Integral

Inside

Dear Friends,

Welcome to the second edition of *Integral*, our department's annual newsletter. A year has flown by since we published our inaugural edition in September 2006. Much has happened and much more is planned.

First of all, we've had an ambitious recruitment effort and are delighted to be welcoming six new faculty to the department this year: Professors Paul Seidel and James McKernan; tenured Associate Professors Ju-Lee Kim and Jacob Lurie; and Assistant Professors Jon Kelner and Abhinav Kumar. You can learn more about them and about their mathematics on page 2.

The job market for mathematicians is quite strong these days, a big change from what I remember back in the 1970s, when jobs were few and far between. Now we face very tough competition from other great mathematics departments for top people, yet we've been remarkably successful. We are excited about the diversity of experience they will bring to our community, and we are proud to welcome them to MIT.

Our fantastic students are another source of great pride. With the stunning achievements of our undergraduate students on the Putnam and MCM competitions, and the spectacular successes of our graduate students at getting offers of the very best faculty positions, we know we're doing something right.

Speaking of undergraduate education, a major MIT task force has just completed a comprehensive review of the General Institute Requirements (GIRs) that shape the undergraduate experience of all MIT students and it has made recommendations for various changes in these requirements. MIT faculty and administrators are currently reviewing these proposed changes, some of which will undoubtedly be implemented. Our department is considering the impact of these changes on our programs and whether we ought to review our own offerings and requirements. Feel free to send ideas about restructuring our mathematics major programs directly to me at sipser@math.mit.edu.

This year, the huge turnouts for our Simons lectures given by Terry Tao and David Donoho necessitated finding larger lecture halls. MIT helped with publicity by spotlighting the series on the main Institute home page. The Simons lecturers next spring will be John Conway and Peter Teichner. In the fall term, Assaf Naor of New York University's Courant Institute of Mathematical Sciences will give the Wiener Lectures.

We're in the early stages of planning a conference for women mathematics PhDs who are graduate and undergraduate alumnae of the MIT Department of Mathematics. Participants will speak about their research, and will lead panel discussions of their individual experiences of what helped or hindered them in their careers. That conference is planned for April 12-13, 2008, and will follow a meeting of the department's Visiting Committee.

Thanks to the overwhelming support of our alumni and other friends, our $15 million fundraising "Campaign for Mathematics" has been going exceedingly well. At the present time, we are 90 percent of the way to our goal, so that means you still have time to participate and we hope you do! Please look inside for additional details.

As we move forward and look toward an unusually high number of faculty eligible for retirement over the next few years, we are planning to continue our active recruitment efforts. To that end, we are also thinking about the directions within mathematics that we want to develop within the department. The MIT administration has been tremendously supportive of our efforts and we have a close relationship with the new dean of science, Marc Kastner. Our future looks very bright indeed.

