, who situates the act of knowing in the individual consciousness of the introspecting subject, transcendental or otherwise, is the chief anthropocentrist. But so are the intuitionists, especially Brouwer. Among philosophers Husserl and, presumably, Descartes join Kant as anthropocentrists. The logocentrists, perhaps with Spinoza and Leibniz as antecedents, include Frege, Russell, Whitehead—for whom “the subject emerges from the world”—and Hilbert’s formalist school; structuralism and the postmodernism of Michel Foucault represent logocentrism in a radicalized form.⁵

And these philosophers and mathematicians—what is it they are being romantic or objectivist, intuitionist or formalist, logocentric or anthropocentric

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⁵ Derrida uses the term “logocentrism” in a different sense, as the “metaphysics of phonetic writing,” so that Leibniz’s project of a universal characteristic “had opened a breach within logocentric security.” Derrida. Of Grammatology, Johns Hopkins, 1976, pp. 5, 98.
about? About identity, sometimes; about imaginary numbers, briefly. But especially about the continuum, which looms over these historic antitheses, a brooding presence, frequently disguised, unknowable, undecidable, source of paradox, and, according to Chaitin, irreducibly random.

**Synopsis of the Plot**

Tasic’s text is structured by a variety of literary devices—foreshadowing and flashbacks, digressions and false leads, nested narratives—so that trying to summarize it feels...reductionist, as if the review had to be at least coextensive with the book. Most of Tasic’s protagonists do, however, seem to be concerned with two themes, intimately related:

Postmodern thought is concerned with **discontinuity** and **difference**. Hence, it seems reasonable to...[consider] what some mathematicians had to say about continuity (the continuum) and identity (p. 36).

The continuum is problematic for at least two reasons: it is too big (cf. the first antinomy of Kant’s *Critique of Pure Reason*, where he does not use the word *Wesamthheit*), and its bits are too small (cf. Kant’s second antinomy). These days one might conveniently define a mathematician as a person unwarried by these two antinomies—both mentioned in MRPT—thanks to the Axiom of Infinity (number 7 on the Zermelo-Fraenkel list) and the $\epsilon - \delta$ definition, respectively, and more generally to the influence on the curriculum of people like Dieudonne. But one hundred years ago lots of people, mathematicians included, found these antinomies very worrisome. Dedekind and Cantor had hardly finished constructing the continuum when Brouwer set about its deconstruction. This meta-narrative has been told many times, usually focusing on the conflict with Hilbert. Tasic manifests his difference by stressing the parallels of Brouwer’s positions with the philosophy of Heidegger, Nietzsche, Wittgenstein, and Derrida.

Most contemporary accounts of Brouwer, presented from the standpoint of current mathematical practice, stress the negative features of his philosophy, especially his rejection of the law of the excluded middle. Tasic’s Brouwer is at heart a romantic, whose mathematics is “a continuous creative flow, ‘free will,” some inner activity of the mind that cannot be reduced to, or deduced from, language” (p. 46). Here is Brouwer, speaking in Vienna in 1928:

> There is neither exactness nor certainty in will transmission, especially not in will transmission by language [...]. There is, therefore, also for pure mathematics no certain language (quoted on p. 46, and again on p. 120).

If this reminds you of Wittgenstein, you are on Tasic’s wavelength: the Viennese philosopher was in Brouwer’s audience, an encounter reportedly responsible for Wittgenstein’s return to active philosophical work and ultimately for some of the concerns addressed in the *Philosophical Investigations*. More intriguing perhaps and certainly more slippery is Tasic’s comparison of Brouwer’s slippery version of the continuum with that of Heidegger. For Brouwer the intuition of the continuum is derived from time rather than space, and Brouwer’s anthropocentric vision replaces the instant in the time continuum with the “falling apart of a life-moment”; “the basic concept of all mathematics according to Brouwer” (p. 38), whose “points” (the scare quotes are in Tasic) are “open, indeterminate processes that actively involve the individual” (p. 39). It is not at all clear, for example, whether Brouwer would have invited Chaitin’s $\Omega$ into his continuum. This description leads Tasic to propose a dramatic “thought experiment” in which he is “a being thrown into the river of Brouwer’s time continuum” who “cannot know myself as I am because I conceive of time continuum itself by ‘looking ahead’” (p. 42). How much of this is really in Brouwer is not clear from the exposition, but “thrown” is a key Heideggerian term Tasic introduces to describe the “self” from *Being and Time*, which “is never fully ‘present’ to itself...but is a ceaseless opening toward the continuum of its existential possibilities” (p. 42). Though the word “continuum” seems to be absent from *Being and Time*, “continuous” (kontinuerlich) appears in Heidegger’s indictment of the “inauthentic temporality” of Dasein—i.e., you and me, more or less, in our better moments—when, refusing to acknowledge human finitude, it conceives of time as an “uninterrupted...sequence of ‘nows’” (*Being and Time*, par. 81). Tasic compares Heidegger’s inauthentic “they” to “the people who,” like the American in Münster but unlike Brouwer, “think they can know the square root of 2 because they can describe it in mathematical language and approximate it with any desired precision” (p. 43).

As Tasic recalls, Heidegger was aware of “the controversy between the formalists and the intuitionists,” to which he alludes explicitly in the beginning of *Being and Time* in support of his thesis on “the ontological priority of the question of being.” Tasic notes a curious similarity of Brouwer’s continuum to what Heidegger once called “the mathematical...that evident aspect of things within which we are always already moving...the fundamental presupposition of the knowledge of things” (quoted on p. 43). Heidegger’s notorious characterization of Dasein as the kind of being

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6 One might view the successful non-resolution of the debate in Münster as a contemporary refutation of Heidegger’s thesis.
that "in its Being, has a relationship towards that Being—a relationship which itself is one of Being" (*Being and Time*, par. 4) is, for Tasić, "the consequence of the very structure of the continuum" (p. 151).

Later avatars of Brouwer's continuum include what Hermann Weyl, under Brouwer's influence, called "a medium of free Becoming," literary critic Julia Kristeva's "the semiotic," and especially Derrida's "*différence*", of which more later. The dialectic of change and continuity has an ancient pedigree in metaphysics;7 in twentieth-century France Bergson (cited by Tasić) privileged the duration, whereas Bachelard (not cited) considered the instant primary. In one way or another, all these authors want "objective knowledge of the continuum" (p. 50)—to know what really happens between time t and time t + ε—what Weyl apparently meant by "Becoming," no need to invoke postmodernism. What the postmoderns have in common with each other, and with Brouwer's intuitionism, is, for Tasić, a concern with the "decidedly romanticist notion of "the inability of logic and language"—the Cantor-Dedekind continuum, for instance—"to capture the sense of continuity; in particular the continuity of inner time" (p. 31). In a discussion of Turing's Halting Problem, Tasić calls the continuum "the other of any programming language" (p. 50), a postmodern play on words and an anticipation of his discussion of Gödel's and Chaitin's theorems, symptoms of perhaps the most diagonal paradox of all: that we know the continuum well enough to derive from our ignorance of it nearly everything we know, mathematically speaking, about the limits to our knowledge.

After the funhouse of Brouwer's continuum and its variants due to Weyl and Heidegger, it comes as something of a relief to encounter Poincaré's earlier version of intuitionism. As philosopher, Poincaré seems to be enjoying something of a revival. Elie Zahar's recent *Poincaré's Philosophy* offers a "rational reconstruction" of positions Poincaré the scientist never developed as systematic philosophy. Here "rational" in large measure means making Poincaré safe for analytic philosophers; Tasić prefers to view Poincaré as a precursor of postmodernism, a "dialogical partner" of Derrida and others. From Poincaré Tasić chooses to concentrate on the problem of identity—on what remains constant between time t and time t + ε, for example. Tasić uses Poincaré's familiar critique of Euclidean geometry's hidden assumptions regarding rigid motion as a springboard to the postmodern problematic of identity and difference, or *différence*.

Poincaré maintained that the identity of objects can only be continually *motivated* by intuition, in the sense that the invariance of an object under some group of transformations is ceaselessly reestablished perceptually... The very concept of identity of an object depends on the possibility of it being different... given a chance (flow of time, "history") to change. A familiar corollary follows: Identity can be established with absolute certainty only from beyond history...[T]his reflection... seems to be the starting point of parts of postmodern theory (p. 62).

This "diachronic" version of Poincaré's critique of identity abruptly gives way to a "synchronic" version. Suppose, Tasić asks, the identity of an object... is granted through its relationship with all the other objects from which it is different... a view... usually associated with the work of the Swiss linguist Ferdinand de Saussure (p. 63).

If "granting identity" is conflated with mathematical definition, the result is an *impredicative definition*, one in which "an element is defined by an appeal to the *totality* to which it belongs" (p. 142; emphasis added). An impredicative definition particularly handy for freshman calculus is that of a least upper bound in the continuum. Less judicious impredicative definitions give rise to Russell's paradox and the like, one reason Poincaré rejected them and presumably would have had little enthusiasm for the German's suggestion in Münster regarding the existence of the continuum. For Tasić the danger is greatest in "structures that are in some sense 'generative,' for example the generative grammar of a language, which produces new elements over time" (p. 64). If you stop to ask what generative grammar has to do with the least upper bound axiom, you will miss the connection with what Tasić calls "Derrida's basic theorem," that "identity is not present to itself":

[The totality cannot be 'totalized' because 'writing' [a basic Derridean term] induces change and the appearance of new units... the identity that can be assigned to structural units by means of structural differentiation alone is always subject to possible changes. It cannot a priori be guaranteed to have achieved its full signification... simply because we cannot a priori know the (finite but unbounded) totality through which it achieves its signification (p. 144).]
Optimistically pegging his text at a nonspecialist public, Tasić includes a chapter on Hilbert's formalism and its unintended corollaries due to Gödel, Turing, and Chaitin, covering ground that most mathematicians will find familiar. But the title of this chapter, "The Expired Subject," leads directly to postmodernism, specifically the postmodernism of Michel Foucault. As missing link between Hilbert's logocentrism and that of Foucault—and thus between the "crisis of foundations" in mathematics and postmodernism—Tasić proposes French philosopher Jean Cavailles. Readers in English-speaking countries, where his work is practically unknown, can hardly imagine Cavailles's centrality for postwar French philosophy of mathematics. Tasić is to be thanked for making this compelling figure more widely known outside France—a French resistance leader, executed by the Nazis in 1944 for sabotage, of whom historian and philosopher Georges Canguilhem, his schoolmate at the École Normale Superieure, wrote the year after May 1968: "A philosopher–mathematician loaded with explosives, lucid and reckless, resolute without optimism. If that's not a hero, what is a hero?" Canguilhem was speaking at the dedication of one of several philosophy lecture halls named in Cavailles's honor. Cavailles himself wrote that "the mathematician is embarked on an adventure which he can only stop in an arbitrary way and which at every instant brings a radical novelty."

Tasić links Cavailles to Foucault through Canguilhem, the later philosopher's teacher, and indeed Canguilhem wrote in 1967, in a clear reference to Foucault and the structuralists, that Cavailles was twenty years ahead of his time in calling for "substituting for the primacy of lived or reflected consciousness the primacy of the concept, the system, or the structure." There are more links, not mentioned by Tasić: Cavailles visited Hilbert's Göttingen in 1931, where he collaborated with Emmy Noether on a translation of the correspondence between Cantor and Dedekind; at the École Normale he was a contemporary of the founders of Bourbaki and close friend of Chevalley in particular; and posthumous editions of his works contain prefaces by H. Cartan and Ehresmann, among others.

Alluding to an earlier subplot, Tasić sees Cavailles as "doing a little Hegel on Hilbert's 'Kant'" (p. 84) when he wrote that "the true meaning of a theory is not in what is understood by the scientist as essentially provisional, but in a conceptual becoming that cannot be halted." It doesn't matter that this reading is probably wrong, insofar as Cavailles saw himself as a Spinozist rather than a Hegelian, and wrote that the fact that the development of a mathematical concept "doesn't happen all at once has nothing to do with history but is the characteristic of the intelligible." Tasić wants to rescue a "hope" for an invariant mathematical truth from the following notion he reads into Cavailles:

The meaning of mathematics is in the endless historical process of its changes. Since mathematical truth always changes, it remains beyond the reach of individuals (p. 89).

For Tasić this is a "dangerous bit of formalistic ideology" that "denies human beings any creative role" (p. 88). Again, it is not important that Cavailles, brought up as a devout Protestant, who saw his engagement in the resistance as following a necessity strictly analogous to that of the development of mathematics, would not have understood matters this way, that indeed he was convinced, in spite of Gödel's theorems, of the objectivity of mathematical truth and spent his short professional life looking for a philosophically sound way to express that conviction. Cavailles' role in MRPT is to pave the way to the danger that actually came to pass: Foucault's rejection of any notion of continuity and his denial "that people...can contribute to discourse in some innovative and irreducible manner" (p. 95).

The historical moment that saw the rise of Foucault's philosophy is not exactly virgin territory. The path Tasić draws from Cavailles to Foucault is slimmer, while French and American commentators alike agree on the influence of Bachelard on Foucault, in the ideas they shared about discontinuity, for example. But it is only a story, and with

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5. In particular, he mentions Hilbert's purported intention to axiomatize geometry so thoroughly that the terms "points, lines, planes" could be replaced by "chairs, tables, beer mugs" without any change in meaning.


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8. But the title of this chapter, "The Expired Subject," leads directly to postmodernism, specifically the postmodernism of Michel Foucault. As missing link between Hilbert's logocentrism and that of Foucault—and thus between the "crisis of foundations" in mathematics and postmodernism—Tasić proposes French philosopher Jean Cavailles. Readers in English-speaking countries, where his work is practically unknown, can hardly imagine Cavailles's centrality for postwar French philosophy of mathematics. Tasić is to be thanked for making this compelling figure more widely known outside France—a French resistance leader, executed by the Nazis in 1944 for sabotage, of whom historian and philosopher Georges Canguilhem, his schoolmate at the École Normale Superieure, wrote the year after May 1968: "A philosopher–mathematician loaded with explosives, lucid and reckless, resolute without optimism. If that's not a hero, what is a hero?" Canguilhem was speaking at the dedication of one of several philosophy lecture halls named in Cavailles's honor. Cavailles himself wrote that "the mathematician is embarked on an adventure which he can only stop in an arbitrary way and which at every instant brings a radical novelty."

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10. Ibid., p. 505. This text was written in a nonspecialist public—of which Cavailles soon escaped—and is forgivably obscure.

11. Ibid., pp. 517-518.


13. See, for example, Cavailles, op. cit., pp. 180-181. Cavailles' objectivity is immanent, rather than transcendental, in a Platoist or Kantian fashion. For a bit of variety, one can also read Cavailles as an intuitionist; cf. Emmanuel Barot, Cahiers Alfred Binet, vol. 666, Nancy, March 2001.

Foucault we have finally come home to postmodernity. Tasić, whose tone has mostly been playful up to this point, does not conceal his irritation with Foucault's antihumanism, arguing memorably with this (non-Saussurian) structuralist tradition, bivalence between...

Tasic scoffs at Artificial Intelligence theorists and their “thinking thermostats,” classed along with this (non-Saussurian) structuralist tradition, confusingly, as “functionalists.” Wittgenstein (who did use the word Gesamtheit, in the Tractatus) fares little better, his philosophy haunted by an ambivalence between “something unpleasantly close to cultural determinism” (p. 120)—his Brouwerian side that involves “little more than a reformulation of one of the fundamental principles of romanticist language philosophy” (p. 118)—and “ordinary language formalism” in which “the I, or some deeper self,...ultimately ‘divides out’ from the language games” (p. 131).

And then we reach the end of the book and discover that Derrida, whose vision of a continuum of meanings as différence retrospectively illuminates Tasic’s project, was always already the protagonist of MRPT. Derrida’s neologism for “the origin or production of differences and the differences between differences,” referring simultaneously to the verbs “differ” and “defer”, designating a “sameness which is not identical,” is “neither a word nor a concept” and therefore naturally resists definition.15 Derrida himself has not been stingy with characterizations of différence, calling it elsewhere “the formation of form,” “the history of life,” among others. Non-belief, practiced by the Frenchman in Munster, is not a real option for Derrida: “To risk not meaning anything is to enter the game, and in the first place the game of différence.”16

Tasic finds différence “somehow akin to the indivisible flow of Brouwer’s continuum” (p. 147). Tying together his themes of identity and continuity, Tasic’s final chapter argues that Derrida, claiming (1) that I am not in a position to ‘totalize’ the entirety of the “text-in-general” which is the source of meaning because (2) “anything that is written anywhere instantly causes a change in meaning” therefore concludes that (3) any attempt to imagine “writing-in-general” leads to a vision of “endless sequences interspersed with presently unknowable spontaneous acts”, I.e., (4) “something like Brouwer’s continuum” as Tasic has presented it (pp. 146-147). More concisely:

If the semantic identity of some unit can only be conceived of in terms of its “location” in the continuum of possible meanings—due to the changes incurred by generating choice sequences through rules and spontaneous acts of writing—then this identity is “not present to itself.” In Brouwer’s continuum, there is no present (p. 148).

Whether or not this is what Derrida had in mind, I found this hypothesis and the entire final chapter extremely helpful: a handle for me, as a mathematician, on the role of Derrida’s philosophy in the (mainly literary) settings in which it is invoked, as well as on the possible role of mathematics in Derrida’s thought.17

And so identity and difference, nonlinguistic and the linguistic, are somehow intertwined...woven in the continuous tapestry that Derrida calls différence. One would certainly like to know how Derrida understands the relevance of his position to science...What sort of mathematics would fit his philosophical position? What would be Derrida’s philosophy of mathematics? (p. 153).

At the time of publication Tasic had not gotten around to asking Derrida these questions. For the sequel...

16 From Positions, Minuit, 1972, p. 23; quoted in Dosse, op. cit., II, p. 50.
17 A role present from the beginning, Foucault’s relation to Cavaillé’s is mediated, but Derrida invokes him explicitly in his first publication—for which he was awarded the Prix Cavaillé in 1962—an introduction to his translation of Husserl’s fragmentary essay on The Origin of Geometry.
The Polemic

I had a lot of fun with this audacious and exasperating book. There is no shortage of recent non-specialist texts in English on the nature of mathematics, but the philosophical framework is almost invariably analytic and Anglo-American; those that even acknowledge the existence of post-Kantian continental philosophy can be counted on the fingers of one hand. Despite the unfamiliarity, not to say obscurity, of some continental concepts, Tasić vividly characterizes his protagonists, conceptual as well as human, and the book is a pleasure to read. Following Tasić’s suggestion to think of MRPT as “a story,” I went through it the first time with an eye for the unconventional connections, letting the details take care of themselves. On this reading MRPT looks more than a little like Greil Marcus’s *Lipstick Traces*, a “secret history” tracing punk rock through May 1968 and French Situationism to utopian movements in various times and places in Europe (sixteenth-century Münster, for instance)—connections that, without a story, Marcus dismisses as merely “tradition as arithmetic” [p. 184].

On the second reading I began to worry about the details. Tasić’s history is selective and often distressingly hypothetical, and his interpretations of philosophical texts are frequently outlandish. That doesn’t bother me: he is hardly alone on either count. What interests me is whether or not his “speculative reconstruction” provides coherent and original insight into the problems motivating his main characters. But even if Tasić doesn’t pretend MRPT is strictly faithful to history, one has to wonder what it means to say that influence could possibly have followed the course of his speculation. Mathematicians have not shown particular sensitivity to philosophical issues raised by the question of historical influence. Witness, for example, the dispiriting controversy over the intellectual authorship of the conjecture on modularity of elliptic curves over \( \mathbb{Q} \), where different national mathematical communities have apparently adopted different solutions to the historical question without the slightest attempt to come to a methodological consensus. If specialists in the same branch of number theory are unable to agree on what is at stake, what can be meaningfully said about influence that transgresses disciplinary boundaries? While preparing this review, for example, I learned that mathematician Gregory Chaitin and performance artist Marina Abramovic discovered intellectual affinities in the course of a recent joint interview. Should we henceforth be looking for signs of mutual influence? How would we recognize them? In what terms could we judge their significance?

Tasić is absolutely right to remind us that mathematics did not have the first word on the continuum, or identity, and that mathematicians should not expect to have the last word either. There was a time of crisis, Tasić recounts, when Weyl quoted Nietzsche, Husserl discussed phenomenology with Hilbert, and Cavailles collaborated with Emmy Noether. In spite of catastrophes, chaos, and complexity, that time is past. Postmodernists and mathematicians may still be talking, separately, about continuity, but the evolution of the concept of the continuum since the crisis of foundations has apparently been... discontinuous. Which means the most rigorous historical work may well be beside the point. Even if Tasić had displayed an unbroken paper trail of direct person-to-person contact from Dedekind to Foucault, through Hilbert and Cavailles and as many links as you like, it would not mean very much if Dedekind’s continuum and Foucault’s discontinuity were intrinsically irrelevant to each other. MRPT would be much more effective if Tasić argued convincingly that there is some significant overlap, other than the name, between what Derrida and the number theorists in Münster have in mind by continuity.

But to be convincing, Tasić would have had to explore the contexts in which the continuum (or identity) appears relevant to postmodern philosophers and literary critics, as well as to contemporary mathematicians. Tasić did not set out to undertake the substantial scholarship such a project would require. Neither he nor anyone else is likely to do so in the future. Still, Tasić’s silence on what contemporary mathematics and postmodernists are really after can lead to misunderstanding. Regarding impredicative definitions, for example, which have a precise meaning in logic, Tasić writes:

\[ \text{It seems to be a general feature of impredicative definitions that...} \]

Someone whose experience of life is limited to mathematics, especially of the Bourbaki variety, may well wonder what on earth this could possibly mean. To me it brought to mind Yoneda’s Lemma on representable functors— that the functor, taking an object \( X \) of a category \( C \) to the contravariant functor from \( C \) to \( \text{Sets} \) given by \( Y \rightarrow \).
Morphisms \((Y, X)\), is fully faithful—the basis of standard techniques in topology (classifying spaces) and algebraic geometry (moduli spaces). The danger that “new elements” might be introduced into a category seems minimal. In category theory the operational notion is that of isomorphism rather than identity. My Jussieu colleague Pierre Schapira recently had the opportunity to explain the difference between these notions to an audience of philosophers.\(^{21}\) For Schapira the set-theoretic point of view, which continues to dominate all writing about philosophy of mathematics for nonspecialists, Tasić’s book included, is merely "anecdotal", having been "supplanted for nearly half a century by the categorical viewpoint" (outside of certain branches of logic, of course).\(^{22}\) Schapira mentions the influence of Grothendieck, but he also writes that "the appearance of categories is...more or less concomitant with the outbreak of structuralism in the human sciences."\(^{23}\)

This is a connection Tasić does not pursue. Nor does he have much to say about the better documented interaction between the structuralists and Bourbaki. Two paragraphs in Tasić’s chapter on structuralism attest to his awareness of this interaction. But Tasić is content to quote Gian-Carlo Rota’s view of Bourbaki as an example of "the pernicious influence of mathematics on philosophy." Tasić apparently agrees with this assessment, and he has a lot of company. Nevertheless, though Dieudonné may have been guilty of bravado in the passage quoted above, there is no sense of crisis in my field of number theory, for one, happily Bourbakist in most of its branches. In a book for nonspecialists, it is highly misleading to skip directly from the generation of the foundations crisis, through Gödel and Turing, to Chaitin, without mentioning that the rise of Bourbaki was surely one of the principal factors in the dissipation of the crisis.

Absence of a serious consideration of Bourbaki’s role or of the contemporary evolution of the foundations crisis more generally is one omission that mars MRPT. Symmetrically, Tasić devotes little time to discussion of nonmathematical roots of postmodernism. The most glaring omission is perhaps the absence of any reference to politics. Apart from an allusion to the "little red book", one would not suppose on Tasić’s account that the transformation of society was a major motivation for many of postmodernism’s central figures and even more so for their readers. Tasić’s portrayal of an anti-humanist Foucault who "calls for a formalistic final solution" to the "special status" of human beings (p. 93) is hard to square with the philosopher’s public role as what is usually called a human rights activist, who once described his books as "little toolboxes" to be used to "disqualify systems of power."\(^{23}\) As a direct result of the May 1968 strikes in Paris, Foucault spent the last period of his life as a prime example of the intellectuel engagé, and his work underwent a simultaneous shift in emphasis.\(^{25}\) The most consistent theoretician of anti-humanism was not Foucault but rather Louis Althusser—nowhere mentioned by Tasić—whose notion of "structural causality" was designed to rescue Marxism from its Stalinist as well as its humanist associations by guaranteeing its status as "science" rather than "ideology".\(^{27}\) More recently, Bruno Latour’s retroactive abortion of postmodernism on the grounds that We Have Never Been Modern is explicitly directed against the theoretical separation of science and politics and is written under the sign of the events of 1989 in Eastern Europe.\(^{28}\)

**Return to Reality**

By chance I found myself sitting on a cross-country flight last year next to a well-known string theorist, and after lunch we began comparing our gripes about the continuum. In a host of problems in which it plays a supporting role, I find all those unknowable real (and complex) numbers an an

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20 I think Tasić’s discussion would have been clearer had he quoted Hilbert at this point: “When we increase the number of fundamental objects in an axiomatic system the axioms acquire...a new extension and must then be tested again and, if necessary, modified” (cf. Poincaré, Science et Méthode, p. 146).

21 In Salle J. Cavallès, naturally; see http://www.math.jussieu.fr/~schapira.


23 Some of these points, and many others besides, are made by Yu. I. Manin in “Georg Cantor and His Heritage”, arXiv:math.AG/0209244. Manin’s talk, addressed to mathematicians rather than philosophers, features two quotations—of a literary nature—from MRPT!
noying distraction, concealing the really interesting ones (periods of algebraic integrals, zeros of the Riemann zeta function) in their midst. The physicist confided his hope that the universe could be modeled by a discrete dynamical system in which the real numbers' role would be merely anecdotal, a goal apparently shared by an increasing number of his colleagues.\footnote{See, for instance, comments in the introduction to G. 't Hooft, "Quantum gravity as a dissipative deterministic system", Classical Quantum Gravity 16 (1999), 3263.} Higher (much higher) up the Amazon.com sales charts, one finds Stephen Wolfram in A New Kind of Science promoting a similar vision of "the whole history of the universe in spacetime...represented by a giant four-dimensional network."\footnote{Interview of Stephen Wolfram by Steven Levy in Wired, June 2002. See also reviews of Wolfram's book by Lawrence Gray (Notices, February 2003) and Steven Krantz (Bulletin of the AMS, January 2003), as well as Jordan Ellenberg's review on Slate, at http://slate.msn.com/id/2067547.} Différence would be a good name for the "three or four lines of code"\footnote{Interview of Stephen Wolfram by Steven Levy in Wired, June 2002. See also reviews of Wolfram's book by Lawrence Gray (Notices, February 2003) and Steven Krantz (Bulletin of the AMS, January 2003), as well as Jordan Ellenberg's review on Slate, at http://slate.msn.com/id/2067547.} that Wolfram imagines might suffice to generate this network.

Successfully banishing the continuum from physics might alleviate the metaphysical tension latent in the Münster restaurant debate, inasmuch as the different positions would no longer have distinct material consequences. In the meantime, we mathematicians bear our responsibilities as best we can. If you are curious about the details of the "crisis of foundations", you should read a conventional history. If you are seeking a serious antidote to science wars doldrums, you should read Ian Hacking's The Social Construction of What?, which among its other merits actually managed to transform science war rhetoric into philosophically respectable debate, or The One Culture? by Jay Labinger and Harry Collins, in which leading warriors on both sides talk peace. On the other hand, if you are a mathematician mystified, as I think you should be, by the apparent fondness of (some) postmodern philosophers for mathematical metaphors, you will find MRPT stimulating, provided you follow the author's suggestion and read it as literature. And if your attempts to reconcile the set-theoretic continuum with something familiar and intuitive leave you prone to intermittent identity crises, Tasić's book will reassure you that you are not alone.

Acknowledgments

For answering questions, providing references, placing ideas in context, pointing out ambiguities, and suggesting improvements, I am deeply grateful to D. Blasius, G. Chaitin, J. Ellenberg, C. Goldstein, J.-M. Kantor, A. Plotnitsky, P. Schapira, N. Schappacher, G. Stolzenburg, and B. Velickovic.
Ronald L. Rivest, Adi Shamir, and Leonard M. Adleman received the 2002 ACM A.M. Turing Award from the Association for Computing Machinery (ACM) for their contributions to public key cryptography. The ACM presented the Turing Award on June 7, 2003, at the Federated Computing Research Conference in San Diego, California. Since its inception in 1966, the ACM’s Turing Award has honored the computer scientists and engineers who created the systems and underlying theoretical foundations that have propelled the information technology industry.

—From an ACM news release

The Association for Computing Machinery (ACM) has named Ronald L. Rivest, Adi Shamir, and Leonard M. Adleman as winners of the 2002 A.M. Turing Award, considered the "Nobel Prize of Computing", for their contributions to public key cryptography. The Turing Award carries a $100,000 prize, with funding provided by Intel Corporation.

As researchers at the Massachusetts Institute of Technology in 1977, the team developed the RSA code, which has become the foundation for an entire generation of technology security products. It has also inspired important work in both theoretical computer science and mathematics. RSA is an algorithm—named for Rivest, Shamir, and Adleman—that uses number theory to provide a pragmatic approach to secure transactions. It is today’s most widely used encryption method, with applications in Internet browsers and servers, electronic transactions in the credit card industry, and products providing email services.

Rivest is the Viterbi Professor of Computer Science in MIT’s Department of Electrical Engineering and Computer Science. He is a founder of MIT’s Cryptography and Information Security Group. He received a B.A. in mathematics from Yale University and a Ph.D. in computer science from Stanford University.

Shamir is the Borman Professor in the Applied Mathematics Department of the Weizmann Institute of Science in Israel. He received a B.S. in mathematics from Tel Aviv University and a Ph.D. in computer science from the Weizmann Institute.

Adleman is the Distinguished Henry Salvatori Professor of Computer Science and Professor of Molecular Biology at the University of Southern California. He earned a B.S. in mathematics at the University of California, Berkeley, and a Ph.D. in computer science, also at Berkeley.

The ACM presented the Turing Award on June 7, 2003, in conjunction with the Federated Computing Research Conference in San Diego, California. The award was named for Alan M. Turing, the British mathematician who articulated the mathematical foundation and limits of computing and who was a key contributor to the Allied cryptanalysis of the German Enigma cipher during World War II. Since its inception in 1966, the ACM’s Turing Award has honored the computer scientists and engineers who created the systems and underlying theoretical foundations that have propelled the information technology industry.

