Northwestern
WEINBERG COLLEGE OF **ARTS & SCIENCES**
Department of **Mathematics**

From the Chair

Paul Goerss, Department Chair

The department here at Northwestern University is a rich and diverse community, working together to study and teach mathematics. All of us contribute, each in his or her own way, to the overall project. We are a welcoming group, with an incredibly rich slate of visitors, special lectures, and any number of conferences. It is also an ever-changing and ever-renewing community. One of the great benefits to being Chair of the department is that I get to meet and get to know all these remarkable people. Here's some news about some of them.

Our research faculty had a remarkable year, recognized in many ways. Aaron Naber was awarded a 2018 Breakthrough Prize, one of the "Oscars of Science," celebrating top achievements in physics, life sciences and mathematics. These prizes are sponsored by Silicon Valley elites, including Facebook's Mark Zuckerberg and Google's Sergey Brin. The Summer of 2018 brings us the International Congress of Mathematicians in Rio de Janeiro; this quadrennial event includes talks highlighting the best work of the past four years, and this year Northwestern mathematicians Laura DeMarco, Mihnea Popa, and Emmy Murphy will all give lectures. Last, but by no means least, both Emmy Murphy and John Francis have been promoted to Associate Professors with tenure, a real mark of their contributions
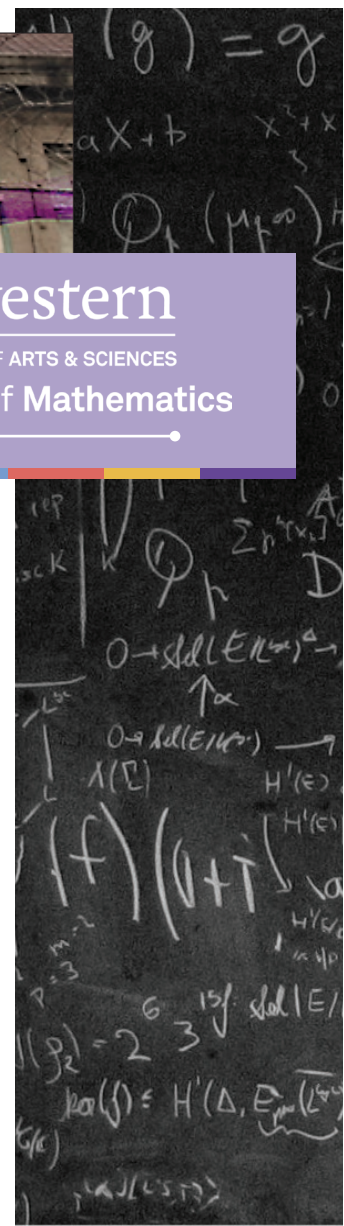
to the department, the University, and the profession.

Great research mathematicians visit us all the time, both in our weekly seminars and in more exceptional events. Every two years Northwestern awards the Nemmers Prize in math, a prestigious honor given for path-breaking mathematics. This spring, the 2016 winner, János Kollár from Princeton is in residence, and we also announced the 2018 winner, Assaf Naor, also from Princeton. Professor Naor works in analysis and geometry. We also have two prestigious lecture series each year: Maciej Zworski from Berkeley was the Bellow lecturer and Ulrike Tillmann of Oxford University was the Pinsky lecturer.

Lectures don't need to be entirely about research. In the fall we had the third GROW conference designed to introduce undergraduate women to life as a graduate student. This conference has emerged as a permanent feature of the mathematics year, but we never intended it to be permanently at Northwestern. Next year it will move to the University of Michigan. This coming summer there is also a training conference for graduate students in Probability, sponsored our NSF Research Training Grant.

Another extremely important group for us is the postdocs, who are typically here for three years right after they earn their Ph.D. There are about a dozen Boas Assistant Professors—the research postdocs—and perhaps three or four Postdoctoral Lecturers, whose primary mission is teaching. They are vital members

Newsletter

Photos left to right: Tuca Auffinger at GROW 2017; (left to right) Tuca Auffinger, Ingrid Daubechies, Emmy Murphy (holding mic), Benjamin Antieau, and Bryna Kra at GROW 2017; Aaron Naber at the 2018 Breakthrough Prize Awards

Department News

2018 Frederic Esser Nemmers Mathematics Prize Recipient

The 2018 Nemmers Prize in Mathematics has been awarded to **Assaf Naor** of Princeton University for his profound work on the geometry of metric spaces, which has led to breakthroughs in the theory of algorithms. The selection committee was **Jared Wunsch** of Northwestern University, **Akshay Venkatesh** from Stanford, and **Mikhail Lyubich** from Stony Brook.

