

# Fine LETTERS

Spring 2017 Issue 6  
Department of Mathematics Princeton University

## Letter From the Chair



Congratulations to our 28 undergraduate math majors of the class of 2016 and to the 8 graduate students who are now '16. About half of the undergrads went off to grad

school, others found positions in finance and industry and a few followed other paths including the Korean army. We look forward to hearing both from and about you in the future.

We are thrilled that John Pardon '11 and Allan Sly joined the Department as professors, Tatyana Shcherbyna as an assistant professor, and Otis Chodosh, Ziyang Gao, Ilya Khayutin, Francesco Lin, Evita Nestoridi, and Konstantin Tikhomirov as instructors and that Emmanuel Abbe (PACM, EE) and Ramon van Handel (ORFE) became Associated Faculty. They have all made a difference to the Department.

Congratulations to our 2nd place Putnam team; Eric Schneider, Alex Song, and Xiaoyu Xu and to Eric Schneider and Murilo Zanarella who both earned N1 distinction.

All our finishing grad students did very well, though some chose new directions. Four of this year's twenty Sloan Foundation Fellowship winners in mathematics went to our former grad students Wei Ho '09, Chi Li '12, Jonathan Luk '12, and Aaron Pixton '08 '13, and two

others went to Assistant Professors Nicholas Sheridan and Han Liu (ORFE).

Some highlights among faculty recognitions include Charlie Fefferman '69 winning the Wolf Prize in Mathematics, the fourth current faculty member and the sixth Princeton alum to do so. John Pardon '11 won the NSF's Alan T. Waterman Award. Also, Professor Allan Sly was awarded the Doebelin Prize and Assistant Professors Adam Marcus and Vlad Vicol were awarded NSF CAREER grants. See page 4 for a more complete list of major recognitions.

Our beloved Scott Kenney retired following 30+ years of service, including 25 years as Department Manager followed by 5 years as Special Projects Manager. In all his roles he was uniformly welcoming, approachable and totally devoted to the Department. To many of us Scott was the face of the Math Department. He will be sorely missed.

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## Pardon Receives Waterman Award

Professor John Pardon '11 has received a National Science Foundation Alan T. Waterman Award, which is the nation's highest honor for early-career scientists and engineers. The prize carries a five-year, \$1 million grant.



Pardon was recognized for "revolutionary, groundbreaking results in geometry and topology" that "have extended the power of tools of geometric analysis to solve deep problems in real and complex geometry, topology, and dynamical systems," according to the prize citation. He was selected along with Baratunde Cola, an associate professor of mechanical engineering at Georgia Tech.

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*Provost David Lee, President Christopher Eisgruber, and Dean of the Faculty Debra Prentice congratulated Pardon at a special tea in his honor.*

# Faculty Appointments

## Professor John Pardon



John Pardon '11 returned to Princeton as a professor this year, having completed his Ph.D. at Stanford University in 2015, where he was then appointed as an assistant professor.

As an undergraduate math major at Princeton, Pardon's groundbreaking solution to Gromov's knot-distortion problem was published in the *Annals of Mathematics* and earned him the 2012 Morgan Prize.

Pardon continues to work on long-standing problems. His proof of the 3-dimensional Hilbert-Smith conjecture in 2013 was the first general result on that venerable problem since the 2-dimensional solution more than 60 years earlier.

His groundbreaking achievements were recognized this April when he received the National Science Foundation's Alan T. Waterman Award, the nation's highest honor for early-career scientists.

"My main personal motivation to work on problems in mathematics is aesthetic," Pardon has said. "The most satisfying part of doing mathematics is to find a beautiful proof or a beautiful theorem. I can only hope that I have succeeded in a small way in this respect."

Pardon is also an accomplished cellist and has joined the department's growing musical ensemble.

## Professor Allan Sly



Allan Sly joined the department this fall as a professor, coming to us from the Department of Statistics at the University of California, Berkeley.

Sly is an expert in discrete probability theory and its applications, focusing on the analysis of the mixing times of Markov chains—particularly the Glauber dynamics and the role phase transitions play in the computational complexity—and in probabilistic models more generally.

Sly has received numerous recognitions for his work, including the Wolfgang Doeblin Prize (2016), a Faculty Early Career Development (CAREER) grant from the National Science Foundation (2014–2019), the Rollo Davidson Prize (2013), and a Sloan Fellowship in mathematical sciences (2012).

Before joining the faculty at Princeton, he was an assistant professor (2011–2015) and associate professor (2015–2016) at Berkeley, where he also received his Ph.D. in 2009 under the supervision of Elchanan Mossel. He did his postdoctoral work in the theory group at Microsoft Research in Redmond, Washington.

## From the Chair

*Continued from previous page...*

I must report the loss of three long-time faculty: Professor Emeritus John C. Moore, Professor Emeritus Gerard Washnitzer \*50, and Professor John Mather \*67. John Mather's untimely passing cut short a very active research career. Please read the brief biographies on the following pages.

The primary research goal of Fine Hall is to address the most interesting, fundamental and challenging mathematical problems, find beauty and structure where it was not known to exist and to find new mathematical directions. Whether we are undergrads writing senior theses, graduate students, postdocs, instructors, assistant professors or long time senior faculty, we all share this common goal. Through our teaching and advising, our faculty strives to transmit their excitement, curiosity and understanding to our students and they in turn enliven Fine Hall with their energy and enthusiasm. We particularly value independence, so while we are extremely gratified when they become prominent researchers and outstanding teachers we are very happy when they passionately follow their own direction, even when it takes them outside of academic mathematics.

