SUMMER **2024**

DEPARTMENT OF MATHEMATICS • UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

MATH TIMES

New Name, Enduring Mission

The Department of Mathematics' Illinois Geometry Lab is now the Illinois Mathematics Lab.

In This Issue

Message from the Chair

I am so proud of the growth of our mathematics department's influence, and I'm struck by how well this year's Math Times cover story on the Illinois Mathematics Lab (IML) reflects that growth.

The IML (known as the Illinois Geometry Lab until earlier this year) is our premier undergraduate research program. This spring, more than 300 students applied for a spot in the program. Fifty-five were ultimately selected and spent the semester working on advanced research problems from across the field. What started as a tentative meeting in the basement of Altgeld Hall has expanded to include about a dozen faculty members and again as many graduate students. The IML is being replicated across the country, with alumni of the lab becoming faculty themselves and starting their own versions of the program.

That influence can also be seen in our ongoing success in earning research grants. About 80 percent of our faculty - excluding the eight new hires that we introduce in the Department News section - are principal investigators. They were awarded more than $2.3 million from the National Science Foundation in fiscal year 2023 alone, which made up more than 15 percent of all grants earned by the College of Liberal Arts & Sciences' faculty.

We saw several other exciting milestones this year. After a hiatus brought by COVID-19, we relaunched the Tondeur Lecture Series. Princeton's **Noga Alon**, known for his work in combinatorics and theoretical computer science, was our speaker. We also introduced a set of "on-ramp" courses in Calculus, Precalculus, and College Algebra, which will address educational losses resulting from the pandemic and increase access to learning opportunities for historically underrepresented or underserved students.

Faculty were acknowledged nationally and internationally for their impact, as well. Professors **József Balogh** and **Yuliy Baryshnikov** were named 2024 Simons Fellows in Mathematics. Balogh received the American Mathematical Society's 2024 Leroy P. Steele Prize for Seminal Contribution to Research. Professors **Daniel Berwick-Evans** and Felix Janda, meanwhile, both won NSF CAREER awards, given to exceptional early career faculty across the country.

Whether earning accolades, attracting new opportunities, or spreading our approach to undergraduate education, our faculty, students, and alumni are hard at work. And people far and wide are noticing their impact! We hope you will enjoy this issue of Math Times and spend a few minutes learning more.

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CONVOCATION **2024**

Don't Be Bashful

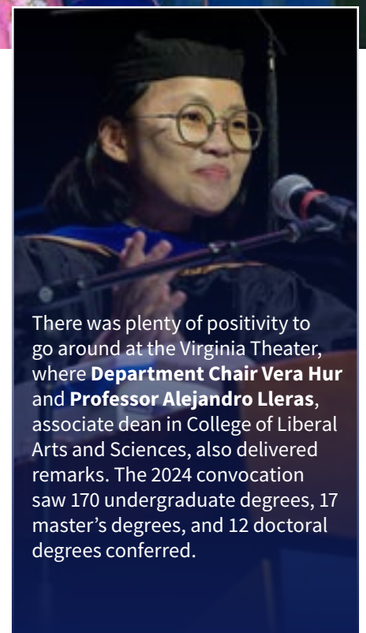
Alum Gail Kellogg speaks to graduates at the 2024 convocation ceremony.

During her commencement address to mathematics students on May 12, 2024, Gail Kellogg encouraged graduates to,

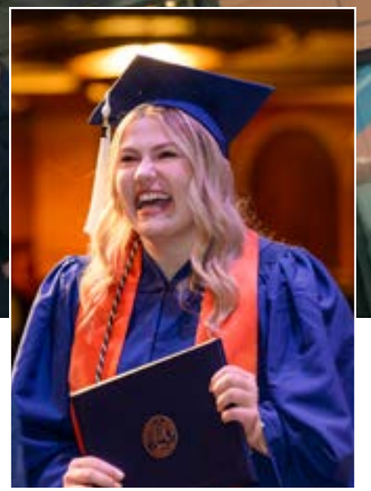
> **"Do whatever job you are doing very, very well. Don't be too impatient to get to the next step, but certainly don't be bashful, either."**

Kellogg is an alum and a retired partner with Hewitt Associates, a global human resources consulting firm. She currently serves on the board of the U of I Foundation and was previously on the board of the Alumni Association. She helped establish the Mathematics Development Advisory Board in 2010.

> **"I am convinved that positivity always outruns negativity, and it really matters."**



There was plenty of positivity to go around at the Virginia Theater, where **Department Chair Vera Hur** and **Professor Alejandro Lleras**, associate dean in College of Liberal Arts and Sciences, also delivered remarks. The 2024 convocation saw 170 undergraduate degrees, 17 master's degrees, and 12 doctoral degrees conferred.



Weren't able to make it to the ceremony?

Watch the 2024 Mathematics Convocation, including Gail Kellogg's talk, by scanning the QR code.

DEPARTMENT**NEWS**

Returning to Its Former Glory

The stony skin of Altgeld Hall dates back to 1896. A lot of history, and gunk, has built up on the stone since. As part of an overhaul to the interior and exterior of Altgeld, masonry cleaning, stone repairs, and repointing work are now underway.

It's a manual, painstaking process. The Hinckley sandstone – quarried more than 125 years ago in southern Minnesota – has taken on a black and green cast. Lathered with special restoration cleaner used on historic buildings, the exterior is hand scrubbed and rinsed. Lighter, pink and yellow hues are exposed for the first time in generations.

Caustic or acidic treatments could ruin the look and integrity of the stone, while very hot water would not have been effective enough. High-pressure washing was considered too aggressive, too, according to Karla Smalley. Smalley is associate principal at Bailey Edward, an architecture firm in Champaign that is working on the historic renovation.

Structural improvements to the belltower and classroom renovations are also taking place inside.

"The many years of water intrusion on this open, exposed structure have not been kind," said Kevin Price, project manager at the University of Illinois' Facilities & Services. "When completed, along with the roof replacement work, the Phase 2 work of this project will return the exterior of this iconic building to its former glory."

Read more on the restoration process at *https://go.math.illinois.edu/23-Altgeld-Glow-Up.*

Eight New Faculty Added

The Department of Mathematics welcomed eight new tenure-stream faculty this year. They represent a breadth of research specialties and include:

- **Daniel Cooney**, assistant professor, is a mathematical biologist who models evolutionary biology using partial differential equations, dynamical systems, and stochastic processes.
- **Tolulope Fadina**, assistant professor, works in theoretical finance and insurance, focusing on asset pricing and risk measures.
- **Pei-Ken Hung**, assistant professor, studies problems in geometry through an analytic lens.
- **Felix Janda,** assistant professor, is an algebraic geometer who studies moduli spaces.
- **Jake Rasmussen**, Robert and Ann Canary Professor, studies problems in knot theory and low-dimensional topology.
- **Sarah Rasmussen**, assistant professor, is a low-dimensional topologist also trained in physics.
- **Xuan Wu**, assistant professor, solves problems in probability, particularly those at the intersection of random matrix theory, stochastic systems, and statistical physics.
- **Amanda Young**, assistant professor, uses analytical tools to investigate the spectral and dynamical properties of quantum lattice systems.

Balogh Among Winners of Steele Prize

Professor **József Balogh**, along with his collaborators **Robert Morris** (Instituto de Matemática Pura e Aplicada), and **Wojciech Samotij** (Tel Aviv University) received the American Mathematical Society's 2024 Leroy P. Steele Prize for Seminal Contribution to Research for their 2015 paper "Independent Sets in Hypergraphs," published in the J*ournal of the American Mathematical Society.*

"Their method has had an immediate and dramatic impact on the study of enumerative and extremal problems in random settings, and has provided a powerful new tool for constructing counterintuitive combinatorial objects," according to AMS's announcement of the award.

