Department of Mathematics

The Department of Mathematics seeks to sustain its top ranking in research and education by hiring the very best faculty, with special attention to the recruitment of women and candidates from underrepresented minorities, and by continuing to serve the varied needs of the department's graduate students, mathematics majors, and the broader MIT community.

New Faculty

The Mathematics Department had a very successful year in faculty hires for FY2013. Three senior faculty members and one junior faculty member accepted the department's offers.

Alice Guionnet is a leading probability theorist, specializing in random matrices, large deviations, and spin glasses. She will join the faculty as professor in fall 2012, adding to the senior probability group of professors Alexei Borodin and Scott Sheffield. She received her PhD from École Normale Supérieure Paris in 1995 under G. Ben Arous and has served as professor and director of research at the École Normale Supérieure Lyons since 2005.

Larry Guth is a brilliant young mathematician with major results across a number of fields in harmonic analysis, geometry, and combinatorics. He received his PhD at MIT under Tomasz Mrowka in 2005. Following a junior faculty appointment at the University of Toronto, Dr. Guth was appointed professor at the Courant Institute of Mathematical Sciences at New York University in 2011.

William P. Minicozzi II is a powerful mathematician in geometric analysis and Partial Differential Equations. A long-time collaborator with professor Tobias Colding, he will join the faculty as professor in fall 2012. He received his PhD from Stanford University in 1994 under Richard Schoen. He joined the mathematics faculty at Johns Hopkins University in 1994, and has been the Krieger-Eisenhower Professor since 2007.

Aaron Naber will join the faculty as assistant professor. He is a specialist in algebraic geometry. He completed his PhD at Princeton University under Gang Tian in 2009 and has since been appointed a CLE Moore instructor at MIT.

Promotions, Retirement, and Departures

Associate professor Ju-Lee Kim (representation theory and *p*-adic groups) was promoted to professor.

Assistant professors Jonathan Kelner (theoretical computer science) and Abhinav Kumar (number theory) were promoted to associate professor.

Professor Daniel Freedman, who joined the MIT faculty in applied mathematics in 1980 and (jointly) the MIT theoretical physics faculty in 2001, retired from MIT after 31 years. He is a specialist in quantum field theory, quantum gravity, string theory, and, more

recently, on the computation and properties of on-shelf amplitudes in supersymmetric theories. A former Sloan Fellow, and twice a Guggenheim Fellow, Professor Freedman received the Dirac Medal and Prize in 1993 and gave the 2002 Andrejewski Lectures in mathematical physics. In 2006 he received the Dannie Heineman Prize for Mathematical Physics (with Sergio Ferrara and Peter Van Nieuwenhuizen) "for constructing supergravity, the first supersymmetric extension of Einstein's theory of general relativity." He was recognized as a distinguished alumni fellow by the Physics Department at the University of Wisconsin Madison in 2006. He is a fellow of the American Academy of Arts and Sciences and of the American Physical Society.

Professor Peter Ozsváth (low-dimensional geometry) will join the faculty at Princeton University. Associate Professor Kiran Kedlaya (number theory) will join the faculty at the University of California, San Diego.

Administration

Michael Sipser will continue as department head.

Haynes Miller will continue as associate department head and as the undergraduate officer.

Tomasz Mrowka will continue as chair of the pure mathematics committee, and Michel Goemans as chair of the applied mathematics committee. Paul Seidel follows Bjorn Poonen as co-chair (with Gigliola Staffilani) of the graduate student committee in pure mathematics. Peter Shor will continue as chair of the committee in applied mathematics graduate admissions. Steven Johnson and Ju-Lee Kim will continue to cochair the committee of undergraduate advisors, and Ruben Rosales will continue to chair the diversity committee.

Faculty Honors and Awards

Mark Behrens received the 2010–2011 School of Science prize for excellence in graduate teaching.

Bonnie Berger was elected fellow of the American Academy of Arts and Sciences and fellow of the International Society for Computational Biology.

