Dear Friends,

We're back! Back on campus with the pandemic hopefully behind us, and back to publishing *Integral*. We have lots to report. The past few years have been extraordinary in so many ways, it would be impossible to do it all justice in only a few pages. As you'll see in this issue focusing on faculty changes, we've had an amazing run of new faculty hires, bringing us close to capacity. A follow-up issue later this year will focus on our students and other aspects of department life. Here are a few highlights from this period.

Teaching through the Pandemic

In March 2020, the campus shut down. All classes became remote, with only two weeks to prepare for this radical change. Lectures needed to be redesigned, technologies learned, rules rewritten. The Institute activated existing rules for a "Significant Disruption" and announced an emergency grading system. As you can imagine, we faced many challenges, but our resilient faculty, students, and staff rose creatively to the occasion. We hired undergraduate assistants (UAs) to help our students learn, and our instructors teach, in this unfamiliar setting. The UAs led problem sessions, served as informal mentors, and answered student questions in the zoom chat during lectures — and it worked surprisingly well in most cases. Students missed the precious MIT experience of collaborating on problem sets in their dorm, so Mathematics Principal Research Scientist Andrew Sutherland led a team that developed Pset Partners, an online app that matches students based on their schedules and preferences. This app worked so well that many other departments adopted it, and they still use it now to help students form study groups. Some students returned to campus for the fall 2020 and spring 2021 semesters but most classes continued to be remote. The current academic year has seen a welcome return to in-person teaching.

Simons Lectures

They return this year, following a two-year hiatus, with Bhargav Bhatt and Cynthia Dwork. In 2019, we had June Huh and Alexander Barvinok and in 2018, Stephen Boyd and Sylvia Serfaty. These popular lectures, aimed at a broad audience, provide an opportunity for us to hear from leaders across fields in pure and applied mathematics.

Putnam Competition Blowout

MIT did unbelievably well in the 2021 competition, having the #1 team, all 5 Putnam Fellows, and 9 out of the next 10 Highest Individuals, as well as the Elizabeth Lowell Putnam Prize top female winner. Our 2021 performance bested our already phenomenal 2019 performance (2020 wasn't held) which in turn beat our fantastic 2018 performance, and so on… It can't continue to get better each year, but it always does!

Broadening Our Reach

Though we enjoy our competition triumphs, we treasure all of our 441 majors, a rapidly growing number. We have revised our curriculum to provide more intermediate-level offerings and put an increased emphasis on mentoring and community-building. The SPUR program fosters undergraduate research. Department student groups—the Undergraduate Mathematics Association, the Undergraduate Society of Women in Mathematics, and the Council for Math Majors—work actively to improve the undergraduate experience. In outreach to the broader community, we offer several programs for high school students to provide guided reading and research, and to promote increased diversity and inclusion in mathematics. You can read about one such program, the Menezes Challenge PRIMES Circle, in our donor profile on page 8.

Finally, I want to thank my colleagues, our students, and our amazing staff, for their ongoing hard work and contributions. I would especially like to thank our Academic Administrator, Barbara Peskin, who will be retiring this summer after 10 years of complete dedication to the department. We all owe a special thanks to my predecessor, Tom Mrowka, whose years of service, first as Pure Math Committee Chair and then as Department Head, led to the hiring of many key members of our faculty today. And, last but not least, our department has benefited enormously from the leadership and vision of Mike Sipser, who stepped down as Dean of Science to return to our faculty. I look forward to a bright future indeed for Mathematics at MIT.