Read more at *https://go.math.illinois.edu/24-SteelePrize*.

New Prep Courses for Calculus and Algebra

The Department of Mathematics rolled out three new courses this fall to support students who need additional preparation to transition to math courses. This "on-ramp" instruction will address educational losses resulting from the pandemic and increase access to learning opportunities for historically underrepresented or underserved students. The on-ramp courses will teach key skills and mathematical foundations, with a particular emphasis on building healthy mathematical study habits to better engage with the materials for Calculus, Precalculus, and College Algebra.

An important statistical marker for long-term success in a math course is performance on the first exam, which generally happens around four weeks into the semester. Rather than just dropping a course after that exam or stepping down to an earlier course in the class sequence, the new on-ramp courses will be available in the second half of each fall and spring semester. In these one-credit hour courses, students will receive eight weeks of targeted preparatory instruction, to increase their chances of success when retrying the course without delaying their degree completion.

Learn more from Math's Alison Reddy, who led development of the courses at *https://go.math.illinois.edu/23-MathOnRamps*.

Department News

Pure Math for Beginners

This year's Summer Illinois Math Camp courses showed the wonderful world of pure mathematics, at a level that even beginners can appreciate. Campers learned how mathematical concepts can be used to study moving objects, explored the deep relationships between numbers and space, saw recurring examples of math in nature and art, and got a primer on chaos theory.

Run by graduate students in the Department of Mathematics, the week-long camp is held annually for students in the 8th to 11th grades, offering students a sneak peek into "the creative, discoery driven side of mathematics."

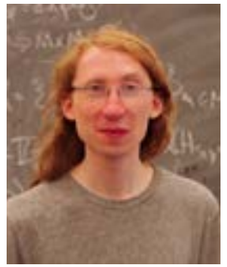
Find details on SIM Camp at *https://go.math.illinois.edu/24-SIM-Camp*.

Alon Gives Tondeur Lectures

Princeton University's **Noga Alon** was our invited speaker for the Tondeur Lecture Series in Mathematics in December 2023. In a series of three lectures, he revisited three well-known examples of distance problems in discrete geometry: the Erdős Unit Distance Problem, the Erdős Distinct Distances Problem, and the Hadwiger-Nelson Problem. Alon also discussed recent solutions of the analogs of all three problems, and how combinatorial, geometric, and probabilistic methods can be combined with tools from linear algebra, topology, and algebraic geometry to answer related questions.

Stay Up to Date

Get Department of Mathematics news delivered directly to your inbox by signing up below.



Berwick-Evans (left) and Janda (right) | photos

Janda and Berwick-Evans Earn CAREER Award

Professors **Daniel Berwick-Evans** and **Felix Janda** recently received NSF CAREER grants. The grants will support Janda's work on the geometric foundations for the log gauged sigma linear model (GLSM) and Berwick-Evans' work in elliptic cohomology and quantum field theory.

You can read more about both faculty members in this issue of Math Times.

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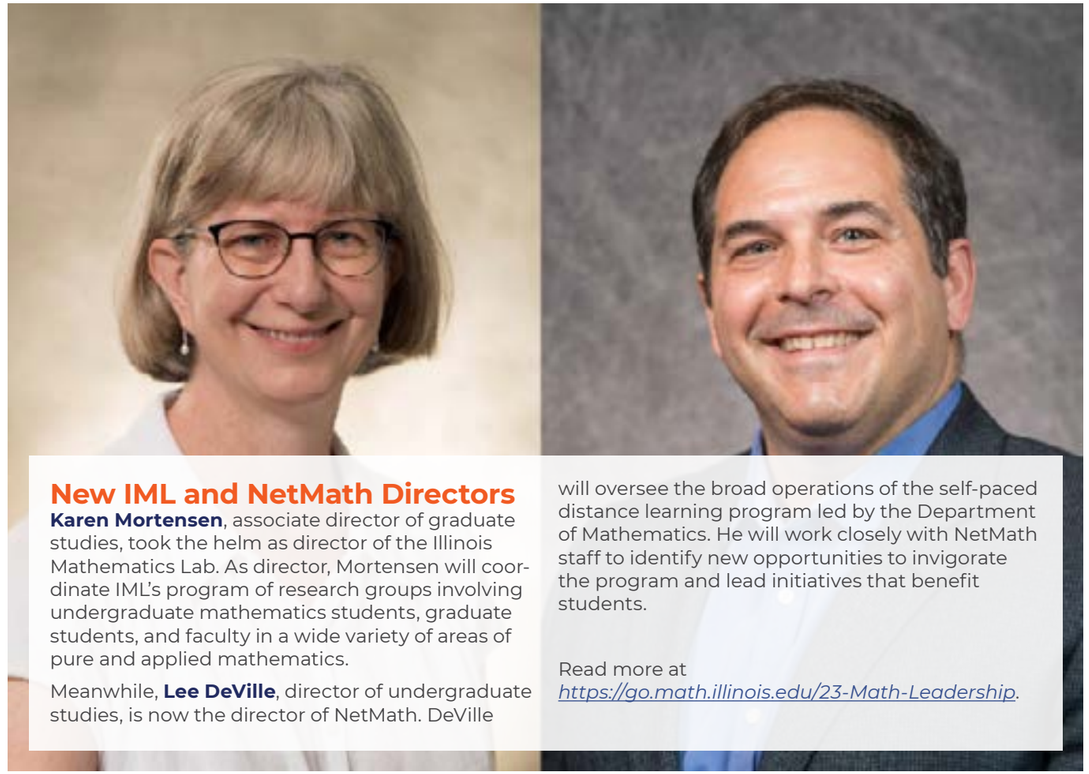
On Facebook, you can follow us by searching "Illinois Department of Mathematics" or using the QR code.

Balogh and Baryshnikov named Simons Fellows

Professors **József Balogh** and **Yuliy Baryshnikov** were named 2024 Simons Fellows in Mathematics, among only 50 awarded by the Simons Foundation this year. Fellows receive academic leaves from one term to a full year, enabling recipients to focus solely on research for the long periods often necessary for significant advances.

Read more at *https://go.math.illinois.edu/24-Simons-Fellows*.



New IML and NetMath Directors

Karen Mortensen, associate director of graduate studies, took the helm as director of the Illinois Mathematics Lab. As director, Mortensen will coordinate IML's program of research groups involving undergraduate mathematics students, graduate students, and faculty in a wide variety of areas of pure and applied mathematics.

Meanwhile, **Lee DeVille**, director of undergraduate studies, is now the director of NetMath. DeVille will oversee the broad operations of the self-paced distance learning program led by the Department of Mathematics. He will work closely with NetMath staff to identify new opportunities to invigorate the program and lead initiatives that benefit students.

Read more at *https://go.math.illinois.edu/23-Math-Leadership*.

DEPARTMENT NEWS

Inside the Illini Hall Time Capsule

It's been more than a year since workers lifted the cornerstone of Illini Hall. It was a momentous event during the building's demolition and marked the opening phase of the Altgeld and Illini Hall Project. A crowd of onlookers and news media were on hand to witness the occasion.

Illini Hall was constructed in 1907 as the University YMCA headquarters. **Jim Hinterlong** (BS, '92, psychology), executive director for the University YMCA, knew there might be a time capsule at the site, based on historical photos and documents. He and the crowd were not disappointed.

"We had hoped that there was a time capsule there, but we really didn't know for sure until they lifted the cornerstone back," he said. Sure enough, they found a small, water-stained box. In September 2023, the YMCA hosted an event to open the capsule during its 150th anniversary.

