


Notices

of the American Mathematical Society

May 2008

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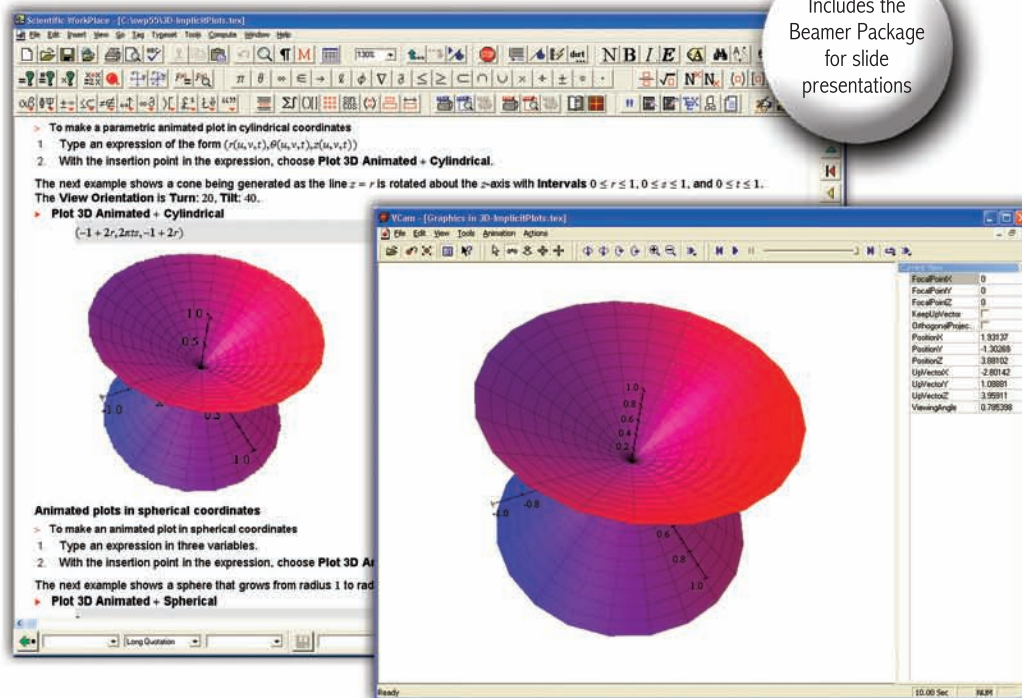

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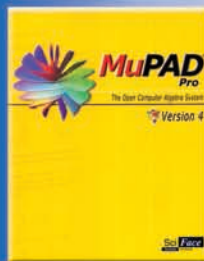


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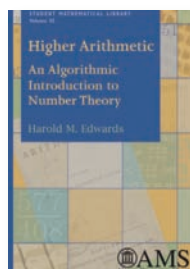
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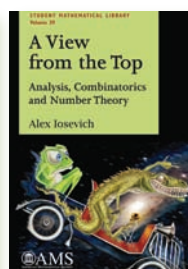
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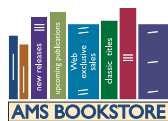
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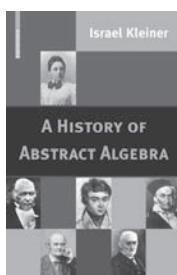
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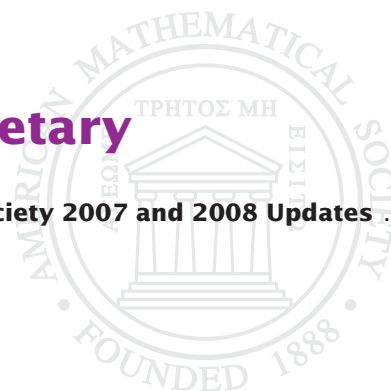
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Triumphs and Struggles in a Mathematics Classroom

I first met JR two years ago in his 9th grade year when I was student teaching. He was a small kid on a skateboard, Leonardo DiCaprio's Puerto Rican doppelganger. Funny, manipulative, and bright, he was a serious troublemaker, distracted and distracting in the classroom. In his 10th grade year, he doodled through his math class, chatted with other students, smiled a lot and rarely did any math. But he had brief moments of brilliance, unpredictably spouting out articulate explanations for his mental solutions to problems. And then he got held back a grade.

I was a little bit terrified when I saw his name on my roster for 10th grade this year. Students who have been held back are often unsuccessful in their repeating years, powerfully influencing the social system of their classes with negative and disruptive attitudes. JR had been pretty difficult even when he was on track. I was worried.

To my surprise, as the school year started, JR was the delight of our entire class. He was outspoken, clever, and funny. He could be distracting, but he was often a model mathematics student: he worked hard, explained his ideas well, participated in the class discussion every day, turned in his homework, and enjoyed class. He raised the bar for intelligence, participation, and work in our classroom. His attitude and humor brought joy to the mathematics that we explored and brought out the best in me as a teacher. His presence made the classroom a better place to be.

I teach algebra and geometry now at the same small school where I first met JR. New Design High School is a holistic college prep school on the Lower East Side of Manhattan devoted to the success of students whose educations have not heretofore prepared them for college or life in general. Our students arrive at high school terrified of fractions, struggling with signed numbers, unused to homework, and sometimes having forgotten the basics of multiplication and division.

Nevertheless I work to promote discovery, inspire inquiry, and cultivate a deep understanding of the whys of the mathematics we study. I ask my students to develop independence in problem-solving by working in groups and asking each other questions before they ask me. I ask them to discuss and debate their ideas, to justify their mathematical thinking, and explain the mathematical thinking of others. I ask them to be fearless about making mistakes and trying strategies they aren't sure of. It is difficult for them; they want to know if they are right or wrong, they are uncomfortable with not knowing, they get frustrated when I don't tell them the answer right away.

But the result is that in class my students can explain not only procedurally how to solve an equation for an unknown but also why and how they are using inverse operations to do so. They can determine if three given lengths can form a triangle and also explain how the triangle inequality supports their reasoning. They challenge each other to justify their thinking when discussing a solution, they are articulate in their presentations at the board, and their leadership and confidence has created a community in which I am just one of many resources for them in a room full of teachers. My students are empowered to come up with their own ideas, and they literally applaud the ideas of others. They have a good time doing mathematics—which is why those of us who love mathematics do it in the first place.

But also, the achievement and learning I observe in my classroom does not accurately predict either the success my students have on standardized tests, or the kinds of choices they make in their lives outside of school. As the school year progressed, JR's grades fell. He missed school for court dates regarding graffiti charges, failed the first marking period, and ended up transferring to a school in New Jersey. I hope he has found a fresh start there. I hope he finds success. I hope that he brings his will and imagination to his new community. I hope he is one of those popular brilliant kids that make it cool to be good at school.

JR may still fall through the cracks. The work being done in my classroom may not yield success that can be seen in standardized testing. Perhaps my work is not enough, or perhaps the tests are assessing something different from what I am teaching. Perhaps my students' lack of strong mathematics background prior to high school simply demands more time to prepare them. Regardless, I intend to enliven mathematics for my students, inspire their leadership, cultivate their problem solving, and induct them into the community of mathematicians. Whatever JR does in his future, he has been a mathematician, excited in his moments of discovery and brave in his leadership in the classroom. I hope he finds a way to return to it.

—Jesse Johnson
*New Design High School, New York City,
Math for America Newton Fellow*

Paying for Paid Referees

In the May and October issues of the *Notices* (vol. 54, pp. 589 and 1119), Michael Fried proposes that mathematical journals should pay referees. Of course, it would be nice if we referees (yes, I was and also am referee of many papers) would get paid and good referees certainly deserve it. But where would the money come from? Mathematicians have been making big efforts (even leaving editorial boards in protest for high prices), with strong support from the AMS and its *Notices*, to make journals less expensive, so libraries (and individuals) can afford them. Clearly, paying referees would make journals considerably more expensive.

—Janos Aczel
Distinguished Professor Emeritus
University of Waterloo, Ontario
jdaczal@math.uwaterloo

(Received December 23, 2007)

The Mathematical Research Communities

I read the report “Building a research career” (*Notices*, Feb. 2008) with amusement and skepticism. What amused me was the yuppiespeak: “...provide them with structured activities aimed at building social and collaborative networks...” What next? Should a young mathematician consider investing in a Rolodex? Lest I appear to cavil at a well-intentioned idea, let me clarify that facilitating bonds between young researchers is a superb idea and one that is overdue. What makes me pause is the jamboree aspect of the Mathematical Research Communities (MRC) idea.

Firstly, consider this: “Careful choices of conference topics over the years will ensure that a wide range of mathematical areas is covered.” Really? Given that two of the three MRC conferences in 2008 involve a measly 20 participants, one fears that either: (a) Each MRC Conference would have to be considerably more narrowly defined in order to attain critical mass with a mere 20–25 participants; or (b) An ostensibly

broadly conceived MRC Conference would actually devolve into catering (pandering?) to a fashionable clique within the broadly-defined subject area. Whether or not scenario (b) ever arises, it seems to me that a majority of peridocctoral researchers will have to make their way into the world in the traditional style while they wait for a “structured activity” to come their way.

There is a strong undercurrent of passion and risk-taking inherent in doing good mathematics. While most math today is collaborative in nature, any aspiring mathematician has to learn how to independently conceive of a research project. This necessitates a certain loneliness in which the mathematical individuality can develop, and the risk of crashlandings as the young mathematician learns to invent. The MRC would, I am sure, nurture a happy school of professionals, all of whom would know each other, and would be on first-name terms with a clutch of conspicuous and energetic senior mathematicians. But are we convinced that the quantum of self-reliant mathematicians and well-conceived research projects would be markedly smaller if the MRC never existed?

If all this did not involve public money—and the imperative to be efficient with it—I would not be writing this. I too have been in collaborations, in my peridocctoral years, with peridocctoral colleagues. We got together because of an affinity of interests, and *not* because we were put into a talented persons’ summer camp by the AMS. Yes, we would definitely have appreciated access to funds that would have enabled us to meet face-to-face at crucial junctures when the collaboration needed it. Perhaps, if the MRC had recognized this type of need, it could have spread its money among a larger number of needy cases. After all, it costs less per capita when one unit of a research group is funded to fly, say, once a year, to meet up with a (static) colleague than to host a jamboree wherein 100 percent of a small target group has to be flown/fed/housed.

Of course, the first idea does not make a splash. It is disheartening that the AMS nowadays feels compelled, in so many things, to make a splash.

—Gautam Bharali
Indian Institute of Science
bharali@math.iisc.ernet.in

(Received February 2, 2008)

My Teach for America Experience

John Haws recommends that young mathematicians apply to Teach For America, a national non-profit that places teachers in some of the highest needs school districts in the country. In his article, he shares his successful experience in “making a difference” in the lives and educations of the students he taught, as well as emphasizing that he benefited from “the insight, skills, and confidence” that he gained while teaching in the Rio Grande Valley.

I am following a trajectory similar to his: as I was finishing my undergraduate education, I successfully applied to Teach For America, taught in a high school in Newark, NJ, for three years, and am now pursuing an M.S. in math.

To those who, after reading Mr. Haws’ article, would apply to Teach For America, I would offer some words of warning. Nothing in my life, before or since, left me so physically, emotionally, or spiritually drained as any one day of teaching, let alone the struggle to persist week after week. Furthermore, I feel as if nothing could have prepared me for the task I took upon myself. In November of my first year of teaching, the word at the forefront of my mind was inadequacy; specifically, my own inadequacy at teaching math to the young people in my classes.

Furthermore, when I ultimately left my school, I had very few illusions about the amount of change that my presence had brought about. When I started in September of 2004, I was the teacher with the least seniority (not to mention virtually no training

in math education). Had I remained another year, in September of 2007 I would have been the math teacher who had been at the high school for the third longest amount of time, out of nine teachers. Furthermore, my department chairperson was frantically searching for four math teachers for the following year. All of the above is to suggest that the problems that faced the school where I taught, and which are replicated in hundreds of schools across the country, can at best be alleviated, and then, only slightly, by any one person's short-term commitment.

If I were in a position to recommend a course of action to young mathematicians, I would plead with them to become involved in math education. If Teach For America were the vehicle that young mathematicians choose to begin teaching, I would support their choice because, undoubtedly, without the committed participation of a sizeable part of the mathematical community, the problems faced by our youth cannot be solved. But I would also caution the young mathematicians that they should not let themselves be fooled. The problems that need solving have something to do with innovative teachers and curricula, as Haws suggests, but they have much more to do with a set of institutions that systematically direct resources away from the vulnerable and towards the powerful in our society. Teach For America never names these institutions, so let me do that here: institutional racism, segregation, capital liberalization, the military-industrial complex. Young people who commit to working to ensure that schools everywhere are going to have the teachers they need ought to be aware that those are the obstacles they are fighting to overcome.

I don't say this to make the reader despair that nothing can be done, but as a matter of intellectual honesty, and as an encouragement to analyze the full scope of the challenge and its implications.

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Interview with Martin Davis

Martin Davis is one of the world's outstanding logicians. He was born in 1928 in New York City, where he attended City College and was influenced by Emil L. Post. Early on, Davis came under the spell of Hilbert's Tenth Problem: Does there exist an algorithm that can, given an arbitrary Diophantine equation, decide whether that equation is solvable? Davis's Ph.D. dissertation, written at Princeton University under the direction of Alonzo Church, contained a conjecture that, if true, would imply that Hilbert's Tenth Problem is unsolvable. In rough terms, the conjecture said that any computer can be simulated by a Diophantine equation. The implications of this conjecture struck many as unbelievable, and it was greeted with a good deal of skepticism; for example, the conjecture implies that the primes are the positive part of the range of a Diophantine polynomial. Work during the 1950s and 1960s by Davis, Hilary Putnam, and Julia Robinson made a good deal of headway towards proving the conjecture. The final piece of the puzzle came with work of Yuri Matiyasevich, in 1970. The resulting theorem is usually called either DPRM or MRDP (Matiyasevich favors the former and Davis the

latter). The unsolvability of Hilbert's Tenth Problem follows immediately.



Martin Davis

(the book also appeared under the name *Engines of Logic*; it was reviewed by Brian Blank in the May 2001 issue of the *Notices*).

What follows is the edited text of an interview with Martin Davis, conducted in September 2007 by *Notices* senior writer and deputy editor Allyn Jackson.

Early Years

Notices: *I'd like to start at the beginning of your life. Could you tell me about your family? Were you an only child?*

Davis: I had a younger brother who died in childhood. He was 8 and I was 13.

Notices: *That must have been very hard on your family.*

Davis: It was devastating. My parents grew up in Poland; they were Polish Jews. They knew one another casually in Lodz but met again in New York and married. We were hit very hard by the Great Depression and were really quite poor. For a while we were on what was then called "home

relief" and later called welfare. I went to school in the New York public school system, benefiting from the Bronx High School of Science. Later I went to City College where the tuition was free. I was not an athletic boy at all. I was a bookish boy. And I got beat up a lot by more athletic boys! I got interested in science quite early. I wanted to be a paleontologist, then I wanted to be a physicist, and finally I fell in love with mathematics.

Notices: *What were your early influences as a child or teenager in pushing you toward math and science? Was it teachers, or books?*

Davis: It was certainly more books. I read Bell's *Queen of the Sciences*, and was delighted by another book that, as a mature mathematician I

thought rather awful, *Mathematics and the Imagination*, by Kasner and Newman. At high school I met a lot of boys who had similar interests, and we bounced off one another. Then at City College, there were two people who had a big influence on me. One was Emil L. Post, who was a great logician and a very direct influence on the direction of my work, and Bennington Gill, who was really a very inspiring teacher, even though his mathematical productivity pretty much ended with his dissertation.

Notices: *Can we go back to the Bronx High School of Science? What was it like to be a student there at that time?*

Davis: It was during the Second World War, and that dominated the atmosphere in many ways. The principal went to Washington and talked to various people in the government and came back with the idea of what were called “pre-induction courses”, to modify the curriculum in the direction of subjects that would be useful when we were taken into the army, which, it was assumed, we would be. So for example, light and sound were deleted as topics from the physics curriculum, and what was thrown in to replace them was a lot more work on alternating current circuits and things of that sort. We were told that these were very significant things and that a great deal of attention would be paid once we were in the army due to the fact that we had had these courses—which of course was a lot of nonsense.

The faculty adviser for the Mathematics Club thought that we should do things that were more useful, so suddenly we spent the semester talking about navigation and spherical trigonometry.

Notices: *Did you find navigation interesting?*

Davis: I found it boring! I remember I gave a talk about dead reckoning, which was the technique that Columbus used. I was also president of the Astronomy Club for a while.

Notices: *You were clearly very motivated toward education. How much education did your parents have?*

Davis: They had no formal education. They went to night school courses for immigrants to learn English. My father was really a remarkable man. His life would have been very different under other circumstances. He worked hard to support the family, but he was a very gifted artist. Recently we donated thirteen of his paintings to the YIVO Institute for Jewish Research in New York; they formed a cycle inspired by events in Europe during the Second World War, especially by what was happening to the Jews.

Notices: *So your parents encouraged you to get an education.*

Davis: Oh yes, that was the given in Jewish families in the Bronx. They imagined I would become a doctor or a lawyer, and they were at a loss to know what to make of the direction my interests were taking. They simply didn’t know what it was and were worried I would starve in a garret! And of course an academic career for a Jew in America was a very difficult thing before the war. That changed dramatically after the war.

Notices: You mentioned the influence on you of Emil Post. Can you tell me about him and the changes that were going on in logic at that time, with the work of Church and Turing?

Davis: Goodness, that’s a lot! You know, I edited Post’s collected works [6] and wrote an introductory article on his life and work. I gave a talk about him here at the Logic Colloquium just a couple of weeks ago. We could spend the whole interview talking about that! Briefly, Post was a bit older than Church and certainly older than Turing, and so he came into these ideas well before them, in the early 1920s. From one point of view, he really discovered all the main results well before them. From another point of view, he never got his formulations to the point where they would have been acceptable for publication. Post’s own comment on this I find very poignant. He was always writing postcards to people and sent one to Gödel shortly after they met. He apologized for what he thought was his over-exuberant behavior with Gödel and then said about his own earlier contributions, “The best I can say is that in 1921 I would have proved Gödel’s theorem if I had been Gödel.”

Notices: *So he knew of Gödel’s result but wasn’t able to carry it through himself.*

Davis: The problem was that, in effect, Post bumped up against what later was called Church’s Thesis, or the Church-Turing Thesis, and didn’t see how to justify it properly. His formulation was fundamentally based on the assumption of the adequacy of Russell and Whitehead’s *Principia Mathematica*, for anything that could be done mathematically, whereas Gödel’s theorem itself partly contradicted that. So Post decided that what was needed was something he called “psychological fidelity”, which would somehow encompass any processes that the human mind could develop. And then he just went totally off the track, in my opinion, in how to develop such a thing. In effect, what he was looking for is what Turing did to analyze the notion of a computation, but he didn’t find it. Post had other difficulties.



One was that he suffered from bipolar disease. He was a manic-depressive and had episodes that were totally debilitating. Also, he faced a climate of mathematical opinion that was somewhat hostile to the whole enterprise of mathematical logic. For example, some of the important results in his dissertation were not accepted for publication until they finally appeared a decade later, as an *Annals* study.

I had done calculus somewhat on my own before coming to City College, so I started with elective advanced courses right at the beginning. In my sophomore year, there was a course that Post gave in real variable theory, which was quite famous among City College students. But because of the war it wasn't going to be given. So five of us went to him and asked whether he would be willing to give



it as what was called an honors course, in effect a reading course. He agreed, and we met once a week for a two-hour period. Every one of the five of us would tell you that this was an emotionally wringing experience!

Notices: *Why?*

Davis: The pedagogical method was the following. We had a textbook, which was awful; it was just full of mistakes. So Post had prepared about forty pages of material correcting and supplementing the text. Each week we were given an assignment for the next week in which there was a certain amount of text with accompanying notes that we had to read, absorb, and learn. Then what would happen during the two-hour period is that he would randomly call on us to go to the blackboard, with no notes, and expound parts of the text. This was very hard! But it was great training.

Notices: *Did some of these five other than you go on in mathematics?*

Davis: All of us.

Notices: *So maybe he did something right!*

Davis: Well, at that time, the mathematical talent at City College was just incredible. Everywhere you go, you find mathematicians who were graduates of City College.

Notices: *Who do you remember in particular?*

Davis: In the group in that real variable class, there was Murray Rosenblatt, who is a probabilist at La Jolla. Also Gerry Freilich, who wrote a fine dissertation and was on the faculty at Queens College; Julie Dwork, who was at Burlington; Seymour

Ginsburg, who became a computer scientist and an expert on context-free languages. People who arrived a little later included Donald Newman, Jack Schwartz, Leon Ehrenpreis, and Bob Aumann, 2005 Nobel Laureate in economics. I should also mention John Stachel, who is now an Einstein scholar at Boston University. John was a broadly educated physics major with strong mathematical interests. I learned a lot from him about various things. His father was an important member of the American Communist Party, which in those years was a tricky business. During the McCarthy years, which of course came later, John was quite isolated. One of our fellow mathematics students, Herman Zabronsky, wrote a dissertation at Penn, and later got a job at a national lab, Oak Ridge or Los Alamos. Around Christmas week he came back to New York, and a bunch of us were going to get together somewhere, and he stipulated that John Stachel shouldn't be there. He said, "If John Stachel is there I'm going to flunk the lie detector test"—to give you an idea of the atmosphere!

At City College, there was a required course for science majors in logic and scientific method, given in the Philosophy Department. I took that course in my freshman year, and it turned out to be a beginning course in symbolic mathematical logic. So I learned the basics of propositional calculus and quantification theory as a freshman in that philosophy course. There wasn't any meta-theory, but still it meant I knew the basic material very early. I read in Bell's *Development of Mathematics* that Post in his dissertation had developed a many-valued logic. So I knew that he worked in the area of logic. His real variable theory course certainly touched on topics close to logic. Also, I had heard about Gödel, and there was a copy in the City College library—undoubtedly because Post put it there—of the mimeographed notes that Kleene and Rosser had taken of Gödel's 1934 lectures at the Institute for Advanced Study. The notes were published in reasonable form only much later, first in my anthology *The Undecidable* [5], and then in Gödel's *Collected Works*. So I took it out of the library and tried to make sense of it quite early, and I associated all that with Post—I don't exactly know why or how, but somewhere along the line, I started talking with Post regularly. He gave me a batch of his reprints. John Stachel and I asked Post if we could do a reading course with him in mathematical logic. That was in my junior year. We didn't get very far in the course, because Post had one of his breakdowns after a few weeks. He had just made an important discovery regarding incomparable degrees of unsolvability, and the excitement was too much for him and pitched him over into the manic phase. We didn't see him again for some months.

Notices: *You are mentioning Gödel and Post, who had mental problems. And there are others,*

for example, Cantor. Do you think there is any association between math and mental illness?

Davis: Probably. Particularly logicians seem to be prone to it! In fact, I had a joke with John Stachel. Post had lost an arm in a childhood accident. Hans Reichenbach, who was sort of a logician and a philosopher, came to City College for a semester to give some courses, and he was essentially stone deaf. Church had vision problems—he had bad cataracts, which in those days was much more of a problem than it is today. So the joke was that, if I'm going to be a logician, maybe I should give up a finger now, instead of something worse!

By the time I graduated City College, I knew I wanted to be a logician. I had written a term paper for an advanced logic course in the Philosophy Department, which in a way was a first draft of part of what was later my dissertation. I went to Princeton to work with Church, but I was really much more influenced by Post than by Church.

Culture Clash in Princeton

Notices: How was it for you as a graduate student at Princeton?

Davis: I was pretty unhappy there, all in all. Let's say there was a very heavy culture clash. I grew up in a working class Jewish family in the Bronx. At the City College cafeteria we had our "mathematician's table" where we argued and learned from each other. In that noisy atmosphere we had to speak loudly just to be heard. Besides in our culture, a loud voice simply indicated excitement. I spoke at the Logic Seminar in Princeton shortly after I arrived. Leon Henkin's comment on my talk was that it was too loud. Let me say without going into great detail that I certainly felt a culture clash. I finished my degree in two years and was very glad to leave when I was done.

Notices: Leon Henkin was a student there at the same time?

Davis: Earlier. He was a postdoc my first year.

Notices: What kind of person was Alonzo Church?

Davis: Alonzo Church was a shy, retiring man, extremely pedantic, very compulsive in his habits. A famous, quite true story about him is the thorough way he would clean the blackboards every day before his lecture. One day some of us students cleaned the board before he came in. This had utterly no effect on his behavior; he cleaned it in exactly the same way. I have often thought that, when he was younger, when Kleene and Rosser were in his classes and he was developing lambda calculus, he must have had a much more spirited lecture style. His lecture style was slow, tediously slow.

Notices: Who else was there among your student colleagues when you were at Princeton?

Davis: My good friend from New York and roommate later, Melvin Hausner, who was a

student of Bochner's there and was later a colleague at NYU. Washnitzer, who later was on the faculty at Princeton, was an older student, and to some extent acted as a mentor. Leo Goodman, who is in the National Academy, is a sociologist and a statistician who was part of my class. And of course John Nash was a fellow student when I was there. We didn't get along at all. If you look at Sylvia Nasar's biography of Nash [7], I make a brief entrance.

Notices: I read the book, but I don't remember what you had to say about Nash.

Davis: She quotes me as saying that Nash once asked me whether I grew up in a slum. Serge Lang was also a fellow student in Princeton.

Notices: What was he like in those days? Was he as intense and committed as he was later on?

Davis: I knew him as being very eager to have Emil Artin take him on as a student and very worried that that might not happen. I always had friendly relations with him.

Notices: Was it when you were a graduate student that you got interested in Hilbert's Tenth Problem? Or was that earlier?

Davis: Well, it was Post's fault. An important paper of Post's that was published in 1944 mentioned Hilbert's Tenth Problem and said that it begged for an unsolvability proof. Most of my mathematical career I have had an ambivalent relationship with the problem. On the one hand, it fascinated me and pulled me in, seduced me, and on the other hand I felt that it was to a very large extent a number theory problem, and I was no number theorist. When I was a graduate student I kept thinking I should stay away from it, because I needed to write a dissertation! I had one topic that I knew was going to be easy because it was completely untouched territory—what was later called the hyperarithmetical hierarchy—and that topic was one part of my dissertation. But the dissertation also included my first contribution to Hilbert's Tenth Problem—what later was called the Davis normal form.

Notices: Post said that it needed an unsolvability proof.

Davis: It wasn't hard to see.

Notices: Why was that?

Davis: Well, people have been working on Diophantine equations since Diophantus, and what is there to show for it? A lot of special cases. The idea that there should be a general algorithm that would tell you whether any Diophantine equation had a solution or not? That's super-utopian. Once it becomes possible to consider that problems of that kind could be solved negatively, Hilbert's Tenth Problem was a natural candidate. When Post said it begged for an unsolvability proof, he was exactly right, but that didn't mean one knew how to construct such a proof.

What I proposed in my dissertation, and went a small way towards proving, was a much stronger statement from which the unsolvability would follow: That anything that can be done by an algorithmic process could also be defined by a specific Diophantine equation. Yuri Matiyasevich later referred to this as “Davis’s daring hypothesis”. I had a reason for thinking this might be true, even though the general opinion for years was that it wasn’t, until it was proved finally by Yuri giving the last step. The experts all thought it was false. It has to do with recursively enumerable sets, which are sets that can be listed by an algorithm. The basic result from which unsolvability results follow is that there are recursively enumerable sets that are not computable—for which there is no deciding algorithm. My conjecture was that every recursively enumerable set has a Diophantine definition. The class of recursively enumerable sets has the key property that while it is closed under union and intersection, it is not closed under complementation: There is a recursively enumerable set whose complement is not recursively enumerable. I could prove in a nonconstructive way, and it was easy, that the Diophantine sets, the sets definable by Diophantine equations, have the same properties: They are closed under union and intersection but not under complementation. That made me think that they might be the very same class—which turned out to be true.

Notices: *But there was skepticism that this was true. What was the reason for the skepticism?*

Davis: It seemed like a stretch that something as simple as polynomial equations could capture the full gamut of things that are algorithmic. Ten years after my dissertation there was a theorem of me and Hilary Putnam and Julia Robinson [1] that proved the analogue of that conjecture for exponential Diophantine equations—that is, we proved the conjecture under the assumption that you allow the equations to have variable exponents. It followed from earlier work of Julia Robinson that the full conjecture would be a consequence of what Hilary and I called “Julia Robinson’s Hypothesis”, that there is a polynomial Diophantine equation whose solutions grow exponentially as



a function. Yuri finally proved this hypothesis ten years later by giving an explicit example. Georg Kreisel reviewed our paper for *Mathematical Reviews*. In his review, he didn’t think it was worthwhile noting that we had shown that my conjecture, and consequently the unsolvability of Hilbert’s Tenth Problem, would follow from the Julia Robinson Hypothesis, but he did express his opinion that these results were likely not to have any connection with Hilbert’s Tenth Problem. You can imagine why I like quoting that!

Notices: *Why did your conjecture seem hard to believe?*

Davis: I can tell you what Kreisel’s reason

was. One of the things that follows from my conjecture-become-a-theorem is that not only is every algorithmic process definable by a Diophantine equation, but it’s also definable by a Diophantine equation with a bounded number of variables. In fact, later work of Julia and Yuri brought the number of variables down to 9. And such a bound was thought to be totally implausible.

Notices: *It does seem implausible, doesn’t it? It’s really surprising.*

Davis: Yes! The point is that people talked about polynomial equations, but what they were thinking of was equations of degree maybe 3 or 4, and with maybe four or five unknowns. The idea of equations of arbitrary degree and arbitrary number of unknowns—people had no intuition or experience with those. It was too hard.

Hilary Putnam had a cute trick that turns any Diophantine set into the positive part of the range of a polynomial. When I was talking to number theorists before Yuri’s work, I would say, “Do you think the prime numbers could be the positive part of the range of a polynomial?” And often I would get the following answer: “No, that couldn’t be. Give me a half hour and I’ll prove it.”

Notices: *A half hour! That’s all they required?*

Davis: Yeah!

Notices: *But it is counterintuitive, isn’t it?*

Davis: Yes, sure it is!

Notices: *What gives Diophantine equations this power? What is the richness there?*

Davis: There are two pieces of richness. There is the richness that reaches to exponentiation, that the set of triples a , b , and c , such that $a = b^c$, has a Diophantine definition. Logically speaking, that should have been the first thing proved, but it was the last. Way back in the 1950s, Julia started working on this and showed it would follow from what Hilary Putnam and I later called the Julia Robinson Hypothesis, which as I said wasn't proved until Yuri did it in 1970. The second piece of richness is, once you have exponentiation, going all the way. In the case of that first result, the richness comes from the power of second-degree Diophantine equations—Pell equations, or Fibonacci numbers. They have the power to move up to exponentiation.

The proof in the paper the three of us wrote [1] goes back to the Chinese remainder theorem. It was Gödel who first used the Chinese remainder theorem as a device to code finite sequences. That's what I used in my dissertation result, but it didn't go all the way. Technically, a bounded universal quantifier stood in the way of the definition that one wanted to be entirely existential. Using the Chinese remainder theorem to code the effect of the bounded universal quantifier needed some clever tricks, and that's what the three of us developed. When Hilary and I first tried to prove this, our proof had the major flaw that we needed to assume that there are arbitrarily long progressions consisting entirely of prime numbers—something that was only proved two years ago by Ben Green and Terence Tao. If we had had that theorem, our proof would have been a perfectly good proof. But at the time it was Julia who showed how to do without that then unproved assumption.

Notices: *So ultimately Hilbert's Tenth Problem was resolved by work of you, Hilary Putnam, Julia Robinson, and Yuri Matiyasevich, and your conjecture became the DPRM theorem. So often in mathematics there are priority disputes. But that did not happen with you four.*

Davis: It's just the opposite. We all like and respect one another. I guess we are nice people! Some people want to call the result Matiyasevich's Theorem, and Yuri insists no, it's DPRM. Other people say MRDP. A story I like to tell is about the later collaboration of Julia and Yuri, in which the number of unknowns was knocked down to nine. As I said, once you had the main result, it was clear that there was a bound. If you just took the crude proof, you would get an estimate of forty or so unknowns. Julia and Yuri took on the task of trying to get a better bound. They published a very nice paper in which they got it down to thirteen. Then Yuri, basically using the same methods that they had developed but refining them, managed to get it down from thirteen to nine and proposed to Julia that they publish a joint paper. She said, "No, I didn't have anything to do with getting it down

to nine, that's your result, you publish it." He said, "No, it uses our methods, I'm not going to publish it unless you will be a joint author." What finally happened is James Jones got permission from Yuri to include the proof in a paper that he wrote, and that's how the proof was finally published [2].

Notices: *Can you tell me your memories of Julia Robinson, what she was like as a person?*

Davis: Very nice, very straightforward. Broad in her interests, mathematical and otherwise. And great power—there is no question in my mind that she was a much more powerful mathematician than I. We worked together on a problem on which we didn't get anywhere. We were trying to prove the unsolvability of the decision problem for word equations. It turned out that we wouldn't have been able to do that because the problem is solvable. Makanin solved it positively. That had a curious relationship to Hilbert's Tenth Problem, because some of the Russians were interested in proving it unsolvable because its unsolvability would have been a way to get the unsolvability of Hilbert's Tenth Problem, without proving my conjecture, which they thought was likely false. But in fact, it turned out to be on the other side of the line.

Notices: *What made you think that it was unsolvable?*

Davis: I don't know that we thought it was unsolvable. We thought it might be unsolvable. When we were working on the problem, Julia and I would stand at a blackboard on the campus here in Berkeley, and you could just feel the power. You could feel the power in her papers too, particularly her dissertation on the definition of the integers in the theory of the rational numbers—it's really a powerful piece of number theory. It was also uncharted territory. It was the kind of number theory nobody was doing.

Notices: *Do you have a sense that any outstanding mathematical problems out there nowadays might be unsolvable?*

Davis: In the sense of nonexistence of an algorithm? Not really. The easy stuff has all been scooped up, I would say. One thing that is clear from many cases is that the boundary is tricky, as is often the case with sharp mathematical boundaries. Particularly in the case of Hilbert's *Entscheidungsproblem*, the boundary between cases that are solvable and the ones that are unsolvable boils down to the question, Are there two quantifiers, or three? I don't think anyone would have guessed to start with that three is unsolvable and two is solvable, but that's how it turned out.

Programming the ORDVAC

Notices: *After Princeton, in 1950, you got a job at Illinois, and that was when you started programming. You were one of the world's first programmers, weren't you?*

Davis: Well, let's say an early one, anyway. I had a research instructorship at Urbana-Champaign, which was basically a kind of postdoc. I taught a logic course, and the second semester was about computability. I wrote a book that was published years later, in 1958, called *Computability and Unsolvability*, and the second semester was sort of a first draft of that book. Part of what I was doing was writing Turing machine programs on the blackboard. Edward Moore, later known for his work on sequential machines, was an auditor of the course. He had just finished a Ph.D. and had joined the computer project at Urbana-Champaign. They were building an early computer, called the ORDVAC, one of a family of early computers called "johniacs" after John von Neumann. Moore came up after one of the classes to tell me that a program I had written on the board could be improved and showed me how to do it better. He said, "You really ought to come across the street, we've got one of those there!"

Notices: *Did you know of the existence of the computer there?*

Davis: No, I was not aware of it. I should have followed it up, but I didn't. What happened instead was that, as a result of the Korean War, I was in danger of being drafted. A military project started up, the Control Systems Lab, and I was given the opportunity to join it, which seemed like a good way to avoid being in the army. What they set me doing was writing programs for the ORDVAC. In fact, I wrote a program that was supposed to navigate 100 airplanes in real time! Of course it was a preposterous thing with the technology available. But I did produce the program. My course in computer science consisted of a five-minute lecture by Abe Taub, who said, "This is how you program." I was given the von Neumann-Goldstine reports, which had a lot of sample programs.

Notices: *What was it like to program on this computer? What did you have to do?*

Davis: What I had to do was to write code on a piece of paper with a pencil. A secretary would type it on a teletype machine, which would produce a piece of punched paper tape that would have the code on it, and that was what was fed into the computer.

The memory consisted of forty cathode ray tubes, little TV screens. On each one, there would be a grid of 32 by 32 bits. A 0 was two dots, and a 1 was one dot. So the data was stored as electrostatic charge on the surface of the tube. This had the serious defect that charge doesn't stay put, it decays. So they had what was called "read-around", a process by which the memory was constantly being read and rewritten. The programmers had to be aware of this, because if they wrote a program in such a way that the read-around didn't get a chance to correct the memory, the data would

become unreliable. We had to avoid tight inductive loops in our code.

Notices: *Did working with computers at this time affect your thinking about the purely mathematical problems you were working on?*

Davis: It affected the way I thought about computability. It certainly affected my book *Computability and Unsolvability* [4]. A number of people who became computer scientists at a time when there was no computer science told me that they learned programming from that book, even though it's not a practical book at all, but a theoretical one.

The Mind and the Brain

Notices: *In 1951 you went to a lecture by Gödel in Providence. Can you tell me about this lecture, and how it influenced you?*

Davis: You are not getting my pure memory of the lecture, because I have since read the text several times, after it was published in his collected works. The lecture was altogether remarkable. It was the Gibbs Lecture. Gibbs of course was an applied mathematician par excellence, and here was Gödel, coming to lecture the mathematicians on philosophy! He said that, if you look at his incompleteness theorem and what it implies about mathematics and about the human mind, you are faced with a pair of alternatives. One is that thinking is entirely mechanistic, and it's all done by the brain, in which case you have to think that the brain is just a Turing machine. Then our mathematical doings would be subject to the incompleteness theorem, and there would be number-theoretic truths that we will never be able to prove. The other alternative is that the human mind surpasses any mechanism, and that's of course what Gödel really believed. He was a Cartesian dualist. He really thought the mind has an existence quite separate from the physical brain. Those were the two alternatives he provided. I came out with my head spinning.

Notices: *Which alternative do you think is true?*

Davis: Oh, the first one. I'm a mechanist.

Notices: *Why is that so clear to you?*

Davis: I think the more research is done about the human brain, particularly about people who suffer brain damage of one kind or another, the more we see that various aspects of what we think of as mind really sit in the brain. I recently read an article in the *New Yorker* by Oliver Sacks, about a man who had total amnesia. He simply could not form a memory of anything happening to him but still was perfectly capable of sitting down at the piano and playing at a high professional level of skill. People in whom the corpus callosum, the connection between the two halves of the brain, has been severed, behave as though there were two separate people inhabiting their skull. Also, there

is just the general historical fact that vitalism as a philosophy has been in retreat.

When I was at City College, a biology professor said that he didn't think biology would at bottom end up being physics and chemistry. But now we know about DNA and genes. And if you think the human mind is separate from the brain, what about the mind of a chimpanzee? Is that really qualitatively different? Or is it just that there are some extra little subroutines that enable us to use language?

One of the strange things about this argument about mechanism and mind is that people on one side of the divide don't even seem to be able to understand what it is that people on the other side could be thinking. My good old friend Raymond Smullyan can't understand how a sensible person can believe what I believe! And I find it hard to imagine what he thinks.

Notices: *There have been books looking into this question in recent years, for example, the book by Roger Penrose [8].*

Davis: I was involved in a polemic with him in print, in the publication *Behavioral and Brain Science*.

Notices: *I see. Penrose used Gödel's ideas to argue that the mind must be more than the brain.*

Davis: Yes. He went a lot further than Gödel would have been willing to go. Gödel at least had an alternative. Penrose is a remarkable mathematician and physicist, but on this subject he is simply foolish. He won't listen to what we logicians tell him. It's simply not true, as he asserts, that we can see a truth that no machine can see. All we ever see is that, if a particular system is consistent, then that statement is true. But your favorite machine can see the very same implication. The tricky part is knowing which formal systems are consistent. You can find by the wayside formal systems proposed by first-rate logicians that have turned out to be inconsistent, starting with Frege and continuing with Church, Quine, Rosser, and others. So the assumption that we can somehow really tell whether a formal system is consistent is unjustified. Turing wondered about this way back, in his famous article on whether computers can think [11]. The way he put it is that a machine has to be allowed to make mistakes just as human mathematicians make mistakes. That was his way of saying that a formal system might be inconsistent, and he asked for "fair play" for computers!

Notices: *You spent 1952–1954 at the Institute for Advanced Study in Princeton. Did you have much contact with Gödel during that time?*

Davis: I spoke to him twice. Once by myself, to tell him about something I was working on, in which he showed not the least interest. The second time was with John Shepherdson, an English



Martin Davis and his wife Virginia.

logician who was at the Institute at that time as well. We had heard a rumor that Gödel had a proof of the independence of the axiom of choice from the axioms of set theory and decided we should make an appointment to ask him about that. I can't remember the details of the meeting, but it was awkward, and we came away without any information.

One person we were very friendly with at the Institute was Julian Bigelow, the engineer who, one could almost say, built the Institute johniac computer with his own soldering iron. He was a very interesting person. He wanted to move a house from point A to point B in Princeton. Some utility poles with wires were in the way. When he contacted the utility company about temporarily moving the poles so he could move the house, the cost was prohibitive. So what he did was take a hand-saw and horizontally saw the house in half, move the two pieces separately, and then screw them together with great big flat brackets!