We greatly value and encourage excellent teaching. The Department bestowed graduate student teaching awards to Anibal Velozo and Charles Stibitz, and junior faculty teaching awards to Assistant Professors Nicholas Sheridan and Vlad Vicol. Our teaching was also recognized outside of Fine Hall. We are very proud that faculty Christine Taylor and Hansheng Diao were

*Continued on page 12...*



# Faculty Appointments

## Otis Chodosh

*Veblen Research Instructor*  
*Geometrical Analysis and PDEs*

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Otis Chodosh joins the department after a year as a Research Fellow at Cambridge University. He completed his graduate and undergraduate studies at Stanford, receiving his Ph.D. in 2015. Otis was an NSF Graduate Research Fellow at Stanford, and received that institution's Walter J. Gores Award for excellence in teaching.



## Ilya Khayutin

*Veblen Research Instructor*  
*Ergodic Theory, Number Theory*

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Ilya Khayutin completed his undergraduate and graduate degrees at Hebrew University in 2006 and 2016, respectively. In 2015 Ilya received the Springer Prize for Doctoral Students, in 2014 the Zochovitzky Prize for Excellence in Research, and in 2008 the Wolf Scholarship for an Excellent Master's Thesis.



## Evita Nestoridi

*Instructor*  
*Combinatorics, Probability*

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Evita Nestoridi received her Ph.D. from Stanford in 2016 and her bachelor's degree from the National and Kapodistrian University of Athens, Greece in 2011. At Stanford she received the Centennial Teaching Award and the Colleen and Robert D. Haas Graduate Fellowship.



## Konstantin Tikhomirov

*Instructor*  
*Discrete Mathematics*

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After his undergraduate work at Samara State University in Russia, Konstantin moved to the University of Alberta, where he completed his Ph.D. in 2016. There he received numerous prizes and fellowships, including the Faculty of Science Dissertation Award, and the Dean's Excellence Award. In 2010 he also received the Young Scientists Award from the Russian Government.



## Ziyang Gao

*Instructor*  
*Arithmetic Geometry*

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Ziyang Gao completed his Ph.D. in 2014 at Université Paris-Sud Orsay and Leiden University, Netherlands. He received the 2015 Stieltjes Prize from the Dutch Research School in Mathematics, awarded annually for the best Ph.D. thesis. After completing his doctorate, Ziyang spent time at CNRS in Paris and at the Institute for Advanced Study in Princeton before coming to Princeton.

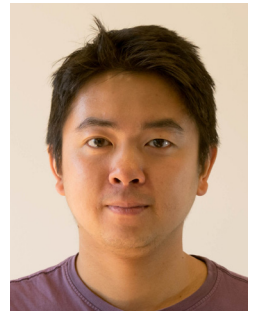


## Francesco Lin

*Veblen Research Instructor*  
*Gauge Theory, Topology*

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Francesco Lin received his Ph.D. from MIT in 2016 after his undergraduate studies at Università di Pisa in 2012. Francesco received the Johnson Prize at MIT for best published research by a graduate student, the MIT Praecis Presidential Fellowship, and the St. John's College (Oxford) exchange scholarship.

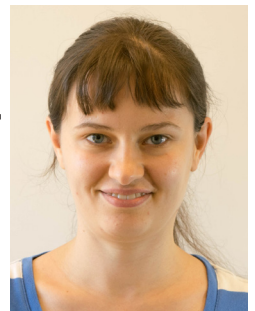


## Tatyana Shcherbyna

*Assistant Professor*  
*Analysis, Mathematical Physics*

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Tatyana Shcherbyna works in random matrix theory and statistical mechanics. Before coming to Princeton she was a member at the Institute for Advanced Study from 2015–2016 and 2012–2013, and a postdoctoral fellow at St. Petersburg State University.

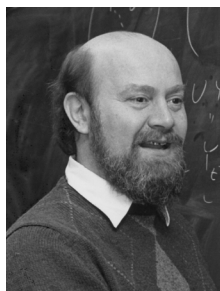


Tatyana received her Ph.D. in 2012 from the Institute for Low Temperature Physics, Kharkiv, Ukraine and her bachelor's degree in 2007 from V.N. Karazin Kharkiv National University, Ukraine.

She received the President of Ukraine award for young scientists (2011–2012), the JSC "Gazprom Neft" award for postdoctoral fellows (2014), and the Ahiezer's fond prize (2009).

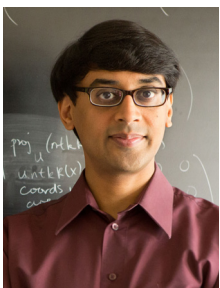
# Honors and Awards

## Michael Aizenman



has been elected a foreign member of Academia Europa and was named a fellow of the American Academy of Arts and Sciences.

## Manjul Bhargava



Credit: Denise Applewhite

was elected an honorary fellow by the Indian Academy of Sciences and was named a fellow of the American Academy of Arts and Sciences.

## Charles Fefferman



shared the 2017 Wolf Prize in Mathematics for his work in a number of areas, including complex multivariate analysis, partial differential equations, and sub-elliptical problems. He shares this prize with Richard Schoen of the University of California at Irvine.

## Peter Oszváth



has been elected a foreign member of the Hungarian Academy of Sciences for his work in the topology of 3- and 4-dimensional manifolds and his proof of the Thom conjecture with Professor Zoltán Szabó.

## Peter Sarnak



received an honorary degree from the University of St. Andrews at its June 2016 graduate ceremony.

## Amit Singer



has been named a National Finalist for the Blavatnik Awards for Young Scientists. The Blavatnik Family Foundation, with the guidance of the New York Academy of Sciences, founded the Blavatnik Awards for Young Scientists in 2007 to celebrate the innovative achievements of young post-doctoral and faculty scientists who work in New York, New Jersey, or Connecticut.

## Allan Sly



was awarded the Doebelin Prize from the Bernoulli Society for Mathematical Statistics and Probability. The Doebelin Prize "is awarded to a single individual for outstanding research in the field of probability, and who is at the beginning of his or her mathematical career."