Inside, they found the University YMCA's annual report for June 1907, the University YMCA's constitution from 1904, a copy of the Champaign Daily Gazette newspaper for June 10, 1907, a copy of The Illini newspaper (now the Daily Illini) from June 11, 1907, and the University of Illinois Bulletin from April 15, 1907. The box had been placed in the cornerstone on June 9, 1907, during what was then called Alumni Day and later became Homecoming,

Read more about University Library's preservation efforts for these documents and watch a video of the capsule's opening at *https://go.las.illinois.edu/Illini-Time-Capsule*

Machine Learning for Parkinson's Assessments

Professor **Richard Sowers** collaborated with the Carle Illinois College of Medicine's **Manuel Enrique Hernandez** and **Johns Hopkins' James R. Brasic** on new machine-learning approaches to improve the accuracy of low-cost, wearable sensors for patients with Parkinson's disease.

The researchers adapted the gold standard of clinical assessment, the Movement Disorders Society-sponsored revision of the Unified Parkinson's Disease Rating Scale. The MDS-UPDRS outlines specific tasks that a patient would perform and qualitative observations a physician would make during an exam and organizes them into categories for scoring. For their study, the researchers had patients perform tasks and muscle movements while wearing sensors to provide the data in the categories scored by MDS-UPDRS. They used data from both patients with Parkinson's disease and from healthy older adults to train their machine learning model.

Results were published in a November 2023 issue of the journal Sensors.

Find out more about this study at *https://go.news.illinois.edu/24-ML-wearables*.

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Missing Links Between Geometry and Quantum Field Theory

Daniel Berwick-Evans, assistant professor of mathematics, studies connections between quantum field theories, differential geometry, and algebraic topology. He discussed his work with us recently. The interview has been edited for length and clarity.

Q: What are you working on now?

A: I am working on a conjecture that was first loosely formulated by Ed Witten and Graeme Segal in the 1980s, and has a more modern incarnation due to Stephan Stolz and Peter Teichner. At its heart, the conjecture proposes that a deep object in algebraic topology (called elliptic cohomology) contains the same information as a space of quantum field theories coming from theoretical physics. It is a surprising conjecture, because on face value these two subjects don't have anything to do with one another.

Q: How has this conjecture evolved over time?

A: In the late 1980s, Ed Witten was studying a class of quantum field theories related to string theory. Some of his calculations suggested that deformation invariants of 2-dimensional supersymmetric quantum field theories should take values in elliptic cohomology. Motivated in part by Witten's observations, Mike Hopkins and his collaborators expanded the theory of elliptic cohomology, making it into one of the more powerful tools in modern algebraic topology. At the same time, Graeme Segal started investigating the precise connection between elliptic cohomology and quantum field theory. This was picked up some years later by Stolz and Teichner. Thanks to the work of these and other researchers spanning several decades, we are starting to glimpse the depth of this connection between physics and topology.

Q: What are some of the ways you think your work on this conjecture can shed new light on the role of mathematics in developing quantum field theory?

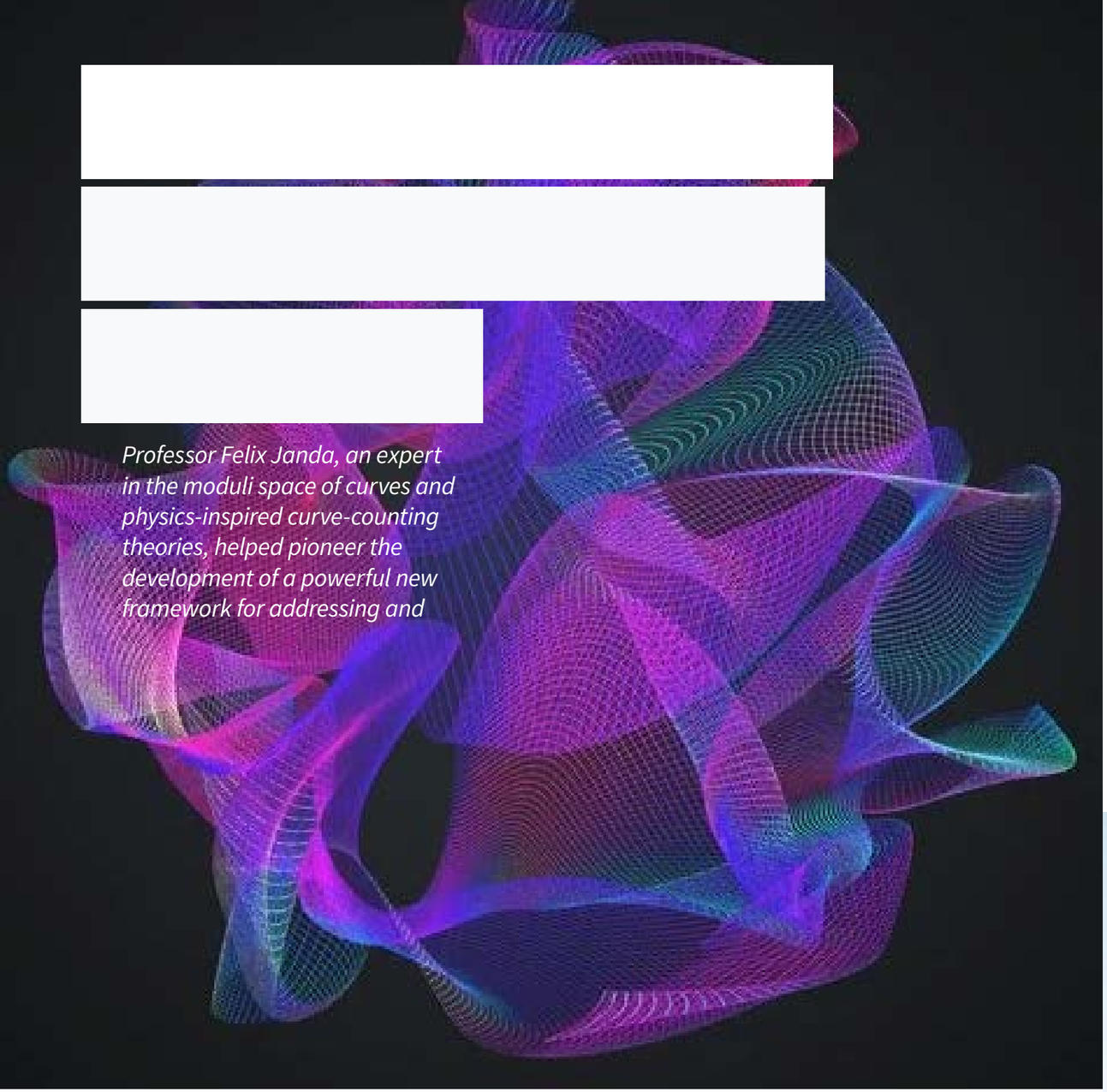
A: One is the role of symmetries. Specifically, quantum theories of open strings have quite a rich symmetry structure, and aspects of this are mirrored by certain structures in elliptic cohomology. Another aspect is that many problems in modern theoretical physics require one to analyze an entire space of quantum field theories rather than a particular theory in isolation, e.g., the landscape problem, or classifying topological phase of matter. Stolz and Teichner's conjecture indicates that spaces of quantum field theories (even for relatively simple cases) can be very intricate.

The ideas surrounding this central conjecture also prompt a lot of new questions in algebraic topology and mathematical quantum field theory. For example, several of my PhD students are developing tools and language for understanding the nuances of quantum symmetries.

Q: How has your field changed since your career began?

A: The available mathematical language to describe quantum field theory has expanded quite a bit. The mathematical understanding of elliptic cohomology has also grown. This has all helped get a better handle on this central conjecture.

Read more of our interview at *https://go.math.illinois.edu/24-Berwick-Evans*.



Professor Felix Janda, an expert in the moduli space of curves and physics-inspired curve-counting theories, helped pioneer the development of a powerful new framework for addressing and

In 1991, physicists studying string theory made a strange discovery that shook up the field. Using some experimental techniques to predict curve counts in six-dimensional space, they achieved a result that indicated a strong relationship between two very different geometric worlds.