Notices: *Didn't that just ruin the house?*

Davis: Apparently not!

Notices: *Did you get to know von Neumann?*

Davis: I met von Neumann back in Urbana, and that was the only time I had a conversation with him. I attended the inauguration of the Control Systems Laboratory, and there were many guests, and von Neumann was one of them. I wanted to meet him, but I was much too shy to walk up to him. My wife Virginia was there—we weren't married yet—and took care of the problem. She made me a scotch and soda that was more scotch than soda, and after that von Neumann and I had a wonderful chat about sun spots and ice ages and heaven knows what! But I never talked to him at the Institute.

Computer Science Culture

Notices: *After the Institute you went to the University of California at Davis. You had various jobs*

for a while and then eventually you ended up at New York University, where the computer science department was just getting started.

Davis: Well, I came to NYU in 1965, and the Computer Science Department was started in 1969, and I was there to join it at that time.

Notices: I've heard people say it's unfortunate that computer science departments split off from math departments at this time. You witnessed this happening at NYU. Do you think they should have stayed together?

Davis: No, it wouldn't have worked. It's really a different culture. There are things about the culture I don't like, but it is different. The way the theoretical and the pragmatic parts of the subject interact is very different from how applied math-

theorems are stated but rarely proved, and somehow judgments are made. But the things that are claimed to be proved are not always in fact proved. And the stakes are high. People's subsequent careers could depend on getting papers accepted in these conferences. That's what I didn't like.

Notices: The outstanding problem in computer science now seems to be the P versus NP problem. Do you care to speculate on whether or how that will be resolved?

Davis: I have very unconventional views about that. It is taken for granted in the field that P and NP are different but that it's just much too hard for people to prove it. I think it's 50-50! I wouldn't be in the least astonished to find that P equals NP . I think the heuristic evidence that is given, when

you look at it carefully, is just circular. I certainly agree that it's very unlikely that there are really good algorithms for NP -complete problems like satisfiability. But the equating of "good" with polynomial-time computability seems to me to lack evidence. People say "polynomial", but they mean with an exponent no higher than 3. I sort of see it as a reprise of the situation with Hilbert's Tenth Problem, where people didn't have any real imagination about what a polynomial with high degree could do. I was an invited speaker last summer at a meeting in Lisbon devoted

to the satisfiability problem. In my talk I said that if I were a young person I would try to find a polynomial-time algorithm for satisfiability, not expecting it to be a particularly good algorithm!

Notices: Really!

Davis: Why not? I don't see any compelling reason there shouldn't be one.

Notices: But people aren't working on it from that point of view. People seem to think that P and NP are different.

Davis: Well, there is a million-dollar prize!

Notices: Is the question of whether there is a polynomial-time algorithm the correct way of measuring the difficulty of solving problems?

Davis: Well, that's really the question. Certainly theoretically the class of things for which there are polynomial-time algorithms has nice closure properties. So it's a mathematically attractive class. But the idea of identifying them with what's computationally feasible is I think the result of looking at an analogy with Church-Turing computability, which is a very successful formalization of the intuitive notion of what is calculable in principle when you don't think about resources. But it's just not a compelling analogy in my opinion.



ematics of the classical sort interacts with pure mathematics. At NYU, we were involved in finding our way as a separate department. Of course we knew very well that the mathematical power of the people at the Courant Institute—people like Nirenberg and Lax and Varadhan and so on—was of a very different caliber than the mostly young people who we had in the computer science department. But still, we had our own culture and needs, and we had to convince them, for example, that it wasn't appropriate that a Ph.D. student in computer science be required to pass an exam in complex variable theory.

Notices: What are the aspects of the computer science culture that you don't like?

Davis: I am thinking of theoretical computer science particularly, where the field moves very fast, leaving unsolved problems behind, under the assumption that, because they haven't been able to deal with the problems in a year or two, the problems are intractable. And they go on to another subject. Following the habits in the more applied parts of computer science, the intellectual center is not finished public articles, but rather conferences. A conference program committee—I have been on one of them—gets extended abstracts in which

At the January meeting [New Orleans Joint Mathematics Meetings, January 2007] Margaret Wright gave a talk about linear programming. Linear programming was also thought to be an intractable problem for which there were no polynomial-time algorithms—until the polynomial-time algorithms popped up. First there was the ellipsoid method found by the mathematician Karmarkar, then the interior-point method. Also, one of the things Margaret Wright showed was that, in very specific cases where you're doing serious computation and trying to deal with hundreds of thousands of linear constraints, the old exponential-time algorithm of Dantzig often does better than the polynomial-time algorithms! So I just don't see on what basis people measure feasibility in this way. It's not that I bet that P equals NP . I just can't see any compelling evidence either way.

Steve Cook once pointed out to me that the one separation in the field is between log-space at the bottom end and polynomial-space at the top end. In between there are classes that theoretical computer scientists study: P and NP , and the whole polynomial-time hierarchy, and then $PSPACE$ sits on top of all of that. But the only separation theorem that has been proved is between the very bottom and the very top. All the other layers could collapse, for all anybody knows. But people will publish papers that say, "If such and such is so, then the polynomial-time hierarchy will collapse at level 2" and think that, since that's not going to happen, they have essentially proved their result.

Notices: *Do you think that maybe the problem is just not cast in the correct way, with the right viewpoint?*

Davis: I've thought about that and tried to think what the right viewpoint might be, but I haven't come up with anything! Maybe there is no real notion of feasibility, or maybe there is a notion, and it hasn't been found yet.

A Continuing Mystery: The Continuum Hypothesis

Notices: *Do you think the Continuum Hypothesis will ever be resolved?*

Davis: I think it has a truth value, meaning that it's a coherent statement that is either true or false. Whether the human race will ever be able to resolve it or not, I have no idea. I don't think we can do everything. But I don't think it's ill-posed, in the way Sol Feferman does. He wrote an article "Does mathematics need new axioms?" [9], in which he suggested that the final fate of the continuum problem will be that it's just regarded as incoherent and ill-posed. If you think that the universe of sets is a human creation and that there is no objective truth about it, then the way Sol thinks makes sense. If the world of sets is a human creation in the way the play *Hamlet* is, then the question, "Was *Hamlet* a virgin?" might not have any answer!

But if you think that there is something objective about the universe of sets, then in that universe, regardless of what we are able to do, it will have a definite answer.

Notices: *Do you think that the work of people like Hugh Woodin and John Steel might eventually bring a decision about the Continuum Hypothesis?*

Davis: Yes, I am hopeful. I have to say first of all that I can't claim I really understand in any but the vaguest way what those people are doing. I admire it tremendously, but I find it very hard to follow in detail. But as an outsider, what comes to my mind is this. Before Paul Cohen, people thought of the Zermelo-Fraenkel axioms as pretty much determining the world of sets. They knew about the Skolem-Löwenheim theorem, that there had to be countable models—but it seemed as though those would just be weird and peculiar things. Then Paul Cohen invented the method of forcing, and suddenly the Zermelo-Fraenkel axioms, instead of being like the axioms of, say, Euclidean geometry, became like the axioms of group theory. Suddenly you could make models of the Zermelo-Fraenkel axioms every which way, with whatever properties you want. It had tremendous flexibility, and that was a big obstacle in trying to settle a problem like the continuum problem, because you can force the continuum to be \aleph_{17} or whatever you want. But even before Woodin's work, there was the so-called Martin's Maximum, which is a certain axiom added to the axioms of set theory that in effect prevents forcing from working. When Martin's Maximum is added to the Zermelo Fraenkel axioms, it turns out that the cardinality of the continuum is \aleph_2 . I wouldn't be a bit surprised if the true value really turns out to be \aleph_2 . That's certainly what some of Woodin's work suggests, and I can be rash enough to say it, because, as a bystander trying to understand what's going on, my opinion isn't worth much!

One thing you have not asked me about but that I think is very important is the following. We know as a theoretical matter that there are mathematical propositions that, formally speaking, have a very simple form involving solvability of specific Diophantine equations and that require set-theoretic methods for their resolution. Harvey Friedman has found examples of this kind with a combinatorial flavor. To me a really interesting question is: Do any important unsolved problems that are really significant to mathematicians fall into that category? One of the things Gödel himself conjectured in that remarkable Gibbs Lecture was that the Riemann Hypothesis might be of that character. And that wouldn't surprise me in the least.

Notices: *So you are saying the Riemann Hypothesis can be reduced to a question about solvability of a specific Diophantine equation?*

STANFORD UNIVERSITY
STANFORD, CALIFORNIA

DEPARTMENT OF MATHEMATICS

Nov. 27, 1963

Dear Martin,

I have thought about writing you for some time, but never quite got around to it. First, I hope you received a preprint of my work. Gödel has now submitted the paper to the PNAS & it comes out in Dec. & Jan. issues.

I really should thank you for the encouragement you gave me in Stockholm. You were directly responsible for my looking once more at Set theory. Previously I had felt rather outplayed & even humiliated by the logicians I had spoken to. Of course, the problem I solved had little to do with my original intent. In retrospect, though, the basic ideas I developed previously played a big role when I tried to think of throwing back a proof of the Axiom of Choice, as I had previously thought about throwing back a proof of a contradiction.

I have received 2 letters from A. Edelson of Technical Publishing Co. I have not decided what to do about a book and so I cannot say much at this point.

What do you think I should attempt to cover in a book?

How is Newman? I will be in Miami January & then in N.Y. so I will certainly see you then.

Regards to all.

Sincerely,
Paul Cohen

Davis: Yes. The technical notion is what logicians call a Π_1^0 proposition. These are statements that a certain decidable property of natural numbers is true of all natural numbers. Decidable, in the sense that there is an algorithm to tell whether a given number has the property or not. By using the MRDP theorem, one easily shows that every Π_1^0 proposition is equivalent to a statement asserting about a particular polynomial equation with integer coefficients that that equation has no natural number solutions. That's entirely equivalent to the first

Text of letter from Paul Cohen to Martin Davis (shown at left), dated November 27, 1963:

Dear Martin,

I have thought about writing you for some time, but never quite got around to it. First, I hope you received a preprint of my work. Gödel has now submitted the paper to the PNAS [*Proceedings of the National Academy of Sciences*] and it comes out in Dec. and Jan. issues.

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Regards to all.

Sincerely,

Paul Cohen

version that I stated. And the Riemann Hypothesis certainly is of that character. We worked it out in our paper [10] quite explicitly. I had the help of a number theorist at NYU, Harold Shapiro, who pointed me in the right direction. But it was clear to everybody who thought about it that the Riemann Hypothesis had the character of being a Π_1^0 proposition, by thinking about the behavior of a Cauchy integral on a path around zeros and approximating the integral in some way or other.

I am certainly no analyst, but the reason I think the Riemann Hypothesis is a good candidate for undecidability by elementary methods is that it is sitting right in the middle of classical analysis, and it has been attacked by brilliant mathematicians—Paul Cohen spent a lot of time on it—and the existing methods just don't seem to resolve it. It's hard to believe it isn't true. And why shouldn't it be one of those propositions that require set-theoretic methods? That would be great!

Suppose someone proves that the existence of a measurable cardinal implies the Riemann Hypothesis. Would mathematicians accept that as a proof of the Riemann Hypothesis? Whether there exist measurable cardinals is something that can't be proved from the Zermelo-Fraenkel axioms. Evidence for it is like the kind of evidence that physicists come up with, not the kind of evidence that mathematicians typically want. I hope it's clear I am presenting all of this as a wild speculation, not something that I believe is true.

Notices: *The Diophantine equation that you can reduce the Riemann Hypothesis to—what does that thing look like? Is it horribly complicated?*

Davis: Sure.

Notices: *So you can't just look at it and get any information.*

Davis: No. What I say is, This is an equation that only its mother could love.

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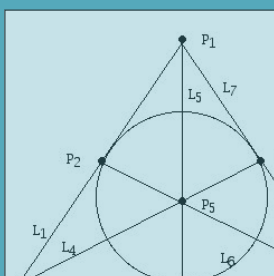
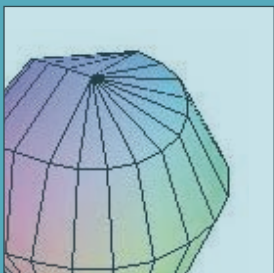
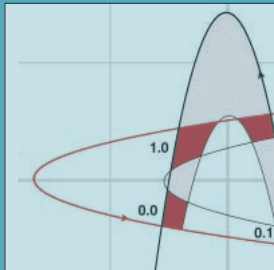
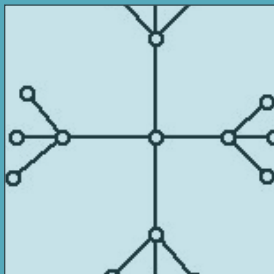
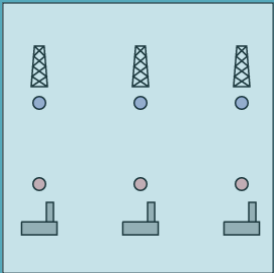
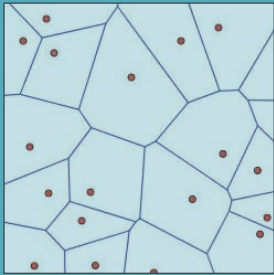

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October 4–5, 2008 (Saturday–Sunday)
University of British Columbia and PIMS,
 Vancouver, Canada
 (2008 Fall Western Section Meeting)
 Fourth Annual Einstein Lecture

October 11–12, 2008 (Saturday–Sunday)
Wesleyan University, Middletown, CT
 (2008 Fall Eastern Section Meeting)

October 17–19, 2008 (Friday–Sunday)
Western Michigan University, Kalamazoo, MI
 (2008 Fall Central Section Meeting)

October 24–26, 2008 (Friday–Sunday)
University of Alabama, Huntsville,
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Julia Robinson and Hilbert's Tenth Problem

Reviewed by Carol Wood



Julia Robinson and Hilbert's Tenth Problem

Zala Films

Produced and directed by George Csicsery

This film by George Csicsery is an hour-long documentary on the life and work of Julia Robinson, an extraordinary mathematician who played a key role in the solution of Hilbert's Tenth Problem. Csicsery is perhaps best known in the mathematical community for his documentary about Paul Erdős, *N is a Number*. The final version of Csicsery's latest work premiered at the Joint Mathematics Meetings in San Diego on January 7, 2008, to an appreciative audience. The setting was particularly appropriate: Julia moved with her family to San Diego when she was a small girl, and she remained there through her early years of college. The film includes a 1920s view of a pristine bay, now the site of the convention center and meeting hotels.

The documentary was many years in the making and draws on various archival materials, both film and still shots, plus interviews of colleagues and friends of the Robinsons, including the other key figures involved in the solution of Hilbert's Tenth Problem (H10): Martin Davis, Hilary Putnam, and Yuri Matijasevich. H10 asks whether there is an algorithm for determining when a polynomial equation with integer coefficients has an integer solution (for details, see Bjorn Poonen's article in the April 2008 *Notices*). The film is narrated sweetly by Danica McKellar, actress (Winnie in *The Wonder Years*), math major (at the University of California, Los Angeles), and author of a book about mathematics aimed at girls (*Math Doesn't Suck*).

Carol Wood is professor of mathematics at Wesleyan University. Her email address is cwood@wesleyan.edu.

Csicsery intertwines for us a human story and a mathematical story. In Julia Robinson we find a mathematician who was a heroine in her own time and a role model for all time. It is a story of childhood, illness, love, marriage, disappointment, obsession, and triumph. It is filled with extraordinary instances of luck both good and bad. The stars of the film are the incandescent Bowman sisters, Julia Robinson and Constance Reid. Julia was very fortunate to have Constance as a sister and a spokesperson. Julia's sister is no stranger to the mathematical community, having written prize-winning books about mathematics and mathematicians, including a masterpiece about Hilbert. Reid's storytelling and her presence enliven the film. Her 1996 book *Julia, A Life in Mathematics*, published in the MAA Spectrum series, is a perfect companion to the film. (See also Reid's article, "Being Julia Robinson's Sister" in the December 1996 *Notices*.)

The narrative begins with Julia's childhood, and follows her mathematical and personal odyssey.



The Bowman sisters, Julia Robinson and Constance Reid.

My Julia Story

In 1968 a 22-year-old graduate student and her 25-year-old mathematician husband walked through the lobby of the headquarters hotel at the San Francisco AMS meeting. This was the first mathematics meeting for either of them. Walking in the other direction was a distinguished-looking couple of an older generation. They stopped to speak to the young couple, saying, "We live in this area and decided we should come to the meeting and meet some new people. We are Julia and Raphael Robinson." The student doesn't remember any further detail of the pleasantries that were exchanged in the lobby that day, although perhaps she had the presence of mind to mention that she was taking a course in model theory from Abraham Robinson. Once out of earshot she asked her husband excitedly "Do you *know* who they are??!!"

I was that student, and I had just met two of the stars in my mathematical world. Nothing that thrilling has happened to me at AMS meetings in the intervening 40 years, nor do I expect it ever will.

—C. W.



Left to right: Martin Davis, Julia Robinson, Yuri Matiyasevich.

Opportunities for young women in mathematics were severely constrained in her day. Nonetheless, in the late 1930s she found her mathematical milieu in Berkeley. Two figures stand out in her mathematical development. Raphael Robinson was one of her first teachers at Berkeley. He then became her mentor and soon thereafter her husband. Her thesis advisor, Alfred Tarski, arrived at Berkeley during her graduate study. Both Robinsons benefited from Tarski's presence. One of Tarski's great strengths was his ability to pose powerful, insightful questions. As the story goes, many of these were communicated at the men's faculty club, some to Raphael. Fortunately, Raphael passed them along to Julia.

The main result of Julia's 1948 thesis, easily in my top ten list of favorite theorems, answered one of Tarski's questions. She proved the definability of the integers in the rationals, a result that transported Gödel's undecidability phenomenon from the integers to the rational numbers. Shortly thereafter she began to work on H10 and produced an inspired sufficient condition for a negative solution, showing that if one could find a

single diophantine equation whose roots displayed exponential growth, then the full problem would be undecidable. Fulfilling the condition, called JR by others, would provide the missing piece of the solution as envisioned by Davis, Putnam, and Robinson. This was finally achieved in 1970 by Yuri Matiyasevich, to the delight of the other three. An endearing aspect of the story about H10 is the generosity of the four main players in deflecting credit toward each other. Once the solution of H10 was complete, recognition of Julia's role came swiftly and dramatically, a truly joyful part of the story Csicsery tells.

The film also takes us to an era when the speed of mathematical communication could be glacial. It is already difficult to imagine life without email, much less to recall the severe restrictions on travel and correspondence due to the cold war. Communication with many Russian colleagues was extremely difficult throughout Julia's lifetime. Yuri Matiyasevich was not allowed to travel to the U.S. They did meet in other countries, but their collaboration was done mostly via handwritten letters. Yuri's description of the challenge of mailing a letter with mathematical content to the U.S. in the 1970s is quite amazing.

Julia's life ended too early, but she will be remembered as she wished to be, for the mathematics that she did. Her work has a modern quality, with its emphasis on definability and on the connections between number theory and logic. Her collected works, edited by Solomon Feferman, were published by the AMS in 1996. The film is made all the more timely by current activity related to H10, e.g., by Poonen's recent improvement of Julia's

thesis. Poonen's result reduces the complexity of the formula needed to select the integers from among the rationals, bringing us closer to the desired analogue of H10 for the rational numbers; how close remains to be seen.

I cannot resist a word here about Raphael Robinson, something I believe Julia would want said. "Hillary Clinton is a politician in her own right!" sounds quaint in 2008. But surely Julia, in her role as the wife of a Berkeley professor, was regularly referred to as "a mathematician in her own right", up to and including the time of her election to the National



Julia and Raphael Robinson.



Academy. My point is that one should not over-compensate, while celebrating the achievements of Julia, by overlooking the related work of her husband. As luck would have it, his fame does not match hers, nor is he the subject of this film, although his crucial role in Julia's mathematical development is acknowledged. However, this kind and quiet man was very much a "mathematician in his own right", with many beautiful results to his credit, including undecidability results for certain function fields, together with an impressive record as a problem solver. He was a key figure in early work on tiling of the plane and the author of undecidability results for certain fields. One account of Raphael's work is found in the article by Leon Henkin in the *Bulletin of Symbolic Logic*, Volume 1, No. 3 (1995).

The AMS film premier was hosted by the Clay Mathematics Institute, which was a major

sponsor of the film's production, as were Margaret and Will Hearst. George Csicsery, Constance Reid, and Martin Davis were present at the showing, adding to the celebratory atmosphere. Even without principal figures in attendance, this film is worth a viewing by readers of the *Notices*. It is equally suitable for an undergraduate math club and for a mathematics colloquium audience. I have not yet had the opportunity to show it to nonmathematicians, but I can imagine that a general audience, such as viewers of the *NOVA* series on PBS, would also be captivated by the story. However, this is a film about mathematics and mathematicians, and it will be most deeply appreciated by mathematicians and our students.

Photo credits for this article:

Page 575—top and bottom photos by Ralph Bowman, courtesy of Constance Reid. Page 576—left, photo by Louise Guy; right/top, photo by Raphael Robinson, courtesy of Constance Reid; right/bottom, courtesy of Constance Reid, photographer unknown. Page 577—top, photo by Ralph Bowman, courtesy of Constance Reid; middle, photo courtesy of George Csicsery from *Julia Robinson and Hilbert's Tenth Problem*; bottom, photo by Constance Reid.



Top of page: Julia and Constance at the beach. Below: Constance Reid and Julia Robinson.

Interview with George Csicsery

George Csicsery is the producer and director of the film *Julia Robinson and Hilbert's Tenth Problem* (see movie review, pages 573–575, this issue). The following is an interview with Csicsery, conducted on February 19, 2008, by *Notices* graphics editor Bill Casselman, University of British Columbia.

Notices: *How did you come to make this film?*

Csicsery: The idea for this film came in 1998. Charlie Silver, a logician and a friend, sent me an email in which he summarized the idea of the film for me in a few enthusiastic paragraphs, beginning with “While waking up this morning, I had a flash of a math film” In the rest of his email he outlined much of what eventually went into the film.

Charlie had helped me a great deal while I was making *N is a Number: A Portrait of Paul Erdős*,

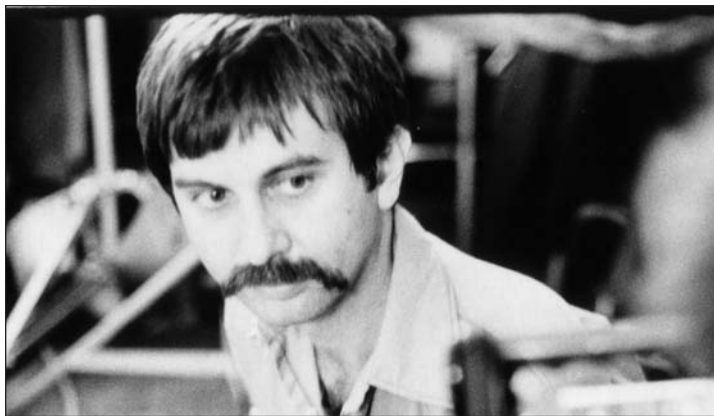
you consider that she had already written, or co-written, Julia Robinson’s autobiography, *Julia: A Life in Mathematics*.

My main conceptual contribution was to tell the mathematical story inside the biography of Julia Robinson. And this proved to be the most difficult part—making the two parts move forward in tandem so that neither would subtract from the other.

Notices: *How did you get interested in making mathematics films in general?*

Csicsery: That’s a question I get often, since I’m not a mathematician and my understanding of mathematical ideas is rather primitive. Just as often, my official answer is that I’m a refugee from the social sciences looking for terra firma. And this is only half a joke, because in my lifetime there has been terrific erosion in the quality of work being done in what used to be called the social sciences, and more precisely the fields in which I was best trained—anthropology, sociology, comparative religions, and history. My interest in mathematicians, rather than mathematics itself, was sparked by hearing and reading about individuals who had a passionate dedication to finding out things that might actually be close to truth. There’s a second part to this. My films about mathematicians are also films about people who found ways to overcome the less pleasant aspects of life. Paul Erdős and Julia Robinson are both interesting exemplars of the life of the mind prevailing over the daily travails that consume most people.

Constance Reid was already a legend in mathematics, being the pre-eminent biographer she is. I always felt that she is an important part of the story in her own right, independently of Julia Robinson. Constance also had a wonderful collection of photographs taken by their father. She made these and countless other artifacts available to the project.



Photograph courtesy of George Csicsery.

George Csicsery filming in 1977.

and he’s worked extensively on the films of Errol Morris. He had been a student of Julia Robinson at Berkeley, and knew her. As he explained it, the story of how Hilbert’s Tenth Problem was solved came to life for me.

When I agreed that the story was compelling, Charlie flew out to California and we went to visit two people together. One was Constance Reid, the other Martin Davis. Both of them embraced the idea for a film and agreed to participate. In a sense, Constance, being Julia Robinson’s sister, became her surrogate in the film. This is not so strange if



Photograph by Helen Moore, courtesy of George Csicsery.

Some of the people involved in the making of the Julia Robinson film, including Kirsten Eisentraeger, Yuri Matiyasevich, Alexandra Shlapentokh (top row, first, fourth, and seventh from left), George Csicsery (front row, third from left), Bjorn Poonen (to the right of Csicsery), and Martin Davis (standing, third from right). All of those named appeared in the film, with the exception of Csicsery.

Martin Davis is one of the four people credited with solving Hilbert's Tenth Problem. He had worked with Hilary Putnam, then with Julia Robinson, and then later, with Yuri Matiyasevich. His descriptions of the other participants and of events turned out to be key parts of the narrative, shedding light not only on an important piece of mathematical history, but adding color and nuance to the characters.

About a year into the process I was able to meet Yuri Matiyasevich at a Hilbert's Tenth Problem meeting in Gent, Belgium. Here was the man who had actually succeeded in solving the problem in 1970, and then, overcoming the immense political barriers between the U.S. and the USSR at the time, went on to forge a creative partnership with Julia Robinson and Martin Davis. Is there anything more dramatic? Matiyasevich proved invaluable to the film. The deep sincerity and intense emotion with which he addressed every one of my questions reveals a great deal about him. He brought another gift to the project—his own 8mm films from 1970 and 1971. His first presentations of his solution to Hilbert's Tenth Problem were filmed, and he had the footage, which you see in our film. In 1971 he also filmed about one minute of scenes with Julia and Raphael Robinson at the Bucharest mathematics meeting where they first met. As far as I know, this is the only existing piece of film with Julia Robinson in it.

Notices: *What were the trials and tribulations involved in making this film?*

Csicsery: The biggest challenge for most documentary films is funding. The second is finding

an audience, or in the case of a film like this one, creating an audience. The third is actually making the film. Of course, these three things are intimately connected.

I started working on the film with no funding because Constance Reid was flying to St. Petersburg, Russia, in January 1999 to celebrate her birthday and the anniversary of the solution of H10 with Yuri Matiyasevich, and I thought this should be covered. It was frustrating to say the least; I paid a Russian crew to follow them around, but in the end could not afford to go myself. Talk about remote directing. Well, as you can imagine, there is very little footage from that adventure in the finished film. Then I was committed. I kept shooting from 1999 through about 2005 with no resources. There were two or three times when I was working on projects for MSRI [Mathematical Sciences Research Institute] and would be shooting an interview with someone who figured in Julia Robinson's story as well. I asked David Eisenbud, the former director of MSRI, if I could shoot an extra roll or two for the Julia Robinson film. Fortunately, he always said yes. Finally, in 2005 I got a decent grant from the Clay Mathematics Institute, followed by two more. And in 2007 we got a generous grant from the Margaret & Will Hearst Foundation. As a result we were able to schedule the final shoots and complete the editing. The film premiered at the Joint Mathematics Meetings in San Diego in January 2008.

The challenge of finding an audience for the film seems mitigated by the terrific outpouring of interest from mathematicians and teachers. I can only hope that this will lead to some television broadcasts. It's hard to be optimistic about TV though;

even the best science series have been dumbed down to accommodate the fleeting attention spans of viewers. If you've seen the film you can appreciate that it takes more than five seconds to grasp some of the concepts.

Finally, there was the challenge of actually making the film. The film has three threads: the biography of Julia Robinson, the history of how Hilbert's Tenth Problem was solved, and some quite demanding mathematics. Weaving these together into a single narrative without sacrificing any of the bits was possibly the hardest task I've ever attempted. To be honest, I'm still not sure how well we succeeded. I worked with a superb editing crew consisting of film editor Tal Skloot, and assistant editor/ animator Andrea Hale. We also had the best available mathematical consultants, many of whom are in the film, and had worked—or still work—on some of the ideas we had to find ways of presenting on screen. It's an impressive list of names: Martin Davis, Yuri Matiyasevich, Solomon Feferman, Hilary Putnam, Lenore Blum, Bjorn Poonen, Steve Givant, and several others. And Charlie Silver was always there in the background, making sure that I would keep the balance between making a coherent film and maintaining some fidelity to the mathematical ideas.

Notices: What did you enjoy most about this film and the earlier one about Erdős?

Csicsery: With Paul Erdős I got the feeling that I was in the presence of a rare and wonderful human being who happened to be one of the greatest mathematicians of the twentieth century. The people around him are impressive enough, but he had a special quality that inspired. I actually felt that he was not eccentric at all; that his approach to life made absolute sense.

Julia Robinson died in 1985, interestingly, at a hospital less than 100 yards from my home and office. We never met, and this posed another challenge for the film. I had to get a sense of her from Constance Reid and from her colleagues and students. In the end, I think we succeed in presenting not only the facts, but also a flesh and blood human being. I hope that her voice, her writings, the dozens of photographs, Yuri's footage from Bucharest, and the stories in the film about her, do bring her to life.

In both cases, however, I was never quite sure until very near the end that the films worked. You spend years on a project, and during that whole

time it's impossible to explain to people why you have chosen such an arcane subject. People seem to question your grip on reality, and sometimes you start suspecting they may be right and that you're wasting your time on a futile effort that was doomed from the outset. Then you show the film, and people with no interest in mathematics come up and say they got something out of it. And when you ask what that might be, they tell you the exact thing that you had in mind when you set out to make the film. That is rewarding.

Notices: Can you tell us a bit about your own background?

Csicsery: I was born in Germany in 1948. My parents were refugees from Hungary, and we came to the United States in 1951. They sent me to a six-year boarding school in Buffalo, New York, that had been founded by Hungarian refugee priests who had run some of the best high schools in Hungary before the war. From there I went to Berkeley in 1965, and got to experience the full blast of the 1960s. While I did earn a B.A. in Comparative Religions four years later, the Berkeley-in-the-Sixties experience probably accounts for how I kept up my careers in journalism and film. I've been making films since 1968, most of them documentary. There are so many themes that it's hard to detect a thread, but with *N is a Number: A Portrait of Paul Erdős* (1993) I got typecast as a biographer of mathematicians. It's a terrific niche; there's not a lot of competition.

Notices: Do you have any future projects planned involving mathematicians?

Csicsery: We just finished a feature-length documentary about the 2006 U.S. International Math Olympiad team. *Hard Problems: The Road to the World's Toughest Math Contest* also premiered in San Diego at the JMM in January 2008. It's available from the MAA on DVD. This was really a different kind of project for me, and I really enjoyed it. It's a great experience to work with the very brightest high school students, and to watch them stop and think before they answer a question. I think the film provides a glimmer of hope about the next generation.

During 2008 I hope to finish a small piece about Paul Halmos for the MAA that I started in 1999, and there are a few other projects in the planning stages that I'd rather not discuss. Somewhere down the road I would love to make a film about Coincidence.



Above: Still shots from the Julia Robinson movie. Top to bottom: Julia at 3, as a young woman, and shortly before her death.

Photos courtesy of Zala Films.

Visualizing the Sieve of Eratosthenes

David N. Cox

Every so often new technology is applied to an age-old problem to produce unexpected results. This article re-examines the Sieve of Eratosthenes. The Sieve is a one-dimensional device for finding prime numbers. The numbers from 2 to n are written as a single, long sequence. Then the multiples of 2 are crossed out but leaving 2. Then the multiples of 3 are crossed out but leaving 3. And so on until the only numbers remaining are the primes. This paper explores what happens if the procedure is converted from one dimension to two. Rather than a single sequence, a matrix is constructed such that in the first row every column is marked with a dot. In the second row, every other column is marked with a dot. In the third row, every third column is marked with a dot. In general, in the n^{th} row, every n^{th} column is marked with a dot. In this fashion a two-dimensional image is built for all n^2 cells. Results of this procedure as generated by computer software are presented in this article. Despite the simplicity of this method, when enough dots are generated, the resulting image turns out to be stunning. This article demonstrates well that computerized visualization can shed new light on old subjects—even those more than 2,000 years old.

According to [1] Eratosthenes lived from 276 to 194 BC. Only fragments of Eratosthenes's original documents have survived. However, a description of his sieve method for finding prime numbers was described in "Introduction to Arithmetic" by Nicomedes written sometime prior to 210 BC [2].

To use the method imagine a written sequence of numbers from 2 to n . Starting at 2 cross off every other number in the sequence except for 2 itself. When done, repeat for 3 (which will be

the next remaining number in the sequence) by crossing off every third number. When done, the next number remaining in the sequence will be 5. Repeat the process for every fifth number in the sequence. Continue with this process until you reach the end of the sequence. At the end of the process the numbers remaining in the sequence will be the primes.

This simple technique has been used for more than 2,000 years to find prime numbers. One would think that everything there is to know about the method has long since been discovered. Indeed, there are advanced sieve methods and optimization methods. However, these are significant variations of the original method and do not provide any additional characterization of the original method itself. After 2,000 years what more could be said?

This article explores the use of computerized visualization to further characterize the Sieve of Eratosthenes. After all, Eratosthenes didn't have a computer and computer graphics and visualization have only been widely available for the past 20 of those 2,000 years. With a simple extension of the Sieve we arrive at a novel result.

The Method

The method extends the Sieve of Eratosthenes from a one-dimensional sequence to a two-dimensional matrix. The method constructs a matrix of dots that can be easily viewed on a computer screen. The method is as follows. In the first row of the matrix every column contains a dot. This would correspond to crossing off every number in Eratosthenes's original sequence. In the original method this is not done. However, in two dimensions it proves useful.

In the second row of the matrix, every other column contains a dot starting with the second column. This corresponds to crossing off every other

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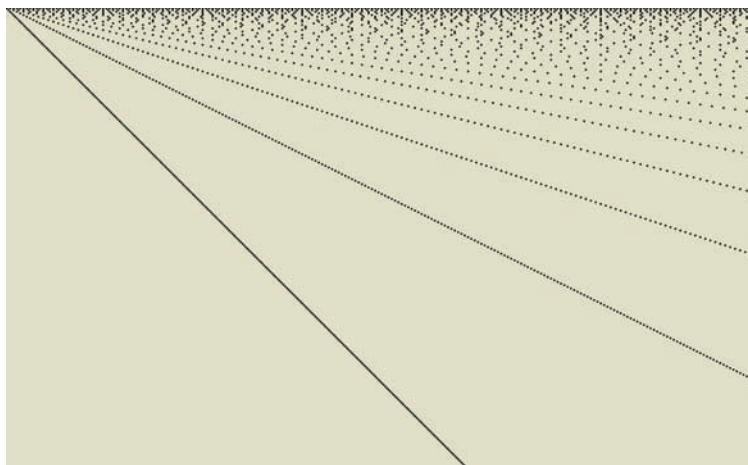


Figure 1.

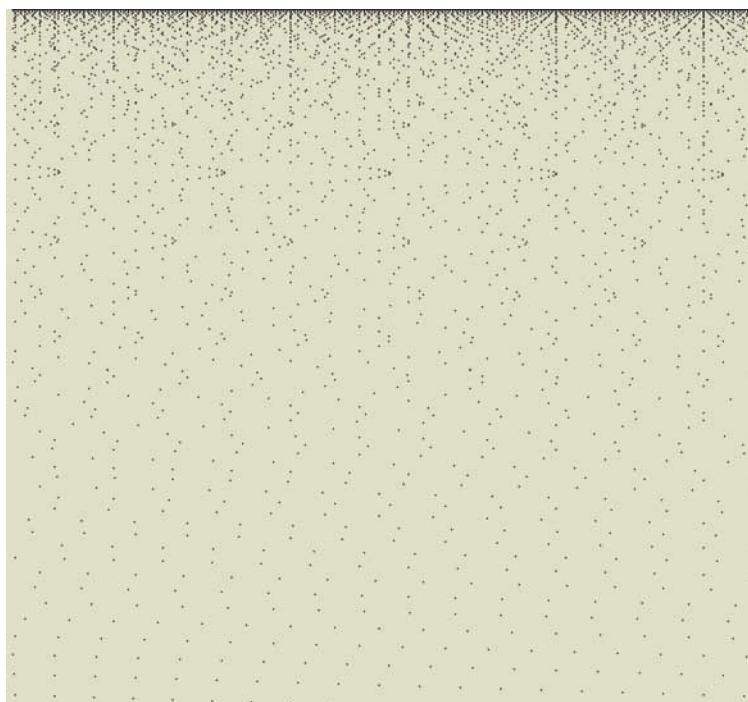


Figure 2.

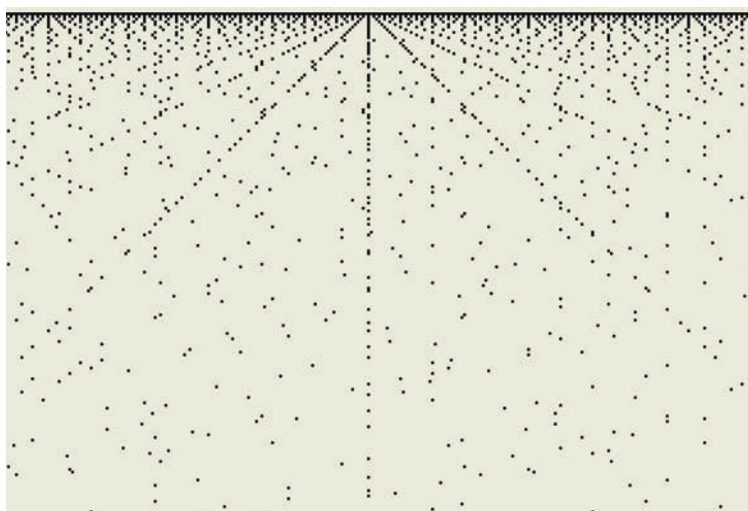


Figure 3.

number in the original sequence. In the third row, every third column contains a dot starting with the third column. Again, this corresponds to crossing off every third number in the original sequence. In general, in the n^{th} row, every n^{th} column contains a dot starting with the n^{th} column.

Aside from extending the one-dimensional sequence of length n to a two-dimensional matrix of size $n \times n$, the process of crossing off numbers (using dots) remains faithful to the original method with two differences. In the first row every number is marked with a dot. In the remaining rows every n^{th} number is marked with a dot including n itself. Consequently, even though 2 is not crossed off in Eratosthenes's original sequence, it is marked with a dot in row 2. The same holds for rows 3, 5, 7, etc. The implication of this is that a prime number corresponds to a column containing two dots—one in the first row (division by 1) and one in the n^{th} row (division by the number itself).

Using this method a computer program was created to generate a matrix containing 1 million columns and the first 1,000 rows. The matrix is easily converted into a binary bitmap for viewing. Because it is not possible to view the entire matrix on a computer screen, a scrolling facility was provided to traverse through the columns and rows.

The computer algorithm builds the image of the matrix with the first row at the top of the screen and the first column at the left. The only reason for doing this is because most computers address pixels beginning with (0,0) at the top left. Other orientations would also work. As will be shown, the resulting image has several interesting features.

Results

Figure 1 shows several hundred columns and rows beginning with column 1 on the left. The most striking feature is the set of diagonals. Close inspection of these diagonals reveals a pattern. The main diagonal has a slope of 1 and consists of contiguous dots. The adjacent diagonal has a slope of 2 and has a dot in every other column. The third diagonal has a slope of 3 and has a dot in every third column. And so on. Remarkably, these diagonals are constructed in exactly the same manner as the rows from which the image was constructed.

Figure 2 shows a portion of the matrix beginning at number 17918. Diagonals are apparent at the bottom of the image. Towards the top the dots merge into other patterns. From row 1 there are smaller diagonals radiating out from the top row. Several rows below appear parabolic-like structures.

Some of the diagonals radiating out from the first row will be very prominent. An example is 327600 as shown in Figure 3. This prominence is related to the number of dots in the central column. The more dots, the more prominent the

diagonals. This is easy to understand by considering that a dot represents that column c is evenly divisible by row r . Consider two rows, r_1 and r_2 , that both evenly divide column c . Clearly, if c is divisible by r_1 , then so is $c + r_1$. Similarly, $c + r_2$ is divisible by r_2 . Consequently a dot will be plotted at $(r_1, c + r_1)$ and another dot will be plotted at $(r_2, c + r_2)$. These points lie on a line with a slope of 1. The same reasoning can be extended to a dot at $(r_1, c + 2r_1)$ and another at $(r_2, c + 2r_2)$ which both lie on a line with a slope of 2.