—From an ACM news release
2002 Annual Survey of the Mathematical Sciences

(Second Report)


Ellen E. Kirkman, James W. Maxwell, and Kinda Remick Priestley

Update on the 2001–2002 U.S. Doctoral Recipients

Introduction
The Annual Survey of the Mathematical Sciences collects information each year about departments, faculties, and students in the mathematical sciences at four-year colleges and universities in the United States. Definitions of the various groups surveyed in the Annual Survey can be found in the box on page 812 of this report. Departments in the former Group Vb (operations research and management science) are no longer being surveyed.

This Second Report includes data from two parts of the 2002 Annual Survey. First, we update information about new doctoral recipients reported earlier in the February 2003 issue. Second, we present the starting salaries of the new doctoral recipients who responded to a follow-up survey.

Prior to 2000, this report contained a third part presenting information about the faculties and instructional programs at the undergraduate and graduate levels in these departments. Starting with the 2000 survey, we chose to present this data in a separate report that is now published in the September issue of the Notices of the AMS. The 2002 Annual Survey represents the forty-sixth in an annual series begun in 1957 by the American Mathematical Society. The 2002 Survey is under the direction of the Data Committee, a joint committee of the American Mathematical Society, the American Statistical Association, the Institute of Mathematical Statistics, and the Mathematical Association of America. The current members of this committee are Amy Cohen-Conwin, Donald M. Davis, Lorraine Denby, Alexander J. Hahn, Naresh Jain, G. Samuel Jordan, Stephen F. Kennedy, Ellen E. Kirkman (chair), David J. Lutzer, and James W. Maxwell (ex officio). The committee is assisted by AMS survey analyst Kinda Remick Priestley and survey coordinator Colleen Rose. Comments or suggestions regarding this Survey Report may be directed to the committee.

Information about recipients of doctoral degrees awarded between July 1, 2001, and June 30, 2002, was collected from doctorate-granting departments beginning in late spring 2002 and from a follow-up census of individual degree recipients beginning in October. The "2002 Annual Survey First Report" (Notices of the AMS, February 2003, pages 238–53) presented survey results obtained about new doctoral

Ellen E. Kirkman is professor of mathematics, Wake Forest University. James W. Maxwell is AMS associate executive director for Membership and Programs. Kinda Remick Priestley is AMS survey analyst.
Highlights

• There were 960 doctoral recipients from U.S. institutions for 2001-2002, down 105 (10%) from the previous year’s number. This is the lowest annual number of new doctoral recipients reported since 1989-1990, when there were 950. The annual number of new doctoral recipients has declined each year since the all-time high of 1,176 reported for 1997-1998.

• This year’s drop of 105 in the number of doctoral recipients is almost entirely due to the drop of 104 in the number of recipients who are U.S. citizens (a decline of 20% over the previous year’s number, 532). This year’s count of 428 doctoral recipients who are U.S. citizens is the lowest annual figure reported since 1989-1990. The percentage of U.S. citizens among all doctoral recipients this year is 45%, down from 50% last year. This percentage had been close to 50% for the past three years.

• The number of new doctoral recipients who are non-U.S. citizens, while down by only one from the previous year, has been declining every year for the past five years: from 639 in 1997-1998 to 532 in 2001-2002.

• Females totaled 296 (31%) of all new doctoral recipients, down in number (and up in percentage) from 311 (29%) last year. Of the 428 U.S. citizen new doctoral recipients, 130 are female (30%), down from 31% last year. The highest percentage of females among the annual counts of U.S. doctoral recipients was 34%, reported for 1998-1999.

• The final unemployment rate for 2001-2002 doctoral recipients was 2.9%, the lowest reported since 1990, when it was 2.2%.

• Of the 829 new doctoral recipients known to have employment in fall 2002, 732 (88%) new doctoral recipients found employment in the U.S. last year this percentage was 90%.

• The proportion of this year’s total employed doctoral recipients who took U.S. academic positions in fall 2002 is 67%, up over last year’s figure of 63%.

• The total number of new doctoral recipients taking positions in U.S. business and industry was 136 in fall 2002, a 30% decrease from last year’s number and down from 234 reported in fall 1998 (a 42% decrease).

• The number of new doctoral recipients hired by master’s and bachelor’s institutions was 148 this year. This number has been dropping each of the past five years, resulting in a 27% decrease in the annual number from fall 1998 to fall 2002. This decline may reflect more hiring at these institutions of individuals completing a postdoctoral appointment.

• There were 572 new doctoral recipients responding to the EENDR survey; of the 510 who found employment in the U.S., 52% reported obtaining a permanent position (last year this percentage was 56%).

Table 1A: Annual U.S. Doctoral Recipients, Fall and Final Counts, 1993 to 2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Final</th>
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<tbody>
<tr>
<td>1992-1993</td>
<td>1104</td>
<td>1116</td>
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<tr>
<td>1999-2000</td>
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<td>1127</td>
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<tr>
<td>2000-2001</td>
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</tr>
<tr>
<td>2001-2002</td>
<td>948</td>
<td>960</td>
</tr>
</tbody>
</table>

Table 1B: Citizenship of Annual U.S. Doctoral Recipients, 1998 to 2002

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S.</th>
<th>Non-U.S.</th>
<th>TOTAL</th>
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<tbody>
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<td>1127</td>
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<tr>
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</tr>
<tr>
<td>2001-2002</td>
<td>428</td>
<td>532</td>
<td>960</td>
</tr>
</tbody>
</table>

Table 1C: 2001-2002 U.S. Doctoral Recipients by Type of Degree-Granting Department

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<th>I (Pr)</th>
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<th>III</th>
<th>IV</th>
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<td>124</td>
<td>224</td>
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<td>18</td>
<td>13</td>
<td>23</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 1B shows trends in the number of new doctoral recipients for the past five years broken down by U.S. citizens and non-U.S. citizens. There was a drop of 111 new doctorates from 1997-1998 to
### Table 2A: 2001-2002 U.S. Doctoral Recipients: Field of Thesis by Fall 2002 Employment Status, Updated April 2003

<table>
<thead>
<tr>
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<td>15</td>
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<td>9</td>
<td>3</td>
<td>4</td>
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<td>13</td>
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<td>0</td>
<td>73</td>
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<td>13</td>
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<td>1</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>1</td>
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1. Includes those whose status is reported as "unknown" or "still seeking employment".

### Table 2B: 2001-2002 U.S. Doctoral Recipients: Type of Degree-Granting Department by Fall 2002 Employment Status, Updated April 2003

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<td>46</td>
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* Includes those whose status is reported as "unknown" or "still seeking employment".*
2002 Annual Survey of the Mathematical Sciences

Table 2C: 2001–2002 U.S. Doctoral Recipients: Field of Thesis by Type of Degree-Granting Department, Updated April 2003

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<td>Group Va</td>
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<tr>
<td>TOTAL</td>
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Table 2D: Percentage of Total Employed New Doctoral Recipients by Type of Employer, Fall 1998 to Fall 2002

<table>
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<th>%</th>
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<th>Non-U.S. Employed</th>
<th>TOTAL NUMBER</th>
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<td>Fall 2001</td>
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<td>Fall 2002</td>
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2000-2001, mostly explained by a drop of 106 non-U.S. citizen new doctoral recipients. This year the total number of new doctoral recipients was down from the previous year by 105, with a drop of 104 in U.S. citizens. The count of 428 U.S. citizens is the lowest figure reported since 1989-1990. The all-time high number of non-U.S. citizen new doctoral recipients was 679 in 1992-1993. These trends bear watching in the future.

Table 1C gives a breakdown of the 960 doctoral degrees awarded in the mathematical sciences between July 1, 2001, and June 30, 2002, by type of degree-granting department.

Tables 2A, 2B, and 2C display updates of employment data, found in these same tables in the First Report, for the fall count of 2001-2002 doctoral recipients plus twelve additional doctoral recipients reported late. These tables are partitioned by field of thesis research, by the survey group of their degree department, and by type of employer. At the time of this Second Report, the fall 2002 employment status of 866 of the 960 doctoral recipients was known.

Figure 1: Percentage of New Doctoral Recipients Unemployed, As Reported in the Respective Annual Survey Second Reports, 1978 to 2002
The fall 2002 unemployment rate for new doctoral recipients, based on information gathered by the time of the Second Report, was 2.9%. The unemployment rate rose steadily in the early 1990s and reached its all-time high of 10.7% in both 1994 and 1995. Since then the rate has fluctuated between 3.3% and 4.9%, until this year's figure of 2.9%, the lowest rate reported since 1990. Figure 1 presents the fall 1978 through fall 2002 trend in the final unemployment rate of new doctoral recipients. The counts on which these rates are determined do not include those new doctoral recipients whose fall employment status was unknown at the time of the Second Report. Note that prior to 1999 the new doctoral recipients from Group Vb are included in the total unemployment rate for each year.

Of the 866 new doctoral recipients whose employment is known, 732 were employed in the U.S., 97 were employed outside the U.S., 25 were still seeking employment, and 12 were not seeking employment.

Table 2D presents the trend in the percentage of employed new doctoral recipients by type of employment each of the past five years. Academic employment includes those employed by research institutes and other nonprofits. The percentage of the total employed new doctoral recipients that are in academic positions is at a five-year low.

Among new doctoral recipients who are employed, the percentage taking nonacademic employment (U.S. government, U.S. business and industry, and non-U.S. nonacademic) varied significantly by field of thesis. For those whose field of thesis is in the first three columns in Table 2A, this percentage is the lowest at 9%, while the percentage for those with theses in probability or statistics is the highest at 39%.

Table 2A: Number of New Doctoral Recipients Taking Positions in Business and Industry in the U.S. by Type of Degree-Granting Department, Fall 1998 to Fall 2002

<table>
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<th>Group</th>
<th>I (Pu)</th>
<th>I (Pr)</th>
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<td>66</td>
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<td>185</td>
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Tables 3A through 3D first appeared in the First Report for 2000–2001, although they do not have the same table numbers in that report. They have all been updated with information obtained from the individual new doctoral recipients who responded to a follow-up questionnaire. The next few paragraphs discuss some of the information presented in these tables.

The fall 2002 numbers in Table 3A are down from last year in each category, and over five years the total shows a 42% decrease. The trend away from jobs in business and industry most likely reflects problems in the economy.

Table 3B: Number of New Doctoral Recipients Taking U.S. Academic Positions by Type of Degree-Granting Department, Fall 1998 to Fall 2002

<table>
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<th>III</th>
<th>IV</th>
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<td>82</td>
<td>86</td>
<td>39</td>
<td>610</td>
</tr>
<tr>
<td>Fall 2000</td>
<td>132</td>
<td>82</td>
<td>126</td>
<td>79</td>
<td>131</td>
<td>28</td>
<td>590</td>
</tr>
<tr>
<td>Fall 2001</td>
<td>159</td>
<td>71</td>
<td>126</td>
<td>80</td>
<td>108</td>
<td>30</td>
<td>574</td>
</tr>
<tr>
<td>Fall 2002</td>
<td>133</td>
<td>86</td>
<td>107</td>
<td>91</td>
<td>102</td>
<td>34</td>
<td>553</td>
</tr>
</tbody>
</table>

Table 3C: Number of New Doctoral Recipients Taking U.S. Academic Positions by Type of Hiring Department, Fall 1998 to Fall 2002

<table>
<thead>
<tr>
<th>Group</th>
<th>I-III</th>
<th>IV</th>
<th>Va</th>
<th>M&amp;8</th>
<th>Other</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 1998</td>
<td>187</td>
<td>36</td>
<td>5</td>
<td>203</td>
<td>116</td>
<td>547</td>
</tr>
<tr>
<td>Fall 1999</td>
<td>233</td>
<td>47</td>
<td>19</td>
<td>193</td>
<td>118</td>
<td>610</td>
</tr>
<tr>
<td>Fall 2000</td>
<td>216</td>
<td>51</td>
<td>11</td>
<td>180</td>
<td>132</td>
<td>590</td>
</tr>
<tr>
<td>Fall 2001</td>
<td>214</td>
<td>49</td>
<td>11</td>
<td>178</td>
<td>122</td>
<td>574</td>
</tr>
<tr>
<td>Fall 2002</td>
<td>222</td>
<td>45</td>
<td>10</td>
<td>148</td>
<td>128</td>
<td>553</td>
</tr>
</tbody>
</table>

The fall 2002 numbers in Table 3A are down from last year in each category, and over five years the total shows a 42% decrease. The trend away from jobs in business and industry most likely reflects problems in the economy.

Table 3C shows that the number of new doctoral recipients hired by Groups M and B has been dropping each of the past five years, and there has been a 27% decrease in the number of new doctoral recipients hired by master's and bachelor's departments from fall 1998 to fall 2002. This decline may reflect more hiring at these institutions of individuals completing a postdoctoral appointment.

Table 3D gives information about the production and hiring of female new doctoral recipients in the doctoral-granting departments of this survey. From Table 2B we see that 42% of the new doctoral recipients hired by Group M departments were female, while 34% of those hired by Group B departments were female.
Table 3E: 2001–2002 Male U.S. Doctoral Recipients: Type of Citizenship by Fall 2002 Employment Status

<table>
<thead>
<tr>
<th>TYPE OF EMPLOYER</th>
<th>U.S. CITIZENS</th>
<th>NON-U.S. CITIZENS</th>
<th>TOTAL MALE DOCTORAL RECIPIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permanent Visa</td>
<td>Temporary Visa</td>
<td>Unknown Visa</td>
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<tr>
<td>U.S. Employer</td>
<td>245</td>
<td>20</td>
<td>228</td>
</tr>
<tr>
<td>U.S. Academic</td>
<td>184</td>
<td>12</td>
<td>222</td>
</tr>
<tr>
<td>Groups I, II, III, and Va</td>
<td>77</td>
<td>6</td>
<td>175</td>
</tr>
<tr>
<td>Group IV</td>
<td>22</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>Non-Ph.D. Department</td>
<td>92</td>
<td>5</td>
<td>99</td>
</tr>
<tr>
<td>Research Institute/Other Nonprofit</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>U.S. Nonacademic</td>
<td>61</td>
<td>8</td>
<td>89</td>
</tr>
<tr>
<td>Non-U.S. Employer</td>
<td>13</td>
<td>1</td>
<td>58</td>
</tr>
<tr>
<td>Non-U.S. Academic</td>
<td>13</td>
<td>1</td>
<td>49</td>
</tr>
<tr>
<td>Non-U.S. Nonacademic</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Not Seeking Employment</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Still Seeking Employment</td>
<td>10</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Subtotal</td>
<td>270</td>
<td>23</td>
<td>129</td>
</tr>
<tr>
<td>Unknown (U.S.)</td>
<td>28</td>
<td>2</td>
<td>16</td>
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<tr>
<td>Unknown (non-U.S.)</td>
<td>0</td>
<td>0</td>
<td>20</td>
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<tr>
<td>TOTAL</td>
<td>298</td>
<td>25</td>
<td>335</td>
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</table>

1 Includes those whose status is reported as "unknown".

Table 3F: 2001–2002 Female U.S. Doctoral Recipients: Type of Citizenship by Fall 2002 Employment Status

<table>
<thead>
<tr>
<th>TYPE OF EMPLOYER</th>
<th>U.S. CITIZENS</th>
<th>NON-U.S. CITIZENS</th>
<th>TOTAL FEMALE DOCTORAL RECIPIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permanent Visa</td>
<td>Temporary Visa</td>
<td>Unknown Visa</td>
</tr>
<tr>
<td>U.S. Employer</td>
<td>117</td>
<td>15</td>
<td>107</td>
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<tr>
<td>U.S. Academic</td>
<td>95</td>
<td>8</td>
<td>77</td>
</tr>
<tr>
<td>Groups I, II, III, and Va</td>
<td>30</td>
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<td>33</td>
</tr>
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<td>Group IV</td>
<td>4</td>
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<td>4</td>
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<tr>
<td>Non-Ph.D. Department</td>
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<td>6</td>
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<tr>
<td>Research Institute/Other Nonprofit</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>U.S. Nonacademic</td>
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<td>Non-U.S. Employer</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-U.S. Academic</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-U.S. Nonacademic</td>
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<td>0</td>
</tr>
<tr>
<td>Not Seeking Employment</td>
<td>1</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Still Seeking Employment</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Subtotal</td>
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<td>129</td>
</tr>
<tr>
<td>Unknown (U.S.)</td>
<td>9</td>
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<td>5</td>
</tr>
<tr>
<td>Unknown (non-U.S.)</td>
<td>0</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>130</td>
<td>19</td>
<td>140</td>
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</tbody>
</table>

1 Includes those whose status is reported as "unknown" or "still seeking employment".

Updated Information about 2001–2002 U.S. Doctoral Recipients by Sex and Citizenship

Tables 3E and 3F show the sex and citizenship of the 960 new doctoral recipients and the fact that 732 new doctoral recipients found jobs in the U.S. this year. This is 88% of the 829 new doctoral recipients known to have jobs in fall 2002. Last year this percentage was 89%.

Sex and citizenship is known for all of the 960 new doctoral recipients. The final count of new doctoral recipients who are U.S. citizens is 428 (45%). For the previous three years, this figure remained very close to 50%, the largest percentages reported by the Annual Survey since the mid-1980s. Pages 243–6 of the First Report present further information related to the citizenship of the 2001–2002 new doctoral recipients.

Of the 428 U.S. citizen new doctoral recipients, 130 are female and 298 are male. The 130 female new doctoral recipients comprise 30% of the U.S. citizen total for 2001–2002, a decrease from last year's count of 166 (down 22%); last year female new doctoral recipients were 31% of the U.S. citizen new doctoral recipients. The number of U.S. citizen males, 298, is down 68 (19%) from 366 last year.

Table 3G shows that while U.S. academic doctoral departments, Groups I through Va, hired 44% U.S.
citizens, U.S. academic positions other than in the doctoral departments hired 57% U.S. citizens. Those hired for nonacademic positions in the U.S. who are U.S. citizens was 46%. Among those 732 2001-2002 doctoral recipients taking employment in the U.S., 24% took nonacademic employment (government or business and industry). This is down from 30% in 2000-2001 and from 31% in 1999-2000.

New Information from the EENDR Survey
Of the 948 new doctoral recipients reported in the First Report, the 890 whose addresses were known were sent the Employment Experiences of New Doctoral Recipients (EENDR) survey in October 2002, and 572 (64%) responded. The response rates varied considerably among the various subgroups of new doctoral recipients defined by their employment status as reported by departments. Among those who were employed, the highest response rate, 75%, was from those in academia in the U.S., while the lowest, 10%, was from those in foreign nonacademia.

The EENDR gathered details on employment experiences not available through departments. The rest of this section presents additional information available on this subset of the 2001-2002 doctoral recipients.

Table 4A provides the trend in EENDR respondents taking permanent and temporary positions in the U.S. for fall 1998 through fall 2002. This year we see that among the 510 employed in the U.S., 264 reported obtaining a permanent position and 245 a temporary position (one individual did not answer this question). Of the 245 in temporary positions, 110 (45%) reported taking temporary employment because a suitable permanent position was not available and 234 (96%) classified their position as postdoctoral. Furthermore, among those in postdoctoral positions, 37% responded that they took the position because a suitable permanent position was not available. Of particular note in Table 4A is the steady increase in the percentage of temporarily employed respondents who reported taking a postdoctoral position.

Table 4B shows the employment trends of permanent and temporary positions broken down by sector for the last five years. There has been a
continuing increase in the proportion of EENDR respondents taking permanent employment in academia and an offsetting decline in the proportion taking permanent positions in business and industry.

Among the 264 who reported obtaining a permanent position in the U.S. in fall 2002, 70% were employed in academia (including 3% in research institutes and other nonprofits), 6% in government, and 23% in business or industry. Women held 36% of the permanent positions.

Among the 245 individuals with temporary employment in the U.S. this year, 93% were employed in academia (including 5% in research institutes and other nonprofits), 6% in government, and 1% in business or industry.

Figure 2 gives the age distribution of the 556 new doctoral recipients who responded to this question. The median age of new doctoral recipients was 30 years, while the mean age was 32 years. The first and third quartiles were 28 and 34 years, respectively. These figures are very similar to those reported in previous years.

**Previous Annual Survey Reports**
The 2002 First Annual Survey Report was published in the *Notices of the AMS* in the February 2003 issue. For the last full year of reports, the 2001 First, Second, and Third Annual Survey Reports were published in the *Notices of the AMS* in the February, August, and September 2002 issues respectively. These reports and earlier reports, as well as a wealth of other information from these surveys, are available on the AMS website at www.ams.org/employment/surveyreports.html.

**Starting Salary Survey of the 2001–2002 U.S. Doctoral Recipients**
The starting salary figures for 2002 were compiled from information gathered on the EENDR questionnaires sent to individuals who received doctoral degrees in the mathematical sciences during the 2001–2002 academic year from universities in the United States (see previous section for more details).

The questionnaires were distributed to 890 recipients of degrees using addresses provided by the departments granting the degrees; 572 individuals responded between late October and April. Responses with insufficient data or from individuals who indicated they had part-time or non-U.S. employment were considered unusable. Numbers of usable responses for each salary category are reported in the following tables.

Readers should be warned that the data in this report are obtained from a self-selected sample, and inferences from them may not be representative of the population.

**Key to Tables.** Salaries are listed in hundreds of dollars. Nine-month salaries are based on 9–10 months’ teaching and/or research, not adding extra stipends for summer grants or summer teaching or the equivalent. Years listed are the academic year in which the doctorate was received. M and F are male and female respectively. Some persons receiving a doctoral degree had been employed in their present position for several years, so those who had “one year or less experience” were analyzed separately from the total. Male and female figures are not provided when the number of salaries available for analysis in a particular category was five or fewer. Also, quartile figures are not available for 1965 through 1980. All categories of “Teaching/Teaching and Research” and “Research Only” contain those recipients employed at academic institutions only. The “Academic Research Only, 9–10-Month Salaries” category was dropped from the published analyses in 1998 because so few recipients respond in this category that the data were not considered meaningful. Starting salaries for those reporting a 9–10-month salary postdoctoral position are available for a sixth year. These salaries are also included within the “Academic Teaching/Teaching and Research, 9–10-Month Salaries” table and boxplot on page 809.


For each boxplot the box shows the first quartile (Q1), the median (M), and the third quartile (Q3). The interquartile range (IQR) is defined as Q3 - Q1. Think of constructing invisible fences 1.5xIQR below Q1 and 1.5xIQR above Q3. Whiskers are drawn from Q3 to the largest observation that falls below the upper invisible fence and from Q1 to the smallest observation that falls above the lower invisible fence. Think of constructing two more invisible fences, each falling 1.5xIQR above or below the existing invisible fences. Any observation that falls between the fences on each end of the boxplots is called an outlier and is plotted as ◦ in the boxplots. Any observation that falls outside of both fences either above or below the box in the boxplot is called an extreme outlier and is marked as ◦ in the boxplot.
Academic Teaching/Teaching and Research
9-10-Month Salaries
(in hundreds of dollars)

<table>
<thead>
<tr>
<th>Ph.D. Year</th>
<th>Min</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>70</td>
<td>—</td>
<td>80</td>
<td>—</td>
<td>105</td>
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<tr>
<td>1970</td>
<td>85</td>
<td>—</td>
<td>110</td>
<td>—</td>
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<td>1975</td>
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<td>420</td>
<td>461</td>
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<td>450</td>
<td>500</td>
<td>840</td>
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<td>475</td>
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<td>413</td>
<td>443</td>
<td>620</td>
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<td>430</td>
<td>475</td>
<td>650</td>
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</table>

Academic Postdoctorates
9-10-Month Salaries
(in hundreds of dollars)

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<th>Q3</th>
<th>Max</th>
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<td>1999</td>
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<td>365</td>
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<td>595</td>
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2002 Annual Survey of the Mathematical Sciences
### Academic Teaching/Teaching and Research
#### 11-12-Month Salaries (in hundreds of dollars)

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<th>Median</th>
<th>Q3</th>
<th>Max</th>
<th>Reported Median in 2002 $</th>
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<td>1970</td>
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### Academic Research Only
#### 11-12-Month Salaries (in hundreds of dollars)

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### Government

**11-12-Month Salaries**

(in hundreds of dollars)

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#### Business and Industry

**11-12-Month Salaries**

(in hundreds of dollars)

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**Salary (in hundreds of 2002 dollars)**

- **2002 Annual Survey of the Mathematical Sciences**

**AUGUST 2002**

**NOTICES OF THE AMS**

**811**
Definitions of the Groups
As has been the case for a number of years, much of the data in these reports is presented for departments divided into groups according to several characteristics, the principal one being the highest degree offered in the mathematical sciences. Doctoral-granting departments of mathematics are further subdivided according to their ranking of "scholarly quality of program faculty" as reported in the 1995 publication Research-Doctorate Programs in the United States: Continuity and Change.¹ These rankings update those reported in a previous study published in 1982.² Consequently, the departments which now comprise Groups I, II, and III differ significantly from those used prior to the 1996 survey.

The subdivision of the Group I institutions into Group I Public and Group I Private was new for the 1996 survey. With the increase in number of the Group I departments from 39 to 48, the Data Committee judged that a further subdivision of public and private would provide more meaningful reporting of the data for these departments.

Brief descriptions of the groupings are as follows:

Group I is composed of 48 departments with scores in the 3.00-5.00 range. Group I Public and Group I Private are Group I departments at public institutions and private institutions respectively.

Group II is composed of 56 departments with scores in the 2.00-2.99 range.

Group III contains the remaining U.S. departments reporting a doctoral program, including a number of departments not included in the 1995 ranking of program faculty.

Group IV contains U.S. departments (or programs) of statistics, biostatistics, and biometrics reporting a doctoral program.

Group V contains U.S. departments (or programs) in applied mathematics/applied science, operations research, and management science which report a doctoral program.

Group Va is applied mathematics/applied science; Group Vb, which is no longer surveyed as of 1998-99, was operations research and management science.

Group M contains U.S. departments granting a master's degree as the highest graduate degree.

Group B contains U.S. departments granting a baccalaureate degree only.

Listings of the actual departments which comprise these groups are available on the AMS Website at www.ams.org/employment/surveyreports.html.


² These findings were published in An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, DC, 1982. The information on mathematics, statistics, and computer science was presented in digest form in the April 1983 issue of the Notices, pages 257–67, and an analysis of the classifications was given in the June 1983 Notices, pages 392–3.

Acknowledgments
The Annual Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical sciences scene for the use and benefit of the community and for filling the information needs of the professional organizations. Every year, college and university departments in the United States are invited to respond. The Annual Survey relies heavily on the conscientious efforts of the dedicated staff members of these departments for the quality of its information. On behalf of the Annual Survey Data Committee and the Annual Survey Staff, we thank the many secretarial and administrative staff members in the mathematical sciences departments for their cooperation and assistance in responding to the survey questionnaires.

Other Data Sources


Doctoral Degrees Conferred 2001–2002
Supplementary List
The following list supplements the list of thesis titles published in the February 2003 Notices, pages 264–80.

ARIZONA
Arizona State University (6)

MATHEMATICS
Archibald, Richard, Boundary detection and reconstruction in magnetic resonance imaging.
Dunn, Charles, Extensions of a simple competitive graph coloring algorithm.
Kuo, Yu-Ju, Interior point algorithms for second order cone problems with applications.
Loladze, Irakli, The importance of being stoichiometric: Population dynamics from the perspective of chemical elements.
Marthaler, Daniel, Two problems from nonlinear dynamical systems.
Zela, Dritan, A continuum spine model for the horizontal cell-to-cone feedback in cat outer retina.

COLORADO
University of Colorado (3)

MATHEMATICS
Caravone, Curtis, On the convergence of model-free policy iteration algorithms for reinforcement learning: Stochastic approximation under discontinuous mean dynamics.
Caulk, Suzanne, Explicit action of Hecke operators on Hilbert-Siegel modular forms.
Kornelson, Keri, Local solvability of Laplacian difference operators arising from the discrete Heisenberg group.

GEORGIA
University of Georgia (2)

MATHEMATICS
Bindner, Donald, On the space spanned by the powers of an operator and its adjoint.
Liu, Ruihua, Hierarchical control and filtering of stochastic markovian system.

NORTH CAROLINA
Duke University (1)

MATHEMATICS
Collins, Anne D., Configuration spaces in robotic manipulation and motion planning.

PENNSYLVANIA
Carnegie Mellon University (2)

STATISTICS
Ghiuvea, Cristian, Pricing of generalized American options with applications to energy derivatives.
Janus, Juliana, Approximate robust Bayesian inference with applications to sample size calculation.
Feferman and Stanley Receive Schock Prizes

Four Rolf Schock Prizes for 2003 have been awarded, two of them to mathematicians: SOLOMON FEFERMAN and RICHARD P. STANLEY.

The versatile philosopher and artist Rolf Schock (1933-1986) describes in his will a prize to be awarded in such widely differing subjects as logic and philosophy, mathematics, the visual arts, and music. The Royal Swedish Academy of Sciences, the Royal Swedish Academy of Fine Arts, and the Royal Swedish Academy of Music have awarded these prizes every other year since 1993. Each prize carries a monetary award of SEK 400,000 (about US$51,400).

Solomon Feferman

The Schock Prize in Logic and Philosophy was awarded to Solomon Feferman of Stanford University "for his works on the arithmetization of metamathematics, transfinite progressions of theories, and predicativity."

Solomon Feferman has made important contributions to all the main areas of logic. The works that motivate this year's Rolf Schock Prize concern arithmetization, transfinite progressions of theories, and predicativity. Arithmetization is a method of coding statements about a theory as formulas in the theory itself. It was introduced by the Austrian logician Kurt Gödel in the proof of his celebrated incompleteness theorems: any consistent and sufficiently expressive axiomatic theory is incomplete in the sense that it cannot prove all true statements expressed in its own language, and in particular not (the arithmetized version of) the statement that the theory itself is consistent, i.e., free from contradictions. Arithmetization is now a standard technique in logic, and it was Feferman who first systematically studied its scope and limitations, which among other things led him to an important sharpening of Gödel's second theorem.

In a transfinite progression based on some theory one attempts to diminish its incompleteness by successively adding infinitely many true but unprovable statements as new axioms. In the late 1950s Feferman proved fundamental results about such progressions, using the arithmetization technique. This work also led to a study of predicativity. A predicative theory disallows definitions that are in a certain sense circular. Such theories can be approached via progressions, and in the early 1960s Feferman solved the problem of how far into the transfinite the predicative part of the theory of mathematical analysis reaches. In later works he has also made important contributions to our understanding of the concept of predicativity.