Michael Sipser
Department Head

Mathematics welcomes six new faculty

James McKernan, Professor of Mathematics, is a major figure in higher dimensional algebraic geometry. A recipient of a 2007 Clay Research Award for his groundbreaking work with Christopher Hacon on the Minimal Model Program, he earned a BA from Trinity College in 1985 and a PhD from Harvard University in 1991.
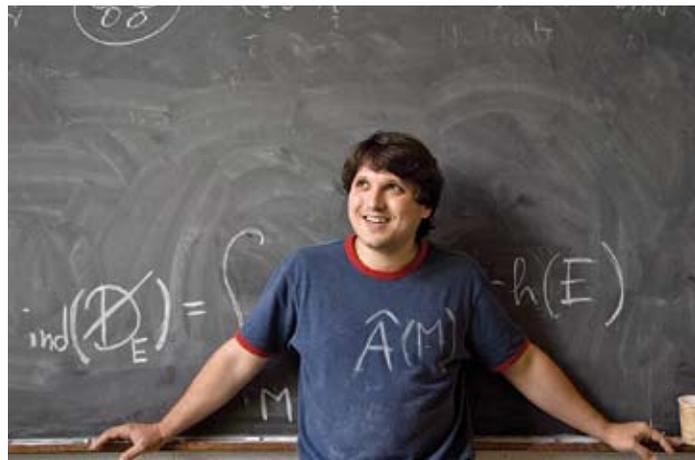
Paul Seidel, Professor of Mathematics, is well known for his outstanding work in symplectic topology, a field originating in the study of Hamiltonian mechanics and now connected to string theory. A recipient of the European Mathematical Society Prize in 2000, he received his Diploma from Heidelberg University in 1994 and the PhD from Oxford University in 1998.
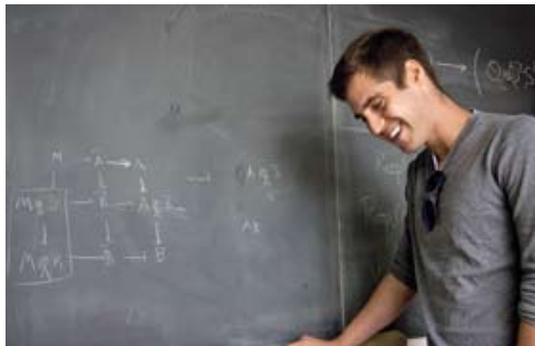
Jacob Lurie, Associate Professor of Mathematics with tenure, is a rising star in algebraic topology. A winner of several awards, including 1st place in the 1996 Westinghouse Science Talent Search, the 2000 Morgan Prize, and an AIM five-year fellowship in 2004, he holds a BA from Harvard University in 2000 and a PhD from MIT in 2004.


Ju-Lee Kim, Associate Professor of Mathematics with tenure, has made important contributions to p-adic representation theory and harmonic analysis, with connections to the local Langlands program. Her undergraduate studies in the Korea Advanced Institute of Science and Technology were completed in 1991 and she received her PhD from Yale University in 1997.

Abhinav Kumar, Assistant Professor of Mathematics, works in number theory. A 1998 IMO Gold Medalist and Putnam Fellow in 1999 and 2000, he received his SB from MIT in 2002 and his PhD from Harvard in 2006.

Jonathan Kelner, Assistant Professor of Mathematics, is a theoretical computer scientist. Recipient of the 2002 David Mumford Award and the 2004 STOC best student paper award, he earned a BA from Harvard University in 2002 and a PhD from MIT in 2006.
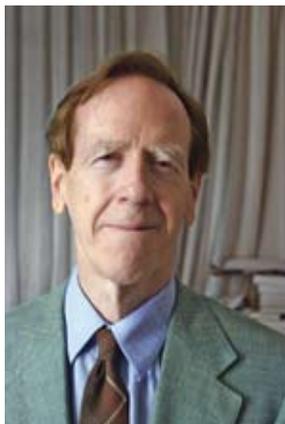
Gilbert Strang

Victor Kaç

Mark Behrens

Graduate awards: Haynes Miller, Teena Gerhardt, and Jason Burns.

Awards and achievements

Tom Mrowka received the AMS Oswald Veblen Prize in Geometry with Peter Kronheimer from Harvard, "for their joint contributions to both three and four-dimensional topology through the development of deep analytical techniques and applications." **Gil Strang** received the MAA Deborah and Franklin Tepper Haimo Award, the ICIAM Su Buchin Prize and the ETH/SIAM Peter Henrici Prize for research in applied analysis and mathematics education worldwide. **Peter Shor** was named one of Caltech's "Distinguished Alumni." **Eric Lauga** received the Andreas Acrivos Dissertation Award in Fluid Dynamics from the American Physical Society. **Mark Behrens** and **Katrin Wehrheim** both received Sloan Research Fellowships. **Michel Goemans** received a Guggenheim Fellowship in computer science. **Victor Kaç** and **Tom Mrowka** are newly elected members of the American Academy of Arts and Sciences. **George Lusztig** received the Diploma of Academic Merit from the Romanian Academy. **David Vogan** has been appointed as the Robert Collins Distinguished Scholar.

Associate Professors **Martin Bazant** and **Alex Postnikov** received tenure. **Kiran Kedlaya** was promoted to Associate Professor.