At first, the result was hard for many mathematicians to take seriously. Up to that point, no tool in mathematics had been capable of doing what the physicists had achieved. Later, when mathematicians were able to confirm the predictions, many fields of mathematical research exploded with possibilities, in some cases spawning brand new areas of study. Questions at the center of that 1991 discovery continue to inspire mathematicians and physicists today.

Professor Felix Janda, who joined the faculty at University of Illinois Urbana-Champaign in Fall 2023, is one such mathematician. The work he is doing right now could shake up the field once again.

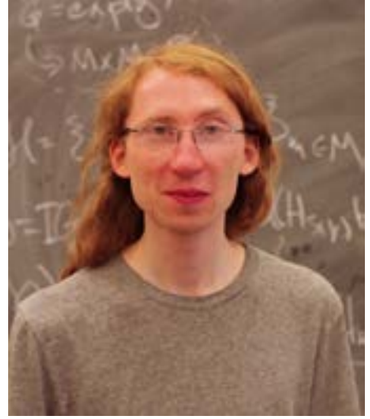
A Curious Link

Since the 1980s, scientists have been using string theory to explain the existence of subatomic particles such as quarks, electrons, and neutrinos. In string theory, these particles are made of tiny, vibrating strings.

Over time, physicists began to understand that, to account for things like gravitational forces and quantum mechanics, those tiny, vibrating strings must exist in 10 different dimensions – or spaces with unique physical properties.

The observable world comprises four dimensions. So what is going on in those extra six dimensions? How do we define them? These questions fueled a large body of scientific research for several decades.

One thing we know about the extra dimensions is that they must take the shape of a Calabi-Yau threefold; an example of this shape is a quintic threefold. We know this partly because the mathematical fields of algebraic geometry and topology gave us tools we needed to examine and define the extra dimensions.



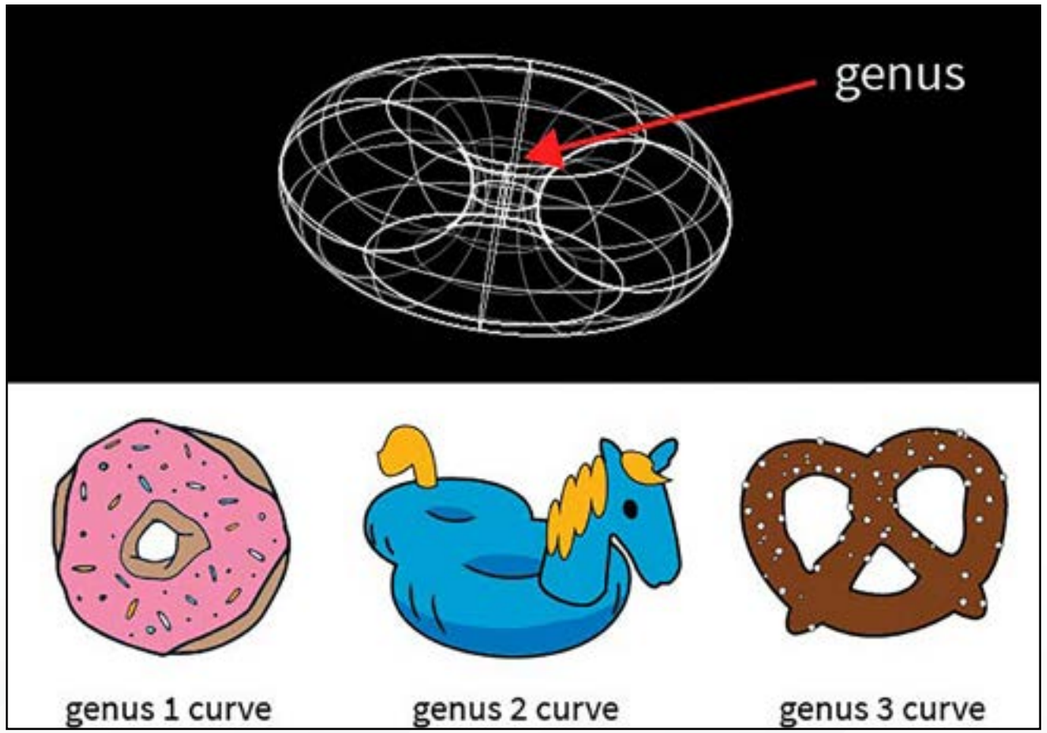
Algebraic geometry allows us to translate properties of a given space into polynomial equations. Polynomial equations can be graphed so that we can literally study their shape. When polynomials contain complex numbers, they can result in intricate shapes known as "complex manifolds," or spaces with complex structures.

But not all types of spaces can be defined using complex geometry. For instance, "phase space," which can be thought of as a complete accounting of all possible position and momentum variables in a physical system, is commonly defined by principles of "symplectic geometry."

For many years, complex and symplectic geometries didn't seem to have much to do with each other; for one thing, they account for wildly different types of spaces. Complex geometry is quite rigid, whereas symplectic geometry – a tool that, among other things, helps humans define motion – allows much more variance.

One result of that groundbreaking 1991 discovery was the revelation that these two geometric spaces – which had once been deemed so different they had to be studied separately – actually held "mirror symmetries." Mirror symmetry is a term used to describe a very specific relationship between geometries. Through the theory of mirror symmetry, one can relate complex structures of one space to symplectic structures in a very different "mirror" space.

For mathematicians, the impact of that revelation was huge. The ability to relate the two geometries suddenly gave researchers on either side of the mirror a new faction of tools they might use to study problems in their respective fields.



In complex geometry, two-dimensional shapes are called curves, and the genus represents the number of "holes" of a surface. A sphere is an example of a genus zero curve.

The Problem with Curves

The mathematical knowledge available to understand complex and symplectic geometries, and a common language to describe that knowledge, expanded further over the last thirty years. But significant challenges to curve-counting problems remained.

For one, when those physicists were making predictions about curves in 1991, they were only accounting for specific types of curves – those with algebraic curves of genus zero. Higher genus curves, which produce more complicated geometric objects, are significantly more challenging for mathematicians and physicists to count.

Over time, theoretical physicists developed heuristics to help them grapple with higher genus curves. These methods have been used to predict curve counts on quintic threefolds of up to genus 64.

However, advancement on the mathematical front has been more restricted. This is partly because, broadly speaking, physicists' methods help them make predictions about curve counts. Mathematicians' work to confirm those predictions often requires a different set of tools. For many years, the tools geometers had at their disposal were not always suitable for tackling curve-counting problems.

It took more than a decade, but mathematicians eventually proved physicists' genus zero and genus 1 curve predictions. When it came to higher genus curve counts, progress stalled.

Until Felix Janda came up with a new idea.

Creating the log GLSM

Janda, an algebraic geometer, is interested in moduli spaces of curves. Moduli spaces give mathematicians a way to learn about distinct objects – usually geometric objects – in a universal context.

Another way to think of moduli spaces is this: Imagine biologists who are studying the social behaviors of a particular species of animal. Should those biologists choose to study the animals one at a time, they will likely make interesting observations about that species, but those observations may not have a discernible pattern. If they studied those same animals in a group setting, patterns would likely emerge, giving the biologists important insights about how the species interacts with its environment.

Moduli spaces work like the latter method of observation, allowing mathematicians to zoom out on a given subject and notice patterns. Moduli spaces can be vast, and they are often rife with opportunities to establish connections between different areas of mathematics.

While collaborating with fellow researchers on a study of two specific algebraic objects on the moduli space of curves, Janda found inspiration for a technique that could be applied to new curve-counting problems.