Solomon Feferman was born in New York in 1928. He obtained his Ph.D. in mathematics at the University of California, Berkeley, in 1957. Since then he has taught at Stanford University, from 1968 as professor of mathematics and philosophy. In 1993 he also became Patrick Suppes Family Professor in the School of Humanities and Sciences at the same university. Since 1990 he has been a fellow of the American Academy of Arts and Sciences. Feferman is the editor-in-chief of Kurt Gödel's Collected Works, volumes I-V.

Richard P. Stanley

The Schock Prize in Mathematics was awarded to Richard P. Stanley of the Massachusetts Institute of Technology "for his fundamental contributions to combinatorics and its relationship to algebra and geometry, in particular for his important contributions to the theory of convex polytopes and his innovative work on enumerative combinatorics."

Richard P. Stanley has made many pioneering contributions to combinatorics. In addition, he has forcefully and with great originality contributed to the discovery of new connections between combinatorics and other areas of mathematics, to great mutual benefit.

Among his most significant results are his contributions to the study of convex polytopes, the bodies that in higher dimensions correspond to three-dimensional polyhedra (such as cubes and pyramids), especially his proof of necessity in the characterization of f-vectors of simplicial polytopes via algebraic geometry (toric varieties). Furthermore, he has produced first-rate work prompted by enumerative problems, which he often solves in unexpected ways using techniques primarily from commutative algebra, algebraic and convex geometry, and representation theory. His ideas have not only influenced and altered combinatorics profoundly and permanently; they
have also stimulated research in the other areas mentioned.

Stanley's scientific production is marked by clarity, breadth, substance, and originality. The methods he has introduced are innovative and have led to decisive progress in many areas of mathematics. He has also spent much effort in writing graduate-level textbooks that have rapidly set the norm.

Richard P. Stanley was born in New York in 1944. He studied at the California Institute of Technology and Harvard University, where he received his doctorate in 1971. Since 1979 he has been professor of applied mathematics at MIT. He has been a visiting professor at a number of universities in the United States and France, and also at Stockholm University and the Royal Institute of Technology in Stockholm.


—From Royal Swedish Academy news releases

Hobson Wins Adams Prize

The University of Cambridge has announced the winner of one of its most prestigious prizes. The Adams Prize is awarded each year by the Faculty of Mathematics and St. John's College to a young researcher based in the United Kingdom who is doing first-class international research in the mathematical sciences.

The winner for 2003 in the area of financial mathematics is DAVID HOBSO N of Bath University for contributions over a wide range of major current topics in the field that have "important implications for the stock market," according to the prize citation.

Hobson's research includes the use of coupling methods to establish price inequalities for complex pricing models, deep results on robust hedging, pricing and hedging of passport options, and pricing of real options. He has also achieved results in theoretical probability, martingale inequalities, and Skorokhod embedding.

The Adams Prize is named after the mathematician John Couch Adams and was endowed by members of St. John's College. It is currently worth £15,000 (approximately US$24,000), of which one third is awarded to the prizewinner on announcement of the prize, one third is provided to the prizewinner's institution (for research expenses of the prizewinner), and one third is awarded to the prizewinner on acceptance for publication in an internationally recognized journal of a substantial (normally at least twenty-five printed pages) original survey article of which the prizewinner is an author.

—From University of Cambridge announcement

Prizes of the Mathematical Society of Japan

The Mathematical Society of Japan (MSJ) has awarded its 2003 Spring Prize to TOMOTADA OHTSUKI of Tokyo University and the Algebra Prize to KEICHI WATANABE of Niho n University.

The Spring Prize is awarded each year to a mathematician who is not older than forty and who has made an outstanding contribution to mathematics. Ohtsuki was honored for contributions to the study of quantum invariants for 3-manifolds. The Algebra Prize is awarded every year to a maximum of two algebraists in recognition of outstanding contributions in algebra. Watanabe was honored for his outstanding contributions to commutative ring theory and its applications to singularity theory.

—From an MSJ announcement

Leibniz Prizes Awarded

The Deutscherforschungsgemeinschaft, the main scientific research funding agency of the German government, has awarded the 2003 Leibniz Prizes to eleven researchers. Five of the prizewinners work in the mathematical sciences. Each prize provides a research grant of 1.55 million euros (approximately US$1.7 million) over five years.

HELENE ESNAL U T and ECKHART VIEHWEG are the first married couple to receive a Leibniz Prize for joint work. They have been collaborating for more than twenty years and during this time have coauthored approximately twenty-five substantial publications. Their work is in the area of algebraic and arithmetic geometry. Esnault received her Ph.D. from the Université de Paris VII in 1984. Viehweg received his Ph.D. at the Universität Mannheim in 1975. Both are currently professors at the Universität Essen.

GERHARD ERKIEHSN works at the crossroads of pure mathematics and theoretical physics. His mathematical research is in analysis and differential geometry, and his physics research is in general relativity. He received his Ph.D. from the Universität Heidelberg in 1983 and is currently the director of the Albert Einstein Institute for Gravitational Physics, a Max Planck Society institute in Golm, a suburb of Potsdam.

RUPERT KLEIN is a leading expert in theoretical fluid mechanics whose research is highly regarded in engineering as well as in applied and numerical mathematics. Some of his most important work has centered on models for tropical meteorology. He studied mechanical engineering at the RWTH (Rheinisch-Westfälische Technische Hochschule) Aachen, receiving his Ph.D. in 1988. He currently holds a joint appointment at the Freie Universität Berlin and at the Potsdam Institute for Climatology.

HANS-PETER SEIDEL works in modeling, graphics, and visualization. He has developed algorithms as part of a wholistic approach to problems that extends from data acquisition to modeling to graphical synthesis. He received his Ph.D. in mathematics in 1987 at the Universität...
Tübingen. Since 1999 he has been the director of the Max Planck Institute for Computer Science in Saarbrücken and an honorary professor at the Universität des Saarlandes in Saarbrücken.

—Allyn Jackson

National Academy of Sciences Elections

The National Academy of Sciences has announced the election of seventy-two new members and eighteen foreign associates. The following mathematical scientists are among the newly elected members: GEORGE E. ANDREWS, Pennsylvania State University; JAMES O. BERGER, Duke University; YAKOV ELIASBERG, Stanford University; G. DAVID FORNEY JR., Massachusetts Institute of Technology; and SOLOMON W. GOLOMB, University of Southern California. HAM BREVIS, Université Pierre et Marie Curie, Paris, France, was elected as a foreign member.

—From an NAS announcement

American Academy of Arts and Sciences Elections

Ten mathematical scientists have been elected to membership in the American Academy of Arts and Sciences for 2003. They are: THOMAS COVER, Stanford University; PERCY A. DEFT, Courant Institute, New York University; LAWRENCE C. EVANS, University of California, Berkeley; SOLOMON W. GOLOMB, University of Southern California; RICHARD HAMILTON, Columbia University; IAIN JOHNSTONE, Stanford University; WILLIAM M. KAHAN, University of California, Berkeley; NICHOLAS M. KATZ, Princeton University; and WILFRIED SCHMID, Harvard University. JAMES G. ARTHUR of the University of Toronto was elected a foreign honorary member for 2002.

The American Academy of Arts and Sciences was founded in 1780 to foster the development of knowledge as a means of promoting the public interest and social progress. The membership of the academy is elected and represents distinction and achievement in a range of intellectual disciplines—mathematical and physical sciences, biological sciences, social arts and sciences, and humanities and fine arts.

—From an American Academy announcement

Putnam Prizes Awarded

The winners of the 63rd William Lowell Putnam Competition have been announced. The Putnam Competition is administered by the Mathematical Association of America and consists of an examination containing mathematical problems that are designed to test both originality and technical competence. Prizes are awarded to both individuals and teams.

The five highest ranking individuals, listed in alphabetical order, were: REID W. BARTON, Massachusetts Institute of Technology; GABRIEL D. CARRELL, Harvard University; DENNIS CEBRINS, Massachusetts Institute of Technology; ALEXANDER B. SCHWARTZ, Harvard University; and MELANIE E. WOOD, Duke University.

Institutions with at least three registered participants obtain a team ranking in the competition based on the rankings of three designated individual participants. The five top-ranked teams (with team members listed in alphabetical order) were: Harvard University (Gabriel D. Carrell, George Lee Jr., Alexander B. Schwartz); Princeton University (Stefan L. Horne, Mihai Manea, Radu H. Mihescu); Duke University (David G. Arthur, Oaz Nir, Melanie E. Wood); University of California, Berkeley (Boris Bukh, James M. Merrifield, Austin W. Shapiro); and Stanford University (Chee Hau Tan, Paul A. Valiant, Daniel Wright).

The top five individuals in the competition received cash awards of $2,500; the next ten received $1,000. The first-place team was awarded $25,000, with each team member receiving $1,000. The team awards for second place were $20,000 and $800; for third place, $15,000 and $600; for fourth place, $10,000 and $400; and for fifth place, $5,000 and $200.

The Elizabeth Lowell Putnam Prize is awarded periodically to a woman whose participation in the Putnam Competition is deemed particularly meritorious. In the recent competition, this prize went to MELANIE E. WOOD of Duke University. The prize carries a cash award of $1,000. Wood also received this prize in last year’s competition.

—Elaine Kehoe

USA Mathematical Olympiad

The thirty-second annual USA Mathematical Olympiad (USAMO) was held April 29 and 30, 2003. The students participating in the Olympiad were selected on the basis of their performances on the American High School and American Invitational Mathematics Examinations, which involved hundreds of thousands of students.

The twelve highest scorers in the USAMO, listed in alphabetical order, were: BORIS ALEXEEV of Athens, Georgia; JAE BAE of Hackensack, New Jersey; DANIEL KANE of Madison, Wisconsin; ANDERS KASGREN of Charlotte, North Carolina; MARK LIPSON of Lexington, Massachusetts; TIANKAI LIU of Exeter, New Hampshire; PO LING LOH of Madison, Wisconsin; PO RU LOH of Madison, Wisconsin; AARON PFEFTON of Vestal, New York; KOWKUNG TANG of Exeter, New Hampshire; TONY ZHANG of Exeter, New Hampshire; and YAN ZHANG of Alexandria, Virginia. Tienkai Liu and Po Ru Loh received perfect scores.

The twelve USAMO winners will attend the Mathematical Olympiad Summer Program (MOSP), after which six of the twelve students will be selected as the United States team to compete in the International Mathematical Olympiad (IMO) to be held in Tokyo, Japan, July 7-19, 2003.

—Elaine Kehoe
Mathematics Opportunities

NSF Focused Research Groups

The Focused Research Groups (FRG) activity of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) supports small groups of researchers in the mathematical sciences.

The DMS has announced deadline dates for the fiscal year 2003 competition for FRG grants. The deadline for receipt of the required letters of intent to submit FRG proposals is August 19, 2003. The deadline date for full proposals is September 19, 2003.


—From an NSF announcement

NSF Mathematical Sciences Postdoctoral Research Fellowships

The Mathematical Sciences Postdoctoral Research Fellowship program of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) awards fellowships each year for research in pure mathematics, applied mathematics and operations research, and statistics. The deadline for this year’s applications is October 17, 2003. Applications must be submitted via FastLane on the World Wide Web. Go to http://www.fastlane.nsf.gov/ and click on “Postdoctoral Fellowships”. Information can be found there for the Mathematical Sciences Postdoctoral Research Fellowships, as well as other NSF fellowship opportunities. For more information, telephone the DMS at 703-306-1870 or email: msprf@nsf.gov.

—From an NSF announcement

COBASE Collaborative Grants

With funding from the National Science Foundation (NSF), the Office for Central Europe and Eurasia of the National Research Council, the operating arm of the National Academies, offers grants to individual American specialists who plan to establish new research partnerships with their colleagues from Central/Eastern Europe (CEE) and the Newly Independent States (NIS). This program is designed primarily to prepare these new partnerships for competition in NSF programs. The Collaboration in Basic Science and Engineering (COBASE) program accepts proposals for collaborative research in all fields of basic science supported by NSF. Mathematics is one of the fields in which applications will be given special priority.

Project Development and Initiation Grants support American specialists who wish to host and/or visit their CEE or NIS colleagues in order to initiate research projects and prepare collaborative research proposals for submission to the NSF. U.S. applicants may now request support for up to two visits in either or both directions (i.e., either traveling to CEE/NIS or hosting a colleague from the region here in the U.S.), with the total combined duration of the visit(s) not to exceed eight weeks. Each individual visit proposed must be at least two weeks (10–14 days) in length. Grants will be in the range of $2,500 to $10,000.

Participating countries: Armenia, Azerbaijan, Bosnia (hosting in U.S. only), Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, (Former Yugoslav Republic of) Macedonia, Moldova, Poland, Romania, Russia (see website for updated list of ineligible partner institutions), Serbia and Montenegro (hosting in U.S. only), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. A special topic focus area this year is Central Asia. Proposals involving collaboration with scientists in the Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan are especially encouraged. Projects may be in any of the accepted fields of science and engineering listed in the program announcement and
may include partners from more than one eligible foreign
country if appropriate for the research proposed.

Eligibility: All applicants must: (1) be U.S. citizens or per­
manent residents, (2) be affiliated with U.S. universities or
other nonprofit research institutions, and (3) possess Ph.D.
degrees or equivalent research experience. Foreign coun­
terparts involved must possess CEE/NIS citizenship, be
permanently employed at CEE/NIS institutions, and hold
Ph.D. (kandidat) degrees or research training and experi­
cence equivalent to a doctoral degree. Employees of private
companies and the U.S. government generally are not
supported under the COBASE program. Each set of part­
ers may receive no more than one COBASE grant, and each
individual may be involved in no more than two grants in
a four-year period. Generally, those who hold a current NSF
grant and are eligible for an NSF international supplement
should not apply to this program.

Special Opportunities for Junior Investigators: American
applicants who have received their doctoral degrees within
the past ten years will receive special consideration. The
COBASE program allocates at least 25 percent of its grants
to researchers in this category in order to encourage be­
ginning investigators to become involved in international

Collaborative proposals involving any field of mathe­
matics are welcome, including but not limited to algebra
and number theory, analysis, computational mathematics,

geometric analysis, statistics and probability, and topology
and foundations. Projects in applied mathematics involv­
ing collaborations with specialists from other fields such
as the biological, computer, and environmental sciences are
also encouraged. Collaborative research proposals involving
the modeling of complexity are particularly welcome.

The postmarking deadline for proposals is August 25,
2003. For application forms and instructions, visit the
website http://www7.nationalacademies.org/
dsc/COBASE_Grants_Program.html. For more infor­
tation, telephone 202-334-2644, send a fax to 202-334-2614,
or send email to ocee@nas.edu.

—From an NAS announcement

Awards made through this competition are dependent
upon responsiveness of the proposals to the announcement,
the quality of the proposed research, and the availability
of funds. The DMS and the NIGMS anticipate making 20–25
awards totaling about $6 million in each of the fiscal years
2003-2005. The projected range is from $100,000 to
$400,000 per award per year (total costs), with durations
of 4–5 years.

The program announcement is on the webpage http://
next deadline for proposals is June 30, 2004.

—NSF announcement

Call for Nominations for National Academies
Communication Awards

The National Academies is accepting nominations for the
new National Academies Communication Awards for ex­
cellence in reporting and communicating science and tech­
tology to the general public. Three $20,000 prizes will be
presented to scientists, engineers, medical researchers,
journalists, authors, and film/television/radio producers
who, in the preceding two years, have made special con­
tributions to the public's understanding of science or the
promise of cutting-edge interdisciplinary research.

The Communication Awards are one component of a
new initiative called the "National Academies Keck Fu­
tures Initiative", which is designed to realize the untapped
potential of interdisciplinary research.

Nominations must be received by August 1, 2003. The
first three winners will be honored at the National Ac­
demies' Beckman Center in Irvine, California, during the Keck
Futures Conference to be held November 14–16, 2003.

For information on eligibility, submission requirements,
and nomination procedures, visit http://www.
nationalacademies.org/keck/awards.

—From a National Academies announcement

DMS/NIGMS Program in
Mathematical Biology

The Division of Mathematical Sciences (DMS) of the National
Science Foundation and the National Institute of General
Medical Sciences (NIGMS) at the National Institutes of
Health sponsor the Joint DMS/NIGMS Initiative to Sup­
port Research in the Area of Mathematical Biology. The ini­
itiative focuses on mathematics and statistics related to
mathematical biology research.

The DMS and the NIGMS recognize the need for additional
research at the boundary between the mathematical sci­
ences and the life sciences. This competition is designed to
encourage new collaborations at this interface, as well as to
support existing ones.
About the Cover
This month's cover was suggested by the article on dessins d'enfants in this issue. It was produced by David Burggraf, until recently a graduate student at the University of British Columbia.

Each of the six images shows a dessin d'enfant arising from a Belyi covering of \( \mathbb{P}^1(\mathbb{C}) \) by an elliptic curve of the form
\[
y^2 = (x - r_1)(x - r_2)(x - r_3)
\]
where the \( r_i \) are distinct roots of \( x^{12} - \left( \frac{12}{11} \right) x^{11} + 1 \). The Galois group of this polynomial is the symmetric group \( S_{12} \), which permutes the associated Belyi coverings, as well as the associated dessins. This particular set is the orbit of one of them under the group generated by \( \sigma = (1 2 3 4 5 6)(7 8 9 10 11 12) \). The coloring of the 'flower stems' indicates the action of \( \sigma \) on edges.

Similar images can be found in David Burggraf's thesis, available from a link on his home page at http://www.math.ubc.ca/~burggraf/.

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

Inside the AMS

AMS-AAAS Media Fellowship
Each year the AMS sponsors a fellow to participate in the Mass Media Fellowship program of the American Association for the Advancement of Science (AAAS). This program places science and mathematics graduate students in summer internships in media outlets.

The 2003 AMS-AAAS Mass Media Fellowship has been awarded to CLAUDIA CLARK, a mathematics graduate student at Northeastern University. Clark will be based at the Voice of America for her summer fellowship upon completion of the program orientation in Washington, DC.

—AMS Washington office

Deaths of AMS Members

JOHN J. BARON, of Newburyport, MA, died on January 19, 2003. He was a member of the Society for 38 years.

MARJORIE HECKEL BEATY, of Vermillion, SD, died on July 18, 2002. She was a member of the Society for 72 years.

C. J. BOUKAMP, of Eindhoven, The Netherlands, died on February 23, 2003. He was a member of the Society for 50 years.

MICHAEL EDELSTEIN, of Vancouver, Canada, died on January 27, 2003. He was a member of the Society for 41 years.

JOHN V. HOLBERTON, of Rockville, MD, died on April 18, 2003. He was a member of the Society for 46 years.

HAYON KIM, of Brossard, Canada, died on December 2, 2002. He was a member of the Society for 41 years.

ANN O'NEILL, of North Attleboro, MA, died on January 13, 2003. She was a member of the Society for 61 years.

HENRY G. RICE, of Davis, CA, died on April 14, 2003. He was a member of the Society for 61 years.

M. H. SAMSON, of Adge, France, died on April 10, 2003. He was a member of the Society for 53 years.

JEROME G. SOWUL, of Cupertino, CA, died on July 7, 2002. He was a member of the Society for 42 years.

F. A. VALENTINE, of UCLA, died on November 1, 2002. He was a member of the Society for 66 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.tamu.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 979-845-6028 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

Upcoming Deadlines

July 15, 2003: Applications for Women's International Science Collaboration (WISC) Program. See http://www.aaas.org/international/wisctnew.shtml or contact WISC Travel Grant, American Association for the Advancement of Science, Directorate for International Programs, 1200 New York Avenue, NW, Washington, DC 20005.


August 1, 2003: Applications for 2004-2005 Fulbright traditional lecturing and research grants. Contact

Where to Find It

A brief index to information that appears in this and previous issues.

AMS Bylaws—November 2001, p. 1205
AMS Email Addresses—November 2002, p. 1275
AMS Ethical Guidelines—June/July 2002, p. 706
AMS Officers 2002 and 2003 (Council, Executive Committee, Publications Committees, Board of Trustees)—May 2003, p. 594
AMS Officers and Committee Members—October 2002, p. 1108
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Mathematics Research Institutes Contact Information—August 2003, p. 821
National Science Board—January 2003, p. 64
New Journals for 2001—June/July 2003, p. 708
NRC Board on Mathematical Sciences and Their Applications—March 2003, p. 383
NRC Mathematical Sciences Education Board—April 2003, p. 489
NSF Mathematical and Physical Sciences Advisory Committee—February 2003, p. 261
Program Officers for Federal Funding Agencies—October 2002, p. 1103 (DoD, DoE); November 2002, p. 1278 (NSF Education Program Officers); December 2002, p. 1406 (DMS Program Officers)
the Council for International Exchange of Scholars (CIES), 3007 Tilden Street, NW, Suite 5L, Washington, DC 20008-3009; telephone 202-686-7877; email: apprequest@cies.iie.org; or see http://www.cies.org.


**September 15, 2003**: Nominations for Sloan Research Fellowships. Contact the Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, New York 10111, or see http://www.sloan.org.

**September 19, 2003**: Full proposals for NSF Focused Research Groups. See "Mathematics Opportunities" in this issue.

**October 1, 2003**: Nominations for AWM Hay Award and Schafer Prize. Contact The Hay Award Selection Committee or The Alice T. Schafer Award Selection Committee, Association for Women in Mathematics, 4114 Computer & Space Sciences Building, University of Maryland, College Park, MD 20742-2461; telephone 301-405-7892; email: awm@math.umd.edu; website: http://www.awm-math.org.

**October 15, 2003**: Applications for spring semester of Math in Moscow and for AMS scholarships. See http://www.mccme.ru/mathinmoscow or contact Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax +7095-291-65-01; email: mim@mccme.ru. For information about and application forms for the AMS scholarships, see http://www.ams.org/careers-edu/mimoscow.html or contact Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904; email: prof-serv@ams.org.

**October 17, 2003**: Applications for NSF Mathematical Sciences Postdoctoral Research Fellowships. See "Mathematics Opportunities" in this issue.

**November 1, 2003**: Applications for 2004-2005 Fulbright spring/summer seminars in Germany, Korea, and Japan and for summer German Studies Seminar. Contact the Council for International Exchange of Scholars (CIES), 3007 Tilden Street, NW, Suite 5L, Washington, DC 20008-3009; telephone: 202-686-7877; email: apprequest@cies.iie.org; or see http://www.cies.org.

**December 31, 2003**: Entries for Cryptologia paper competitions. See http://www.dean.usma.edu/math/pubs/cryptologia/ or contact Cryptologia, Department of Mathematical Sciences, United States Military Academy, West Point, NY 10996; email: Cryptologia@usma.edu.


**June 30, 2004**: Proposals for DMS/NIGMS Program in Mathematical Biology. See "Mathematics Opportunities" in this issue.

**Contact Information for Mathematics Institutes**

**American Institute of Mathematics (AIM)**

ARCC (Academic Research Conference Center)
360 Portage Avenue
Palo Alto, CA 94306-2244
Telephone: 650-845-2074
Fax: 650-845-2074
email: conrey@aimath.org
World Wide Web: http://www.aimath.org
http://www.aimath.org/ARCC/

Stefan Banach International Mathematical Center
8 Sniadeckiach str.
00-950 Warszawa, Poland
Telephone: (+48-22) 628-01-92
Fax: (+48-22) 622-57-50
email: banach@impan.gov.pl

**Banff International Research Station**
c/o PIMS Central Office
University of British Columbia
1933 West Mall
Vancouver, BC, Canada V6T 1Z2
Telephone: 780-492-3613
Fax: 780-492-6826
email: rvm@pims.math.ca
World Wide Web: http://www.pims.math.ca/birs/

**Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)**
CoRE Building, 4th Floor
Rutgers University
96 Frelinghuysen Road
Piscataway, NJ 08854-8018
Telephone: 732-445-5930
Fax: 732-445-5932
email: center-admin@dimacs.rutgers.edu
World Wide Web: http://dimacs.rutgers.edu

**Center for Scientific Computation and Mathematical Modeling (CSCAMM)**
University of Maryland
4146 CSIC Building #406
Paint Branch Drive
College Park, MD 20742-3289
Telephone: 301-405-0662
Fax: 301-314-6674
email: info@cscamm.umd.edu
World Wide Web: http://www.cscamm.umd.edu

**Centre International de Rencontres Mathématiques (CIRM)**
Case 916, 163, avenue de Luminy
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Fax: (+33) 04 91 83 30 05
email: cirm@cirm.univ-mrs.fr

**Centre for Mathematical Physics and Stochastics (MaPhySto)**
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Reference and Book List

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http://www.maths.anu.edu.au/CMA/

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World Wide Web:
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Centro de Investigación en Matemáticas (CIMAT)
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C.P. 36000, Mexico
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http://www.cmi.ac.in

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Fax (+43) 1 317 20 47/30
email: secr@esi.ac.at
World Wide Web:
http://www.esi.ac.at/

Euler International Mathematical Institute
27, Fontanka
St. Petersburg 191011, Russia
Telephone: 7 (812) 312-40-58
Fax: 7 (812) 310-53-77
email:
admin@euler.pdmi.ras.ru
World Wide Web:
http://www.pdmi.ras.ru/EIMI/index.html

Fields Institute for Research in Mathematical Sciences
222 College Street, 2nd Floor
Toronto, Ontario, Canada M5T 3J1
Telephone: 416-348-9710
Fax: 416-348-9714
email:
geninfo@fields.utoronto.ca
World Wide Web:
http://www.fields.utoronto.ca

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http://www.fim.math.ethz.ch

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World Wide Web:
http://www.ihes.fr

Institut Henri Poincaré
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75231 Paris Cedex 05, France
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Fax: 01 43 25 40 67

Institut Mittag-Leffler
Auravägen 17
S-182 62 Djursholm, Sweden
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email: widman@ml.kva.se
World Wide Web:
http://www.ml.kva.se

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email: math@math.ias.edu
World Wide Web:
http://www.math.ias.edu

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http://www.ims.nus.edu.sg

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Fax: 612-626-7370
email: staff@ima.umn.edu
World Wide Web:
http://www.ima.umn.edu

Institute for Pure and Applied Mathematics (IPAM)
IPAM Building
460 Portola Plaza
Box 957121
Los Angeles, CA 90095-7121
Telephone: 310-825-4755
Fax: 310-825-4756
email: ipam@ucla.edu
World Wide Web:
http://www.ipam.ucla.edu

Institute of Mathematical Sciences
Chinese University of Hong Kong

NOTICES OF THE AMS 822 VOLUME 50, NUMBER 7
Reference and Book List

Research Institute for Mathematical Sciences (RIMS)
Kyoto University
Kyoto, 606-8502 Japan
Fax: (+81) 75 753 7276
World Wide Web: http://www.kurims.kyoto-u.ac.jp/

Statistical and Applied Mathematical Sciences Institute (SAMSI)
19 T. W. Alexander Drive
P.O. Box 14006
Research Triangle Park, NC 27709-4006
Telephone: 919-685-9350
Fax: 919-685-9360
email: info@samsi.info
World Wide Web: http://www.samsi.info/

Steklov Institute of Mathematics
Russian Academy of Sciences
Leninsky, 32a
Moscow, Russia
Telephone: (+7) 095 938-1902
Fax: (+7) 095 938-1466
email: admin@pdmi.ras.ru
World Wide Web: http://www.pdmi.ras.ru

Steklov Institute of Mathematics
27, Fontanka
St. Petersburg 191011, Russia
Telephone: (+7) 812-312-40-58
Fax: (+7) 812-310-53-77
email: admin@pdmi.ras.ru
World Wide Web: http://www.math.tifr.res.in

Tata Institute of Fundamental Research
School of Mathematics
Homi Bhabha Road
Mumbai 400 005, India
Telephone: (+91) 22 2152971
Fax: (+91) 22 2152110, 2152181
email: registra@tifr.res.in
World Wide Web: http://www.math.tifr.res.in

Weierstrass Institute for Applied Analysis and Stochastics
Mohrenstrasse 39
10117 Berlin, Germany
Telephone: (+49) 30-203720
Fax: (+49) 30-2044975
email: lohse@wias-berlin.de
World Wide Web: http://www.wias-berlin.de/main/

http://www.wias-berlin.de/main/

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.


The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics, by Karl Sabbagh. Farrar Straus
"This book will be of value to anyone working in the field of differential geometry. It is a place to learn Cartan’s theory of differential systems and his method of equivalence, as well as more recent ideas on conservation laws and characteristic classes, all in the context of the classical variational problems close to the heart of geometry."