Mathematics Faculty Win 2018 Linzer Grant

For the second year in a row, faculty of the Mathematics Department have been awarded a Daniel I. Linzer grant to promote equity and inclusion. This year the award went to Professors **Zaslow**, **Alongi**, **Cañez**, **Kra**, and **Onnie Rogers**, from Psychology, for the Causeway Postbaccalaureate Program. Last year the award went to Professors **Kra**, **DeMarco**, **Getzler**, and **Goerss** for the Graduate Research Opportunities for Women (GROW) workshops.

Northwestern mathematician wins award at 'Oscars of Science'

Northwestern University mathematician **Aaron Naber** was among several awardees of the 2018 Breakthrough Prize, the so-called "Oscars of Science," which celebrates top achievements in physics, life sciences and mathematics and is sponsored by Silicon Valley elites including Facebook's **Mark Zuckerberg** and Google's **Sergey Brin**.

Aaron Peterson Receives Arts and Sciences Alumni Teaching Award

Director of Calculus at Northwestern University, **Aaron Peterson,** has won the 2018 Arts and Sciences Alumni Teaching Award in Weinberg College of Arts and Sciences. Prof. Peterson previously received the 2016 Departmental Excellence in Teaching Award.

Faculty Invited to Speak at the 2018 International Congress of Mathematicians

Professor **Laura DeMarco**, **Emmy Murphy**, and **Mihnea Popa** have been invited to speak at the International Congress of Mathematicians in Rio de Janeiro, August 2018.

Mathematics Undergraduate Alumni awarded a fellowship by the Knowles Teacher Initiative.

Nina Ozdemir, mathematics alumni of the class of '07, was chosen by the Knowles Teacher Initiative as a member of its 2017 Cohort of Teaching Fellows awarding promising high school mathematics teachers early in their careers.

Faculty win Gold Prizes for their papers from the International Congress of Chinese Mathematicians.

Tuca Auffinger and his coauthor **Wei-Ku Chen** authored a paper on "The Parisi measure has a unique minimizer" in Communications in Mathematical Physics. **Gang Liu** authored a paper on "Gromov-Hausdorff limits of Kaehler manifolds and the finite generation conjecture" in the Annals of Math.

Incoming Faculty

Bao V. Le Hung
Associate Professor

Bao Le Hung is interested in the geometry of moduli spaces of Galois representations. These spaces appear to have many fascinating connections to diverse areas of mathematics such as geometric representation theory, modular representation theory, and automorphic forms, and are crucial to understanding Langlands reciprocity and its mod p and p-adic variants. Bao received his PhD. from Harvard University in 2014, was a Postdoctoral Fellow at the Mathematical Sciences Research Institute (MSRI) in 2014, and was an L.E. Dickson Instructor at the University of Chicago from 2014-2017. Before arriving at Northwestern, Bao was a member of the Institute for Advanced Study (IAS) from September 2017 to the present. Bao also enjoys listening to classical music.

Aaron Greicius
Associate Professor of Instruction

Aaron Greicius did his undergraduate work at Columbia University, New York and received his Ph. D. in mathematics from U.C. Berkeley in 2007, where he worked under the supervision of Bjorn Poonen. From 2008-2011 he held a German Research Foundation (DFG) research postdoc at Humboldt-Universität in Berlin, Germany. His research interests lie within number theory and arithmetic geometry. In particular he is interested in families of l-adic Galois representations arising from abelian varieties and modular curves. Dr. Greicius has been a member of the faculty at Loyola University Chicago from 2011-2018.

From the Chair

of the department, but by the very nature of these positions, these mathematicians are with us for only a few years. We are always a little sad to see them go, but we take delight in their success: for example, Qiang Zeng, Martha Precup, and Xin Jin will be going to tenure-track research positions, and Silas Johnson will leave us for a permanent teaching-track position.

Teaching is equally part of the profession, and we have a very strong group of Professors of Instruction, greatly enhancing our undergraduate program. Santiago Cañez and Eugene Kushnirsky were both promoted to Associate Professor of Instruction this spring. Aaron Peterson has now fully taken over as Calculus Director next fall and is leading a two-year project to revisit and thoroughly revise our core curriculum. John Alongi has replaced the newly retired and sorely missed Mike Stein as our Director of Undergraduate Studies. Many of you surely met John as an instructor or as Director of MENU, and I'm sure you'll agree with me that he is just the person for this important leadership position.