Alexei Borodin gave the 2012 London Mathematical Society Lectures at the University of Glasgow, a series of 10 lectures on determinantal point processes and representation theory.

Pavel Etingof was selected by department faculty to be the next Robert E. Collins distinguished scholar, in support of his research in representation theory, quantum groups, and noncommutative algebra.

Jacob Fox was selected by the department faculty committee to receive the Edmund F. Kelly Research Award.

Alice Guionnet and Paul Seidel were chosen as Simons Investigators by the Simons Foundation.

Victor Kac was among the first group of scholars selected to be a Simons Fellow in Mathematics by the Simons Foundation.

Bjorn Poonen was elected fellow of the American Academy of Arts and Sciences.

Igor Rodnianski was awarded the 2011 Fermat Prize by the Toulouse Mathematics Institute for his fundamental contributions to the study of the equations of general relativity and of the propagation of light on curved space-times.

Paul Seidel gave the 2012 Mordell Lecture at the University of Cambridge and the 2011–2012 Distinguished Lecture Series at the University of California, Los Angeles.

Michael Sipser was selected by the Provost's Office to be the next holder of the Barton L. Weller professorship.

Three of the department's junior faculty were selected by the School of Science for the following support:

- Sug Woo Shin—NEC Corporation Fund for Research in Computers and Communications
- Jared Speck—Solomon Buchsbaum AT&T Research Fund
- Gonçalo Tabuada—NEC Corporation Fund for Research in Computers and Communications.

Research Staff

Postdoctoral associate Alejandro Rodriguez and research scientist Andrew Sutherland each received the School of Science Infinite Mile Award.

Andrew Sutherland was also awarded the Selfridge Prize for the top paper at the Algorithmic Number Theory Symposium. He will be promoted to principal research scientist next year.

Resource Developmnt

The Department of Mathematics had another successful year in reaching out to and engaging alumni and friends of the department. Faculty members continued to give presentations for alumni, parents, and friends. Professor Tom Leighton gave a talk in Greenwich, CT, titled "From Theory to Practice: The Akamai Story—Using Mathematics and Algorithms to Make the Internet Scale." Professor Gilbert Strang gave a breakfast talk on campus titled "Random Triangles, Signal Processing, and OpenCourseWare." These talks provide a good opportunity to share the work that the department's faculty is doing and to highlight the needs of the department. Donors can also meet the department's students and faculty at the stewardship events that take place on campus. Next fall will see the seventh edition of the department's annual newsletter, *Integral*.

Building 2 Renovations

Building 2, home of the Mathematics Department, has been identified as a candidate for major near-term renovation under MIT2030, a comprehensive process to envision the MIT of the future. This long-anticipated renovation would enliven the departmental quarters in multiple ways, providing attractive conference and seminar rooms and casual community spaces to facilitate small-group interactions. Offices would be laid out thoughtfully for the way mathematicians work today. The renovation would also restore the antiquated infrastructure of the building. Built in the early 1900s, the other buildings in the so-called Main Group have similar infrastructure problems. A successful renovation of Building 2 would confirm the possibilities of restorations in other sections of the Main Group.

Last year, the Institute commissioned a planning/feasibility study to be done by Imai Keller Moore Architects. The purpose of the study was to evaluate the existing condition of Building 2, document current space needs, assess the capacity of the building to accommodate future growth and change, and explore potential design concepts that would improve the function and aesthetics of the space. The architectural team proved invaluable in facilitating conversations among the constituent groups in the department (faculty, graduate students, instructors, and staff). The study offered many ideas and possibilities. The faculty viewed sketches at a lunch meeting, and gave a spontaneous round of applause.

This spring the Institute Selection Committee arranged presentations by four leading architectural firms that hoped to do the design. The selection committee included members of the Provost's Office, the School of Science, the Registrar's Office, the Department of Facilities, Resource Development, and the Department of Mathematics. With the list narrowed to two firms, final presentations were made in April to president Susan Hockfield, provost Rafael Reif, associate provost Martin Schmidt, executive vice president and treasurer Israel Ruiz, and representatives of the Institute Selection Committee. The firm of Ann Beha Architects was selected to design the renovations of Building 2.