Thus, while it is not immediately obvious, every column of points will have corresponding diagonals. What about the diagonals in Figure 1? What central column of points do they correspond to? If the procedure used to construct the matrix is extended to the left, we arrive at a result that is illustrated in Figure 4. There is a central column where every row contains a dot. The image to the left of this column is the mirror image of that to the right. Furthermore, the central column corresponds to the number 0.

Any binary image is easily represented numerically using 1's and 0's. Consequently, Figure 1 can be represented as in Figure 5.

Carrying this idea further, these numbers can be replaced by remainders. In other words, each cell will contain the value $c \bmod r$ where c and r are the column and row respectively. Doing so gives the result in Figure 6.

The central column of red numbers are the remainders of 15 divided by $1, 2, 3, \dots, 15$. Notice that these same remainders appear in the diagonals that are highlighted in red, yellow, and blue for easier reading. What is interesting is that every number will have a column of divisors that will be repeated in corresponding diagonals radiating out from the first row.

This simple method for visualizing the Sieve of Eratosthenes has resulted in surprisingly complex patterns. The set of dots in each column represents a set of divisors for that column. Extending out from each column is a set of diagonals with slopes of 1, 2, 3, etc. containing sets of dots that map 1-to-1 to the divisors in the corresponding column. This is true for every column.

Every column except for column 0 has a finite set of dots. Clearly every integer has a finite set of divisors while 0 is divisible by everything. Hence, column 0 contains an infinite set of dots.

The original Sieve is used to find prime numbers. In this method, the prime numbers are represented in the image as columns containing exactly two dots. Column c corresponds to a prime number if it contains a dot in row 1 and row c and nowhere else.

Alternatively, these images can be represented numerically using a matrix whose cells are filled with 1's and 0's. However, it is not necessary to limit the numerical representation to 1's and 0's.

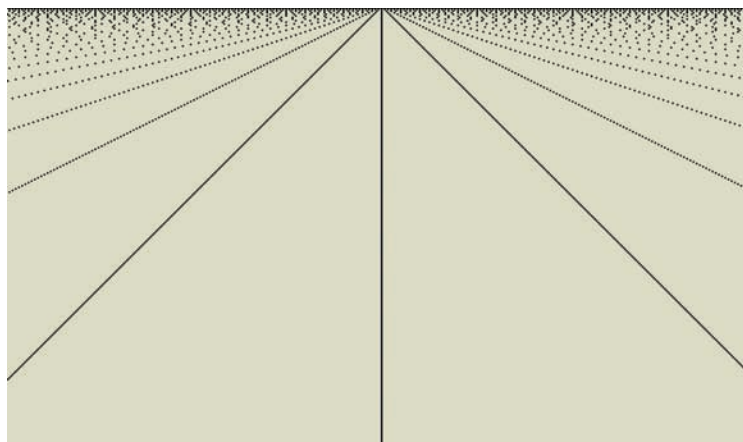


Figure 4.

1	1	1	1	1	1	1	1	1	1	1
0	1	0	1	0	1	0	1	0	1	0
0	0	1	0	0	1	0	0	1	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1

Figure 5.

The cells of the matrix can also be filled with remainders found by dividing each column by each row. Doing so reveals copies of each number's divisors along diagonals extending out from the first row. These diagonals have slopes of 1, 2, 3, etc.

These images are instructive in that they reveal that the divisors are not distributed randomly. There is repetition of each number's divisors along the diagonals that radiate from each number. Although a number's divisors radiate diagonally and are intertwined with those of other numbers, they do not interfere with another number's divisors. Interestingly, the spacing of the divisors along these diagonals mirrors the spacing of dots used to create the initial images.

Finally, there are other parabolic-like patterns that emerge in these images. The points of several of these patterns have been checked and verified that they do indeed lie on a true parabola. For example, the point corresponding to column 17956 and row 134 is a vertex of a left-opening parabola.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0
3	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	0
4	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	0
5	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	0
6	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	0
7	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	0
8	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	0
9	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8	0	1	2	3	0
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13	0	1	2	3	4	5	6	7	8	9	10	11	12	0	1	2	3	4	5	6	7	8	9	10	11	12	0	1	2	3	4	0
14	0	1	2	3	4	5	6	7	8	9	10	11	12	13	0	1	2	3	4	5	6	7	8	9	10	11	12	13	0	1	2	0
15	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	0	0
16	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	0
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18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	0	1	2	3	4	5	6	7	8	9	10	11	12	0
19	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	0
20	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	0	1	2	3	4	5	6	7	8	9	10	0
21	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	0	1	2	3	4	5	6	7	8	9	0
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23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	0	1	2	3	4	5	6	7	0
24	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	0
25	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	0	1	2	3	4	5	0
26	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	1	2	3	4	0
27	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	0	1	2	3	0
28	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	0	1	2	0
29	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	0	1	0
30	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	0	0

Figure 6.

The vertex of another left-opening parabola is nearby at column 18050 and row 95. In all cases up to number 1,000,000 the observed parabolas have all been left-opening. It remains to be proven that the points on all of these parabolic-like patterns do, in fact, lie on true parabolas and why. Furthermore, it remains to be proven if all such parabolas are left-opening and why.

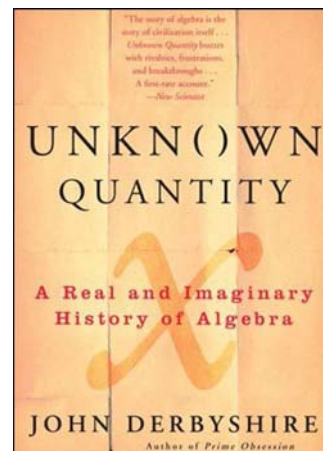
Clearly, these images illustrate the wonderful nature of the integers. Moreover, these images illustrate that even with a method more than 2,000 years old, a surprising new way of viewing the results can be found through the use of computerized visualization.

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Unknown Quantity

Reviewed by Sanford L. Segal



Unknown Quantity: A Real and Imaginary History of Algebra

John Derbyshire

2007, Plume

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This is not a book to give to anyone mathematically knowledgeable. It is appropriate for someone who knows precious little about mathematics and would like to find out more. As the author says in the first sentence of his introduction: “This book is a history of algebra, written for the curious non-mathematician.” The book is divided into three sections: The Unknown Quantity, Universal Arithmetic, Levels of Abstraction.

However, one has to know some mathematics to read such a history. Consequently, the author’s fifteen chapters are interspersed with “Math Primers”. The first of these precedes the first chapter of the book. It is perhaps good, first of all, to say what these “Math Primers” contain, since they are the mathematical substance of Derbyshire’s book, before proceeding to his history of algebra. The first one, which opens the book is on Numbers and Polynomials and begins with the “five Russian dolls” \mathbb{N} , \mathbb{Z} , \mathbb{Q} , \mathbb{R} , and \mathbb{C} . There is an explanation of why we need to extend the natural numbers and others of the “Russian dolls”, so $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R} \subset \mathbb{C}$. What it means for \mathbb{Q} to be dense is explained. The appearance of complex numbers in the sixteenth century is mentioned and $(1 + i)/\sqrt{2}$ is demonstrated to be \sqrt{i} (the distinction between i and $-i$ is not mentioned). A sequence of definitions explains polynomials.

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The second primer is on cubic and quartic equations (which, in fact, is where complex numbers made their necessary appearance—previously, in quadratic equations, complex solutions had been neglected under the assumption that “the solution does not exist”). This primer deals with the reduced cubic (called by the old term “depressed” by the author) and graphs (Derbyshire nowhere mentions that graphs did not exist for a long time, e.g., as late as Omar Khayyam). He explains the “irreducible case” and comments (in an endnote) how this is inappropriate terminology. A solution to the general cubic is given. Then comes the quartic solution (as in fact it did historically).

The primer on roots of unity includes Gauss’s solution of the constructibility of the heptadecagon (but not a geometric construction of it, nor a mention of Gauss’s diary entry). And there is a misprint: at the bottom of page 112, $k = 6$ should be $k = 5$.

The primer on Vector Spaces and Algebras is “an entirely modern treatment—using ideas and terms that began to be current around 1920”. Addition of vectors is defined, as is linear dependence (and independence), and also dimension and basis. It is emphasized that the concept of vector space is purely algebraic. Linear transformations are defined, as are the notions of projection and embedding. The dual of a vector space is defined, as is inner product. An algebra is defined as a vector space with a multiplication.

The last two math primers are Field Theory and Algebraic Geometry. Field Theory precedes the first chapter of Levels of Abstraction, Part III of the text. It mentions finite fields (with an example) and extension fields, pointing out that an extension field, say of \mathbb{R} , is a vector space over \mathbb{R} . Galois groups are defined (the ensuing chapter will talk further about Galois).

The final math primer is on algebraic geometry and begins first with conic sections and the eccentricity of an ellipse, to introduce the idea of invariant. All conic sections (including degenerate ones) are discussed. Points at infinity and projective geometry with its line at infinity and homogeneous coordinates are introduced. The topological distinction between the Euclidean plane, the projective plane, and the surface of a sphere is discussed. Also, the fact that the lines and points are in a certain sense interchangeable is discussed.

Derbyshire's book is written in a light informal style. Included in this style is a sort of potted history with random remarks by Derbyshire reflecting his historical prejudices. For example, on the *Rubaiyat* of Omar Khayyam, he says that Edward Fitzgerald's "translation" "was a great favorite all over the English-speaking world up to World War I" and is a "sort of death-haunted hedonism with an alcoholic threat somewhat prefiguring A. E. Housman." I do not know of an "alcoholic threat" in Housman, and Fitzgerald was read long after World War I. In fact, one disadvantage for Derbyshire's readers is that he has no bibliography. This, of course, allows his potted history of mathematical irrelevancies "to give the atmosphere" while remaining uncheckable.

Furthermore, Derbyshire does not take a great deal of effort to explain the mathematics not in his primers. For example, Omar Khayyam's use of the intersection of two quadratic curves to solve a cubic is noted on page 55. All he says, in discussing the cubic equation $2x^3 - 2x^2 + 2x - 1$, which he says has solution .647798871...but does not say where this comes from, is "Khayyam took an indirect approach, ending up with a slightly different cubic which he solved numerically via the intersection of two classic geometric curves." But he does not present this approach, nor even mention what the curves are. Thus we are left to marvel at Khayyam's ingenuity in solving somehow (not given) the geometric problem leading to a cubic equation (approximately, but not exactly (!) the one discussed). This sort of throwaway filler litters the book. Often where Derbyshire could say something intelligibly concrete to anyone, he avoids saying anything at all. He could, after all, say what Khayyam did instead of wasting sentences on what he did not do. This sort of remark extends itself to the copywriter of the dust jacket blurb who says: "Moving deftly from Abel's proof to the higher levels of abstraction developed millennia later by Galois..." (!) (As though Abel were in the Garden of Eden.)

Sometimes Derbyshire's "atmospheric" potted history leads him astray, e.g., he knows that Fibonacci means "filius Bonacci", but he does not mention that this name was first stuck on Leonardo of Pisa some six centuries after he lived (!),

or that Eduard Lucas is responsible for the term Fibonacci Sequence. Derbyshire quotes Fibonacci's real root of $x^3 + 2x^2 + 10x = 20$, but does not show (as Leonardo did) that it could not be rational (which is surely not beyond his intended audience).

In explaining that Khayyam spent his life under the rule of Seljuk Turks ($2\frac{1}{2}$ pages that are mathematically irrelevant), Derbyshire manages to insert his version of the origin of the Crusades in 1095 as a throwaway remark.

Derbyshire, in discussing Bombelli (who was the first to give rules for multiplying complex numbers), talks about his solution of $x^3 = 15x + 4$. Using Cardano's method for solving the cubic, he gets

$$x = \sqrt[3]{2 + \sqrt{-121}} + \sqrt[3]{2 - \sqrt{-121}}.$$

Then according to Derbyshire, "By some ingenious arithmetic he works out the cube roots to be $2 + \sqrt{-1}$ and $2 - \sqrt{-1}$, respectively." Adding of course produces 4. But he never produces the "ingenious arithmetic". Of course inspection shows that 4 is a solution. I do not know what Bombelli did, but cubing $a \pm ib$ and asking that a be 2 (since 4 was a solution) would give the required solution.

Derbyshire is not above presenting the usual idea of algebra as confusing, e.g., on page 90 or page 119. Similarly (endnote 30) he avoids giving the solution in general to Archimedes' cubic, though he does give the easy solution to one case.

In discussing analytic geometry, Derbyshire omits Fermat. In fact, while Descartes and Fermat both, in 1637, connected algebra and geometry, it was Fermat who took what seems today to be the more "modern approach" making the algebraic equation central.

Descartes brings us to the conclusion of Part I. Part II, entitled Universal Arithmetic, begins with Newton. Derbyshire's description of Newton, the person, leaves something to be desired. For example, it seems a bit much to call Newton's disputes with Hooke or Flamsteed "petty squabbles", and his persecution of Leibniz even beyond the grave does not sit well with the description of Newton as a "cold fish"; nor does his friendship with John Locke, nor his nervous breakdown in 1693, which followed frequent explosions of anger and depressions.

Chapter 7, entitled "The Assault on the Quintic" deals fairly with Ruffini, Lagrange, Vandermonde, and Abel. It ends with the declaration that the strictly chronological approach followed up to this point in the book will be dispensed with in the next few chapters. The chapter that follows deals reasonably with Hamilton and Grassman, though it does not mention the attraction that quaternions had for Maxwell, Tait, and their physics colleagues (though Maxwell is credited with using vectors to

“fill out the math” for Faraday’s lines of force). The fact that Faraday knew no mathematics is not mentioned.

After this, we swing back to the origins of matrices in ancient China. Derbyshire’s comments at the end of 9.6 (page 174) are typical of his “light writing”: “Matrices are, in short, the bee’s knees. They are tremendously useful, and any modern algebra course quite rightly begins with a good comprehensive introduction to matrices.” While anyone would agree that matrices are important, apparently Derbyshire has never heard of the late Paul Halmos’ *Finite Dimensional Vector Spaces*.

In talking about Sylvester (page 175), Derbyshire hints at homoeroticism. Hirst, who is cited innocently here, was more than a “mathematical hanger-on” (among other things he was a president of the London Mathematical Society). This sort of hint, or sexual remark, occupies Derbyshire elsewhere. For example, we learn that Henri III of France, though married, was “flamboyantly gay” and assassinated “while sitting on his commode” (whatever that has to do with the history of algebra).

On page 206, nearly one hundred pages after the quintic, which was addressed on page 115 ff., we reach Galois. Derbyshire mentions the novel about Galois by Tom Petsinis (who teaches mathematics in Australia), and, of course, E. T. Bell, whose fictionalization is dismissed, and the website by Tony Rothman, which updates his 1982 *American Mathematical Monthly* article (unmentioned). He does not mention Mario Livio’s *The Equation that Couldn’t be Solved*, also written for the general reader, which covers some of the same ground as Derbyshire’s book. Livio’s book also has a bibliography (so that the interested reader can pursue matters further).

Derbyshire puts a question mark after Ernest (page 210) to query Ernest Armand Duchatelet’s name, Galois’ supposed opponent in the fatal duel. As the opponent is identified in a newspaper article in Lyon, a good distance from Paris, as “L. D.”, he wants the first name to begin with L, as is clear on page 211. This is more potted history—if you don’t like the facts, change them.

Derbyshire makes it clear in an endnote that Liouville’s journal was founded many years before it published Galois’ papers. On page 218, the First Sylow Theorem is (half) mentioned, since the idea of normal subgroups is not mentioned until later. The last sentence on page 218 is another example of Derbyshire’s “light” writing: “...and it is infallibly the case, at any point in time that somewhere in the world is a university math department with a rock band calling themselves ‘Sylow and his p -subgroup’.” I suppose this made-up irrelevancy assures the reader that Derbyshire is a “regular guy”. On page 222, the size of the Fischer-Griess “monster” is given (presumably to horrify readers).

The next chapter is cutely titled “Lady of the Rings” who is, of course, Emmy Noether, though she only occupies the last two of nine sections of this chapter, which is mostly spent appropriately on Fermat’s Last Theorem, Kummer, and Dedekind. Incidentally, on page 253 there is not a picture of a Klein bottle (which is not explained) in a mathematical exhibit (since a Klein bottle requires four dimensions); but only a model of a Klein bottle. We are then led through “Geometry Makes a Comeback” (which consists of brief mentions of classical algebraic geometry, projective geometry, varieties, the Nullstellensatz, Riemann, the Erlangen Program, Lie).

The next chapter: “Algebraic This, Algebraic That” points out that the Möbius strip should be named for Listing (who first used the word *Topologie*, though *Analysis Situs* was popular for quite a while). This chapter also mentions intuitionism (à la Brouwer, though I do not know what that has to do with the history of algebra), algebraic number theory and p -adic numbers (which are explained), and ends with Lefschetz and Zariski. André Weil’s situation in World War II is mentioned but not Bourbaki (strangely for a book about algebra).

The last chapter “From Universal Arithmetic to Universal Algebra” ends essentially with Grothendieck. This is preceded by a description of category theory (where forming a field of fractions from an integral domain is described in terms of functors). For Grothendieck, Derbyshire gives one of the sources he rarely acknowledges, namely Allyn Jackson’s superb “As If Summoned from the Void”, *Notices*, October 2004 and November 2004.

While there are no mathematical errors visible in Derbyshire’s book, as this review makes clear, there is not much mathematical substance either. The treatment of most individuals is fair and accurate, with the occasional shock. Derbyshire’s book will be found excellent by those for whom it is written. They are not, however, mathematicians.



WHAT IS . . .

a Toric Variety?

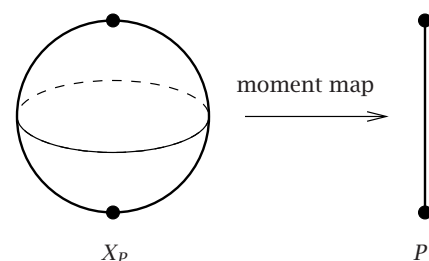
Ezra Miller

A toric variety X_P is a certain algebraic variety—or, over the real or complex numbers, a differentiable manifold with some singularities allowed—modeled on a convex polyhedron P . Examples include all (products of) projective spaces, which are modeled on (products of) standard simplices. Algebraically, toric geometry is the study of sparse polynomials, whose nonzero coefficients are attached to specified monomials. In general, toric varieties admit equivalent descriptions arising naturally in many mathematical areas, including symplectic geometry, algebraic geometry, theoretical physics, and commutative algebra, as we shall see. These perspectives, combined with intimate connections to pure and applied topics as wide-ranging as integer programming, representation theory, geometric modeling, number theory, algebraic topology, and enumerative combinatorics, lend toric varieties their importance, especially in view of their concreteness as examples.

In the symplectic setting [2], the space X_P is constructed by specifying a surjection to the polyhedron $P \subseteq \mathbb{R}^n$. The faces of P are all assumed to possess normal vectors with rational numbers for coordinates. (Thus P could be a regular cube but not a regular icosahedron.) The fiber over any point $p \in P$ is declared to be a real compact torus T^d —a product of d circles. The dimension of this torus equals that of the smallest face of P containing p . As p moves to the boundary of this face, a certain subtorus of the fiber is required to shrink and, at the boundary, collapse. Set theoretically, then, X_P is a disjoint union, over all faces F of P , of products $F^\circ \times T^{\dim(F)}$, where F° is the relative interior of F .

Example 1. If P is an interval of length ℓ then X_P is a sphere of diameter ℓ . The moment map collapses the circles of latitude, which shrink toward the north and south poles as their collapsed images move to the endpoints of P ; see the figure.

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Example 2. If P is the positive orthant in \mathbb{R}^n then X_P is the complex vector space \mathbb{C}^n . The moment map squashes each of the n copies of \mathbb{C} to a ray by collapsing the concentric circles around the origin to points. The decomposition of X_P as a disjoint union over the faces of P is $\mathbb{C}^n = \bigcup_I (\mathbb{C}^\times)^I$, where \mathbb{C}^\times is the group of nonzero complex numbers, and $(\mathbb{C}^\times)^I$ is the *algebraic torus* indexed by the subset $I \subseteq \{1, \dots, n\}$.

As in the figure, the projection $X_P \rightarrow P$ is called the *moment map*. It is an instance of a general construction wherein a particularly well-behaved group action on a symplectic manifold X induces a map from X to the dual of the group's Lie algebra.

When the vertices of P have integer coordinates, X_P is a disjoint union of algebraic tori, one for each face of P , as is \mathbb{C}^n . If P has dimension n , then X_P carries a global action of the algebraic torus $(\mathbb{C}^\times)^n$. Restricting to the piece of X_P corresponding to the interior P° yields the regular action of $(\mathbb{C}^\times)^n$ on itself. This description is definitive [3]: a *toric variety* over \mathbb{C} is a complex algebraic variety with an action of $(\mathbb{C}^\times)^n$ and a dense open subset isomorphic to $(\mathbb{C}^\times)^n$ carrying the regular action. That is, a toric variety is an algebraic torus orbit closure. The same works for fields other than \mathbb{C} , such as the real numbers \mathbb{R} or algebraically closed fields of positive characteristic. With this definition, the connection to polyhedra is a fundamental theorem: the quotient of a complex toric variety X_P by the global action of the compact torus $T^n \subseteq (\mathbb{C}^\times)^n$ is the moment map to P in the dual \mathbb{R}^n to the Lie algebra of T^n .

The term *variety* indicates a relation to polynomials, which occurs in this integer-vertex case. Any subgroup of $(\mathbb{C}^\times)^n$ isomorphic to $(\mathbb{C}^\times)^d$ has an orbit closure in \mathbb{C}^n through the point $(1, \dots, 1)$. This *affine toric variety* is parametrized by monomials: the inclusion $(\mathbb{C}^\times)^d \hookrightarrow \mathbb{C}^n$ takes (τ_1, \dots, τ_d) to $(\tau^{a_1}, \dots, \tau^{a_n})$, where $\tau^{a_i} = \tau_1^{a_{i1}} \cdots \tau_d^{a_{id}}$ is a monomial for each i . For example, the parabola in the plane \mathbb{C}^2 is the curve parametrized by $t \mapsto (t, t^2)$. Every toric variety has a finite open cover by affine toric varieties; hence torus orbit closures in \mathbb{C}^n are, in a toric sense, locally universal.

The parametrized view of (not necessarily affine) toric varieties is key in applications to geometric modeling, because every polynomial parametrization of a space is the projection of a monomial one. Thus projections of toric varieties over the real numbers generalize *Bézier curves*, which come from rational normal curves X_P , where P is an interval of integer length. Geometrically, the moment map carries the positive real part of a toric variety X_P homeomorphically to P itself, and the wavy polyhedral patch $X_P^+(\mathbb{R})$ can be used for modeling purposes. When P is a lattice triangle, for instance, $X_P^+(\mathbb{R})$ is a *Bézier triangle* in a Veronese embedding of the projective plane.

In commutative algebra, monomial parametrizations give rise to simple implicit equations. As with any variety in \mathbb{C}^n , an affine toric variety can be expressed as the set of points in \mathbb{C}^n where a family f_1, \dots, f_r of polynomials in variables x_1, \dots, x_n all simultaneously vanish. The crucial observation is that in the toric case, one can always choose all of the f_j to be *binomials*, of the form $x^u - x^v$ for some nonnegative integer vectors u and v of length n . The binomials can be interpreted as linear equations on the exponent vectors of the parametrizing monomials. In the parabola example, the parametrized curve $(x, y) = (t, t^2)$ is implicitly defined as the set of points where the binomial $y - x^2$ vanishes; this binomial says that the exponent on the second t -monomial is twice the exponent on the first one. In this way, the binomials for X_P encode crucial information about the lattice points in P , and the integer vectors joining them. Aside from endowing the vanishing ideal of X_P with particularly rich algebraic and combinatorial structure, the binomials thereby convert toric varieties into vehicles for investigating *integer programming*, where the goal is to find a (path to a) vertex of P that maximizes some given linear *cost function*.

The combinatorial structure of toric varieties makes various flavors of cohomology explicitly computable. These computations have surprisingly wide applications, the overarching idea being that the topology of X_P usefully distills the combinatorics of P itself, and vice-versa. For instance, *Brion's formula* interprets a statement in equivariant K -theory of toric varieties as a shockingly

elegant expression for the sum of the monomials corresponding to the lattice points in P . The underlying geometry is that global sections of holomorphic line bundles on X_P correspond to lattice points in polytopes related to P . Brion's formula is the key to A. Barvinok's polynomial-time algorithms for enumerating lattice points in polytopes. Concrete cohomological computations also form the basis for R. Stanley's approach to the enumerative combinatorics of polytopes. The question is how to count faces of convex polytopes. Translating into the toric world, Morse theory indicates an efficient way to encode the numbers of faces, and the Hard Lefschetz theorem from algebraic geometry implies unimodality for the encoded face numbers.

In theoretical physics, toric varieties arise in the context of *gauged linear sigma models*. Quantum field theory considers maps from a Riemann surface into \mathbb{C}^n , which carries an action of a compact d -torus T^d . Ground states for this theory, obtained by setting the potential energy to zero, constitute a certain fiber of the moment map of \mathbb{C}^n ; modulo gauge equivalence—the T^d -action—this results in a toric variety X_P . (When $n = 2$ and X_P is the complex projective line, gauge equivalence is the *Hopf fibration* $S^3 \rightarrow S^2$.) Duality for polytopes in this setting gives rise to the phenomenon known as *mirror symmetry*.

A huge amount of active research has ties to toric methods. The symplectic setting has seen increasingly deep Euler-Maclaurin type summation formulas. Generalizations of toric spaces are ubiquitous, including *log schemes*, which are toric étale locally; *quasitoric manifolds* and *torus manifolds*, which are more flexible topological versions of toric varieties; and *toric stacks*, which take geometric account of extra arithmetic data beyond the polyhedron P . For the purpose of pushing Stanley's enumerative combinatorics to the setting of nonrational polytopes, there has even been success in abstracting toric cohomological computations polyhedrally, without constructing any sort of toric space at all! The future will surely see other types of developments, as well.

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Evansville Honors the First Black Ph.D. in Mathematics and His Family

Talitha M. Washington

About four years ago I came across the Mathematicians of the African Diaspora website and discovered that the first Black in the world to earn a Ph.D. in mathematics was from my neighborhood in Evansville, Indiana. While growing up, no one talked to me about Elbert Frank Cox, who is the first Black in the world to earn a Ph.D. in mathematics. After stumbling upon Elbert, excitement came over me and then I became curious about who he was and what motivated him to be successful in mathematics.

In 2001 I became the second African American from Evansville to earn a Ph.D. in mathematics. Thus, I felt a personal responsibility and an obligation to give Evansville and the world an opportunity to thank Elbert for his accomplishments as they opened doors for me and many other mathematicians.

In 1895 Elbert Frank Cox was born to Johnson and Eugenia Cox at 715 Oak Street in Evansville, Indiana (which is located less than one mile from where I grew up). Elbert's father, Johnson D. Cox, was principal and teacher for over forty years at Third Avenue School. In those days the Evansville schools were segregated and Third Avenue School was an elementary school for African Americans. There is no confirmation that J. D. had an advanced degree but it was common to not have a college degree before entering the teaching profession. However, J. D. did further his education by taking courses at Indiana University in the summer of 1927 and the summer and fall of 1928. He continued his studies by completing four summer courses from 1930 to 1939 at Evansville College, which is now my place of employment, the University of Evansville. J. D. Cox must have known

the value of an education which then led him to encourage his son, Elbert, to succeed.

In 1913 Elbert graduated from Clark High School and enrolled at Indiana University. In 1915 Cox joined Kappa Alpha Psi, which is a Black fraternity that emphasizes achievement. When Cox received his transcript from IU, it had "Colored Student" printed across the top. At that time it was common for colleges and universities to distinguish race on an academic transcript. By doing so, employers would immediately know if the person was Black so that they could grant or deny a position based on race.

After graduation, Cox taught for a year at Alves Street School in Henderson, Kentucky. Later he entered the U.S. Army and taught at Shaw University. He had enrolled in summer graduate classes at Cornell University as early as 1920 to learn more about science. After a couple of years Cox left Shaw to study mathematics at Cornell University. Under the supervision of William Lloyd Garrison Williams, Cox completed and successfully defended his dissertation "Polynomial Solutions of Difference Equations". In 1925 he became the first African



Photograph courtesy of the author.

The author and the plaque dedicated to J. D. Cox and his son Elbert Frank Cox in Evansville, Indiana.

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American to receive a Ph.D. in mathematics and the first graduate of an Evansville high school to receive a Ph.D. degree. Ironically and sadly, during the year that Elbert joined an elite group of only twenty-eight men who were awarded Ph.D.'s in mathematics in the country, thirty-one Black men were lynched.

After leaving Cornell he went on to become the head of the Math and Physics Departments at West Virginia State University. In the summers he would visit his brother, Avalon, in Princeton, Indiana. At Avalon's church, Bethel African Methodist Episcopal Church, he met Beulah Kaufman and married her after a six-year courtship. In 1929 he joined the faculty at Howard University. In those days many Black scholars migrated to Howard University. In 1929 Cox joined the faculty, and by 1943, Howard University employed five of the eight Black math Ph.D.'s. Cox retired in 1965 and passed on in 1969.

Sometimes I wonder if J. D. Cox knew that his passion for education would encourage his son to become a trailblazer for so many. On November 18, 2006, Evansville welcomed J. D. Cox's grandson and great-grandchildren to a dedication ceremony of a plaque at Liberty Baptist Church. In the main hallway of the Liberty, one can still find J. D. Cox's picture hanging on the wall.

The ceremony stirred up various emotions of thanks and gratitude from the Cox family for their forefathers. J. D.'s great-grandson, Elbert Lucien Cox Jr., spoke about how the educational legacy of his family contributed to his accomplishments. He now serves as a program manager for NASA (National Aeronautics and Space Administration). J. D.'s grandson was touched by the presence of the brothers of the Kappa Alpha Psi Fraternity who proudly wore the red blazers in their support of their Kappa brother, Elbert. At the end of the ceremony the Cox family was moved by J. D.'s students as they stood up and gave testimonials about how he encouraged and inspired all children to do better.

On that day, the Evansville-Vanderburgh School Corporation, University of Evansville, University of Southern Indiana, and Ivy Tech Community College joined together to support the plaque that reads:

HOME OF

JOHNSON DUNCAN COX

J. D. COX (1873-1952) WAS A TEACHER AND PRINCIPAL AT THIRD AVENUE SCHOOL FOR 40 YEARS. IN 1925, HIS SON, ELBERT FRANK COX, BECAME THE FIRST GRADUATE OF AN EVANSVILLE HIGH SCHOOL TO RECEIVE A Ph.D. DEGREE AND THE FIRST AFRICAN AMERICAN TO EARN A Ph.D. IN MATHEMATICS

My hope is that a child will stroll by the plaque, pause, and then read it and become amazed. The



Photograph courtesy of Liberty Missionary Baptist Church.

Photograph which hangs in the hallway of the Liberty Baptist Church. J. D. Cox is in the middle row, second from the left.

child will realize that "if Elbert could earn such a high degree in mathematics, then I can do anything." Behind the child, a parent will follow, and after reading the plaque, the parent will gaze at the nearby tulip tree and know that her child has no limitations in this world. The parent will know that J. D.'s passion for education helped his son succeed, and will become encouraged to value her own child's education. When the child becomes frustrated in mathematics, the parent will provide a kind reminder about the man named Cox who broke through racial barriers and stereotypes to become the first African American to earn the Ph.D. in mathematics.



Ask Professor Nescio

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

—Andy Magid

Dear Professor Nescio,

I'm wrapping up my Ph.D. thesis and will graduate the end of this semester. My advisor just told me that he thinks we should submit my thesis results as a joint paper. Some of my fellow grad students tell me that this is a good idea because my advisor is so famous, but others say it's a bad idea because it will look like the thesis work is his, not mine. Of course I don't want to make my advisor mad at me at this stage. What should I tell him?

—*Troubled*

Dear Troubled,

Understand that the answer to this question is tricky. A correct answer, if it exists, would depend on a lot of additional information not contained in your query. Even with additional information, I can almost guarantee the solution is not unique and you have to try for a solution that optimizes some set of criteria.

The fact that your advisor is "famous" says that he/she really doesn't need to pad his/her publication list; therefore the motive for putting his/her name on the paper lies elsewhere. (Unless, that is, the advisor is an insecure egomaniac. It's not impossible for a famous person to have an uncontrollable desire to plaster their name everywhere but the walls of a public toilet. If that's the case, grin and bear it. Contesting this is likely to lead to a confrontation.)

If, on the other hand, all is normal, there is a spectrum of responses, and I would ask you some additional questions if we were talking over a glass of wine (or beverage of your choice). The first question is the obvious one: Did your advisor prove any of your theorems? I am going to assume the answer to this one is "No," since the opposite indicates a clear answer. Maybe the next question I would ask you is, "Do you like your advisor?" If that strikes you as an odd question in these circumstances, let me say that I have met mathematicians having the

entire spectrum of feelings about their advisor. If you really like him/her, then I would suggest the two of you sit down and have a friendly conversation where you express your concerns. So let's assume your feelings are somewhere between indifference and dislike and you don't feel comfortable approaching this directly.

Understand that advising a Ph.D. student is hard work. In many cases, even when the thesis is published only by the student, there is a lot of the advisor's energy and creativity in the work. This is hard to measure but is certainly a reason why some advisors want their name on the student's work. Some have even told me that each doctoral student is one less paper in their bibliography. Thus the request is neither unique nor entirely unreasonable. I think the assumption of most mathematicians is that the advisor has helped the student with the dissertation. In some cases that may be an unfair assumption. Having both names on the paper reinforces the perception. Nevertheless understand a fundamental fact. When you talk about the thesis at a conference or in a colloquium, one of two things is going to happen. Either you will dispel that notion and affirm your dominance or equality as a contributor, or you will convince the audience that your advisor's input was even more significant than originally thought. In other words, having a joint paper with your advisor is unlikely to affect the mathematics community's pre-conceived view of the work, and only you can convince them you were the driver.

Incidentally, some of your friends are correct. Given that your advisor is famous, there could be a benefit to shared authorship: people are more likely to look at the paper seriously. Yes, the content will ultimately determine whether the research is judged meritorious, but name recognition draws quick attention.

I have had several doctoral students and have contributed to their theses in different ways—occasionally with a good idea, sometimes just as a

cheerleader, and sometimes as the person who plants a kick in an appropriate place at the appropriate time. Some students probably thought I contributed less than I think I did, some thought the opposite. I generally avoided trying to be a co-author and sometimes I had to insist to the student that they should publish solo. So if your advisor were asking me, I'd advise letting you publish under your name alone.

In summary, this is one of those questions that have many possible correct answers. I hope that even if I haven't answered your question, I have provided a bit of perspective so you can come to your own conclusion.

—*Respectfully,*
Professor N. N.

Dear Professor Nescio,

I'm up for tenure along with three other assistant professors. The tenure committee has asked me, and not the others, to meet with them to talk about my research. All our dossiers are pretty similar. Should I be worried about this "special" treatment?

—*Flummoxed*

Dear Flummoxed,

Professor Nescio is shocked! Shocked that in this day and age a tenure committee does not understand that all candidates must be approached and treated the same. Whether you should be worried or not is unclear, but I cannot imagine a reason for such a singular meeting.

I would hope that after the time you have spent at your university you have made a good friend in the tenured ranks—a mentor, a confidant, a senior researcher in your area who values your work. (If you haven't, this may be a cause for greater concern than your singular treatment.) Approach this person or the department chair and mention this turn of events. If you can do this casually during an encounter in the hallway, all the better since this will seem to say the request is not a major event in your life. (Sometimes a trace of naiveté is useful.) It's likely they will be surprised and can, perhaps, get to the bottom of this matter. In the meantime, agree to the meeting.

Frankly, if you were denied tenure and the others were not, you might have grounds for a lawsuit. I am not a lawyer, but it is my understanding that most of the lawsuits that concern tenure or promotion are based on procedural issues, not the final decision.

—*Respectfully,*
Professor N. N.

Dear Professor Nescio,

I am working on my thesis and have written two papers, which I posted on the arXiv and submitted

for publication. I received an email from a mathematician who said that he and a co-author were working on some of the same problems treated in my papers. Although their work is not available as a preprint, he said they had lectured on this subject and suggested that I acknowledge their work in my papers. They have now sent me a preprint. Do I need to acknowledge their work in my papers?

—*Confused*

Dear Confused,

This is an innocuous request. Strictly speaking, there is no necessity to acknowledge their work, but what will you lose if you do? Since you now have their preprint, a footnote along the following lines might be good: "Upon seeing my paper on the arXiv, Professor X kindly informed me of his work with Professor Y [here cite the preprint] that is related to the present work." This does three things. First it informs the interested reader of additional information on the subject, thus furthering the advance of mathematics. Second it extends a professional courtesy to Professors X and Y, who, given that they are working in your area, may be of assistance in the future. Finally it firmly proclaims that you did not have access to their ideas when you were doing your research. Then you should inform Professor X about what you are doing and urge him/her to post his preprint on the arXiv. It may well be that at some point in the future you too will ask for such a professional courtesy.

So, gentle supplicant, understand, as you begin your voyage across that wide sea of discovery that we call a career, that even though this voyage is fraught with peril, every swell in that sea is not a portent of an approaching storm.

—*Respectfully,*
Professor N. N.

Dear Professor Nescio,

The referee report for a recent paper of mine suggested that I add citations to several papers by a certain author, which are only peripherally related to my paper. I suspect that the author is the referee and that he is simply trying to promote his own work. And yet, in order for the paper to be accepted, I am supposed to revise it in accordance with the referee's comments. How can I handle this situation?

—*Baffled*

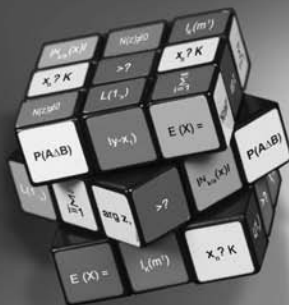
Dear Baffled,

Your suspicion sounds realistic and Professor Nescio understands your reluctance to comply. He understands pride, having enough of this trait that some humble folks of a religious bent might accuse him of possessing this one of the seven deadly sins. No one likes to be asked for such a revision that

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seems to be pandering to an anonymous force. Nevertheless let us ask, "How accurate is your use of the word 'peripherally'?" This will be difficult, but try to objectively assess the relation of the references to your work. Then ask, "Does including the reference damage my work?" With the added detachment that time brings, you might be able to address these issues correctly, and the answers to the questions should indicate your response.

Your situation reminds me of a pair of referee reports I received at an early stage of my career. In one of these cases my paper solved a problem raised in another mathematician's work. I included a different proof of one of his results, and I said in the paper that my proof was easier. The referee, who I strongly suspect was the original author, said he didn't see that my proof was easier. Professor Nescio was proud of his proof. Nevertheless, he removed the offending word, kept the proof in his paper, and said, "The following is an alternate proof." This satisfied the referee, though to this day I think my proof was easier.

In the other case I was more forceful because the referee was off base. After having held onto my paper for about 18 months, he returned a report only after I had prompted the editor to prod this negligent mathematician. In the report he said that the proof of my main theorem could be shortened by using a result that appeared in a standard reference. In fact the referenced result was connected to mine only by the fact that they both belonged to the same area of mathematics; there was no connection between the hypotheses and conclusions of the two. Even at this tender age Professor Nescio was quite disturbed by such a lack of professionalism. After making some other, minor changes called for by the referee, I sent the manuscript back to the editor with the following statement in my cover letter. "I fail to see the relevance of the referee's comment number 6." I was notified in about three weeks that the paper was accepted.

I have included these two tales from my past to indicate that there is a wide spectrum of possible responses to a referee's report and to illustrate that such a report need not be slavishly heeded. You are a professional mathematician, and your opinion is valid. Your opinion of your own paper is not objective, but it has merit.

Returning to your situation, it sounds like it is closer to the first of my two experiences. Nevertheless, if you truly find including the references to be offensive, tell the editor that this is the case, state your reasons, and ask for his/her advice and/or intervention. Remember that an editor is not supposed to be a mere paper processor but to exercise judgment.

—Respectfully,
Professor N. N.

Kontsevich and Witten Receive 2008 Crafoord Prize in Mathematics

The Royal Swedish Academy of Sciences has announced the recipients of the Crafoord Prize in Mathematics and Astronomy 2008.

The mathematics portion of the prize is awarded jointly to MAXIM KONTSEVICH, Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France, and EDWARD WITTEN, Institute for Advanced Study, Princeton, NJ. The two were cited “for their important contributions to mathematics inspired by modern theoretical physics”.

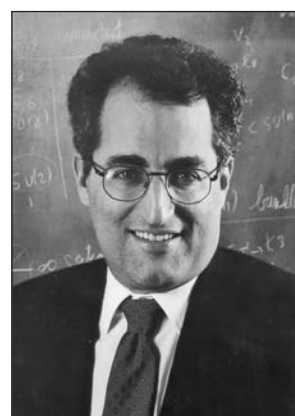
The laureates in mathematics have used the methodology of physics to develop a revolutionary new mathematics intended for the study of various types of geometrical objects. Their work is not only of great interest in the discipline of mathematics but may also find applications in totally different areas. Its results are of considerable value for physics and research into the fundamental laws of nature. According to string theory, which is an ambitious attempt to formulate a theory for all the natural forces, the smallest particles of which the universe is composed are vibrating strings. This theory predicts the existence of additional dimensions and requires very advanced mathematics. The laureates have resolved several important mathematical problems related to string theory and have in this way paved the way for its further development.