Dan Kane '07 was awarded the Bucsela Prize for outstanding MIT mathematics major. Dan also received the AMS-MAA-SIAM Frank and Brennie Morgan Prize for outstanding undergraduate research in mathematics. **Yaim Cooper '07** received the AMITA Senior Academic Award. She was also runner-up for the Schafer Prize for Undergraduate Women in Mathematics. Graduate student **Pavlo Pylyavskyy** was selected for a Clay Liftoff Fellowship. For their outstanding research papers, **Silvia Montarani** and **Luis Rademacher** each received the Charles and Jennifer Johnson Prize. **Ilya Elson**, with **Jason Burns** and **Teena Gerhardt** as runners-up, received the Charles and Holly Housman Award for Excellence in Undergraduate Teaching. **Michael Manapat** received the Dean's Education Award. **Andrew Sutherland** received an EECS Sprouls Award for an outstanding thesis in computer science. Staff member **Kim Makara** was awarded MIT's Infinite Mile Award. Academic administrator **Joanne Jonsson** received the Dean's Recognition Award.
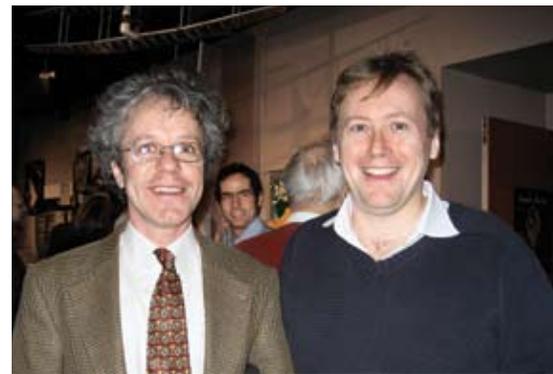
Peter Kronheimer and Tom Mrowka
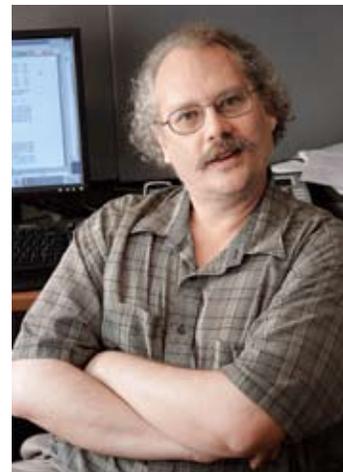
Peter Shor

George Lusztig

Possible future mathematician Ilaria Seidel, daughter of Paul Seidel and Ju-Lee Kim.

The UMO

The Undergraduate Mathematics Office, one of the first offices for undergraduate administration at MIT and still one of the few Institute offices devoted solely to undergraduate education, was a revolutionary entity when Professor Arthur Mattuck created it 30 years ago. Joanne Jonsson and her colleagues, Debbie Bower, Stephanie (Stevie) Gallarelli and Anna Ferrigno Ward now provide essential coordination of our extensive offerings of basic mathematics subjects such as calculus and linear algebra to students across all disciplines, as well as caring, individualized guidance to our mathematics majors.

Finding instructors for recitation sections, mentoring students, coordinating faculty with classes, and keeping everyone content are just a few of the wide umbrella of tasks that Joanne Jonsson has taken on in her more than two decades running our UMO. Jonsson is widely known and respected at MIT for her expertise. According to Gallarelli, "Her vast knowledge of MIT policies and her diplomatic nature make her very effective at identifying problems and finding solutions." Faculty know that she is the person to call when they are uncertain about advising a student, especially in difficult cases. Department Head Michael Sipser says, "We're all deeply grateful that Joanne works so hard to make the department run smoothly, allowing the faculty to concentrate on research and teaching."

This year, the UMO is getting a much-needed renovation. Uppermost in Jonsson's and her colleagues' minds is maintaining the welcoming feeling that has been their hallmark. Undergraduate students, graduate students, instructors and faculty will then continue to drop in regularly, chat, have candy, and find answers to all of their problems.

Project laboratory class creates "eureka!" moments for students

Imagine a billiards table with no friction or spin. The ball is struck and hits the sides in some sequence. What sequences are theoretically possible? What if the table is triangular or pentagonal?

MIT students explored this scenario recently through the Mathematics Project Laboratory.