Michel Goemans

Three Department Leaders Retire

Three major figures have recently retired from our faculty: Haynes Miller, Richard Stanley, and David Vogan. Each has figured transformatively in their own discipline and in the lives of many students. At the same time all three have played likewise transformative roles in our department which has been their intellectual home for decades.
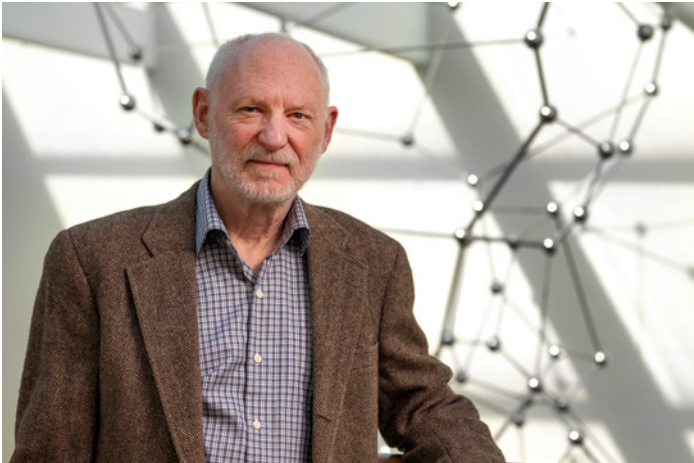

Haynes Miller joined our faculty in 1986 following his PhD from Princeton in 1974 under John Moore and faculty positions at Harvard, Northwestern, University of Washington, and Notre Dame. Algebraic Topology, his research specialty, has a storied history at MIT and Haynes has long been its cornerstone and champion in our department. His appointment as Margaret MacVicar Faculty Fellow, the highest honor MIT bestows on its faculty for education, recognizes his dedication to our students, especially at the undergraduate level. Beyond that, Haynes contributed to MIT through his leadership in many ways including, serving as Associate Head for the Mathematics Department and as a member of the Institute Faculty Policy Committee.

Richard Stanley came to MIT as a CLE Moore instructor in 1970 and joined the faculty in 1973. His PhD is from Harvard in 1971 under Gian-Carlo Rota. His research field is algebraic combinatorics. For many years, Richard, together with Rota and Danny Kleitman, made MIT the place to be for combinatorics. Their many students (Richard alone has had 60), postdocs, and visitors spread the gospel far and wide. He received the 2001 Leroy P. Steele Prize in Mathematical Exposition for his influential two-volume book *Enumerative Combinatorics* and a second Steele Prize (this one for Lifetime Achievement) in 2022. He is a fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences.
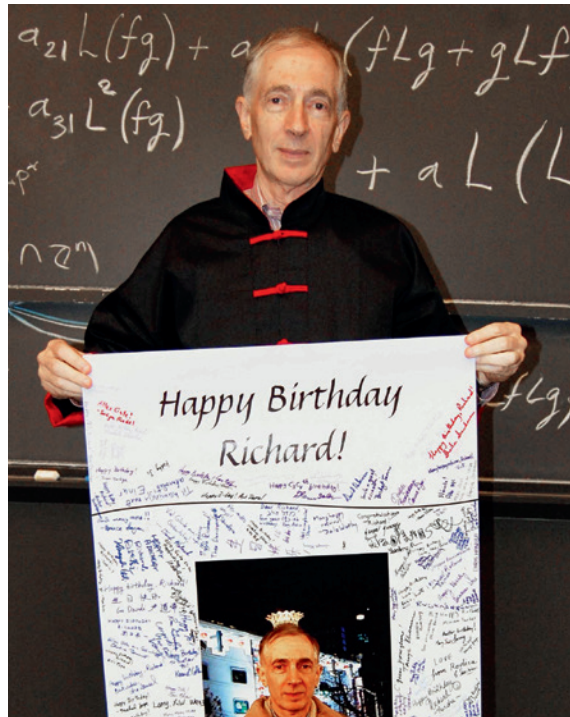