## NSF CAREER Grants

Assistant Professors **Adam Marcus** and **Vlad Vicol** were awarded NSF CAREER grants. The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of early-career faculty.

## Sloan Fellowships

Assistant Professors **Nicholas Sheridan** and **Han Liu** (ORFE) were named Sloan fellows this year. The 2017 class of Sloan fellows in mathematics also includes **Wei Ho '09**, Assistant Professor at the University of Michigan; **Chi Li '12**, Assistant Professor at Purdue University; **Jonathan Luk '12**, Assistant Professor at Stanford University; and **Aaron Pixton '08 '13**, Assistant Professor at the MIT.

## Department Administration

### Chair:

**David Gabai**

### Associate Chair:

**János Kollár**

### Acting Associate Chair:

**Christopher Skinner**

### Directors of Graduate Study:

**Peter Ozsváth**

and **Javier Gómez Serrano**

### Department Representative:

**János Kollár**

### Acting Dept. Representative:

**Christopher Skinner**

### Assoc. Department Representative:

**Jennifer Johnson**

### Acting Assoc. Dept. Rep.

**Christine Taylor**

### Senior Advisor:

**Zeev Dvir**

### Junior Advisor:

**Mark McConnell**

### Placement Officer:

**Vlad Vicol**



# Honors and Awards

## Department Junior Faculty and Graduate Teaching Awards

The Department's annual teaching awards were announced at a special tea on Monday, October 10, 2016. This year's Junior Faculty Teaching Awards went to Assistant Professors Nicholas Sheridan and Vlad Vicol, and the Graduate Student Teaching Awards went to Charles Stibitz and Anibal Velozo. The awards are given by the senior faculty and are based largely on student evaluations.

Professor Sheridan's students have noted his clear, engaging lectures and have called him "an amazing professor" who "breaks the mold" and even "the best teacher [they] have ever had." Professor Vicol's students shared similar praise, noting that while fast-paced, his lectures were informative, challenging, and stimulating, and that he "welcomes questions" and is "always willing to help." As one of them put it: "The absolute best."



*From left: Stibitz, Vicol, and Velozo*

Though less experienced teachers, the graduate student recipients received no less appreciation from their students. Stibitz's students found him a funny and personable instructor with an engaging and authentic style; one wrote: "we all love Charlie. Math is math, but he makes it good." Velozo's students were inspired by his obvious passion for mathematics, finding his lectures well prepared and interesting. They were grateful to know that he really cared about helping them succeed and appreciated the work he put in to explaining complicated material.

## Hansheng Diao and Christine Taylor Honored with Excellence in Teaching Awards

Mathematics Department members Hansheng Diao and Christine Taylor were awarded the Excellence in Teaching Award by the Undergraduate and Graduate Engineering Student Councils on March 2, 2017.

This student-nominated award is for a professor or TA who "was especially dedicated, taught the material clearly, and simply deserves to be recognized for the hard work he or she put into the course." These awards are entirely student-run, and any professor or AI instructing an engineering, mathematics, or physics course is eligible.



*Diao (left) and Taylor at the annual Excellence in Teaching Awards*

## Anibal Velozo Receives Graduate School Teaching Award

Anibal Velozo, a fourth year graduate student, was one of ten recipients of the 2017 Graduate School Teaching Award.

Every year the Graduate School presents graduate students who have demonstrated excellence in teaching at the undergraduate level with the prestigious Teaching Award. By providing exceptional service as an assistant-in-instruction, these individuals have emerged within their programs and departments as outstanding classroom leaders and scholars. This year's award recipients were selected by a committee chaired by the dean of the Graduate School and comprised of the academic affairs deans and staff from the McGraw Center for Teaching and Learning from a pool of nominees put forth by departments and programs. We recognize their distinguished achievement and thank them for their hard work and dedication.



# Faculty Memorials

## Professor John Mather \*67, 1942–2017

By Morgan Kelly, Office of Communications

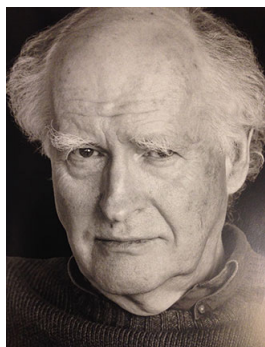


Photo by Mariana Cook, "Mathematicians: An Outer View of an Inner World"

Professor of Mathematics John Mather, remembered as a "great mathematician" with a reserved and pleasant demeanor, died Jan. 28 of complications from prostate cancer at his home in Princeton. He was 74.

Mather specialized in differential topology and dynamical systems. After receiving his Ph.D. in mathematics from Princeton in 1967, Mather, as an associate professor at the Institute of Advanced Scientific Studies in France, soon distinguished himself when he proved a conjecture by renowned French mathematician René Thom. Mather and Thom went on to develop the Thom-Mather isotopy theorem, one of many influential theorems in topology and dynamics that bear Mather's name. Others include the Mather-Thurston theorem and the Aubry-Mather theory.

Professor Charles Fefferman knew Mather since they were both graduate students at Princeton in the 1960s. While they did not study the same field, Fefferman followed Mather's work and appreciated his exceptional talent, he said.

"Most mathematicians feel about math the way musicians feel about music — when we encounter a masterpiece, it's a great privilege," Fefferman said.

"He was a great mathematician. If you were not well enough informed in math to know how much he had done, there was no clue from his behavior that he was a great man. He was modest and self-effacing," he said. "Because of his introverted personality, one had to work hard to talk about John's work with him. It was an effort amply repaid, but you had to put in the effort. I'm very happy to have put in the effort."