In May, Ann Beha and her team met with various department groups. They will be drawing up plans during the summer for review. The department has set up a central renovations and blog site on its web page for members to review, respond, and contribute to design proposals. By June 2013 the department will vacate Building 2 so that two years of renovation work can begin.

Simons Lecture Series

Two world-renowned mathematicians presented the 2012 Simons Lectures: Alexander Lubotsky, who holds the Maurice and Clara Weil Chair in Mathematics at Hebrew University, and László Lovász, professor of mathematics at Eötvös Loránd University. Professor Lubotsky is known for extensive contributions to geometric group theory, representation theory of discrete groups, and applications of group theory to combinatorics and computer science. He is a recipient of the Erdös Prize

and the Rothschild Prize. His series was titled, "Expanders in Pure Mathematics." Professor Lovász has done fundamental work in discrete mathematics, combinatorial optimization, and algorithm theory. He has received the Bolyai Prize, the Wolf Prize, and the Kyoto Prize, among other distinctions. Professor Lovász spoke on topics in a series titled "Large Graphs and Their Limits."

Women in Mathematics

The department is very pleased that Alice Guionnet, a leading probabilist, will join the faculty as professor. Three new postdoctoral associates will also join the instructional staff. In the overall department profile for AY2013, women will make up 10 percent of the faculty and 22 percent of instructors and lecturers.

In an effort to build a sense of community among women members, Professor Gigliola Staffilani hosts a dinner at her home in the fall term for women graduate students, postdoctoral associates, and faculty. Women members are also invited from the mathematics departments at Boston University and Harvard University. The D.W. Weeks Lecture Series, which has been a great success, continues, supported in part by a grant from Katrin Wehrheim.

The Undergraduate Society of Women in Mathematics organized a new event over the independent activities period (IAP) called "SUMiT." It is partly supported by the Mathematics Department. Here is a description:

> SUMiT is a one-of-a-kind collaborative math event for 6th–10th grade girls. It was held with Girls' Angle and took place over IAP. The event itself took a whole day, and was essentially an adventure where the girls were presented with a series of puzzles and problems that, when combined, allowed them to achieve a larger goal. If they succeeded, they were awarded with a multitude of prizes supplied by our company sponsors. The 2012 theme was "Freeing Hypatia."

In September 2011, at the invitation of the mathematics department, MIT hosted the annual Advantage Testing Foundation Math Prize for Girls for the first time. This is a national mathematics contest for middle-school and high-school girls, founded by Arun Alagappan, president of the Advantage Testing Foundation, and by Ravi Boppana ('86 PhD, Department of Electrical Engineering and Computer Science), who serves as co-director. The concluding ceremony was held in Kresge auditorium, where professor Tom Leighton and president Susan Hockfield welcomed the 277 participants and their families and guests. High-school sophomore Victoria Xia of Vienna, VA, took the first-place prize of $25,000. MIT will host the Advantage Testing Foundation contest again in September 2012.

Diversity Efforts

The Mathematics Department continues to explore diversity opportunities through its Diversity Advisory Committee (chaired by Professor Ruben Rosales), with guidance from Dr. Martin Luther King, Jr., visiting professors.

Recruitment

Despite outreach efforts, recruitment of qualified candidates to the department's graduate program and for postdoctoral and faculty openings is still of limited success. This is particularly true of our graduate student applicants: this year only 27 of 464 applicants were from underrepresented minorities groups, and only one had the necessary qualifications.
The department has seen more qualified applicants for postdoctoral openings, although none has been suitable for a faculty appointment. Currently the department has appointed two African American instructors; a third African American instructor, a woman, will join the department next year.