Photo Gallery

> "The department here at Northwestern University is a rich and diverse community, working together to study and teach mathematics."
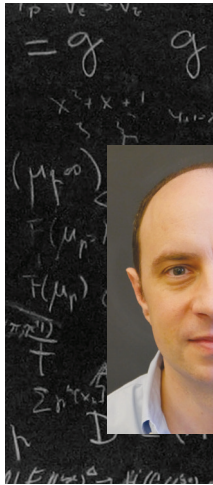>
> — Paul Goerss, Department Chair

From top left, clockwise: Professor Ezra Getzler and graduate students at the Beginning of the Year Party; Professor Bryna Kra with GROW 2017 participants; Undergraduate students after the 2017 Undergraduate Awards Lecture; Professor Laura DeMarco with GROW 2017 participants; Professor Elton Hsu, Silas Johnson, and Daniel Cuzzocreo at the Undergraduate Awards Lecture; Undergraduate student at the Undergraduate Awards Lecture

From top left, clockwise: Chair Paul Goerss; Frosty the Snowman visits the Holiday Party; Associate Chair Ursula Porod, Professor Emeritus Mike Stein, and others at the Beginning of the Year Party; Undergraduate students listen to the Undergraduate Awards Lecture; Professor Mihnea Popa with graduate students Mingyi Zhang and Yagna Dutta; Graduate students Abraham Rabinowitz, Sean Pohorence, and Greg Edwards; Graduate student Johan Konter and Frosty the Snowman at the Holiday Party

The Undergraduate Program 2017-2018

John Alongi, *Director of Undergraduate Studies*

With the end of each academic year we recognize the accomplishments of both our students and faculty. This spring we expect 98 students to graduate with either a major or minor in mathematics, two of whom are will pursue graduate study in mathematics. Ethan Dlugie will attend the University of California, Berkeley, and Ben Ekeroth will attend Yale University. Ethan, Ben, Nicholas Irons and Emmanuel Rockwell each wrote a senior thesis this year. Supervising these theses were Professors Antonio Auffinger, Steven Zelditch, Santiago Cañez, and Han Gan, respectively. Also among our faculty, Professor Aaron Peterson won an Arts and Sciences Alumni Teaching Award. As Director of Calculus, Aaron has strengthened our calculus courses by improving access to affordable course materials, streamlining academic resources, and developing curricula that better meet our students' needs.

At the conclusion of my first year as Director of Undergraduate Studies in Mathematics, I am confident that the quality of mathematics instruction at Northwestern has never been better, and that our program, with 203 majors and 28 minors, is strong. Nonetheless, we strive to provide better experiences in our calculus courses, to expose all majors and minors to essential areas of modern mathematics, and to increase the representation of women among our majors and minors.

As we celebrate our successes and pursue our goals we are grateful to the alumni who donate to the department. This year alumni donations funded our Undergraduate Prize Lecture by Professor Laura Taalman of James Madison University and supported a variety of academic initiatives that further our undergraduate teaching mission. Information about how to donate appears at the end of this newsletter.

Graduate Student News

Elton Hsu, *Director of Graduate Studies*

The famous German writer Heinrich Heine once commented that in a university professors are pyramids of knowledge while students come and go. This year eleven graduate students successfully completed their studies in our program and earned their PhD degrees: Lauren Bandklayder, Greg Edwards, Elden Elmanto, Xavier Garcia, Aron Heleodoro, Johan Konter, Nicole Looper, Andrew Reiser, Nan Shi, Paul Vankoughnett, and Brian Williams. Nine of them have found academic positions in the US and abroad and two will work in industry.

True to Heine's words to a fault, exactly the same number of new graduate students will join us this September: Carlos Cortez-Lemos (Massachusetts Institute of Technology), Daniel Fletcher (Oxford University), Eivind Hjelle (Norwegian University of Science and Technology), Adam Holeman (Montana State University), Erik Hupp (University of Chicago), Hy Lam (University of California, Berkeley), Wenyuan Li (Peking University), Wanxing Liu (University of Michigan, Ann Arbor), Kaitlyn Loyd (University of California, Los Angeles), Benjamin Zhou (Stanford University), Yuxin Zhou (East China Normal University Shanghai).