Maxim Kontsevich was born in 1964 in Khimki, Russia. He received his Ph.D. in mathematics in 1992 at the University of Bonn. He is a professor at the Institut des Hautes Études Scientifiques. He received the Fields Medal in 1998.

Edward Witten was born in 1951 in Baltimore, MD. He received his Ph.D. in physics in 1976 from Princeton University. He is the Charles Simonyi Professor in the School of Natural Sciences at the Institute for Advanced Study in Princeton. He received the Fields Medal in 1990.



Maxim Kontsevich



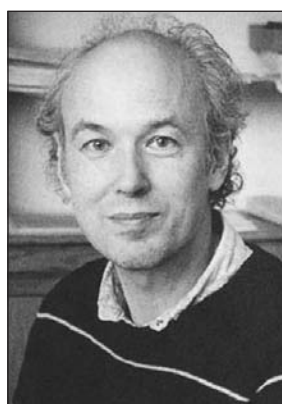
Edward Witten

The amount of this year's Crafoord Prize is US\$500,000. Kontsevich and Witten are awarded one half, and the other half is awarded to Rashid Sunyaev, an astrophysicist who is receiving the astronomy prize. The prize-awarding ceremony will take place at the Academy in Stockholm on April 23, 2008, in the presence of His Majesty the King.

The Royal Swedish Academy of Sciences, founded in 1739, is an independent organization whose overall objective is to promote the sciences and strengthen their influence in society. Traditionally, the Academy takes special responsibility for the natural sciences and mathematics.

*—From a news release of the Royal Swedish
Academy of Sciences*

Deligne, Griffiths, and Mumford Receive 2008 Wolf Prize



Pierre R. Deligne



Phillip A. Griffiths



David B. Mumford

Prize in Mathematics is available on the website of the Wolf Foundation, <http://www.wolffund.org.il>.

Description of Prizewinners' Work

The following description of the work of Deligne, Griffiths, and Mumford was prepared by the Wolf Foundation.

The 2008 Wolf Prize in Mathematics has been awarded jointly to three individuals:

PIERRE R. DELIGNE, Institute for Advanced Study, Princeton, "for his work on mixed Hodge theory; the Weil conjectures; the Riemann-Hilbert correspondence; and for his contributions to arithmetic";

PHILLIP A. GRIFFITHS, Institute for Advanced Study, Princeton, "for his work on variations of Hodge structures, the theory of periods of abelian integrals, and for his contributions to complex differential geometry"; and

DAVID B. MUMFORD, Brown University, "for his work on algebraic surfaces; on geometric invariant theory; and for laying the foundations of the modern algebraic theory of moduli of curves and theta functions."

The US\$100,000 prize will be presented by the president of the State of Israel in a ceremony at the Knesset (parliament) in Jerusalem on May 25, 2008. The list of previous recipients of the Wolf

Prize in Mathematics is available on the website of the Wolf Foundation, <http://www.wolffund.org.il>. Central to modern algebraic geometry is the theory of moduli, i.e., variation of algebraic or analytic structure. This theory was traditionally mysterious and problematic. In critical special cases, i.e., curves, it made sense, i.e., the set of curves of genus greater than one had a natural algebraic structure. In dimensions greater than one, there was some sort of structure locally, but globally everything remained mysterious. The two main (and closely related) approaches to moduli were invariant theory on the one hand and periods of abelian integrals on the other. This key problem was tackled and greatly elucidated by Deligne, Griffiths, and Mumford.

David B. Mumford revolutionized the algebraic approach through invariant theory, which he renamed "geometric invariant theory". With this approach, he provided a complicated prescription for the construction of moduli in the algebraic case. As one application he proved that there is a set of equations defining the space of curves, with integer coefficients. Most important, Mumford showed that moduli spaces, though often very complicated, exist except for what, after his work, are well-understood exceptions. This framework is critical for the work by Griffiths and Deligne. Classically, the moduli space of curves was parameterized by using periods of the abelian integrals on them. Mathematicians, e.g., the Wolf Prize winner André

Weil, have unsuccessfully tried to generalize the periods to higher dimensions.

Phillip A. Griffiths had the fundamental insight that the Hodge filtration measured against the integer homology generalizes the classical periods of integrals. Moreover, he realized that the period mapping had a natural generalization as a map into a classifying space for variations of Hodge structure, with a new non-classical restriction imposed by the Kodaira-Spencer class action. This led to a great deal of work in complex differential geometry, e.g., his basic work with Deligne, John Morgan, and Dennis Sullivan on rational homotopy theory of compact Kähler manifolds.

Building on Mumford's and Griffiths' work, Pierre R. Deligne demonstrated how to extend the variation of Hodge theory to singular varieties. This advance, called mixed Hodge theory, allowed explicit calculation on the singular compactification of moduli spaces that came up in Mumford's geometric invariant theory, which is called the Deligne-Mumford compactification. These ideas assisted Deligne in proving several other major results, e.g., the Riemann-Hilbert correspondence and the Weil conjectures.

Biographical Sketches

Pierre R. Deligne was born in 1944 in Belgium. Starting in 1967, he was a visitor at the Institut des Hautes Études Scientifiques, where he worked with Alexander Grothendieck. Deligne received his *doctorat en mathématiques* in 1968 and his *doctorat d'état des sciences* in 1972, from the Université de Paris-Sud. He was a professor at the IHÉS from 1970 until 1984, when he took his current position as a professor at the Institute for Advanced Study in Princeton. Deligne received the Fields Medal in 1978, the Crafoord Prize in 1988, and the Balzan Prize in 2004.

Phillip A. Griffiths was born in the United States in 1938. He received his Ph.D. from Princeton University in 1962 under the direction of Donald Spencer. Griffiths has held positions at University of California, Berkeley (1962–1967), Princeton University (1967–1972), Harvard University (1972–1983), Duke University (1983–1991), and the Institute for Advanced Study (1991 to the present), where he was director until 2003. He received the AMS Steele Prize in 1971.

David Mumford was born in England in 1937 but grew up in the United States from 1940 on. He was an undergraduate and graduate student at Harvard University, where he received his Ph.D. in 1961, under the direction of Oscar Zariski. Mumford was on the faculty at Harvard until 1996, when he moved to Division of Applied Mathematics at Brown University. He received the Fields Medal in 1974 and the AMS Steele Prize in 2007.

—Allyn Jackson

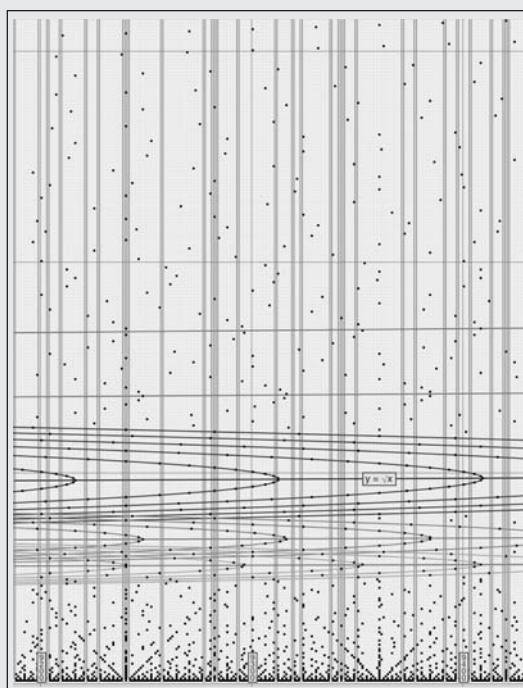
About the Cover

Patterns of factorization

This month's cover is derived from David N. Cox's article on the arithmetic sieve. The pixels in the column above n are at heights equal to the divisors of n . The primes are characterized in this figure by yellow columns.

Clues in the cover image ought to help in figuring out the origin of the parabolas Cox observes. Various other views of Cox's factorization images will bring to light other interesting patterns, but none seem to involve deep number theory. What's astonishing is how good the human eye is at perceiving regular patterns in a noisy background.

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



Taubes Receives NAS Award in Mathematics



Clifford H. Taubes

CLIFFORD H. TAUBES has received the 2008 NAS Award in Mathematics from the National Academy of Sciences. He was honored “for groundbreaking work relating to Seiberg-Witten and Gromov-Witten invariants of symplectic 4-manifolds, and his proof of the Weinstein conjecture for all contact 3-manifolds.”

The NAS Award in Mathematics was established by the AMS in commemoration of its centennial, which was celebrated in 1988. The award is presented every four

years in recognition of excellence in research in the mathematical sciences published within the past ten years. The award carries a cash prize of US\$5,000. Previous recipients are Robert P. Langlands (1988), Robert MacPherson (1992), Andrew J. Wiles (1996), Ingrid Daubechies (2000), and Dan Virgil Voiculescu (2004).

The Work of Clifford Taubes

The *Notices* asked D. Kotschick, Ludwig-Maximilians-Universität München, and T. S. Mrowka, Massachusetts Institute of Technology, to comment on the work of Taubes. They responded:

“By his own account, Cliff Taubes would like to be considered a topologist. Ignoring this wish, most of his colleagues see him as a great geometric analyst, whose work has had a profound impact on geometry, topology and mathematical physics.

“Starting out in mathematics with a physics background, Taubes did some of the early foundational work in mathematical gauge theory studying vortices and Bogomolny monopoles and building up a substantial existence theory for the self-dual Yang-Mills, or instanton, equations on

four-manifolds. The latter was, of course, crucial in Donaldson’s celebrated application of gauge theory to four-dimensional differential topology. Taubes himself proved the existence of uncountably many exotic differentiable structures on R^4 ; he reinterpreted Casson’s invariant in terms of gauge theory and proved a homotopy approximation theorem for Yang-Mills moduli spaces. Taubes also proved a powerful existence theorem for anti-self-dual conformal structures on four-manifolds.

“When Witten proposed the study of the so-called Seiberg-Witten equations in 1994, Cliff Taubes was one of the handful of mathematicians who quickly worked out the basics of the theory and launched it on its meteoric path. From an analyst’s point of view, the quasi-linear Seiberg-Witten equations may seem rather mundane, at least when compared to the challenges offered up by the Yang-Mills equations. True to this spirit, Taubes announced at the time that he would never again write a paper more than twenty pages long. Of course, this resolution lasted only for about six months! After that, Taubes wrote a whole series of deep, technical, and very long papers that became known by the slogan ‘Seiberg-Witten = Gromov’. These papers establish the most profound results known to this day about the Seiberg-Witten equations, linking their solutions on symplectic four-manifolds to Gromov’s pseudo-holomorphic curve theory in a very precise way.

“Taubes’s work on the Seiberg-Witten equations remains one of the cornerstones underpinning the current very productive symbiosis between symplectic geometry and low-dimensional topology. Nevertheless, it was a shock to many when Taubes knocked off one of the holy grails of symplectic topology last year. The Weinstein conjecture predicts the existence of periodic orbits for the Reeb flows of arbitrary contact forms on closed three-manifolds. Many special cases had been proved by a variety of methods from symplectic geometry,

and a proof of the full conjecture was one of the ultimate goals of symplectic field theory. However, Taubes's proof follows a rather different line, using gauge theory and deploying a strategy similar to his work on 'Seiberg-Witten = Gromov'. The proof also hinges on a novel estimate for the spectral flow of a family of Dirac-type operators.

"It is in the nature of Cliff Taubes's work that his papers are not usually short or easy to read. Rather they are difficult and original, and technically demanding by necessity. His faithful readers take comfort in the knowledge that Cliff is at least as hard on himself as he is on the readers, and they appreciate his very personal style peppered with what they affectionately refer to as 'Cliffisms'."

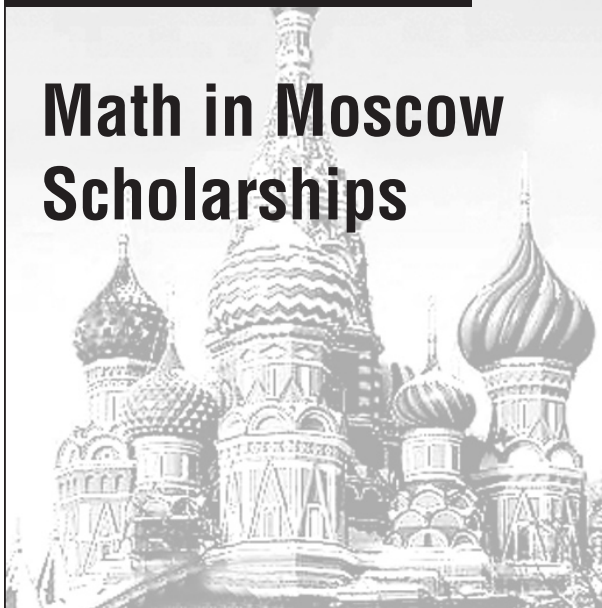
Biographical Sketch

Clifford Taubes grew up in Rochester, New York. After his undergraduate education at Cornell University, he received a Ph.D. in physics from Harvard University in 1980. After a Harvard Junior Fellowship, taken in the mathematics department at Harvard, he taught for two years at the University of California, Berkeley. Since 1985 he has been at Harvard, where he is the William Petschek Professor of Mathematics. He received the AMS Veblen Prize (1991) and the Élie Cartan Prize of the French Mathematical Society. He is a member of both the American Academy of Arts and Sciences and of the National Academy of Sciences.

—Allyn Jackson

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Contact: Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294, USA; telephone: 800-321-4267, ext. 4170; email: student-serv@ams.org.



2008 Award for an Exemplary Program or Achievement in a Mathematics Department

The Award for an Exemplary Program or Achievement in a Mathematics Department was established by the AMS Council in 2004 and was given for the first time in 2006. The purpose is to recognize a department that has distinguished itself by undertaking an unusual or particularly effective program of value to the mathematics community, internally or in relation to the rest of society. Departments of mathematical sciences in North America that offer at least a bachelor's degree in mathematical sciences are eligible. The award carries a cash prize of US\$1,200 and is given annually.

The award is presented by the AMS Council acting on the recommendation of a selection committee. For the 2008 award, the members of the selection committee were: Steven A. Bleiler, Joel B. Brawley, Karl Knight (chair), Donal B. O'Shea, and Roger A. Wiegand.

The previous recipients of the award are Harvey Mudd College (2006) and the University of California, Los Angeles (2007).

The recipient of the 2008 Award for an Exemplary Program or Achievement in a Mathematics Department is the THE MATHEMATICS DEPARTMENT AT THE UNIVERSITY OF IOWA. What follows is the selection committee's citation.

Citation

The American Mathematical Society (AMS) presents its third annual Award for an Exemplary Program or Achievement in a Mathematics Department to the University of Iowa. The Mathematics Department at the University of Iowa is a national leader in recruiting and developing underrepresented U.S. minority doctoral students in mathematics. The department has accomplished this by devising a model for recruiting and developing U.S. minority doctoral students that could be used at other institutions.

The department's long-term commitment to graduate education in mathematics for students from underrepresented minority groups began in 1995 and has continued with support from several Department of Education grants. African American,

Latina/o, and Native American U.S. citizens or permanent residents accounted for 20–25 percent of the department's graduate student population over the six-year period ending in 2005. This is an especially impressive percentage, given Iowa's demographics, and is currently among the highest at U.S. majority institutions.

The department's recruitment effort is supported by a carefully designed program that includes an intensive summer institute, weekly help sessions, and intensive faculty and peer mentoring. The program is open to majority students as well and, as often happens with well-designed programs developed for particular groups, has raised the level of educational achievement for all students. It has also made an impressive difference on a national level. The three minority students that received their Ph.D.'s in the department in 2002–2003 represented roughly 10 percent of the math doctorates awarded nationally to U.S. minority students during that year.

Members of the University of Iowa's Mathematics Department have willingly shared their methods with other departments at invited talks and conferences, including a session at a national AMS meeting and at a conference at NSF [National Science Foundation]. Furthermore, the department has established partnerships with other institutions in the United States and abroad that support the goal of increasing minority participation in mathematics. For example, the University of Iowa Mathematics Department has worked with the Department of Mathematics at Florida A&M University to build a partnership called the Alliance for the Production of African American Ph.D.'s in the Mathematical Sciences, supported by a US\$1.8 million NSF grant, with the goal of providing a seamless transition for graduates of Alliance undergraduate institutions who wish to study at majority Ph.D. institutions.

The mathematics community is fortunate to have the University of Iowa present such an outstanding example of an exemplary program in a mathematics department.

University of Iowa Wins Exemplary Program Award

Allyn Jackson

We are happy to get the awards, but we are even happier to watch the students get Ph.D.'s.

—Philip Kutzko

In the mid-1990s, the mathematics department at the University of Iowa decided to apply for a large government grant to support fellowships for graduate students. The aim was to use the grant to recruit students from minority groups that are underrepresented in mathematics. Eight such students came. Some did well, others less well. One finished a doctorate in the department; others had new doors opened to them: One ended up getting an MBA, and another earned a Ph.D. in computer science. But the department did not stop there. Rather, faculty members got to know the students and tried to understand the factors behind their achievements and setbacks. The experience of bringing in those eight students put the department on a new path. "What happened as a result of that first year or two is, we began to change as a department," says Iowa faculty member Philip Kutzko. "It's a bit funny to say it this way, but we started to become a little less white."

Nowadays if you ask members of the Iowa department about their minority students, they can hardly stop rattling off the success stories. There is Juan Ariel Ortiz, who came from the University of Puerto Rico at Humacao, fell in love with topology, and is now a postdoc at the University of Rochester. There is Sara del Valle, who was a recent immigrant from Mexico with limited English skills but tremendous intelligence, and who now holds a Ph.D. and is on the permanent faculty at Los Alamos National Laboratory. Among the current students is Paulette Willis, an African-American from New Orleans whom Kutzko says is one of the strongest students in the department. Willis has passed all of her exams and is now working on her dissertation under the direction of Paul

Muhly. Although clearly on track to a successful research career, she is still sometimes beset by anxieties that stem from having so few role models. "I have never seen any black people do this," she told Kutzko.

Over the years, the Iowa department has listened carefully to its students and has observed closely their successes and failures. The department has used this knowledge to rejuvenate its graduate program, making it a place where students of all colors can thrive. The department has received several awards for its success in recruiting minority students, including the 2004 Presidential Award for Science and Engineering Mentoring and designation as a "Program that Makes a Difference" by the AMS Committee on the Profession. This year, the Iowa department was chosen for the AMS Award for Exemplary Program or Achievement by a Mathematics Department.

Mentoring is Key to Success

It's an attitude of, "It's our job to make sure everybody succeeds," as opposed to, "It's our job to find out who the best students are."

—David Manderscheid

Over the past decade, the University of Iowa mathematics department produced about 1 percent of the total number of doctorates granted in the U.S., and about 4 percent of those granted to students who are members of underrepresented minorities. During that time, twelve minority students received Ph.D.'s at Iowa. Today about a quarter of the department's approximately 115 graduate students are minority, and about 40 percent are women. Because the department's retention rate has risen so much in recent years, more success stories are surely on the way. Before the minority recruitment initiative, the Iowa graduate student

population was dominated by international students. Today, the majority are American.

The commitment that the department made to the minority students who started arriving in substantial numbers in the mid-1990s inspired a transformation of the department's basic philosophy. As department chair Yi Li explains it, "The old business-as-usual would be: Okay, you come to our program, that's it. If you study and you do well, that's okay; if you don't do well, you leave." At Iowa, this you're-on-your-own, sink-or-swim attitude has been replaced by one that puts student success as the top priority. With this student-centered attitude has also come a new spirit of inquiry that has allowed the department to analyze critically its graduate program to address trouble spots and make changes.

One of the most important changes has been the institution of a mentoring program. Every new student is assigned, or is allowed to choose, a mentor from among the department's faculty. The mentor is usually a person different from the thesis advisor—someone with whom the student can discuss a wide range of problems, from difficulties fitting in with other students, to lack of background in a particular mathematical area. "Having seen the impact and having seen what a broad change it brought to our program, I am a firm believer of mentoring early and in time," says Li. He noted that it is particularly important that students have a mentor from the very beginning of their graduate studies, so that problems are not left to fester. Many students come from smaller schools where the instruction in mathematics was not as rigorous as in a Ph.D. department like the one at Iowa, and the change can be a shock even for highly talented and motivated students. Proper guidance in the early stages can make a big difference.

After each midterm examination in the first-year graduate courses, the results are sent to the department's Graduate Committee, which identifies students who seem to be struggling. That information is then passed along to the mentors, who talk to the students about what might have caused poor performance on the exams. "We are trying to help the students as much as we can and to find out, if they are not performing, what the problem is," explains Li. "There may be a cultural problem, maybe homesickness, other personal problems, or language problems." The mentors also try to determine if some part of the student's mathematical background is lacking or needs shoring up. In addition, the mentoring system helps build support for the minority program across the whole department: Helping the students they mentor succeed has built faculty members' loyalty to the program. Says Li, "We all see that this is a great thing for the department, for the students, and for the educational purpose."

Building Community

Iowa is largely a white population...so for a minority student to be at Iowa, isolated, would be very difficult. We try to build a community so that they feel at ease, at home, so they have a sense of belonging.

—Yi Li

One of the hallmarks of the Iowa department is the strong sense of community that has developed, and this happened in large part as a result of the minority program. "Before we started bringing in minority students, the graduate students were not a very cohesive group," says faculty member Juan Gatica. "They didn't work together; they kept pretty much to themselves. When we started bringing in minority students, we asked them to get together and have study groups, and the non-minority students started participating in this too. It was a surprise that this became a big movement in the department and transformed it in many ways." There are now study groups for algebra, analysis, topology, and other topics, as well as exam-preparation study groups.

Another strategy to build community sounds mundane but made a big difference: Replacing the worn-out 1970s vinyl furniture in the department lounge. "I think one of the most brilliant things I did as department chair was getting new furniture for our lounge," says David Manderscheid, who was on the faculty at Iowa for twenty years before taking a position as the dean of the College of Arts & Sciences at the University of Nebraska in 2007. "It sounds sort of silly, and my dean thought it was sort of silly when I proposed it to her. But I really pushed it. It made the lounge a comfortable place for the students and faculty to hang out." The lounge is now the heart of the department, where faculty and students can meet informally and where coffee and cookies are served every afternoon. The department used to keep the lounge open only until 5 p.m. but now keeps it open until 11 p.m., as a way of encouraging students to gather and study together. On the way home in the evening, faculty often pass through the lounge and stop to talk to the students or to help with mathematical questions.

Also reinforcing a cohesive community among the students are recent changes to the graduate program. When the department decided to apply for a VIGRE (Vertically Integrated Research and Education) grant from the National Science Foundation, it gave a lot of thought to the VIGRE requirement that departments get students involved in research early on in their graduate studies. What emerged, along with a successful proposal, was a new structure for the graduate program. Previously, students took a couple of years' worth of graduate courses with the aim of passing the

comprehensive examination as the gateway to starting research. Now, all students now must take a standard set of first-year graduate courses in analysis, topology, and differential equations, and in either algebra or numerical analysis. If students are not prepared to jump into these courses right away, they can take undergraduate-level courses to build the necessary background. Once finished with the first-year courses, students must take a qualifying examination on the material covered. After that they can start doing reading courses with an advisor, take advanced graduate courses, and prepare for the comprehensive examination. This new structure, with its clearer timetable, gets students into research more quickly.

Having students take all the first-year courses together has reinforced the community bonds. "They know each other much better because they are all taking these core courses, they study together, they help each other, they lecture to each other," says Li. "You will see them standing in front of blackboards, teaching each other. They develop a very active semi-research activity already" in their initial studies. In addition, students rose to the challenge of the new and tougher degree requirements. "People were concerned" about this change, says Manderscheid. "Would it have a negative impact on our minority students?" In fact the opposite happened: Students did better under the new system, in which expectations and milestones are clearly laid out. "Students were getting more feedback more quickly, and they loved it," notes Manderscheid.

In another innovative twist, the department started hiring third- and fourth-year graduate students to be teaching assistants in recitation sections in the first-year graduate courses. Not only does the extra instruction help the students, but the TAs serve as peer mentors to the younger students, further enhancing the sense of community in the department. The Iowa faculty are quick to point out that the changes inspired by the minority program have boosted the success of all students, minority, majority, and international. "These programs are always designed for the benefit of all of our students," says Manderscheid.

Developing a Path into Mathematics

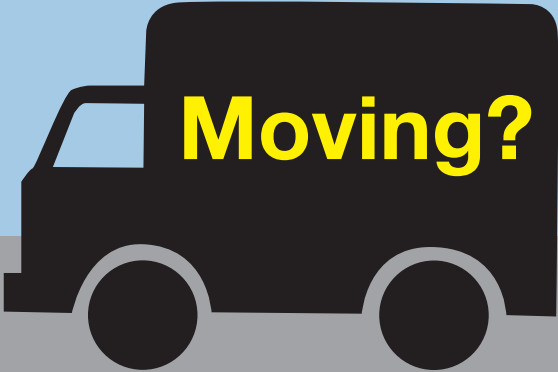
I remember one of our faculty members was slow to become involved in our initiative. Then he mentored during our summer program, and I remember him getting up and saying at the closing ceremonies, to all of these mostly African-American kids, "I want to thank you for reminding me why I came into this profession."

—Philip Kutzko

The department has several ways of opening paths into graduate study in mathematics. One is its NSF-funded Alliance program, a collaborative effort of the mathematical sciences departments at the University of Iowa, Iowa State University, and the University of Northern Iowa, together with the mathematics departments at fifteen to twenty minority-serving institutions around the nation. Through the Alliance, students at the minority-serving schools are mentored by local faculty and by faculty in Iowa, and they also can attend the summer Research Experiences for Undergraduates program run by the three Iowa schools. The University of Iowa department also has the Heartland Partnership program, which has a structure similar to the Alliance and serves twelve small colleges in Iowa and surrounding states. Finally, the department's VIGRE grant supports undergraduates attending the summertime REU. In addition to giving undergraduate math majors a taste of research, these programs cultivate a diverse talent pool that is on track to graduate school in mathematics, whether at the University of Iowa or elsewhere.


When minority students apply to graduate school at Iowa, their applications are carefully studied by the department's Minority Recruitment and Development Committee, currently chaired by Gatica. This committee has over the years gained a lot of experience and skill in identifying students who have the potential to succeed in the graduate program. Picking students "is a hard job, and we are getting pretty good at that now," says Kutzko. "There are students who we know won't fit standard profiles but who we are pretty sure are going to succeed." Since the department has developed a reputation as a place with a supportive environment in which students flourish, it has started to receive applications from students with very strong backgrounds who would be able to get into the top schools in the country. While this is a clear boon for the department, the Minority Committee does not choose to take the easy path. Says Kutzko, "If we start resting on our laurels now and only accept black and Latino kids from elite institutions, because they want to come to graduate school at a comfortable place, we are not going to accomplish what our ultimate goal is, which is to change the population who do mathematics." The department wants to remain a place where high-potential students with non-standard backgrounds are welcome and can excel.

With the success of its minority program, the department has found its esteem rising within the university. It has also helped other departments on campus to launch recruitment programs of their own. The national recognition the department has garnered has opened the door for collaborations with other mathematics departments interested in enhancing the achievement of minority students.

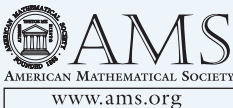


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It has also helped the department to attract high-quality faculty members. For example, the department recently hired Julianna Tymoczko, who earned a Ph.D. from Princeton in 2003. She was a Clay Mathematics Institute Liftoff Fellow as well as an NSF Postdoctoral Fellow. Says Manderscheid, "The fact that Iowa has this very active, vibrant graduate program that is doing things differently I think made the difference" to Tymoczko in deciding where to take a permanent job.

A Harmonious Department

The opportunity that this department has afforded me [to work in the minority program] has been invaluable. It has transformed my life and given me great satisfaction.

—Juan Gatica

One perhaps surprising fact about the faculty in the Iowa mathematics department is that it does not have a large minority presence: Less than 10 percent, three out of forty, are members of underrepresented minorities. Furthermore, the Iowa minority program has not been based on the model of a single charismatic figure who serves as a magnet for students. Rather, it has been a communal effort of the department—and the whole department has benefited. "This was a place that had its political troubles before we started doing this," says Kutzko. "I think now we are a department that has a harmony to it that is very, very rare."

For the faculty who have been directly involved in the minority program, the personal satisfaction has been enormous. "It's energizing," says Manderscheid. "It made me enthused. It made me want to come to work every day! Because I saw what great things we were doing, and I saw how we were giving opportunities to students who wouldn't go to graduate school otherwise."

Mathematics Programs that Make a Difference

Each year, the AMS Committee on the Profession (CoProf) selects two or more outstanding mathematics department programs to be designated as *Mathematics Programs that Make a Difference*. For 2008 the honored programs are the SUMMER UNDERGRADUATE MATHEMATICAL SCIENCE RESEARCH INSTITUTE (SUMSRI) at Miami University (Ohio), and the MATHEMATICS SUMMER PROGRAM IN RESEARCH AND LEARNING (MATH SPIRAL) at the University of Maryland, College Park.

CoProf created the Mathematics Programs that Make a Difference designation in 2005 as a way to bring recognition to outstanding programs that successfully address the issue of underrepresented groups in mathematics. Each year CoProf identifies two exemplary programs that:

1. aim to bring more individuals from underrepresented minority backgrounds into some portion of the pipeline beginning at the undergraduate level and leading to an advanced degree in mathematics, or retain them in the pipeline;
2. have achieved documentable success in doing so; and
3. are replicable models.

Previously designated Mathematics Programs that Make a Difference are: the graduate program at the University of Iowa and the Summer Institute in Mathematics for Undergraduates/Research Experience for Undergraduates at Universidad de Puerto Rico, Humacao (2006); and Enhancing Diversity in Graduate Education (EDGE) and the Mathematical Theoretical Biology Institute (MTBI) (2007).

The 2008 CoProf Subcommittee on Mathematics Programs that Make a Difference consisted of: Sylvia Bozeman, Rhonda Hughes, Kimberly Pearson (chair), and Francis Su.

Below is CoProf's citation, followed by brief descriptions of the programs prepared by *Notices* staff.

Citation

This year, the subcommittee recommends that the AMS recognize the Summer Undergraduate Mathematical Science Research Institute (SUMSRI) at Miami University (Ohio) and the Mathematics Summer Program in Research and Learning (Math SPIRAL) at the University of Maryland.

The main goals of SUMSRI include 1) addressing the shortage of minority mathematical scientists by encouraging minority students and women to become mathematical research scientists, 2) to provide the students with a research environment and improve their research abilities, 3) to improve the students' ability to work in groups and give them a long term support group, and 4) to provide professional role models. The Institute is especially interested in, but not limited to, African Americans and other underrepresented minorities and women. SUMSRI describes itself as a "mixed format" REU for rising juniors and seniors, emphasizing lecture classes the first three weeks and group research the last four weeks.

Of 114 program graduates to date, forty-six have either received a master's degree or passed their Ph.D. qualifying exams and another thirty-five have started their graduate programs (70 percent); three have received their Ph.D.s. Another twenty-one are still undergraduates. Fifty-six program graduates are from underrepresented ethnic groups; of the forty-three of those who have completed college, 88 percent are either in a graduate program or have received a graduate degree.

Math SPIRAL is a six-week program (primarily for rising juniors) that seeks to enrich the mathematical education of outstanding students from underrepresented groups, and to inspire them to pursue advanced mathematics. The model is unique in that a large research university (Maryland) has partnered with eight "affiliate" institutions, including several historically black colleges and universities. SPIRAL's student participants are recruited from these affiliates, and SPIRAL directors annually meet with affiliate liaisons and communicate regularly through the year. SPIRAL operates under the umbrella of STAND (Science & Technology: Addressing the Need for Diversity) at the University of Maryland.

Since its inception in 2003, a total of seventy-three students have participated. Sixty-nine are African American or foreign students of African heritage. One has completed a master's degree in operations research, eight are enrolled in doctoral programs, and five are enrolled in master's degree programs in various mathematical sciences; all of these students are African American with the

exception of one African student and one Caucasian.

Both SUMSRI and SPIRAL have program models and recruitment strategies that are clearly replicable. SUMSRI is supported by Miami University (Ohio), the National Security Agency, and the National Science Foundation. SPIRAL is supported by the NSA, the NSF, and the Mark & Catherine Winkler Foundation.

Program Description: SUMSRI

SUMSRI, conducted under the guidance of Miami University's Department of Mathematics and Statistics, is aimed at talented undergraduate students in the mathematical sciences who are interested in pursuing advanced degrees. Because of the shortage of minority and women mathematical scientists, the program is especially focused on, but not limited to, African Americans and other underrepresented minorities and women.

The main goals of SUMSRI are to encourage minority students and women to become mathematical research scientists, and to help the students improve their research abilities. In addition, SUMSRI aims to foster the students' ability to work in groups, to give them a long-term support group, and to provide them with professional role models. In the program, students increase their technical writing skills and are given an opportunity to write a technical research paper and present a talk at a mathematics conference. They also receive information about available financial aid, opportunities for graduate school, and career opportunities in the mathematical sciences.

SUMSRI runs for seven weeks on Miami University's campus in Oxford, Ohio. During that time, students participate in problem seminars in mathematics or statistics. The program also includes a technical writing seminar, a GRE preparation workshop, two short courses on algebra and real analysis, and colloquium talks given by well-known mathematical scientists. In addition, there are panel discussions about graduate school and career opportunities. SUMSRI pays for participants' travel, room, board, and supplies and provides each student with a stipend. Funds are available for travel and support to selected national meetings.

The ideal candidate for SUMSRI is a sophomore or junior student who has completed with distinction the calculus series and at least one proof-based mathematics or statistics course. All SUMSRI students return to their home institutions as undergraduates after participating in the program.

Program Directors: Dennis Davenport and Vasant Waikar

Website: <http://www.units.muohio.edu/sumsri/>.

Program Description: Math SPIRAL

Math SPIRAL, a multi-year summer program funded by the National Science Foundation (NSF) and the National Security Agency (NSA), brings gifted rising sophomores and juniors to the University of Maryland, College Park, for a six-week intensive program to help prepare them for graduate study in the mathematical sciences. Math SPIRAL was developed in close coordination with a group of nine affiliated minority-serving colleges and universities; this network is a central strength of the program.

Math SPIRAL has three core components: academics, research, and professional development. Students are enrolled in a 3-credit summer course consisting of two parallel sub-courses. The first focuses on combinatorics and a strategic analysis of winning strategies for a variety of games, while the second emphasizes the core methods of mathematical reasoning and proof. In addition to solving problems, students must accurately communicate their solutions both in writing and verbally. Formal public presentations of the academic and the research results are a key part of the SPIRAL program.

The research program has focused on the analysis of games, an area that provides a genuine research experience without requiring knowledge of higher-level mathematics courses. Research teams of three or four students carry out the investigations. Teams meet frequently with a graduate student mentor and a faculty advisor and make weekly oral presentations of their progress. The highlight of the program is the final formal presentations by the students.

Professional development activities comprise field trips, colloquia, and panel discussions. Past field trip destinations have included Booz Allen Hamilton, GEICO, the National Institute of Standards and Technology, the National Security Agency, and Northrup Grumman. Colloquia are given by established figures from academia, government, and industry to offer personal insights. The panel discussions provide advice on preparing for and succeeding in graduate school as well as on how to obtain financial support.

The founding program director was Dan Rudolph, who is now at the University of Colorado. Brian Hunt (UMCP) took the reins when Rudolph left for Colorado, and Ken Berg (UMCP) became director in the fall of 2007.

Program Director: Ken Berg

Associate Directors: Marshall Cohen (Morgan State University); Bill Gasarch (UMCP); Leon Woodson (Morgan State University)

Program Coordinator: Cyntrica Eaton

Website: <http://www.math.umd.edu/undergraduate/spiral/>.

2008 JPBM Communications Award

The 2008 Communications Award of the Joint Policy Board for Mathematics (JPBM) was presented at the Joint Mathematics Meetings in San Diego in January 2008.

The JPBM Communications Award is presented annually to reward and encourage journalists and other communicators who, on a sustained basis, bring accurate mathematical information to nonmathematical audiences. JPBM represents the AMS, the American Statistical Association, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. The award carries a cash prize of US\$1,000.

Previous recipients of the JPBM Communications Award are: James Gleick (1988), Hugh Whitemore (1990), Ivars Peterson (1991), Joel Schneider (1993), Martin Gardner (1994), Gina Kolata (1996), Philip J. Davis (1997), Constance Reid (1998), Ian Stewart (1999), John Lynch and Simon Singh (special award, 1999), Sylvia Nasar (2000), Keith J. Devlin (2001), Claire and Helaman Ferguson (2002), Robert Osserman (2003), Barry Cipra (2005), Roger Penrose (2006), and Steven H. Strogatz (2007).

The 2008 JPBM Communications Award was presented to CARL BIALIK. The text that follows presents the selection committee's citation, a brief biographical sketch, and the recipient's response upon receiving the award.

Citation

The 2008 JPBM Communications Award is awarded to Carl Bialik, the *Wall Street Journal's* "Numbers Guy", for increasing the public's understanding of mathematical concepts.

In his regular columns and blogs, Carl Bialik exposes the misuse of numbers and statistics throughout society and in applications ranging over every part of life, from economics and politics to sports and medicine. His writing does more than document the misuse, however, because he gently introduces sound mathematical reasoning in everything he writes. He shows how to use numbers and mathematics in a way that illustrates sound principles of scientific inquiry, paying careful attention to original sources and using professional mathematical scientists to validate his work.

Carl Bialik exemplifies the best traditions of scientific journalism, bringing mathematics and mathematical thinking to a large readership. The breadth, volume, and quality of his writing are all spectacular.

Biographical Sketch

Carl Bialik was born and raised in New York City, where his sister taught him early math lessons, his father crunched baseball numbers with him, and his mother trained him in statistics. He attended the Bronx High School of Science, where he edited the *Math Bulletin*, was a member of the school and city math team, and was a finalist in the 56th Science Talent Search for his biophysics research at Mount Sinai Hospital. He majored in math and physics at Yale, where he served as executive editor of the weekly *Herald* newspaper.

Bialik has written for the *Wall Street Journal Online* since early 2002. He became a technology reporter the following year. He began writing the weekly online "Numbers Guy" column in 2005. In 2006 Bialik won second place in the online category of the National Society of Newspaper Columnists contest. In March 2007 the column began running every other week on the Marketplace page of the print *Journal*, complemented by a blog updated each weekday. Bialik has also coauthored the online *Journal's* "Daily Fix" sports column since 2002. Outside the *Journal*, he is cofounder of the online *Gelf Magazine* and hosts the magazine's Varsity Letters sports reading series in New York.

Response

I'm immensely honored to receive this award, particularly because of my admiration for all the prior recipients—and my particular appreciation for several who have helped me frequently with my column. Many other members of the AMS and ASA also have provided indispensable help as I try to decipher tricky numbers and explain them to readers, a daily challenge that is always enjoyable.

I encourage your organizations to continue to engage with journalists, as you have done so graciously with me. Numbers are a popular tool to obfuscate and mislead. Too often the press falls prey to faulty figures. We would like to do a better job of writing about numbers and deciding which numbers don't deserve press. And we need your help to do so.

My column is, I hope, a step in the right direction. Its existence and success are a credit to Bill Grueskin, the editor who conceived of it and handed me this fun assignment, and to Jason Anders, who has ably edited and improved the column since its inception.



Carl Bialik

MAA Prizes Presented in San Diego

At the Joint Mathematics Meetings in San Diego in January 2008, the Mathematical Association of America (MAA) presented several prizes.

Gung and Hu Award for Distinguished Service

The Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics is the most prestigious award made by the MAA. It honors distinguished contributions to mathematics and mathematical education, in one particular aspect or many, and in a short period or over a career.

LIDA K. BARRETT received the 2008 Gung and Hu Award. The prize citation says: "Lida K. Barrett's solid mathematical background and her ability to get at the heart of problems and to find bold solutions led her into positions in mathematical policy: as a senior administrator at several universities, as president of the Mathematical Association of America, as senior staff associate at the National Science Foundation [NSF], and as professor of mathematics at the U.S. Military Academy at West Point. To this day, she continues to serve on many committees and boards and to contribute to mathematics, to mathematics education, and to increasing the participation of members of under-represented groups in mathematics." Her concern for education and students likely has its roots in her background: For example, in graduate school at the University of Texas, she and Mary Ellen Rudin were the only female students. Barrett finished her master's degree there in 1949 and her Ph.D. in 1954, at the University of Pennsylvania. Her husband was also a mathematician, and she suffered under the anti-nepotism rules that were common at that time. Her husband's death at an early age left Barrett to raise three children on her own. Despite these hardships, she built an outstanding career as a faculty member and an administrator

and had a considerable impact on the U.S. mathematical community.