There are particular challenges facing the mathematical community in building a pipeline to graduate-level research. Preparation requires a strong undergraduate program that cannot be sufficiently supplemented by a semester or year spent at an outside top school. Attracting more underrepresented minority undergraduates to the mathematics major at MIT—fostering their development and orientation to graduate study— is the most effective strategy to build our graduate and postdoctoral programs.

The Mathematics Major

MIT has recently increased its admitted underrepresented minority undergraduate population to 24 percent; 12 percent of mathematics majors now belong to underrepresented minority groups. The department is coordinating the following activities and programs to increase interest in the mathematics major.

Talent recruitment. Each term, the department reminds recitation instructors to identify and encourage the very best students to consider a math major or double major. In spring 2012 a diversity awareness component was added to the teaching workshop, modeled after one developed by MIT's Department of Chemistry. Participants are asked to pay special attention to excellent female and underrepresented minority students and to encourage them to participate in departmental activities such as the D.W. Weeks lecture series.

MIT Summer Research Program. In summer 2011, professors Mark Behrens and Paul Seidel supervised two outside underrepresented minority undergraduates, with additional support provided by a National Science Foundation (NSF) Research Training Group grant. Both students have applied to mathematics PhD programs; one has been accepted to the Rutgers University program, and the second, who won first place for her presentation at the National Association of Mathematicians MathFEST, has been accepted to the Purdue University graduate program. Our faculty will supervise three summer research program students in summer 2012.

Reading Outreach for Undergraduate Talent Exploration partnerships. The IAP Directed Reading Program saw an increase in its enrollment from 14 to 25 students over the past two years, with 25% underrepresented minority group participation each year. The department decided to pilot an expanded, year-long program in spring 2012. An undergraduate is mentored by a graduate student through the reading of a mathematics

text and then embarks on a research project during the second half of the year. The selection criteria are weighted to favor students who show the greatest improvement in mathematics, rather than those who are already among the strongest students. One of the primary goals of the mentoring program is to promote and accelerate the trajectories of underrepresented minority mathematics majors, although the program is not restricted to these populations. Two undergraduates participated in spring 2012. The goal is to enroll two new participants per semester.

MLK Visiting Professorship Program

Assistant professor Terrence Blackman will join the department through the Dr. Martin Luther King, Jr., visiting professor program. A representation theorist working with David Vogan, Professor Blackman is on the faculty at Medgar Evers College of the City University of New York. He is a highly experienced educator and familiar with the challenges of underrepresented minority groups, particularly of African Americans who are pursuing mathematics. The department is looking forward to his evaluation of our diversity efforts throughout the year.

Education

The Mathematics Academic Services Office

In January 2012, leadership of the Mathematics Academic Services office passed to Barbara Peskin, PhD ’80.

In June 2012, the Mathematics Department was awarded a $231,000 grant from the Davis Educational Foundation to redevelop Course 18.05 Probability and Statistics, under the leadership of associate head Haynes Miller and lecturer Jeremy Orloff.

Under a $149,000 grant from the NSF Division of Undergraduate Education, material generated from the department’s intensive subjects has been used to seed a national resource for undergraduate mathematical communication courseware. This has been done through the Mathematical Sciences Digital Library operated by the Mathematical Association of America.

Graduate Students

There were 102 graduate students in mathematics in 2011–2012, all in the PhD program. During the academic year, 22 students received the doctoral degree.

Most of these graduates went on to postdoctoral positions in mathematics departments or institutes, including both national universities (Princeton University, Stanford University, Northeastern University, University of Chicago, University of Arizona, University of Minnesota, University of Michigan, and University of California, Berkeley) and international institutions (University of York, University of Quebec, McGill University, McMaster University, Brazil’s Instituto Nacional de Matemática Pura e Aplicada, and the Korean Advanced Institute in Science and Technology). A few went into non-academic positions, with one graduate joining Google, another working for a government contracting agency, and a third taking a position in the financial industry.