—Blaine Lawson,
State University of New York, Stony Brook

Paper $22.00
## American and Canadian Mathematicians Visiting Abroad

<table>
<thead>
<tr>
<th>Name and Home Country</th>
<th>Host Institution</th>
<th>Field of Special Interest</th>
<th>Period of Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goncharov, Alexander (U.S.A.)</td>
<td>Max Planck Institute, Germany</td>
<td>Arithmetic Algebraic Geometry</td>
<td>9/03 - 8/04</td>
</tr>
</tbody>
</table>

## Visiting Foreign Mathematicians

<table>
<thead>
<tr>
<th>Name and Home Country</th>
<th>Host Institution</th>
<th>Field of Special Interest</th>
<th>Period of Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absil, Pierre-Antoine (Belgium)</td>
<td>Massachusetts Institute of Technology</td>
<td>Numerical Linear Algebra</td>
<td>9/03 - 6/04</td>
</tr>
<tr>
<td>Adler, Robert (Israel)</td>
<td>University of California, Santa Barbara</td>
<td>Probability and Stochastic Processes</td>
<td>9/03 - 3/04</td>
</tr>
<tr>
<td>Agoston, István (Hungary)</td>
<td>Carleton University</td>
<td>Algebra</td>
<td>9/04-12/04</td>
</tr>
<tr>
<td>Baur, Karin (Switzerland)</td>
<td>University of California, San Diego</td>
<td>Representation Theory</td>
<td>7/03 - 8/05</td>
</tr>
<tr>
<td>Bishwal, Jaya (India)</td>
<td>University of California, Santa Barbara</td>
<td>Stochastic Processes</td>
<td>7/03 - 6/04</td>
</tr>
<tr>
<td>Bojanov, B. (Bulgaria)</td>
<td>Vanderbilt University</td>
<td>Constructive Approximation</td>
<td>1/04 - 5/04</td>
</tr>
<tr>
<td>Boumazgour, Mohamed (Morocco)</td>
<td>Université Laval</td>
<td>Operator Theory</td>
<td>9/03-12/03</td>
</tr>
<tr>
<td>Cabrelli, Carlos (Argentina)</td>
<td>Vanderbilt University</td>
<td>Computational Mathematics</td>
<td>1/04 - 5/04</td>
</tr>
<tr>
<td>Carmona Mejias, Angeles (Spain)</td>
<td>University of California, San Diego</td>
<td>Combinatorics</td>
<td>8/03-12/03</td>
</tr>
<tr>
<td>Chatterjee, Pralay (India)</td>
<td>Oklahoma State University</td>
<td>Lie Groups and Algebraic Groups</td>
<td>9/03 - 5/04</td>
</tr>
<tr>
<td>Cuny, Christophe (France)</td>
<td>Carleton University</td>
<td>Probability</td>
<td>10/02-10/03</td>
</tr>
<tr>
<td>Davydov, Oleg (Germany)</td>
<td>Vanderbilt University</td>
<td>Approximation Theory</td>
<td>8/03 - 4/05</td>
</tr>
<tr>
<td>DeMoura, Adriano (Brazil)</td>
<td>Massachusetts Institute of Technology</td>
<td>Representation Theory</td>
<td>9/03 - 3/04</td>
</tr>
<tr>
<td>Foertsch, Thomas (Switzerland)</td>
<td>University of Michigan</td>
<td>Differential Geometry</td>
<td>8/03 - 4/05</td>
</tr>
<tr>
<td>Fu, Lei (China)</td>
<td>University of California, Irvine</td>
<td>Arithmetic Algebraic Geometry</td>
<td>3/04 - 6/04</td>
</tr>
<tr>
<td>Furtado, Fred (Brazil)</td>
<td>SUNY at Stony Brook</td>
<td>Computational Fluid Dynamics, Hyperbolic Systems, Flow and Porous Media</td>
<td>6/03 - 8/04</td>
</tr>
<tr>
<td>Gabbouhy, Mostafa (France)</td>
<td>Université Laval</td>
<td>Applied Mathematics</td>
<td>10/03 - 9/04</td>
</tr>
<tr>
<td>Gonard, Bertrand (France)</td>
<td>University of Georgia</td>
<td>Group Theory</td>
<td>8/03 - 7/05</td>
</tr>
<tr>
<td>Grigorian, Alexander (United Kingdom)</td>
<td>University of California, Irvine</td>
<td>Geometric Analysis</td>
<td>9/03-12/03</td>
</tr>
<tr>
<td>Groeneveld, Gilbert (South Africa)</td>
<td>Virginia Polytechnic Institute and State University</td>
<td>Operator Theory</td>
<td>8/03-12/03</td>
</tr>
<tr>
<td>Hanai, Sadaka (Egypt)</td>
<td>Northeastern University</td>
<td>Mathematical Statistics</td>
<td>3/03 - 9/04</td>
</tr>
<tr>
<td>Hanke, Timo (Germany)</td>
<td>University of California, San Diego</td>
<td>Algebra</td>
<td>8/02-4/04</td>
</tr>
<tr>
<td>Ih, Su-ion (Republic of Korea)</td>
<td>University of Georgia</td>
<td>Number Theory</td>
<td>8/03 - 7/05</td>
</tr>
<tr>
<td>Intissar, Ahmed (Morocco)</td>
<td>Massachusetts Institute of Technology</td>
<td>Differential Geometry</td>
<td>2/04 - 4/04</td>
</tr>
<tr>
<td>Jakobsen, Per (Norway)</td>
<td>University of Arizona</td>
<td>Classical and Quantum Physics/Nonlinear Optics</td>
<td>Fall 2003-Spring 2004</td>
</tr>
<tr>
<td>Jedynak, Bruno (France)</td>
<td>Johns Hopkins University</td>
<td>Probability, Imaging</td>
<td>9/03 - 8/04</td>
</tr>
<tr>
<td>Jezek, Jaroslav (Czech Republic)</td>
<td>Vanderbilt University</td>
<td>Universal Algebra</td>
<td>8/03-12/03</td>
</tr>
<tr>
<td>Karonski, Michal (Poland)</td>
<td>Emory University</td>
<td>Random Structures and Algorithms</td>
<td>9/03-12/03</td>
</tr>
<tr>
<td>Katz, Matya (Israel)</td>
<td>SUNY at Stony Brook</td>
<td>Computational Geometry</td>
<td>8/03 - 7/04</td>
</tr>
<tr>
<td>Keller, Julien (France)</td>
<td>Massachusetts Institute of Technology</td>
<td>Differential Geometry</td>
<td>9/03-11/03</td>
</tr>
</tbody>
</table>

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans and Canadians visiting abroad. Note that there are two separate lists.
<table>
<thead>
<tr>
<th>Name and Home Country</th>
<th>Host Institution</th>
<th>Field of Special Interest</th>
<th>Period of Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knorr, Andreas (Germany)</td>
<td>University of Arizona</td>
<td>Physics, Nonlinear Optics</td>
<td>Fall 2003-Spring 2004</td>
</tr>
<tr>
<td>Kochel, Martin (Slovakia)</td>
<td>Vanderbilt University</td>
<td>Graph Theory</td>
<td>8/03-12/03</td>
</tr>
<tr>
<td>Lakatos, Piroska (Hungary)</td>
<td>Carleton University</td>
<td>Algebra</td>
<td>1/04-2/04</td>
</tr>
<tr>
<td>Li, Gang (People's Republic of China)</td>
<td>Carleton University</td>
<td>Applied Probability</td>
<td>4/03-3/04</td>
</tr>
<tr>
<td>Lin, Wei (China)</td>
<td>York University</td>
<td>Neural Networks and Functional-Differential Equations</td>
<td>9/03-8/04</td>
</tr>
<tr>
<td>Lukács, Erzsébet (Hungary)</td>
<td>Carleton University</td>
<td>Algebra</td>
<td>9/04-12/04</td>
</tr>
<tr>
<td>Mohamadian, Majid (Iran)</td>
<td>Université Laval</td>
<td>Applied Mathematics</td>
<td>2/03-3/04</td>
</tr>
<tr>
<td>Molter, Ursula (Argentina)</td>
<td>Vanderbilt University</td>
<td>Computational Mathematics</td>
<td>1/04-5/04</td>
</tr>
<tr>
<td>Mulansky, B. (Germany)</td>
<td>Vanderbilt University</td>
<td>Approximation Theory</td>
<td>1/04-5/04</td>
</tr>
<tr>
<td>Ossine, Denis (Russia)</td>
<td>Vanderbilt University</td>
<td>Group Theory</td>
<td>8/03-5/05</td>
</tr>
<tr>
<td>Ou, Chunhua (China)</td>
<td>York University</td>
<td>Functional Differential Equations and Singular Perturbation</td>
<td>9/03-8/04</td>
</tr>
<tr>
<td>Pardo Llorente, Leandro (Spain)</td>
<td>Bowling Green State University</td>
<td>Statistics</td>
<td>1/04-5/04</td>
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<tr>
<td>Pareigis, Bodo (Germany)</td>
<td>University of California, San Diego</td>
<td>Algebra</td>
<td>7/03-4/04</td>
</tr>
<tr>
<td>Pereira, Braganca (Brazil)</td>
<td>Pennsylvania State University</td>
<td>Statistics</td>
<td>2/03-2/04</td>
</tr>
<tr>
<td>Popa, Catalin (Romania)</td>
<td>University of Wyoming</td>
<td>Partial Differential Equations and Control Theory</td>
<td>1/03-5/03</td>
</tr>
<tr>
<td>Prüss, Jan (Germany)</td>
<td>Vanderbilt University</td>
<td>Applied Analysis</td>
<td>8/03-5/04</td>
</tr>
<tr>
<td>Pujo-Menjouet, Laurent (France)</td>
<td>Vanderbilt University</td>
<td>Differential Equations</td>
<td>8/03-5/04</td>
</tr>
<tr>
<td>Rigoli, Marco (Italy)</td>
<td>Washington University</td>
<td>Differential Geometry</td>
<td>6/03-8/03</td>
</tr>
<tr>
<td>Rodrigo, Marianito (Philippines)</td>
<td>New Jersey Institute of Technology</td>
<td>Analysis of Partial Differential Equations</td>
<td>9/03-6/04</td>
</tr>
<tr>
<td>Safoui, Abdessamad (Moroc)</td>
<td>Université Laval</td>
<td>Equations aux dérivées partielles</td>
<td>7/03-9/03</td>
</tr>
<tr>
<td>Sanat, Nilabh (India)</td>
<td>Oklahoma State University</td>
<td>Number Theory</td>
<td>9/03-5/04</td>
</tr>
<tr>
<td>Seneta, Eugene (Australia)</td>
<td>Bowling Green State University</td>
<td>Statistics</td>
<td>10/03-11/03</td>
</tr>
<tr>
<td>Singer, Michael (United Kingdom)</td>
<td>Massachusetts Institute of Technology</td>
<td>Differential Geometry</td>
<td>8/03-8/04</td>
</tr>
<tr>
<td>Thangavelu, Sundaram (India)</td>
<td>University of Oregon</td>
<td>Harmonic Analysis</td>
<td>9/03-6/04</td>
</tr>
<tr>
<td>Xu, Shengzhi (People's Republic of China)</td>
<td>Vanderbilt University</td>
<td>Noncommutative Geometry</td>
<td>8/03-5/04</td>
</tr>
<tr>
<td>Yuan, Juan-Ming (Taiwan)</td>
<td>Oklahoma State University</td>
<td>Applied Mathematics</td>
<td>9/03-5/04</td>
</tr>
</tbody>
</table>
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O. Biquard and P. Bolch; A.B. Goncharov and Yu. I. Manin;
A. Hayward; J. Kock; P. Mezo; M. Morishita; A. Ogus; A. Pillay;
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800-872-7423
From the AMS Secretary

Report of the Executive Director, State of AMS, 2003

Most members think of the American Mathematical Society (AMS) as an organization that does things: it represents their interests on matters of policy, holds meetings, awards prizes and scholarships, publishes books and journals, delivers *Mathematical Reviews*, provides employment services, conducts surveys, and generally supports mathematics research. Most people do not care precisely how these things get done; they merely rely on the Society to do them.

In this year’s annual report I want to tell you about how things are done rather than what is done. I will use this year’s report to explain the structure of the AMS—that is, how the Society is organized in order to carry out its work. It is a different view of the AMS, but a view that is worth seeing from time to time.

Overview
The AMS has over 27,000 members. More than a third of our members are international; about one-fourth are students. It is important to remember that there are many kinds of members: ordinary, life, emeritus, reciprocity, cat-S, etc. Over 7,000 of our members are nominees (that means they are appointed by their institutions as a benefit of institutional membership). Over 500 institutional members appoint those nominees.

Operations of the Society generated more than $21 million in revenue during 2002. Most of that (73%) came from publications-related activities. Only $1.4 million (6.5%) came from individual member dues, and only 4% came from meetings. Grants typically account for 3%-4% of our revenue, but since expenses associated to the grants almost always exceed the grants themselves, they seldom contribute to the Society’s general operations.

For the first time in 2002, we used “income” from a portion of the reserves to support operations, allocating approximately $800,000 for that purpose. Our total reserves at the end of 2002 were slightly more than $38 million, including $6.4 million in the actual endowment and $31.6 million in the quasi-endowment. Like many other institutions, we have experienced a dramatic drop in the value of our investments during the past several years.

At the start of 2003 the AMS is healthy. Membership is reasonably steady (with some decrease in reciprocity members, however). Publications are scientifically and financially robust. The Society has maintained and improved important services (the Employment Center and survey work) and expanded others (Mathjobs and support for Young

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1 Category-S members are from developing nations and pay dues of $16 (or, equivalently, write two reviews for Mathematical Reviews) each year for member benefits that include either the Bulletin or the Notices.

2 The endowment consists of funds that have been given to the Society for specific purposes (for example, prizes), restricting use to the intended purpose. The quasi-endowment consists of reserves: funds accumulated over time for future needs but without restrictions on their use.
Scholars programs). Visibility for mathematics has been greatly expanded, both by our substantial presence in Washington and by the Public Awareness Office. All these things and many others are signs of a vigorous organization.

The Society is governed by the Council and the Board of Trustees, an arrangement that separates responsibility for scientific policy and finance between the two elected bodies along with their various committees. The job of the staff is to carry out the policy they set and to ensure that the Society’s finances are sound (and remain so in the future).

The AMS has approximately 215 employees (down from a high of 250 twelve years ago) who are organized into six divisions. The staff works from four different locations: AMS headquarters in Providence, a warehouse/printing plant in nearby Pawtucket, Mathematical Reviews in Ann Arbor, and the Washington office.

Publications
The Publications Division is the largest division at the AMS, with approximately 73 employees in six departments. The Society publishes twelve journals and distributes an additional eight for other publishers. Some are large (Transactions published 5,232 pages in 2002), and some are small (Sugaku published only 248 pages). Most are published in both print and electronic format. There were twenty-nine new Memoirs last year, totaling 3,448 pages.

The AMS also published over one hundred new books in 2002, ranging from high-level research monographs and conference proceedings to elementary exposition for undergraduates. The Society has more than 3,000 titles in print—an incredible number of titles dating back to the first half of the twentieth century. It also produces a number of "administrative" publications such as the Combined Membership List, Professional Directory, Employment Information in the Mathematical Sciences, and (last year) the World Directory of Mathematicians.

The Society sells all these books and journals to people and institutions around the world, including many thousands of mathematicians, universities, agents, and bookstores. The role of our online bookstore continues to expand, but delivery of scholarly publications is still a complicated business.

When mathematicians think of the publication program, they most often think about acquisitions and production, the departments that deal directly with authors. And indeed these departments include approximately half the staff of the division. But there are many other essential parts of Publications. Dealing with the thousands of customers, both individuals and institutions, requires a large customer services staff, and marketing our publications requires considerable effort, especially in negotiating and monitoring distribution arrangements overseas. We maintain a large warehouse and distribution center in Pawtucket, Rhode Island, for the distribution of books and journals, and we ship hundreds of orders each day. Many members are unaware that the Society has its own printing and binding facility, designed specifically for the type of book and journal production done at the Society. The majority of AMS printing is carried out in-house (although long-run jobs such as the Notices are done outside).

At the start of 2002 the Publications Division was reorganized, and the executive director now serves as publisher (heading the division).
From the AMS Secretary

Mathematical Reviews

Almost every mathematician knows about *Mathematical Reviews*, a database of more than 1.9 million reviews of mathematics articles and books covering the literature from 1940 to the present. The database includes material from about 1,800 journals and nearly 400,000 authors. It now includes links from the reviews to more than 230,000 original articles, allowing users to navigate the online literature, and it contains reference lists (again with links) for papers in approximately one hundred journals going back to 1998. The reference lists already include more than 600,000 references.

*Mathematical Reviews* is not a journal—it is a database, and the distinction is important. For many years the large orange volumes sat on library shelves alongside indices that made searching the database possible (often with considerable effort). When the database was put online in 1996 as MathSciNet, it was considerably easier to use. Today, what previously required an afternoon of painstaking work can be done in minutes or even seconds. Even the job of writing papers is easier with the MR-lookup tools for standardizing and linking references. An online database is a software application.

But while mathematicians use and admire MathSciNet, they often do not fully understand the effort required to assemble the database and to make it accessible. In order to add the approximately 75,000 new items each year, more than 100,000 articles and books must be scanned. That requires a staff of seventy people in the Ann Arbor office of the AMS to deal with hundreds of publishers, thousands of journals, and more than 10,000 reviewers. Like any major piece of software, MathSciNet is upgraded once each year, led by staff in Ann Arbor and including computer staff in the Providence office as well. New tools and ideas for improving the database and its delivery are continually considered. This is a multimillion-dollar effort that never stops.

And *Math Reviews* is like the rest of our publication program: there are many other essential parts hidden from view. Taking orders from customers, shipping the volumes, negotiating licenses for electronic delivery, maintaining access controls, providing help for online users—all are essential to the success of *Math Reviews* and all are done by the same departments that do them for journals and books. In recent years consortia have become an important part of *Math Reviews* subscriptions. Because of consortia, the number of institutions with access to *Math Reviews* has more than doubled over the past ten years. Negotiating and maintaining consortia is labor intensive, and it is carried out by staff in the publisher's office.

By any measure, *Math Reviews* is a thriving success, widely thought of as the signature product of the AMS. The Society is justifiably proud of that success.

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Meetings and Professional Services

When most people think of a scientific society, they think of the activities done in this division. Holding meetings, cultivating membership, providing services to the community, and promoting mathematics—this is the division that carries out the work of a membership society.

Meetings and Programs

Meetings (9)
Membership & Progs (5)
Public Awareness (2)

Attendance at Recent Joint Meetings

The Meetings Department supports one national meeting each year (held jointly with the Mathematical Association of America, as well as a number of other organizations). The Joint Meetings have grown in recent years, and the recent meeting in Baltimore set a record for the number of mathematicians attending. The department also supports eight sectional meetings, one or two joint international meetings, the summer research conferences, and various other functions (such as the Arnold Ross Lecture, which is held at a science museum and directed at high school students). In the past few years we have staffed MathFest in the summer as a sale of service to the MAA. Running a meeting of 5,000 people is a tough job; our Meetings Department is known for its professionalism and service.

Membership and Programs has recently taken on the responsibility of "membership development", a task that is separate from day-to-day service to members. This is a department with a wide variety of tasks: the annual surveys, the Employment Center, the new Mathjobs program, book donations, Young Scholars, the Ky Fan China program, the selection of summer conferences, support for the NSF and NSA postdoc panels, etc. During the current year this department is also leading an effort to review and plan for future changes in the way we approach membership.

Last year’s annual report to the Council concentrated on the Public Awareness Office. In just a few years this part of the AMS has changed the way we approach outreach beyond our community. There is an increased presence of press at the Joint Meetings in January, and it will be crucial to nurture that increase. Mathematical Moments (one-page sheets designed to convey the importance of mathematical research) have been a great success and are widely admired and circulated. The popular Who Wants to be a Mathematician game has drawn enthusiastic audiences of high school students. The column “What’s New in Mathematics” on our website is a wonderful resource. And many written materials, from brochures to newsletters, have explained the AMS to members and nonmembers alike. The Public Awareness Office is now an integral part of the Society’s operations.

Washington Office

The Washington office of the AMS is just a bit over ten years old, and it is hard to imagine how the Society would function without it. The most important function of the office is to network with various groups in Washington: Congress and its staff, the agencies, and other scientific societies. Mathematics now has a visible presence in these communities, and that presence serves our discipline well. Whether it is a public quote in Science by Sam Rankin, the head of our Washington office, or a private phone call for advice about a pending bill, the many small ways in which mathematics is drawn into the affairs of Washington policy accumulate to a real advantage for mathematics.

In addition, there are many other projects carried out by the Washington office each year, including support for the Mass Media Fellows Program, an
annual Congressional Luncheon, the Joint Public Service Award, the Department Chairs Workshop (held at the Joint Meetings), prize breakfasts for the winners of the Presidential Awards (for high school teachers), our involvement in Preparing Future Faculty, and several education projects done jointly with the Mathematicians and Educational Reform Forum (MER).

We do all these things with a Washington office staff that is nominally three people, but in fact almost always has been two in recent years. Monica Foulkes, Sam's extremely able assistant, will be retiring in 2003; we will all miss her.

Administration

Administration sounds boring. But running a moderately large organization depends on effective administration for everything from managing employees (the Human Resources Department) to coordinating budgets and planning. Development work is carried out by this office in cooperation with the executive director's staff. The division is directed by the deputy executive director, who stands in for the executive director when necessary.

In our present organization, Administration also contains three of the four computing departments in the Society. (The fourth is at Math Reviews in Ann Arbor.) Electronic Product Development works on projects for all other parts of the Society but spends much of its time on publications-related activities. It maintains and updates the AMS website. Management Information Systems supports all the internal computer applications that are required by any large business today, integrating our customer database with every part of our operation. Its job is to make information available whenever it is needed, not an easy job in a complex business. Systems and Operations supports the computing environment in our Rhode Island offices. It does everything from fine-tuning our Internet connection (and fending off attacks from the outside) to supporting individual users of office applications. Again, in a modern business this kind of computer support is crucial.

Finance

This is the other part of Administration, and it includes the Facilities Department as well as the Fiscal Department (which deals with every aspect of our finances). This division is headed by the chief financial officer.

The Facilities Department handles all aspects of our buildings and their support in Rhode Island. That includes a sprawling office complex in Providence as well as the warehouse/printing plant in nearby Pawtucket. People who haven’t thought about it are often surprised at what is necessary to maintain large facilities like this—everything from shopping for utilities to installing new office furniture to repaving parking lots to warding off flocks of nesting crows. Purchasing major equipment and supplies for a multimillion-dollar publishing operation is a major job by itself.

The Society is a reasonably complicated business for the size of its budget. Because of its diverse activities, from publishing to policy, its finances are more complex than most businesses of its size. Much of its business is international, making those finances even more complex. And the rules governing financial reporting for nonprofit organizations are complicated as well. Over the years the Society has developed extremely informative (and accurate) financial reporting.

Other than the computing departments, our administrative structure is relatively small at the AMS; we view this as a virtue. Many people, especially in academic life, forget about the costs associated with administrative support for electricity and water, for waste collection, for security at night, for mail delivery, for annual auditors, for legal advice, for workers insurance, etc. In universities those services are embedded in everyday life and are part of the normal environment; they are easy to forget. In an organization such as ours, however, these are necessary and real—and someone has to pay for them. This is why journals and books cost more than many expect.
The description above is meant to provide an operational view of the Society. It is not a static view (we move departments from one division to another from time to time), and it does not mention many important activities in order to keep the description brief. But it is a description that is meant to show how the Society functions, day-by-day and year-by-year, carrying out its work both efficiently and flexibly in order to adjust to changing circumstances. That is something scientific societies must do easily and often.

—John Ewing


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 direct contact 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. 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. It contains summary information regarding the operating results and financial condition of the Society for 2002, review of audited financial reports, and a discussion of the Society's operations, and a discussion of the assets and liabilities of the Society. Finally, in the last part of the report there are summary financial statements which present the balance sheet and other financial statements of the Society.

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 grant awards and the spendable income from prize and other income-restricted endowment funds. Permanently restricted net assets are those that must be invested in perpetuity and are commonly referred to as endowment funds. The accompanying financial information principally relates to the unrestricted net assets, as this category includes the operating activities of the Society.

Unrestricted expenses in excess of unrestricted revenues for the year ended December 31, 2002, resulted in a deficit of approximately $4,315,000. Of this amount, net losses on the unrestricted portion of the long-term investment portfolio totaled $6,247,000, and net income from operations totaled $1,932,000. The continuing weak financial markets in the U.S. during the year contributed to losses in the long-term portfolio of approximately 13.3%. These and other matters are discussed in more detail in the following sections.

The Society's net assets totaled $43,043,000 at December 31, 2002: $2,690,000 is permanently restricted, consisting principally of the original amount of donor restricted gifts and bequests received by the Society; $1,361,000 is temporarily restricted by donor-imposed limitations that will lapse upon the passage of time or the use of the asset for its intended purpose; $38,992,000 is unrestricted, of which $31,651,000 has been designated by the Board of Trustees as reserved for future expenditure, principally in the form of the Economic Stabilization Fund (ESF). This fund's purpose is to provide a source of cash in the event of a financial crisis. The Society's Board of Trustees set the minimum level at which to maintain the ESF at the current estimate of the postretirement health benefit obligation plus 75% of operating expenses. As of the end of 2002, the value of the ESF exceeds the established minimum level. The remaining unrestricted net assets consist of $4,466,000 invested in fixed assets and undesignated net assets of $2,875,000.
II. Review of 2002 Operations

As indicated in the graph on the prior page, the past three years have been very good years financially for the Society, apart from investment losses incurred in these years.

Although the Society experienced investment losses in all of the past three years, the losses were a bit less than those seen in the broad market indexes, such as the S&P 500. In spite of these losses, long-term investments have generated high returns over a long period, and that income has helped the endowment funds (and the income they produce) to keep pace with inflation.

In 2002 the Board of Trustees appropriated investment income from the endowment funds whose use of income is unrestricted and from a portion of the Economic Stabilization Fund to support operations. The amount of such appropriations included in operating revenue is $760,811 in 2002. Without this income included, operating revenues would have been only $273,000 higher than in 2001, and operating income would have been approximately $217,000 lower than in 2001. Of course, the long-term investment loss would have been lower by $760,811 also.

When reflecting on years with good operating results, it is instructive to review the Society's record for a somewhat longer period. The chart above shows operating income as a percentage of operating revenues. Two observations are noteworthy. First, the margins achieved from 1997 to 2002 are somewhat higher than the average of the years presented. Second, the variation in margin over the more recent years is smaller than the variation in the earlier years. Taken together, these are positive financial indicators.

If the Board of Trustees had not appropriated investment income to support operations in 2002, the operating income margin percentage above would have been approximately 5.5%. While this is the lowest margin percentage in a number of years, it is still above the average for the 25-year period shown above.

Sales Trends

The graphs that follow show sales trends from 1994 through 2002, first in historical dollars and second in constant dollars (using 2002 as the base year and adjusting other years for inflation).

The trends shown in Sales Trends—Historical Dollars are mildly upward, and this is partly due to pricing strategies that counter the effects of inflation. Opposite, the chart is repeated with the underlying data converted to constant dollars.
**Mathematical Reviews.** Total sales of MR in its various forms increased in 2002. This is partly due to price increases effective in 2002. Also, the value of the dollar in many overseas markets began to fall in 2002, thus improving the exchange rate and lowering the effective cost of the products in many other countries. The Society continues to concentrate its marketing efforts on working with consortia, where costs can be spread over a larger number of institutions. This has the effect of providing the MR product line to a much wider audience than could afford it as individual institutions, as well as protecting the current revenue stream for future years. MR is currently financially healthy; however, it is probably unrealistic to expect significant increases in sales.

**Journals.** Journal revenues are holding reasonably constant, with perhaps slight improvements in the last three years. There continue to be financial pressures on libraries everywhere in the world. In particular, many countries have experienced economic problems that have been compounded by decreases in the value of their currency as compared to the dollar. This makes U.S. journals quite expensive, even though AMS journals have experienced very small price increases in U.S. dollars. This currency effect began to reverse course, with the dollar starting to weaken against major currencies in 2002 and into 2003. Hopefully, this will aid the Society’s retention efforts.

The drop in 1996 resulted from decisions made by those in control of four Russian journals (Izvestiya, Sbornik, Steklov, and Doklady) to use sources other than the AMS for translation into English and distribution of the resulting translation journals.

**Books.** Book revenues recovered slightly from the 2001 sales level, although this only countered the effects of inflation for the year. There continues to be an overall sluggish market in scholarly book sales worldwide, consistent with the overall economic conditions. The Society continues to work with distributors and has revamped marketing efforts in order to keep the book program as healthy as possible in a difficult market.

**Dues.** Dues, the sum of individual and institutional, have shown a slight upward slope on the historical dollars chart and a nearly flat line in constant dollars. This is expected for institutional dues, as the number of members varies little from year to year and the dues rates have been set so that dues will increase at about the same level as inflation. There has been a slight decline in individual dues from their high in 1998.

**Major Expense Categories**
The table on the next page shows the major expenses for 2000, 2001, and 2002 in thousands of dollars. In terms of how expense dollars are allocated, there is not much change from year to year.

**III. Assets and Liabilities**
So far, this report has dealt with revenues and expenditures that affect unrestricted net assets. Another aspect of the Society’s finances is what it owns and owes, or its assets and liabilities, which are reported in the Balance Sheets. As discussed previously, the Society’s net assets and activities that increase or decrease net assets are classified as unrestricted, temporarily restricted, or permanently restricted. A majority of the assets and liabilities detailed on the accompanying Balance Sheets constitutes the unrestricted net assets. The permanently restricted net assets are supported by investments in the long-term investment portfolio, and the temporarily restricted net assets are supported by investments in the long-term and short-term investment portfolios. The Market Value of Invested Funds shows the market value of each endowment and Board-designated (quasi-endowment) fund, including any reinvested earnings.

The Society’s fiscal year coincides with the period covered by subscriptions and dues. Since dues and subscriptions are generally received in advance, the Society reports a large balance of cash and short-term investments on its financial statements at year-end. This amounted to approximately $13,985,000 and $14,349,000 at December 31, 2002 and 2001, respectively. The recorded liability for the revenues received in advance was
From the AMS Secretary

Major Expense Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Costs</td>
<td>$12,152</td>
<td>$12,801</td>
<td>$12,945</td>
</tr>
<tr>
<td>Building and equipment related</td>
<td>1,561</td>
<td>1,541</td>
<td>1,436</td>
</tr>
<tr>
<td>Postage</td>
<td>926</td>
<td>838</td>
<td>844</td>
</tr>
<tr>
<td>Outside printing and binding</td>
<td>950</td>
<td>817</td>
<td>848</td>
</tr>
<tr>
<td>Travel, staff and volunteers</td>
<td>588</td>
<td>462</td>
<td>488</td>
</tr>
<tr>
<td>All other expenses</td>
<td>3,659</td>
<td>3,213</td>
<td>3,602</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>$19,836</td>
<td>$19,672</td>
<td>$20,163</td>
</tr>
</tbody>
</table>

approximately $11,155,000 and $10,510,000 at December 31, 2002 and 2001, respectively.

The Society's property and equipment include land, buildings and improvements, office furniture and equipment, and software. The Society also owns a small amount of transportation equipment. The land, buildings, and improvements include the Society's Rhode Island headquarters, with buildings in Providence and Pawtucket, and the Mathematical Reviews offices in Ann Arbor. The largest part of the Society's office equipment is its investment in computer facilities.

The Society's endowment is managed under the "total return concept." Under this management policy, income in excess of a reasonable amount (set by the Board of Trustees) is reinvested and increases the value of the fund. This allows for growth in income over time. As discussed previously, in 2002 the Board of Trustees appropriated investment income from the true endowment funds whose use of income is unrestricted and a portion of the Economic Stabilization Fund to support operations. The amount of such appropriations included in operating revenue is $760,811 in 2002.