Among those who are leaving us after graduation, Elden Elmanto and Nicole Looper received the department's annual Best Thesis Awards. They were supervised by Professors John Francis and Laura DeMarco, respectively. In addition, Nicole also received the Graduate School's Holt Award to Support Dissertation Completion. This year's Gelfand prize, which recognizes a graduate student who has achieved outstanding progress in their own research or made extraordinary contributions to the research goals of the department's graduate community, went to Yajnaseni Dutta. Our current graduate students Sean Pohorence and Kitty Yang have received the Graduate Teaching Assistant Awards. Congratulations to them all!

We appreciate the efforts of all our graduate students who contributed to the friendly atmosphere of our community. Our special thanks go to Greg Edwards and Kyle Casey for running happy hours and for wine & cheese and Yajit Jain for the graduate student seminar. Thanks are also due to those who hosted the prelim boot camps to help our new graduate students with the preliminary exams: analysis (Nick McCleery and Mike Geis in September and Fanjun Meng and Yuxiang Wang in June), algebra (Yajnaseni Dutta and Khashayar Filom in September and Yaroslav Khromenko and Fanjun Meng in June), and geometry/topology (John Snadden and Kyle Casey in September and Kyle Casey and John Snadden in June).

All of us are looking forward to another fruitful new academic year.

Undergraduate Perspectives

Rachel Gallegos
Graduating Senior

My journey through Northwestern has been a long road of self-discovery and acceptance. I entered my freshman year as a violin performance major, convinced music was my path. I loved math growing up, but pursuing it in college was not even on my radar. This quickly changed as I found myself growing hungrier for the challenge that only calculus classes provided me.

Unlike many who go on to pursue a math major, my first math class was Math 220. Not realizing that the MENU program existed, I naively continued on, struggling and loving every quarter. Although it seemed that many of my peers outperformed me, I continued taking math classes. And within my first year, I decided to switch my major from violin performance to undecided. The curriculum, incredibly caring professors, student-TA-turned-close-friend, Joseph Breen, and the best friends I picked up along the way, kept me interested in the subject and motivated to continue. Still unable to fully recognize my identity as a Northwestern student studying math, I declared my math major at the end of my sophomore year.

Sophomore year was also the first year I started attending the lectures that the Northwestern University Math Society (NUMS) hosted, purely because Joseph Breen was the president and they gave out free Giordano's pizza *every week*. At the time, I comprehended little of the talks, but it was here where I found a community of students that I loved. Joe was graduating that year, so I offered to take his place alongside Sam Mossing my junior year. This is when my relationship with the math department really began and blossomed.

As president of NUMS for the past two years, I have had the incredible pleasure of meeting a diverse group of professors, hearing interesting and exciting lectures, getting to know the amazing staff of the department, developing close relationships with my peers, and consuming way too many slices of pizza each week. Lunt now feels like a slice of home, and I will be forever grateful for the time spent there.

Although my relationship with math itself has been divisive at times, it has above all else been gratifying and rewarding. I attribute this to the extraordinary group of math teachers, professors, and mentors growing up, who sparked and cultivated my interest in the subject. So, a thousand times over – thank you. I leave Northwestern confident in my decision to pursue a math degree, and I look forward to continuing on in my journey of self-discovery and acceptance.

Ethan Dlugie,
Graduating Senior

I am always adamant in telling people that I don't believe I could be in the position where I am now in life if it weren't for Northwestern. The people you interact with and the opportunities available at the university are, I believe, above and beyond what I could have found anywhere else. As an example, I am quick to point to our math department. Even looking back now, I am shocked and grateful for the experiences and opportunities that have come my way as a math major.

I would say my experience as a member of the department really started at the end of my freshman year. I wanted to keep taking math classes to complement my declared major at the time, so I went to visit then DUS Mike Stein to ask for suggestions. After seeing my success in my first year MENU sequence, he decided that becoming a math major really would be the best thing for me and promptly led me down to the office to fill out the appropriate forms. Coercive? Perhaps. But I am grateful for that moment as it truly set me on the road to where I am today.

In the intervening years, I have been able to participate in two independent summer research projects supervised by faculty in the department and funded by resources on campus. One project led to a published paper and the other to a senior thesis. I have had the chance to attend the SNAP summer program, sit in on seminars and colloquia, and enroll in graduate courses. I have also been able to improve my teaching skills and work more closely with faculty as an undergraduate TA.

All together, the opportunities I have found by being a math major at Northwestern have allowed me to experience and learn much more than I believe I could have at another university. Now I am on the verge of beginning a PhD with the intention of ultimately becoming a math professor myself, and I truly feel that I would not have made it to this point without the people I have met and the resources I have found in Lunt Hall. I can only hope that I will get to interact with this amazing community again in my mathematical future.

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