There will be 23 new graduate students in our doctoral program in 2012–2013, including four women. The policy of offering all first-year students fellowship support continues; as usual, many incoming students come with support from external sources.

Graduate Student Awards

Sheel Ganatra, Alejandro Morales, and Hoeskuldur Halldorsson received the Housman Graduate Student Teaching Award for their exceptional skill and dedication to undergraduate teaching.

Steven Sam was awarded the Charles W. and Jennifer C. Johnson Prize for an outstanding research paper accepted in a major journal.

Undergraduate Majors

During 2011–2012, 329 students listed mathematics as their major, making this the largest undergraduate program in the School of Science. Of these, 81 students graduated with a first degree in mathematics; 38 more finished with a second degree in the department. Although the response to our senior survey was incomplete, at least nine of our seniors are continuing in graduate school in mathematics, and more than 20 are continuing in other disciplines. Other graduates will begin work in a wide array of related areas, with software engineering and the financial sector being popular choices.

Undergraduate Awards

The MIT team placed fifth in the William Lowell Putnam Mathematical Competition. The winning team consisted of sophomore Vlad Firoiu and seniors Colin Sandon and Jacob Steinhardt. Overall, MIT students once again dominated the competition. Three MIT participants ranked in the top 14 test-takers; four were in the next nine, and a record 22 received honorable mention (among 58 honorees). Students benefited from excellent coaching by professors Richard Stanley and Abhinav Kumar.

The Jon A. Bucsela Prize in Mathematics, given in recognition of distinguished scholastic achievement, professional promise, and enthusiasm for mathematics, was awarded to senior Fan Wei. Fan also received the Alice T. Schafer Prize for excellence in mathematics by an undergraduate woman, given by the Association for Women in Mathematics.

Senior Jacob Steinhardt received a Hertz Fellowship, in support of outstanding students with the freedom to innovate as part of their graduate studies.

Undergraduate and High School Summer Research Programs

In summer 2011 the department hosted its 15th Summer Program in Undergraduate Research, a six-week intensive mathematical research experience for MIT undergraduates in which each undergraduate pursues an individual project with a graduate student mentor. Eleven MIT undergraduates participated, supervised by six graduate students. The program culminates in written papers and lectures. A jury of faculty members selects winners for the Hartley Rogers Jr. Family Prize, which is awarded jointly to a student-mentor team. The 2011 Rogers Prize was awarded to junior Whan Ghang and graduate student John Ullman.

Summer 2011 was the 19th year of the Mathematics Department's participation in the Research Science Institute program (RSI) for gifted high school students. Twelve students carried out mathematics projects in RSI. Several achieved great success with their RSI projects in the Intel Science Talent Search (Intel STS 2012) and the Siemens Competition in Math, Science and Technology (Siemens 2011). Of the nine students who were US residents and hence eligible for these competitions, six reached the semifinal stage (top 300) in one or both competitions. One of them, Sitan Chen, supervised by mentor Jesse Geneson, won the third prize ($40,000 scholarship) in the Siemens 2011 and became a finalist (top 40) in the Intel STS 2012.

The PRIMES Program

In 2011 the department participated in MIT's first high school research program, the Program for Research in Mathematics, Engineering and Science (PRIMES). Of the 21 students who presented projects at the first annual conference, 15 worked in the mathematical section of PRIMES, mentored by seven graduate students and postdocs. Results of those projects have appeared this year in 13 research papers, including seven published on arXiv.org. Ten projects were presented at the Undergraduate Student Poster Session of the 2012 Joint Mathematics Meeting, and two students received an Outstanding Presentation award. Several students received awards for their projects in the Intel STS 2012 (two finalists and three semifinalists), in the Siemens 2011 (four regional finalists and three semifinalists), and in the 2012 Massachusetts Science and Engineering Fair (third place). One student, Fengning Ding, supervised by mentor Sasha Tsymbaliuk, won the fourth prize ($40,000) in the Intel STS.