David Vogan began his MIT career as a graduate student, receiving his PhD here in 1976 under Bert Kostant. He joined the faculty in 1979 following positions at the Institute for Advanced Study and as Instructor at MIT. He works in group representations and Lie algebras, and is noted for computing the character table of the Lie group E_8, whose highly symmetrical projected image subsequently appeared in a great variety of places. David served as Head of the Mathematics Department and as President of the American Mathematical Society. He is a fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences.
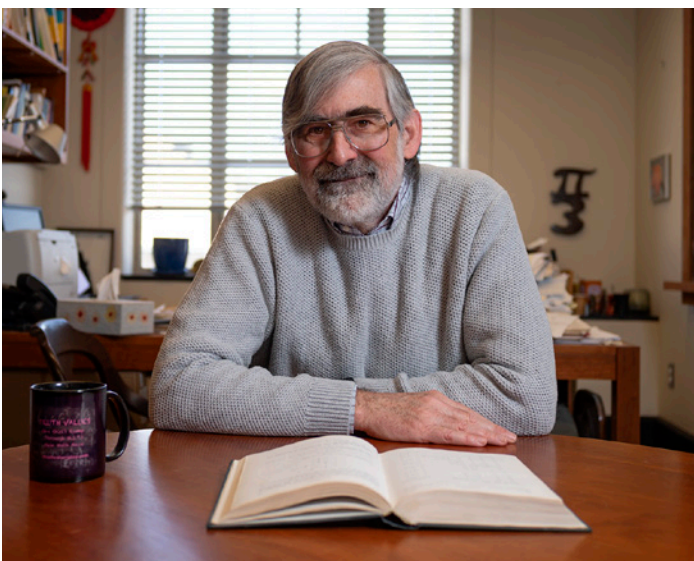
Mathematics Welcomes Three Senior Faculty

Nike Sun (Fall '18) is a probabilist working at the intersection of probability, combinatorics, theoretical computer science, and statistical physics. She completed her BA in mathematics at Harvard in 2009, and her PhD in statistics at Stanford in 2014 under Amir Dembo. Nike was subsequently a Schramm Fellow at Microsoft New England and MIT. She joined the statistics faculty at UC Berkeley in 2016, concurrent with a Simons Postdoctoral Fellowship at the Simons Institute for the Theory of Computing. Her distinctions include the 2017 Rollo Davidson Prize and the 2020 Wolfgang Doeblin Prize from the Bernoulli Society.
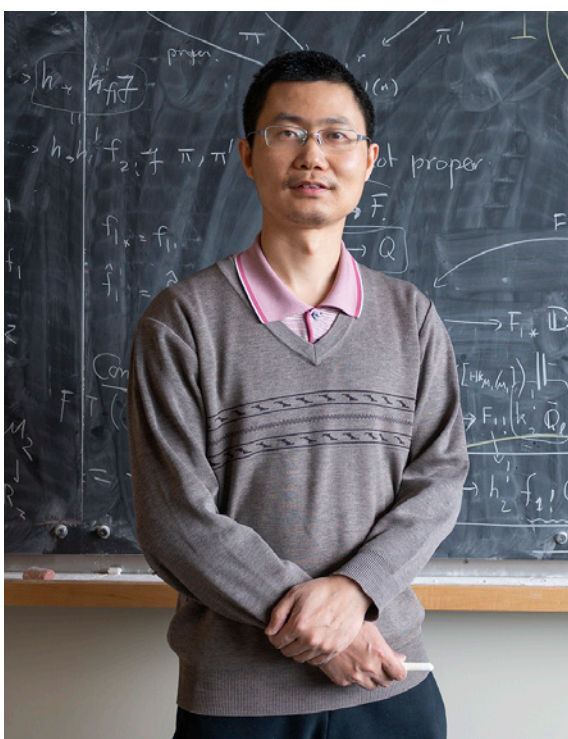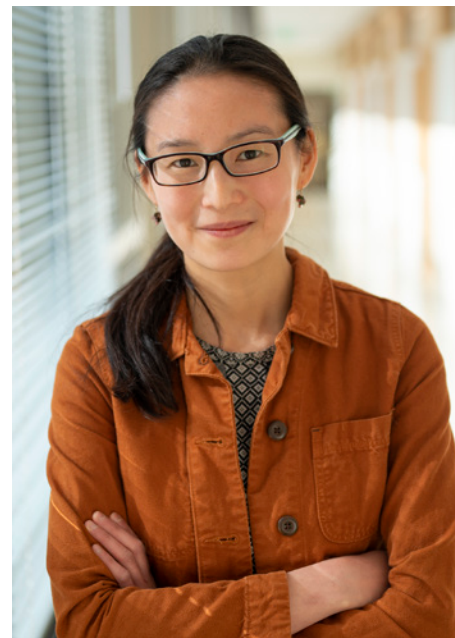
Zhiwei Yun (Spring '18) is a representation theorist working on the Langlands program at the crossroads between algebraic geometry, number theory, and representation theory. Zhiwei received his BS in mathematics from Peking University in 2004, and his PhD from Princeton in 2009 under Robert MacPherson. He was a CLE Moore Instructor at MIT from 2010 to 2012, and joined the faculty at Stanford in 2012, then moved to Yale in 2015. Distinctions include the 2012 SASTRA Ramanujan Prize, the 2013 Packard Fellowship, the 2019 Gold Medal by the International Congress of Chinese Mathematicians, a 2020 Simons Investigatorship, and the 2018 New Horizons Prize in Mathematics.