Vadim Kaloshin, a professor of mathematics at the University of Maryland who was Mather's graduate student, recalled weekly meetings with Mather at which they would freely share ideas and insights. During one session, Mather made a comment that became the crux of Kaloshin's Ph.D. thesis wherein he solved a 30-year-old conjecture posed by American mathematician Stephen Smale.

"His questions and comments pushed me toward the solution to this conjecture. He made an important comment that later became a central part of my thesis," said Kaloshin, who received his doctorate from Princeton in

2001. "Once he started talking, it was very interesting because he was extremely knowledgeable. He also would be willing to listen, which to me is a great quality."

"His death is a big loss for our community worldwide because he was one of the leaders in this field," Kaloshin said. "He leaves a big void."

Mather received numerous awards for his work, including the Birkhoff Prize in Applied Mathematics from the American Mathematical Society (2003); a Guggenheim Fellowship (1989); the John J. Carty Award from the National Academy of Sciences (1978); and a Sloan Fellowship (1970). Mather also was a member of the American Mathematical Society and the National Academy of Sciences, among other organizations.

Mather is survived by his wife, Naomi Mather, and children Mara Mather (Noah Mercer) of Los Angeles; Thomas John Mather '99 (Karen Madsen) of Boston; and Frank Mather and Emily Mather of Princeton.

Mather (left) with his father, Norman Mather, a professor of electrical engineering. They became the University's first father-son professors since 1932.



# Faculty Memorials

## Professor Emeritus John C. Moore, 1923–2017

By Morgan Kelly, Office of Communications

Professor Emeritus John C. Moore, described as a committed and influential mathematician, died Jan. 1 in Rochester, New York. He was 92.

Moore joined the Princeton faculty as an instructor in mathematics in 1952 before being named an assistant professor in 1954. He became a full professor in 1961 and was named co-chair of the Department of Mathematics in 1962 before retiring from Princeton in 1989.

Moore specialized in algebraic topology and had many important concepts named after him, including the Borel-Moore homology published in 1960, and



the Eilenberg-Moore spectral sequence published in 1962. In 1965, he published his most cited paper, which pertained to Hopf algebras, with renowned mathematician and Stony Brook

University mathematics professor John Milnor, who received his bachelor's and doctoral degrees in mathematics from Princeton in 1951 and 1954, respectively, and served as a Princeton professor of mathematics from 1960 to 1967.

Peter May, a University of Chicago professor of mathematics and graduate student under Moore in the early 1960s, said that his former mentor belonged to a "great generation" of mathematicians, many of them algebraic topologists, who were hugely influential.

Moore brought deep algebraic structure to algebraic topology, May said. His work reflected his profound and constant thinking about mathematics, May said. Moore would ruminate on mathematical problems even if he were in the middle of another task. May recalled that if Moore made a mistake or got stuck during a class, he would stop everything and silently ponder the error until the correct answer came to him. So deep was he in thought that Moore never recalled these instances afterward, May said.

Moore was born May 27, 1923, in New York City. He was a National Science Foundation Fellow from 1953 to 1955 and chair of the United States Commission on Mathematical Instruction from 1960 to 1962. Moore is survived by a niece, Jennifer West, and nephew, Jeff West.

## Professor Emeritus Gerard Washnitzer \*50, 1926–2017

By Morgan Kelly, Office of Communications



Photo by Jack Turner

Gerard Washnitzer, professor of mathematics, emeritus, known for his work in algebraic geometry and lively personality, died April 2 in hospice in Scotch Plains, New Jersey. He was 91.

Colleagues and family recalled Washnitzer as an avid reader who loved history as much as mathematics — particularly the history of mathematics. He ex-

ercised his extensive knowledge on topics in spirited yet friendly debates, and by pushing his students intellectually.

"Gerry was always very much interested in the history of mathematics, somewhat unusual among real mathematicians, and he taught the rather rare history of mathematics courses in the department before he retired," said Robert Gunning, a Princeton professor of mathematics.

Washnitzer received his Ph.D. in mathematics from Princeton in 1950 and joined the Princeton faculty as a professor of mathematics in 1963.

Washnitzer's quick mind and exuberance also came out in his role as an educator, Gunning said. "His lectures were memorably wild, with some notable digressions when he was struck by a different idea or an alternative approach to a problem," he said.

Washnitzer was married to Lilian Noble née Berg, who escaped from Belgium in 1941, from 1953 until her death Jan. 23. Washnitzer is survived by his sons George Noble and Bernard Noble of New York City, and James Noble of Summit, New Jersey, and by seven grandchildren.



# Women and Mathematics

## Princeton-IAS Program for Women and Mathematics

By Christine Taylor

Each May, about 40-60 undergraduate, graduate, and postdoctoral women studying mathematics from institutions all over the country gather on the campus of the Institute for Advanced Study in Princeton for an intensive residential mentoring program. The two-week Program for Women and Mathematics is generously sponsored by the NSF, IAS, and Princeton Mathematics department. The program aims to inspire talented women from undergraduate through doctoral levels to achieve their educational and career goals, as well as to address the isolation and lack of support many women face in mathematics.

Research mathematicians such as Professor Maria Chudnovsky '03 and Wei Ho '09 are recruited to give lecture series and colloquia which focus on a particular mathematical theme of current research each year. Some topics in recent years are "Combinatorics and Graph Theory (2013)", "Random Matrix Theory (2014)", "Aspects of Algebraic Geometry (2015)", "Curves, Loops, and Words in Geometry (2016)", "Geometry and Randomness in Group Theory (2017)".

In addition to lectures and seminars, evening Women in Science seminars explore topics of interest to women mathematicians. Some popular topics include "Work-Life Balance in a Mathematical Career", "Surviving in Graduate School", "Career Paths for Women in Mathematics", "Becoming an Academic Mathematician".