Developed by Professors Michael Artin and Haynes Miller, the Mathematics Project Laboratory has no syllabus, no problem sets, and meets sporadically. Students, predominantly seniors, work in groups and select open-ended mathematical questions to investigate. Experiments are generally conducted on a computer, but some students use old-fashioned paper and pencil.

"I found that the class was an excellent way to gain experience with working in a group and making discoveries together," said Curtis Fonger, a senior mathematics major. "The class was a terrific way to learn the basics of mathematical research and presentation."

The class, fully subscribed in both 2006 – 2007 semesters, allows students to meet an Institute undergraduate laboratory requirement while experimenting with complex mathematical situations and formulating explanations for patterns they observe. The class, 18.821, was developed under a grant from the Cambridge-MIT Institute, a wide-ranging partnership aimed at enhancing the UK economy. This grant funded an exchange of ideas for computer-based explorations, starting from and enhancing a large collection of such projects long in use at Cambridge University.

"The first thing to understand about these projects is that they are not well-defined," Miller said. "Part of the challenge to the students is to find an aspect of the problem that is interesting and approachable. So every time a team does a project it comes out differently."

Projects are drawn from many mathematical areas, including dynamical systems, number theory, algebra, fluid mechanics, asymptotic analysis, knot theory and probability. Students choose from a selection of problems or design one of their own. During the semester, each group of three students works on three questions in which they design and run experiments, analyze the results and present their findings to the class.

A recent project invited students to think through a mathematical model of water seeping through a sand bed. The sand bed is riddled with tiny, interconnected channels, each open or blocked with some probability. Is there is a connected sequence of open channels that goes all the way through the bed?

"This is a classic threshold phenomenon: there is almost surely not an open sequence until the probability of a specific channel being open reaches a certain critical value," Miller said. "Each team that has worked on this project has discovered some new aspect of this problem."

During a sabbatical leave, Artin set up and ran an analogous, ongoing course at the University of Michigan. A number of other universities, he said, have also expressed interest in setting up a Mathematics Project Laboratory of their own.

Spectacular performance (again!) on the Putnam Competition

MIT undergraduate students, including many math majors, dominated the 67th William Lowell Putnam Mathematical Competition held in early December. The competition drew 3,640 undergraduates from 508 colleges and universities in the United States and Canada. This year, 126 MIT students spent a Saturday taking the exam. That is the highest number of students taking the exam from a single institution in Putnam history.

For the third consecutive year, three MIT students were named Putnam Fellows for placing in the top five. The new Fellows are Hensheng Diao '09, Daniel Kane '07, and Yufei Zhao '10. Along with the honor of being named a Fellow, these three students each received a $2,500 prize. Daniel Kane is now one of seven four-time Putnam Fellows in the history of the competition.

MIT swept all of the other top categories of individual rankings as well. Six of the next ten highest-ranking individuals were MIT students. Overall, 13 MIT students (exactly one-half!) were among the top 26 money prize winners and MIT had 26 (exactly one-third!) of the top 78 participants receiving honorable mention or higher.

For the team component of the exam, the MIT team finished third behind Princeton and Harvard and earned $15,000 for the Math Department's Putnam Fund. The team members were Oleg Goldberg '08, Daniel Kane '07, and Kuat Yessenov '08.

We thank Professors Hartley Rogers and Richard Stanley and Associate Professor Kiran Kedlaya for their dedication to the competition. As the results show, all the hard work by students and coaches was rewarded brilliantly this year.

Professor Hartley Rogers presents Putnam Competition winnings to the department.

2007 Simons lectures
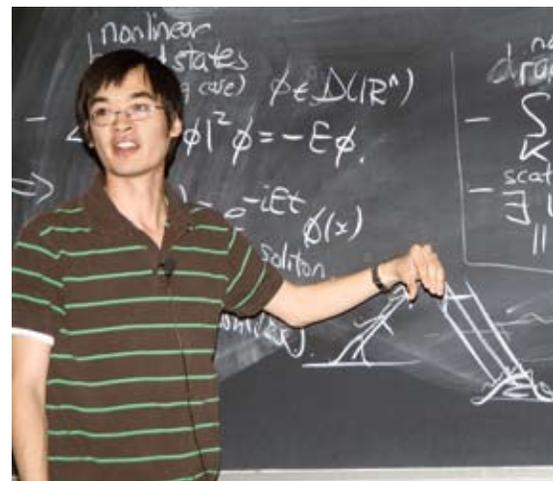
This year's Simons Lectures in Mathematics featured Professors Terence Tao from UCLA and David Donoho from Stanford University. The lecture series, named for benefactor and MIT math alumnus Jim Simons, has run annually for five years.