In 2012, the department participated in the second year of PRIMES. Sixteen gifted high school students from Greater Boston worked on individual and group research projects in the mathematical section of PRIMES, mentored by nine graduate students and postdoctoratal associates. In May, PRIMES held its second annual conference at MIT, where all 16 students presented their projects. The well-attended event demonstrated the spectacular success of the program. Several projects will likely lead to publications in professional journals and will be strong contenders at national science competitions for high school students. Several PRIMES students will enter MIT as undergraduates in fall 2012 and will continue their research under the Unergraduate Research Opportunities Program.

Faculty Research Highlights

Tobias Colding_is a geometric analyst, whose program focuses on Einstein manifolds, and more generally manifolds with a lower Ricci curvature bound. Over the past year he has submitted five manuscripts; two have been accepted: one in the *Journal of Geometric and Functional Analysis*, another in *Annals of Mathematics*. His paper to *Annals* was written jointly with Aaron Naber. The main new result of this paper is a sharp Holder estimate for the change of the geometry of balls along a minimizing geodesic in a manifold with a lower Ricci curvature bound. This is a completely new kind of estimate that should have parallels for many other regularity problems. The proven new sharp Holder estimate settles many conjectures that have been open for the past 15 years, and gives significant new insight to Ricci flat and Einstein manifolds.

Colding's recent work will be part of the 2013 workshop and summer school at the International Centre for Mathematical Sciences in Edinburgh, Scotland, titled "Ricci Curvature: Limit Spaces and Kähler Geometry."

Over the past five years, Pavel Etingof's most important work has focused on the development of the structure and representation theory of Cherednik algebras, symplectic reflection algebras and quiver algebras, Poisson homology, and the theory of tensor categories. In particular, he proposed a program of using the representation theory of affine Lie algebras to develop representation theory of Cheredniik algebras and symplectic reflection algebras, and proposed a number of conjectures in this direction. Some of these conjectures were recently proved by Gordon-Losev and Peng-Vasserot.

Jacob Fox works on the development and application of powerful combinatorial and probabilistic techniques, to advance on some of the fundamental problems in extremal combinatorics. These problems include understanding the bounds in graph regularity and removal lemmas, the growth of Ramsey numbers of graphs and hypergraphs, Sidorenko's conjecture on subgraph density, and the Erdös-Hajnal conjecture. Over the past year, in joint work, Fox used recently developed methods to solve the following problems: that of Alon, Gowers, Lovasz, and Szegedy on bounds in graph regularity and removal lemmas; that of Erdös and Alon on extensions of Ramsey's theorem; and that of Erdös and Rothschild on edges in triangles.

Michel Goemans's most important research has been to obtain solutions to two long-standing problems in the area of approximation algorithms for hard optimization problems. The most recent result is the first approximation algorithm for the asymmetric traveling salesman problem, with a sublogarithmic performance guarantee (jointly with A. Asadpour, A. Madry, S. Oveis Gharan, and A. Saberi). This is the first major improvement of this classical problem in more than 30 years, and received the Best Paper award at the Symposium on Discrete Algorithms 2010. The second is the first approximation algorithm for degree-bounded spanning trees, which relaxes the degree bounds by an additive constant of 2, and provides a cost that is better than optimal. Both results have stimulated much research: the first on thin trees (the focus of Goemans's current research), and the second leading to the discovery of a new technique for designing approximation algorithms by Singh and Lau.