In the middle of the two-week

program, participants spend a day in Fine Hall to hear lectures given by Princeton faculty members. Lunch and dinner in the Professors' Lounge are highlights of the day where participants enjoy meeting Princeton graduate students, postdocs, and faculty as well as the spectacular view from the top of Fine Hall.

Last May, Princeton alum Carlee Joe-Wong '11, current graduate student Sophie Spirkl, and Professor Zoltán Szabó talked about their work in network behavior, graph theory, and knot theory respectively. Lillian Pierce '02 '09 shared her experiences building support networks for women mathematicians throughout her career.

This May, new instructor Evita Nestoridi, Assistant Professor Adam Marcus, and Professor Assaf Naor will each give expository talks on their work. In addition, there will be a two-hour computing workshop to instruct participants on the use of GAP (Groups, Algorithms, and Programming) software for computations in group theory.

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## The Noetherian Ring

The Noetherian Ring is an informal organization for the Princeton Mathematics Department's women at all levels, from first year undergraduates to senior faculty. It offers opportunities for female mathematicians to interact with one another in many different forums, with the goal of building networks of support.

The Mathematics Department and the Noetherian Ring host a luncheon in the fall to welcome first-year students in MAT203, 215, and 216, and a luncheon in the spring to welcome sophomores who are likely math majors. These luncheons are well attended by math majors, graduate student, postdocs, and faculty members, who share their experiences and perspectives with one another. In addition, since spring 2017, female graduate students, postdocs, faculty, and visiting mathematicians meet regularly over a casual buffet dinner at the IAS to bond socially and mathematically.

*Graduate and undergraduate students enjoy lunch in the Professors' Lounge as part of the Noetherian Ring*





# The Minerva Program

## The Minerva Program: Shmuel Weinberger and Maryna Viazovska

This year Shmuel Weinberger came to Princeton as our Minerva Distinguished Lecturer and Maryna Viazovska joined us as our Minerva Distinguished Visitor.

In the fall Weinberger, the Andrew MacLeish Professor of Mathematics at the University of Chicago, delivered a series of three Minerva Lectures on "Episodes from Quantum Topology". These talks focused on the questions of how effective are solutions of topological problems, and in particular, how large solutions to geometric topological problems are with various measures of complexity.



*Weinberger*

In the spring, Maryna Viazovska joined the department as our Minerva Distinguished Visitor. During her month at Princeton, Viazovska delivered a series of four talks on "Solving packing problems by linear programming." The sphere packing problem asks which biggest portion of the euclidean  $d$ -dimensional space can be covered by non-overlapping unit balls. In most dimensions  $d$  this question is believed to be an extremely difficult combinatorial geometric problem. Viazovska explained the surprisingly simple solutions to this problem in dimensions 8 and 24 based on linear programming bounds.



*Viazovska*

## Program for Women and Mathematics

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Over two weeks, women mathematicians from all levels learn, work, and socialize together in a supportive environment. Mathematical bonds are often created between senior mathematicians and graduate students/postdocs. Past participants overwhelmingly report that they feel inspired and encouraged by the women they meet during the program, and that the program is a vital opportunity to reinvigorate their studies and research. Many student participants return to the program in subsequent years as teaching assistants, lecturers, and colloquium speakers.

Since 1994, over 1,000 women mathematicians

have visited Princeton as part of the Women and Mathematics program; about 70% have remained in academia. Over the 8-year period 1999-2006, the average Ph.D. completion rate for WAM undergraduate participant alum is 64.6%, while the average Ph.D. completion rate for WAM graduate participant alumnae over the 10-year period 1999-2008 is 79.8%. For comparison, the 10-year completion rate for a mathematics Ph.D. is 51% for both genders. The program alumnae who have benefitted from their experience at the Women and Mathematics Program will help us to continue to strengthen the program for future women mathematicians.

# Extracurricular Activities

## Scribble Naturally: Using Technology to Enhance Collaboration

By John Stogin '11 \*17



Can tablets help us solve mathematical problems at the research level? What about computers? I think so, and here's why.

Together with some other Princeton stu-

dents, we have been talking to many people—mostly mathematicians and scientific researchers—to learn why they are still uncomfortable using technology for their scratch work. The cool thing is we identified some ways to make it easier for mathematicians to transition to computers (especially tablets) for developing and communicating our mathematical ideas with one another. Using the ideas we learned, we started the Scribble Naturally project.

Just to emphasize what computers have to offer, consider how computers helped the novelists. In the day of the typewriter, the novelists had to think carefully before writing things down on paper. But today, anyone can instantly type any idea that comes to mind in a word processor, then they can cut and paste as they iterate towards a better paragraph. It's very freeing. But when it comes to equations and diagrams, we're still stuck with pen and paper—the mathematician's typewriter.

The Scribble Naturally project website is currently in a beta testing stage, but feel free to try it out. Through this project, we hope to replicate the experience of two (or more) people standing in the same room and working on

the same chalkboard, so collaborative research can take place even between colleagues who aren't able to meet in person.

At the most basic level, our website supports real-time collaborative drawing (like Google docs, but for handwritten equations and diagrams) with embedded voice and video calling. It also supports uploading and exporting PDF documents that can be annotated on-screen. For users

we need to hear other researchers want. Besides peer-to-peer collaboration, other possible applications include recording and posting solutions to problems, hosting a course question-and-answer forum, giving lectures with a tablet, holding remote seminars between multiple universities, and digitally organizing personal notes and scratch work. We are looking to talk to more students and researchers, especially at different universities, to learn how this proj-

### A.2 Higher order elliptic estimates

In this subsection, we prove Lemma A.3, which controlling angular derivatives. As a first step, we the standard spherical Laplacian.