Wei Zhang (Fall '17) is a number theorist working in automorphic forms and arithmetic geometry, specifically the generalized Gross-Zagier formula. Wei received his BS in mathematics from Peking University in 2004, and his PhD from Columbia in 2009 under Shou-Wu Zhang. In 2010, he was a Benjamin Peirce Fellow at Harvard, and in 2011 he joined the faculty at Columbia. Distinctions include the 2010 SASTRA Ramanujan Prize, a 2013 Sloan Research Fellowship, the 2016 Morningside Gold Medal, a 2017 Simons Fellowship, a 2019 Clay Research Award, and the 2018 New Horizons Prize in Mathematics.
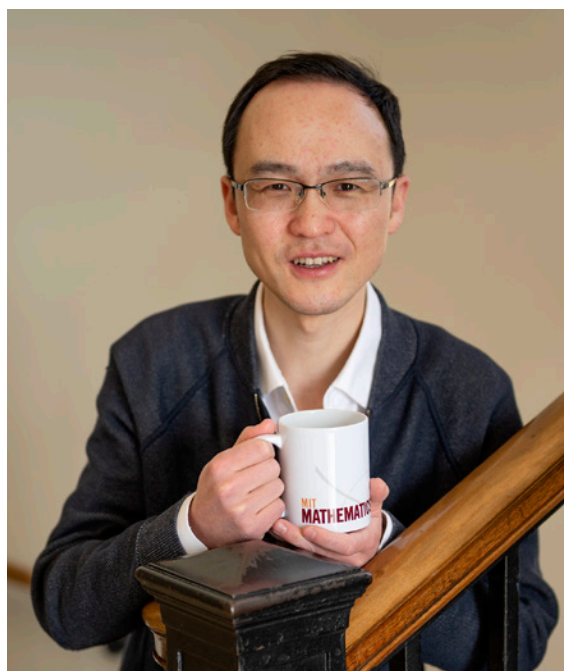
...and Seven Junior Faculty

> **Tristan Collins** (Fall '18) works in complex geometry, concentrating on problems in gauge theory and areas of algebraic geometry, such as mirror symmetry. He earned an undergraduate degree in 2009 from the University of British Columbia and a PhD from Columbia in 2014 under Duong Phong. He was a Benjamin Peirce Fellow at Harvard and concurrently a visiting assistant professor at Chalmers University in spring 2017. His distinctions include a 2018 Sloan Research Fellowship and the 2021 André Aisenstadt Prize in Mathematics.

< **Jeremy Hahn** (Fall '21) works in algebraic topology and homotopy theory, emphasizing structured ring spectra. His contributions, with collaborators, lie in equivariant chromatic homotopy theory, the classification of high-dimensional manifolds, and the redshift conjectures in algebraic K-theory. After his SB from MIT, he received a 2018 PhD from Harvard under Michael Hopkins. He returned to MIT as a CLE Moore instructor.

> **Dor Minzer** (Fall '20) works in computational complexity theory, especially probabilistically checkable proofs, Boolean function analysis, and combinatorics. With collaborators, he has proved the 2-to-2 Games Conjecture, a central problem closely related to the Unique Games Conjecture. He earned his bachelor's degree in 2014 and his PhD in 2018 under Muli Safra, both from Tel-Aviv University, and then was a postdoc at the IAS. He received the 2019 ACM Doctoral Dissertation Award and a 2021 Sloan Research Fellowship.