IV. Summary Financial Information

The following are summaries of the audited annual financial statements 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
### STATEMENTS OF ACTIVITIES

**Years Ended December 31, 2002 and 2001**

#### Changes in unrestricted net assets:

<table>
<thead>
<tr>
<th>Operating Revenue</th>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication:</td>
<td>$8,361,089</td>
<td>$8,103,793</td>
</tr>
<tr>
<td>Mathematical Reviews and related activities</td>
<td>$8,361,089</td>
<td>$8,103,793</td>
</tr>
<tr>
<td>Journals (excluding MR)</td>
<td>3,891,416</td>
<td>3,772,670</td>
</tr>
<tr>
<td>Books</td>
<td>2,936,959</td>
<td>2,865,934</td>
</tr>
<tr>
<td>Sale of services</td>
<td>420,552</td>
<td>329,931</td>
</tr>
<tr>
<td>Other</td>
<td>130,638</td>
<td>119,970</td>
</tr>
<tr>
<td>Total publication revenue</td>
<td>$15,740,654</td>
<td>$15,187,298</td>
</tr>
</tbody>
</table>

| Membership and professional services: | 2002          | 2001          |
| Dues, services and outreach | 4,164,299     | 3,567,146     |
| Grants, prizes and awards | 960,517       | 780,856       |
| Meetings                    | 872,541       | 865,038       |
| Total membership and professional services revenue | 5,997,357     | 5,215,040     |
| Short-term investment income | 262,141       | 508,973       |
| Other                        | 94,434        | 149,059       |
| **Total operating revenue**   | $22,094,586   | $21,060,370   |

#### Operating Expenses:

| Publication:                 |              |              |
| Mathematical Reviews and related activities | $5,377,497   | $5,317,096   |
| Journals (excluding MR)      | 1,038,486    | 1,011,740    |
| Books                       | 2,512,238    | 2,463,291    |
| Total publication expense    | $11,241,136  | $11,633,199  |

| Membership and professional services: | 2002          | 2001          |
| Dues, services and outreach | 2,772,368     | 2,728,458     |
| Grants, prizes and awards | 1,029,662     | 891,956       |
| Meetings                    | 803,132      | 700,899       |
| Governance                  | 384,256      | 393,892       |
| Total membership and professional services expense | $5,505,367   | $4,946,875 |
| Other                      | 71,075       | (102,387)     |
| **Total operating expenses** | $20,162,651  | $19,672,045  |

| Excess of operating revenue over operating expenses | $1,931,935 | $1,388,325 |
| Long-term investment loss in excess of investment earnings available for spending | $(6,247,209) | $(4,305,159) |
| **Decrease in unrestricted net assets** | $(4,315,274) | $(2,916,834) |

#### Contributions and grants:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>58,069</td>
<td>80,626</td>
</tr>
</tbody>
</table>

#### Long-term investment income (loss):

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>(109,647)</td>
<td>(108,766)</td>
</tr>
</tbody>
</table>

#### Net assets released from restrictions:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>(373,015)</td>
<td>(396,070)</td>
</tr>
</tbody>
</table>

#### Decrease in temporarily restricted net assets:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>(424,593)</td>
<td>(424,210)</td>
</tr>
</tbody>
</table>

#### Change in permanently restricted net assets—Contributions:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>337,198</td>
<td>266,142</td>
</tr>
</tbody>
</table>

#### Change in net assets:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4,402,669)</td>
<td>(3,251,242)</td>
</tr>
</tbody>
</table>

#### Net assets, beginning of year:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>47,445,803</td>
<td>50,697,045</td>
</tr>
</tbody>
</table>

#### Net assets, end of year:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>$43,043,134</td>
<td>$47,445,803</td>
</tr>
</tbody>
</table>

### MARKET VALUE OF INVESTED FUNDS

**December 31**

#### Endowment Funds:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prize Funds:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steele</td>
<td>$466,213</td>
<td>$570,297</td>
</tr>
<tr>
<td>Birkhoff</td>
<td>28,204</td>
<td>34,500</td>
</tr>
<tr>
<td>Veblen</td>
<td>9,525</td>
<td>11,651</td>
</tr>
<tr>
<td>Wiener</td>
<td>9,525</td>
<td>11,651</td>
</tr>
<tr>
<td>Böcher</td>
<td>6,927</td>
<td>8,474</td>
</tr>
<tr>
<td>Conant</td>
<td>31,092</td>
<td>38,034</td>
</tr>
<tr>
<td>Cole</td>
<td>16,358</td>
<td>18,787</td>
</tr>
<tr>
<td>Satter</td>
<td>24,763</td>
<td>30,291</td>
</tr>
<tr>
<td>Marquand</td>
<td>33,836</td>
<td>41,390</td>
</tr>
<tr>
<td>Albert Whiteman</td>
<td>35,438</td>
<td>30,438</td>
</tr>
<tr>
<td>Arnold Ross Lectures</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Trjitzinsky</td>
<td>374,719</td>
<td>458,254</td>
</tr>
<tr>
<td>C. V. Newsom</td>
<td>174,433</td>
<td>213,376</td>
</tr>
<tr>
<td>Centennial</td>
<td>89,438</td>
<td>107,570</td>
</tr>
<tr>
<td>Menger</td>
<td>9,250</td>
<td>10,602</td>
</tr>
<tr>
<td>Ky Fan (China)</td>
<td>366,757</td>
<td>366,757</td>
</tr>
<tr>
<td>Epsilon</td>
<td>448,808</td>
<td>340,350</td>
</tr>
<tr>
<td><strong>Total (Income Restricted)</strong></td>
<td>$2,175,286</td>
<td>$2,342,422</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endowment</td>
<td>563,358</td>
<td>679,815</td>
</tr>
<tr>
<td>Morita</td>
<td>96,337</td>
<td>109,011</td>
</tr>
<tr>
<td>Henderson</td>
<td>3,019,927</td>
<td>3,644,206</td>
</tr>
<tr>
<td>Schoenfeld/Mitchell</td>
<td>197,347</td>
<td>217,116</td>
</tr>
<tr>
<td>Laha</td>
<td>156,879</td>
<td>189,309</td>
</tr>
<tr>
<td>Ritt</td>
<td>179,923</td>
<td>217,116</td>
</tr>
<tr>
<td>Moore</td>
<td>16,966</td>
<td>20,466</td>
</tr>
<tr>
<td><strong>Total (Income Unrestricted)</strong></td>
<td>$4,224,931</td>
<td>$4,899,283</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Endowment Funds</td>
<td>$6,400,217</td>
<td>$7,202,345</td>
</tr>
</tbody>
</table>

#### Quasi-Endowment Funds:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends of Math</td>
<td>123,572</td>
<td>123,572</td>
</tr>
<tr>
<td>Russian Royalties</td>
<td>17,829</td>
<td>17,829</td>
</tr>
<tr>
<td>Journal Archive Fund</td>
<td>237,078</td>
<td>225,750</td>
</tr>
<tr>
<td>Economic Stabilization Fund</td>
<td>30,880,809</td>
<td>32,493,104</td>
</tr>
<tr>
<td>Young Scholars</td>
<td>391,485</td>
<td>450,787</td>
</tr>
<tr>
<td>Charitable Gift Annuities</td>
<td>42,854</td>
<td>47,532</td>
</tr>
<tr>
<td><strong>Total Quasi-Endowment Funds</strong></td>
<td>$31,650,773</td>
<td>$33,353,896</td>
</tr>
</tbody>
</table>

### Total Funds:

<table>
<thead>
<tr>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$58,069</td>
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<td>47,445,803</td>
<td>50,697,045</td>
<td></td>
</tr>
<tr>
<td>$43,043,134</td>
<td>$47,445,803</td>
<td></td>
</tr>
</tbody>
</table>
Add this Cover Sheet to all of your Academic Job Applications

How to use this form

1. Using the facing page or a photocopy, (or visit the AMS web site for a choice of electronic versions at www.ams.org/coversheet/), fill in the answers which apply to all of your academic applications. Make photocopies.

2. As you mail each application, fill in the remaining questions neatly on one cover sheet and include it on top of your application materials.

The purpose of the cover form is to aid department staff in tracking and responding to each application for employment. Mathematics departments in Bachelor's-, Master's-, and Doctorate-granting institutions are expecting to receive the form from each applicant, along with the other application materials they require.

The AMS suggests that applicants and employers visit the Job Application Database for Mathematicians (www.mathjobs.org), a new electronic resource being offered by the AMS (in partnership with Duke University) for the second year in 2002-03. The system provides a way for applicants to produce printed coversheet forms, apply for jobs, or publicize themselves in the "Job Wanted" list. Employers can post a job listing, and once applications are made, search and sort among their applicants. Note-taking, rating, e-mail, data downloading and customizable EOE functions are available to employers. Also, reference writers can submit their letters online. A paperless application process is possible with this system, however; employers can choose to use any portion of the service. There will be annual employer fees beginning this year. This system was developed at the Duke University Department of Mathematics.

Please direct all questions and comments to: emp-info@ams.org.
Academic Employment in Mathematics

AMS STANDARD COVER SHEET

Last Name __________________________
First Name __________________________
Middle Names __________________________
Address through next June __________________________

Home Phone __________________________

e-mail Address __________________________

Current Institutional Affiliation __________________________

Work Phone __________________________

Highest Degree Held or Expected __________________________

Granting Institution __________________________

Date (optional) __________________________

Ph.D. Advisor __________________________

Ph.D. Thesis Title (optional) __________________________

Indicate the mathematical subject area(s) in which you have done research using the Mathematics Subject Classification printed on the back of this form or on the AMS website. Use the two-digit classification which best fits your interests in the Primary Interest line and additional two-digit numbers in the Secondary Interest line.

Primary Interest __________________________

Secondary Interests optional __________________________

Give a brief synopsis of your current research interests (e.g. finite group actions on four-manifolds). Avoid special mathematical symbols and please do not write outside of the boxed area.

Most recent, if any, position held post Ph.D.

University or Company __________________________

Position Title __________________________

Indicate the position for which you are applying and position posting code, if applicable __________________________

If unsuccessful for this position, would you like to be considered for a temporary position?

□ Yes □ No If yes, please check the appropriate boxes.

□ Postdoctoral Position □ 2+ Year Position □ 1 Year Position

List the names, affiliations, and e-mail addresses of up to four individuals who will provide letters of recommendation if asked. Mark the box provided for each individual whom you have already asked to send a letter.

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<td>Difference and functional equations</td>
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<td>Mathematics education</td>
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<td>Sequences, series, summability</td>
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The most comprehensive and up-to-date Mathematics Calendar information is available on e-MATH at http://www.ams.org/mathcal/.

August 2003

*2003 WSEAS Conferences: Call for Invited Papers and Invited Sessions, Mykonos Island, Greece.

*7-12 Joint MapHySto and QUANTOP Workshop on Quantum Measurements and Quantum Stochastics, Department of Mathematical Sciences, University of Aarhus, Denmark.
Information: http://www.maphydroko.dk/events2/QFPA2003/.

*18-September 5 Short Programme on Analysis and Resolution of Singularities, Centre de Recherches Mathematiques, Montreal, Quebec, Canada.
Description: Effective methods in resolution of singularities are becoming central to a modern generation of problems from analysis and geometry, for example, spectral theory and Hodge theorem for algebraic varieties, stability of oscillating integrals, existence of Kähler-Einstein metrics, and sharp forms of Moser-Trudinger inequalities. The diversity of the problems and their very different origins and aims have led to a lack of communication among researchers on these and related topics. This program, bringing together leading experts in resolution of singularities, complex differential geometry, and real analysis and partial differential equations, may have groundbreaking impact.

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 held in North America 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. Meetings held outside the North American area may carry more detailed information. In any case, 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.

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, 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 meeting 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/.
Lecturers: A. Bergeron (UQAM), G. Bourque (CRM), D. Bryant (McGill Univ.), M. Csirõs (Univ. de Montréal), N. El-Mabrouk (Univ. de Montréal), M. Hallett (McGill Univ.), J. Hein (Oxford Univ.), J. Kececioglu (Univ. of Arizona), M. Raffinot (Univ. d’Evry), D. Sankoff (Univ. d’Ottawa).

September 2003

*1-3 3rd WSEAS International Conference on Instrumentation, Measurement, Control, Circuits and Systems, Malta, Italy.

*1-3 3rd WSEAS International Conference on Information Science and Applications, Malta, Italy.

*1-3 3rd WSEAS International Conference on Soft Computing, Optimization, Simulation & Manufacturing Systems, Malta, Italy.

*3-6 ERATO Conference on Quantum Information Science 2003 (EQIS’03), Nihonmakaikan, Kyoto, Japan.
Description: The EQIS meetings are to focus on quantum information science and technology, a new interdisciplinary field bridging computer science, quantum physics, mathematics, optics, and nano-technologies. EQIS’03 will be the third conference in a series and is to concentrate on theoretical and also experimental aspects of quantum information science. The program of EQIS’03 will consist of invited talks, short communications and posters. EQIS’03 is also expected to be accompanied by satellite pre- and postconference workshops.

Contributions for short communications and posters will be solicited in the research areas related to quantum information science, including but not limited to: design and analysis of quantum algorithms and circuits; quantum games; quantum computational and communication complexity; quantum computing and automata models; quantum cryptography; quantum information theory; quantum entanglement; quantum fault-tolerant and decoherence-free computations; quantum continuous variable computations; quantum geometric and topological computations; nonstandard models of quantum computation; quantum optics; NMR and solid state technologies; fermionic, bosonic, and anyonic computation.

Sponsors: ERATO Quantum Computation and Information Project, Japan Science and Technology Corporation.

Information: http://www.qci.jst.go.jp/eqis03/.

*7-11 Topological Phases in Condensed Matter Physics, AIM Research Conference Center, Palo Alto, California.
Program: This workshop, sponsored by AIM and the NSF, will explore the interface between topological quantum field theory and solid state physics. We will study which "topological phases" might be physically realized and how they might be detected and finally manipulated.
Deadline: June 1, 2003.

*9-11 Quantum Analysis in Operator Algebras, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.


*17-19 Computational Modelling in Medicine, Edinburgh, UK.
Topics: Mathematical modelling and numerical simulation play a major role in many important medical applications. The meeting will be organised around the two interlinked themes of the vascular and pulmonary systems and soft tissue mechanics. The purpose is to bring together people who work on mathematical modelling, numerical analysis, simulation and direct medical applications related to these areas, and to act as a focus to stimulate further research and the development of even more realistic medical simulations.
Information: http://www.ma.hw.ac.uk/icmas/meetings/2003/cmm/.

*20-21 Innovative Teacing of Mathematics "New Concepts & Cutting Edge Technology Applied to Mathematical Education", Research Institute for Mathematical Sciences (RIMS), Kyoto University, Kyoto, Japan.
Description: Until now many conferences have been devoted to Clifford geometric algebra and its applications. In the 1990s Clifford geometric algebra started to be used for undergraduate and graduate teaching at some universities. In the view of the conceptual merits of geometric algebra there are increasingly strong efforts (e.g., summer courses for school teachers) under way to introduce Clifford geometric algebra also into school curricula. In order to further investigate and communicate the conceptual advantages of geometric algebra for the teaching of mathematics, the time seems ripe for an international symposium with an explicit focus on Clifford geometric algebra for teaching.

The second major focus of this symposium is to present new ways of innovative cooperation between the industrial and scientific communities for the use of modern communication technology in mathematical teaching. A kind of forum for the two communities is intended to exchange new ideas and steer the future development in the most meaningful direction.
Organizers: R. Nagaoka (Univ. of the Air, Tokyo), H. Ishi (Yokohama City Univ.), E. Hitzer (Fukui Univ.).
Speakers: Speakers both from abroad and domestic Japanese experts are invited. Confirmed are: D. Hestenes (Arizona), R. Gonzalez Calvet (Barcelona), U. Kortenkamp (Berlin), H. Uno (SHARP, Japan).
Information: http://sinai.mech.fuku-i.ac.jp/ITIV2003/.

*21-24 Inference and Prediction in Neocortical Circuits, AIM Research Conference Center, Palo Alto, California.
Program: This workshop, sponsored by AIM, NSF, and RNI, will be devoted to working toward an understanding of inference and prediction in neocortical circuits.

The cerebral cortex is responsible for most of our conscious experience, yet we remain largely ignorant of the principles underlying its function despite progress on many fronts of neuroscience. The principal reason for this is not a lack of data, but rather the absence of a solid theoretical framework for motivating experiments and interpreting findings. The purpose of this workshop is to bring together mathematicians, statisticians, computer scientists, neuroscientists, and psychologists in order to work towards a theoretical framework for neocortical function.

*24-28 Workshop on Cauchy Problem for the Einstein Equations, Centre de Recherches Mathematiques, Montreal, Quebec, Canada.
Description: A number of major advances have been achieved over the past few years in the analysis of the Cauchy problem in general relativity. These include the proof of the nonlinear stability of Minkowski space, the proof of the Riemannian Penrose
conjecture, and the rigorous description of the asymptotic behavior at infinity of the admissible Cauchy data. This workshop will bring together some of the key players who have been involved in these developments and will provide an opportunity for exploring some of the remaining open problems.

The workshop will be preceded by two short courses given by G. Huisken (MPI Golm) and A. Ashtekar (Penn State).

Organizers: F. Finster (Regensburg), N. Kamran (McGill).


October 2003

1-5 Workshop on the Interaction of Gravity with Classical Fields, Centre de Recherches Mathématiques, Montréal, Québec, Canada.

Description: The interaction of gravity with external fields is governed by highly coupled systems of partial differential equations on manifolds. The analysis of these systems leads to rigorous analytical results on fundamental questions such as the scattering of waves by black holes and the role of external fields in the dynamics of gravitational collapse and black hole formation.

The workshop will be preceded by two short courses given by J. Smoller (Michigan). It will be simultaneous with the first series of Aisenstadt lectures for the year, to be delivered by S. T. Yau.

Organizers: F. Finster (Regensburg), N. Kamran (McGill).


13-15 3rd WSEAS International Conferences on Simulation, Modelling and Optimization; Signal, Speech and Image Processing; Multimedia, Internet and Video Technologies; Robotics, Distance Learning and Intelligent Communication Systems; Nanoelectronics, Nanoelectronics and Electromagnetic Compatibility, Rethymno, Crete, Greece.


17-18 Twenty-Third Southeast-Atlantic Regional Conference on Differential Equations, Kennesaw State University, Kennesaw, Georgia.

Information: http://math.kennesaw.edu/searcde/.

23-26 Amoebas and Tropical Geometry, AIM Research Conference Center, Palo Alto, California.

Program: This workshop will be devoted to a brand new subject called tropical geometry. Tropical varieties are piecewise-linear objects in Euclidean space. The link between the classical complex geometry and the tropical geometry is provided by amoebas or logarithmic images of complex varieties. The tropical varieties appear as certain degenerations of amoebas.


November 2003

3-7 DIMACS Workshop on Data Quality, Data Cleaning and Treatment of Noisy Data, DIMACS Center, Rutgers University, Piscataway, New Jersey.

Short Description: Many disciplines have taken piecemeal approaches to data quality. The areas of process management statistics, data mining database research, and metadata coding have all developed their own ad hoc approaches to solve different pieces of the data quality puzzle. These include statistical techniques for process monitoring, treatment of incomplete data and outliers, techniques for monitoring and auditing data delivery processes, database research for integration, discovery of functional dependencies and join paths, and languages for data exchange and metadata representation. We need an integrated end-to-end approach within a common framework, where the various disciplines can complement and leverage each other's strengths. This workshop our broad objective is to bring together experts from different research disciplines to initiate a comprehensive technical discussion on data quality, data cleaning, and treatment of noisy data specifically to provide an overview of the existing research in data quality to present data quality as a continuous, end-to-end concept to discuss and update the definition of data quality to develop metrics for measuring data quality to emphasize data exploration, data browsing, and data profiling for validating schema specific constraints and identifying aberrations; to focus on disciplines such as knowledge representation and rule-based programming for capturing and validating domain specific constraints; to highlight applications and case studies; to present research tools and techniques; and to identify research problems in data quality and data cleaning.

Organizer: P. Dasu, AT&T Labs, tam@research.att.com

Local Arrangements: M. Mercado, DIMACS Center, mercado@dimacs.rutgers.edu, 732-445-3928.


Information: Visit http://dimacs.rutgers.edu/Workshops/DataCleaning/.

27-28 II International Workshop on Information Technologies and Computing Techniques for the Agro-Food Sector, CIMNE, Barcelona, Spain.

Description: Mathematical models combined with appropriate numerical simulations have become indispensable to make accurate predictions in industry applications, but also to optimize and control processes. Moreover, current trends are moving towards the combination of information technologies with computational techniques.

The main objective of this second edition of the AFoT workshop is to provide a thorough introduction to the most important issues regarding the use of information technologies, and mathematical and computing techniques in the context of the food sector. Topics of interest include novel IT-related methods and tools (e.g., Web-based simulation and decision support systems) plus all the traditional computer simulation techniques (especially regarding distributed process systems), as well as signal processing techniques for advanced sensors.

Agro-Food Technology (AFoT) is a thematic area within MACSI-Net, a European network supported by the Information Society Technologies Programme (IST) of the Fifth Framework Programme.
of the European Commission. MACSI-Net is an initiative to form an open network for the advancement of mathematics, computing, and simulation for industry.

The workshop is one of the activities of the MACSI-Net network to urge unified mathematical and computing techniques involving food scientists, engineers, and industrial people, as well as to encourage new cooperation at an international level between companies and research institutions.

Information: email: ebalad@cirnne.upc.es

December 2003

* 5-8 Numerical Probabilistic Methods for High-Dimensional Problems in Finance, AIM Research Conference Center, Palo Alto, California.

Program: This workshop, sponsored by AIM and the NSF, will be devoted to developing and studying efficient numerical algorithms, based on probabilistic methods, for solving high-dimensional optimization/nonlinear problems in finance and exploring the connection with the theory of Forward Backward Stochastic Differential Equations while at the same time extending that theory. The workshop will bring together researchers in numerical methods, PDES, Monte Carlo simulation, quantitative finance, Malliavin calculus, Forward Backward Stochastic Differential Equations, nonparametric regression kernel techniques, and similar. We hope especially to facilitate communication on this topic between mathematicians, researchers from finance departments, and those from the finance industry.

Organizers: J. Cvitanic and N. Touzi.

* 14-18 Computational Algebraic Statistics, AIM Research Conference Center, Palo Alto, California.

Program: This workshop, sponsored by AIM and the NSF, will bring together researchers in the emerging field of computational algebraic statistics. This new field applies methods of computational algebra and discrete geometry to problems in multivariate analysis, experimental design, probability theory, and disclosure limitation. The interaction of these areas has led, for instance, to the algebraic geometry of hierarchical models and Bayesian networks. The workshop will be a springboard for new ideas to expand the frontiers in computing Gröbner bases in the context of algebraic statistics, counting lattice points in polytopes, and optimally disseminating massive data while preserving confidentiality.

Application Deadline: July 1, 2003.

* 18-20 1st Indian International Conference on Artificial intelligence (ICAI-03), Hyderabad, India.

Focus: This conference focuses on all areas of AI and its applications to many areas. We are inviting paper submissions and sessions proposals.
Information: http://www.1icconference.org.

January 2004

* 5-9 Workshop on Large N Limits of U(N) Gauge Theory in Physics and Mathematics, Centre de Recherches Mathématiques, Montréal, Québec, Canada.

Description: This workshop is devoted to the large N expansion in quantum Yang-Mills theory, particularly in the explicitly solvable 2D setting. During the '90s a series of articles by such physicists as D. J. Gross, W. Taylor, G. Matytsin, M. Douglas, V. Kazakov, and G. Moore produced a series of conjectured expansions for objects of 2D Yang-Mills with gauge group U(N), such as the partition function of a closed surface of genus g, the partition function of a cylinder, the expected value of the Wilson loop functional, as well as certain characters \( \chi_g(U) \). These quantities are related to traces and other invariants of heat kernels, as well as to volumes and traces over moduli spaces of flat connections. The asymptotics of the partition functions are governed by statistics of branched covers of surfaces.

Topics: The Matsyavin asymptotics for the characters \( \chi_g(U) \), recently proved by A. Guionnet and O. Zeitouni; the Kazakov-Douglas phase transition in \( g = 0 \), recently proved by A. Boutet de Monvel and M. Shcherbina; Zelditch's limit formula for the partition function on the cylinder; statistics of branched covers (integrals over Hurwitz spaces); volumes and trace integrals over moduli spaces of flat bundles; the large N limit of objects of \( \mathcal{M}_g \); relations between large N theory of \( \mathcal{M}_2 \) and random matrix models; relations with free probability; the new, very fast developing work of Dijkgraaf-Vafa.

Organizers: P. Bleher (IUPUI), V. Kazakov (École Normale), and S. Zelditch (Johns Hopkins).

* 11-14 Thompson’s Group at 40 Years, AIM Research Conference Center, Palo Alto, California.

Program: This workshop, sponsored by AIM and the NSF, will be devoted to understanding Thompson’s group from many different viewpoints and approaching some open questions about the group.

This workshop will bring together researchers in group theory, category theory, and dynamics for a joint approach towards Thompson’s group. We hope especially to facilitate communication between researchers in these differing fields who may view Thompson’s group in quite different ways. Exploring the connections between these viewpoints will lead to new and innovative approaches to some open problems concerning this group.


Topics: Papers are invited on all aspects of theoretical computer science. Some representative but not exclusive topics include the following: logic, reasoning and verification; formal specification techniques and program semantics; formal development methods, program refinement, synthesis and transformation; concurrent, parallel and distributed system theory; algorithm design and data structures; streaming data computation; computational biology, geometry, and number theory; complexity and computability; automata, types and category theory; tools for automated reasoning; and program analysis and development.


February 2004

* 17-20 Announcement and Call for Papers: IV International Symposium on Mathematical Methods Applied to the Sciences, San José, Costa Rica.

**Topics:** Data Analysis, Multivariate Statistics, Clustering and Classification Probability; Stochastic Processes, Financial Mathematics Optimization, Operations Research, Approximation, Numerical Analysis, Applications of the above topics. To submit a short course or a paper, please visit our website for instructions. Send the abstract to: email: jtrejos@carriar.ucr.ac.cr.

**Deadline:** October 15, 2003.

**Languages:** English and Spanish.

**Registration:** Please visit our website for prices and deadlines. We offer special discounts for Central Americans and students. The preliminary program will be available at the beginning of January 2004.

**Organizers:** J. Trejos (chairman); email: jtrejos@carriar.ucr.ac.cr; W. Mora (webmaster); email: wmo@itcr.ac.cr.

**Information:** http://www.itcr.ac.cr/simmac/; http://www.assist.ucr.ac.cr.

**Further Information:** On the website you can find further details about the Scientific and the Organizing Committees, as well as travel, hotel, tourism, and other information.

March 2004

* 4-6 Workshop on Spectral Geometry, Centre de Recherches Mathématiques, Montréal, Québec, Canada.

**Description:** Relations between the geometric properties of manifolds and the spectrum of the Laplacian have been actively studied for decades. It is well known that many important geometric invariants are determined by the spectrum, and, vice-versa, the behavior of eigenvalues is strongly dependent on the underlying geometry and topology. Still, our understanding of the interplay between geometry and the spectrum is very far from being complete. In recent years some major developments have occurred in various areas of spectral geometry, such as spectral asymptotics, eigenvalue estimates, isospectrality, and others. These problems and their applications will be the focus of the workshop.

**Organizer:** I. Polterovich (Montréal).

**Invited Participants:** M. Ashbaugh (Missouri), C. Gordon (Dartmouth), P. Gilkey (Oregon), D. Goev (UPenn), V. Guillemin (MIT), M. Hitrik (UCLA), V. Ivrii (Toronto), P. Li (UC Irvine), J. Lotz (Michiganan), R. Mazzeo (Stanford), F. Perry (Kentucky).

April 2004

* 1-May 15 Econometric Forecasting and High-Frequency Data Analysis, Institute for Mathematical Sciences, National University of Singapore, Singapore.

**Program Organization:** This is a program jointly organized by the Institute for Mathematical Sciences; National Univ. of Singapore; and School of Economics and Social Sciences, Singapore Management Univ. Co-chairs: R. S. Mariano (Singapore Management Univ.), S. Ouliaris (National Univ. of Singapore), and Y. K. Tse (Singapore Management Univ.); Members: O. E. Barndorff-Nielsen (Univ. of Aarhus, Denmark), A. Pagan (Australian National Univ., Australia), A. T. Tan (National Univ. of Singapore), and G. Tiao (Univ. of Chicago, USA).

**Description:** Econometric forecasting has seen new dimensions recently due to developments in nonstationary time series, systems of equations and nonlinear dynamics modeling, while the advances in high-frequency data (HFD) analysis have recently accelerated with the availability of financial intra-day trade data.

**Format:** The program will focus on two major topics in econometrics: the first three weeks on forecasting, with the other three weeks on HFD analysis. The program will commence with a plenary session providing an overview of the themes and coverage. It will be followed by a series of formal meetings comprised of open forums, tutorials, research seminars/workshops, and a conference for the presentation of research papers on forecasting and high-frequency analysis.

**Registration:** Registration forms for the tutorial/workshop are available at http://www.ims.nus.edu.sg/Programs/econometrics/index.htm and should be received at least one month before commencement of each activity. Registration is free. Membership is not required for participation.

**Membership:** Membership application for visiting the institute under the program is also available from the above website. Members do not need to register for specific activities.

**Contacts:** For general enquiries please email ims@nus.edu.sg, while for enquiries on scientific aspects of the program, please email R. S. Mariano at rsmariano@smu.edu.sg. More information is available at the program website: http://www.ims.nus.edu.sg/Programs/econometrics/index.htm.

May 2004

* 3-8 AARMS-CRM—Workshop on Singular Integrals and Analysis on CR Manifolds, Halifax, Nova Scotia, Canada.

**Description:** The theory of singular integral operators in the context of analysis on CR submanifolds of Cn, in particular the Heisenberg group, has been studied and proven fruitful over the last thirty years. In recent years the emphasis has shifted to singular integral operators which do not fall under the standard Calderon-Zygmund theory. These include operators arising from product kernels on nilpotent Lie groups, which in turn lead to the study of flag kernels. The workshop combines the areas of harmonic analysis, several complex variables, symmetric spaces, and Lie groups. It will include two series of lectures, to be delivered by Alexander Nagel (Wisconsin) and Elias M. Stein (Princeton). The workshop will be held in Halifax, Nova Scotia.

**Organizers:** G. Dafni (Concordia), A. Fraser (Dalhousie).

**Speakers:** A. Boggeson (Texas A&M (*) , A. Bonami (Orleans), D.-C. Chang (Georgetown), P. Ciatti (Padova) (*), M. Cowling (UNSW-Sydney), A. Dooley (UNSW-Sydney), F. Faraut (Paris VI) (*), G. Folland (Seattle), G. Gaudry (UNSW-Sydney) (*), P. Greiner (Toronto), P. Guan (McMaster) (*), K. Hare (Waterloo) (*), A. Korany (CUNY), G. Mckenhaupt (Georgia Tech) (*), L. Rothschild (UCSD) (*), E. Sawyer (McMaster) (*), M.-C. Shaw (Notre Dame) (*), S. Sjogren (Goteborg) (*), N. Stanton (Notre Dame) (*), S. Thangavelu (Bangalore), S. Wainger (Wisconsin) (*)), J. Wright (Edinburgh) (*, to be confirmed.