Prominent curve-counting theories include Gromov-Witten theory, Fan-Jarvis-Ruan-Witten (FJRW) theory, quasimap theory, and the gauged sigma linear model (GLSM). Janda's work traverses these theories and finds hidden links between them.

Before Janda, researchers had already worked out how to relate some of these theories to GLSM, which in physics is central to computations of curve counts on the quintic threefold. Many hoped that this would lead to new computations.

But, as Janda explains, there was still a missing piece of the puzzle.

"In a nutshell, the technical problem with [using] GLSM in math is that it is based on "non-compact spaces." In other words, spaces that go off to infinity in some direction," says Janda.

Logarithmic geometry, a branch of geometry first developed to study problems in number theory, offered a possible solution, as it can be quite useful for studying non-compact spaces. Using his expertise in curve-counting theories and his observations of curve moduli, Janda collaborated with other geometers to create the logarithmic gauged linear sigma model, or log GLSM.

> **"One aspect of my area of study that I particularly enjoy is its interplay between geometry and computations"**

Janda says that "in some sense, log GLSM is an application of logarithmic geometry to GLSM, and thus, curve counts."

According to his peers, the log GLSM is a powerful new framework that could resolve some of the most challenging curve-counting problems. While Janda is still working to further develop the full framework for the log GLSM, it has already been employed to solve several long standing problems in Gromov-Witten theory. It has the potential to answer many more.

For Janda, the foundational work for log GLSM also presents opportunities to find new mathematical relationships.

"One aspect of my area of study that I particularly enjoy is its interplay between geometry and computations," says Janda. "Simple geometric facts can translate into profound relations between curve counts, while patterns in curve counts can uncover geometric structures that had not been observed before."

Janda recently received an NSF CAREER grant that will support his work in completing the geometric foundations for log GLSM.

The applicability of Janda's methods in other fields is not yet known, but, given the steady interchange of ideas between mathematics and physics that preceded him, it's possible that such applications exist.

As for what new discoveries await researchers armed with a fully realized log GLSM, only time will tell.

Get Involved

The Department of Mathematics wants to bring current students in contact with alumni working in mathematics, actuarial science, and computer science to promote networking and generate long-lasting connections.

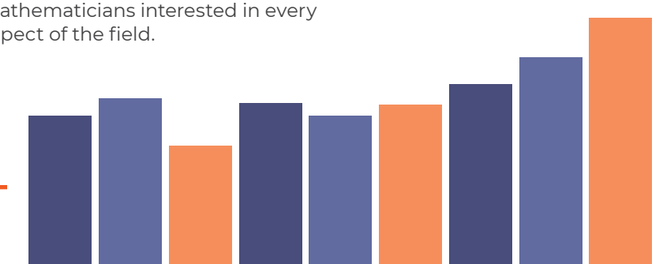
Scan the QR code to let us know about your interest in alumni events!

New Name, **Enduring Mission**

The Department of Mathematics' Illinois Geometry Lab has become the Illinois Mathematics Lab, reflecting the program's broad focus and well-established impact on the entire department.

Ask around Altgeld Hall, and everyone will tell you the same thing. The Illinois Geometry Lab was always about more than geometry. In 2024, the department changed the lab's name accordingly. It's now the Illinois Mathematics Lab (IML), better capturing the fact that it is home to mathematicians interested in every aspect of the field.

The lab gives students semester-long research experiences in advanced mathematics, with dedicated faculty and graduate students serving as mentors. It also supports a registered student organization that brings creative math activities to local schools, libraries, and community events.



"In mathematics, some graduate-level education is necessary to even understand the questions that faculty members are researching, but the IML projects identify some portion of faculty research that is approachable by an undergraduate. The students are eager to be involved in mathematical research," said Karen Mortensen, the Department of Mathematics' Associate Director of Graduate Studies and Director of the IML. "Besides providing valuable experience for students who want to pursue graduate school, the projects show students the rewards and pleasure – and sometimes frustration – of pursuing mathematical questions for their own sake."

Founded in 2011, the IML has grown into one of the most popular programs in the department. About a hundred students participated in 20 research teams last year, chosen from more than 300 applicants. Aided by graduate students, the faculty-led teams rapidly learned the necessary background mathematics and computing skills for each project, then developed new definitions, proved theorems, tested hypotheses with computational experimentation, analyzed data both big and small, and developed visualizations of mathematical concepts.

"In class, math can feel like you're retracing the steps of thousands of others who have done it before," said Matthew Leonardson, a rising junior in mathematics and computer science who took part in an IML research project in the spring of 2024.

"[Work in the IML] is a lot more creative. Compare it to class, where the professor knows the answer, at the end of the day. Here, there's a lot of collaboration and you're figuring it out alongside the professor. You don't get this anywhere else academically."

NEW NAME

Here are some key elements of the IML's growth and success over the years…

Clear Demand

Formal, large-scale involvement of undergraduates in mathematics research was a relatively unusual idea when IML launched. A few campuses around the country had smaller, similar programs, but the founders weren't sure what kind of response they would see. Professor **Jayadev Athreya** (now at the University of Washington) and his PhD student **Anton Lukyanenko** (now a professor at George Mason University) put out a call to undergraduates who might be interested.

"We went and got some coffee and cookies from Panera and got a room in the basement of Altgeld," Athreya said. "We were joking that we're going to have to drink all this coffee and eat all of these cookies ourselves, because no one's going to show up. And then as we sort of wind our way into the basement, we see all these students lined up. I think 'Huh, is there an exam or something? What's going on?' And they were there for us."

"There is this clear demand from students to get involved in these kinds of things. They're excited about it."

Process-Driven

Physics undergrads can get research experience helping build a complicated experimental system. A biology student can get their hands on a pipette under a fume hood early in their studies. A young anthropologist can code survey results for their mentor. Think of the IML as a way for math undergraduates to do something similar.

Faculty propose projects and guide the team assigned to that project. Graduate students lead the teams day-to-day. Undergraduate students – about five per team – work the problem at hand, earning course credit for their efforts. Students spend about 10 hours per week on their project, developing a project plan to start and a final report. They also participate in a mid-semester review and an end-of-semester poster session where they present their findings. In addition to mathematics, they learn crucial collaboration and communication skills.

"Students get to work with an absolutely world-class researcher. They get to be a part of that team that's advancing the frontiers of knowledge. And often things with direct applications, modeling real-world phenomena," Athreya said. "IML keeps the focus on exploration, not the end point. It's much more process-driven than results-driven."

Graduate students have a significant learning experience, as well. "In addition to the mathematics that they learn through helping to lead a project, they gain mentorship, leadership and supervisory skills that will be valuable whether their future careers are in academia or in industry," Mortensen said.

In the spring of 2024, projects investigated topics like spatial models of evolutionary dynamics (led by Professor **Daniel Cooney**), noise in quantum devices (Professor **Marius Junge**), modeling of traffic flow (Professor **Richard Sowers**), and predictability of wins and losses in college sports (Professor **A.J. Hildebrand**), to name a few.

Some IML projects eventually lead to research publications, and some result in public online resources. For example, a group led by Professor **Igor Mineyev** developed a computer game that crowdsources the search for counterexamples to a long-standing conjecture in algebra, while a group from the previous fall worked under the guidance of Professor **Felix Leditzky** to create a publicly available website of known quantum channels and their properties.

Broad Buy In

Dozens of faculty members have led IML projects over the years.

"The department really bought into the concept early on, and so did the university through their public engagement grants," said Professor **Grace Work**. Work was one of first graduate student mentors in the IML and ultimately became graduate manager of the lab. She is now the associate director of undergraduate research in the Department of Mathematics at the University of Wisconsin Madison.