> **Lisa Piccirillo** (Fall '20) specializes in the study of three- and four-dimensional spaces. Her work in four-manifold topology has surprising applications to the study of mathematical knots. She proved that the Conway knot is not "slice," thereby resolving a fundamental, decades-old topological problem. She received her BS in mathematics in 2013 from Boston College and her PhD In 2019 from UT Austin under John Luecke. During 2019-20 she was a postdoc at Brandeis. She received the 2021 Maryam Mirzakhani New Frontiers Prize and a 2021 Clay Research Fellowship.

< **Lisa Sauermann** (Fall '21) works in combinatorics, probability theory, number theory, and theoretical computer science. She solved a 25-year-old conjecture of Erdös, Faudree, Rousseau, and Schelp. After her undergraduate degree at the University of Bonn, she received her PhD in mathematics at Stanford in 2019 under Jacob Fox. She held a Szegö Assistant Professorship at Stanford and a postdoctoral position at the IAS. Her distinctions include the 2021 European Prize in Combinatorics and a 2022 Sloan Research Fellowship.
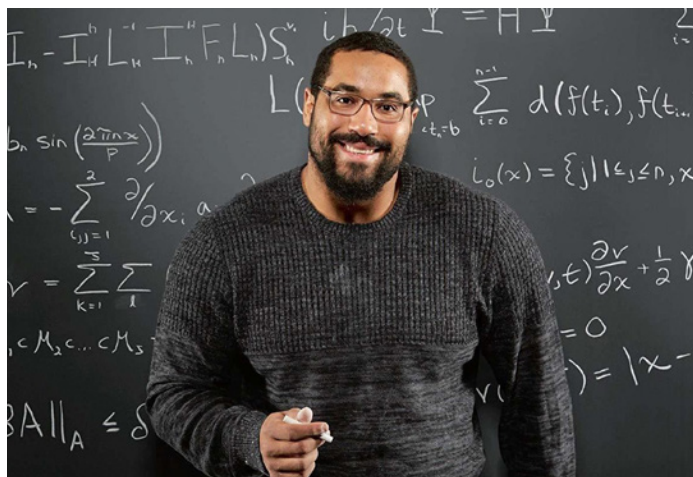
^ **John Urschel** (Fall '23) works in graph theory, numerical analysis, and machine learning. He received his undergraduate degree at Penn State in 2012 and has a 2021 PhD from MIT under Michel Goemans. He was named a Forbes 30 under 30 for Science in 2017. He is currently a postdoc at the IAS and will be a Harvard Junior Fellow next year before joining the MIT faculty.
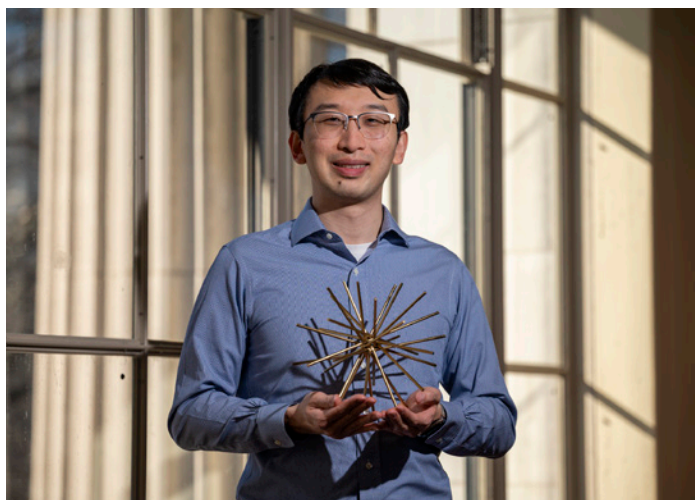
< **Yufei Zhao** (Fall '17) works in combinatorics and graph theory, concentrating on problems with extremal, probabilistic, and additive aspects. He received his 2010 SB and 2015 PhD under Jacob Fox, both from MIT. Yufei was subsequently appointed an Esmée Fairbairn Junior Research Fellow at Oxford, and a research fellow at the Simons Institute for the Theory of Computing. He received the 2018 Dénes König Prize in discrete mathematics and a 2019 Sloan Research Fellowship.