#### Lemma A.2

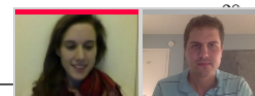
$$\int_{S^2(1)} |\nabla^{2k} u|^2 + \int_{S^2(1)} |\nabla^{2k-1} u|^2$$

**Proof** This in fact holds for any closed manifold sufficiently regular Riemann curvature.

Throughout the proof, all integrals are taken over as they can be determined by contracting over ind term. For example,

$$\nabla^3 u \cdot \nabla^3 u = g^{\alpha_1 \beta_1} g^{\alpha_2 \beta_2} g^{\alpha_3 \beta_3} \nabla_{\alpha_1}$$

The proof for the case  $k = 1$  is well known, version of the procedure for general  $k$ .



*Scribble Naturally allows collaborators to video chat while working on a digital canvas in real time.*

without a tablet, it has a camera scan feature that can convert paper drawings or printed equations into digital markings with the background removed. Although our website is designed to be useful for mathematicians without a writing tablet, we are also working on a tablet companion app to help those who do have writing tablets to make the most use of them. As our project name suggests, we want to support any mechanism through which people draw naturally.

There are a lot of directions we could go with this project, and

ect can provide an ideal experience for them. If you found this article interesting, please contact me at [jstogin@math.princeton.edu](mailto:jstogin@math.princeton.edu). I would love to hear from you.

Try Scribble Naturally at: [www.scribblenaturally.com](http://www.scribblenaturally.com)

*John Stogin defended his dissertation, "Nonlinear Wave Dynamics in Black Hole Spacetimes", advised by Professor Sergiu Klainerman, this April. Next year, in addition to developing the Scribble Naturally project, he will start work at Radix Trading.*



# Alumni Profile

## Musings of a Mathematical Mom: Life After Princeton

By Sasha Fradkin \*11

After getting my Ph.D. from Princeton, I worked for 5 years as a research mathematician at the Center for Communications Research in Princeton.

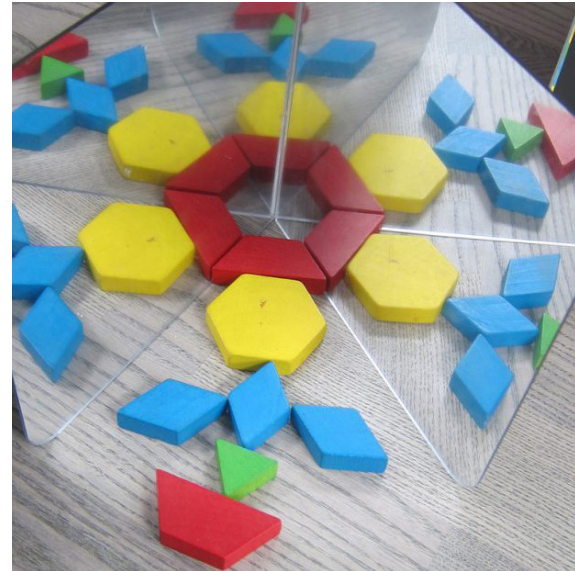


About 4 years ago, when my daughter was 4, I started doing fun enrichment math with her. Around the same time, I began blogging about our math adventures on a blog I entitled *Musings of a Mathematical Mom*. Shortly after I started doing math with Katie, she was joined by a friend, and not long after that I began teaching several larger groups

of kids at the Golden Key Russian School. I quickly became fascinated with just how much one can do with such small children, with how creative and profound their questions can be, and how many deep concepts they could appreciate if they were presented

to them in an age appropriate way. And of course I continued blogging about it all.

A little less than a year ago, I was presented with an exciting and unique opportunity to develop an innovative elementary school curriculum and teach it to small groups of students. Since September, I have worked as the Head of Math at the Main Line Classical Academy, teaching students in grades Kindergarten, 2nd, and 3rd. Some of my goals are 1) to show students that math is about exploration, discovery, and looking for patterns, and not about memorization of facts and formulas. 2) To teach/encourage students to think, reason, notice and wonder. 3) To show them that math is much more than just arithmetic and to give them glimpses of many different areas of



*Sasha's blog covers fun ways to introduce mathematical concepts to children, e.g., using mirrors to create symmetrical shapes*

*Sasha's upcoming book, Funville Adventures, will be published by Natural Math later this year.*



math. 4) To show that math is a human endeavor and to teach it with historical perspective.

Also shortly after I began doing math with Katie, inspired by her love for stories, I started working on a children's fantasy story with interwoven math concepts. This project turned into a book called *Funville Adventures*, co-authored with fellow Princeton undergraduate Allison Bishop, that will be published by Natural Math later this year. The book is a math-inspired fantasy adventure that introduces young children to the concept of mathematical functions; the functions are personified by magical beings with powers.

Visit Sasha's blog, *Musings of a Mathematical Mom*, at:  
<https://aofradkin.wordpress.com/>

# Undergraduate Program

## Putnam Competition

Each year the department fields one or more teams in the William Lowell Putnam competition. This year, the competition's 76th, Princeton's team of Eric Schneider, Alex Song, and Xiaoyu Xu won 2nd place.

Eric Schneider and Murilo Zanarella earned N1 distinction (6th-14th place), and sophomore Simona Diaconu won the Elizabeth Lowell Putnam Prize as the highest ranking female contestant.

We also have seven honorable mentions this year: Rodrigo Angelo, Andre Arslan, Simona Diaconu, Eric Neyman, Mel Shu, Xiaoyu Xu, and Roy Zhao.