There, she frequently collaborates with Professor **Caglar Uyanik**, director of the Madison Experimental Mathematics Lab that shares a similar mission with the IML. Uyanik and Work were colleagues at UIUC while earning their PhDs. Other IML alumni have gone on to found similar labs at George Mason University and University of Michigan, among other institutions.

IML undergraduate alumni, meanwhile, have earned faculty positions at prestigious departments all across the country including Professors **Brian Freidin** (Auburn University), **Matthew Novack** (Purdue University), and **J.D. Quigley** (University of Virginia).

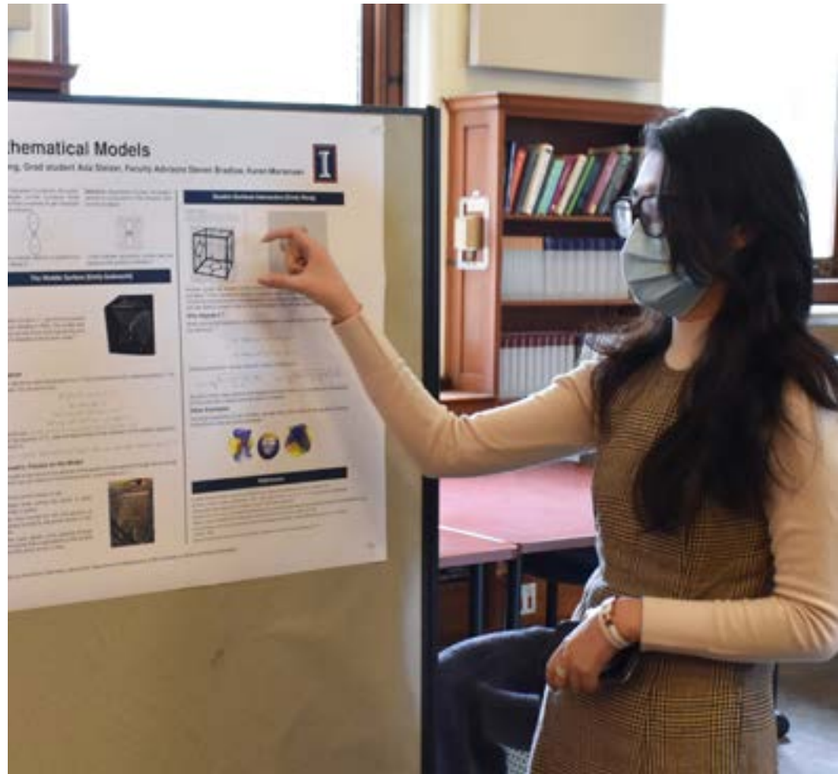
"I love that," Athreya said. "It indicates, from the start, that this lab was based on collaboration and cooperation among faculty, graduate students, and undergraduates… None of this could have happened unless you had all these folks excited. None of this was a solo effort. These are all Illinois alums who were deeply influential, and I hope the lab had a big influence on them."

Learning, Engaging,

About 20 students are part of the lab through IML Outreach, a registered student organization that welcomes all majors across campus. IML Outreach members volunteer throughout the Champaign-Urbana area, learning to make the technical more accessible and sharing the beauty and impact of math with a broad audience.

For example, members help out at the Champaign Public Library's after-school "Teen Hour" program, engaging middle school students in mathematical activities involving tiling and tessellations and more. They also conduct similar activities at local schools' STEM nights, after-school programs, and at the farmers market in Urbana.

"People don't even realize that math can be this interactive or that it has these applications," Work said.



2023–24 **AWARDS**

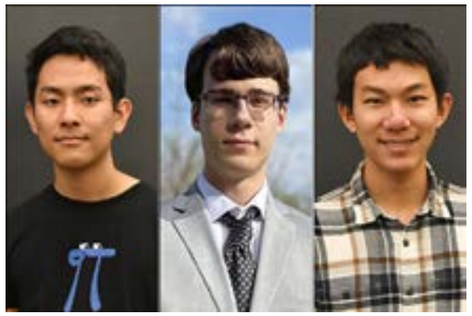
Mock Putnam Exam and Freshman Math Contest

In October 2023, students gathered to compete in two local math contests at University of Illinois Urbana-Champaign, the Paul Erdős Mock Putnam Exam and the Paul Erdős Freshman Math Contest. The Department of Mathematics has sponsored local contests in mathematics for decades. Last year, these contests were renamed in honor of Hungarian mathematician Paul Erdős, who famously offered monetary prizes for the resolution of open problems in mathematics.

For the second year in a row, **Adrian Calinescu** took first place in the Paul Erdős Mock Putnam Exam. **Uyen Nguyen** placed second in the contest, and **Andrey Vlasov** placed third. The Putnam began in 1938 as a competition between mathematics departments at colleges and universities. The competition has grown to be the leading university-level mathematics examination in the world.

When the Freshman Math Contest debuted in 2011, it offered incoming students an opportunity to showcase their problem-solving skills. Today, the competition welcomes those in their first year at the University of Illinois and students from local high schools to participate.

Yuuki Sawanoi was the first-place winner of the 2023 Paul Erdős Freshman Math Contest. Sawanoi is a mathematics and computer science major at Illinois. **Chenning Xu**, also a mathematics major, placed second. High school student **Jaewoo Park** was third.



Lange Wins LAS Staff Award

Acknowledged for her "unwavering support of graduate students," **Emily Lange** received the LAS Staff Award, established to recognize individuals for their outstanding contributions to the college. Lange has been part of the Department of Mathematics since 2019 and is assistant director of human resources.

In her role, she develops and oversees hiring activities for all academic professionals, civil service, and academic hourly positions. This includes developing job descriptions, organizing and training search committees, facilitating interview and candidate selection processes, and providing onboarding support to newly hired members of the department. Lange manages H-1 visa and green card requests, working closely with International Student and Scholar Services to assist our international students' and faculty members' compliance with federal, state, and university regulations.

Read more about Lange's award at *https://go.math.illinois.edu/24-LAS-Staff-Award*.

Bateman Prize in Number Theory

Di Liu and **Qihang Sun** were named joint recipients of the 2024 Bateman Prize in Number Theory. The prize is awarded to graduate students in recognition of outstanding research in number theory.

Liu is a fifth-year PhD student in mathematics working under the supervision of Professor **Alexandru Zaharescu**. Liu's work in analytic number theory examines various questions on the distribution of zeros of L-functions, with special emphasis on fractional parts of imaginary parts of zeros, zero density estimates, and Laguerre-Polya type inequalities for Dirichlet L-functions.

Sun is a fifth-year PhD student working under the supervision of Professor **Scott Ahlgren**. Sun's research primarily focuses on analytic number theory and modular forms, such as the applications of estimating various types of Kloosterman sums.

Wolfgang Haken Prize

Jason Liu, a graduate student in mathematics, was awarded the 2024 Wolfgang Haken Prize in Geometry and Topology. Liu researches problems in symplectic geometry. He has been working with mathematics faculty members at University of Illinois Urbana-Champaign to advance a conjecture regarding Hamiltonian circle action on compact manifolds, and he has pursued two other related conjectures independently.

Kuo-Tsai Chen Prize

Hanna Kim, a PhD candidate in mathematics, earned the 2024 Kuo-Tsai Chen Prize in Mathematics. Kim's research focuses on spectral geometry, which establishes relationships between partial differential equations and differential geometry.

The Kuo-Tsai Chen Prize, established in 1989, is given in recognition of outstanding scholastic achievement by a graduate student whose research examines relationships between analysis and either geometry or algebra.

Read more at *https://go.math.illinois.edu/24-KT-Chen-Prize*.

Philippe Tondeur Dissertation Prize

Graduate students **Shiliang Gao** and **Qihang Sun** were jointly awarded the 2024 Philippe Tondeur Dissertation Prize, which recognizes exceptional students in their final year of the mathematics PhD program at Illinois.