Richard Dudley 1938–2020

Dick had many interests outside mathematics. While teaching at Berkeley in the mid-1960s, he volunteered at radio station KPFA where he wrote and read the news on Saturday nights. A big fan of the outdoors and hiking, he edited the 1979 Appalachian Mountain Club *White Mountain Guide*, 22nd Edition. Dick enjoyed classical music. When he retired, he edited Wikipedia articles about Clara Schumann, Amy Beach, Dvořák, and Mozart.

Dick Dudley joined the MIT mathematics faculty in 1967 and retired in 2015. He died on January 19, 2020 at the age of 81 after a long illness. Dick shaped the contemporary fields of Probability and Mathematical Statistics, and founded the modern theory of empirical processes. His work continues to influence the ever-growing theory of machine learning.

Dick was much beloved by his PhD students, 33 in all. At his memorial service, his former student Dominique Haughton told how Dick and his wife Liza would invite his students to their New Hampshire house for memorable weekends in the mountains. She recounted how much Dick meant to his students and the profound impact he had on their professional and personal lives.
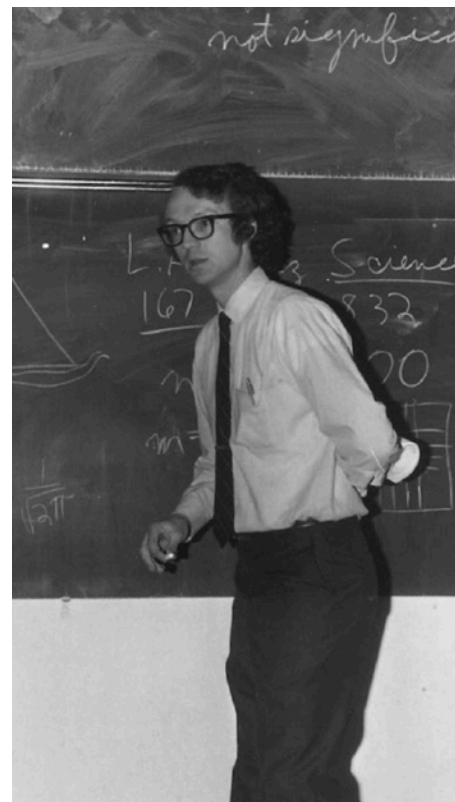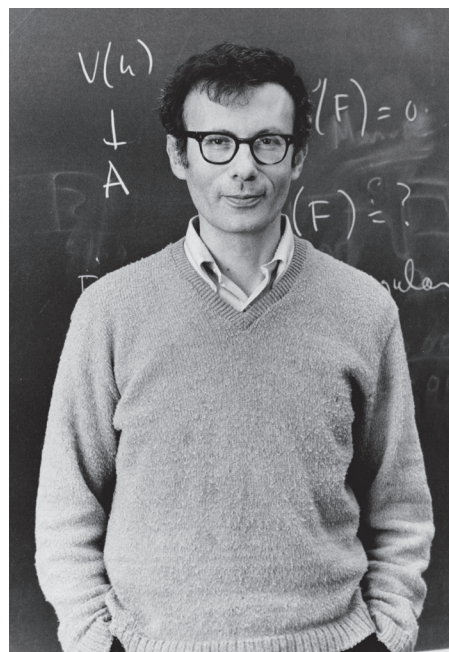
Arthur Mattuck 1930–2021

Arthur Mattuck passed away on October 8, 2021 at the age of 91. He came to MIT as a CLE Moore Instructor in 1955, joined the faculty in 1958, and retired after 52 years of service in 2010. He continued to teach through fall 2019. He worked in algebraic geometry, contributing to the theory of abelian varieties and the Riemann-Roch theorem.