## Department Awards

2015-2016 Academic Year

### George B. Covington Prize

Arka Adhikari '16

Daniel Nelson Dore '16

### Middleton Miller '29 Prize

Yuval Wigderson '16

Elizabeth Yang '16

### Andrew H. Brown Prize

Daniel Siyan Li '17

Peter Park '17

### Peter A. Greenberg '77 Prize

Iason Kountouridis '17

Joseph Obiajulu '17

### The Class of 1861 Prize

Xiaoyu Xu '18

## From the Math Club:

By Jenny Kaufmann '18

Hello from your undergraduate Math Club president! This year Math Club hosted a variety of events, including weekly colloquia for undergraduate audiences, the traditional biweekly Board Game Nights, Meet Your Professor dinners in which students can talk to professors in a social context, and the Mentoring Mobius peer mentorship program. We also hosted the annual Pi Day celebration (complete with a dozen pies), as well as the end-of-year dinner in May, which provides students with the rare opportunity to socialize in the Professors' Lounge.

The Math Club continues to assist with the Mercer County Math Circle, a program open to all mathematically inclined high school students. At this program, Math Club members teach lessons on interesting topics of their choice. This past fall, many Math Club members became involved with MathReach, a new Pace Center-affiliated outreach program which partners with a Trenton high school to broaden access to enrichment math to a more diverse array of students. Through MathReach, volunteers visit classes and teach lessons in recreational math topics such as Pascal's Triangle or mathematical games and puzzles.

In that spirit, here is a puzzle for your enjoyment:

### *The Chocolate Bar.*

I have an  $n$  by  $m$  rectangular chocolate bar and want to break it up fully into  $nm$  mini bars. What is the minimum number of breaks needed to accomplish this? What is the maximum?

## From the Chair

*Continued from page 2...*

awarded the Excellence in Teaching Awards by the Undergraduate and Graduate Engineering Student Councils, and that Anibal Velozo received the Graduate School's Teaching Award.

I thank Igor Rodnianski for serving as Acting Chair last year while I was on leave at the IAS. From overseeing the renewal of the faculty, to initiating the refurbishment of Fine Hall, to hosting events, he was outstanding.

Finally it is my pleasure to thank Bob and Luisa Fernholz, the Class of 1971 Fund, and Michael '91 & Victoria Bershadsky for their very generous and ongoing support of our Department. Their support of faculty, students and department activities has made a huge difference.

I continue to be amazed by the faculty, students, and staff in our Department. It is both inspiring and humbling to see the next generation of mathematicians develop and grow. Thank you for reading this newsletter and reconnecting with the Department. I'd love to hear your thoughts and views.

David Gabai \*77,\*80  
gabai@math.princeton.edu



# Graduate Program

## Graduate Profile: Medhi Yazdi

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I worked on geometric topology during my Ph.D. My thesis is about foliations where I have constructed counterexamples to a conjecture of Bill Thurston, my academic

grandfather. Next Fall, I will go to the University of Oxford where I will be a Glasstone Fellow.

I grew up in Iran and finished my undergraduate studies at Sharif University of Technology in Tehran. I like painting and also playing soccer. I guess that my love for topology and geometry and my passion for painting and visual arts stem from the same source. We had a soccer team in the intramural games named FC Fine, after Fine Hall. We used to play as FC Fine for the past three years and FC Fine even won the tournament in the university once. I hope this tradition continues as new students enter the program. Surely Princeton has a lot to offer mathematically, but in my personal experience, the lovely people that I met in this town are even more valuable. I will certainly miss my friends, my advisor, Jill — the graduate administrator who always takes care of us — and Wilhelmina who is our lovely company for the afternoon chat over coffee.

## Director of Graduate Studies: Peter Ozsváth

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Princeton is a unique place to pursue graduate studies. The primary focus of the graduate program is to train leading researchers in mathematics, putting as few hurdles as possible along the way. Of course the students work closely with their advisors, who are top mathematicians; but what I think is special about our department is the relationships between the students, who often work very closely with one another, whether it is to prepare for their generals, follow our research-level courses, give expository talks, or to actually engage in joint

research projects. The bonds that form in this program are strong and, as I can attest after having graduated from here myself in 1994, span decades.

This year was a particularly successful one for graduate student recruiting. The entire department came together to this very important end. Starting in December, a committee of seven professors went through the roughly 350 applications, consulting with their colleagues along the way. In January, the full senior faculty met to go through the top files to make the final admission decisions. Faculty members then contacted students in their areas to provide information about research and mathematical life at Princeton. Jill LeClair went through the daunting task of organizing what turned out to be a very successful open house for our prospective graduate students. During this event, many students and faculty presented their work, both formally and informally, to the prospective students who came from around the world. At the end, we exceeded expectations, admitting a class of 24 graduate students!

The job of a Director of Graduate Studies (DGS) is a pleasant and easy one: typically, I meet with many interesting students, who are happily pursuing their dream of becoming a mathematician. When problems arise, students can turn to me for advice, or they can turn to my fellow DGS, Javi Gómez Serrano, who is reliable and organized, but more importantly very approachable and friendly. Jill LeClair, our graduate administrator, is an invaluable resource both for us and for the students. She goes far beyond the call of duty to make sure that the life of graduate students is as pleasant as possible, whether it is by organizing various aspects of student life, lending an ear to students with professional or personal problems, or by organizing our spectacular Spring Recital, which gives our students and faculty a non-mathematical outlet for their talents. I write this the day after the recital, with the sounds of the music still reverberating, looking forward to greeting our new incoming class next year!