Gao works in algebraic combinatorics with his adviser Professor **Alexander Yong**. His work primarily focuses on combinatorial representation theory, commutative algebra, and symmetric functions and tableau combinatorics. Yong describes Gao as a "fantastic problem solver," who exhibits technical mastery of many subjects with a genial personality well-suited to teaching and mentoring others in his field.

Gao is a recipient of an NSF graduate fellowship and the Irving Reiner prize at the University of Illinois Urbana-Champaign, as well.

Sun works in number theory, focusing on analytic properties of arithmetic functions. He studies various techniques and applications of automorphic forms and spectral theory. Much of his work centers around Kloosterman sums. Professor **Scott Ahlgren**, who is Sun's adviser, says that Sun shows "enormous mathematical strength, dedication, and capacity for hard work."

Sun has published in Research in Number Theory and Forum Mathematicum, and he is now a postdoc at the University of Lille.

STOPPING BY THE SCC

It's a bright afternoon in April, and spring fever has reached campus. The sun has finally come out after a bout of cold and rain. Dozens of students pepper the quad, playing frisbee, chatting with friends, or laying out to enjoy the nice break in the weather.

Just a few yards away, a group of students climbs the stairs of the English Building to the third floor. They are headed to the Math & Statistics Student Support Center (SSC). With just a few weeks left until finals, these students want to stay on track with their calculus coursework.

As they enter the door of Room 304B, the students come to a table with a sign-in QR code. They scan the code with their phones, then make their way toward one of eight study tables in the room.

Each table has been assigned a course number, such as MATH 220: Calculus I or STAT 400: Statistics and Probability I. Students take a seat and begin working on their assignments. When they reach a problem they need help with, they put a hand in the air to alert the tutors. One of those tutors is senior Sean LeBlanc, who is majoring in mathematics and econometrics. LeBlanc started working for the SSC in spring of 2022.

Even though it has been a few semesters since he took the courses he tutors students in most, he still uses the concepts regularly in his economics coursework. "Now that I have seen a lot of the different applications of the concepts taught in those classes – like with optimizations and integrations – it's kind of nice to have the chance to work on these kinds of problems and explain them to people," he says.

As LeBlanc darts from table to table to help tutees, the other tutors in the room sit down with their peers, providing individualized support, talking them through each problem until the students feel comfortable resuming work on their own. For Jamie Bondelli, a mathematics major planning to teach in secondary education, the reward is being able to help her peers.

"I've essentially been tutoring people forever," Bondelli says. "My sister, my friends, and now here – I've helped a lot of people with math over the years."

The SSC was established in the fall of 2021, and later expanded with funding from the College of LAS's student success initiative. It was originally conceived to help students recover from educational losses brought by the COVID-19 pandemic. The original proposal for the center indicated that remote learning had caused significant challenges in mathematics and statistics courses, where "students typically benefit from active learning exercises performed with peers and instructors."

Shortly after opening, the SSC was seeing 50 to 80 students a week. By Fall 2022, the SSC was averaging 175 student visitors per week. According to April Hoffmeister, the director of the SSC, those numbers rose even more in Fall 2023 – so much that she had to reserve additional space for tutoring sessions.

The SSC now holds regular hours during the fall and spring semesters for free, walk-in tutoring. Some students take advantage of the flexible hours and visit when it is most convenient for them, but some students make a special point to come in during the shift that their course assistant is working. Felicity Biza, a freshman studying engineering, and Sofia Koziura, a sophomore chemistry major, visit the SSC about once a week. Both say that the SSC has helped them manage their academic loads more effectively.

"I focus a lot better in this room," says Koziura. "It's nice to have one-on-one support when you're doing homework." Biza and Koziura both have Margot Pierce as a course assistant for their classes. Pierce also tutors in the SSC.

"This room can get a little packed at times," says Biza, "but I really like when Margot is here. She walks me through everything, and it's really nice to have the extra time to work with your [course assistant] outside the classroom."

In the past three years, the SSC has served thousands of students. In the Fall 2023 semester alone, the SSC saw more than 2,500 individual visits. Attendance through week 10 of the semester saw an increase of more than 50 percent compared to Fall 2022 numbers. Bondelli, who began tutoring in the SSC last spring, says she has already noticed that some regular SSC visitors pick up mathematical ideas more readily and gain confidence.

"At the beginning of the semester, someone might take a long time to process something, but as people come back on a regular basis, we have definitely seen growth." Bondelli also says that tutoring her peers has improved her own performance in mathematics courses. "There's a different level of knowing required to teach something than to just learn it," she says.

But the SSC doesn't just exist to help students perform better in a particular class; it is also a place for students to connect and build relationships.

"For underrepresented and first-gen students, navigating college can be difficult," says Hoffmeister. "Students may need additional resources beyond the traditional course offerings. The peer mentorship of the SSC can be another avenue for these students to seek help and feel supported in a welcoming learning environment."

LeBlanc believes that, in this regard, the SSC is achieving its mission: "As someone who is in there quite often, the SSC continues to be a place where students not only are assisted through their course work but also a place with a strong sense of community."

Shelby Koehne for Math Times

The Math & Statistics Student Support Center relies on grant and donor funding. To learn more about how you can support the mission of the SSC, please reach out to Evan Tammen (*etammen2@illinois.edu*), the director of development for mathematics & statistics.

ALUMNI **NEWS**

New Members for Mathematics Development Advisory Board

The Mathematics Development Advisory Board (MDAB) inducted three new members at its Fall 2023 meeting. They included **Lisa Hays** (BS; '89; mathematics, economics), chief actuary at Great American Insurance Company; **Jo Jones** (BS, '63, teaching of mathematics), retired business manager at the University of Iowa Museum of Art; and **Matthew Ando,** a former associate dean for life and physical sciences in the College of LAS who is now dean of the College of Arts & Sciences at Ohio University.

Professor **Sheldon Katz** was also presented with a plaque recognizing his contributions to the board's continued success. Katz was prominently involved with the establishment of MDAB and served as its chair for 13 years.

Since its inception, MDAB has created and funded an undergraduate scholarship program, endowed professorships, and an alumni awards program. Board members have also organized opportunities for alumni engagement and provided essential support for the Altgeld and Illini Hall project.

Read more at *https://go.math.illinois.edu/23-MDAB*.

Morisato Didn't Hesitate to Help Launch LAS Days of Service

When **Meg Edwards**, director of corporate and foundation relations for the College of LAS Office of Advancement, reached out to alumna **Susan Morisato** (BS, '75; MS, '77, mathematics) to share her idea of inviting alumni to volunteer in their hometowns, Morisato agreed to help without hesitation. After all, Morisato has seen the far-reaching impact of service throughout her career with United Healthcare and AARP.

The College of LAS Days of Service launched last fall to engage LAS alumni across the U.S. in their local communities. During the inaugural event, more than 50 volunteers provided more than 100 hours of service in Champaign, Chicago, and San Antonio – sorting food at a foodbank, packing meals for those who needed them, and community building at a local park.

"Volunteering is a way for individuals to get physically and mentally active, to feel good about what they are doing," Morisato added. "When [Edwards] said she was thinking about creating Days of Service, I did not hesitate, because I could see all of the benefits. These can be seen happening within the alumni community as well. This is a way to stretch and strengthen our network of alumni."

Morisato has served as a founding member of the Department of Mathematics Development Advisory Board and is a current member of the College of LAS Alumni Council. She recently received the 2024 Dean's Quadrangle Award, an honor bestowed upon extraordinary LAS alumni who have maintained a lifelong personal bond with the college.

Read more at *https://go.math.illinois.edu/24-LAS-Days-Service*.

Du Featured in Quanta

Xiumin Du (PhD, '17, mathematics) was featured in Quanta Magazine for her work on Falconer's conjecture. Du studied under the supervision of Professor **Xiaochun Li**. She is currently a professor of mathematics at Northwestern University.