* 3-June 26 2004 Geometric Partial Differential Equations, Institute for Mathematical Sciences, National University of Singapore, Singapore.

**Description:** Combining geometric insights and analytic techniques together has generated many fruitful ideas and surprising results. The advances of the analytical results on nonlinear partial differential equations have helped to accelerate research on differential geometry for the last forty years. On the other hand, geometry has provided subtle and elegant equations for investigation. The objective of the program is to initiate and conduct investigations into nonlinear partial differential equations arising from geometric problems, especially those related to the scalar curvature, Q-curvature, and Sigma curvature.

**Organizing Committee:** Co-chairs: X. Xu (Nat. Univ. of Singapore) and P. Yang (Princeton Univ.); M. Ding (Beijing Univ., China), M. C. Leung (Nat. Univ. of Singapore), C. S. Lin (Nat. Chung Cheng Univ., Taiwan), P. Pung (Nat. Univ. of Singapore), G. Tian (MIT), and N. S. Trudinger (Australian Nat. Univ.).

**Format:** The program will consist of tutorials on background material and a workshop (May 28–June 2, 2004) at research level, in addition to seminars and informal discussions. The program will focus on the following topics: (i) scalar curvature problem, especially prescribed scalar curvature problem on n-spheres; (ii) conformally invariant operators; (iii) geometric flow problem; and (iv) fully nonlinear partial differential equations.
Registration: Registration forms for the tutorial/workshop are available at http://www.ims.nus.edu.sg/Programs/pdes/index.htm and should be received at least one month before commencement of each activity. Registration is free. Membership is not required for participation.

Membership: Membership application for visiting the institute under the program is also available from the above website. Members do not need to register for specific activities.

Information: For general enquiries please email ims@nus.edu.sg, and for enquiries on scientific aspects of the program, please email X. Xu at math@nus.edu.sg. More information is available at the program website: http://www.ims.nus.edu.sg/Programs/pdes/index.htm.

*4-7 Workshop on Spectral Theory and Automorphic Forms, Centre de Recherches Mathematiques, Montreal, Quebec, Canada.

Organizers: D. Jakobson (McGill), Y. Petridis (CUNY).

Description: In the last forty years it has been understood that there is a close connection between the spectral theory of hyperbolic manifolds and the theory of L-functions attached to automorphic forms. Trace formulas of Selberg and Kuznetsov-Bruggeman are extremely useful in studying the spectrum and eigenfunctions of the hyperbolic Laplacian. Surprising connections have also been discovered between subconvexity estimates for L-functions and the equidistribution results for Eisenstein series and cusp forms. Trace formulas of Selberg and Kuznetsov-Bruggeman are extremely useful in studying the spectrum and eigenfunctions of the hyperbolic Laplacian. Surprising connections have also been discovered between subconvexity estimates for L-functions and the equidistribution results for Eisenstein series and cusp forms.

Analytical questions about families of L-functions include questions about the distributions of zeros and GRH, value-distribution, special values and applications, as well as connections with arithmetical questions (such as distribution of primes, size of class groups, analytic ranks of elliptic curves). One of the most fruitful approaches to the study of statistical properties of zeros of L-functions involves establishing connections with random matrix theory.

The goal of this workshop is to bring together leading researchers in those fields, to introduce young researchers and graduate students to the state of the art results, and to give an account of applications of techniques from analytic number theory to problems in analysis.

The workshop will coincide with the second series of Aisenstadt lectures for the year, to be given by P. Sarnak.

Invited Participants: J. Bolte (Bristol)(*), B. Conrey (AIM)(*), D. Goldberg (Columbia)(*), W. Duke (UCLA), J. Friedlander (Toronto)(*), H. Hejhal (Minnesota), J. Hoffstein (Brown), L. Ji (Michigan), C. Judge (Indiana), K. Keating (Bristol)(*), E. Kowalski (Bordeaux)(*), S. Koyama (Keio)(*), E. Lindenstrauss (Stanford)(*), W. Luo (Ohio), F. Michel (Montpellier)(*), S. Miller (Rutgers), W. Mueller (Bonn), R. Murty (Queen’s)(*), C. O’Sullivan (CUNY)(*), P. Perry (Kentucky)(*), B. Randal (CUNY)(*), Z. Rudnick (Tel Aviv), P. Sarnak (Princeton), K. Soundararajan (Michigan)(*), N. Vatsal (UBC), A. Venkov (Aarhus), M. Wakahaya (Kyushu)(*), A. Zaharescu (Illinois)(*), S. Zelditch (Johns Hopkins)(*), to be confirmed.

*24-28 Workshop on Hamiltonian Dynamical Systems (jointly with The Fields Institute), Centre de Recherches Mathematiques, Montreal, Quebec, Canada.

Description: A conference on analytic techniques of dynamical systems, including perturbation theory, variational methods, and stability theory. The workshop will cover both finite-dimensional Hamiltonian systems such as in celestial mechanics, and infinite-dimensional Hamiltonian systems, such as those arising from PDE or from other dynamical systems with infinitely many degrees of freedom. Part of The Fields Institute thematic program, it follows a workshop on integrable and near-integrable Hamiltonian PDE, held the previous week in Toronto.

Organizing Committee: D. Bambusi (Milano), W. Craig (McMaster), S. Kuksin (Edinburgh), C. E. Wayne (Boston), chair; E. Zehnder (ETH-Zentrum).

June 2004

*1-11 Workshop on Semi-classical Theory of Eigenfunctions and PDEs, Centre de Recherches Mathematiques, Montreal, Quebec, Canada.

Description: Many questions in quantum chaos are motivated by the correspondence principle in quantum mechanics. It asserts that certain features of the classical system manifest themselves in the semiclassical (as Planck’s constant \( h \in 0 \)) limit of a quantization of the classical system. The exact relationship between classical dynamics and asymptotic properties of high energy eigenstates of a quantized system is still not completely understood, despite exciting developments in the last twenty years. Important issues related to the correspondence principle include asymptotic L^2 (L^2) bounds for the eigenfunctions, integrated (and pointwise) Weyl errors and scarring. Another fundamental question concerns the local and global statistical properties of eigenfunctions (e.g., the random wave model), their nodal sets and critical points. These problems draw extensively on the theory of partial differential equations, and so we propose to bring together experts in these areas.

The workshop will include several short courses. H. Donnelly (Purdue)(*), N. Nadirashvili (Chicago), and D. Jerison (MIT)(*), have been invited.

Organizers: D. Jakobson (McGill), J. Toth (McGill).

Invited Participants: P. Bleher (UIUPU)(*), E. Bomboloni, D. Borthwick (Emory)(*), N. Burq (Paris-Sud)(*), Y. Colin de Verdiere (Grenoble)(*), W. Craig (McMaster)(*), C. Fefferman (Princeton)(*), L. Friedlander (Arizona), P. Gerard (Paris-Sud), P. G. Goen (McMaster)(*), V. Guillemin (MIT)(*), B. Helffer (Paris-Sud)(*), F. Holler (Harvard)(*), V. Ivrii (Toronto)(*), E. Martinez (UCLA)(*), Min-Oo (McMaster)(*), D. J. Nonnenmacher (Ulm)(*), K. Ooki (San Diego)(*), G. Popov (Nantes)(*), T. Paul (Ecole Normale)(*), Z. Rudnick (Tel-Aviv), Y. Safarov (London), P. Sarnak (Princeton)(*), B. Shiffman (Johns Hopkins)(*), M. Shubin (Northeastern)(*), J. Sjostrand (Polytechnique)(*), U. Smlansky (Weizmann), A. Sobolev (Nantes), C. Sogge (Johns Hopkins), T. Tate (Reo)(*), A. Uribe (Michigan)(*), A. Voros (Saclay)(*), S. T. Yau (Harvard)(*), S. Zelditch (Johns Hopkins)(*), M. Zworski (Berkeley)(*), to be confirmed.

*16-19 AIMS’ Fifth International Conference on Dynamical Systems and Differential Equations, California State Polytechnic University, Pomona, California.

Topics: The conference will cover all major research areas in analysis and dynamics. Equally emphasized will be real world applications in terms of modeling and computations.

Description: The conference will provide a unique international forum for the international community of mathematicians and scientists working in analysis, differential equations, dynamical systems, and their applications to real world problems in the forms of modeling and computation. The aim of this conference is to bring the worldwide senior experts as well as young researchers together to report recent achievements, exchange ideas, and address future trends of research in a relaxing but stimulating environment.

Format: There will be one-hour plenary talks, 30-minute special session talks, and 10-minute contributed talks.

Organizing Committee: I. Mihaila, M. Nakashima, C. Pinter-Lucke, S. Wirkus, W. Xie (chair), xuei@cau-pomona.edu.

Scientific Committee: J. Balser, S. Hsu (chair), shu209f@ssu.edu, X. Lu (coordinator: lux@gmu.edu), W.-M. Ni, M. Otani, R. Temam, K. L. Teo.


Proceedings: The conference proceedings will be published by AIMS-press.

Funding: Limited funding from the NSF is expected to support graduate students and young researchers.

Information: Abstract submission, registration, housing, plenary speakers, special sessions, and more details will be posted at http://AIMSsciences.org/. For local information, please contact W. Xie.
30-July 7 *Fourth World Congress of Nonlinear Analysts (WCNA2004)*, Hyatt Orlando, Orlando, Florida.

**Short Description:** The Fourth World Congress (WCNA—2004) of Nonlinear Analysts will be held at the Hyatt Regency Orlando (Near Walt Disney World Resort) under the auspices of the International Federation of Nonlinear Analysts (IFNA). The vision of IFNA and WCNA is to promote, encourage, and influence more cooperation, understanding, and collaboration in the world community of nonlinear analysts from various diverse disciplines; to bring together various disciplines that attempt to understand nonlinear phenomena and solve nonlinear problems; and to help minimize the ever-widening gap between the developed and developing countries by providing scientific and technical research assistance in various forms. It is with this spirit that the International Federation of Nonlinear Analysts was established in 1992 as a transdisciplinary world society. IFNA sponsors the World Congress of Nonlinear Analysts periodically once every four years.

**Scientific Program:** There will be several invited lectures, organized sessions, minisymposia and workshops (by academic, industrial, and government experts) covering recent trends in nonlinear problems arising in such diverse disciplines as: aerospace sciences, atmospheric sciences, biological sciences, chemical sciences, cosmological sciences, economics, engineering & technological sciences, environmental sciences, geophysical sciences, medical & health sciences, numerical & computational sciences, oceanographic sciences, physical sciences, social sciences, and mathematical sciences. There will be opportunities to present short communications (30 minutes), organize informal seminars, and propose special sessions. More details concerning travel facilities, social events, preregistration, accommodations, submission of abstracts, scientific program, and invited lectures will be provided in the second announcement, which will be posted shortly.

**Information:** [http://kerner.math.fit.edu/](http://kerner.math.fit.edu/) email: wcna2004@ims.nus.edu.sg

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**July 2004**

1-December 31 **Wall Bounded and Free-Surface Turbulence and Its Computation**, Institute for Mathematical Sciences, National University of Singapore, Singapore.

**Description:** Turbulence in fluid flow has remained one of the challenging problems of science and engineering today. Although important advances have been made in our knowledge and understanding of the processes of turbulence since the experiments of Osborne Reynolds more than a hundred years ago, our current ability to accurately predict turbulent events and their properties is still very limited for all but simple flows. The present program seeks to create a forum for the exchange of ideas and knowledge on recent developments in the theory of turbulence, turbulence modeling and computation, and turbulence control. The emphasis will be on turbulence at surfaces, since this is commonly encountered in applications, but related works in boundary layer transition and turbulence are also welcome.

**Organizing Committee:** Co-chairs: B. E. Launder (Univ. of Manchester Inst. of Sci. and Tech.), C. C. Mei (MIT), and K. S. Yeo (Nat. Univ. of Singapore).

**Registration:** Registration forms for participation in tutorials/workshops are available at [http://www.ims.nus.edu.sg/Programs/vbcfs/index.htm](http://www.ims.nus.edu.sg/Programs/vbcfs/index.htm) and should be received at least one month before commencement of each activity. Registration is free of charge. Membership is not required for participation.

**Information:** For general enquiries please email ims@nus.edu.sg, while for enquiries on scientific aspects of the program, please email K. S. Yeo at mpeyeaks@nus.edu.sg. More information about the program is available at the website: [http://www.ims.nus.edu.sg/Programs/vfbcfs/index.htm](http://www.ims.nus.edu.sg/Programs/vfbcfs/index.htm).

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5-9 **19th “Summer” Conference on Topology and Its Applications**, Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, South Africa.

**Keynote Lecturers:** O. Alas (Univ. of Sao Paulo, Brazil); A. Edalat (Imperial College London, UK); M. Erné (Univ. of Hannover, Germany); M. I. Garrido (Univ. of Extremadura, Badajoz, Spain); V. Gutev (Univ. of Natal, Durban, South Africa); P. Johnstone (Univ. of Cambridge, UK); V. Pestov (Univ. of Ottawa, Canada); D. Repovs (Univ. of Ljubljana, Slovenia).

**Workshops:** Topological Methods in Algebra: M. D. Neusel (Texas Tech Univ. at Lubbock, USA); Duality as a Unifying Framework: I. Revzitzy (Univ. of Cape Town, South Africa).

**Special Sessions:** Session 1: Topology and Set Theory (e.g. Foundations, Continuum Theory). Session 2: Topology in Algebra (e.g. Topological Groups, Topological Semigroups). Session 3: Topology in Analysis and Geometry (e.g. Function Spaces, Dynamical Systems, Uniformity, Asymmetric Topology). Session 4: Topology and Computer Science (e.g. Domain Theory, Computational Topology). Session 5: Topology and Category Theory (e.g. Pointfree Topology, Topological Categories, Closure Operators). Participants are invited to present 20-minute talks.

**Organizers:** H. Kunzi, C. Gilmour, G. Brummer, J. Frits, S. Mabibiza, I. Revzitzy, A. Schauer (Univ. of Cape Town); D. Holgate, P. Matutu (Univ. of Stellenbosch); N. Marcus (Univ. of the Western Cape).

**Information:** Summer Conference on Topology and Its Applications, Department of Mathematics and Applied Mathematics, University of Cape Town, Private Bag, Rondebosch 7701, South Africa; email: topausa04@maths.uct.ac.za; fax: 27-21-6502334; [http://www.ims.maths.uct.ac.za/Conferences/Topology/](http://www.ims.maths.uct.ac.za/Conferences/Topology/).

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26-30 **IMS Annual Meeting/6th Bernoulli World Congress**, Barcelona, Spain.

**Topics:** The program covers a wide range of topics in statistics and probability, presenting recent developments and the state of the art in a variety of modern research topics and in applications such as mathematical finance and statistical bioinformatics. The program include up to twelve Special Invited Lectures given by leading specialists, thirty-five invited Paper Sessions and a large number of contributed talks.

**Organizers:** D. Nualart, Chairman of the Organizing Committee; W. Kendall, Chairman of the Scientific Committee.


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26-30 **Workshop on Spectral Theory of Schrödinger Operators**, Centre de Recherches Mathématiques, Montréal, Québec, Canada.

**Description:** This workshop will focus on the spectral theory of random and quasiperiodic Schrödinger operators. In solid state physics random and almost periodic Schrödinger operators serve as models of disordered systems such as alloys, glasses and amorphous materials. The disorder of the system is reflected by the dependence of the potential on some random parameters.

From a mathematical point of view, random Schrödinger operators show quite "unusual" spectral behavior. If the disorder is large enough, then these operators have dense point spectrum with exponentially decaying eigenfunctions (Anderson localization). The appearance of dense point spectra is a reflection of the physical fact that the strongly disordered systems are bad conductors. It is believed that in the weak disorder regime and for dimensions larger than 2 these operators have some absolutely continuous spectrum which corresponds to the nonzero conductivity of the weakly disordered systems. The mathematical proof of this expected spectral phase transition is an important open problem in mathematical physics.

This workshop will bring together the world leaders in spectral theory of random and quasi-periodic Schrödinger operators. Its goal is to review the state of the art of the field and to map new directions of the research.

The program includes short courses to be given by M. Aizenman (Princeton), B. Simon (Caltech), and J. Itomiskaya.
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.

**August 2004**

*2-6 Workshop on Dynamics in Statistical Mechanics, Centre de Recherches Mathématiques, Montréal, Québec, Canada.*

**Description:** During the last years significant efforts have been devoted to the study of dynamical properties of (classical and quantum) open systems. In particular, through the study of noisy or forced dissipative systems, or Hamiltonian systems with a large number of degrees of freedom, our understanding of the mathematical structure of nonequilibrium statistical mechanics has greatly improved. The aim of this meeting is to present the latest results and discuss the possible future directions of research in this area. The following topics will be discussed:

- **Axiomatic approaches:** Under appropriate hypotheses on the ergodic properties of the underlying dynamical system (chaotic hypothesis, asymptotic abelianness, etc.), it is possible to prove various predictions of nonequilibrium thermodynamics (linear response, Kubo formula, Onsager’s relations, etc.). This approach also leads to unexpected results, like the Gallavotti-Cohen fluctuation theorem.

- **Specific models:** Modern techniques (quantum field theory, algebraic quantum dynamical systems, spectral analysis, renormalization group, etc.) have been successfully applied to the study of various models (spin-boson, spin-fermion, Lorentz-gas, etc.).

- **Elementary physical properties:** Like return to equilibrium or existence and structural properties of nonequilibrium steady states have been observed in this way. More difficult questions, like the emergence of the Föllinger law, are currently under investigation.

- **Markovian dynamics:** It gives a natural mathematical framework to study the dynamics of various nonequilibrium processes: Hamiltonian systems coupled to reservoirs, exclusion processes on the lattice, noisy extended systems.

- The program includes short courses to be given by H. Araki (Kyoto), B. Derrida (École Normale), J. Frehlich (ETH), J.-P. Eckmann (Geneva) (*). Organizers: V. Jaksic (McGill), C.-A. Pillet (Toulon). Invited Participants: J. Avron (Technion), J.M. Barbaroux (Toulouse), J. M. Combes (Marseille) (*), D. Damianuk (Caltech), E. B. Davies (London), R. Del Río (UNAM), A. Elgart (Princeton), D. Fedotov (St. Petersburg), A. Figotin (Irvine), R. Froese (UBC) (*), G. Germinet (Lille), F. Gesztesy (Missouri), M. Goldstein (Toronto), G. Grünberg (Kiel), A. Herbst (Virginia), I. Hislop (Kentucky), D. Hundertmark (Caltech), A. Joye (Grenoble), Y. Karpeshina (Alabama), R. Killip (Paris), W. Kirsch (Bochum), A. Kiselev (Wisconsin), A. Klein (Irvine), A. Kupiainen (Helsinki), K. Lederer (Montreal), D. Lenz (Chemnitz), S. Molchanov (UNCC), L. Pastur (Paris), C. Remling (Osnabrück), W. Schlag (Caltech), A. Sobolev (Sussex), P. Stollmann (Chemnitz), G. Stolz (Alabama), S. Tcheremchantsev (Orleans), B. Vainberg (UNCC) (*). To be confirmed.

*6-7 New Directions in Probability Theory, Fields Institute, Toronto, Canada.*

**Description:** The meeting consists of five sessions and four one-hour lectures, of which two are IMS Medallion Lectures. It is intended for a general probability audience interested in recent developments in probability theory. The topics of the session are Random Walks with Self-Repulsion, Random Matrices, Random Media, Superprocesses, and Markov Chains with Algorithms.

**Co-Sponsor:** The Institute of Mathematical Statistics (IMS) and the Fields Institute for Research in Mathematical Sciences. The meeting immediately precedes the Joint Statistical Meetings of August 8-12 (co-sponsored by ASA, IMS, ENAR, WNAR, SSC). It will take place on Friday/Saturday and will be held at the Fields Institute.

**Information & Registration:** There will be no registration fee for the meeting. However, space at the Fields Institute is limited, and so early registration is recommended: [http://www.imstat.org/meetings/NDPT/default.htm](http://www.imstat.org/meetings/NDPT/default.htm).

**December 2004**

*5-16 International Workshop on Nonlinear Partial Differential Equations, IPM, Tehran, Iran.*

**Scope:** New trends and activities in the theory and applications of nonlinear partial differential equations. Topics include free boundary problems, applications of nonlinear pde’s in fluids and geometry, inverse problems in pde’s, stochastic and kinetic pde’s, fully nonlinear pde’s.

**Sponsors:** Institute for Studies in Theoretical Physics and Mathematics (IPM) [http://www.ipm.iran](http://www.ipm.iran), Tehran, Iran; Wolfgang Pauli Institute (WPI) [http://www.wpi.ac.at](http://www.wpi.ac.at), Vienna, Austria.

**Organizers:** P. A. Markowich (WPI), M. Shahshahani (IPM).

**Scientific Committee:** H. W. Engl (Linz, Austria), P. A. Markowich (WPI, Vienna), H. Shahgholian (KTH, Sweden), M. M. Shahshahani (IPM, Tehran), S. Tahvildarzadeh (Rutgers, USA), M. Uhlmann (St. Petersburg, Russia).

**Call for Papers:** Papers will be accepted for presentation at the workshop subject to approval by the Scientific Committee. Please send submissions (extended abstract) electronically (preferably in PDF format) to one of the organizers at an email address listed below.

**Contact:** M. M. Shahshahani (mehrdad@ipm.iran); P. A. Markowich (wittgenstein.mathematik@univie.ac.at).

*17-19 International Conference on Smarandache Algebraic Structures, Indian Institute of Technology, IIT Madras, Chennai - 600 036 Tamil Nadu, India.*

**Description:** A Smarandache n-structure on a set S means a weak structure W on S such that there exists a chain of proper subsets $P_{n-1} \subset P_{n-2} \subset \cdots \subset P_2 \subset P_1 \subset S$ whose corresponding structures verify the inverse chain $W_{n-1} \supset W_{n-2} \supset \cdots \supset W_2 \supset W_1 \supset W_0$, where $W_0$ signifies “strictly stronger” (i.e., structure satisfying more axioms).

**Program:** (1) Smarandache-type groupoids, semigroups, rings, fields; (2) Smarandache-type k-modules, vector spaces, linear algebra, fuzzy algebra.

**Organizer:** W. B. Vasantha Kandasamy.

**Speakers:** R. Padilla, M. Khoshraveshan, M. Popescu.

**Deadline:** November 30, 2004.

**Information:** [http://www.gallup.unm.edu/~smarandache/ebooks-otherformats.htm](http://www.gallup.unm.edu/~smarandache/ebooks-otherformats.htm).
New Publications Offered by the AMS

Algebra and Algebraic Geometry

Commutative Algebra
Interactions with Algebraic Geometry
Luchezar L. Avramov, University of Nebraska, Lincoln, Marc Chardin, Université de Paris VI, Marcel Morales, University of Grenoble I, St. Martin d’Hères, France, and Claudia Polini, University of Notre Dame, IN, Editors

This volume contains 21 articles based on invited talks given at two international conferences held in France in 2001. Most of the papers are devoted to various problems of commutative algebra and their relation to properties of algebraic varieties.

The book is suitable for graduate students and research mathematicians interested in commutative algebra and algebraic geometry.

Contents:
- J. A. Montaner and S. Zarzuela, Linearization of local cohomology modules; M. Brion, Multiplicity-free subvarieties of flag varieties; R.-O. Buchweitz, Morita contexts, idempotents, and Hochschild cohomology—applications to invariant rings—; A. Campillo and S. Encinas, Some applications of two dimensional complete ideals; S. D. Cutkosky, Generically finite morphisms and simultaneous resolution of singularities; J. Elias, Two results on the number of generators; K. Eto, When is a binomial ideal equation equal to a lattice ideal up to radical?; H.-B. Foxby and S. Iyengar, Depth and amplitude for unbounded complexes; A. Guerrieri and I. Swanson, On the ideal of minors of matrices of linear forms; M. Hashimoto, Surjectivity of multiplication and F-regularity of multigraded rings; J. Herzog, D. Popescu, and M. Vladoiu, On the Ext-modules of ideals of Borel type; M. R. Johnson, Sums of linked tepli ideals; B. Malgrange, Cartan involutiveness = Mumford regularity; C. Miller, The Frobenius endomorphism and homological dimensions; U. Nagel, Characterization of some projective subschemes by locally free resolutions; O. Piltant, On unique factorization in semigroups of complete ideals; J.-E. Roos, Modules with strange homological properties and Chebychev polynomials; M. E. Rossi and I. Swanson, Notes on the behavior of the Ratliff-Rush filtration; S. Sather-Wagstaff, On symbolic powers of prime ideals; W. V. Vasconcelos, Multiplicities and the number of generators of Cohen-Macaulay ideals; K.-i. Watanabe, Chains of integrally closed ideals.

Contemporary Mathematics, Volume 331

Théorie de Hodge et géométrie algébrique complexe
Claire Voisin

This book uses material from both complex differential geometry and complex algebraic geometry.

The first part of the book presents the fundamental results of Hodge theory, including a few preliminary chapters on Kähler geometry and sheaf cohomology. It concludes with the development of the notion of Hodge structure and the study of its variation with respect to the complex structure.

The second part is more advanced and presents applications of Hodge theory to complex algebraic geometry. It starts with a study of the topology of families of algebraic varieties, both classical and modern, and then focuses on the applications of the theory of infinitesimal variations of Hodge structure. The last chapters are devoted to the presentation of relations between Hodge theory and algebraic cycles, whose conjectural part is the famous Bloch-Beilinson conjecture.

This book will be useful for Ph.D. students and for researchers interested in modern methods of differential and algebraic geometry. Readers will find here a complete didactic exposition and an up-to-date presentation of applications of Hodge theory to the study of algebraic cycles.

(continued)
New Publications Offered by the AMS

A publication of the Société Mathématique de France (SMF). Distributed by the AMS in North America. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

This item will also be of interest to those working in geometry and topology.

Contents: Introduction; Partie I. Preliminaires: Fonctions holomorphes de plusieurs variables; Variétés complexes; Métriques kählériennes; Faisceaux et cohomologie; Partie II. La décomposition de Hodge: Formes harmoniques et cohomologie; Cas des variétés kählériennes; Structures de Hodge et polarisations; Complexes de de Rham holomorphes et suites spectrales; Partie III. Variations de structure de Hodge: Familles et déformations; Variation de structure de Hodge; Partie IV. Cycles et classes de cycles: Classes de Hodge; Cohomologie de Deligne-Bellinson et application d'Abel-Jacobi; Partie V. Topologie des variétés algébriques: Le théorème de Lefschetz sur les sections hyperplanes; Etude des pinceaux de Lefschetz; Monodromie; Suite spectrale de Leray; Partie VI. Variation de structure de Hodge: Transversalité et applications; Filtration de Hodge des hypersurfaces; Fonctions normales et invariants infinitésimaux; Travaux de Nori; Partie VII. Cycles algébriques: Groupes de Chow; Le théorème de Mumford et ses généralisations; La conjecture de Bloch et ses généralisations; Bibliographie; Index.

Cours Spécialisés—Collection SMF, Number 10


Analysis

Supplementary Reading Independent Study

Problems in Mathematical Analysis III
Integration

W. J. Kaczor and M. T. Nowak,
Marie Curie-Skłodowska University, Lublin, Poland

From reviews for Volumes I and II:
A valuable resource. —American Mathematical Monthly

Would be an ideal choice for tutorial or problem-solving seminars. The volume is also suitable for self-study ... presentation of material is designed to help student comprehension and to encourage them to ask their own questions and to start research ... a really useful book for practice in mathematical analysis. —Zentralblatt MATH

Belongs to the great tradition of Eastern European problem books ... if you love mathematics and are serious about understanding analysis, this book is a must. —MAA Online

A very stimulating problem book ... The style ... is proven to be a motivating approach in constructing and conveying mathematical knowledge ... leads the readers to find new solutions and hence boosts their ability to carry out further research ... thorough coverage of some topics that are covered very briefly in other comparable books ... of interest to anyone who wishes to pursue research in mathematical analysis and its applications ... also excellent for students who want to enhance their skills in real analysis ... a useful supplement to any graduate textbook in mathematical analysis ... some problems are also suitable for undergraduate students. —MAA Online

The best way to penetrate the subtleties of the theory of integration is by solving problems. This book, like its two predecessors, is a wonderful source of interesting and challenging problems. As a resource, it is unequalled. It offers a much richer selection than is found in any current textbook. Moreover, the book includes a complete set of solutions. This is the third volume of Problems in Mathematical Analysis. The topic here is integration for real functions of one real variable. The first chapter is devoted to the Riemann and the Riemann-Stieltjes integrals. Chapter 2 deals with Lebesgue measure and integration. The authors include some famous, and some not so famous, inequalities related to Riemann integration. Many of the problems for Lebesgue integration concern convergence theorems and the interchange of limits and integrals. The book closes with a section on Fourier series, with a concentration on Fourier coefficients of functions from particular classes and on basic theorems for convergence of Fourier series. The book is mainly geared toward students studying the basic principles of analysis. However, given its selection of problems, organization, and level, it would be an ideal choice for tutorial or problem-solving seminars, particularly those geared toward the Putnam exam. It is also suitable for self-study. The presentation of the material is designed to help student comprehension, to encourage them to ask their own questions, and to start research. The collection of problems will also help teachers who wish to incorporate problems into their lectures. The problems are grouped into sections according to the methods of solution. Solutions for the problems are provided.

Problems in Mathematical Analysis I and II are available as Volumes 4 and 12 in the AMS series, Student Mathematical Library.

Contents: Problems: The Riemann-Stieltjes integral; The Lebesgue integral; Solutions: The Riemann-Stieltjes integral; The Lebesgue integral; Bibliography; Index.

Student Mathematical Library, Volume 21

September 2003, approximately 368 pages, Softcover, ISBN 0-8218-3298-0, LC 99-087039, 2000 Mathematics Subject Classification: 00A07, 26A42; 26A45, 26A46, 26D15, 28A12, All AMS members $39, List $49, Order code STUD/21N
Spectral Properties of Self-Similar Lattices and Iterations of Rational Maps

Christophe Sabot, Université Paris VI

In this text, the author considers discrete Laplace operators defined on lattices based on finitely ramified self-similar sets and their continuous analogs defined on the self-similar sets. He focuses on the spectral properties of these operators. The basic example is the lattice based on the Sierpinski gasket. He introduces a new renormalization map which appears to be a rational map defined on a smooth projective variety. (More precisely, this variety is isomorphic to a product of three types of Grassmannians: complex Grassmannians, Lagrangian Grassmannian, and orthogonal Grassmannians.) He relates some characteristics of the dynamics of its iterates with some characteristics of the spectrum of the operator. Specifically, he gives an explicit formula for the density of states in terms of the Green current of the lattice. Depending on the asymptotic degree of the map, he can prove drastically different spectral properties of the operators. The formalism is valid for the general class of finitely ramified self-similar sets.