Lida Barrett wrote the following response, which appeared in the prize booklet: "I am honored to have received this prize. The Mathematical Association of America has been an important part of my life. The many activities offered have contributed significantly to my career: the hour addresses that kept me aware of the vast scope of mathematics, the panel discussions and other presentations on current professional topics, and the opportunities to meet and discuss mathematics and educational activities with my fellow mathematicians. Working on committees and projects within MAA and within the broader mathematical community has enriched my professional life. Friendships with the many fine folks in MAA have provided a special plus. I am especially grateful to Professor Harlan Miller, who pushed me to work on a Ph.D. at Texas, and to my late husband, John Barrett, who, after he completed his degree, insisted I finish mine and kept house for us while I did."

Haimo Awards for Teaching

The Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching were established in 1991. These awards honor college or university teachers who have been widely recognized as extraordinarily successful and whose teaching effectiveness has been shown to have had influence beyond their own institutions.

The 2008 Haimo Awards were presented to ANNALISA CRANNELL, KENNETH I. GROSS, and JAMES MORROW.

"Annalisa Crannell is well known for her boundless energy and enthusiasm for all things mathematical," the prize citation states. As a new faculty member at Franklin & Marshall College, she immediately began to incorporate essay-writing into her mathematics classes. Her experience in this

teaching technique led to many invitations to speak on “writing across the curriculum” programs, as well as to the co-authoring of the book *Writing Projects for Mathematics Courses: Crushed Clowns, Cars and Coffee to Go*, published in 2004 by the MAA. Crannell has also actively pursued the connections between mathematics and art, producing a book, together with colleague Marc Frantz, *Viewpoints: Mathematical Perspective and Fractal Geometry in Art*, which will be published by Princeton University Press. The prize citation concludes, “[Crannell] continues to search for innovative ways to excite those around her about mathematics.”

“Kenneth I. Gross has had a dramatic impact on mathematics, education, and the lives of his students,” the prize citation states. “[His] teaching and mentoring have been inspirational for all levels of students, from high school students to entry-level college students, undergraduate mathematics majors, and graduate students who are now accomplished mathematicians and scientists, elementary and middle school teachers, and adult learners who desire to further their education.” In 1993 Gross and a high school teacher co-founded a week-long residential summer enrichment program for talented Vermont high school students, aimed especially at girls and rural Vermonters. Then, in 1999, Gross founded the Vermont Mathematics Initiative (VMI), a statewide master’s degree-granting program that trains elementary and middle school teachers to serve as mathematics leaders in their schools and districts. To date, over two hundred teachers from nearly 90 percent of the school districts in Vermont have participated in the program.

James Morrow “has had a fundamental impact at the University of Washington and throughout the Pacific Northwest,” the prize citation says. Since 1988 he has directed a Research Experiences for Undergraduates site focusing on questions related to inverse problems in tomography. Eight of its participants have received NSF graduate fellowships, and many have gone on to substantial success in this area and other fields of mathematics. For the past six years he has also been preparing students for the Mathematical Contest in Modeling, in which his students “have an enviable record of success.” Since 1994 Morrow has organized a Mathday at the University of Washington, bringing 1,200 high schoolers to the campus to showcase for them the relevance of mathematics to a variety of disciplines. He is also codirector of the Summer Institute for Mathematics at the University of Washington, which brings twenty-four high schoolers from the U.S. and Canada to campus for six weeks in the summer.

Chauvenet Prize

The Chauvenet Prize recognizes a member of the MAA who has written an outstanding expository article. First awarded in 1925, the prize is named for William Chauvenet, who was a professor of mathematics at the United States Naval Academy.

ANDREW GRANVILLE received the 2008 Chauvenet Prize for his article “It is easy to determine whether a given integer is prime”, *Bulletin of the AMS* (N.S.) **42** (2005), 3–38. “This article is fascinating, readable, and understandable, with lots of proofs,” the prize citation says. It presents the statement and proof of the surprising 2002 result by Agrawal, an Indian computer scientist, and his two undergraduates, Kayal and Saxena, giving a “polynomial-time deterministic” test for deciding if integers are primes. “The paper is full of significant information, including discussions of Carmichael numbers, random polynomial time algorithms, probabilistic (almost) proofs, and much more,” says the citation.

Beckenbach Book Prize

The Beckenbach Book Prize, presented since 1982, is awarded to an author of a distinguished, innovative book published by the MAA.

WILLIAM DUNHAM received the 2008 Beckenbach Prize for his book *Euler: The Master of Us All*, MAA, Dolciani Mathematical Expositions, Vol. 22, 1999. Dunham’s exposition “is itself innovative and brilliant in its organization and scope, its clarity and verve, and its accessibility and appeal,” says the prize citation. After providing a biographical sketch, Dunham devotes one chapter each to important contributions by Euler to eight areas of mathematics. “Dunham is well known for writing mathematical page-turners, and this book is no exception: the seamless presentation of mathematics and its history is so entertaining, accessible, clear, and lively that it is difficult to put the book down until one has read it from cover to cover,” the citation says. “Besides his inimitable writing style, the author is to be commended for his inspired yet careful selection and organization of historical and mathematical material and for his presentation of Euler’s mathematical work in such a clear and accessible yet faithful manner.”

Euler Book Prize

The Euler Book Prize is given to the author(s) of an outstanding book about mathematics. The prize was given for the first time in 2007, to commemorate the 300th anniversary of the birth of Leonhard Euler.

BENJAMIN H. YANDELL was posthumously awarded the Euler Prize for his book *The Honors Class. Hilbert’s Problems and Their Solvers*, A K Peters, Natick, MA, 2002. This book provides portraits of the people who solved problems on



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David Hilbert's famous list of 23 problems, which he presented in 1900. "Even when discussing well-known mathematicians such as Hilbert, Gödel, and Kolmogorov, Yandell manages to say something fresh and to correct some oft-repeated errors," the citation says. "The book is a monumental labor of love, yet breathtakingly readable and inspiring. It is written at a level that bright mathematics students can understand, but it will also widen the horizons of professional mathematicians, since almost no one is as familiar with as many fields as Hilbert was. The *Honors Class* should be in every mathematician's library."

David P. Robbins Prize

In 2005 the family of David P. Robbins gave the MAA funds sufficient to support a prize honoring the author or authors of a paper reporting on novel research in algebra, combinatorics, or discrete mathematics. The Robbins Prize is awarded every third year.

The 2008 Robbins Prize was awarded to NEIL J. A. SLOANE of AT&T Shannon Labs for his paper "The on-line encyclopedia of integer sequences", *Notices of the AMS*, 50 (2003), 912-915. "Although not quite a research paper in the usual sense, the paper describes an extraordinary research tool that has had an impact on mathematics far beyond that of almost any paper, especially in the areas that David Robbins cared so much about," the prize citation says. Sloane's Online Encyclopedia of Integer Sequences (OEIS) enables mathematicians to identify sequences from just a few terms, "giving them access to a wealth of information that might immediately point their research in useful directions.... The importance and pervasiveness of this tool is evident from the number and diversity of papers that cite the OEIS." The OEIS database has more than 120,000 entries, an active editorial board with twenty-five members, and a Wikipedia entry.

Certificates of Meritorious Service

Each year the MAA presents Certificates of Meritorious Service for service at the national level or for service to a section of the MAA. Those honored in 2008 are: Illinois Section: HERBERT KASUBE, Bradley University; Kentucky Section: DONALD E. BENNETT, Murray State University; Missouri Section: VICTOR GUMMERSHEIMER, Southeast Missouri State University; Northern California, Nebraska, and Hawaii Section: LEONARD F. KLOSINSKI, Santa Clara University; Seaway Section: H. JOSEPH STRAIGHT, State University of New York, Fredonia; Wisconsin Section: ANDREW MATCHETT, University of Wisconsin-LaCrosse.

—From MAA announcements

AWM Awards Given in San Diego

The Association for Women in Mathematics (AWM) presented two awards at the Joint Mathematics Meetings in San Diego in January 2008.

Louise Hay Award

The Louise Hay Award for Contributions to Mathematics Education was established in 1990 to honor the memory of Louise Hay, who was widely recognized for her contributions to mathematical logic and for her devotion to students.

The 2008 Louise Hay Award was presented to HARRIET S. POLLATSEK of Mount Holyoke College “in recognition of her wide range of outstanding contributions to mathematics education”. The award citation lauds Pollatsek for maintaining an active presence in mathematical research while also making substantial contributions to improving mathematics education at the collegiate level. “What has most characterized her entire career is her love of mathematics and her energy and enthusiasm for fostering a love of it in others,” the citation says. “She believes that everyone can benefit from learning mathematics and that the way it is taught should give students multiple opportunities to be brought into the mathematical fold.”

Pollatsek came to Mount Holyoke in 1970, and since then she has worked tirelessly to improve courses for math majors and nonmajors alike. She was one of the designers of the Five College Calculus in Context sequence; played a key role in a Dana Foundation effort to increase underrepresented individuals in mathematics courses; and was one of the developers of a program, funded by the National Endowment for the Humanities, to spread mathematics across the curriculum. For majors and potential majors she co-developed an innovative mathematics laboratory course and then became a coauthor and the lead editor of a textbook for it, *Laboratories in Mathematical Experimentation*. This course has become the cornerstone of the mathematics major at Mount Holyoke. Pollatsek chaired the Mathematical Association of America’s Committee on the Undergraduate Program in Mathematics (CUPM) and led the writing team that produced the *CUPM Curriculum Guide 2004*. On top of all this, Pollatsek has also worked on mathematics education at the precollege level.

The award citation concludes: “By the Louise Hay Award, AWM is proud to honor Harriet S. Pollatsek for her steadfast enthusiasm and

commitment to the goal of leading as many students as possible to a genuine and deep appreciation for mathematics and mathematical thinking.”

Schafer Prize

The Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman was established in 1990. The prize is named in honor of Alice T. Schafer, one of the founders of AWM and one of its past presidents.

The 2008 Schafer Prize was awarded to GALYNA DOBROVOLSKA of the Massachusetts Institute of Technology and to ALISON MILLER of Harvard University.

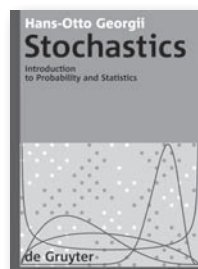
Dobrovolska is a senior mathematics major at MIT. She has exhausted all of the undergraduate offerings in the mathematics department, earning the highest grades, and has begun taking graduate courses. “Dobrovolska has further distinguished herself through her impressive and original mathematical research,” the prize citation says. “Her research is focused in algebra and would be considered broad even for a mathematician much further along in her career.” She co-authored a paper that has now been published. In addition to winning a gold medal at the International Mathematics Olympiad, Dobrovolska won the top prize in 2006 in the Summer Program of Undergraduate Research at MIT.

Miller, a senior at Harvard University, is the first woman ever to have won a gold medal in the International Mathematical Olympiad. She also was twice the winner of the Elizabeth Lowell Putnam award for outstanding performance by a woman on the Putnam competition. Her participation in a Research Experiences for Undergraduates program at the University of Wisconsin led to her writing two papers in number theory. The first answers a deep and difficult question originating in the work of Richard Borcherds and has been published in the *Proceedings of the AMS*. The second paper has appeared as a preprint.

The AWM also awarded honorable mentions to three outstanding senior mathematics majors: NAOMI BROWNSTEIN, University of Central Florida; REAGIN TAYLOR MCNEILL, Smith College; and MARY WOOTTERS, Swarthmore College.

—From AWM announcements

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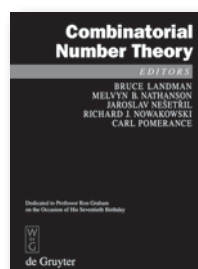
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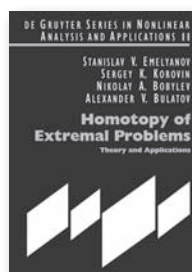
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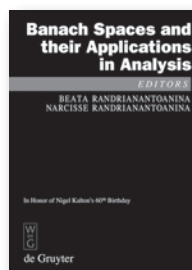
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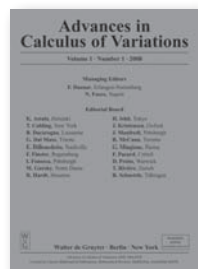
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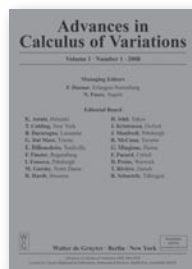
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Mathematics People

Gilbert Receives NAS Award

ANNA C. GILBERT of the University of Michigan, Ann Arbor, has received the 2008 National Academy of Sciences (NAS) Award for Initiatives in Research. According to the prize citation, Gilbert was honored for “innovative algorithms using wavelets and sampling techniques and their impact on data analysis and sparse approximation.” The award, which carries a cash prize of US\$15,000, is presented annually to recognize innovative young scientists and to encourage research likely to lead to new capabilities for human benefit. For 2008 the award was given in the fields of computational science and applied mathematics. It was established by AT&T Bell Laboratories in honor of William O. Baker and is supported by Alcatel-Lucent.

—From an NAS announcement

Feigenbaum Awarded Heineman Prize

MITCHELL J. FEIGENBAUM of Rockefeller University has been awarded the 2008 Dannie Heineman Prize in Mathematical Physics “for developing the theory of deterministic chaos, especially the universal character of period doubling, and for the profound influence of these discoveries on our understanding of nonlinear phenomena in physics.”

The prize carries a cash award of US\$7,500 and is presented in recognition of outstanding publications in the field of mathematical physics. The prize was established in 1959 by the Heineman Foundation for Research, Educational, Charitable, and Scientific Purposes, Inc., and is administered jointly by the American Institute of Physics (AIP) and the American Physical Society (APS). The prize is presented annually.

—From an APS announcement

Chavez Receives AAAS Mentor Award

CARLOS CASTILLO CHAVEZ of Arizona State University has received the 2007 Mentor Award from the American Association for the Advancement of Science (AAAS) for his

efforts to help underrepresented students earn doctoral degrees in the sciences.

Chavez, who earned his Ph.D. from the University of Wisconsin, has served as dissertation adviser for four Hispanic Americans who earned their doctorates in mathematics or the biological sciences. Another eleven Hispanic Americans whom he mentored in an undergraduate research program have gone on to earn doctorates in the biological sciences, mathematics, statistics, or bioinformatics at various institutions. He has also raised funding for and run a summer research program, the Mathematical and Theoretical Biology Institute, aimed at encouraging Hispanic American and Native American undergraduate students to enter Ph.D. programs with an emphasis on mathematical or computational biology. As a result of this program, fifty-nine Hispanic Americans and Native Americans have gone on to graduate programs.

The AAAS Mentor Award honors members of the AAAS who have mentored and guided significant numbers of underrepresented students toward Ph.D. degrees in the sciences and who have demonstrated scholarship, activism, and community building on behalf of underrepresented groups, including women of all racial or ethnic groups; African American, Native American, and Hispanic men; and people with disabilities. This award recognizes individuals in the early or mid-career stage who have mentored students for less than twenty-five years. The recipient receives US\$5,000 and a commemorative plaque.

—From an AAAS announcement

Schedler Receives AIM Five-Year Fellowship

TRAVIS SCHEDLER of the University of Chicago has been named the recipient of the 2008 American Institute of Mathematics (AIM) Five-Year Fellowship.

Schedler will complete his Ph.D. at the University of Chicago under the direction of Victor Ginzburg. He works in the area of noncommutative algebraic geometry. His thesis defines and applies a new formalism of differential operators for associative algebras. Other work involves computing Hochschild and cyclic homology of algebras associated with quivers. He has written or coauthored eleven papers, one of which has appeared in the *Journal of the American Mathematical Society*. He received his A.B.

from Harvard in 2002 and spent a year of graduate study at the École Normale Supérieure.

—From an AIM announcement

2008 Clay Awards Announced

The Clay Mathematics Institute (CMI) has announced the recipients of the 2008 Clay Research Fellowships and Research Awards.

Clay Research Fellowships

SPYROS ALEXAKIS of Princeton University received his Ph.D. from Princeton in 2005. In his thesis, he proved a special case of the Desser-Schwimmer conjecture in conformal geometry, and he has recently proved the full case. This conjecture characterizes all pointwise Riemannian invariant polynomials in the metric tensor and its derivatives whose integrals over a compact manifold without boundary are invariant under conformal deformations.

ADRIAN IOANA of the California Institute of Technology received his Ph.D. in 2007 from the University of California, Los Angeles. In a 2006 paper he showed that any group that contains a copy of the free group on two letters has uncountably many orbit inequivalent actions.

XINYI YUAN will receive his Ph.D. degree in 2008 from Columbia University. In 2006 he proved an arithmetic analogue of a theorem of Siu and derived a natural sufficient condition for the case in which the orbit under the absolute Galois group is equidistributed.

Clay Research Fellows are appointed for terms ranging from two to five years; graduating doctoral students and mathematicians within three years of receiving the doctoral degree are eligible for the fellowships.

Clay Research Awards

The 2008 Clay Research Awards have been presented to CLIFFORD TAUBES of Harvard University for his proof of the Weinstein conjecture in dimension three, and to CLAIRE VOISIN of the Centre National de la Recherche Scientifique, the Institut des Hautes Études Scientifiques, and the Institut Mathématique de Jussieu for her disproof of the Kodaira conjecture.

The Weinstein conjecture is a conjecture about the existence of closed orbits for the Reeb vector field on a contact manifold. A contact manifold is an odd-dimensional manifold with a one-form A such that A wedged with the n -th exterior power of dA is everywhere nonzero. In particular, the kernel of A is a maximally non-integrable field of hyperplanes in the tangent bundle. The Reeb vector field generates the kernel of dA and pairs to one with A . Alan Weinstein asked some thirty years ago whether this vector field must, in all cases, have a closed orbit. (The unit sphere in complex n -space with A the annihilator of the maximal complex subspace of the real tangent space is an example of a contact manifold and contact 1-form. In this case, the orbits of the Reeb vector field generate the circle action whose quotient gives the associated complex projective space.) Note, by contrast,

that there exist non-contact vector fields, even on the 3-sphere, with no closed orbits. These are the counterexamples (due to Schweitzer, Harrison, and Kuperberg) to the Seifert conjecture. Hofer affirmed the Weinstein conjecture in many 3-dimensional cases, for example the three-sphere and contact structures on any 3-dimensional, reducible manifold. Taubes's affirmative solution of the Weinstein conjecture for any 3-dimensional contact manifold is based on a novel application of the Seiberg-Witten equations to the problem.

The Kodaira conjecture was formulated in 1960, when Kunihiko Kodaira showed that any compact complex Kähler surface can be deformed to a projective algebraic surface. For the proof, Kodaira used his classification theorem for complex surfaces. The conjecture asks whether Kähler manifolds of higher dimension can be deformed to a projective algebraic manifold. Voisin constructs counterexamples: in each dimension four or greater there is a compact Kähler manifold that is not homotopy equivalent to a projective one. For dimension at least six, she gives examples that are also simply connected. A later result gives a substantial strengthening: in any even dimension ten or greater, there exist compact Kähler manifolds, no bimeromorphic model of which is homotopy equivalent to a projective algebraic variety. Distinguishing the homotopy type of projective and nonprojective Kähler manifolds is achieved through novel Hodge-theoretic arguments that place subtle restrictions on the topological intersection ring of a projective manifold.

—From a CMI announcement

Iyama Wins ICRA Award

OSAMU IYAMA of Nagoya University has been selected to receive the first ICRA Award from the International Conferences on Representations of Algebras (ICRA). Iyama was honored for "original and influential work on developing a 'higher' theory for almost split sequences and Auslander correspondence and his subsequent work on Calabi-Yau categories, which have strong connections with the cluster algebras of Fomin-Zelevinsky."

The ICRA conference series was established in 1974 to bring together both experts and young researchers in the field of representations of finite-dimensional algebras. The award will be given at each conference session to a young mathematician who has done outstanding work in the field.

—From an ICRA announcement

National Academy of Engineering Elections

The National Academy of Engineering (NAE) has announced the election of sixty-five new members and nine foreign associates, including six whose work involves the

mathematical sciences. Their names, institutions, and the research for which they were elected follow.

JON M. KLEINBERG, Cornell University, for contributions to the understanding of the structure and behavior of the World Wide Web and other complex networks; PRABHAKAR RAGHAVAN, Yahoo! Research, Santa Clara, California, for significant contributions to algorithms and the structure of the World Wide Web; VLADIMIR ROKHLIN, Yale University, for the development of fast multipole algorithms and their application to electromagnetic and acoustic scattering; and JAMES A. SETHIAN, University of California, Berkeley, for the development of efficient methods of tracking moving interfaces. Elected as foreign associates were ARTHUR JOHN ROBIN GORELL MILNER, University of Cambridge, for fundamental contributions to computer science, including the development of LCF, ML, CCS, and the pi-calculus; and EKKEHARD RAMM, University of Stuttgart, for contributions to the finite element analysis of plates and shells and leadership in computational mechanics.

—From an NAE announcement

Alex Rosenberg (1926–2007)

Alex Rosenberg died on October 27, 2007, in Schwerte, Germany, his home for the last decade. He was born in Berlin, Germany, on December 5, 1926. His family fled Germany in August 1939, first to Les-Plans-Sur-Bex, Switzerland, where they stayed for almost a year. After a brief stay in England, the family resettled in Ontario.

Alex studied at the University of Toronto. He earned a B.A. (math/physics) in 1948 and stayed on for an M.A. in 1949. Moving to the University of Chicago for his further graduate study, Rosenberg obtained his Ph.D. in 1951 under the supervision of Irving Kaplansky.

In 1961 Rosenberg joined the faculty at Cornell University as professor of mathematics and remained there for a quarter of a century. He was chairman of the mathematics department from 1966 to 1969, when it was at its largest. Later, in 1986, he moved to the University of California, Santa Barbara, as chair of the department of mathematics. A few years after his retirement in 1994, he moved back to Germany, where he lived until his death.

Rosenberg made fundamental contributions to algebra by applying newly developed homological techniques to Galois theory and quadratic forms as well as to other areas. He was also an active member of the mathematical community, holding many important posts in the leadership of both the AMS and the Mathematical Association of America, including serving as editor of the *Proceedings of the AMS* (1960–65).

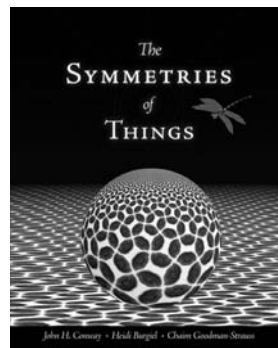
Alex Rosenberg, whose occasionally gruff manner masked his wit, kindness, and generosity, was a major figure in the post-World War II U.S. mathematical community whose wise counsel was crucial to mathematics in the U.S. For additional information, see <http://www.spelman.edu/~colm/alexrosenbergobit.html>.

—Lance Small, University of California, San Diego

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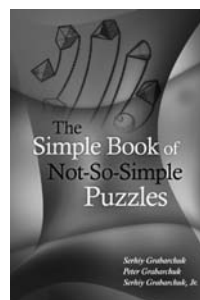
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Mathematics Opportunities

NSF Postdoctoral Research Fellowships

The National Science Foundation (NSF) awards Mathematical Sciences Postdoctoral Research Fellowships (MSPRF) for appropriate research in areas of the mathematical sciences, including applications to other disciplines. Awardees are permitted to choose research environments that will have maximal impact on their future scientific development. Awards are made in the form of either Research Fellowships or Research Instructorships. The Research Fellowship option provides full-time support for any eighteen academic-year months in a three-year period in intervals not shorter than three consecutive months. The Research Instructorship option provides a combination of full-time and half-time support over a period of three academic years, usually one academic year full time and two academic years half time. Under both options, the award includes six summer months; however, no more than two summer months of support may be received in any calendar year. Under both options, the stipend support for twenty-four months (eighteen academic-year months plus six summer months) will be provided within a forty-eight-month period.

The deadline for proposals is **October 15, 2008**. See http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5301&org=DMS.

—From an NSF announcement

NSF-CBMS Regional Conferences, 2008

With funding from the National Science Foundation (NSF), the Conference Board of the Mathematical Sciences (CBMS) will hold nine NSF-CBMS Regional Research Conferences during the summer of 2008.

These conferences are intended to stimulate interest and activity in mathematical research. Each five-day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based on these lectures.

Support for about thirty participants will be provided for each conference. Both established researchers and interested newcomers, including postdoctoral fellows and graduate students, are invited to attend.

Information about an individual conference may be obtained by contacting the conference organizer. The conferences to be held in 2008 are as follows.

May 12–16, 2008: Imaging in Random Media. George Papanicolaou, lecturer. Rice University. Organizers: Liliana Borcea, 713-348-5723, email: borcea@caam.rice.edu; Danny C. Sorensen, 713-348-5193, email: sorensen@caam.rice.edu; William W. Symes, 713-348-5997, email: symes@caam.rice.edu; conference website: <http://www.caam.rice.edu/~CBMS2008/>.

May 13–18, 2008: Water Waves: Theory and Experiment. Harvey Segur, lecturer. Howard University. Organizer: Mohammad F. Mahmood, 202-806-6295, email: mahmood@howard.edu; conference website: <http://www.coas.howard.edu/mathematics/CBMS-Mahmood.html>.

May 27–31, 2008: Inverse Scattering for Radar Imaging. Margaret Cheney, lecturer. University of Texas, Arlington. Organizer: Tuncay Aktosun, 817-272-1545, email: aktosun@uta.edu; conference website: <http://omega.uta.edu/~aktosun/cbms2008>.

June 2–6, 2008: Topology, C^ -Algebras, and String Duality.* Jonathan Rosenberg, lecturer. Texas Christian University. Organizers: Greg Friedman, 817-257-6343, email: g.friedman@tcu.edu; Robert Doran, 817-257-7335, email: r.doran@tcu.edu; conference website: <http://www.math.tcu.edu>.

June 22–27, 2008: Convex Duality Method in Mathematical Finance. Marco Frittelli, lecturer. University of California, Santa Barbara. Organizers: Jean-Pierre Fouque, 805-893-5637, email: fouque@pstat.ucsb.edu; Guillaume Bonnet, 805-893-4188, email: bonnet@pstat.ucsb.edu; Raya Feldman, 805-893-2826, email: feldman@pstat.ucsb.edu; conference website: <http://www.pstat.ucsb.edu/projects/cbms/>.

June 22–28, 2008: Ergodic Ramsey Theory: A Dynamical Approach to Static Theorems. Vitaly Bergelson, lecturer. Eastern Illinois University. Organizer: Patrick R. Coulton, 217-581-6276, email: prcoulton@eiu.edu; conference website: <http://www.ux1.eiu.edu/~prcoulton/cbms07/>.

July 9–13, 2008: Knots and Topological Quantum Computing. Zhengnan Wang, lecturer; Ara Basmajian, Short Course on Knots. University of Central Oklahoma. Organizers: Charlotte Simmons, 405-974-5294, email: cksimmons@ucok.edu; Jesse Byrne, 405-974-5575, email: jbyrne@ucok.edu; conference website: <http://www.math.ucok.edu/cbms/cbms.html>.

August 7–12, 2008: Malliavin Calculus and Its Applications. David Nualart, lecturer. Kent State University. Organizers: Oana Mocioalca, 330-672-9083, email: oana@math.kent.edu; Kazim M. Khan, 330-672-9110, email: kazim@math.kent.edu; conference website: <http://www.math.kent.edu/math/CBMS2008.cfm>.

December 13–17, 2008: Tropical Geometry and Mirror Symmetry. Mark Gross, lecturer. Kansas State University. Organizers: Ricardo Castano-Bernard, 785-532-0585, email:

rcastano@math.ksu.edu; Yan Soibelman, 785-532-0584, email: soibel@math.ksu.edu; Ilia Zharkov, 617-495-8797, email: zharkov@math.harvard.edu; conference website: <http://www.math.ksu.edu/~rcastano/CBMS.html>.

—From a CBMS announcement

Call for Proposals for 2009 NSF-CBMS Regional Conferences

To stimulate interest and activity in mathematical research, the National Science Foundation (NSF) intends to support up to seven NSF-CBMS Regional Research Conferences in 2009. A panel chosen by the Conference Board of the Mathematical Sciences will make the selections from among the submitted proposals.

Each five-day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based on these lectures, which is normally published as a part of a regional conference series. Depending on the conference topic, the monograph will be published by the American Mathematical Society, by the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics.

Support is provided for about thirty participants at each conference, and both established researchers and interested newcomers, including postdoctoral fellows and graduate students, are invited to attend.

The proposal due date is **April 21, 2008**. For further information on submitting a proposal, consult the CBMS website, http://www.cbmsweb.org/NSF/2009_call.htm, or contact: Conference Board of the Mathematical Sciences, 1529 Eighteenth Street, NW, Washington, DC 20036; telephone: 202-293-1170; fax: 202-293-3412; email: lkolbe@maa.org or rosier@georgetown.edu.

—From a CBMS announcement

International Mathematics Competition for University Students

The fifteenth International Mathematics Competition (IMC) for University Students will be held July 25–31, 2008, at the American University in Blagoevgrad, Bulgaria. Participating universities are invited to send several students and one teacher; individual students are welcome. Students completing their first, second, third, or fourth years of university education are eligible. The competition will consist of two sessions of five hours each. Problems will come from the fields of algebra, analysis (real and complex), and combinatorics. The working language will be English.

The deadline for registration is **May 31, 2008**. For details, see the website <http://www.imc-math.org.uk/> or contact John Jayne, University College London, Gower Street, London WC1E 6BT, United Kingdom; telephone: +44-20-7679-7322; email: j.jayne@ucl.ac.uk.

—John Jayne, University College London

News from the IMA

The 2008–2009 thematic program at the Institute for Mathematics and its Applications (IMA) at the University of Minnesota will be on “Mathematics and Chemistry”. Computational chemistry has reached a stage of development where many chemical properties of both simple and complex systems may now be computed more accurately, more economically, or more speedily than they can be measured. Further advances in accuracy and practicality will depend on the development of both new theory and new algorithms, and mathematical techniques will play an important role in both of these areas. The advances in chemical theory and computations have built on interfaces with a number of areas of mathematics, including differential equations, linear and nonlinear algebra, optimization theory, probability theory, stochastic analysis, sampling theory, complex analysis, geometry, group theory, and numerical analysis. Further progress in computational chemistry will require that the ties between chemistry and mathematics be strengthened. This IMA program will provide a setting for the chemistry and mathematics communities to examine some of these problems together. The year will focus on issues in electronic structure, dynamics, and statistical mechanics, including both the mathematical underpinnings of modern molecular modeling and simulation and practical issues in state-of-the-art applications. Applications areas will include organic and inorganic chemistry, biochemistry, solid-state chemistry, nanochemistry, advanced materials, photochemistry, catalysis, and environmental chemistry. Emphasis will be placed on mingling applied mathematicians with theoretical and computational chemists in each workshop. Limited financial support is available for the workshops. Detailed information about this program can be found at <http://www.ima.umn.edu/2008-2009>.

The 2009–2010 IMA thematic program will be on “Complex Fluids and Complex Flows”. This program is broadly concerned with fundamental challenges of modeling, analysis, and computation for (mostly) incompressible fluid dynamics. Much attention will be focused on non-Newtonian fluids in which complex material constitutions produce nonlinear and/or nonlocal relationships between stresses and rates-of-strain (and sometimes strains) leading to unique and often unforeseen flow phenomena. Complex fluids are ubiquitous in engineering applications and the applied sciences from biology to geology. They serve as the focus of active areas of research within the larger fluid dynamics community. Complex flows include those of both simple and complex fluids in simple and complex domains, in the presence of moving

boundaries, and turbulent flows. Key questions for such flows include transport and mixing properties, and flow-structure interactions generating motions including swimming, flying, sliding, and crawling. Recent research has revealed new connections between fluid characteristics, flow complexity, and transport properties that will in part serve as a unifying theme throughout the program. The mathematical scope of this program will be very broad, ranging from fundamental modeling questions through issues of computation, simulation, approximation and analysis. Program participants will include researchers from the engineering and applied sciences—including both theorists and experimentalists—numerical analysis, and scientific computation, and both applied and abstract analysts. A central goal of the program will be to bring these interdisciplinary perspectives together and facilitate productive engagement. Opportunities for participation in the 2009–2010 program include New Directions research professorships for established mathematicians seeking to branch into new interdisciplinary research directions, regular and industrial postdoctoral fellowships (application deadline is **January 5, 2009**), and general memberships (visits of a month or more, no application deadline).

The IMA actively solicits proposals for programs from members of the mathematical sciences community. Possibilities include annual programs (running September–June), summer programs (typically running two to four weeks and involving between 60 and 120 participants), and Hot Topics workshops (typically lasting a few days and treating a topic of exceptional contemporary interest and potential impact). Submission timelines: Preproposals for annual programs, at least four years in advance of the proposed start date; summer program proposals, roughly two to three years in advance; Hot Topics workshop proposals, a year in advance, cosponsorship by an industrial partner or institute is preferred. Additional information is available at <http://www.ima.umn.edu/solicit>.

—From an IMA announcement

News from IPAM

The Institute for Pure and Applied Mathematics (IPAM), located at the University of California, Los Angeles, holds long- and short-term research programs and workshops throughout the academic year for junior and senior mathematicians and scientists who work in academia, the national laboratories, and industry. IPAM sponsors two summer programs as well. IPAM's programs for 2008–2009 are listed below. Please go to <http://www.ipam.ucla.edu> for detailed information and online application and registration forms.

IPAM's Science Advisory Board meets in November, when it considers program proposals. Proposals from the community are encouraged; instructions are available at our website.

IPAM is seeking a second associate director, to begin July 2008. Information about the position and how to apply is available on our website.

Optimal Transport. March 10–June 13, 2008. Applications for the long program are closed, but individuals may still register for the three remaining workshops:

Workshop III: Transport Systems in Geography, Geosciences, and Networks: May 5–9, 2008.

Workshop IV: Optimal Transport in the Human Body: Lungs and Blood: May 19–23, 2008.

Mini-Workshop: Entropies and Optimal Transport in Quantum Mechanics: June 5–6, 2008.

Summer School. Mathematics in Brain Imaging, July 14–25, 2008. Individuals may register online.

Internet Multi-Resolution Analysis. September 8–December 12, 2008. This long program includes the following workshops that are also open for participation. Individuals may apply online for support to be core participants for the entire program or to attend individual workshops.

Tutorials: September 9–12, 2008.

Workshop I: Multiscale Representation, Analysis and Modeling of Internet Data and Measurements: September 22–26, 2008.

Workshop II: Applications of Internet MRA to Cyber-Security: October 13–17, 2008.

Workshop III: Beyond Internet MRA: Networks of Networks: November 3–7, 2008.

Workshop IV: New Mathematical Frontiers in Network Multi-Resolution Analysis: November 17–21, 2008.

Winter 2009 Short Programs. Individuals may apply online for support to attend each workshop.

Quantitative and Computational Aspects of Metric Geometry: January 12–16, 2009.

Numerical Approaches to Quantum Many-Body Systems: January 22–30, 2009.

Laplacian Eigenvalues and Eigenfunctions: Theory, Computation, Application: February 9–13, 2009.

Rare Events in High-Dimensional Systems: February 23–27, 2009.

Quantum and Kinetic Transport Equations: Analysis, Computations, and New Applications. March 9–June 12, 2009. This long program includes the following workshops that are also open for participation. Individuals may apply online for support to be core participants for the entire program or to attend individual workshops.

Tutorials: March 10–13, 2009.

Workshop I: Computational Kinetic Transport and Hybrid Methods: March 30–April 3, 2009.

Workshop II: The Boltzmann Equation: DiPerna-Lions Plus 20 Years: April 15–17, 2009.

Workshop III: Flows and Networks in Complex Media: April 27–May 1, 2009.

Workshop IV: Asymptotic Methods for Dissipative Particle Systems: May 18–22, 2009.

—IPAM announcement

Inside the AMS

Epsilon Awards for 2008

The AMS Epsilon Fund for Young Scholars was established in 1999 to provide financial assistance to summer programs for mathematically talented high school students in the United States. For many years these programs have provided mathematically talented youngsters with their first serious mathematical experiences. The name for the fund was chosen in remembrance of the late Paul Erdős, who was fond of calling children “epsilons”.

The AMS has chosen eight summer mathematics programs to receive Epsilon grants for activities in the summer of 2008. The grants will support program expenses and student scholarships and, in some cases, scholarships only. The programs were chosen on the basis of mathematical excellence and enthusiasm. Award amounts were governed by the varying financial needs of each program and total US\$100,000.

The programs receiving grants are: All Girls/All Math, University of Nebraska, Lincoln; Hampshire College Summer Studies in Mathematics, Amherst, Massachusetts; MathPath, University of Vermont, Burlington; Michigan Math and Science Scholars Summer Program, University of Michigan, Ann Arbor; PROMYS, Boston University; PROTaSM (Puerto Rico Opportunities for Talented Students in Mathematics), University of Puerto Rico, Mayaguez; Ross Mathematics Program, Ohio State University, Columbus; and Texas State University Honors Summer Math Camp, Texas State University, San Marcos.

The grants for summer 2008 are paid for by the AMS Epsilon Fund for Young Scholars (supplemented by the AMS Program Development Fund). The AMS is continuing to build the endowment for the Epsilon Fund, with a goal of raising US\$2 million through individual donations and grants.

For further information about the Epsilon Fund for Young Scholars, visit the website <http://www.ams.org/giving-to-ams/> or contact development@ams.org. Information about how to apply for Epsilon grants is available at <http://www.ams.org/outreach/epsilon.html>. A fairly comprehensive listing of summer programs

for mathematically talented high school students (including those with and without Epsilon grants) is available at <http://www.ams.org/outreach/mathcamps.html>.

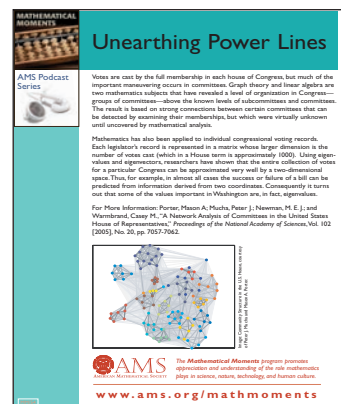
—AMS Development Office

From the AMS Public Awareness Office

Podcasts with Mathematical Moments. Now you can listen to researchers talk about their work, such as investigating connections in the U.S. Congress or the mathematics associated with recent results on invisibility. Look for the POD icon at <http://www.ams.org/ams/mathmoments.html> to listen or download, or get the podcasts at iTunes.

AMS Exhibit at the Annual AAAS Meeting. The Public Awareness Office hosted an exhibit at the American Association for the Advancement of Science (AAAS) annual meeting held in Boston, MA, February 15–18, 2008. The exhibit provided another way for mathematics to be represented at this meeting, which draws scientists from many disciplines, science writers and media, students, and families. On display were a sampling of AMS books, the *Calendar of Mathematical Imagery*, and a selection from the 60-plus *Mathematical Moments* that show the role mathematics plays in science, nature, technology, and human culture.

AMS Presidents: A Timeline. AMS presidents have played a key role in leading the Society in its publications, meetings, professional visibility, and support for research, and many have interesting biographies. Some presidents came from humble backgrounds, others from families



of privilege. Several of the Society's presidents were born or trained outside the U.S. The early presidents had been awarded honorary Ph.D.'s. Some stayed at the same institution for decades, others traveled the world to do research, give talks, and represent the AMS. Most worked in academia, and a few worked in applied mathematics; some trained in well-known mathematics departments, others at small colleges. Some were quiet leaders, others outgoing and highly visible. All have in common an international recognition for their mathematical achievements and effective leadership. See a brief biography of each AMS president from 1888 through 2008 at <http://www.ams.org/ams/amspresidents.html>.

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

MathSciNet Links to Mathematics Genealogy Project

MathSciNet now offers direct linking to the Mathematics Genealogy Project (MGP, <http://www.genealogy.ams.org/>) through the MathSciNet "Authors" search tab. The results obtained after doing an author search on this page include a drop-down menu (hover the cursor over the author of interest) that includes a link to the author's MGP page. On MGP users can find information about that author: name of the university that awarded his or her degree, the year in which the degree was awarded, the complete title of the dissertation, the name(s) of the advisor(s), and for some, a list of the mathematician's students.

—AMS Announcement

Deaths of AMS Members

RICHARD D. ANDERSON, former AMS vice president, died on March 4, 2008. Born on February 17, 1922, he was a member of the Society for 62 years.

NIKOLAY V. AZBELEV, professor, Perm State Technical University, Russia, died on November 3, 2006. Born on April 15, 1922, he was a member of the Society for 11 years.

CHARLES L. CLARK, professor emeritus, California State University, Los Angeles, died on February 22, 2008. Born in November 1917, he was a member of the Society for 68 years.

HELEN F. CULLEN, from Harwich, MA, died on August 25, 2007. Born on January 4, 1919, she was a member of the Society for 58 years.

BELMONT G. FARLEY, former faculty member at the University of Pennsylvania, and professor emeritus of Temple University, died on February 28, 2008. Born on December 29, 1920, he was a member of the Society for 66 years.

DAVID GALE, professor emeritus, University of California, Berkeley, died on March 7, 2008. Born on December 13, 1921, he was a member of the Society for 61 years.

ALFRED W. GOLDIE, from Cumbria, England, died on October 8, 2005. Born on December 10, 1920, he was a member of the Society for 18 years.