Read the story at *bit.ly/falconers-conjecture*.

From Quanta Magazine

Polikoff Earns Tenure

Morgan Polikoff (BS, '06, mathematics) was recently promoted to full professor at the University of Southern California Rossier School of Education. Polikoff earned his PhD in education policy at the University of Pennsylvania. He has been a faculty member at USC for the past 14 years, studying standards and curriculum policy, Americans' educational experiences since COVID, and their views on education policy.

Lanius Receives NSF Funding for Math Anxiety Research

Melinda Lanius (MS, '14; PhD, '18, mathematics) successfully piloted a study to test how well fitness trackers could predict math anxiety in undergraduate students and is the principal investigator for an NSF funded project to leverage the results of her research. Lanius is a professor of mathematics at Auburn University.

Lakins Appointed Editor of MAA Journal

Allegheny College Professor of Mathematics **Tamara Lakins** (PhD, '93, mathematics) has been appointed editor of The College Mathematics Journal, published by the Mathematical Association of America (MAA). Lakins served as editor-elect in 2023. Her five-year term as editor will run from

2024 to 2028.

Share Your Story

Are you an Illinois math alum who recently landed a new job? Won an award? Made a breakthrough in your research? Whatever your news, we want to celebrate it with you! Get in touch using this form to tell us what you're up to. You could be featured in the next newsletter!

Scan the QR code to let us know about your new adventures!

Denne Featured in The New Yorker

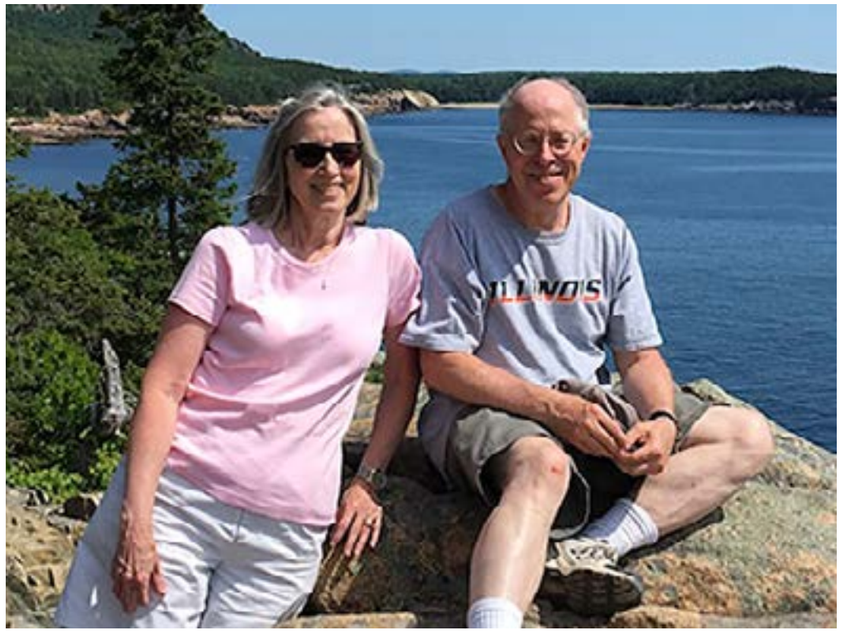
Elizabeth Denne (PhD, '04, mathematics) talked about knot theory in a November 2023 New Yorker article, "The Man Who Invented Fifteen Hundred Necktie Knots." Denne is a professor of mathematics at Washington and Lee University.

From The New Yorker

ALUMNI **SPOTLIGHT**

Making Space for Exploration

Alum Matthew Deady and his wife support spaces for student collaboration in Altgeld Hall renovation.



When **Matthew Deady** (BS, ‘75, mathematics and physics; MS, ‘77, mathematics) remembers his time at the University of Illinois, Altgeld Hall stands out as a friendly, inviting place

“Anything I was interested in, someone would tell me, this is who you talk to about what course to take or book to read. There was always a professor who would take the time to talk to you,” he recalled. Altgeld’s architecture, with faculty offices side by side with classrooms, was part of that friendly environment, lowering the barrier for Deady to talk with and get advice from faculty mentors like **Kenneth Appel**, one of the Illinois mathematicians who proved the Four Color Theorem in 1976.

> **“That made it possible for me to explore.”**

His own lengthy career as a college educator gave Deady additional appreciation for the role physical space plays in how students connect with one another and with faculty. At Bard College, where he joined the faculty in 1987 and remains an emeritus professor, there is a lab near his office where students often gather between classes to study and hang out.

“The fact I was right there meant I could hear them out there being confused, and I could wander out and help them out,” he said. “I also saw how the students who got the most out of their education were the ones who formed bonds with one another and learned how to work together.”

“I think we underplay the need for physical space for collaborative work to happen, for faculty and for students,” Deady added.

Thanks to a generous gift from Deady and his wife, Mary, Altgeld will continue to provide faculty and students with those critical spaces for collaboration and exploration. A large conference room and a registered student organization office will bear their names.

“The College of LAS is grateful to Dr. and Mrs. Deady for their generous gift in support of student spaces and students in the renovated Altgeld Hall,” said mathematics Professor **Sheldon Katz**, who also serves as a coordinator and special advisor for the project. “The Department of Mathematics will be able to provide its students with new spaces designated for student clubs, as well as new spaces that can be used flexibly for group study, office hours for large classes, informal interactions, and more.”

Deady still marvels at opportunities and experiences he found as a U of I student. Taking a wide range of courses across the College of LAS was key. “You need to know how to ask the questions, and... the LAS background at Illinois helped me question everything,” he said.

The research he participated in as an operator of the linear accelerator at Illinois’ Nuclear Physics Laboratory helped prepare him for his PhD program at MIT, and his advanced mathematics degree helped him “be the bridge between the experimentalists and the theoreticians” during his years conducting research at the Bates Accelerator Laboratory. The training and experience he gained during his graduate studies provided a foundation for his decades teaching at Bard. But he also appreciates the $1 movies shown by campus clubs on the weekend, the variety of music in venues around town, and getting to know people from many different backgrounds while living in the residence halls.

“Whatever you were interested in, you could find 100 other people who were interested too, and that was the critical mass to get it done,” he said. “That happened to me in place after place on campus.”

He wants to ensure that future students have similar opportunities. “I feel an obligation to help students have the experience I had. Places like Illinois, where there are people who are really good at a whole lot of things, they need to be supported.”

Mathematics Alumni Awards

Did you know?

The Department of Mathematics sponsors several awards that recognize our exceptional alumni.

Our alumni awards include:

- Outstanding Achievement Award
- Alumni Humanitarian Award
- Outstanding Recent Alumni Award
- Actuarial Science Alumni of the Year

We are accepting nominations for 2024 alumni awards through **November 29, 2024.**

Hail to the orange! Hail to the blue!

If you know a mathematics alum who is **ever so true...**

Nominate them for an alumni award today!

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Leave a *Legacy*

The culture of innovation and purpose at University of Illinois Urbana-Champaign has fostered some of the world's brightest minds and most important inventions. You can be an important part of that legacy through an estate gift.

By designating the Department of Mathematics as a beneficiary during your estate planning, you can help support broad and critical student success and faculty development programs, or you can even designate your estate gift for a particular use or gift fund within the department.

For questions or recommended language for a beneficiary designation for one of your accounts, please contact Evan Tammen in the College of LAS Advancement Office, (217) 300-5114, etammen2@illinois.edu. The LAS Advancement Office can also provide further information to ensure that your wishes are carried out.

For more information about giving to the Department of Mathematics at Illinois, or to make a gift, visit

go.math.illinois.edu/Giving.

Learn more