Steven Johnson's group has invented and designed several new types of devices: a new class of efficient nonlinear frequency converters based on resonance, front-coatings that enhance solar-cell efficiencies, new types of hollow-core fibers in which light slows down to enhance material interactions (e.g., for lasing or spectroscopy), new types of waveguide coupler designs for slow-light devices, and a new class of single-photon "optical transistor" that enters into the quantum regime. They have identified an unexpected phenomenon by which explosions may cause brain damage by electrically polarizing the skull. In the basic theory of wave phenomena, their work has shed new light on the origin of localization in complex microstructures and the fundamental limitations of optical "invisibility" designs. They have developed new and enhanced computational electromagnetic methods for quasicrystals, robust optimization (taking uncertainty into account), subpixel methods that improve

accuracy at sharp interfaces, and improved techniques for absorbing boundaries to circumvent fundamental limitations that they revealed in existing approaches. They have also made major strides in the theoretical modeling of Casimir forces that arise in micromechanical systems because of quantum electrodynamic fluctuations: they showed how classical computational tools can be used to attack this problem, developed the first computational tools that can handle arbitrary geometries and materials without modification, published the first three-body calculation of a Casimir force, and have identified a number of surprising phenomena that arise for these forces in complex structures that were previously inaccessible to theorists—showing how even the sign of the force can be changed by geometry alone.

Over the past five years, Robert Melrose has worked on problems related to the index theory and *K*-theory, to asymptotic behavior of solutions to wave equations, to scattering and inverse scattering theory, and to smooth group actions. Major results include the definition and properties of delocalized equivariant cohomology, following questions of Baum, Brylinski, and MacPherson in the 1980s. Recently with Chris Kottke, Melrose has characterized the generalized blowdown map, an important step in the structure theory of manifolds with corners. Most recently he has been working on gluing problems for Kähler metrics, on asymptotes of eigenvalues, and on the wave equation in general relativity.

Scott Sheffield's research achievements over the last year include describing the scaling limits of random planar maps weighted by statistical physical models in a particular topology, making use of a surprising connection to inventory management. This is a major step toward showing that discrete random planar maps are equivalent (in the fine mesh limit) to the so-called Liouville quantum gravity, a model for string theory introduced by Polyakov in 1981. In joint work with Jason Miller, Sheffield produced a long and comprehensive study of the "imaginary geometry" generated by the Gaussian free field. Jointly with Miller, he resolved the Schramm-Loewner Evolution (SLE) time reversal symmetry conjecture. SLE is a particular natural kind of random curve from a fixed point x to a fixed point y on the boundary of a planar domain. Since SLE was invented in 1999 by Oded Schramm, it has been conjectured that an SLE from x to y has the same law as an SLE from y to x (up to time reversal). Sheffield and Miller's joint work confirmed this conjecture.

Sug Woo Shin has made significant contributions to the Langlands program by establishing new instances of the so-called global Langlands correspondence. For this he computed the étale cohomology of Shimura varieties by bringing together techniques from number theory, algebraic geometry, representation theory, and harmonic analysis, and along the way applied the recent proof of the fundamental lemma by Bao Chau Ngo and the Langlands theory of endoscopy in an essential way. The representative paper of this work was published in *Annals of Mathematics* last year. Sug Woo's research provide essential input for significant recent results in algebraic number theory, such as the recent complete proof of the Sato-Tate conjecture for Hilbert modular forms and the proof of the Iwasawa main conjecture for GL(2).

Richard Stanley has obtained many new results on a widely studied class of permutations called "alternating permutations." Many of these results use representation theory, which has never been applied in such a way before. In a paper with R.R.X. Du, Richard showed how identities in Hecke algebras can be used to analyze certain random walks. He proved (and generalized) a conjecture of G. Han concerning some identities involving hook lengths of partitions, and he proved (and generalized) a conjecture of M. Bona on the distribution of elements in the cycles of a product of cycles. In a paper with T. Amdeberhan, Richard greatly extended a classical result of Lucas on the number of coefficients of $(1+x)^n$ divisible by a prime p. In a paper with Herb Wilf, he obtained new properties of the well-known Stern diatomic sequence. In a further paper, he obtained new results on the enumeration of skew Young tableaux that complement recent work of Baryshniktov and Romik. A joint paper with Corteel, Stanton, and Williams produced new enumerative results related to the asymmetric exclusion process (ASEP) and Askey-Wilson polynomials.

Michael Sipser
Department Head
Professor of Applied Mathematics