RAOUL HAILPERN, from Amherst, NY, died on February 9, 2008. Born on July 19, 1916, he was a member of the Society for 45 years.

JAMES E. HOUSEHOLDER, from Las Vegas, NV, died on January 23, 2008. Born on December 26, 1916, he was a member of the Society for 52 years.

RAYMOND F. KRAMER JR., from Manhattan Beach, CA, died on February 23, 2008. Born on June 6, 1932, he was a member of the Society for 49 years.

BENJAMIN N. MOYLS, from Vancouver, Canada, died on November 10, 2007. Born on May 1, 1919, he was a member of the Society for 61 years.

GEN-ICHIRO SUNOUCHI, from Sendai, Japan, died on March 7, 2008. Born on October 29, 1911, he was a member of the Society for 53 years.

PETER SZÜSZ, professor emeritus, SUNY Stony Brook, died on February 16, 2008. Born on November 11, 1924, he was a member of the Society for 42 years.



Noticed

Kevin Short, a mathematician at the University of New Hampshire, is co-recipient of a 2008 Grammy Award. Short used his "Chaotic Compression Technology" to restore a bootleg wire recording of a Woody Guthrie concert that is the only known recording of the folk singer performing before a live audience. The result, *The Live Wire: Woody Guthrie In Performance 1949*, earned him and the team of producers and engineers the 2008 Grammy Award for Best Historical Album.

Manil Suri, a mathematician at the University of Maryland, Baltimore County, has published his second novel. His first novel, *The Death of Vishnu*, was published to high acclaim and has been translated into twenty-two foreign languages. Suri received a Guggenheim Fellowship for fiction in 2004. His latest novel, *The Age of Shiva*, appeared in February of this year.

Reference and Book List

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

Contacting the Notices

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

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

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

Upcoming Deadlines

April 18, 2008: Applications for Project NExT: New Experiences in Teaching. See <http://archives.math.utk.edu/projnext/>.

April 21, 2008: Proposals for 2009 NSF-CBMS Regional Conferences. See "Mathematics Opportunities" in this issue.

May 1, 2008: Applications for AWM Travel Grants. See <http://www.awm-math.org/travelgrants.html>; telephone 703-934-0163; email: `awm@awm-math.edu`; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

Where to Find It

A brief index to information that appears in this and previous issues of the *Notices*.

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AMS Email Addresses—February 2008, p. 274

AMS Ethical Guidelines—June/July 2006, p. 701

AMS Officers 2006 and 2007 Updates—May 2008, p. 629

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Information for Notices Authors—June/July 2007, p. 765

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New Journals for 2005, 2006—June/July 2007, p. 767

NRC Board on Mathematical Sciences and Their Applications—March 2008, p. 401

NRC Mathematical Sciences Education Board—April 2008, p. 515

NSF Mathematical and Physical Sciences Advisory Committee—February 2008, p. 276

Program Officers for Federal Funding Agencies—October 2007, p. 1173 (DoD, DoE); December 2007, p. 1359 (NSF), December 2007, p. 1526 (NSF Mathematics Education)

Program Officers for NSF Division of Mathematical Sciences—November 2007, p. 1358

Stipends for Study and Travel—September 2007, p. 1022

May 1, 2008: Applications for May review for the National Academies Postdoctoral and Senior Research Associateship Programs. See <http://www7.nationalacademies.org/rap/index.html> or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: rap@nas.edu.

May 15-June 15, 2008: Proposals for DMS Workforce Program in the Mathematical Sciences. See http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503233.

May 31, 2008: Registration for International Mathematics Competition for University Students. See "Mathematics Opportunities" in this issue.

June 1, 2008: Applications for Christine Mirzayan Science and Technology Policy Graduate Fellowship Fall Program. See <http://www7.nationalacademies.org/policyfellows> or contact The National Academies Christine Mirzayan Science and Technology Policy Graduate Fellowship Program, 500 Fifth Street, NW, Room 508, Washington, DC 20001; telephone: 202-334-2455; fax: 202-334-1667; email: policyfellows@nas.edu.

June 10, 2008: Proposals for Enhancing the Mathematical Sciences Workforce in the Twenty-First Century. See http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf05595.

August 1, 2008: Applications for August review for the National Academies Postdoctoral and Senior Research Associateship Programs. See <http://www7.nationalacademies.org/rap/index.html> or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: rap@nas.edu.

August 18, 2008: Applications for NSF Research Experiences for Undergraduates (REU) program sites. See http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07569.

October 1, 2008: Applications for AWM Travel Grants. See <http://www.awm-math.org/travelgrants.html>; telephone: 703-934-0163; email:

awm@awm-math.edu; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

October 15, 2008: Proposals for NSF Postdoctoral Research Fellowships. See "Mathematics Opportunities" in this issue.

November 1, 2008: Applications for November review for the National Academies Postdoctoral and Senior Research Associateship Programs. See <http://www7.nationalacademies.org/rap/index.html> or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: rap@nas.edu.

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.

Alfred Tarski: Life and Logic, by Anita Burdman Feferman and Solomon Feferman. Cambridge University Press, October 2004. ISBN 0-521-80240-7. (Reviewed September 2007.)

Amongst Mathematicians: Teaching and Learning Mathematics at University Level, by Elena Nardi. Springer, November 2007. ISBN-13: 978-0-387-37141-2.

Ants, Bikes, and Clocks: Problem Solving for Undergraduates, by William Briggs. Society for Industrial and Applied Mathematics, 2005. ISBN 0-89871-574-1.

The Archimedes Codex, by Reviel Netz and William Noel. Weidenfeld

and Nicolson, May 2007. ISBN-13: 978-0-29764-547-4.

The Art of Mathematics: Coffee Time in Memphis, by Béla Bollobás. Cambridge University Press, September 2006. ISBN-13: 978-0-52169-395-0.

The Artist and the Mathematician: The Story of Nicolas Bourbaki, the Genius Mathematician Who Never Existed, by Amir D. Aczel. Thunder's Mouth Press, August 2006. ISBN 1-560-25931-0. (Reviewed October 2007.)

Benjamin Franklin's Numbers: An Unsung Mathematical Odyssey, by Paul C. Pasles. Princeton University Press, October 2007. ISBN-13: 978-0-69112-956-3.

Bourbaki, a Secret Society of Mathematicians, by Maurice Mashaal. AMS, June 2006. ISBN 0-8218-3967-5. (Reviewed October 2007.)

The Calculus Wars: Newton, Leibniz, and the Greatest Mathematical Clash of All Time, by Jason Socrates Bardi. Thunder's Mouth Press, April 2007. ISBN-13: 978-1-56025-992-3.

The Cat in Numberland, by Ivar Ekeland. Cricket Books, April 2006. ISBN-13: 978-0-8126-2744-2.

A Certain Ambiguity: A Mathematical Novel, by Gaurav Suri and Hartosh Singh Bal. Princeton University Press, June 2007. ISBN-13: 978-0-691-12709-5. (Reviewed February 2008.)

Chases and Escapes: The Mathematics of Pursuit and Evasion, by Paul J. Nahin. Princeton University Press, May 2007. ISBN-13: 978-0-69112-514-5.

Descartes: A Biography, by Desmond Clarke. Cambridge University Press, March 2006. ISBN 0-521-82301-3. (Reviewed January 2008.)

Does Measurement Measure Up?: How Numbers Reveal and Conceal the Truth, by John Henshaw. Johns Hopkins University Press, March 2006. ISBN-13: 978-0-8018-8375-0.

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

Flatland—The Movie: A Journey of Many Dimensions. Flatworld Productions, 2007. Special Educator Edition DVD, <http://store.flatlandthemovie.com>. (Reviewed November 2007.)

Fly Me to the Moon: An Insider's Guide to the New Science of Space Travel, by Edward Belbruno. Princeton University Press, January 2007. ISBN-13: 978-0-691-12822-1. (Reviewed April 2008.)

The Great π/e Debate: Which Is the Better Number?, DVD by Colin Adams and Thomas Garrity. Mathematical Association of America, 2007. ISBN 0-88385-900-9.

**Group Theory in the Bedroom, and Other Mathematical Diversions*, by Brian Hayes. Hill and Wang, April 2008. ISBN-13: 978-0-8090-521-96.

A History of Abstract Algebra, by Israel Kleiner. Birkhäuser, October 2007. ISBN-13: 978-0-8176-4684-4.

How Mathematicians Think: Using Ambiguity, Contradiction, and Paradox to Create Mathematics, by William Byers. Princeton University Press, May 2007. ISBN-13: 978-0-6911-2738-5. (Reviewed December 2007.)

**How Round Is Your Circle*, by John Bryant and Chris Sangwin. Princeton University Press, January 2008. ISBN-13: 978-0-6911-311-84.

I Am a Strange Loop, by Douglas R. Hofstadter. Basic Books, March 2007. ISBN-13: 978-0-46503-078-1. (Reviewed August 2007.)

The Indian Clerk, by David Leavitt. Bloomsbury USA, September 2007. ISBN-13: 978-1-5969-1040-9.

An Introduction to Gödel's Theorems, by Peter Smith. Cambridge University Press, August 2007. ISBN-13: 978-0-52167-453-9.

**Irreligion: A Mathematician Explains Why the Arguments for God Just Don't Add Up*, by John Allen Paulos. Hill and Wang, December 2007. ISBN-13: 978-0-8090-591-95.

John von Neumann: Selected Letters, edited by Miklós Rédei. AMS, November 2005. ISBN 0-8218-3776-1. (Reviewed June/July 2007.)

Karl Pearson: The Scientific Life in a Statistical Age, by Theodore M. Porter. Princeton University Press, (new edition) December 2005. ISBN-13: 978-0-69112-635-7. (Reviewed December 2007.)

The Legacy of Mario Pieri in Geometry and Arithmetic, by Elena Anne Marchisotto and James T. Smith. Birkhäuser, May 2007. ISBN-13: 978-0-8176-3210-6.

Leonhard Euler, a Man to Be Reckoned With, by Andreas K. Heyne and Alice K. Heyne. Birkhäuser, 2007. ISBN-13: 978-3-7643-8332-9. (Reviewed March 2008.)

**Making Mathematics Work with Needlework: Ten Papers and Ten Projects*, edited by Sarah-Marie Belcastro and Carolyn Yackel. A K Peters, September 2007. ISBN-13: 978-1-56881-331-8.

The Math behind the Music, by Leon Harkleroad. Cambridge University Press, August 2006. ISBN-13: 978-0-521-00935-5.

Math Doesn't Suck: How to Survive Middle-School Math without Losing Your Mind or Breaking a Nail, by Danica McKellar. Hudson Street Press, August 2007. ISBN-13: 978-1-5946-3039-2.

Mathematical Mind-Benders, by Peter Winkler. A K Peters, August 2007. ISBN-13: 978-15688-1336-3.

The Mathematician's Brain, by David Ruelle. Princeton University Press, July 2007. ISBN-13: 978-0-691-12982-2.

Mathematics at Berkeley: A History, by Calvin C. Moore. AK Peters, February 2007. ISBN-13: 978-1-5688-130-28.

The Millennium Prize Problems, edited by James Carlson, Arthur Jaffe, and Andrew Wiles. AMS, June 2006. ISBN-13: 978-0-8218-3679-8.

The Mind of the Mathematician, by Michael Fitzgerald and Ioan James. Johns Hopkins University Press, May 2007. ISBN-13: 978-0-8018-8587-7.

More Mathematical Astronomy Morsels, by Jean Meeus. Willmann-Bell, 2002. ISBN 0-943396-743.

More Sex Is Safer Sex: The Unconventional Wisdom of Economics, by Steven E. Landsburg. Free Press, April 2007. ISBN-13: 978-1-416-53221-7.

The Motion Paradox: The 2,500-Year Old Puzzle behind All the Mysteries of Time and Space, by Joseph Mazur. Dutton Adult, April 2007. ISBN-13: 978-0-52594-992-3.

Mr. Hopkins' Men: Cambridge Reform and British Mathematics in the 19th Century, by A. D. D. Craki. Springer, July 2007. ISBN-13: 978-1-8462-8790-9.

Music and Probability, by David Temperley. MIT Press, January 2007. ISBN-13: 978-0-262-20166-7.

Music: A Mathematical Offering, by David J. Benson. Cambridge University Press, December 2006. ISBN-13: 978-0-521-61999-8.

New Theories of Everything, by John D. Barrow. Oxford University Press, July 2007. ISBN-13: 978-0-192-80721-2.

Nonplussed! Mathematical Proof of Implausible Ideas, by Julian Havil. Princeton University Press, May 2007. ISBN-13: 978-0-691-12056-0.

The Numbers behind NUMB3RS: Solving Crime with Mathematics, by Keith Devlin and Gary Lorden. Plume, August 2007. ISBN-13: 978-0-4522-8857-7.

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

Perfect Figures: The Lore of Numbers and How We Learned to Count, by Bunny Crumpacker. Thomas Dunne Books, August 2007. ISBN-13: 978-0-3123-6005-4.

The Poincaré Conjecture: In Search of the Shape of the Universe, by Donal O'Shea. Walker, March 2007. ISBN-13: 978-0-8027-1532-6. (Reviewed January 2008.)

Poincaré's Prize: The Hundred-Year Quest to Solve One of Math's Greatest Puzzles, by George Szpiro. Dutton Adult, June 2007. ISBN-13: 978-0-525-95024-0. (Reviewed January 2008.)

**The Presidential Election Game*, by Steven J. Brams. A K Peters, December 2007. ISBN-13: 978-1-5688-134-86.

The Probability of God: A Simple Calculation That Proves the Ultimate Truth, by Stephen D. Unwin. Three Rivers Press (October 26, 2004). ISBN-13: 978-1-4000-5478-7. (Reviewed February 2008.)

Pythagoras: His Life, Teaching and Influence, by Christoph Riedweg. Translated by Steven Rendall. Cornell University Press, March 2005. ISBN-13: 978-0-80144-240-7.

Pythagoras: The Mathemagician, by Karim El-koussa. Cloonfad Press, September 2005. ISBN-13: 978-0-97694-042-5.

The Pythagorean Theorem: A 4000-Year History, by Eli Maor. Princeton University Press, May 2007. ISBN-13: 978-0-69112-526-8.

Solving Mathematical Problems: A Personal Perspective, by Terence Tao. Oxford University Press, September 2006. ISBN-13: 978-0-199-20560-8.

The Square Root of 2: A Dialogue Concerning a Number and a Sequence, by David Flannery. Springer, December 2005. ISBN-13: 978-0-38720-220-4.

**Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart*, by Ian Ayres. Bantam, August 2007. ISBN-13: 978-0-5538-054-06.

Superior Beings: If They Exist, How Would We Know? Game-Theoretic Implications of Omnipotence, Omniscience, Immortality, and Incomprehensibility, by Steven Brams. Springer, second edition, November 2007. ISBN-13: 978-0-387-48065-7. (Reviewed February 2008.)

Thinking about Gödel and Turing: Essays on Complexity, 1970–2007, by Gregory J. Chaitin. World Scientific, August 2007. ISBN-13: 978-9-8127-0895-3.

The Triumph of Numbers: How Counting Shaped Modern Life, by I. B. Cohen. W. W. Norton, July 2006. ISBN-13: 978-0-393-32870-7. (Reviewed December 2007.)

The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next, by Lee Smolin. Joseph Henry Press, October 2006. ISBN 0-309-10192-1. (Reviewed September 2007.)

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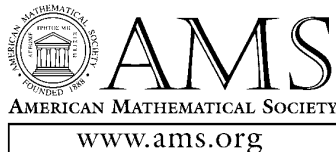
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May 2008

* 2–5 **The 46th Cornell Topology Festival**, Cornell University, Ithaca, New York.

Description: This year's festival includes a concentration of talks in symplectic topology and geometry. There will be two introductory workshops and a panel discussion.

Information: Financial support is available. Young researchers are especially encouraged to apply. For registration and further details see the festival web page: <http://www.math.cornell.edu/~festival/>; email: dls37@cornell.edu;

* 5–14 **The Sixth Annual Spring Institute on Noncommutative Geometry and Operator Algebras**, Vanderbilt University, Nashville, Tennessee.

Description: The Sixth Annual Spring Institute on Noncommutative Geometry and Operator Algebras is a spring school and international conference. Several mini-courses on a variety of topics from noncommutative geometry, operator algebras and related areas will be given by leading experts.

Topic: The topic of this year's conference/school is KK-Theory of Operator Algebras and Noncommutative Geometry. Students and postdocs are especially encouraged to attend. Mini-courses by: Alain Connes, Nigel Higson, Ralf Meyer, Mikael Rordam, Georges Skandalis and other. Organizers: Dietmar Bisch, Alain Connes (Director of the Sixth Annual Spring Institute), Bruce Hughes, Gennadi Kasparov and Guoliang Yu (all at Vanderbilt University).

Information: dietmar.bisch@vanderbilt.edu; <http://www.math.vanderbilt.edu/~ncgoa08/>.

* 8–10 **International Conference on Inverse Scattering Problems Honoring David Colton and Rainer Kress**, Sestri Levante, Genova, Italy.

Description: The organization of this conference is in recognition of the international leadership and outstanding scientific achievements of David Colton and Rainer Kress in the area of inverse scattering problems. This event is open to participants interested in inverse scattering problems and applications.

Information: email: cakoni@math.udel.edu; <http://www-rocq.inria.fr/~haddar/ckconf/>.

* 19–23 **6th Seminar on Stochastic Analysis, Random Fields and Applications**, Centro Stefano Franscini, Ascona, Switzerland.

Topics: Stochastics and climatology; stochastic partial differential equations; random fields; stochastic analysis and finance; energy, climate and finance.

Among the speakers: R. Carmona (Princeton), J. Duan (Illinois), D. Filipovic (Munich), H. Geman (ESSEC and London), P. Imkeller (Berlin), A. Kyprianou (Bath), A. J. Majda (New York), B. Maslowski (Prague), J. C. Mattingly (Duke), S. Sircar (Princeton), A. N. Shiryaev (Moscow), A. Stuart (Warwick), J. Wörner (Göttingen), Y. Xiao (Michigan).

Information: email: dozzi@iecn.u-nancy.fr; <http://www.math.univ-paris13.fr/~russo/ASCONA08/Ascona08.html>.

* 21–24 **Sixth Annual Workshop on Combinatorial and Additive Number Theory (CANT 2008)**, CUNY Graduate Center, 365 Fifth Avenue, New York, New York

Description: This is the sixth in a series of annual workshops

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 or mathcal@ams.org.

In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **eight months** prior to the scheduled date of the meeting.

The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. The March, June/July, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.

The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: <http://www.ams.org/>.

sponsored by the New York Number Theory Seminar on problems in combinatorial and additive number theory and related parts of mathematics. Program information will be posted on the conference website: <http://www.NewYorkNumberTheory.com>. Mathematicians who wish to speak at the meeting should submit a title and abstract by email to: melvyn.nathanson@lehman.cuny.edu. It is expected that there will be some financial support, especially for graduate students and young faculty. For more information please contact melvyn.nathanson@lehman.cuny.edu.

Information: <http://www.NewYorkNumberTheory.com>.

*26–31 **Stochastic Phenomena**, Babes-Bolyai University, Cluj-Napoca, Romania.

Description: The Second Transylvanian Summer School and Workshop proposes to offer a discussion and meeting platform for researchers from various fields of sciences interested in the complex interdisciplinary field of stochastic phenomena. We are expecting scientists and students from the fields of mathematics, physics, informatics, biology, chemistry, electric engineering, sociology, geography and economics, working in problems that would fit the general theme of the conference.

Information: email: zneda@phys.ubbcluj.ro; <http://summerschools.ro>.

June 2008

*8–14 **Reconnect Conference 2008**, DyDAn Center, Rutgers University, Piscataway, New Jersey.

Description: About the Reconnect Conference: The DyDAn Summer Reconnect Conferences will expose faculty teaching undergraduates to the role of the mathematical sciences in homeland security by introducing them to a current research topic that will be relevant for classroom presentation. The conferences also offer researchers in government or industry the opportunity to learn about recent techniques in emerging application areas relevant to homeland security. Topics will be presented in a week-long series of lectures and activities led by an expert in the field. Participants will be involved in both research activities and in writing materials useful in the classroom or to share with their colleagues, with the possibility of ultimately preparing these materials for publication in either our Technical Report or our Educational Modules Series.

Speaker: Nina Fefferman, Rutgers University, fefferman@Math.Princeton.EDU.

Organizer: Fred S. Roberts, Rutgers University (froberts@dimacs.rutgers.edu).

Registration Fees: Academic participants: Lodging and meals will be provided through DHS funding. Limited funds are expected to be available for travel awards. There are no registration fees. Applicants from government and for-profit corporations are asked to provide their own travel and lodging, plus registration fees* (that cover all meals from Sunday dinner to Saturday lunch) as follows:

◦ Government Lab participants: \$350. ◦ Corporate participants: \$500.

* Funds may be available to waive part or all of the registration fee and/or partially support travel and lodging. Who May Apply? Anyone may apply.

Application Deadline: Extended to March 3, 2008.

Information: <http://dydan.rutgers.edu/Education/reconnect/2008/>. Or, contact the Reconnect Program Coordinator, at reconnect@dimacs.rutgers.edu; tel: (732) 445-4304.

*9–13 **Educational Week on Noncommutative Integration**, Leiden University, Leiden, Netherlands.

Description: During this educational week the main lecturers Fyodor Sukochev (Flinders University, Adelaide) and Ben de Pagter (TU Delft) will cover several aspects of noncommutative integration associated with von Neumann algebras, as well as some applications of this theory. The intended audience consists of advanced master

students, Ph.D.-students, postdocs and other people interested in this field.

Participation and Funding: Participation is free. We are trying to obtain funds for limited travel support for participants from outside the Netherlands.

Information: email: mdejeu@math.leidenuniv.nl; http://www.math.leidenuniv.nl/~mdejeu/NoncomIntWeek_2008.

*9–20 **Symmetry and Integrability of Difference Equations**, Université de Montréal, Québec, Canada.

Description: The field of symmetries and integrability of difference equations is a very dynamical one in which great progress has been made over the last 15 years or so. The key methods that have been developed in this area are based either on the inverse spectral approach or on the application of geometric and group theoretical techniques.

Topics: Specifically the topics to be covered are the following: (1) Discrete integrable and isomonodromic systems; (2) Discrete Painlevé equations; (3) Singularity confinement, algebraic entropy and Nevanlinna theory; (4) Discrete differential geometry; (5) Special functions as solutions of difference or q-difference equations; (6) Integrability, symmetry and numerical methods; (7) Lie symmetries of difference systems; (8) Integrable chains. The most relevant applications of this field of scientific activity are to coding theory, image reconstruction and processing and visual tracking, starting from discrete and usually sparse data.

Information: email: Benhima@crm.umontreal.ca; <http://www.dms.umontreal.ca/~sms/>.

*14–28 **International Summer School on Modelling and Optimization in Micro- and Nano-Electronics - MOMINE'08**, Conference Centre Baia Samuele, Ragusa, Sicily, Italy.

Description: Modelling week: Advanced Modelling Methods for the Design of Electronic Circuits and Devices, June 14–21, 2008. Optimization Week: Advanced Optimization Methods and Algorithms for the Design of Electronic Circuits and Devices June 21–28, 2008. There will be several seminars complementing the topics treated in the course.

Deadline for Early Registration: March 31, 2008.

Information: For any questions please send email to momine08@dm1.unict.it; <http://www.dm1.unict.it/~momine08/>.

*15–22 **ESF-MSHE-PAN Conference on Operator Theory, Analysis and Mathematical Physics**, Mathematical Research and Conference Center, Bédlewo, Poland.

Description: First Call for Applications: ESF Conference, in partnership with MSHE and the Institute of Mathematics on operator theory, analysis and mathematical physics.

Scope: Random and quasi-periodic differential operators, orthogonal polynomials, Jacobi and CMV matrices, and quantum graphs. In particular spectral properties of operators from various domains of mathematical physics.

Chairs: Jan Janas, Polish Academy of Sciences; Pavel Kurasov, Lund Institute of Technology; Ari Laptev, Royal Institute of Technology; Serguei Naboko, St. Petersburg State University.

Deadline: Closing date for applications and abstract submission: March 30, 2008.

Information: Application: Scientific programme and application form are accessible on-line through <http://www.esf.org/conferences/08279>. For further information contact: Anne Blondeel-Oman (ablondeel@esf.org).

*16–20 **15th Conference of the International Linear Algebra Society**, Westin Resort and Spa, Cancun, Mexico.

Description: The conference deals with all themes related to Linear Algebra; theory, applications, numerical aspects, and education. The program includes 14 plenary talks, 8 mini-symposia, and contributed talks. The conference proceedings will appear as a special issue of Linear Algebra and its Applications.

Information: email: verde@star.izt.uam.mx; <http://star.izt.uam.mx/ILAS08>.

* **23–27 Differential Equations and Applications to Mathematical Biology**, Le Havre, France.

Goal: The goal of this meeting is to bring together international experts working either on theoretical aspects of differential equations or on applications to mathematical biology.

Scientific Committee: Henri Berestycki (EHESS, France), Shui-Nee Chow (Georgia Tech, USA), Norman Dancer (University of Sydney, Australia), Karl Hadeler (University of Tuebingen, Germany), Vitaly Volpert (University of Lyon 1, France), Hans-Otto Walther (University of Giessen, Germany).

Plenary Speakers: Danielle Hilhorst, University of Orsay, France; Kening Lu, Brigham Young University, USA; Peter Polacik, University of Minnesota, USA; Genevieve Raugel, University of Orsay, France; Yasuhiro Takeuchi, Shizuoka University, Japan; Glenn Webb, Vanderbilt University, USA; Gail Wolkowicz, McMaster University, Canada; Jianhong Wu, York University, Canada; Dongmei Xiao, Shanghai Jiaotong University, China; Yingfei Yi, Georgia Tech, USA.

Organizing Committee: Pierre Magal, pierre.magal@univ-lehavre.fr; Shigui Ruan, ruan@math.miami.edu; Huaiping Zhu, huaiping@mathstat.yorku.ca.

Information: Further information about the conference can be found at <http://litis.univ-lehavre.fr/MathBioConf/>.

* **24–26 Current Geometry, the IX Edition of the International Conference on problems and trends of contemporary geometry**, Hotel Oriente, Via Luigi Serio 10, 80069 Vico Equense, Naples, Italy.

Description: The power of synthesis of Geometry, which led in the past to the formulation of “grand unification theories”, has got an essential role nowadays, especially because of the growing fragmentation of knowledge due to scientific progress. In order to avoid too a big dispersion, geometers need a constant dialogue. Therefore, a stable experience of personal meetings, apart from telematic interchanges, cannot be renounced. Current Geometry was born to allow a periodic update about actual progresses in Geometry (and its applications) on the international scene.

Information: email: cdiopietr@unisa.it; <http://school.diffiety.org/page82/page82.html>.

* **30–July 5 International Conference in Algebraic Geometry**, IMAR Bucharest, Romania.

Invited Speakers: I. Bauer (Bayreuth), L. Badescu (Genova), A. Caldararu (Madison-Wisconsin), F. Catanese (Bayreuth), C. Ciliberto (Rome), A. Dimca (Nice), J.-M. Drezet (Paris), G. Farkas (Berlin), H. Flenner (Bochum), K. Hulek (Hannover), H. Lange (Erlangen), A. Lanteri (Milan), M. Lehn (Mainz), L. Maxim (New York), M. Mella (Ferrara), M. Mustata (Ann Arbor), G. Ottaviani (Florence), S. Papadima (Bucharest), G. Pareschi (Rome), M. Popa (Chicago), K. Ranestad (Oslo), F. Russo (Recife-Pernambuco), F.-O. Schreyer (Saarbruecken), G. Trautmann (Kaiserslautern), C. Voisin (Paris).

Organizing Committee: C. Anghel (IMAR), M. Aprodu (IMAR), V. Brinzanescu (IMAR), N. Manolache (IMAR).

Information: email: Marian.Aprodu@imar.ro; <http://www.imar.ro/%7Eaprodu/ag2008/ag2008.html>.

July 2008

* **7–10 International Conference on Artificial Intelligence and Pattern Recognition (AIPR-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on Automation, Robotics and Control Systems (ARCS-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on Bioinformatics, Computational Biology, Genomics and Chemoinformatics (BCBGC-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on Enterprise Information Systems and Web Technologies (EISWT-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on High Performance Computing, Networking and Communication Systems (HPCNCS-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on Software Engineering Theory and Practice (SETP-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 International Conference on Theoretical and Mathematical Foundations of Computer Science (TMFCS-08)**, Orlando, Florida.

Description: We invite draft paper submissions.

Deadline: The deadline for submissions: February 19, 2008.

Information: The conference will be held at the same time and place where several other major events are taking place. The website contains more details: <http://www.promoterresearch.org/>; email: jeedward@gmail.com.

* **7–10 The Tenth International Conference on Integral Methods in Science and Engineering**, University of Cantabria, Santander, Spain.

Description: The IMSE conferences offer opportunities to scientists from around the world to present their most recent work and exchange ideas on a powerful class of methodologies extensively used for solving mathematical models of physical phenomena and processes. Participation is open to all scientists and engineers whose work makes use of analytic and numerical methods, integral equations, ordinary and partial differential equations, asymptotic and perturbation methods, boundary integral techniques, conservation laws, hybrid approaches, vortex methods, signal processing and image analysis.

Aim: To promote new research tools and procedures that help link mathematics, applied sciences and technology. As the tenth in a successful series of conferences, IMSE2008 will provide an

international forum for communicating recent advances and an opportunity for direct information exchange between delegates from both academia and industry.

Information: email: meperez@unican.es; <http://www.imse08.unican.es>.

- *7-11 **International Conference on Vertex Operator Algebras and Related Areas on the occasion of Geoffrey Mason 60th's Birthday**, Department of Mathematics, Illinois State University, Normal, Illinois.

Aim: To present some of the new developments in vertex operator algebras and related areas. The main aspects of this conference are connections and interactions of vertex operator algebras with physics, Hopf algebras, Infinite dimensional Lie algebras, group theory and number theory. A major part of the conference will focus on bringing leaders in the fields together with students, postdoctoral fellows and young academics in a stimulating, engaging and mentoring environment. This conference will provide opportunities for mathematicians and physicists in the areas to discuss the recent developments in the fields and the direction of future research. Graduate students and young researchers will gain better perspectives of what is going on and what the important problems are in these areas.

Organizers: Gaywalee Yamskulna(ISU), Maarten Bergvelt (UIUC), Wenhua Zhao (ISU).

Deadline: June 1, 2008.

Information: <http://www.math.ilstu.edu/voa>.

- *10-11 **Symposium in honor of Kiyosi Itô: Stochastic Analysis and Its impact in Mathematics and Science**, Institute for Mathematical Sciences, National University of Singapore, Singapore.

Description: The objective of the symposium is to gather together leading mathematicians and scientists to deliver expository lectures on Itô's work and the historical development of stochastic analysis, and their influence and impact in various branches of mathematics and science. It will be aimed at specialists as well as mathematicians and scientists in general.

Organizers: Jointly organized with Research Institute for Mathematical Sciences, Kyoto.

Organizing Committee: Co-Chairs Hans Föllmer (Humboldt-University of Berlin), Masatoshi Fukushima (Osaka University); Members Edwin Perkins (University of British Columbia), Yoichiro Takahashi (Research Institute for Mathematical Sciences, Kyoto).

Partial List of Invited Speakers: Alain Bensoussan, University of Texas at Dallas; Donald Dawson, Carleton University; Masatoshi Fukushima, Osaka University; Shigeo Kusuoka, University of Tokyo; Pierre-Louis Lions, Collège de France; Terry Lyons, University of Oxford; Shinzo Watanabe, Kyoto University; Marc Yor, Université Paris VI.

Information: email: imscec@nus.edu.sg; <http://www.ims.nus.edu.sg/Programs/kiyosi08/index.htm>.

- *17-August 1 **XI Edition of the Italian Diffiety School**, Santo Stefano del Sole (Avellino), Italy.

Description: The aim of this permanent school is to introduce undergraduate and Ph.D. students in Mathematics and Physics, as well as post-doctoral researchers, in a recently emerged area of Mathematics and Theoretical Physics: Secondary Calculus. A Diffiety is a new geometrical object that properly formalizes the concept of the solution space of a given system of nonlinear PDEs, much as an algebraic variety does with respect to solutions of a given system of algebraic equations. Secondary Calculus is a natural diffiety analogue of the standard calculus on smooth manifolds, and as such leads to a very rich general theory of nonlinear PDEs. Moreover, it appears to be the unique natural language for quantum physics, just as the standard calculus is the natural language for classical physics.

Information: <http://school.diffiety.org/page3/page0/page64/page64.html>; email: cdipietr@unisa.it.

- *18-20 **International Conference on Power Control and Optimization**, Chiang Mai Plaza Hotel, 92 Sridonchai Road, Chiang Mai 50100, Thailand.

Description: It is our great pleasure to announce the first event of the International Conference on Power Control and Optimization (PCO-08) organized by Department of Electrical Engineering, Chiang Mai University, Thailand and Curtin University of Technology, Malaysia. The vision of PCO-08 is to bring today's highly inspiring and precision innovative research and resource development for tomorrow's industry in power and control. It has the mission to highlight innovative research and development of academics and industrial experts in the area of power control and its optimization techniques, and to provide a forum to disseminate the results to all industrial sectors in power quality, automation, business, finance, economics and management. The main objective of PCO-08 is to provide a platform for researchers, engineers, practitioners and academicians as well as industrial professionals to present their research results and development activities.

Information: Contacts: Nader Barsoum and Pandian M. Vasant; email: icpco.20@gmail.com and nnb3@hotmail.com; tel: 601 6354154 & 6085443821. For further information, please visit: <http://www.engedu2.net>; email: vasantglobal@gmail.com.

- *21-23 **19th Postgraduate Combinatorial Conference**, Centre for Discrete Mathematics and its Applications (DIMAP), University of Warwick, Coventry, CV4 7AL, United Kingdom.

Description: The Postgraduate Combinatorial Conference is aimed at research students in all areas of combinatorics and discrete mathematics who are currently working on their Ph.D.

Organizer: The conference is organized under the auspices of the British Combinatorial Committee and the Centre for Discrete Mathematics and its Applications (DIMAP).

Sponsors: Include the London Mathematical Society and the Open University.

Information: <http://go.warwick.ac.uk/pcc2008>; email: pcc2008@dcs.warwick.ac.uk.

- *21-August 8 **Summer Course on Multiscale Modeling and Analysis**, University of Texas at Austin, Austin, Texas.

Description: This is a three-week program on multiscale modeling and analysis for advanced undergraduate and 1st year graduate students. This program will contain 5-6 short courses, each consisting of 4-6 one-hour lectures. The lectures will be complemented by problem sessions in the afternoons conducted by senior graduate students. The prerequisites of the course are advanced calculus and linear algebra. Some familiarity with numerical analysis and computer programming will be helpful.

Information: email: lexing@math.utexas.edu; <http://www.math.utexas.edu/rtg/course.html>.

- *28-September 21 **Mathematical Horizons for Quantum Physics**, Institute for Mathematical Sciences, National University of Singapore, Singapore.

Description: The Programme will consist of four overlapping three-week sessions, each devoted to a selected topic.

Organizing Committee: Co-chairs: Berthold Georg Englert (National University of Singapore), Kwek Leong Chuan (Nanyang Technological University). Secretary: Junuzuki (National University of Singapore). Overall Programme Coordinator: Huzihiro Araki (University of Kyoto).

Information: email: imscec@nus.edu.sg; <http://www.ims.nus.edu.sg/Programs/mhq08/index.htm>.

August 2008

- *1-3 **Jairo Charris Seminar in Algebra and Analysis 2008: SJCH 2008**, Universidad Sergio Arboleda, Bogotá, Colombia.

Description: This seminar is dedicated to Jairo Antonio Charris Castañeda (in memoriam) and in this occasion is devoted to

orthogonal polynomials, complex variables and their applications, emphasizing his scientific legacy.

Information: email: primitivo.acosta@upc.edu; <http://www-ma2.upc.edu/primi/sjch2008.htm>.

- * 14–19 **International Conference on Complex Analysis and Related Topics (The Xlth Romanian-Finnish Seminar)**, University of Alba Iulia, Romania.

Topics: The following sections will be included: 1. Analytic functions of one complex variable; 1A. Univalence, 1B. Other subjects; 2. Quasiconformal mappings and Teichmüller spaces; 3. Several complex variables; 4. Potential theory; 5. Functional analytical methods in complex analysis.

Description: The organizers are the Institute of Mathematics “Simion Stoilow” of the Romanian Academy; University of Alba Iulia; University of Pitești; University of Bucharest; and the Faculty of Mathematics and Informatics of the “Babes-Bolyai” University of Cluj-Napoca, in cooperation with the Universities of Helsinki, Joensuu, and Jyväskylä from Finland.

Information: <http://www.imar.ro/~purice/conferences/index.html>; email: lucian.beznea@imar.ro.

- * 24–27 **39th Annual Iranian Mathematics Conference (AIMC39)**, Department of Mathematics, Shahid Bahonar University of Kerman, Kerman, Iran.

Description: The 39th AIMC will be held at Shahid Bahonar University of Kerman Under the auspices of Iranian Mathematical Society in Kerman (a beautiful and historical city), during 24–27 August, 2008. This conference includes invited speakers and presentations of submitted research papers. All areas listed on the cover of Mathematical Reviews, are partitioned in 12 branches by the scientific committee for grouping presentations as follows: Algebra, Analysis, Combinatorics and Graph Theory, Computer Sciences and Logic, Control theory and Optimization, Differential Equation and Dynamical Systems, Fuzzy Mathematics, Geometry and Topology, Mathematical Education, Numerical Analysis, Probability and Statistics, and other areas of mathematics not listed above.

Information: email: salavati@mail.uk.ac.ir; <http://www.aimc39.ir/>.

- * 31–September 6 **Summer School on General Algebra and Ordered Sets**, Trest, Czech Republic.

Description: The summer school focuses on recent trends in universal algebra, especially in connection with theoretical computer science and logic. The program will consist of three tutorials, two plenary invited lectures, and short contributed talks of the participants.

Information: email: stanovsk@karlin.mff.cuni.cz; <http://www.karlin.mff.cuni.cz/~ssaos>.

September 2008

- * 1–12 **School on Algebraic Topics of Automata**, Complexo Interdisciplinar da Universidade de Lisboa Av. Prof. Gama Pinto, 2 1649-003, Lisboa, Portugal.

Description: This school aims to present to the scientific communities, in particular to post-graduate students, various topics on algebraic theory of automata, delivered as courses, advanced seminars and student’s seminars.

Topics: The programme includes eight courses on various aspects of algebraic theory of automata, plus an advanced seminar on mainstream topics and a student’s seminar on their research work.

Sponsor: By the project automata: from mathematics to applications (AutoMathA) of the European Science Foundation (ESF).

Organizer: Within the activities of Centro de Algebra da Universidade de Lisboa (CAUL) and Centro de Matematica da Universidade do Porto (CMUP).

Information: <http://caul.cii.fc.ul.pt/SATA2008/>; email: patricia@cii.fc.ul.pt.

- * 2–4 **2008 MBI Workshop for Young Researchers in Mathematical Biology (WYRMB)**, Mathematical Biosciences Institute, The Ohio State University, Columbus, Ohio.

Description: The workshop is intended to broaden the scientific perspective of young researchers in mathematical biology and to encourage interactions with other scientists. Workshop activities include plenary talks and poster sessions, as well as group discussions on issues relevant to mathematical biologists. We cordially invite young mathematical biologists to participate.

Application deadline: April 17, 2008.

Information: <http://www.mbi.ohio-state.edu/postdocworkshop/wyrm2008.html>; email: jday@mbi.osu.edu.

- * 8–10 **Calculus of Variations and Its Applications From Engineering to Economy**, Departamento de Matemática Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa Caparica, Portugal.

Description: The aim of this event is to promote the scientific exchange of ideas and methods in such a broad and useful area as the calculus of variations. With the goal of applications to different areas such as mathematics, mechanics, engineering, economy, finances, chemistry, biology, just to name a few, models and methods have been developed, with apparent different languages that are susceptible of an unified analytical and numerical treatment. Taking into account the most recent developments in this area of mathematics, we wish to address problems associated with partial differential equations, optimal control, finite or infinite dimension optimization, shape optimization in structural engineering, together with the associated computational aspects.

Information: email: mcm@fct.unl.pt; <http://ferrari.dmat.fct.unl.pt/cva2008/>.

- * 13 **63rd Algebra Day**, Carleton University, Ottawa, Canada.

Speakers: Osamu Iyama (Nagoya), Bernhard Keller (Paris), Claus Michael Ringel (Bielefeld), Paul Smith (Washington).

Information: billig@math.carleton.ca, bsteinbg@math.carleton.ca or vdlab@math.carleton.ca.

- * 15–21 **Ninth Crimean Workshop on the Method of Lyapunov Functions and Its Applications**, Alushta, Crimea, Ukraine.

Description: The conference is dedicated to 70th anniversary of Academician A. M. Samoilenko.

Focus: The workshop will bring together researchers in the theory of stability and related fields of pure and applied mathematics, in particular, qualitative theory of differential equations, mechanics, mathematical modelling and control.

