SCHOOL OF MATHEMATICS **PROOFREADER**

FOR ALUMNI AND FRIENDS



WELCOME FROM THE CHAIR



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We welcome the opportunity to (re-)connect with you, and we hope you are enthusiastic about this update as we are!

In addition to the usual high level of activity in the School of Mathematics, the 2017-18 academic year also brought us the opportunity for an academic program review.

As with any external review, there is a flurry of extra planning, preparing documents and organizing the review. But most importantly the School has had an opportunity to review past accomplishments and to plan and prioritize for the future.

I'll share with you some of the highlights from the School's self-study document, which will give you a bit more insight on where we've been and where we are going.

RESEARCH ADVANCES

SoM has attracted impressive new hires and has been successful in retaining excellent faculty at all levels.

Our strongly positive research trajectory is illustrated by impactful publications, funding awards by both junior and senior faculty, our faculty's presence nationally and globally in high profile research conferences and math institutes, and many research workshops and conferences held at Georgia Tech. The growth in size and guality of the postdoc and PhD programs also reflects the research strength of SoM, with the new School postdoctoral program - the Hale Postdoc program allowing us to expand our postdoc cohort, in addition to those funded through training grants and individual research funding.

We look forward to two major SoM-led research initiatives coming online in the next year, the Southeast Center for Mathematics and Biology and the NSF-funded Research Training Grant in Geometry and Topology. These complement TRIAD - the NSF-funded Foundations of Data Science Center co-lead by SoM, started in 2017.

NEW UNDERGRAD PROGRAMS AND MAJORS

In 2017-18 the new Bachelors of Science came online, with options for students to select one of four concentrations:

- Applied Mathematics,
- Discrete Mathematics,
- Probability & Statistics, or
- Pure Mathematics.

We are seeing a jump in the number of incoming 2019 Math Majors. Our entry 1000-level courses, taken by most students across Georgia Tech, have been reorganized to better meet student needs.

EXPANDING GRADUATE PROGRAMS

Our graduate programs have grown - most noticeably in the PhD program growing by about 1/3 since the last review, with increases in quantity, quality, and diversity. The School is has expanded its partnership in interdisciplinary graduate programs, including several PhD programs including

- Algorithms, Combinatorics & Optimization (ACO),
- Computational Science & Engineering (CSE),
- Bioinformatics,
- QBioS-Quantitative Bioscience,
- Machine Learning (ML),

and the MS programs in CSE, Statistics, and Quantitative Finance.

HIGH SCHOOL AND REU ACTIVITIES

Finally we have a <u>new website</u> which gives visitors an The School is reaching out beyond Georgia Tech through excellent view of what is going on in the School, as well its International Visiting Student Honors program and its as recent news about School members and activities. An large Distance Learning program, in which high school extensive archive of these events is also available, togethstudents take university-level courses. As we expand and er with updated webpages for many of our programs. diversify our leadership locally and globally we continu-Please check in with us there - and in person! - to see ously benefit from the excellent work of our amazing staff. how we realize our goals for the future.

SoM is also leading the Institute with the most number of REUs this Summer 2018, with a total of six REUs involving seven professors, three postdoctoral mentors, and five graduate students working with 13 undergraduate students by summer's end.

SCHOOL TEAMWORK

Excelling in this variety of activities is no small task. As we expand and diversify our ledership locally and globally we continuously benefit from the excellent work of our amazing staff.

We have also have an outstanding cohort of Academic Professionals in the School, who play critical roles in many aspects of our education, training, and outreach programs.

GOALS FOR THE FUTURE

As part of our academic program review we identified focus areas for future efforts, including:

Ensure a high-quality and robust faculty complement to enhance SoM's strong trajectory and global leadership in research activities:

Review and upgrade course offerings, particularly at the upper levels, to support student needs and diversity of career options especially in high tech fields;

Continue to improve grad recruitment and support;

Investment in international programs, advancing SoM as a national and international hub for activities across the mathematical sciences:

Continue to reach out, lead and collaborate in mathematical and cross-disciplinary programs at GT and beyond;

Diversify resources to support ambitious programs, including space, funding, and active participation.

AND FINALLY - A NEW WEBSITE

WRITE TO US! SEND YOUR COMMENT, STORY, CORRECTION, OR LETTER TO THE EDITOR TO COMM@MATH.GATECH.EDU

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BENEFITS ADD UP FOR UNDERGRADS IN SOM REU PROGRAMS

Students get valuable early chances at research, presentation skills

Undergraduate students stay busy studying for their majors, but they do not always get a chance to work on research projects – tasks that will dominate their lives if they go to graduate school. So how important is it for undergraduates to get that early shot at research?