Each speaker gave three lectures over the course of three days on various mathematical topics. Tao, a Fields medalist, focused on "the dichotomy between structure and randomness" and drew over 400 people to his first lecture. Donoho spoke on problems surrounding sparse solutions to underdetermined systems.

Leighton family leads the way in supporting MIT mathematics

Tom Leighton and Bonnie Berger with their children Alex and Rachel and Tom's parents, David and Helen Leighton.

Tom Leighton's lifelong love for mathematics has taken him far beyond his childhood goal of teaching his favorite subject. As an MIT mathematics PhD who joined the faculty in 1982, Leighton played an early role in establishing theoretical computer science in the Department of Mathematics. A popular lecturer, Leighton still occasionally teaches the 100-plus students who regularly enroll in "Mathematics for Computer Science," a subject he helped design through the departments of mathematics and electrical engineering and computer science.

But it's Leighton's achievements at Akamai Technologies, which he co-founded in 1998, that have earned him worldwide recognition as one of the Top 10 Technology Innovators in U.S. News & World Report. Akamai, based in Cambridge, Mass., is the leading global service provider for accelerating content and business processes online. As chief scientist, Leighton is Akamai's technology visionary as well as a key member of the team that sets the company's direction.

A preeminent authority on algorithms for network applications, Leighton, through Akamai, created the world's largest distributed computing platform that dynamically routes content and applications across a network of more than 18,000 servers. At MIT, Leighton serves as head of the Algorithms Group in MIT's Computer Science and Artificial Intelligence Laboratory.

As the World Wide Web developed, Leighton recalled, so did the worldwide wait. In 1995, many Internet users found the level of congestion terribly frustrating. Leighton recognized that the solution to web congestion could be found in applied mathematics and algorithms. With graduate student Danny Lewin, Leighton developed the mathematical algorithms to handle the routing of content.

Leighton will tell you that running a company is a whole different experience from being a math professor. "For starters, summer isn't much different from the other three seasons. However, the culture at Akamai is like MIT in that it's intense, challenging and you get to work with really smart people, many from MIT. Most of all there's a prevailing attitude that you can do anything if you work hard enough," he said.

Leighton is determined to spread the word that MIT's math department is a fantastic environment for teaching and research.

"When it comes to fundraising, the math department is probably at the bottom of the totem pole. It shouldn't be, because it's the leading department of mathematics with the best and the brightest," he said. "I want to give back to the department that has been instrumental in the success of my career and I want to help the department remain strong."

Campaign on track to hit 2008 goal

The math department has raised more than $10 million to date in the first-ever Campaign for Math. Announced in April 2006, the capital campaign is on track to reach its goal of $15 million by April 2008.

"Clearly, the extraordinary generosity of the math department's friends, alumni and alumnae is at the heart of this success," said Director of Development Elizabeth Chadis. "Alumni, former Moore Instructors and other friends have responded to our request for support from all over the globe."

The money will be used for faculty recruitment and retention and to support graduate students.

The premiere issue of Integral featured the $6 million matching gift from Visiting Committee Chair John Reed '61, retired Chairman of Citigroup, Inc, and his wife, Cynthia. When he heard about the campaign, Visiting Committee member Jim Simons '58, President of Renaissance Technologies Corporation, added an incentive to help the department reach its goal. Jim offered to give the department the final $3 million once $12 million is reached. Since that time, Professors Tom Leighton '81 and Bonnie Berger '90 and Tom's parents, David '48 and Helen, have given a Chair to the department. (See full story on this page)

"The success of this campaign is terribly important to the future of the department," stressed Department Head Michael Sipser. "It is vital to sustaining the quality of teaching and scholarship and it demonstrates the degree of commitment and support the department enjoys. "The campaign has raised the visibility of our department within the Administration and increased fund-rising momentum," he said. "With your help, we are confident we will meet Jim Simons' challenge and complete the campaign successfully."