Program Committee: A. M. Samoilenko (chairman), I. V. Gaishun, M. M. Khapayev, D. Ya. Khusainov, V. I. Korobov, A. M. Kovalev, A. I. Malikov, A. A. Martynyuk, N. A. Perestyuk, S. N. Vassilyev.

Organizing Committee: O. V. Anashkin (chairman), E. P. Belan, V. I. Shostka, V. V. Zhuravlev.

Information: Oleg V. Anashkin; email: anashkin@crimea.edu.

- * 21–24 **Applied Statistics 2008**, Hotel Ribno, Ribno, Slovenia.

Description: The conference, organized in Ribno in the vicinity of the beautiful Lake Bled, will provide an opportunity for researchers in statistics, data analysts, and other professionals from various statistical and related fields to come together, present their research, and learn from each other. Cross-discipline and applied paper submissions are especially welcome. A three day program consists of invited paper presentations, contributed paper sections from diverse topics, and finishes with a workshop. Selected papers will be published in *Advances in Methodology and Statistics*, a peer-reviewed journal of the statistical society of Slovenia.

Keynote Speakers: Jaak Billiet, Katholieke Universiteit Leuven, Belgium; Ornulf Borgan, University of Oslo, Norway; William S. Cleveland, Purdue University, USA.

Important Dates: Abstract Submission: June 1, 2008. Registration: July 1, 2008.

Contact: Andrej Blejec, info.AS@nib.si.

Information: <http://conferences.nib.si/AS2008>; email: andrej.blejec@nib.si.

*** 22–26 Multiscale Representation, Analysis and Modeling of Internet Data and Measurements**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.

Overview: We will discuss the structure of the Internet and of network traffic on the Internet. Topics will include current tools to measure and infer the connectivity structure of the Internet, and the modeling of both the emergence of network structures and traffic patterns. Challenges and opportunities in constructing multiscale models for such complex networks and traffic patterns will be studied from various perspectives.

Organizing Committee: Mauro Maggioni, Paul Barford, Anna Gilbert, Morley Mao, Rob Nowak.

Application/Registration: An application/registration form is available at <http://www.ipam.ucla.edu/programs/mraws1/>. If you don't intend to request financial support, you may simply register. We urge you to apply as early as possible. Applications received by August 11, 2008 will receive fullest consideration. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications.

Information: email: sbeggs@ipam.ucla.edu; <http://www.ipam.ucla.edu/programs/mraws1/>.

October 2008

*** 3–5 Iberian Mathematical Meeting**, Departamento de Matemáticas, Universidad de Extremadura, 06071 Badajoz, Spain.

Description: The II Iberian Mathematical Meeting, jointly organized by the Spanish Royal Mathematical Society (<http://www.rsme.es/>), the Portuguese Mathematical Society (<http://www.spm.pt/>), and the Department of Mathematics of the University of Extremadura (<http://matematicas.unex.es/>), will be held on October 3–5, 2008 in Badajoz (Spain). In this second meeting, the main scientific areas will be: Algebra and Algebraic Methods; Functional Analysis–Statistics and Biometry.

Information: <http://imm2.unex.es>; email: ojedamc@unex.es; tel: +34924289568; fax: +34924272911; email: imm2@unex.es.

*** 5–12 International Conference on Differential Equations, Function Spaces, and Approximation Theory: Dedicated to the 100th anniversary of the birthday of S. L. Sobolev**, Sobolev Institute of Mathematics, Novosibirsk, Russia.

Description: October 6, 2008, will be the 100th anniversary of the birthday of Sergei L'vovich Sobolev (1908–1989), an outstanding mathematician of the 20th century. The Sobolev Institute of Mathematics of the Siberian Branch of the Russian Academy of Sciences jointly with Novosibirsk State University are organizing the International Conference on Differential Equations, Function Spaces, and Approximation Theory dedicated to this significant event.

Topics: Ordinary differential equations; partial differential equations; equations of mathematical physics; operator theory; spectral theory; function spaces; embedding theorems; numerical methods; approximation theory; cubature formulas; mathematical modeling.

Information: email: sobolev100@math.nsc.ru; <http://www.math.nsc.ru/conference/sobolev100/english>.

*** 13–16 Scaling up for modeling transport and flow in porous media**, Centre for Advanced Academic Studies, Dubrovnik, Croatia.

Description: The aim of the conference is to bring together researchers, scientists, engineers, and students to exchange and share their experiences, new ideas, and research results about upscaling for modeling, analysis and simulation of flow and transport in porous media and application to problems including subsurface hydrology, petroleum exploration, contaminant remediation, carbon sequestration and nuclear waste storage.

Topics: Flow and transport in heterogeneous porous media, multiphase flows, multiscale phenomena, scaling and heterogeneity, scaling in porous media, in particular scaling of processes from the microscale to the mesoscale, the use of coarse grid descriptions in modeling multiphase flow phenomena, numerical homogenization, numerical simulation of multiphase flow in heterogeneous porous media, mathematical modeling of multiphase flow in porous media.

Information: email: brahim.amaziane@univ-pau.fr; <http://web.math.hr/~jurak/Dubrovnik08/>.

*** 18–20 The Second International Workshop on Post-Quantum Cryptography (PQCrypto 2008)**, University of Cincinnati, Cincinnati, Ohio.

Description: Can we build large quantum computers? What will they do to the cryptographic world, in particular, public key cryptographic world? PQCrypto 2008 is the second of the new series of workshops on Post-Quantum cryptography, which is devoted to the cryptographic research in preparing us for the world of the possible future quantum computers.

Organizers: This series of workshop is organized due to the growing interest from academic researchers, industries and governments in this area. PQCrypto 2008 will serve as a forum for researchers to present results and exchange ideas in post-quantum cryptography.

Information: email: ding@math.uc.edu; <http://math.uc.edu/~aac/pqcrypto2008/>.

*** 20–22 International Conference on Analysis and Its Applications**, Aligarh Muslim University, Aligarh, India.

Information: <http://www.amudirectory.com/ICAA08>. For update informations: <http://ICAA-08.tripod.com>

November 2008

*** 10–12 International Conference on Recent Trends in Mathematical Sciences**, Manama, Kingdom of Bahrain.

Description: The aim of the conference is to bring together the teachers, researchers and scientists working in the field of pure mathematics, applied mathematics, statistics and operation areas including operation research.

Organizer: The International Department of Mathematics, College of Science, University of Bahrain.

Information: email: mabdelaty@sci.uob.bh; <http://www.icrms.uob.edu.bh/page-1.htm>.

December 2008

*** 1–4 SGT-in-Rio: Workshop on Spectral Graph theory with applications on Computer Science, Combinatorial Optimization and Chemistry**, Military Institute of Engineering, Rio de Janeiro, Brazil.

Description: The theory of graph spectra is now a well established field of research in Mathematics and in several applied sciences (e.g. chemistry, computer science and operational research), and many results have been published over the last few decades.

Goals: The main goals of the workshop are to bring together the leading researchers on graph spectra and related topics, to establish the state of the art, and to discuss recent achievements and challenges.

Topics: The topics include applications of graph spectra to computer science, combinatorial optimization, chemistry and other branches of science.

Organizer: In recognition of the strong developments in the subject, this workshop has been organized as a forum for the many researchers around the world.

Information: email: nair@pep.ufrj.br; <http://www.sgt.pep.ufrj.br/~tegrio>.

*** 8–12 Small Ball Inequalities in Analysis, Probability and Irregularities of Distribution**, American Institute of Mathematics, Palo Alto, California.

Description: This workshop, sponsored by AIM and the NSF, will be devoted to a theme common to irregularity of distributions, approximation theory, probability theory and harmonic analysis. In each of these subjects, there are outstanding conjectures in dimensions three and higher that stipulate that functions which satisfy certain conditions on its mixed derivative are necessarily large in sup norm. This workshop will survey these conjectures, seeking both commonalities and differences, describe recent advances, and discuss proof techniques and strategies.

Information: <http://aimath.org/ARCC/workshops/smallballineq.html>.

* 13–17 **The 48th American Society for Cell Biology Annual Meeting**, The Moscone Center, San Francisco, California.

Deadlines: Abstract Deadline (to be considered for minisymposia presentations): August 7, 2008. Abstract Deadline (to be considered for poster presentations only): September 3, 2008. Late Abstract Deadline (to be considered for poster presentations only): October 16, 2008.

Information: For more information, visit: <http://ascb.org/meetings/>.

January 2009

* 5–8 **Joint Mathematics Meetings**, Washington, D.C.

Information: <http://www.ams.org/amsmtgs/national.html>.

* 5–16 **Group Theory, Combinatorics and Computation**, The University of Western Australia, Perth, Australia.

Description: Special Theme Program on group theory, combinatorics and computation at the University of Western Australia.

Invited Speakers: Rosemary Bailey, Peter Cameron, Marston Conder, Marcel Herzog, Kathy Horadam, Sasha Ivanov, William Kantor, Cai Heng Li, Charles Leedham-Green, Martin Liebeck, Brendan McKay, Peter Neumann, Eamonn O'Brien, Tim Penttila, Jan Saxl, Akos Seress.

Topics: Week 1: An international conference in honour of Professor Praeger's 60th birthday. It will contain invited 1 hour talks and short contributed talks by participants. Week 2: An informal week of short courses, workshops and problem sessions, especially beneficial to early career researchers and postgraduate students.

Information: <http://sponsored.uwa.edu.au/gcc09/welcome>; email: alice@maths.uwa.edu.au.

April 2009

* 6–10 **The 3D Euler and 2D surface quasi-geostrophic equations**, American Institute of Mathematics, Palo Alto, California.

Description: This workshop, sponsored by AIM and the NSF, will be devoted to the 3D Euler equations of incompressible fluids and the 2D surface quasi-geostrophic (QG) equation of geophysical flows.

Information: email: farmer@aimath.org; <http://aimath.org/ARCC/workshops/3deuler.html>.

* 19–26 **NoDIA-2009: Nonlinear Differential Equations, Integrability and Applications**, Cape Town, South Africa.

Description: The conference aims to bring together both experts and young researchers in the subject of nonlinear differential equations, with emphasis on the following subjects: integrability of differential equations and systems, hierarchies and sequences of equations, singularity analysis, symmetry analysis and applications. The meeting is financed partially by SIDA (Sweden) and NRF (South Africa).

Information: <http://www.sm.luth.se/~norbert/nodia09.html>; email: norbert@sm.luth.se.

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.

May 2009

* 10–15 **ICMI Study 19: Proof and Proving in Mathematics Education**, Taipei, Taiwan.

Call for contributions: Participation in the conference is by invitation to the authors of accepted contributions following a refereeing process. The International Program Committee (IPC) invites individuals or groups to submit original contributions. A submission should represent a significant contribution to knowledge about learning and teaching proof. It may address questions from one or more of the study themes, or further issues relating to these, but it should identify its primary focus. The Study themes are set out in the Discussion Document which is available on the ICMI Study 19 website (still under construction but functional) <http://jps.library.utoronto.ca/ocs/index.php?cf=8> (or via Google: ICMI 19). Submissions will be a maximum of 6 pages, including references and figures, written in english, the language of the conference. Further technical details about the format of submissions will be available on the study website.

Important dates: By 30 June 2008: Potential authors upload their papers to the conference website. By 15 November 2008: Potential authors receive the result of the refereeing process. Invitations to participate in the conference are sent to authors whose papers are accepted.

ICMI Executive Advisors: Hyman Bass (USA); Mariolina Bartolini-Bussi (Italy).

* 27–June 1 **The International Conference “Infinite Dimensional Analysis and Topology”**, Yaremche, Ivano-Frankivsk, Ukraine.

Topics: The main scientific topics to be presented at the conference are: Infinite dimensional holomorphy, topological tensor products, Banach space theory, operator theory, general topology, set-theoretic topology, geometric and infinite dimensional topology.

Language: Official language of the Conference is English.

Deadline: For registration is May 1, 2009.

Organizers: The organizers of the conference are: Precarpathian National University, Ivano-Frankivsk, Ukraine; Lviv Ivan Franko National University, Lviv, Ukraine; Institute for Applied Problems of Mechanics and Mathematics, Lviv, Ukraine; Institute of Mathematics of National Academy of Sciences, Kyiv, Ukraine.

Information: email: andriyzag@yahoo.com; <http://www.idat.frankivsk.org>.

July 2009

* 27–31 **33rd Conference on Stochastic Processes and their Applications**, Berlin, Germany.

Main Venue: Will be the Mathematics Institute of Technische Universitaet, located in the center of Berlin.

Description: The conference is the major annual meeting for researchers working in the field of Stochastic Processes. The conference covers a wide range of active research areas, in particular featuring 20 invited plenary lectures presented by leading specialists. In addition, there will be a large variety of special sessions, consisting of three talks each.

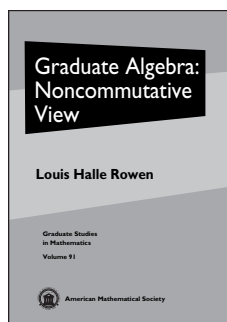
Confirmed Plenary Speakers: J. Baik, S. Chatterjee, F. Delbaen, A. Dembo, S. Hamadène, C. Klüppelberg, J. Martin, S. Martinez, P. Mathieu, J. Mattingly, P. Mörters, E. Perkins, G. Reinert, L. Saloff-Coste, S. Smirnov, A. Schied, G. Slade, M. Takeda, F. Y. Wang, A. Wakolbinger.

Information: email: roelly@math.uni-potsdam.de; <http://www.math.tu-berlin.de/SPA2009>.

New Publications Offered by the AMS

To subscribe to email notification of new AMS publications,
please go to <http://www.ams.org/bookstore-email>.

Algebra and Algebraic Geometry



Graduate Algebra: Noncommutative View

Louis Halle Rowen, *Bar-Ilan
University, Ramat Gan, Israel*

This book is a companion volume to *Graduate Algebra: Commutative View* (published as volume 73 in this series). The main and most important feature of the book is that it presents a unified approach

to many important topics, such as group theory, ring theory, Lie algebras, and gives conceptual proofs of many basic results of noncommutative algebra. There are also a number of major results in noncommutative algebra that are usually found only in technical works, such as Zelmanov's proof of the restricted Burnside problem in group theory, word problems in groups, Tits's alternative in algebraic groups, PI algebras, and many of the roles that Coxeter diagrams play in algebra.

The first half of the book can serve as a one-semester course on noncommutative algebra, whereas the remaining part of the book describes some of the major directions of research in the past 100 years. The main text is extended through several appendices, which permits the inclusion of more advanced material, and numerous exercises. The only prerequisite for using the book is an undergraduate course in algebra; whenever necessary, results are quoted from *Graduate Algebra: Commutative View*.

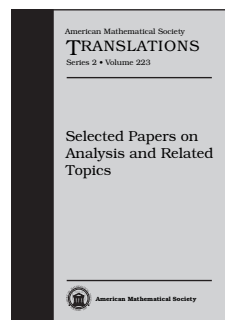
Contents: *The structure of rings:* Fundamental concepts in ring theory; Semisimple modules and rings and the Wedderburn-Artin theorem; The Jacobson program applied to left Artinian rings; Noetherian rings and the role of prime rings; Algebras in terms of generators and relations; Tensor products; Exercises-Part IV; *Representations of groups and Lie algebras:* Group representations and group algebras; Characters of finite groups; Lie algebras and other nonassociative algebras; Dynkin diagrams (Coxeter-Dynkin graphs and Coxeter groups); Exercises-Part V; *Representable algebras:* Polynomial identities and representable algebras; Central simple algebras and the Brauer group; Homological algebra

and categories of modules; Hopf algebras; Exercises-Part VI; Bibliography; Index.

Graduate Studies in Mathematics, Volume 91

June 2008, approximately 613 pages, Hardcover, ISBN: 978-0-8218-4153-2, 2000 *Mathematics Subject Classification:* 16-01, 17-01; 17Bxx, 20Cxx, 20Fxx, **AMS members US\$68**, List US\$85, Order code GSM/91

Analysis



Selected Papers on Analysis and Related Topics

This volume contains translations of papers that originally appeared in the Japanese journal *Sugaku*. The papers range over a variety of topics, including operator algebras, analysis, and statistics.

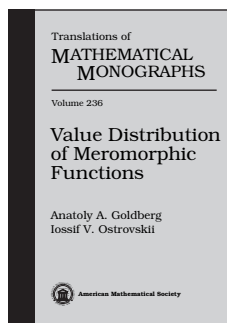
This volume is suitable for graduate students and research mathematicians

interested in analysis and its applications.

Contents: M. Takesaki, Entrance to operator algebras; M. Izumi, Classification of C^* -algebras; A. Miyachi, Weighted Hardy spaces and Jacobi series; S. Igari, Legacy of J. Marcinkiewicz to real analysis in the 20th century; H. Tanaka, The Kakeya conjecture; T. Kumagai, Recent developments of analysis on fractals; S. Akiyama, Symbolic dynamical system and number theoretical tilings; N. Obata, Notions of independence in quantum probability and spectral analysis of graphs; K. Tanaka, On various applications of the wavelet analysis to statistics; H. Tanaka, Bhattacharyya type inequalities.

American Mathematical Society Translations—Series 2, Volume 223

July 2008, approximately 194 pages, Hardcover, ISBN: 978-0-8218-3928-7, 2000 *Mathematics Subject Classification:* 46-06, **AMS members US\$79**, List US\$99, Order code TRANS2/223



Value Distribution of Meromorphic Functions

Anatoly A. Goldberg, *Bar-Ilan University, Ramat Gan, Israel*, and **Iossif V. Ostrovskii**, *Bilkent University, Ankara, Turkey*

This book contains a comprehensive exposition of the Nevanlinna theory of

meromorphic functions of one complex variable, with detailed study of deficiencies, value distribution, and asymptotic properties of meromorphic functions.

A self-contained exposition of the inverse problem for meromorphic functions of finite order with finitely many deficiencies is given in full detail. Many results included in the book belong to the authors and were previously available only in journal articles.

The main body of the book is a translation of the Russian original published in 1970, which has been one of the most popular sources in this field since then. New references and footnotes related to recent achievements in the topics considered in the original edition have been added and a few corrections made. A new Appendix with a survey of the results obtained after 1970 and extensive bibliography has been written by Alexandre Eremenko and James K. Langley for this English edition.

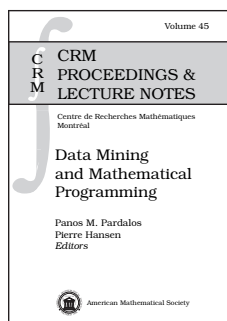
The only prerequisite for understanding material of this book is an undergraduate course in the theory of functions of one complex variable.

Contents: Characteristics of the behavior of a meromorphic function and the first fundamental theorem; Meromorphic functions of finite order; The second fundamental theorem; Deficient values; Asymptotic properties of meromorphic functions and deficiencies; Value distribution with respect to the arguments; Applications of Riemann surfaces to value distribution; On the magnitude of an entire function; Notes; A survey of some results after 1970; Bibliography; Author index; Subject index; Notation index.

Translations of Mathematical Monographs, Volume 236

June 2008, approximately 505 pages, Hardcover, ISBN: 978-0-8218-4265-2, 2000 *Mathematics Subject Classification*: 30D30, 30D35; 30D20, 30D15, **AMS members US\$103**, List US\$129, Order code MMONO/236

Applications



Data Mining and Mathematical Programming

Panos M. Pardalos, *University of Florida, Gainesville, FL*, and **Pierre Hansen**, *HEC Montréal, QC, Canada*, Editors

Data mining aims at finding interesting, useful or profitable information in very

large databases. The enormous increase in the size of available scientific and commercial databases (data avalanche) as well as the continuing and exponential growth in performance of present day computers make data mining a very active field. In many cases, the burgeoning volume of data sets has grown so large that it threatens to overwhelm rather than enlighten scientists. Therefore, traditional methods are revised and streamlined, complemented by many new methods to address challenging new problems. Mathematical Programming plays a key role in this endeavor. It helps us to formulate precise objectives (e.g., a clustering criterion or a measure of discrimination) as well as the constraints imposed on the solution (e.g., find a partition, a covering or a hierarchy in clustering). It also provides powerful mathematical tools to build highly performing exact or approximate algorithms.

This book is based on lectures presented at the workshop on "Data Mining and Mathematical Programming" (October 10-13, 2006, Montreal) and will be a valuable scientific source of information to faculty, students, and researchers in optimization, data analysis and data mining, as well as people working in computer science, engineering and applied mathematics.

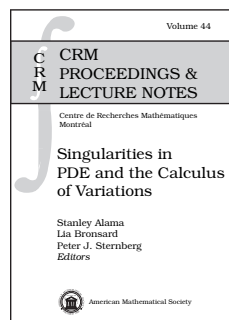
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: E. Carrizosa, Support vector machines and distance minimization; H. Chen and J. Peng, 0-1 semidefinite programming for graph-cut clustering: Modelling and approximation; Z. Csizmadia, P. L. Hammer, and B. Vizvári, Artificial attributes in analyzing biomedical databases; Y.-J. Fan, C. Iyigun, and W. A. Chaovalitwongse, Recent advances in mathematical programming for classification and cluster analysis; P. G. Georgiev, Nonlinear skeletons of data sets and applications—Methods based on subspace clustering; M. R. Guarracino, S. Cuciniello, D. Feminiano, G. Toraldo, and P. M. Pardalos, Current classification algorithms for biomedical applications; G. Kunapuli, K. P. Bennett, J. Hu, and J.-S. Pang, Bilevel model selection for support vector machines; V. Makarenkov, A. Boc, A. Boubacar Diallo, and A. Baniré Diallo, Algorithms for detecting complete and partial horizontal gene transfers: Theory and practice; O. L. Mangasarian and E. W. Wild, Nonlinear knowledge in kernel machines; F. Murtagh, Ultrametric embedding: Application to data fingerprinting and to fast data clustering; O. Seref, O. E. Kundakcioglu, and P. M. Pardalos, Selective linear and nonlinear classification.

CRM Proceedings & Lecture Notes, Volume 45

May 2008, 234 pages, Softcover, ISBN: 978-0-8218-4352-9, LC 2008002772, 2000 *Mathematics Subject Classification*: 68R01, 68P01, 68P10, 90-08, 90C09, 90C27, **AMS members US\$68**, List US\$85, Order code CRMP/45

Differential Equations



Singularities in PDE and the Calculus of Variations

Stanley Alama and Lia Bronsard, McMaster University, Hamilton, ON, Canada, and Peter J. Sternberg, Indiana University, Bloomington, IN, Editors

This book contains papers presented at the “Workshop on Singularities in PDE and the Calculus of Variations” at the CRM in July 2006. The main theme of the meeting was the formation of geometrical singularities in PDE problems with a variational formulation. These equations typically arise in some applications (to physics, engineering, or biology, for example) and their resolution often requires a combination of methods coming from areas such as functional and harmonic analysis, differential geometry and geometric measure theory. Among the PDE problems discussed were: the Cahn-Hilliard model of phase transitions and domain walls; vortices in Ginzburg-Landau type models for superconductivity and superfluidity; the Ohno-Kawasaki model for di-block copolymers; models of image enhancement; and Monge-Ampère functions. The articles give a sampling of problems and methods in this diverse area of mathematics, which touches a large part of modern mathematics and its applications.

This item will also be of interest to those working in analysis.

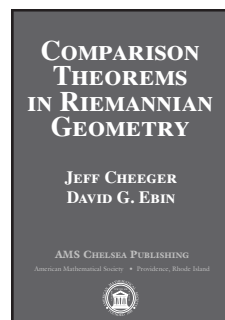
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: E. R. Alvarez-Buylla, M. Benítez, A. Chaos, Y. Cortés, G. Escalera-Santos, C. Espinosa, and P. Padilla, Variational problems arising in biology; F. Béthuel, G. Orlandi, and D. Smets, On the Cauchy problem for phase and vortices in the parabolic Ginzburg-Landau equation; R. Choksi, Nonlocal Cahn-Hilliard and isoperimetric problems: Periodic phase separation induced by competing long- and short-range interactions; T. Giorgi and H. Jadallah, On a generalized Ginzburg-Landau energy for superconducting/normal composite materials; M. Guan, S. Gustafson, K. Kang, and T.-P. Tsai, Global questions for map evolution equations; R. Ignat, Pohožaev-type identities for an elliptic equation; R. L. Jerrard, Some remarks on Monge-Ampère functions; B. Kawohl, Variational versus pde-based approaches in mathematical image processing; M. Kurzke and D. Spirn, On the energy of a Chern-Simons-Higgs vortex lattice; A. Malchiodi, Some recent results about a class of singularly perturbed elliptic equations; V. Millot, The dipole problem for $H^{1/2}(\mathbb{S}^2; \mathbb{S}^1)$ -maps and application; A. Montero, Hodge decompositions, Γ -convergence and the Gross-Pitaevskii energy; Y. Morita, Bifurcation of vortex solutions to a Ginzburg-Landau equation in an annulus; X. Ren, An Allen-Cahn type problem with curvature modification; M. G. Westdickenberg, Rare events, action minimization, and sharp interface limits; W. P. Ziemer, The Gauss-Green theorem for weakly differentiable vector fields.

CRM Proceedings & Lecture Notes, Volume 44

May 2008, 267 pages, Softcover, ISBN: 978-0-8218-4350-5, LC 2008060012, 2000 *Mathematics Subject Classification*: 35J50, 47J30, AMS members US\$79, List US\$99, Order code CRMP/44

Geometry and Topology



Comparison Theorems in Riemannian Geometry

Jeff Cheeger, New York University-Courant Institute, NY, and David G. Ebin, State University of New York at Stony Brook, NY

... this is a wonderful book, full of fundamental techniques and ideas.

– Robert L. Bryant,

Director of the Mathematical Sciences Research Institute

Cheeger and Ebin's book is a truly important classic monograph in Riemannian geometry, with great continuing relevance.

– Rafe Mazzeo, Stanford University

The central theme of this book is the interaction between the curvature of a complete Riemannian manifold and its topology and global geometry.

The first five chapters are preparatory in nature. They begin with a very concise introduction to Riemannian geometry, followed by an exposition of Toponogov's theorem—the first such treatment in a book in English. Next comes a detailed presentation of homogeneous spaces in which the main goal is to find formulas for their curvature. A quick chapter of Morse theory is followed by one on the injectivity radius.

Chapters 6–9 deal with the most relevant contributions to the subject in the years 1959 to 1974. These include the pinching (or sphere) theorem, Berger's theorem for symmetric spaces, the differentiable sphere theorem, the structure of complete manifolds of non-negative curvature, and finally, results about the structure of complete manifolds of non-positive curvature. Emphasis is given to the phenomenon of rigidity, namely, the fact that new topological types can appear when assumptions on the curvature are relaxed from strict to weak inequalities, but only in a restricted way, which usually involves an isometry.

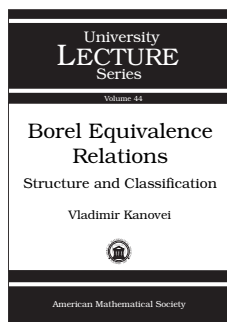
Much of the material, particularly the last four chapters, was essentially state-of-the-art when the book first appeared in 1975. Since then, the subject has exploded, but the material covered in the book still represents an essential prerequisite for anyone who wants to work in the field.

Contents: Basic concepts and results; Toponogov's theorem; Homogeneous spaces; Morse theory; Closed geodesics and the cut locus; The sphere theorem and its generalizations; The differentiable sphere theorem; Complete manifolds of nonnegative curvature; Compact manifolds of nonpositive curvature; Bibliography; Additional bibliography; Index.

AMS Chelsea Publishing

May 2008, 161 pages, Hardcover, ISBN: 978-0-8218-4417-5, LC 2007052113, 2000 *Mathematics Subject Classification*: 53C20; 58E10, AMS members US\$32, List US\$35, Order code CHEL/365.H

Logic and Foundations



Borel Equivalence Relations

Structure and Classification

Vladimir Kanovei, *Institute for Information Transmission Problems, Moscow, Russia*

Over the last 20 years, the theory of Borel equivalence relations and related topics have been very active areas of research in

set theory and have important interactions with other fields of mathematics, like ergodic theory and topological dynamics, group theory, combinatorics, functional analysis, and model theory. The book presents, for the first time in mathematical literature, all major aspects of this theory and its applications.

This book should be of interest to a wide spectrum of mathematicians working in set theory as well as the other areas mentioned. It provides a systematic exposition of results that so far have been only available in journals or are even unpublished. The book presents unified and in some cases significantly streamlined proofs of several difficult results, especially dichotomy theorems. It has rather minimal overlap with other books published in this subject.

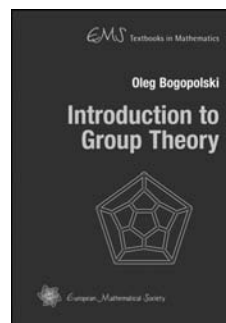
Contents: Introduction; Descriptive set theoretic background; Some theorems of descriptive set theory; Borel ideals; Introduction to equivalence relations; Borel reducibility of equivalence relations; “Elementary” results; Introduction to countable equivalence relations; Hyperfinite equivalence relations; More on countable equivalence relations; The 1st and 2nd dichotomy theorems; Ideal \mathcal{I}_1 and the equivalence relation E_1 ; Actions of the infinite symmetric group; Turbulent group actions; The ideal \mathcal{I}_3 and the equivalence relation E_3 ; Summable equivalence relations; c_0 -equalities; Pinned equivalence relations; Reduction of Borel equivalence relations to Borel ideals; On Cohen and Gandy–Harrington forcing over countable models; Bibliography; Index.

University Lecture Series, Volume 44

July 2008, approximately 236 pages, Softcover, ISBN: 978-0-8218-4453-3, LC 2007060598, 2000 *Mathematics Subject Classification*: 03E15, **AMS members US\$36**, List US\$45, Order code ULECT/44

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Introduction to Group Theory

Oleg Bogopolski, *Technische Universität Dortmund, Germany*

This book quickly introduces beginners to general group theory and then focuses on three main themes:

- finite group theory, including sporadic groups
- combinatorial and geometric group theory, including the Bass–Serre theory of groups acting on trees
- the theory of train tracks by Bestvina and Handel for automorphisms of free groups

With its many examples, exercises, and full solutions to selected exercises, this text provides a gentle introduction that is ideal for self-study and an excellent preparation for applications. A distinguished feature of the presentation is that algebraic and geometric techniques are balanced. The beautiful theory of train tracks is illustrated by two nontrivial examples.

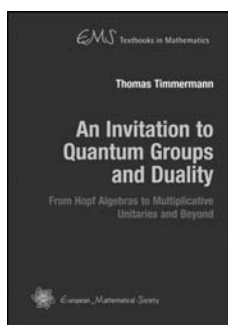
Presupposing only a basic knowledge of algebra, the book is addressed to anyone interested in group theory: from advanced undergraduate and graduate students to specialists.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Introduction to finite group theory; Introduction to combinatorial group theory; Automorphisms of free groups and train tracks; Appendix. The Perron–Frobenius Theorem; Solutions to selected exercises; Bibliography; Index.

EMS Textbooks in Mathematics

March 2008, 187 pages, Hardcover, ISBN: 978-3-03719-041-8, 2000 *Mathematics Subject Classification*: 20-01, 20D08, 20E05, 20E06, 20E08, 20F28, **AMS members US\$38**, List US\$48, Order code EMSTEXT/6



An Invitation to Quantum Groups and Duality

From Hopf Algebras to Multiplicative Unitaries and Beyond

Thomas Timmermann,
*University of Münster,
Mathematisches Institut, Germany*

This book provides an introduction to the theory of quantum groups with emphasis on their duality and on the setting of operator algebras.

Part I of the text presents the basic theory of Hopf algebras, Van Daele's duality theory of algebraic quantum groups, and Woronowicz's compact quantum groups, staying in a purely algebraic setting. Part II focuses on quantum groups in the setting of operator algebras. Woronowicz's compact quantum groups are treated in the setting of C^* -algebras, and the fundamental multiplicative unitaries of Baaj and Skandalis are studied in detail. An outline of Kustermans' and Vaes' comprehensive theory of locally compact quantum groups completes this part. Part III leads to selected topics, such as coactions, Baaj-Skandalis-duality, and approaches to quantum groupoids in the setting of operator algebras.

The book is addressed to graduate students and non-experts from other fields. Only basic knowledge of (multi-) linear algebra is required for the first part, while the second and third part assume some familiarity with Hilbert spaces, C^* -algebras, and von Neumann algebras.

This item will also be of interest to those working in analysis.

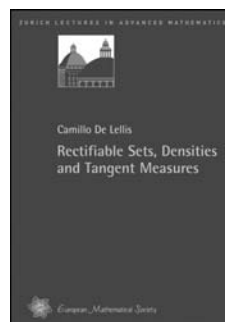
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: *Part I. From groups to quantum groups:* Hopf algebras; Multiplier Hopf algebras and their duality; Algebraic compact quantum groups; *Part II. Quantum groups and C^* -von Neumann algebras:* First definitions and examples; C^* -algebraic compact quantum groups; Examples of compact quantum groups; Multiplicative unitaries; Locally compact quantum groups; *Part III. Selected topics:* Coactions on C^* -algebras, reduced crossed products, and duality; Pseudo-multiplicative unitaries on Hilbert spaces; Pseudo-multiplicative unitaries on C^* -modules; Appendix; Bibliography; Symbol Index; Index.

EMS Textbooks in Mathematics

February 2008, 427 pages, Hardcover, ISBN: 978-3-03719-043-2, 2000 *Mathematics Subject Classification:* 16W30, 46-01, 46L55, 22A22, 22D25, 22D35, 46L10, **AMS members US\$62**, List US\$78, Order code EMSTEXT/5

Analysis



Rectifiable Sets, Densities and Tangent Measures

Camillo De Lellis, *University of Zürich, Zurich, Switzerland*

The characterization of rectifiable sets through the existence of densities is a pearl of geometric measure theory. The difficult proof, due to Preiss, relies on

many beautiful and deep ideas and novel techniques. Some of them have already proven useful in other contexts, whereas others have not yet been exploited. These notes give a simple and short presentation of the former and provide some perspective of the latter.

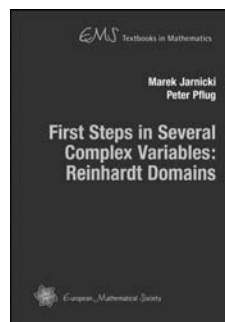
This text emerged from a course on rectifiability given at the University of Zürich. It is addressed both to researchers and students; the only prerequisite is a solid knowledge in standard measure theory. The first four chapters give an introduction to rectifiable sets and measures in Euclidean spaces, covering classical topics such as the area formula, the theorem of Marstrand and the most elementary rectifiability criteria. The fifth chapter is dedicated to a subtle rectifiability criterion due to Marstrand and generalized by Mattila, and the last three focus on Preiss' result. The aim is to provide a self-contained reference for anyone interested in an overview of this fascinating topic.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Introduction; Notation and preliminaries; Marstrand's Theorem and tangent measures; Rectifiability; The Marstrand-Mattila rectifiability criterion; An overview of Preiss' proof; Moments and uniqueness of the tangent measure at infinity; Flat versus curved at infinity; Flatness at infinity implies flatness; Open problems; Appendix A. Proof of Theorem 3.11; Appendix B. Gaussian integrals; Bibliography; Index.

Zurich Lectures in Advanced Mathematics

March 2008, 134 pages, Softcover, ISBN: 978-3-03719-044-9, 2000 *Mathematics Subject Classification:* 28A75, 26B15, 49Q15, 49Q20, **AMS members US\$27**, List US\$34, Order code EMSZLEC/7



First Steps in Several Complex Variables: Reinhardt Domains

Marek Jarnicki, *Jagiellonian University, Kraków, Poland,*
and Peter Pflug, *University of Oldenburg, Germany*

This book provides a comprehensive introduction to the field of several complex variables in the setting of a very special but basic class of domains, the so-called Reinhardt domains. In this way the reader

may learn much about this area without encountering too many technical difficulties.

Chapter 1 describes the fundamental notions and the phenomenon of simultaneous holomorphic extension. Chapter 2 presents a fairly complete discussion of biholomorphisms of bounded (complete) Reinhardt domains in the two dimensional case. The third chapter gives a classification of Reinhardt domains of existence for the most important classes of holomorphic functions. The last chapter deals with invariant functions and gives explicit calculations of many of them on certain Reinhardt domains. Numerous exercises are included to help the readers with their understanding of the material. Further results and open problems are added which may be useful as seminar topics.

The primary aim of this book is to introduce students or non-experts to some of the main research areas in several complex variables. The book provides a friendly invitation to this field as the only prerequisite is a basic knowledge of analysis.

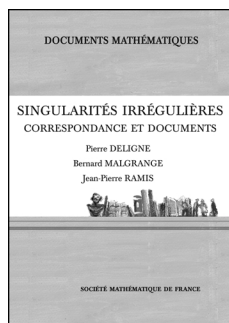
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Reinhardt domains; Biholomorphisms of Reinhardt domains; Reinhardt domains of existence of special classes of holomorphic functions; Holomorphically contractible families on Reinhardt domains; Bibliography; Symbols; List of symbols; Subject index.

EMS Textbooks in Mathematics

March 2008, 367 pages, Hardcover, ISBN: 978-3-03719-049-4, 2000 *Mathematics Subject Classification:* 32-01, 32A05, 32A07, 32A10, 32D05, 32E05, 32F45, **AMS members US\$62**, List US\$78, Order code EMSTEXT/7

Differential Equations



Singularités Irrégulières

Correspondance et Documents

Pierre Deligne, *Institute for Advanced Study, Princeton, NJ*, **Bernard Malgrange**, *Université Grenoble I, St. Martin d'Herès, France*, and **Jean-Pierre Ramis**, *Université Toulouse, France*

The letters collected in this volume concern the irregular singularities of linear differential equations: irregularity, asymptotic expansions, Stokes sheaves, Gevrey analogues, moduli problems, multisummability, Galois and wild fundamental groups, vanishing cycles, Fourier transforms. Most of these letters were written by the authors during the period 1976–1991. Four previously unpublished texts have been added to this correspondence.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico.

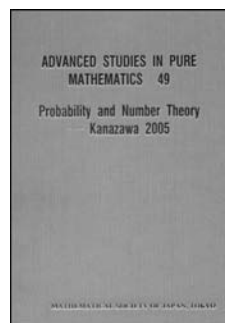
Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Correspondance; Textes; Notes.

Documents Mathématiques, Number 5

November 2007, 188 pages, Hardcover, ISBN: 978-2-85629-241-9, 2000 *Mathematics Subject Classification:* 34Mxx, 12H05, 32G20, **Individual member US\$61**, List US\$68, Order code SMFDM/5

Number Theory



Probability and Number Theory—Kanazawa 2005

Shigeki Akiyama, *Niigata University, Japan*, **Kohji Matsumoto**, *Nagoya University, Japan*, **Leo Murata**, *Meijigakuin University, Japan*, and **Hiroshi Sugita**, *Osaka University, Japan*, Editors

This volume is the proceedings of the International Conference on Probability and Number Theory held at Kanazawa, Japan, in June 2005 and includes several survey articles on probabilistic number theory and research papers on various recent topics around the border area between probability theory and number theory. This volume is useful for all researchers and graduate students who are interested in probability theory and number theory.

This item will also be of interest to those working in probability.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: **B. Adamczewski** and **Y. Bugeaud**, On the Littlewood conjecture in fields of power series; **K. Alladi** and **A. Berkovich**, Series and polynomial representations for weighted Rogers-Ramanujan partitions and products modulo; **G. J. Babu**, **E. Manstavicius**, and **V. Zacharovas**, Limiting processes with dependent increments for measures on symmetric group of permutations; **P. Elliott**, The ramifications of a shift by 2; **K. Fukuyama**, On lacunary trigonometric product; **R. Garunkštis**, On the Backlund equivalent for the Lindelöf hypothesis; **P. Hellekalek** and **P. Liardet**, The dynamics associated with certain digital sequences; **K.-H. Indlekofer**, New approach to probabilistic number theory—compactifications and integration; **S. Ito** and **S.-I. Yasutomi**, On simultaneous Diophantine approximation to periodic points related to modified Jacobi-Perron algorithm; **A. Laurinćikas**, Limit theorems for the Mellin transform of $|\zeta(1/2 + it)|^2$. II; **K. Matsumoto**, On the speed of convergence to limit distributions for Dedekind zeta-functions of non-Galois number fields; **J.-L. Maucclair**, On \mathbb{Q} -multiplicative functions having a positive upper-meanvalue; **M. Mori**, Low discrepancy sequences generated by dynamical systems; **T. Morita**, Renormalized Rauzy inductions; **H. Nagoshi**, The universality of L -functions attached to Maass forms; **Y. Ohkubo**, The diaphony of a class of infinite sequences; **J. Pintz**, Approximations to the Goldbach and twin prime problem and gaps between consecutive primes; **W. Schwarz**, Some highlights from the history of probabilistic number theory;

R. Šleževičienė-Steuding and **J. Steuding**, Gaps between consecutive zeros of the zeta-function on the critical line and conjectures from random matrix theory; **B. Solomyak**, Eigenfunctions for substitution tiling systems; **H. Sugita** and **S. Takanobu**, The probability of two \mathbb{F}_q -polynomials to be coprime; **M. Suzuki**, An analogue of the Chowla–Selberg formula for several automorphic L -functions; **N. Ushiroya**, On a mean value of a multiplicative function of two variables; **R. Winkler**, Hartman sets, functions and sequences—a survey; **Y. Yamasaki**, Integral representations of q -analogues of the Barnes multiple zeta functions.