Arthur was a pioneer in undergraduate education. Among his many enduring innovations from the early 1970s were the Undergraduate Math Office (now called Math Academic Services) and the Undergraduate Committee to oversee the mathematics major and coordinate undergraduate instruction. He was the Committee's first chair. He designed our influential first-year Calculus offering as well as other basic introductory mathematics subjects. A legendary teacher himself, he created programs such as videotaping lectures to help others improve, especially new instructors. In 1981, he produced the booklet *The Torch or the Firehose: A Guide to Section Teaching*, an informal and humorous collection of suggestions, scenarios, and cartoons. At times viewed as tough and demanding, he was the first to win the Institute's "Big Screw" award in 1967. He was also among the six initial MacVicar Faculty Fellows, the Institute's highest recognition for education.

Arthur served as head of the department 1983-1989. He was a great fount of departmental wisdom and lore, some of which appears in his chapter of *Recountings: Conversations with MIT Mathematicians*.

Arthur was an avid vegetable gardener, every summer sharing the bounty from his Fenway garden. He also loved classical music and performed on either cello or piano in the department's IAP Music Recital nearly every year since its creation in the 1970s.

Gerald Sacks 1933–2019

Gerald Sacks joined the MIT mathematics faculty in 1967. He retired in 2006. For much of that time, he held a joint position with Harvard University, where he was on the faculty from 1972 to 2012. He died on October 4, 2019. His research was mainly in recursion theory within the broader field of mathematical logic. These days recursion theory is often known as computability theory due to its connection with algorithms and computer science.

During the late 1960s and 1970s, Gerald, together with his colleague Hartley Rogers, led MIT to become a major center for mathematical logic worldwide. Remarkably many of Gerald's 31 PhD students went on to distinguished careers themselves, notably Lenore Blum, Harvey Friedman, Sy Friedman, Leo Harrington, Richard Shore, Steve Simpson, and Ted Slaman. In 1994, Gerald's colleagues established the Sacks Prize in his honor to celebrate his extraordinary success as a graduate advisor as well as his research. It is awarded annually by the Association for Symbolic Logic to the most outstanding dissertation in mathematical logic.

Gerald's teaching brought clarity and comprehensibility to the material he covered. He was often invited to give talks, including a plenary address at the 1978 International Congress of Mathematicians, because he explained mathematical logic understandably to those outside the field.
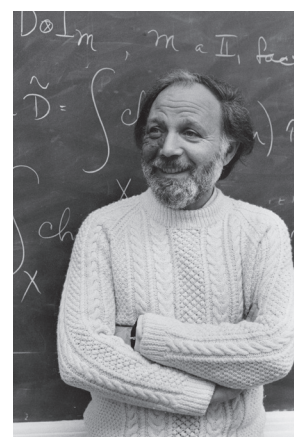
Isadore M. Singer 1924–2021
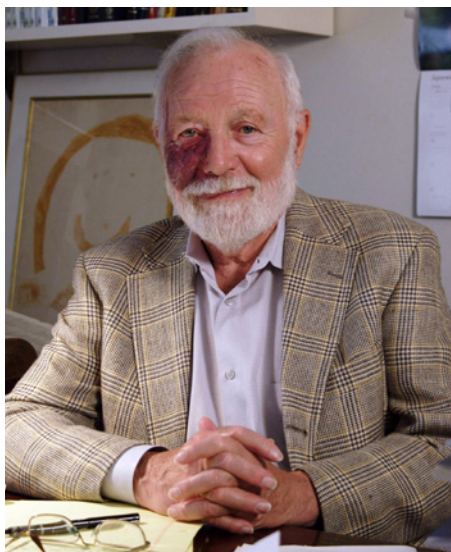
Isadore (Is) Singer came to mathematics indirectly. A relative of Isaac Bashevis Singer (first cousin, once removed), he considered majoring in literature when he began college but he eventually chose physics. After graduating, he studied geometry and group theory because he felt they were necessary to go on with physics, but ended up getting a PhD in mathematics.