A fraction of the news

Throbbing oil mystery solved
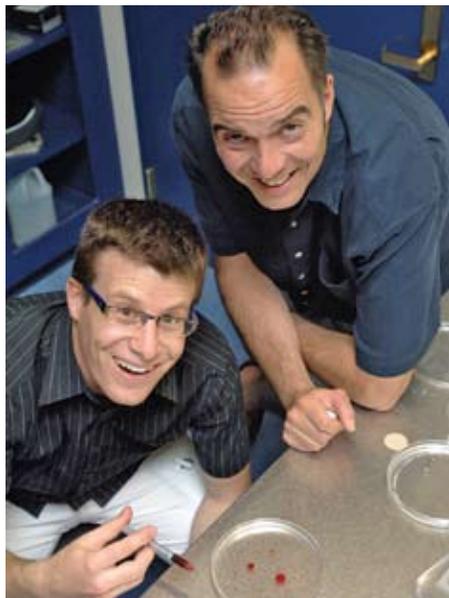
John Bush collaborates with former instructor Roman Stocker, now in MIT's civil and environmental engineering department, to explain why a mixture of mineral oil and detergent will pump like a beating heart when a drop is squeezed onto water.

Upcoming event

Women in Math Conference

MIT Women in Mathematics: A Celebration, will be held on the weekend of April 12-13, 2008, at the Massachusetts Institute of Technology. Seven mathematicians, both pure and applied, will speak on their research. Two panels will discuss the lives of women in mathematics at different stages of their careers. More information can be found at math.mit.edu/womeninmath.

In memoriam

Professor Emeritus George B. Thomas, who served on our faculty from 1944 to 1978, died on October 31, 2006 at the age of 92. In the early 1950s he authored the widely-used textbook, *Thomas' Calculus* as it is known today, now in its 11th edition by Addison Wesley Publishing.

Talented math musicians shine at IAP recital

Tim Nguyen plays Rachmaninoff.

The theme from the Final Fantasy VIII video game and Beethoven's Sonata No. 9 were among the selections showcased at the annual IAP Mathematics Department Music Recital. This annual concert, organized this year by graduate student Tim Nguyen, gives the MIT mathematics community, family and friends a chance to perform for one another.

Among this year's performances, graduate student Peter Buchak showed his virtuosity on the concertina with selections of Irish dance music, while editorial assistant Mike Collver sang ballads accompanied by his wife, Glorianne, on the lute. The musically mathematical couple Lauren Williams, violin, and Associate Professor Denis Auroux, piano, played the Finale from Beethoven's Sonata No. 9.

The afternoon concluded with Kobi Kremnitzer and Avshalom Manela, applied mathematics instructors, providing the hands for Francis Poulenc's "Sonata for Piano Four Hands."

E8 team makes history (and finds happiness)

Alfred Noël, David Vogan, and Peter Trapa

An international team of 18 mathematicians including our own David Vogan has mapped one of the largest and most complicated structures in mathematics. If written out on paper, the calculation describing the structure known as E8 would cover an area the size of Manhattan.

This mathematical feat made international headlines and received a commendation in Congress from Rep. Jerry McNerney (D-Calif.). McNerney concluded, "The participants are to be commended for their work that has expanded the limits of human knowledge and brings hitherto unknown beauty and power to grace our human condition." McNerney's commendation is posted on YouTube. Search for "Congress E8" at www.youtube.com or use the link listed under "Events" on the math department website: math.mit.edu.
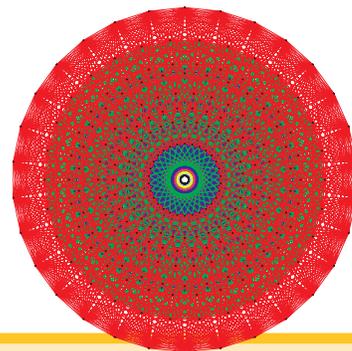
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