Advanced Studies in Pure Mathematics, Volume 49

December 2007, 558 pages, Hardcover, ISBN: 978-4-931469-43-3,
2000 *Mathematics Subject Classification*: 11Kxx; 60Fxx, 11Mxx,
AMS members US\$72, List US\$90, Order code ASPM/49

MATHEMATICAL IMAGERY

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MATHEMATICAL IMAGERY

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The connection between mathematics and art goes
back thousands of years. Mathematics has been used in the design of Gothic cathedrals, Rose windows, oriental rugs, mosaics and tilings. Geometric forms were fundamental to the cubists and many abstract expressionists, and award-winning sculptors have used topology at the basis for their pieces. Dutch artist M.C. Escher represented infinity, Möbius bands, tessellations, deformations, reflections, Platonic solids, spirals, symmetry, and the hyperbolic plane in his works.

Mathematicians and artists continue to create stunning works in all media and to explore the visualization of mathematics—origami, computer-generated landscapes, tessellations, fractals, anamorphic art, and more.

A mathematician, like a painter or poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with ideas.

—G. H. Hardy,
A Mathematician's Apology

Explore the world of mathematics and art, send an e-postcard, and bookmark this page to see new featured works.

Thomas Hull :: The mathematics of origami

This is a version of the Owl-Hull "Five Intersecting Tetrahedra." The visually stunning object should be a familiar sight to those who frequent the landscapes of M.C. Escher or like to thumb through geometry textbooks. Read about the object and how it is constructed on the Origami Gallery.

--- Thomas Hull. Photograph by Nancy Rose Marshall.

Anne M. Burns :: Gallery of "Mathscapes"

Computers make it possible for me to "see" the beauty of mathematics. The artworks in the gallery of "Mathscapes" were created using a variety of mathematical formulas.

--- Anne M. Burns

Notices of the American Mathematical Society :: Cover Art

People have long been fascinated with repeated patterns that display a rich collection of symmetries. The discovery of hyperbolic geometries in the nineteenth century revealed a far greater wealth of patterns, some popularized by Dutch artist M. C. Escher in his Circle Limit series of works. The cover illustration on this issue of the Notices portrays a pattern which is symmetric under a group generated by two Möbius transformations. These are not distance-preserving, but they do preserve angles between curves and they map circles to circles. See Double Cusp Group by David J. Wright in Notices of the American Mathematical Society (December 2004, p. 1322).

GALLERIES & MUSEUMS

Bridges: Mathematical Connections in Art, Music, and Science
M.C. Escher: The Official Website
Images and Mathematics, MathArchives
The Institute for Figuring
Calendar, by Herwig Hauser
The KnotPlot Site
Mathematical Imagery by Jim Layton
Mathematics Museum (Japan)
Visual Mathematics

ARTICLES & RESOURCES

Art & Music, MathArchives
Geometry in Art & Architecture, by Paul Calter (Dartmouth College)
Harmony and Proportion, by John Boyd-Brent
International Society of the Arts, Mathematics and Architecture
Journal of Mathematics and the Arts
Mathematics and Art, the April 2003 Feature Column
www.MathWorld.org



Dear Peter,
Here's one of the e-postcards from the site.

Nancy

www.ams.org/mathimagery

Classified Advertisements

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

MASSACHUSETTS

MASSACHUSETTS COLLEGE OF LIBERAL ARTS FACULTY POSITION AVAILABLE FULL-TIME, BENEFITED POSITION, NON- TENURE-TRACK

With a strong focus on undergraduate education and a commitment to infusing the undergraduate experience with the skills, aptitudes, and values of the liberal arts, Massachusetts College of Liberal Arts has set an ambitious course to become a public liberal arts college of distinction. Located in the beautiful Berkshire Hills of western Massachusetts, one of the nation's premier cultural resort areas, MCLA enrolls approximately 1,500 students. MCLA is a member of the Council of Public Liberal Arts Colleges.

Endowed Chair, Education Department: Applications and nominations are being accepted for this position, commencing fall 2008, with possible renewal. MCLA is seeking an outstanding individual with a background in mathematics (either a Ph.D. or Ed.D.) and experience in math education and project implementation with a record of research and publication, proven excellence in undergraduate and graduate math education. The successful candidate will encompass a partnership with the Berkshire County school systems, teach at MCLA, and help advance the College's accredited programs in mathematics education.

To apply, submit a curriculum vita, research and teaching plans, and a list of at least three references to Human

Resources, Massachusetts College of Liberal Arts, 375 Church Street, North Adams, MA 01247-4100. Review of applications will begin immediately and continue until position is filled. MCLA is an Equal Opportunity, Affirmative Action Employer, with a longstanding commitment to increasing the diversity of the employee community. Visit <http://www.mcla.edu>.

000028

CANADA

UNIVERSITY OF MANITOBA Department of Mathematics Faculty of Science Department Head

The Faculty of Science at the University of Manitoba invites applications or nominations for the position of Head of the Department of Mathematics. The appointment will begin on a mutually agreed date, and will be at the rank of professor or associate professor, commensurate with qualifications and experience. Position Number: 07196. The successful candidate must have a Ph.D. in mathematics, and an outstanding record of accomplishment in both research and teaching. Strong academic leadership experience in research, undergraduate and graduate programs, and evidence of excellent communication, interpersonal and organizational skills, are preferred.

The Department of Mathematics is in the midst of an extensive renewal program, and the department is seeking new leadership to guide it through these

exciting developments. Applications should include a curriculum vitae, the names of three referees, and a brief statement indicating his/her views on the future of research and teaching in mathematics. Review of applications will begin June 1, 2008, and continue until the position is filled. Additional information about the department, and the position profile, can be found at <http://www.umanitoba.ca/science/mathematics>.

Applications or nominations should be forwarded to Dr. Mark Whitmore, Dean, Faculty of Science, University of Manitoba, 250 Machray Hall, Winnipeg, Manitoba, Canada, R3T 2N2, mark_whitmore@umanitoba.ca.

The University of Manitoba encourages applications from qualified women and men, including members of visible minorities, Aboriginal peoples, and persons with disabilities. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. Application materials, including letters of reference, will be handled in accordance with the Freedom of Information and Protection of Privacy Act (Manitoba).

Winnipeg has a great deal to offer, both culturally and recreationally, with a number of arts groups including the Royal Winnipeg Ballet, professional sports teams, outstanding restaurants, and opportunities for all types of outdoor activities in all seasons. The Winnipeg housing market is one of the most favourable in Canada. Further information can be found at <http://www.tourism.winnipeg.mb.ca/>.

000029

Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

The 2007 rate is \$110 per inch or fraction thereof on a single column (one-inch minimum), calculated from top of headline. Any fractional text of 1/2 inch or more will be charged at the next inch rate. No discounts for multiple ads or the same ad in consecutive issues. For an additional \$10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: June/July 2008 issue–April 28, 2008; August 2008 issue–May 28, 2008; September 2008 issue–

June 30, 2008; October 2008 issue–July 29, 2008; November 2008 issue–August 28, 2008; December 2008 issue–October 1, 2008.

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 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to classes@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Advertisers will be billed upon publication.

Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See <http://www.ams.org/meetings/>. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL and in an electronic issue of the *Notices* as noted below for each meeting.

Claremont, California

Claremont McKenna College

May 3–4, 2008

Saturday – Sunday

Meeting #1039

Western Section

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: March 2008

Program first available on AMS website: March 20, 2008

Program issue of electronic *Notices*: May 2008

Issue of *Abstracts*: Volume 29, Issue 3

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: Expired

*The scientific information listed below may be dated.
For the latest information, see www.ams.org/amsmtg/sectional.html.*

Invited Addresses

Michael A. Bennett, University of British Columbia, *Diophantine equations: From Erdos to Wiles and back.*

Chandrashekhar Khare, University of Utah, *Automorphic forms and Galois representations.*

Huaxin Lin, University of Oregon, *Classification of simple amenable C^* -algebras of stable rank one.*

Anne Schilling, University of California Davis, *Affine Schubert news.*

Special Sessions

Algebraic Combinatorics, **Anne Schilling**, University of California Davis, and **Michael Zabrocki**, York University.

Applications of Delay-Differential Equations to Models of Disease, **Ami Radunskaya**, Pomona College.

C^ -algebras, subfactors and free probability*, **Huaxin Lin**, University of Oregon, and **Feng Xu**, University of California Riverside.

Combinatorics of Partially Ordered Sets, **Timothy M. Hsu**, San Jose State University, **Mark J. Logan**, University of Minnesota-Morris, and **Shahriar Shahriari**, Pomona College.

Diophantine Problems and Discrete Geometry, **Matthias Beck**, San Francisco State University, and **Lenny Fukshansky**, Texas A&M University.

Dynamical Systems and Differential Equations, **Adolfo Rumbos**, Pomona College, **Mario Martelli**, Claremont McKenna College, and **Alfonso Castro**, Harvey Mudd College.

Hopf Algebras and Quantum Groups, **Gizem Karaali**, Pomona College, **M. Susan Montgomery**, University of Southern California, and **Serban Raianu**, California State University Dominguez Hills.

Knot Theory and the Topology of 3-manifolds, **Sam Nelson**, Pomona College, **David Bachman**, Pitzer College, **Erica Flapan**, Pomona College, **Jim Hoste**, Pitzer College, and **Patrick Shanahan**, Loyola Marymount University.

Operators, Functions and Linear Spaces, **Asuman G. Aksoy**, Claremont McKenna College, **Stephan R. Garcia**, Pomona College, **Michael Davlin O'Neill**, Claremont McKenna College, and **Winston C. Ou**, Scripps College.

Recent Developments in Riemannian and Kaehlerian Geometry, **Hao Fang**, University of Iowa, **Zhiqin Lu**, University of California, Irvine, **Dragos-Bogdan Suceava**, California State University Fullerton, and **Mihaela B. Vajiac**, Chapman University.

Rio de Janeiro, Brazil

Instituto Nacional de Matemática Pura e Aplicada (IMPA)

June 4–7, 2008

Wednesday – Saturday

Meeting #1040

First Joint International Meeting between the AMS and the Sociedade Brasileira de Matemática (SBM).

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: February 2008

Program first available on AMS website: N/A

Program issue of electronic *Notices*: N/A

Issue of *Abstracts*: N/A

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/internmtgs.html.

AMS Invited Addresses

Ruy Exel, Universidade Federal de Santa Catarina, *Non-commutative dynamics*.

Velimir Jurdjevic, University of Toronto, *Integrable Hamiltonian systems on symmetric spaces*.

Andre Nachbin, IMPA, *Wave dynamics: Asymptotics with differential operators and solutions*.

Richard M. Schoen, Stanford University, *Riemannian manifolds of positive curvature*.

Ivan P. Shestakov, University of Sao Paulo, *Automorphisms of free algebras*.

Amie Wilkinson, Northwestern University, *Partially hyperbolic dynamics*.

AMS Special Sessions

Commutative Algebra and Algebraic Geometry, **Izzet Coskun**, University of Illinois at Chicago, and **Israel Vainsencher**, UFMG.

Complexity, **Gregorio Malajovich**, Universidade Federal do Rio de Janeiro, and **J. Maurice Rojas**, Texas A&M University.

Control and Related Topics, **Jair Koiller**, FGV, **Velimir Jurdjevic**, University of Toronto, and **Fernando Lizarralde**, COPPE/UFRJ.

Extremal and Probabilistic Combinatorics, **Bela Bollobas**, The University of Memphis, and **Yoshiharu Kohayakawa**, University of Sao Paulo.

Geometry, Representation Theory, and Mathematical Physics, **Henrique Bursztyn**, IMPA, **Anthony Licata**, Stanford University, and **Alistair Savage**, University of Ottawa.

Group Theory, **Rostislav I. Grigorchuk**, **Volodymyr Nekrashevych**, and **Zoran Sunic**, Texas A&M University, and **Said N. Sidki** and **Pavel Zalesskii**, University of Brasilia.

History and Philosophy of Mathematics, **Sergio Nobre**, Universidade Estadual Paulista-Rio Claro, and **James J. Tattersall**, Providence College.

Lie Algebras and Their Applications, **Ivan K. Dimitrov**, Queen's University, **Vyacheslav Futorny**, University of Sao Paulo, and **Vera Serganova**, University of California Berkeley.

Low Dimensional Dynamics, **Andre de Carvalho**, University of Sao Paulo, and **Misha Lyubich** and **Marco Martens**, SUNY at Stony Brook.

Low Dimensional Topology, **Louis H. Kauffman**, University of Illinois at Chicago, and **Pedro M. Lopes**, Instituto Superior Tecnico, Technical University of Lisbon.

Mathematical Fluid Dynamics, **Susan J. Friedlander**, University of Southern California, **Milton Lopes Filho** and **Helena Nussenzveig Lopes**, University of Campinas, and **Maria Elena Schonbek**, University of California Santa Cruz.

Mathematical Methods in Biology, **Julie C. Mitchell**, University of Wisconsin-Madison, and **Max O. Souza**, Universidade Federal Fluminense.

Mathematical Methods in Image Processing, **Stacey Levine**, Duquesne University, and **Celia A. Zorzo Barcelos**, Federal University of Uberlândia.

Partial Differential Equations, Harmonic Analysis, and Related Questions, **Haroldo R. Clark**, Universidade Federal Fluminense, **Michael Stessin**, University at Albany, and **Geraldo Soares de Souza**, Auburn University.

Several Complex Variables and Partial Differential Equations, **Shiferaw Berhanu**, Temple University, and **Jorge Hounie**, Federal University of San Carlos.

Vancouver, Canada

University of British Columbia and the Pacific Institute of Mathematical Sciences (PIMS)

October 4–5, 2008

Saturday – Sunday

Meeting #1041

Western Section

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: August 2008

Program first available on AMS website: August 21, 2008

Program issue of electronic *Notices*: October 2008

Issue of *Abstracts*: Volume 29, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: June 17, 2008

For abstracts: August 12, 2008

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Freeman Dyson, Institute for Advanced Study, *Birds and Frogs* (Einstein Public Lecture in Mathematics).

Richard Kenyon, Brown University, *Title to be announced*.

Alexander S. Kleshchev, University of Oregon, *Title to be announced*.

Mark Lewis, University of Alberta, *Title to be announced*.

Audrey A. Terras, University of California San Diego, *Title to be announced*.

Special Sessions

Algebraic Topology and Related Topics (Code: SS 3A), **Alejandro Adem**, University of British Columbia, and **Stephen Ames Mitchell**, University of Washington.

Applications of Algebraic Geometry (Code: SS 14A), **Elizabeth S. Allman**, University of Alaska Fairbanks, and **Rekha R. Thomas**, University of Washington.

Combinatorial Representation Theory (Code: SS 1A), **Sara C. Billey**, University of Washington, **Alexander S. Kleshchev**, University of Oregon, and **Stephanie Jane Van Willigenburg**, University of British Columbia.

Harmonic Analysis and Related Topics (Code: SS 12A), **Malabika Pramanik**, University of British Columbia, and **Burak Erdogan**, University of Illinois at Urbana-Champaign.

Hilbert Functions and Free Resolutions (Code: SS 4A), **Susan Cooper**, California Polytechnic State University, **Christopher A. Francisco**, Oklahoma State University, and **Benjamin P. Richert**, California Polytechnic State University.

History and Philosophy of Mathematics (Code: SS 11A), **Shawnee L. McMurrin**, California State University San Bernardino, and **James J. Tattersall**, Providence College.

Moduli Spaces and Singularity Theory (Code: SS 8A), **James B. Carrell**, **Patrick Brosnan**, and **Kalle Karu**, University of British Columbia.

Noncommutative Algebra and Geometry (Code: SS 6A), **Jason Bell**, Simon Fraser University, and **James Zhang**, University of Washington.

Noncommutative Geometry (Code: SS 13A), **Raphael Ponge**, University of Toronto, **Bahram Rangipour**, University of New Brunswick, and **Heath Emerson**, University of Victoria.

Nonlinear Functional Analysis, Approximations and Applications (Code: SS 10A), **S. P. Singh** and **Mahi Singh**, University of Western Ontario, and **Pranesh Kumar**, University of Northern British Columbia.

Probability and Statistical Mechanics (Code: SS 7A), **David Brydges**, University of British Columbia, and **Richard Kenyon**, Brown University.

Special Functions and Orthogonal Polynomials (Code: SS 2A), **Mizanur Rahman**, Carleton University, and **Diego Dominici**, State University of New York New Paltz.

Wavelets, Fractals, Tilings and Spectral Measures (Code: SS 5A), **Dorin Ervin Dutkay**, University of Central Florida, **Palle E. T. Jorgensen**, University of Iowa, and **Ozgur Yilmaz**, University of British Columbia.

West End Number Theory (Code: SS 9A), **Nils Bruin**, Simon Fraser University, **Matilde N. Lalin**, University of Alberta, and **Greg Martin**, University of British Columbia.

Middletown, Connecticut

Wesleyan University

October 11–12, 2008

Saturday – Sunday

Meeting #1042

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: August 2008

Program first available on AMS website: August 28, 2008

Program issue of electronic *Notices*: October 2008

Issue of *Abstracts*: Volume 29, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: June 24, 2008

For abstracts: August 19, 2008

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Pekka Koskela, University of Jyväskylä, *Title to be announced*.

Monika Ludwig, Polytechnic University New York, *Title to be announced*.

Duong Hong Phong, Columbia University, *Title to be announced*.

Thomas W. Scanlon, University of California, Berkeley, *Title to be announced*.

Special Sessions

Algebraic Geometry (Code: SS 1A), **Eyal Markman** and **Jenia Tevelev**, University of Massachusetts, Amherst.

Complex Geometry and Partial Differential Equations (Code: SS 3A), **Jacob Sturm** and **Jian Song**, Rutgers University.

Dynamical Systems and Applications (Code: SS 8A), **Michael A. Radin**, Rochester Institute of Technology.

Geometric Function Theory and Geometry (Code: SS 5A), **Petra Bonfert-Taylor**, Wesleyan University, **Katsuhiko Matsuzaki**, Okayama University, and **Edward C. Taylor**, Wesleyan University.

Geometric Group Theory and Topology (Code: SS 6A), **Matthew Horak**, University of Wisconsin-Stout, **Melanie Stein**, Trinity College, and **Jennifer Taback**, Bowdoin College.

Number Theory (Code: SS 4A), **Wai Kiu Chan** and **David Pollack**, Wesleyan University.

Real and Complex Dynamics of Rational Difference Equations with Applications (Code: SS 7A), **Mustafa Kulenovic**, University of Rhode Island.

Riemannian and Lorentzian Geometries (Code: SS 2A), **Ramesh Sharma**, University of New Haven, and **Philippe Rukimbira**, Florida International University.

Kalamazoo, Michigan

Western Michigan University

October 17–19, 2008

Friday – Sunday

Meeting #1043

Central Section

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: August 2008

Program first available on AMS website: September 4, 2008

Program issue of electronic *Notices*: October 2008

Issue of *Abstracts*: Volume 29, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: July 1, 2008

For abstracts: August 26, 2008

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/sectional.html.

Invited Addresses

M. Carme Calderer, University of Minnesota, *Title to be announced.*

Alexandru Ionescu, University of Wisconsin, *Title to be announced.*

Boris S. Mordukhovich, Wayne State University, *Title to be announced.*

David Nadler, Northwestern University, *Title to be announced.*

Special Sessions

Affine Algebraic Geometry (Code: SS 9A), **Shreeram Abhyankar**, Purdue University, **Anthony J. Crachiola**, Saginaw Valley State University, and **Leonid G. Makar-Limanov**, Wayne State University.

Computation in Modular Representation Theory and Cohomology (Code: SS 2A), **Christopher P. Bendel**, University of Wisconsin-Stout, **Terrell L. Hodge**, Western Michigan University, **Brian J. Parshall**, University of Virginia, and **Cornelius Pillen**, University of South Alabama.

Graph Labeling, Graph Coloring, and Topological Graph Theory (Code: SS 5A), **Arthur T. White**, Western Michigan University, and **David L. Craft**, Muskingum College.

Homotopy Theory (Code: SS 8A), **Michele Interfont**, Kalamazoo College, and **John R. Martino** and **Jeffrey A. Strom**, Western Michigan University.

Linear Codes Over Rings and Modules (Code: SS 11A), **Steven T. Dougherty**, University of Scranton, and **Jay A. Wood**, Western Michigan University.

Mathematical Finance (Code: SS 3A), **Qiji J. Zhu**, Western Michigan University, and **George Yin**, Wayne State University.

Mathematical Knowledge for Teaching (Code: SS 7A), **Kate Kline** and **Christine Browning**, Western Michigan University.

Nonlinear Analysis and Applications (Code: SS 1A), **S. P. Singh**, University of Western Ontario, and **Bruce B. Watson**, Memorial University.

Optimization/Midwest Optimization Seminar (Code: SS 6A), **Jay S. Treiman** and **Yuri Ledyev**, Western Michigan University, and **Ilya Shvartsman**, Penn State Harrisburg.

Representations of Real and P-adic Lie Groups (Code: SS 10A), **Alessandra Pantano**, University of California Irvine, **Annegret Paul**, Western Michigan University, and **Susana Alicia Salamanca-Riba**, New Mexico State University.

Variational Analysis and its Applications (Code: SS 4A), **Yuri Ledyev** and **Jay S. Treiman**, Western Michigan University, **Ilya Shvartsman**, Penn State Harrisburg, and **Qiji J. Zhu**, Western Michigan University.

Huntsville, Alabama

University of Alabama, Huntsville

October 24–26, 2008

Friday – Sunday

Meeting #1044

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: August 2008

Program first available on AMS website: September 11, 2008

Program issue of electronic *Notices*: October 2008

Issue of *Abstracts*: Volume 29, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: July 8, 2008

For abstracts: September 2, 2008

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/sectional.html.

Invited Addresses

Mark Behrens, Massachusetts Institute of Technology, *Title to be announced.*

Anthony Michael Bloch, University of Michigan, Ann Arbor, *Variational principles and nonholonomic dynamics*.

Roberto Camassa, University of North Carolina, Chapel Hill, *Title to be announced*.

Mark V. Sapid, Vanderbilt University, *Title to be announced*.

Special Sessions

Dynamics and Applications of Differential Equations (Code: SS 3A), **Wenzhang Huang** and **Shangbing Ai**, University of Alabama in Huntsville, and **Weishi Liu**, University of Kansas.

Graph Decompositions (Code: SS 2A), **Robert A. Beeler** and **Robert B. Gardner**, East Tennessee State University.

Mathematical Biology: Modeling, Analysis, and Simulations (Code: SS 1A), **Jia Li**, University of Alabama in Huntsville, **Azmy S. Ackleh**, University of Louisiana at Lafayette, and **Maia Martcheva**, University of Florida.

Shanghai, People's Republic of China

Fudan University

December 17–21, 2008

Wednesday – Sunday

Meeting #1045

First Joint International Meeting Between the AMS and the Shanghai Mathematical Society

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: June 2008

Program first available on AMS website: Not applicable

Program issue of electronic *Notices*: Not applicable

Issue of *Abstracts*: Not applicable

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: October 31, 2008

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/internmtgs.html.

Invited Addresses

L. Craig Evans, University of California Berkeley, *Title to be announced*.

Zhi-Ming Ma, Chinese Academy of Sciences, *Title to be announced*.

Richard Schoen, Stanford University, *Title to be announced*.

Richard Taylor, Harvard University, *Title to be announced*.

Xiaoping Yuan, Fudan University, *Title to be announced*.

Weiping Zhang, Chern Institute, *Title to be announced*.

Special Sessions

Biomathematics: Newly Developed Applied Mathematics and New Mathematics Arising from Biosciences, **Banghe Li**, Chinese Academy of Sciences, **Reinhard C. Laubenbacher**, Virginia Bioinformatics Institute, and **Jianju Tian**, College of William and Mary.

Combinatorics and Discrete Dynamical Systems, **Reinhard C. Laubenbacher**, Virginia Bioinformatics Institute, **Klaus Sutner**, Carnegie Mellon University, and **Yaokun Wu**, Shanghai Jiao Tong University.

Differential Geometry and Its Applications, **Jianguo Cao**, University of Notre Dame, and **Yu Xin Dong**, Fudan University.

Dynamical Systems Arising in Ecology and Biology, **Qishao Lu**, Beijing University of Aeronautics & Astronautics, and **Zhaosheng Feng**, University of Texas-Pan American.

Harmonic Analysis and Partial Differential Equations with Applications, **Yong Ding**, Beijing Normal University, and **Guo-Zhen Lu**, Wayne State University.

Integrable System and Its Applications, **En-Gui Fan**, Fudan University, **Sen-Yue Lou**, Shanghai Jiao Tong University and Ningbo University, and **Zhi-Jun Qiao**, University of Texas-Pan American.

Integral and Convex Geometric Analysis, **Deane Yang**, Polytechnic University, and **Jiazuo Zhou**, Southwest University.

Lie Algebras, Vertex Operator Algebras and Related Topics, **Hu Nai Hong**, East China Normal University, and **Yi-Zhi Huang**, Rutgers University.

Nonlinear Systems of Conservation Laws and Related Topics, **Gui-Qiang Chen**, Northwestern University, and **Shuxing Chen** and **Yi Zhou**, Fudan University.

Quantum Algebras and Related Topics, **Naihuan N. Jing**, North Carolina State University, **Quanshui Wu**, Fudan University, and **James J. Zhang**, University of Washington.

Recent Developments in Nonlinear Dispersive Wave Theory, **Jerry Bona**, University of Illinois at Chicago, **Bo Ling Guo**, Institute of Applied Physics and Computational Mathematics, **Shu Ming Sun**, Virginia Polytech Institute and State University, and **Bingyu Zhang**, University of Cincinnati.

Representation of Algebras and Groups, **Birge K. Huisgen-Zimmermann**, University of California Santa Barbara, **Jie Xiao**, Tsinghua University, **Jiping Zhang**, Beijing University, and **Pu Zhang**, Shanghai Jiao Tong University.

Several Topics in Banach Space Theory, **Gerard J. Buskes** and **Qingying Bu**, University of Mississippi, and **Lixin Cheng**, Xiamen University.

Stochastic Analysis and Its Application, **Jiangang Ying**, Fudan University, and **Zhenqing Chen**, University of Washington.

Topics in Partial Differential Equations and Mathematical Control Theory, **Xiaojun Huang**, Rutgers University,

Gengsheng Wang, Wuhan University of China, and Stephen S.-T. Yau, University of Illinois at Chicago.

Washington, District of Columbia

Marriott Wardman Park Hotel and Omni Shoreham Hotel

January 5–8, 2009

Monday – Thursday

Meeting #1046

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), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Bernard Russo

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: Expired

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/national.html.

AMS Invited Addresses

Oded Schramm, Microsoft, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

Urbana, Illinois

University of Illinois at Urbana-Champaign

March 27–29, 2009

Friday – Sunday

Meeting #1047

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 29, 2008

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/sectional.html.

Special Sessions

Algebraic Methods in Statistics and Probability (Code: SS 3A), Marlos A. G. Viana, University of Illinois at Chicago.

Geometric Function Theory and Analysis on Metric Spaces (Code: SS 6A), Sergiy Merenkov, Jeremy Taylor Tyson, and Jang-Mei Wu, University of Illinois at Urbana-Champaign.

Geometric Group Theory (Code: SS 2A), Sergei V. Ivanov, Ilya Kapovich, Igor Mineyev, and Paul E. Schupp, University of Illinois at Urbana-Champaign.

Graph Theory (Code: SS 4A), Alexander V. Kostochka and Douglas B. West, University of Illinois at Urbana-Champaign.

Mathematical Visualization (Code: SS 7A), George K. Francis, University of Illinois at Urbana-Champaign, Louis H. Kauffman, University of Illinois at Chicago, Dennis Martin Roseman, University of Iowa, and Andrew J. Hanson, Indiana University.

Probabilistic and Extremal Combinatorics (Code: SS 5A), Jozsef Balogh and Jozsef Balogh, University of Illinois at Urbana-Champaign.

q-Series and Partitions (Code: SS 1A), Bruce Berndt, University of Illinois at Urbana-Champaign, and Ae Ja Yee, Pennsylvania State University.

Raleigh, North Carolina

North Carolina State University

April 4–5, 2009

Saturday – Sunday

Meeting #1048

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 4, 2008

For consideration of contributed papers in Special Sessions: To be announced
 For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

Kac-Moody Algebras, Vertex Algebras, Quantum Groups, and Applications (Code: SS 1A), **Bojko N. Bakalov**, **Kailash C. Misra**, and **Naihuan N. Jing**, North Carolina State University.

San Francisco, California

San Francisco State University

April 25–26, 2009

Saturday – Sunday

Meeting #1049

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: September 25, 2008

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

Banach Algebras, Topological Algebras and Abstract Harmonic Analysis (Code: SS 1A), **Thomas V. Tonev**, University of Montana-Missoula, and **Fereidoun Ghahramani**, University of Manitoba.

Worcester, Massachusetts

Worcester Polytechnic Institute

April 25–26, 2009

Saturday – Sunday

Meeting #1050

Eastern Section

Associate secretary: Steven H. Weintraub

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 25, 2008

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Waco, Texas

Baylor University

October 16–18, 2009

Friday – Sunday

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: March 17, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

Dynamic Equations on Time Scales: Analysis and Applications (Code: SS 1A), **John M. Davis**, **Ian A. Gravagne**, and **Robert J. Marks**, Baylor University.

Boca Raton, Florida

Florida Atlantic University

October 30 – November 1, 2009

Friday – Sunday

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: March 30, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Riverside, California

University of California

November 7–8, 2009

Saturday – Sunday

Western Section

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 6, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

San Francisco, California

Moscone Center West and the San Francisco Marriott

January 6–9, 2010

Wednesday – Saturday

Joint Mathematics Meetings, including the 116th Annual Meeting of the AMS, 93rd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL),

with sessions contributed by the Society of Industrial and Applied Mathematics (SIAM).

Associate secretary: Matthew Miller

Announcement issue of *Notices*: October 2009

Program first available on AMS website: November 1, 2009

Program issue of electronic *Notices*: January 2010

Issue of *Abstracts*: Volume 31, Issue 1

Deadlines

For organizers: April 1, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Lexington, Kentucky

University of Kentucky

March 27–28, 2010

Saturday – Sunday

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 28, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

St. Paul, Minnesota

Macalester College

April 10–11, 2010

Saturday – Sunday

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: September 10, 2009

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Notre Dame, Indiana

Notre Dame University

September 18–19, 2010

Saturday – Sunday

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: February 19, 2010

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 5–8, 2011

Wednesday – Saturday

Joint Mathematics Meetings, including the 117th Annual Meeting of the AMS, 94th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: October 2010

Program first available on AMS website: November 1, 2010

Program issue of electronic *Notices*: January 2011

Issue of *Abstracts*: Volume 32, Issue 1

Deadlines

For organizers: April 1, 2010

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Boston, Massachusetts

John B. Hynes Veterans Memorial Convention Center, Boston Marriott Hotel, and Boston Sheraton Hotel

January 4–7, 2012

Wednesday – Saturday

Joint Mathematics Meetings, including the 118th Annual Meeting of the AMS, 95th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: October 2011

Program first available on AMS website: November 1, 2011

Program issue of electronic *Notices*: January 2012

Issue of *Abstracts*: Volume 33, Issue 1

Deadlines

For organizers: April 1, 2011

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

San Diego, California

San Diego Convention Center and San Diego Marriott Hotel and Marina

January 9–12, 2013

Wednesday – Saturday

Joint Mathematics Meetings, including the 119th Annual Meeting of the AMS, 96th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Steven H. Weintraub

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 1, 2012

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Baltimore, Maryland

Baltimore Convention Center

January 15–18, 2014

Wednesday – Saturday

Joint Mathematics Meetings, including the 120th Annual Meeting of the AMS, 97th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Matthew Miller

Announcement issue of *Notices*: 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 1, 2013

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

San Antonio, Texas

Henry B. Gonzalez Convention Center and Grand Hyatt San Antonio

January 10–13, 2015

Saturday – Tuesday

Joint Mathematics Meetings, including the 121st Annual Meeting of the AMS, 96th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: October 2014

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 1, 2014

For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

Central Section: Susan J. Friedlander, Department of Mathematics, University of Illinois at Chicago, 851 S. Morgan (M/C 249), Chicago, IL 60607-7045; e-mail: susan@math.nwu.edu; telephone: 312-996-3041.

Eastern Section: Lesley M. Sibner (until January 31, 2009), Department of Mathematics, Polytechnic University, Brooklyn, NY 11201-2990; e-mail: lsibner@duke.poly.edu; telephone: 718-260-3505. **Steven Weintraub** (after January 31, 2009), Department of Mathematics, Lehigh University, Bethlehem, PA 18105-3174; e-mail: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: Matthew Miller, Department of Mathematics, University of South Carolina, Columbia, SC 29208-0001, e-mail: miller@math.sc.edu; telephone: 803-777-3690.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. **Information in this issue may be dated. Up-to-date meeting and conference information can be found at www.ams.org/meetings/.**

Meetings:

2008

May 3-4	Claremont, California	p. 645
June 4-7	Rio de Janeiro, Brazil	p. 646
October 4-5	Vancouver, Canada	p. 646
October 11-12	Middletown, Connecticut	p. 647
October 17-19	Kalamazoo, Michigan	p. 648
October 24-26	Huntsville, Alabama	p. 648
December 17-21	Shanghai, People's Republic of China	p. 649

2009

January 5-8	Washington, DC Annual Meeting	p. 650
March 27-29	Urbana, Illinois	p. 650
April 4-5	Raleigh, North Carolina	p. 650
April 25-26	San Francisco, California	p. 651
April 25-26	Worcester, Massachusetts	p. 651
Oct. 16-18	Waco, Texas	p. 651
Oct. 30-Nov. 1	Boca Raton, Florida	p. 652
Nov. 7-8	Riverside, California	p. 652

2010

January 6-9	San Francisco, California Annual Meeting	p. 652
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March 27-28	Lexington, Kentucky	p. 652
April 10-11	St. Paul, Minnesota	p. 652
September 18-19	Notre Dame, Indiana	p. 653

2011

January 5-8	New Orleans, Louisiana Annual Meeting	p. 653
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2012

January 4-7	Boston, Massachusetts Annual Meeting	p. 653
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2013

January 9-12	San Diego, California Annual Meeting	p. 653
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2014

January 15-18	Baltimore, Maryland Annual Meeting	p. 654
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2015

January 10-13	San Antonio, Texas Annual Meeting	p. 654
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Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 95 in the January 2008 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of L^AT_EX is necessary to submit an electronic form, although those who use L^AT_EX may submit abstracts with such coding, and all math displays and similarly coded material (such as accent marks in text) must be typeset in L^AT_EX. Visit <http://www.ams.org/cgi-bin/abstracts/abstract.pl>. Questions about abstracts may be sent to abs-info@ams.org. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

Conferences: (see <http://www.ams.org/meetings/> for the most up-to-date information on these conferences.)

Co-sponsored conferences:

June 30–July 3, 2008: Tenth Conference on p-adic and Non-Archimedean Analysis, Michigan State University. See <http://bt.pa.msu.edu/NA08/> for more information.

Take Notice of Cambridge's New and Forthcoming Titles!

Orthogonal Polynomials and Continued Fractions

From Euler's Point of View

Sergey Khrushchev

Encyclopedia of Mathematics and its Applications

\$120.00*: Hardback: 978-0-521-85419-1: 500 pp.

Games, Scales and Suslin Cardinals

Volume 1: The Cabal Seminar I

Edited by Alexander S. Kechris,
Benedikt Löwe, and John R. Steel

Lecture Notes in Logic

\$85.00*: Hardback: 978-0-521-89951-2: 464 pp.

Geometry of Chemical Graphs

Polycycles and Two-faced Maps

Michel Deza and

Mathieu Dutour Sikiric

Encyclopedia of Mathematics and its Applications

\$110.00: Hardback: 978-0-521-87307-9: 280 pp.

Transcendental Dynamics and Complex Analysis

Edited by Phillip J. Rippon and
Gwyneth M. Stallard

*London Mathematical Society Lecture
Note Series*

\$80.00: Paperback: 978-0-521-68372-2: 472 pp.

Symmetry Studies

An Introduction to the Analysis of
Structured Data in Applications

Marlos A. G. Viana

\$60.00: Hardback: 978-0-521-84103-0: 248 pp.

Combinatorial Games

Tic-Tac-Toe Theory

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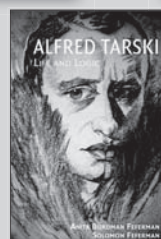
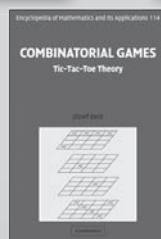
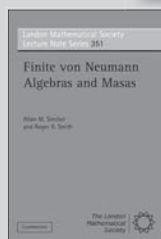
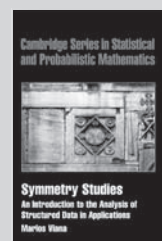
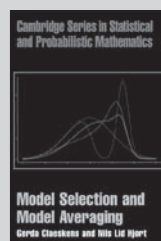
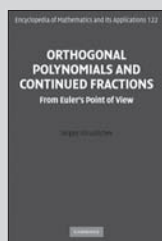
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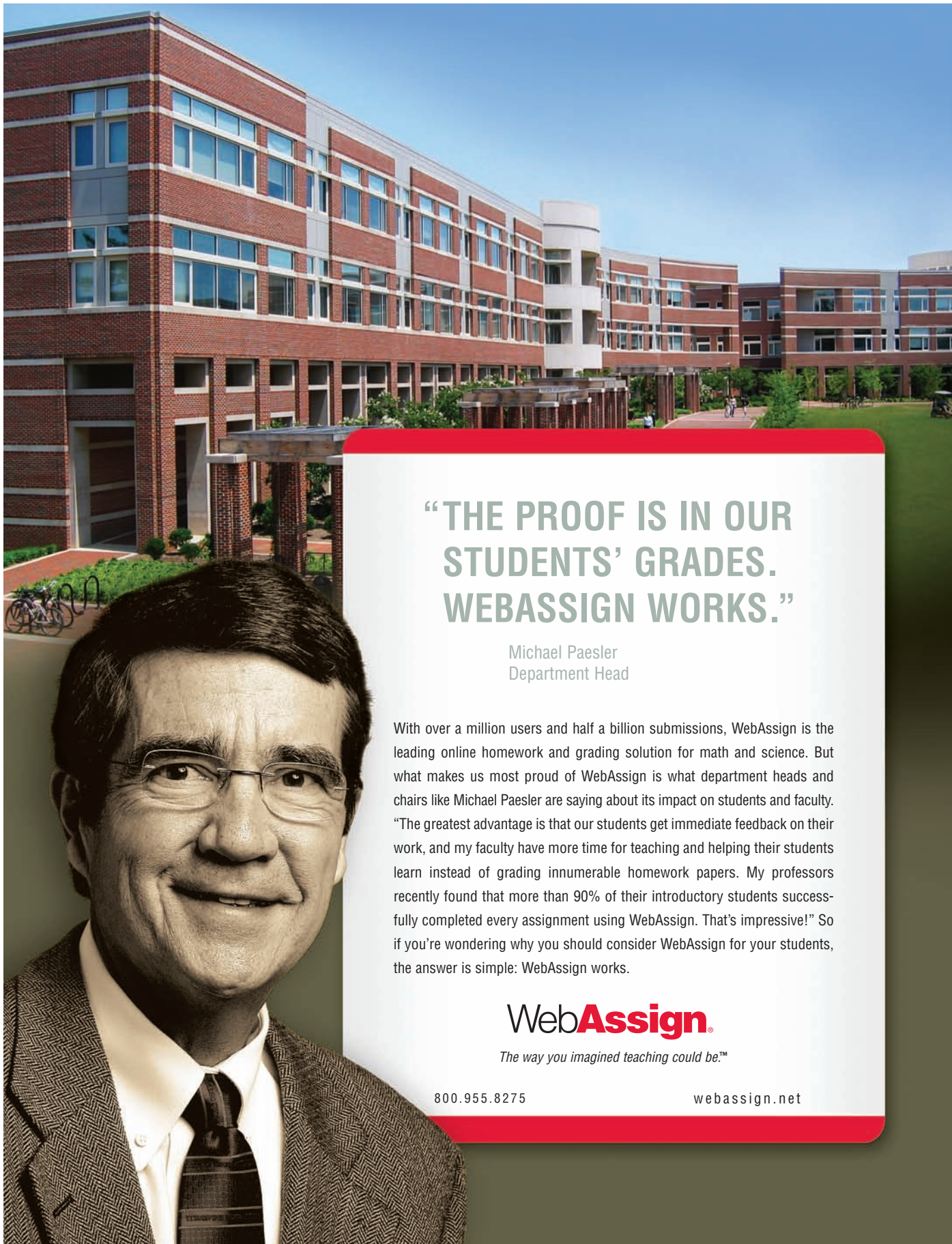
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