Applications

Current Trends in Scientific Computing

Zhangxin Chen, Southern Methodist University, Dallas, TX, Roland Glowinski, University of Houston, TX, and Kaitai Li, Xi'an Jiaotong University, PRC, Editors

This volume contains 36 research papers written by prominent researchers. The papers are based on a large satellite conference on scientific computing held at the International Congress of Mathematics (ICM) in Xi'an, China.
convective terms and its applications to PDEs; J. Xu, S. Dong, M. R. Maxey, and G. E. Karniadakis, Direct numerical simulation of turbulent channel flow with bubbles; X. Yu and Q. Dai, RKDG finite element schemes combined with a gas-kinetic method for one-dimensional compressible Euler equations.

Contemporary Mathematics, Volume 329


Number Theory

Recurrence Sequences

Graham Everest, University of East Anglia, Norwich, England, Alf van der Poorten and Igor Shparlinski, Macquarie University, Sydney, NSW, Australia, and Thomas Ward, University of East Anglia, Norwich, England

Recurrence sequences are of great intrinsic interest and have been a central part of number theory for many years. Moreover, these sequences appear almost everywhere in mathematics and computer science. This book surveys the modern theory of linear recurrence sequences and their generalizations. Particular emphasis is placed on the dramatic impact that sophisticated methods from Diophantine analysis and transcendence theory have had on the subject. Related work on bilinear recurrences and an emerging connection between recurrences and graph theory are covered. Applications and links to other areas of mathematics are described, including combinatorics, dynamical systems and cryptography, and computer science. The book is suitable for researchers interested in number theory, combinatorics, and graph theory.

This item will also be of interest to those working in discrete mathematics and combinatorics.

Contents: Definitions and techniques; Zeros, multiplicity and growth; Periodicity; Operations on power series and linear recurrence sequences; Character sums and solutions of congruences; Arithmetic structure of recurrence sequences; Distribution in finite fields and residue rings; Distribution modulo 1 and matrix exponential functions; Applications to other sequences; Elliptic divisibility sequences; Sequences arising in graph theory and dynamics; Finite fields and algebraic number fields; Pseudo-random number generators; Computer science and coding theory; Appendix: Sequences from the on-line encyclopedia; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 104

Classified Advertisements

Positions available, items for sale, services available, and more

MICHIGAN

MICHIGAN STATE UNIVERSITY
proMSc Program in Industrial Mathematics
East Lansing, MI 48824

Direct your students toward one of the professional M.Sc. programs. Industry needs business-savvy mathematicians. See http://www.scimasters.com/.

TENNESSEE

VANDERBILT UNIVERSITY
Postdoctoral Fellowship in Mathematical Biology/Quantitative Methods in Biology

A postdoctoral opportunity is available at Vanderbilt University to study biological processes using mathematical modeling. Specific research interests include questions related to membrane microdomains, protein trafficking, and cell signaling. The successful candidate will be jointly mentored by a faculty member in the mathematics department and a faculty member in the School of Medicine. A strong background in mathematics and/or quantitative biology is required. To apply, please submit a CV, statement of career goals and research interests, and contact information for three references to Anne Kenworthy, Ph.D., Department of Molecular Physiology and Biophysics, Vanderbilt University School of Medicine, via email at anne.kensworth@vanderbilt.edu.

SOUTH KOREA

POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Mathematics
Faculty Positions Available

We invite applications for permanent faculty positions, which will begin in the spring semester of year 2004. Preferred research areas of the applicants include analysis, differential geometry, and topology. Applicants are advised to send (1) cover letter, (2) curriculum vitae, (3) list of publications, (4) description of research, and (5) transcripts for undergraduate and graduate studies to the address below. Applications are invited for visiting faculty positions in the Department of Mathematics at POSTECH for fall 2003 and/or spring 2004. There are no restrictions upon the research areas of the applicants. However, preferences are given to those (1) who hold a permanent faculty position in their home institutions and (2) whose specialties are resonant with those of faculty members of POSTECH. Appointments can vary in length from one semester to three years. We require the applicants to be capable of speaking Korean or English fluently in the lectures. The salary and fringe benefits will be commensurate with the current rank of the applicants. POSTECH has a low-rent housing option in the faculty housing complex on campus.

Applications should send (1) curriculum vitae, (2) cover letter, (3) list of publications, and (4) letters of recommendation to the following address:

Sungpyo Hong, Chairman
Department of Mathematics
Pohang University of Science and Technology
Pohang 790-784, South Korea

For more details, please contact Sungpyo Hong at:
email: sungpyo@postech.ac.kr
Telephone (+82) 54-279-2302
Fax: (+82) 54-279-2799
Web page: http://www.postech.ac.kr

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 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-AMS (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 classifieds@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Advertisers will be billed upon publication.
Classified Advertisements

and Technology (POSTECH)
Pohang 790-784, South Korea
email: sungpyo@postech.ac.kr
Phone: (+82) 54-279-2302
Fax: (+82) 54-279-2799

Deadlines for application and beginning dates:

For more information on POSTECH, see http://www.postech.ac.kr.

WRITER WANTED

NEEDED: The help of a mathematician to write an introduction based on Mintz’s completed work; Mintz’s website: http://www.euclidchallenge.org, which includes: Euclid Challenge—Successful Response; Review by an American professor of mathematics; Pierre Wantzel (19th century); When using “Traditional Euclidian Methods”; Comparison: Archimedes, Hippias Quadratrix, Milton A. Mintz; Use of Euclid tools: Unmarked straightedge and compass only; Mintz methods include proof of accuracy; Mintz methods: (1) trisection of any angle, (2) square a circle. Milton A. Mintz, email: milton@euclidchallenge.org.
International Mathematics Research Notices

Web Site: http://imrn.hindawi.com

AIMS AND SCOPE

IMRN provides very fast publication of research articles of high current interest in all areas of mathematics. All articles are fully refereed and are judged by their contribution to advancing the state of the science of mathematics. Issues are published as frequently as necessary. IMRN will publish 60± issues in volume 2004. The articles of the IMRN are reviewed/indexed in COMPUMATH Citation Index, Current Contents, ISI Alerting Services, Mathematical Reviews, Science Citation Index, SciSearch, and Zentralblatt für Mathematik.

INSTRUCTIONS FOR AUTHORS

IMRN is devoted to advancing the state of the science of mathematics by publishing research articles of high current interest in all fields of mathematics. Articles of any length are welcome and all articles are refereed and judged for correctness, interest, originality, depth, and applicability. Illustrations can be in color. There are no page charges. Each author shall receive 50 complimentary reprints with covers. Submissions are made by email to submi@imrn.hindawi.com. An abstract for each article should be included. A copy may also be sent to an editor: Only an acknowledgment from the editorial office officially establishes the date of receipt. Submissions not prepared using TEX should be typed or printed on one side of the page, be double-spaced (including references), have ample margins, and be accompanied by a page that lists all potentially ambiguous notations. Check contact information for submission by fax or post. When articles are accepted, production begins immediately; authors should be available to assist the editorial staff.

FORTHCOMING ARTICLES

- Almost Modular Functions and the Distribution of $n^2 \times$ Modulo One, Jens Marklof
- Existence of Solutions for a Class of Hyperbolic Systems of Conservation Laws in Several Space Dimensions, Luigi Ambrosio and Camillo De Lellis
- Geometry of Meromorphic Functions and Intersections on Moduli Spaces of Curves, S. V. Shadrin
- On the Boundary of the Milnor Fibre of Nonisolated Singularities, François Michel and Anne Pichon
- On the Classification of Multiplicity-Free Exterior Algebras, John R. Stembridge
- On the Symmetric Powers of Cusp Forms on GL(2) of Icosahedral Type, Song Wang
- Periods of Hilbert Modular Forms and Rational Points on Elliptic Curves, Henri Darmon and Adam Logan
- Proper Isometric Actions of Thompson's Groups on Hilbert Space, Daniel S. Farley
- Rational Solutions of the Garnier System in Terms of Schur Polynomials, Teruhisa Tsuda
- Structure Constants for Hecke and Representation Rings, Thomas J. Haines
- The Area of a Minimal Embedded 2-Sphere in a Manifold Diffeomorphic to $S^2$, A. Nabutovsky and R. Rotman
- The Asai Transfer to GL(n) via the Langlands-Shahidi Method, M. Krishnamurthy
- Twisted Modules for Vertex Operator Algebras and Bernoulli Polynomials, B. Dayon, J. Lepowsky, and A. Milas

SUBSCRIPTION INFORMATION

Institutional subscription rates for volume 2004 (60± issues) are $2395 for print or online and $2874 for print and online. New print subscribers shall receive a free copy of all back volumes, i.e., volumes 1991-2003. New and current online subscribers shall receive "perpetual" online access to volumes 1991-2004. Please contact orders@hindawi.com for more information.
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/. Programs and abstracts will continue to be displayed on the AMS website in the Meetings and Conferences section until about three weeks after the meeting is over. Final programs for Sectional Meetings will be archived on the AMS website in an electronic issue of the Notices as noted below for each meeting.

Boulder, Colorado
University of Colorado
October 2–4, 2003
Thursday–Saturday
Meeting #989
Joint Central/Western Section
Announcement issue of Notices: August 2003
Program first available on AMS website: August 21, 2003
Program issue of electronic Notices: October 2003
Issue of Abstracts: Volume 24, Issue 4

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 12, 2003

Invited Addresses
Giovanni Forni, Northwestern University, Title to be announced.
Juha M. Heinonen, University of Michigan, Title to be announced.
Joseph D. Lakey, New Mexico State University, Recent progress in time-frequency analysis.
Albert Schwarz, University of California Davis, Maximally supersymmetric gauge theories.
Brooke E. Shipley, Purdue University, Title to be announced.
Avi Wigderson, Institute for Advanced Study, Some insights of computational complexity theory (Erdős Memorial Lecture).

Special Sessions
Algebraic Geometry (Code: AMS SS M1), Holger Kley, Rick Miranda, and Chris Peterson, Colorado State University.
Algebras, Lattices and Varieties (Code: AMS SS A1), Keith A. Kearnes, University of Colorado, Boulder, Agnes Szendrei, Bolyai Institute, and Walter Taylor, University of Colorado, Boulder.
Analysis on Singular Spaces (Code: AMS SS L1), Mario Bonk, University of Michigan, and Juha Heinonen, Mathematical Sciences Research Institute.
Applications of Number Theory and Algebraic Geometry to Coding (Code: AMS SS B1), David R. Grant, University of Colorado, Boulder, Jose Felipe Voloch, University of Texas at Austin, and Judy Leavitt Walker, University of Nebraska, Lincoln.
Associative Rings and Their Modules (Code: AMS SS J1), Gene Abrams, University of Colorado at Colorado Springs, and Kent Fuller, University of Iowa.
Computational and Mathematical Biology (Code: AMS SS S1), Harvey J. Greenberg, University of Colorado, Denver.
Computational Number Theory (Code: AMS SS R1), J. Brian Conrey and Michael Rubinstein, American Institute of Mathematics.
Dynamics of Rational Polygonal Billiards and Related Systems (Code: AMS SS K1), Giovanni Forni, Northwestern University.
Finite Geometries (Code: AMS SS N1), Stanley E. Payne, University of Colorado, Denver, and Robert Allen Liebler, Colorado State University.
Graphs and Diagraphs (Code: AMS SS H1), Michael Jacobson, University of Colorado, Denver, and Richard J. Lundgren, University of Colorado, Denver.
Groupoids in Analysis and Geometry (Code: AMS SS D1), Lawrence Baggett, University of Colorado, Boulder, Jerry Kaminker, Indiana University-Purdue University Indianapolis, and Judith Packer, University of Colorado, Boulder.

Homotopy Theory (Code: AMS SS F1), Daniel Dugger, University of Oregon, and Brooke E. Shipley, Purdue University.

Noncommutative Geometry and Geometric Analysis (Code: AMS SS E1), Carla Farsi, Alexander Gorokhovsky, and Siye Wu, University of Colorado.

Nonlinear Waves (Code: AMS SS P1), Bernard Deconinck, Colorado State University, and Harvey Segur, University of Colorado, Boulder.


Ubiquitous Heat Kernel (Code: AMS SS Q1), Jay Jorgenson, City College of New York, and Lynne Walling, University of Colorado, Boulder.

Accommodations

Participants should make their own arrangements directly with the properties listed below. Special rates for the meeting are available for the period October 1-5. The AMS is not responsible for rate changes or the quality of the accommodations. Hotels have varying cancellation or early checkout penalties; be sure to ask for details when making your reservation. Rates do not include taxes (currently 9.75%).

Best Western Boulder Inn, 770-28th Street, Boulder, CO 80303; 800-233-8469, 303-449-3800; fax 303-402-9118; $75 single and $79 double, $4.50 each additional person; rates include deluxe continental breakfast and free pass to nearby fitness club. Hotel is located 1 mile from the Engineering Center. Deadline for reservations is September 1, 2003. Be sure to check the cancellation policy when making your reservation.

Boulder Outlook Hotel (this property was the Ramada Inn until May 2003), 800-28th Street, Boulder, CO 80303; 303-443-3322; $69.99 single or double; rates include breakfast buffet. Hotel is located .6 mile from the Engineering Center. Deadline for reservations is September 1, 2003. Be sure to check the cancellation policy when making your reservation.

Millennium Harvest House, 1345-28th Street, Boulder, CO 80302; 800-545-6285, 303-443-3850; fax 303-443-1480; $108 single or double. Hotel is located .8 mile from the Engineering Building. Deadline for reservations is August 15, 2003. Be sure to check the cancellation policy when making your reservation.

Food Service

A list of local restaurants will be available at the registration desk.

Local Information and Map

Please visit the websites maintained by the University of Colorado at http://www.colorado.edu; for driving directions: http://www.colorado.edu/visit/directions.html; for a campus map: http://www.colorado.edu/directories/webmap/; and a live web-cam site at http://www.colorado.edu/webcam/. Also see the “Travel” section in this announcement.

Other Activities

Book Sales: Examine the newest titles from the AMS! Complimentary coffee will be served courtesy of AMS Membership Services and will be located in the lobby of the Mathematics Building.

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.

Social Event: The Department of Mathematics will host a reception in the Mathematics Building, Room 350, Friday, October 3, at 6:00 p.m.

Parking on Campus

One-day permits: One-day parking permits are sold for peripheral campus parking lots on a space-available basis. One-day permits cost $5 each and may be purchased from Parking Services, located on Regent Drive across from the Engineering Center. Call 303-492-7384 for more information.

Meters and hourly parking garage: Gray parking meters are $1 per hour and are enforced from 7:30 a.m. to 5:30 p.m. seven days a week.

Blue meters are for disabled parking patrons. The rate is $1 per hour and the meters are enforced from 7:30 a.m. to 5:30 p.m. seven days a week. Please note: Display of a state-issued disability license plate or permit is required at all times when using disability parking meters and spaces on campus.

Red meters are for service vehicles and are $3 per hour. Service meters are enforced 24 hours a day, seven days a week.

Yellow parking computers (The Pay-on-Foot stations) are $1 per hour.

The Euclid Auto Park (EAP) rate is $1.50 per hour and is located on Euclid Avenue off Broadway next to the UMC.

Registration and Meeting Information

The registration desk will be located in the lobby of the Mathematics Building. The desk will be open Thursday, October 2, and Friday, October 4, from 8:00 a.m. until 4:00 p.m. Fees are $40 for AMS or CMS members, $60 for nonmembers, and $5 for students/unemployed/emeritus, payable on site by cash, check, or credit card. The Invited Addresses will take place in the auditorium A2B70, MCDB Biology. All other talks are in the Engineering Center.
Travel
The nearest major commercial airport is the Denver International Airport.

**Directions from the airport:** You will fly in or out of Denver International Airport (DIA). Driving time between DIA and Boulder is approximately 60 to 90 minutes. From DIA follow Pena Boulevard (10 miles) south to I-70, and exit onto I-70 West. Follow I-70 West to I-270 West. I-270 merges into U.S. 36 West and takes you west to Boulder (about 23 miles). Exit at Baseline Road; turn left (west) to Boulder. Continue on Broadway (west) and you will see the campus on the right shortly after you pass Baseline Road. For personalized driving directions, go to [http://www.mapquest.com](http://www.mapquest.com).

**Car rental:** Special rates have been negotiated with Avis Rent A Car for the period September 25 to October 11, 2003, beginning at $23.99/day for a subcompact car at the weekend rate (the weekend rate is available from noon Thursday until midnight Monday). All rates include unlimited free mileage. Rates do not include state or local surcharges, tax, optional coverages, or gas refueling charges. Renter must meet Avis's age, driver, and credit requirements and return to the same renting location. Make reservations by calling 800-331-1600 or online at [http://www.avis.com](http://www.avis.com). Please quote Avis Discount Number B159266 when making reservations.

**SuperShuttle Boulder:** To take the SuperShuttle Boulder (tel. 303-444-0808), go to the Ground Transportation Desk in the baggage claim area and look for the signs for SuperShuttle Boulder. One-way fee is $19, and roundtrip is $36.

**Taxi information:** Taxi services are located outside doors 506, 507, and 510. Taxi companies serving Denver International Airport are: Metro Taxi, 303-333-3333; Yellow Cab, 303-777-7777; Freedom Cab, 303-292-8900. Fares from the airport are approximately $75 one way.

**Public transportation:** Commercial transportation is located at curbside, directly outside the baggage claim area. For more information on Colorado transportation, see [http://www.bouldercoloradousa.com/transportation.html](http://www.bouldercoloradousa.com/transportation.html).

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**Binghamton, New York**

**Binghamton University**

**October 11-12, 2003**

**Saturday-Sunday**

**Meeting #990**

**Eastern Section**

Associate secretary: Lesley M. Sibner
Announcement issue of *Notices* August 2003
Program first available on AMS website: August 28, 2003
Program issue of electronic *Notices* October 2003
Issue of *Abstracts*: Volume 24, Issue 4

**Deadlines**

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 19, 2003

**Invited Addresses**

Peter Kuchment, Texas A&M University, *Quantum graphs and their applications.*
Zlil Sela, Einstein Institute of Mathematics, *Diophantine geometry over groups and the elementary theory of free and hyperbolic groups.*
Zoltan Szabo, Princeton University, *Holomorphic disks and Floer homology for knots.*
Jeb F. Willenbring, Yale University, *Symmetric pairs.*

**Special Sessions**

Biomolecular Mathematics (Code: AMS SS A1), Thomas J. Head and Dennis G. Pixton, Binghamton University; Mitsunori Ogihara, University of Rochester, and Carlos Martin-Vide, Universität Rovira i Virgili.

Boundary Value Problems on Singular Domains (Code: AMS SS C1), Juan B. Gil, Temple University, and Paul A. Loya, Binghamton University.

Character Theory of Finite Groups and Algebraic Combinatorics (Code: AMS SS P1), Kenneth W. Johnson, Pennsylvania State University, and Eirini Polimenidou, New College of Florida.

Dowling Lattices: The 30th Anniversary (Code: AMS SS N1), Thomas Zaslavsky, Binghamton University.

Finite Solvable Groups and Their Representations (Code: AMS SS K1), Ben Brewster, Binghamton University, and Arnold Feldman, Franklin & Marshall College.


Homotopy Theory: Honoring Peter Hilton on His Eightieth Birthday (Code: AMS SS J1), Martin Bendersky and Joseph Roitberg, Hunter College (CUNY).
Infinite Groups and Group Rings (Code: AMS SS D1), Luise-Charlotte Kappe, Binghamton University, and Derek J. S. Robinson, University of Illinois, Urbana-Champaign.

Inverse Problems and Tomography (Code: AMS SS H1), Peter Kuchment, Texas A&M University, Leonid A. Kunyansky, University of Arizona, and Eric Todd Quinto, Binghamton University.

Lie Algebras, Conformal Field Theory, and Related Topics (Code: AMS SS E1), Chongying Dong, University of California Santa Cruz, and Alex J. Feingold and Gaywalee Yamskulna, Binghamton University.

Manifold Theory (Code: AMS SS L1), Erik K. Pedersen, Binghamton University, and Ian Hambleton, McMaster University.

Noncommutative Ring Theory (Code: AMS SS M1), Howard E. Bell and Yuanlin Li, Brock University.

Probability Theory (Code: AMS SS F1), Miguel A. Arcones, Binghamton University, and Evarist Gine, University of Connecticut.

Quasigroups and Loops (Code: AMS SS R1), Tuval S. Foguel, North Dakota State University, and J. D. Phillips, Washburn College.

Statistics (Code: AMS SS G1), Miguel A. Arcones, Anton Schick, and Qingling Yu, Binghamton University.

Topological Combinatorics (Code: AMS SS Q1), Laura M. Anderson, Binghamton University, and Edward R. Swartz, Cornell University.

Accommodations

Participants should make their own arrangements directly with a hotel of their choice. Special rates for the meeting are available at the properties listed below for the nights of Friday and Saturday, October 10 and 11. Room rates do not include the tax of 11%. When making reservations, participants should state they are with the American Mathematical Society conference at Binghamton University.

The AMS is not responsible for rate changes or for the quality of the accommodations. Hotels have varying cancellation or early checkout penalties; be sure to ask for details when making your reservation. This is Homecoming Weekend and hotels may sell out early; participants should make reservations as soon as possible.

Courtyard by Marriott, 3801 Vestal Parkway East, Vestal, NY 13850; 800-541-5800. Standard rooms are $99/single or double. Restaurant for breakfast, pool, spa, and exercise room on premises. Located about one mile from Binghamton University. Deadline for reservations is September 10. Be sure to check the cancellation policy when you make your reservation.

Holiday Inn at the University, 4105 Vestal Parkway East, Vestal, NY 13850-3551; phone: 607-729-6371 or 800-446-4329; fax 607-729-6407; standard rooms are $85/single or double. Restaurant, lounge, pool, and exercise room on premises; complimentary coffee service in lobby. Located across from the main entrance to Binghamton University. Deadline for reservations is September 13. Be sure to check the cancellation policy when you make your reservation.

Howard Johnson, 3601 Vestal Parkway East, Vestal, NY 13850-2232; phone: 607-729-6181 or 800-446-4356; fax 607-797-0309; $49.95/king-bedded room (one or two people), $59.95/two double beds (two people), $89.95/king-bedded room with Jacuzzi; extra person is $5. Restaurant, lounge, and pool on premises; deluxe continental breakfast is included. Located about 1/2 mile from Binghamton University. Deadline for reservations is September 10. Be sure to check the cancellation policy when you make your reservation.

Other Campus Area Accommodations:

Best Inn & Suites, 581 Harry I. Drive, Johnson City, NY; 607-770-9333.

Best Western of Johnson City, 569 Harry I. Drive, Johnson City, NY; 607-729-9194.

Hampton Inn & Suites Binghamton/Vestal, 3708 Vestal Parkway East, Vestal, NY 13850; 607-797-5000; fax 607-797-5610.

Red Roof Inns, 590 Fairview Street, Johnson City, NY; 607-729-8940.

Rodeway Inn, 900 Vestal Parkway East, Vestal, NY; 607-785-3311.

Skylark Motor Lodge, 240 Vestal Parkway East, Vestal, NY; 607-748-3392.

Vestal Motel, 1016 Vestal Parkway East, Vestal, NY; 607-754-8090.

An extensive list of Binghamton area accommodations is available on the departmental website. See http://www.math.binghamton.edu/ams03/ams-accom.html.

Food Service

Hinman Dining Hall on campus is open for a cafeteria-style lunch on Saturday and Sunday. The closest restaurants to campus (about a 10-minute walk) are at the northwest corner of the campus around the intersection of Bunn Hill Road and Route 434, just across from the Holiday Inn. There is also a restaurant in the Holiday Inn. A few more places are on Route 434 west of its intersection with Bunn Hill Road (toward the Howard Johnson). Many restaurants are just a five-minute drive from campus/hotels. Again, because of this popular weekend, restaurants will be crowded.

A handout of available restaurants in the campus region as well as the operating hours of Hinman Dining Hall will be provided at the meeting.

Local Information and Map

An excellent website maintained by our local hosts, with information about the meeting, driving directions, and a campus map, is at http://www.math.binghamton.edu/ams03/ams.html. The URL of Binghamton University is http://www.binghamton.edu. Also see the "Travel" section of this announcement.

Other Activities

Book Sales: Examine the newest titles from the AMS! Many of the AMS books will be available at a special 50% discount available only at the meeting. Complimentary coffee will be
Meetings & Conferences

served courtesy of AMS Membership Services. The AMS Book Sale will operate during the same hours as registration.

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.

Registration and Meeting Information

Binghamton University is located in the Greater Binghamton area in south central New York State. The Greater Binghamton area contains the narrow valley at the confluence of the Susquehanna and Chenango Rivers and the hills surrounding this valley. The campus is on the south side of Route 434 in Vestal, one mile west of the city of Binghamton. Binghamton is 45 miles southeast of Ithaca, 70 miles south of Syracuse, 190 miles north of Philadelphia, and 200 miles northwest of New York City.

All sessions will take place in the Lecture Hall Complex and the adjacent Student Services Wing.

Registration will take place in the Lecture Hall Complex on Saturday from 7:30 a.m. to 4:30 p.m., and on Sunday from 8:00 a.m. to noon. Registration fees are $40 for AMS or CMS members, $60 for nonmembers, and $5 for students/unemployed/emeritus, payable on site by cash, check, or credit card.

Packing

Packing is free (no parking permit required) in the parking lots on campus between 5:00 p.m. Friday and midnight Sunday, with the exception of specially marked meter lots and lots for the disabled. The locations of these parking lots is on the map (http://www.math.binghamton.edu/ams03/ams.html). The closest parking lots to the meeting are lots L and M2. From Monday to Friday, including holidays, visitors can park (for a small parking fee) in the regular lots and the visitors’ parking lots. Weekday parking permits for the regular lots can be purchased at the Information Booth situated at the entrance to campus. Cars without a parking permit parked in lots L and M2 from Monday to Friday may be towed. Rules about the parking places for the disabled should be respected. Visitors with disabled parking permits can park in the parking for the disabled when they follow the requirements above. See http://www.binghamton.edu/home/about/visit.html #parkingon.edu/ams03/ams.html for specifics on campus parking information and where to buy permits.

Social Events

An informal reception hosted by the Binghamton University Department of Mathematical Sciences to mark the eightieth birthday of Peter Hilton, Distinguished Professor Emeritus, will be held on Saturday from 5:30 p.m. to 7:30 p.m. in the Chenango Room (Science 1 Building). All participants are welcome to attend. Wine and soft drinks will be served.

Travel

By air: The area is served by the Binghamton Regional Airport, with flights provided by USAirways, Northwest, United Express, and Delta Connection. Taxi and limousine service are available to campus. Binghamton University is 70 miles (about 1 1/2 hours) from Syracuse and Scranton-Wilkes-Barre airports. Newark Airport is about 3 to 3 1/2 hours’ drive from Binghamton.

By car: The main U.S. interstates to the Binghamton area are I-81 and I-88. These interstates connect with NY-17. From NY-17 take Exit 70S (south) to Route 201 to campus. From I-81 take Exit 45 to Route 363 south to Route 434, following the road signs leading to Vestal. Please note that the college is in Vestal, not in Binghamton. The main entrance to the campus will be on your left.

Car rental: Special rates have been negotiated with Avis Rent A Car for the period October 4-19, 2003, beginning at $42.99/day for a subcompact car at the weekend rate (the weekend rate is available from noon Thursday until Monday at 11:59 p.m.). All rates include unlimited free mileage. Rates do not include state or local surcharges, tax, optional coverages, or gas refueling charges. Renter must meet Avis's age, driver, and credit requirements and return the same renting location. Make reservations by calling 800-331-1600 or online at http://www.avis.com. Please quote Avis Discount Number B159266 when making reservations.

Weather

The climate in the Binghamton area is pleasant in the fall. The normal temperatures for mid-October are a high of 59°F and a low of 41°F. However, fall temperatures are quite variable, so please be prepared for cooler or warmer weather. The fall foliage should be at its best that weekend.

Chapel Hill,
North Carolina

University of North Carolina at Chapel Hill

October 24-25, 2003

Friday-Saturday

Meeting #991

Southeastern Section

Assistant secretary: John L. Bryant
Announcement issue of Notices: August 2003
Program first available on AMS website: September 11, 2003
Program issue of electronic Notices: October 2003
Issue of Abstracts: Volume 24, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: July 19, 2003
For abstracts: September 3, 2003

Invited Addresses

James N. Damon, University of North Carolina, Scale-based geometry and its role for computer imaging.
Accommodations

Participants should make their own arrangements directly with the hotel of their choice. Special rates for the meeting are available at the properties shown below for the nights of Thursday, Friday, and Saturday, October 23–25. Room rates do not include the state and local tax of 12%, subject to change. Please cite the group name AMS/American Mathematical Society when making a reservation. Hotels have varying cancellation or early checkout penalties; be sure to ask details when making your reservation. The AMS is not responsible for rate changes or for the quality of the accommodations. Several conferences will occur at the same time as this meeting, so participants are urged to book their reservations early.

Best Western University Inn, Highway 54 East–Raleigh Road, Chapel Hill, NC 27515; phone: 919-932-3000; fax: 919-968-6513. Queen bedded rooms: $78 (one or two persons); two double-bedded rooms: $89. There is a lounge and outdoor pool on premises, continental breakfast is included, and restaurants are adjacent to premises. Located one mile from the University of North Carolina at Chapel Hill. Deadline for reservations is September 23, 2003. Be sure to check the cancellation policy when making your reservation.

Sheraton Chapel Hill Hotel, One Europa Drive, Chapel Hill, NC 27515; phone: 919-968-4900; fax: 919-968-3520. King-bedded rooms: $119 (one or two persons); two double-bedded rooms: $119. Full-service hotel with restaurant, lounge, and outdoor pool on premises. Located 2.5 miles from the University of North Carolina at Chapel Hill. Deadline for reservations is August 28, 2003. A map that includes the location of and information on other local hotels can be found at http://www.math.unc.edu/ContactInfo/hotels.html. Be sure to check the cancellation policy when making your reservation.