# Most recent Ph.D.s

Name	Undergrad	Advisor	Field	Thesis Title	Original Placement
<b>Maria Avdeeva</b>	Moscow State University	Sinai	Dynamical Systems	Limit theorems for B-free integers and the Moebius function	Queen's University, Ontario/Postdoctoral Fellow
<b>Nathan Dowlin</b>	Yale University	Szabó	Low-Dimensional Topology	Khovanov-Rozansky complexes in the knot floor cube of resolutions	Columbia University/ <b>NSF Postdoctoral Research Fellow</b>
<b>Will Sawin</b>	Yale University	Katz	Number Theory	A Tonnakian category and a horizontal equidistribution conjecture for exponential sums	Institute for Theoretical Studies, ETH Zürich/Junior Fellow
<b>Naser Talebizadeh Sardari</b>	Sharif University of Technology	Sarnak	Number Theory	Optimal strong approximation for quadratic forms	University of Wisconsin, Madison/Postdoctoral Research Fellow
<b>Linh My Truong</b>	University of Pennsylvania	Ozsváth/ Szabó	Low-Dimensional Topology	Applications of Heegaard floor homology to knot concordance	MIT/NSF <b>Postdoctoral Research Fellow</b>
<b>Xuecheng Wang</b>	Peking University	Ionescu	PDEs and Fluid dynamics	Global solutions for the gravity water waves system: infinite depth setting and flat bottom setting	Princeton University/Researcher
<b>Xiu (Chris) Yang</b>	University of Michigan, Ann Arbor	Ozsváth	Low-Dimensional Topology	Elliptic involution in bordered Heegaard floor homology	KCG Holdings/ Quantitative Strategist
<b>Ruobing Zhang</b>	Yantai University	Chang/ Yang	Geometric Analysis	Regularity, quantitative geometry and curvature bounds	Stony Brook University/Simons Instructor

## Waterman Award

*Continued from page 1...*

The Waterman Award is given to at most two recipients each year, and the pool of candidates spans all science and engineering fields. Since its inception in 1976 (the inaugural award went to Professor Charles Fefferman \*69), only seven of 44 Waterman Awards granted to date have gone to mathematicians. Of those seven, six have strong connections to Princeton.

Four of these seven were Princeton faculty at the time of their award: Charles Fefferman, Pardon, Bill Thurston, and Ed Witten \*76 (Physics); Gang Tian joined our faculty after receiving the Waterman Award.

Also of note is that of the seven mathematicians to receive Waterman Awards, Fefferman, Pardon, Witten, and Terence Tao \*96 are Princeton alumni.



# Administrative staff changes

## Scott Kenney: 30 Years of Dedicated Service



Scott Kenney in 1989

My first day in the Math Department was in December 1986 and, while it doesn't seem like yesterday, it doesn't seem like it was 30 years ago, either. In those days I had thick brown hair and two young children (one a toddler). This year—on February 27th—I stood in front of the crowd of people assembled at the lovely Tea the Department was holding for me as a way for me to say good-bye to “my” department.

It is with leaving that I think of those who came before me and the many people I've come in contact with over the years. I replaced the irreplaceable Virginia (Santowaso Nonziato) Dzurkoc—Ginny to all who knew her—after 44 years of service—and quickly realized that I had some catching up to do. Twenty-five years later, I would step down as the Department Manager and semi-retire in a position that allowed me to handle the practicalities of seven conferences in one year and serve. My replacement was Kathleen (Kathy) Applegate, whose energy is only matched by her big heart as she handles the many challenges of being Department Manager. Kathy was gracious enough to put up with having her predecessor with her for four years and kind enough to make me continue to feel valued and appreciated.

I tried to come up with some statistics for my years in the Department and realized that I'd worked with

*Scott shares stories after being named an Honorary Faculty Member at a special tea in his honor.*



10 chairs since 1986 (and two acting chairs). I had my hands on the appointment forms of Fields Medalists and world-famous mathematicians from all over the world. I prepared the appointment papers for probably 200 junior faculty members and virtually all of the senior faculty members hired since 1986. I dealt with visa issues, housing issues, childcare issues, and managed to make lots of friends along the way. I handled the practical arrangements for countless mathematical conferences and remember vividly my first: Eli Stein's 60th birthday celebration, which attracted mathematicians from all over the world and served as such a tribute to the wonderful man who hired me. (Eli Stein was coming to the end of his second stint as chair in 1986.) One of the later conferences I would work on would be to honor Eli Stein for his 80th birthday, too. Conferences became like old home week and I enjoyed the opportunity to catch up with those former students who had found their way in their professional lives since their days as graduate students in Fine Hall.

It was not always an easy job nor did I appreciate all the challenges that came my way. At the end of the day—at the end of my career—it's all about the people. The people are what matters. The Princeton Mathematics Department has been my biggest supporter and advocate. I can't begin to thank them for what they have given me and, as I gaze out the front porch of my new house overlooking the mountains and the bays of rhododendron that seem to be everywhere, I will be perpetually grateful for my 30 years in the Math Department and for all the people: the faculty, students, and staff, who brought so much pleasure to my life.

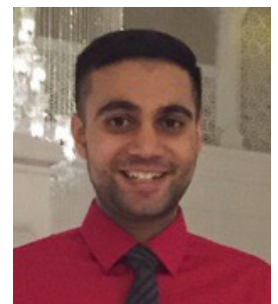
## Ankit Tak

*Department office support*

Ankit joined the department in our new support position this February.

Ankit is originally from New York, and received his B.S. in International Business and Finance from Rider University in 2013.

In his spare time, Ankit enjoys travelling, noting that "travel is about finding those things you never knew you were looking for."





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Alumni, faculty, students, friends, connect with us, write to us at  
[news@math.princeton.edu](mailto:news@math.princeton.edu)

**Annual Alumni Reception**  
Friday, June 2, 2017  
Fine Hall Common Room, third floor  
2:00 pm — 3:30 pm

**Join us for fun, refreshments, and maybe even some math!**

*This year's Department Recital was our largest yet, featuring 20 musicians from the Math Department, other University departments, and the IAS. From left: Professor Clancy Rowley (MAE), Senior Lecturer Mark McConnell, Professor Emeritus William Browder; Yuchen Liu \*17; and Evan O'Dorney (G1)*