Is arrived at MIT in 1950 as a CLE Moore Instructor. He was on the MIT faculty from 1956 until his retirement in 2010, except for the period 1977 to 1984 at UC Berkeley. He died on February 11, 2021. Is was a towering mathematician whose work in geometry and analysis revealed new connections between mathematics and physics. Working with Richard Kadison on the foundations of quantum mechanics, he formulated the Kadison-Singer Conjecture in 1959. It was shown to be equivalent to problems in applied mathematics, engineering, and theoretical computer science, and was finally solved in 2013. With Michael Atiyah, Is developed the Atiyah-Singer Index Theorem in 1963, a centerpiece of twentieth century mathematics bringing together analysis, geometry, and topology. It later turned out to have applications in physics, particularly string theory. Is received many honors and awards including the Abel Prize and the National Medal of Science. He was appointed as an Institute Professor in 1987.

Is was dedicated to MIT and the mathematics department. He, together with colleague Warren Ambrose, made MIT a leading center for geometry in the 1950s. They both helped to shape pure mathematics here. Teaching was important to Is. He offered to teach whatever the department needed and late in his career voluntarily ran calculus recitations. He supervised 33 graduate students including Dan Burns, Dan Freed, John Lott, Hugo Rossi, Linda Rothschild, and Nancy Stanton.

Is got involved with the role of science and mathematics in society. From 1982 to 1988, He served on the White House Science Council and on the governing board of the National Research Council from 1995 to 1999. Together with S.S. Chern and Calvin Moore, he helped found MSRI.

DONOR PROFILE

Victor and Tara Menezes

"It might not change the world, but it does try to light a small candle."

These are modest words from Victor Menezes, SM '72, a Course XV alumnus who recently created the Victor J. Menezes (1972) Challenge Fund in Mathematics. These words reflect the heart of many in the School of Science community where an act of "lighting a small candle" often leads to creativity and exploration that may one day in fact change the world.

The Menezes Challenge Fund in Mathematics will support the department's outreach programs and create challenge opportunities for students from under-represented backgrounds and underserved communities in the United States and elsewhere to support their goals of attending MIT and other top-ranked universities.

Victor Menezes was born and raised in India. After receiving his undergraduate degree in electrical engineering from the Indian Institute of Technology at Bombay, he traveled abroad for the first time.

On that trip, the first of his many around the world, he joined the masters of science program at the MIT Sloan School of Management with a focus on finance and economics. MIT in the 1970s was an evolving and exciting place to be; Professor Paul Samuelson had just won the Nobel Prize in economics; Professor Robert Merton had just started teaching; and Menezes enrolled in his first course in finance and options theory.

"There were quantitative luminaries and future Nobel Prize winners all around us," says Menezes, who was thrilled to be a part

Tara and Victor Menezes, SM '72

Photo: courtesy of the donors

of that community, harboring a belief that mathematics underpins finance, economics, and electrical engineering. It allowed him to flourish in his career.

After completing his SM in 1972, Menezes joined Citibank where he worked for 33 years, living with his wife Tara and their four children all over the world — India, New York, Manila, Hong Kong, Brussels, and finally New York again, where they reside for their retirement.

Menezes remained a close part of the MIT community throughout his career and is a Life Member of the MIT Corporation. When asked about his motivation for the creation of the Menezes Challenge Fund in Mathematics, he stated, "Mathematics was

the bridge in my life. Math is the Latin that binds the modern world. I heard about the Math Department's outreach programs, MathROOTS and PRIMES Circle, and it struck a chord. I thought they were wonderful. They encourage math development at the high school level in the United States and elsewhere when the support is most needed!"

Victor and Tara Menezes are grateful for the knowledge and friendships gained through MIT and are happy to offer their support. "Philanthropy is a very big word. Our support is a small way of saying thank you."

This article appeared in the Winter 2021 issue of *Science@MIT*.

Make a Difference

In order for the math department to remain a leader in research and education, your gifts can help us attract and support top faculty and students. Make an impact by funding innovation in needed areas. Gifts in all amounts are invaluable to the department's funds.

Math Special Needs Fund #3879500
PRIMES Fund #3895820
MathROOTS Fund: #3892422
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To support our talented students and faculty, contact Director of Development Erin McGrath Tribble at emcgrath@mit.edu or 617-452-2807.

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