Food Service

The university is officially closed for fall break during this time, so there are no eating facilities open on campus. Several restaurants are located on Franklin Street within walking distance of campus. For a comprehensive listing of restaurants, visit the following websites: http://www.carolinachamber.org or http://www.chocvb.org. A handout of available restaurants with locations and operating hours will be available at the meeting.

Local Information and Map


Other Activities

Book Sales: Examine the newest titles from the AMS! Many of the AMS books will be available at a special 50% discount available only at the meeting. Complimentary coffee will
Meetings & Conferences

be served courtesy of AMS Membership Services. The AMS Book Sale will operate during the same hours as registration and will be held in Phillips Hall, Room 224.

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.

Registration and Meeting Information

The meeting will take place at the University of North Carolina at Chapel Hill, with sessions in Phillips Hall, Carroll Hall, Gardner Hall, Dey Hall, and Hanes Hall.

A campus map showing all the buildings where sessions and registration will take place can be found at http://www.unc.edu/tour/LEVEL_2/campusmap.htm.

Registration will take place in the Phillips Hall second floor hallway, at the front entrance of the building, on Friday from 7:30 a.m. to 4:30 p.m. and on Saturday from 8:00 a.m. to noon. Registration fees are $40 for AMS or CMS members, $60 for nonmembers, and $5 for students/unemployed/emeritus, payable on site by cash, check, or credit card.

Parking

University Visitor Parking Lots: Campus visitors may seek parking at one of three campus visitor lots. North Campus Lots: The Swain Lot is located off South Columbia Street on Cameron Avenue. The Morehead Planetarium Visitor Lot is on Franklin Street. Each of these lots operates from 7:30 a.m. until 12:00 a.m. Monday through Thursday, 7:30 a.m. until 2:00 a.m. Fridays, and 3:00 p.m. until 2:00 a.m. Saturdays and Sundays. Mid-campus Lot: The Highway 54 Visitor Lot is located on Highway NC-54, one block east of Country Club Road. Parking rates are $1/hour in the Highway 54, Morehead Planetarium, and Swain Visitor Lots. Overnight parking is not permitted in the Swain, Morehead Planetarium, or Highway 54 Visitor Lots. The Swain Lot is located on Cameron Avenue.

Please note that ungated parking lots (with the exception of restricted spaces) are free-of-charge after 5:00 p.m. on weekdays and all day on Saturday and Sunday. EXCEPTION: On weekend days having men's basketball or football games, as you might expect, parking is NOT free, and all lots near the mathematics building will likely be filled to capacity well in advance of the event. This should not be a problem during our meeting weekend.

Additional information can be obtained at http://www.dps.unc.edu/dps/visitor/pay_lots.htm. A map of visitor parking lots can be found at http://www.dps.unc.edu/tp/parking_map.pdf. (One note of caution: the visitor lot located in front of Hanes Hall no longer exists.)

Commercial Lots: Town of Chapel Hill parking lots are open from 7:30 a.m. to 11:00 p.m., Monday–Thursday, and from 7:30 a.m. to 2:00 a.m. Friday. These lots are at the corner of Rosemary and Henderson Streets (Rosemary Street is one block north of Franklin Street), corner of North Columbia and Rosemary Streets, corner of Church and West Rosemary Streets, 150 E. Rosemary Street, and 415 W. Franklin Street. The costs are $.65 per half hour (first 4 hours), $1.30 per hour (4-6 hours), and $1.80 per hour (over six hours).

WARNING: You may be tempted to avoid paying a fee by parking in the University Square parking lot, the Granville Towers parking lot, or other parking lots for customers of a business or tenants of a complex. DO NOT do so. You will be instantaneously towed in all probability. Businesses are vigilant about people who are not customers parking in their premium parking spots. In fact, most of the businesses very near campus have "security" guards whose only job is to spot students and campus visitors illegally parking and have their vehicles summarily towed.

Travel

By air: The nearest major commercial airport is the Raleigh-Durham International Airport (RDU). The airport is located approximately 20 miles from UNC-CH. Travel time from the airport to campus is about 30-40 minutes. Additional information about the airport can be found at http://www.rdu.com.

To get to campus by car, exit the airport and proceed directly onto I-40 West. Ignore the Highway 54 exit for Chapel Hill, and continue to the exit for Chapel Hill Blvd., U.S. Highway 15 and 501. Proceed south on U.S. 15/501. You will come to a fork in the road. Take the right fork onto Franklin Street off of U.S. 15/501. Proceed approximately four miles directly into campus town. You will be making a left onto Cameron Street in the heart of town. At the next turn signal, make a left onto Cameron Street. The mathematics department is in Phillips Hall, the second building on your right.

Listed here are some of the area taxi companies. Approximate rates for a one-way trip from RDU to the UNC-CH campus range from $30 to $35 for one or two people. There is an additional charge for three or more. There is no routine daily shuttle service. Taxis based in Chapel Hill are Airport and Intown Taxi, 919-942-4492; Airport Drop-Off Service, 919-942-9289; Airport Taxi, 919-942-4598; Chapel Hill Express Taxi, 919-941-6993 (flat rate of $25); Tar Heel Taxi, 919-933-1255. RDU Airport Taxi Service, 919-840-7277 is based at the airport. Additional information on taxis and shuttle services operated from RDU can be found at http://www.rdu.com/GroundTrans/groundtransgen.htm.

By car: Extensive driving directions to the UNC campus can be found at http://www.math.unc.edu/ContactInfo/directions.html.

Car rental: Special rates have been negotiated with Avis Rent A Car for the period October 17–November 1, 2003, beginning at $23.99/day for a subcompact car at the weekend rate (the weekend rate is available from noon Thursday until Monday at 11:59 p.m.). All rates include unlimited free mileage. Rates do not include state or local surcharges, tax, optional coverages, or gas refueling charges. Renter must meet Avis's age, driver, and credit requirements and must return to the same renting location. Make reservations by calling 800-331-1600 or online at http://
Automorphic Forms and Functoriality, James Cogdell, Oklahoma State University, and T. N. Venkataramana, Tata Institute of Fundamental Research.


Cycles, K-Theory, and Motives, Eric M. Friedlander, Northwestern University, Steven Lichtenbaum, Brown University, Kapil Paranjape, Institute of Mathematical Sciences, and Vasudevan Srinivas, Tata Institute of Fundamental Research.

Differential Equations and Applications to Population Dynamics, Epidemiology, Genetics and Microbiology, Bindhyachal Rai, University of Allahabad, Sanjay Rai, Jacksonville University, Terrance Quinn, Ohio University, Southern, and Sunil Tiwari, Sonoma State University.


L-Functions, Automorphic Forms and Cryptography, R. Balasubramanian, Institute of Mathematical Sciences, and K. Soundararajan, University of Michigan.


PDE and Applications, Susan B. Friedlander, University of Illinois, and P. N. Srikanth, Tata Institute of Fundamental Research.


Reductive Groups: Arithmetic, Geometry and Representation Theory, Vikram Mehta and R. Parimala, Tata Institute of Fundamental Research, and Gopal Prasad, University of Michigan, Ann Arbor.

Spectral and Inverse Spectral Theories of Schrödinger Operators, Peter David Hislop, University of Kentucky, and Krishna Maddally, Institute of Mathematical Sciences.

Bangalore, India
India Institute of Science
December 17-20, 2003
Wednesday-Saturday
Meeting #992
First Joint AMS-India Mathematics Meeting
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on AMS website: Not applicable
Program issue of electronic Notices: Not applicable
Issue of Abstracts: Not applicable

Deadlines
For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: September 1, 2003

Invited Addresses
R. Balasubramanian, Institute for Mathematical Sciences, Title to be announced.
George C. Papanicolaou, Stanford University, Title to be announced.
M. S. Raghunathan, Tata Institute of Fundamental Research, Title to be announced.
Peter Sarnak, Princeton University and New York University-Courant Institute, Title to be announced.
K. B. Sinha, Indian Statistical Institute, Title to be announced.
Vladimir Voevodsky, Institute for Advanced Study, Title to be announced.

Special Sessions
Algebraic and Geometric Topology, Parameswaran Sankaran, Institute of Mathematical Sciences, and P. B. Shalen, University of Illinois.

Phoenix, Arizona
Phoenix Civic Plaza
January 7-10, 2004
Wednesday-Saturday
Meeting #993
Joint Mathematics Meetings, including the 110th Annual Meeting of the AMS, 87th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the
Meetings & Conferences

National Association of Mathematicians (NAM), 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 2003
Program first available on AMS website: November 1, 2003
Program issue of electronic Notices: January 2004
Issue of Abstracts: Volume 25, Issue 1

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: August 6, 2003
For abstracts: October 1, 2003
For summaries of papers to MAA organizers: September 9, 2003

Joint Invited Addresses
Bonnie Berger, Massachusetts Institute of Technology, Title to be announced (AMS-MAA).
Stephen Wolfram, Wolfram Research Inc., Title to be announced (AMS-MAA).

Joint Special Sessions
Classical and Nonlinear Special Functions (Code: SS 9A), Peter A. Clarkson, University of Kent, Francisco Marcellan, Universidad Carlos III, and Peter A. McCoy, U.S. Naval Academy (AMS-SIAM).
Coding, Geometry, and Hyperbolic Dynamics (Code: SS 21A), Svetlana R. Katok, Pennsylvania State University, and Boris Hasselblatt, Tufts University (AMS-AWM).
History of Mathematics (Code: SS 6A), Joseph W. Dauben, Lehman College (CUNY), and David E. Zitarelli, Temple University (AMS-MAA).

Infinite Combinatorics and Inner Model Theory (Code: SS 22A), Matthew D. Foreman and Martin Zeman, University of California Irvine (AMS-ASL).

Mathematical Techniques in Musical Analysis (Code: SS 1A), Judith L. Baxter, University of Illinois at Chicago, and Robert W. Peck, Louisiana State University (AMS-MAA).
Mathematics and Education Reform (Code: SS 17A), William H. Barker, Bowdoin College, Jerry L. Bona and Naomi Fisher, University of Illinois at Chicago, Kenneth C. Millett, University of California Santa Barbara, and Bonnie Saunders, University of Illinois at Chicago (AMS-MAA-MER).

AMS Invited Addresses
Michael Aschbacher, California Institute of Technology, The status of the classification of the finite simple groups.
Hyman Bass, University of Michigan, Title to be announced (AMS Retiring Presidential Address).

Sun-Yang Alice Chang, Princeton University, Conformal invariants and partial differential equations (Colloquium Lectures).
Eric S. Lander, Whitehead Institute for Biomedical Research, Title to be announced (Josiah Willard Gibbs Lecture).
Gregory F. Lawler, Cornell University, Random planar curves and conformal invariance.
Eva Tardos, Cornell University, Title to be announced.
James A. Yorke, University of Maryland, Properties of "almost every" $C^1$ image of compact sets.

AMS Special Sessions
Arithmetical Algebraic Geometry (Code: SS 33A), Kirti Joshi, Minhyong Kim, and Adrian Vasiu, University of Arizona.
Coding and Design-Theoretic Applications of Polynomials (Code: SS 2A), Donald D. Mills, Southern Illinois University, Carbondale, Patrick S. Mitchell, Middle Western State University, and Kent M. Neuerburg, Southeastern Louisiana University.
Competitive and Adaptive Dynamics in Ecology (Code: SS 15A), Carlos Castillo-Chavez, Los Alamos National Laboratory, Yang Kuang, Arizona State University, Bai-Lian Li, University of California Riverside, and Horst R. Thieme, Arizona State University.
Continued Fractions (Code: SS 26A), James G. McLaughlin and Nancy J. Wyshinski, Trinity College.
Current Events (Code: SS 18A), David Eisenbud, Mathematical Sciences Research Institute and University of California Berkeley.
Discrete Dynamics and Difference Equations (Code: SS 16A), Saber N. Elaydi, Trinity University, Jim M. Cushing, University of Arizona, Gerassimos Ladas, University of Rhode Island, and James A. Yorke, University of Maryland, College Park.


Geometric Structures on Manifolds (Code: SS 31A), Tedi C. Draghici, Gueo V. Grantcharov, and Philippe Rubikbura, Florida International University.

Geometry and Combinatorics (Code: SS 32A), Michael J. Falk, Northern Arizona University, Eva-Maria Feichtner, ETH Zurich, and Dmitry N. Kozlov, Bern University.

Low-Dimensional Topology (Code: SS 7A), Tim D. Cochran, Rice University.


Mathematical Modeling in Neuroscience, Biomedicine, Genetics, and Epidemiology (Code: SS 14A), Steven M. Baer, Arizona
Tallahassee, Florida
Florida State University
March 12-13, 2004
Friday-Saturday

Meeting #994
Southeastern Section
Associate secretary: John L. Bryant
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 13, 2003
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Athens, Ohio
Ohio University
March 26-27, 2004
Friday-Saturday

Meeting #995
Central Section
Associate secretary: Susan J. Friedlander
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 26, 2003
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Invited Addresses
Mario Bonk, University of Michigan, Title to be announced.
Irene M. Gamba, University of Texas at Austin, Title to be announced.

Special Sessions
Algebraic Coding Theory (Code: SSH1), Marcus Greferath, San Diego State University, and Sergio R. López-Permouth, Ohio University.

Diffusion Equations and Control Theory (Code: SSA1), Sergiu Aizicovici and Nicolai Pavel, Ohio University.

State University, Ivo D. Dinov, University of California Los Angeles, and Frank C. Hoppensteadt and Hal L. Smith, Arizona State University.


Modern Function Theory (Code: SS 27A), Beth Schaubroeck, U. S. Air Force Academy, Peter L. Duren, University of Michigan, Ann Arbor, and John A. Pfaltzgraff, University of North Carolina at Chapel Hill.


Nonassociative Algebra (Code: SS 12A), Murray R. Bremner, University of Saskatchewan, Irvin R. Hentzel, Iowa State University, and Luiz A. Peresi, University of Sao Paulo.

Nonlinear Partial Differential Equations and Conformal Geometry (Code: SS 34A), Jie Qing, University of California Santa Cruz, and Yu Yuan, University of Washington, Seattle.

Nonlinear PDEs and Variational Problems (Code: SS 5A), David A. Hartenstine, University of Utah, Ahmed Mohammed, Ball State University, John M. Neuberger, Northern Arizona State University, and John W. Neuberger, University of North Texas.

Nonstandard Methods (Code: SS 8A), Matt Insall, University of Missouri at Rolla, Peter A. Loeb, University of Illinois at Urbana-Champaign, and David A. Ross, University of Hawaii.

Partial Differential Equations and Applications (Code: SS 24A), Xin Lu, University of North Carolina at Wilmington, Yan-Wei Qi, University of California Santa Barbara, Weiqing Xie, California State Polytechnic University, and Hong-Ming Yin, Washington State University.

Probability and Its Applications in Combinatorics and Algorithms (Code: SS 13A), Russell D. Lyons, Indiana University, and Yuval Peres, University of California Berkeley.

Smooth Dynamical Systems and Applications (Code: SS 30A), Qiu-dong Wang and Maciej P. Wojtkowski, University of Arizona.

Theory and Applications of Orthogonal Polynomials (Code: SS 25A), Mourad E. H. Ismail, University of South Florida, and Barry Simon, California Institute of Technology.

Time Scales and Applications (Code: SS 19A), Martin J. Bohner, University of Missouri at Rolla, Billur Kaymakcalan, Georgia Southern University, and Allan C. Peterson, University of Nebraska.

Topological Dynamics and Ergodic Theory (Code: SS 28A), Alicia Miller and Joseph Rosenblatt, University of Illinois at Urbana-Champaign.

Value Distribution Theory in Classical and p-Adic Function Theory (Code: SS 3A), Alain Escassut, Université Blaise Pascal, Ilpo Laine, University of Joensuu, and Chung-Chun Yang, Hong Kong University of Science and Technology.
Dynamical Systems (Code: SSCl), Patrick D. McSwiggen, University of Cincinnati, and Todd Young, Ohio University.

Groups, Representations, and Characters (Code: SSB1), Mark Lewis, Kent State University, and Thomas R. Wolf, Ohio University.

Linear Algebra and Its Applications (Code:SSF1), S. K. Jain, Ohio University, and Michael Neumann, University of Connecticut.

Probabilistic and Asymptotic Aspects of Group Theory (Code: SSK1), Rostislav Grigorchuk, Texas A&M University, Mark Sapir, Vanderbilt University, and Zoran Sunik, Texas A&M University.

Statistics and Probability (Code: SSG1), Maria Rizzo and Vladimir Vinogradov, Ohio University.


Wavelets, Other Multiscale Methods and Their Applications (Code: SSJ1), En-Bing Lin, University of Toledo, and Xiaoping Annie Shen, Ohio University.

Los Angeles, California
University of Southern California
April 3-4, 2004
Saturday-Sunday
Meeting #996
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

Invited Addresses
Dan Boneh, Stanford University, Title to be announced.
Maria E. Schonbek, University of California Santa Cruz, Title to be announced.
Paul Smith, University of Washington, Noncommutative algebraic geometry.
Christopher Martin Thiele, University of California Los Angeles, Title to be announced.

Special Sessions
Contact and Symplectic Geometry (Code: SSA1), Dragomir Dragnev, Ko Honda, and Sang Seon Kim, University of Southern California.

Lawrenceville, New Jersey
Rider University
April 17-18, 2004
Saturday-Sunday
Meeting #997
Eastern Section
Associate secretary: Lesley M. Sibner
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 17, 2003
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Invited Addresses
Sylvia Serfaty, New York University-Courant Institute, Title to be announced.
Wim F. Sweldens, Bell Laboratories, Title to be announced.
Gaoyong Zhang, Polytechnic University, Title to be announced.

Special Sessions
Algebraic Geometry and Mirror Symmetry (Code: SSD1), Ciprian Borcea, Rider University.
Automorphic Forms and Analytic Number Theory (Code: SSA1), Stephen Miller, Rutgers University, and Ramin Takloo-Bighash, Princeton University.
Geometry of Protein Modelling (Code: SSE3), Ileana Streinu, Smith College, and Jack Snoeyink, University of North Carolina at Chapel Hill.
Homotopical Physics (Code: SSG3), James Stasheff, University of North Carolina, and Thomas J. Lada, North Carolina State University.

Homotopy Theory, in honor of William Browder's 70th Birthday (Code: SSC1), Martin Bendersky, Hunter College, and Donald Davis, Lehigh University.
Strings and Branes (Code: SSF1), Thomas P. Branson, University of Iowa, and S. James Gates, University of Maryland.
Surgery, in honor of William Browder's 70th Birthday (Code: SSH1), Frank S. Quinn, Virginia Polytech Institute & State University.
Tomography and Integral Geometry (Code: SSB1), Andrew Markoe, Rider University, and Eric Todd Quinto, Tufts University.

Houston, Texas
University of Houston
May 13–15, 2004
Thursday–Saturday
Meeting #998
Sixth International Joint Meeting of the AMS and the Sociedad Matemática Mexicana (SMM).
Associate secretary: John L. Bryant
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

Invited Addresses
Sara C. Billey, University of Washington, Seattle, Title to be announced.
Peter Ebenfelt, University of California, San Diego, Title to be announced.
Theodore Stanford, New Mexico State University, Title to be announced.
Craig A. Tracy, University of California, Davis, Title to be announced.

Evanston, Illinois
Northwestern University
October 23–24, 2004
Saturday–Sunday
Meeting #1001
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: August 2004
Program first available on AMS website: September 9, 2004
Program issue of electronic Notices: October 2004
Issue of Abstracts: To be announced

Deadlines
For organizers: March 23, 2004
For consideration of contributed papers in Special Sessions: July 7, 2004
For abstracts: August 31, 2004

Invited Addresses
Ian Agol, University of Illinois at Chicago, Title to be announced.
Robert W. Ghrist, University of Illinois, Title to be announced.
Yuri Manin, Northwestern University, Title to be announced.
Paul Siedel, Imperial College-London and University of Chicago, Title to be announced.
Pittsburgh, Pennsylvania
University of Pittsburgh
November 6-7, 2004
Saturday-Sunday
Meeting #1002
Eastern Section
Associate secretary: Lesley M. Sibner
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: April 7, 2004
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Atlanta, Georgia
Atlanta Marriott Marquis
and Hyatt Regency Atlanta
January 5-8, 2005
Wednesday-Saturday
Joint Mathematics Meetings, including the 111th Annual Meeting of the AMS, 88th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association of Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL).
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: October 2004
Program first available on AMS website: To be announced
Program issue of electronic Notices: January 2005
Issue of Abstracts: To be announced
Deadlines
For organizers: April 5, 2004
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Bowling Green, Kentucky
Western Kentucky University
March 25-26, 2005
Friday-Saturday
Southeastern Section
Associate secretary: John L. Bryant
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

Newark, Delaware
University of Delaware
April 2-3, 2005
Saturday-Sunday
Eastern Section
Associate secretary: Lesley M. Sibner
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 2, 2004
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Mainz, Germany
June 16-19, 2005
Wednesday-Sunday
Second Joint AMS-Deutsche Mathematiker-Vereinigung (DMV) Meeting
Associate secretary: Susan J. Friedlander
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
San Antonio, Texas  
Henry B. Gonzalez Convention Center  

January 12–15, 2006  
Thursday–Sunday  
Joint Mathematics Meetings, including the 112th Annual Meeting of the AMS, 89th 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).  
Associate secretary: John L. Bryant  
Announcement issue of Notices: October 2005  
Program first available on AMS website: To be announced  
Program issue of Notices: January 2006  
Issue of Abstracts: To be announced  

Deadlines  
For organizers: April 12, 2005  
For consideration of contributed papers in Special Sessions: To be announced  
For abstracts: To be announced  
For summaries of papers to MAA organizers: To be announced  

New Orleans, Louisiana  
New Orleans Marriott and Sheraton New Orleans Hotel  

January 4–7, 2007  
Thursday–Sunday  
Joint Mathematics Meetings, including the 113th Annual Meeting of the AMS, 90th 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).  
Associate secretary: Susan J. Friedlander  
Announcement issue of Notices: October 2006  
Program first available on AMS website: To be announced  
Program issue of Notices: January 2007  
Issue of Abstracts: To be announced  

Deadlines  
For organizers: April 4, 2006  
For consideration of contributed papers in Special Sessions: To be announced  
For abstracts: To be announced  
For summaries of papers to MAA organizers: To be announced  

San Diego, California  
San Diego Convention Center  

January 6–9, 2008  
Sunday–Wednesday  
Joint Mathematics Meetings, including the 114th Annual Meeting of the AMS, 91st 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).  
Associate secretary: Michel L. Lapidus  
Announcement issue of Notices: October 2007  
Program first available on AMS website: November 1, 2007  
Program issue of electronic Notices: January 2008  
Issue of Abstracts: Volume 29, Issue 1  

Deadlines  
For organizers: April 6, 2007  
For consideration of contributed papers in Special Sessions: To be announced  
For abstracts: To be announced  
For summaries of papers to MAA organizers: To be announced  

Washington, District of Columbia  
Marriott Wardman Park Hotel and Omni Shoreham Hotel  

January 7–10, 2009  
Wednesday–Saturday  
Joint Mathematics Meetings, including the 115th Annual Meeting of the AMS, 92nd 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).  
Associate secretary: Lesley M. Sibner  
Announcement issue of Notices: October 2008  
Program first available on AMS website: November 1, 2008  
Program issue of electronic Notices: January 2009  
Issue of Abstracts: Volume 30, Issue 1  

Deadlines  
For organizers: April 7, 2008  
For consideration of contributed papers in Special Sessions: To be announced  
For abstracts: To be announced  
For summaries of papers to MAA organizers: To be announced  

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NOTICES OF THE AMS  
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Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Sproul Hall, Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu or lapidus@mathserv.ucr.edu; telephone: 909-787-3113.

Central Section: Susan J. Friedlander, Department of Mathematics, University of Illinois at Chicago, 851 S. Morgan (MC 249), Chicago, IL 60607-7045; e-mail: susan@math.nwu.edu; telephone: 312-996-3041.

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 at www.ams.org/meetings/.

Meetings:

2003
October 2-4 Boulder, Colorado p. 858
October 11-12 Binghamton, New York p. 860
October 24-25 Chapel Hill, North Carolina p. 862
December 17-20 Bangalore, India p. 865

2004
January 7-10 Phoenix, Arizona p. 865
March 12-13 Tallahassee, Florida p. 867
March 26-27 Athens, Ohio p. 867
April 3-4 Los Angeles, California p. 868
April 17-18 Lawrenceville, New Jersey p. 868
May 13-15 Houston, Texas p. 869
October 16-17 Nashville, Tennessee p. 869
October 23-24 Albuquerque, New Mexico p. 869
November 6-7 Pittsburgh, Pennsylvania p. 870

2005
January 5-8 Atlanta, Georgia p. 870
March 25-26 Bowling Green, Kentucky p. 870
April 2-3 Newark, Delaware p. 870
June 16-19 Mainz, Germany p. 870

2006
January 12-15 San Antonio, Texas p. 871
Annual Meeting
2007
January 4-7 New Orleans, Louisiana p. 871
Annual Meeting
2008
January 6-9 San Diego, California p. 871
Annual Meeting
2009
January 7-10 Washington, D.C. p. 871
Annual Meeting

Important Information regarding AMS Meetings
Potential organizers, speakers, and hosts should refer to page 108 in the January 2003 issue of the Notices for general information regarding participation in AMS meetings and conferences.

Abstracts
Several options are available for speakers submitting abstracts, including an 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 similarly coded material (such as accent marks in text) must be typeset in \LaTeX{}. To see descriptions of the forms available, visit http://www.ams.org/abstracts/instructions.html, or send mail to abs-submit@ams.org, typing help as the subject line; descriptions and instructions on how to get the template of your choice will be e-mailed to you.

Completed abstracts should be sent to abs-submit@ams.org, typing submission as the subject line. Questions about abstracts may be sent to abs-info@ams.org.

Paper abstract forms may be sent to Meetings & Conferences Department, AMS, P.O. Box 6887, Providence, RI 02940. There is a $20 processing fee for each paper abstract. There is no charge for electronic abstracts. Note that all abstract deadlines are strictly enforced. 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.)
June 5 - July 23, 2004: Joint Summer Research Conferences in the Mathematical Sciences, Snowbird, Utah.
New and Noteworthy Titles from the AMS

Cohomological Invariants in Galois Cohomology

Skip Garibaldi, Emory University, Atlanta, GA, Alexander Merkurjev, University of California, Los Angeles, and Jean-Pierre Serre, Collège de France, Paris

This volume addresses algebraic invariants that occur in the confluence of several important areas of mathematics, including number theory, algebra, and arithmetic algebraic geometry. The invariants are analogues for Galois cohomology of the characteristic classes of topology, which have been extremely useful tools in both topology and geometry. It is hoped that these new invariants will prove similarly useful. The authors are well-known experts in the field. In particular, Serre, who was awarded the Abel Prize by the Norwegian Academy of Science and Letters, is recognized as both a superb mathematician and a master author. The book also includes letters between Serre and some of the principal developers of the theory.

University Lecture Series, Volume 28; 2003; approximately 176 pages; Softcover; ISBN 0-8218-3287-5; List $35; All AMS members $28; Order code ULECT/28BK308

A History of Analysis

Hans Niels Jahnke, University of Essen, Germany, Editor

This volume is designed as a collective work of authors who are proven experts in the history of mathematics. It clarifies the conceptual change that analysis underwent during its development, while elucidating the influence of specific applications and describing the relevance of biographical and philosophical backgrounds. Special features are a separate chapter on the development of the theory of complex functions in the nineteenth century and two chapters on the influence of physics on analysis. The book presents an accurate and very readable account of the history of analysis. Each chapter provides a comprehensive bibliography. Mathematical examples have been carefully chosen so that readers with a modest background in mathematics can follow them.

Copublished with the London Mathematical Society. Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

History of Mathematics, Volume 24; 2003; approximately 432 pages; Hardcover; ISBN 0-8218-2623-9; List $89; All AMS members $71; Order code HMA/24BK308

For many more publications of interest, visit the AMS Bookstore: www.amsbookstore.org
FOURIER ANALYSIS AND ITS APPLICATIONS
A. VRETBLAD, Uppsala University, Sweden

This book presents the basic ideas in Fourier analysis and its applications to the study of partial differential equations. It also covers the Laplace and Zeta transformations and the fundamentals of their applications. The author has included discussions of more advanced topics such as the Gibbs phenomenon, distributions, Sturm-Liouville theory, Cesaro summability and multi-dimensional Fourier analysis, topics which one usually will not find in books at this level. Many of the chapters end with a summary of their contents, as well as a short historical note. The text contains a great number of examples, as well as more than 530 exercises. In addition, one of the appendices is a collection of the formulas needed to solve problems in the field.

2003/288 PP., 24 ILLUS./HARDCOVER/€56.95
ISBN 3-540-40665-2

HETEROGENEOUS MATERIALS I
Linear Transport and Optical Properties
HETEROGENEOUS MATERIALS II
Nonlinear and Breakdown Properties and Atomistic Modeling

M. SAHINI, University of Southern California, Los Angeles, CA

This book describes and discusses the properties of heterogeneous materials. The properties considered include the conductivity (thermal, electrical, magnetic), elastic moduli, dielectrical constant, optical properties, mechanical fracture, and electrical and dielectrical breakdown properties. A main goal of this book is to compare two fundamental approaches to describing and predicting materials properties, namely, the continuum mechanics approach, and those based on the discrete models. Volume I covers linear properties, while Volume II considers non-linear and fracture and breakdown properties, as well as atomistic modeling.

This multi-disciplinary book will appeal to applied physicists, materials scientists, chemical and mechanical engineers, chemists, and applied mathematicians.

1: 2003/736 PP., 130 ILLUS./HARDCOVER/€99.00
ISBN 3-540-40663-6
INTERDISCIPLINARY APPLIED MATHEMATICS, VOLUME 22

II: 2003/680 PP., 97 ILLUS./HARDCOVER/€96.00
ISBN 3-540-40662-8
INTERDISCIPLINARY APPLIED MATHEMATICS, VOLUME 23

SET THEORY
The Third Millennium Edition, Revised and Expanded
T. Jech, Mathematical Institute of the Academy of Sciences of the Czech Republic

Set Theory has experienced a rapid development in recent years, with major advances in forcing, inner models, large cardinals and descriptive set theory. The present book covers each of these areas, giving the reader an understanding of the ideas involved. It can be used for introductory students and is broad and deep enough to bring the reader near the boundaries of current research. Students and researchers in the field will find the book invaluable both as study material and as a desktop reference.

2002/760 PP., HARDCOVER/€129.00
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