For Korynn Claiborne, doing undergraduate research is the difference between learning advanced mathematics concepts in a classroom and applying them in real life. "This helps so much because you actually see the math at work," says Claiborne, a senior at Alabama State University.



Korynn Claiborne presents her work at a July 12, 2017, poster session for undergraduates doing mathematics research at Georgia Tech. (Photo by Renay San Miguel.)



The atrium of Skiles Classroom Building was abuzz on July 12, 2017, during the poster session for participants in the School of Mathematics' 2017 REU program. (Photo by Renay San Miguel.)

Claiborne is part of the School of Mathematics' 2017 <u>Research Experiences for Undergraduates (REU) program</u>. She presented her work during a July 12 poster session with 19 other students. Claiborne says the eight weeks she spent researching her project in the Skiles Classroom Building confirmed her love of math.

That outcome serves as priceless validation of the program, says School of Mathematics Chair Rachel Kuske. "The undergrads get exposed to more open-ended problems and new areas of math," Kuske says. "They also learn soft skills important in research. How do you talk about research? How do you work within a group? How is research different from classwork?"

REU is an eight-week summer program funded by the National Science Foundation to give undergraduates a taste of high-level, real-world research.

The 2015 and 2016 REU classes were funded in partnership with the school's Interdisciplinary Mathematics Preparation and Career Training (IMPACT) program, a postdoctoral-training initiative. For the 2017 program, support from the College of Sciences boosted participation, resulting in the largest group of students in the school's 16-year history of REUs. Students from Georgia Tech and other Georgia colleges, plus universities in Alabama, California, Virginia, Michigan, and Massachusetts took part. in the school stock part stock part.

Ian Katz had opportunities to work on research while an undergraduate at the University of California, Berkeley, but didn't take them. He found out about Tech's program after an exchange of emails with School of Mathematics Professor Dan Margalit and was able to enroll at the last minute. Now Katz says he has a chance to fill the research gaps in his résumé and focus on starting graduate school at Tech.

"I didn't even know what I wanted to do coming into grad school," Katz says. He was interested in topology, the study of shapes and how they can be manipulated without breaking or tearing them. "REU gave me a really

"IT'S MORE IMPORTANT THESE DAYS, WHEN STUDENTS ARE APPLYING TO GRADUATE SCHOOL OR A JOB, TO BE ABLE TO SAY THEY WORKED ON A RESEARCH TEAM, OR GAVE A PRESENTATION OR POSTER SESSION, OR WENT TO THIS OR THAT CONFERENCE," KUSKE SAYS, "STUDENTS NEED A BROAD RANGE OF EXPERIENCES TO PURSUE WHATEVER CAREERS THEY CHOOSE." -RACHEL KUSKE

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equations used in atmospheric science prediction and weather modeling. "There's a lot of computational mathematics, and that's what I enjoy," she says.
Two postdoctoral fellows, Michael Northington and Andre Souza, shared their expertise in research and presentation skills with Claiborne. "It gives the postdocs good experience in training and mentoring as well, so it helps everybody," Kuske says.
Kuske adds that the program includes a lot of Atlanta-area students, which she is happy to see. She hopes to increase the local talent stream by seeking additional funding, along with more partnerships with local colleges.
The Research Experience for Undergraduates (REU) programs are organized by the Coordinators for Undergraduate Research: Igor Belegradek and Dan Margalit.

SoM graduate students Shane Scott, Justin Lanier, Sarah Davis and REU students on the Clough roof.

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SEVEN REUS PLANNED FOR **SUMMER 2018**



Mohammad Ghomi with Alexander Avery: The Shadow Problem.

Suppose the shape of a surface is unknown. And suppose the shadow is one piece when illuminated from any direction. Does it follow that the surface is convex? "Alex is working on the discrete version of this problem," Ghomi says. Avery is looking at surfaces that are not smooth - like balls and eggs - but instead are composed of polygons glued along their edges. "Alex has been making good progress. It looks like the polyhedral case will be similar to the smooth case."

Caitlin Leverson with DeVon Ingram, Hunter Vallejos: Legendrian Knots.

"In mathematics, knots can be thought of as pieces of string which are tied up and then have the ends glued together," says Caitlin Leverson, one of the postdoctoral mentors. "An interesting problem is to decide whether two knots are the same or different." Ingram appreciates the beauty of differential geometry and its relation to physics, and sees correspondence between knot invariants and topological quantum field theories, "I am naturally drawn to a knot theory problem," he says.





Dan Margalit with six* students: Recognizing Polynomials.

"Undergraduates are fearless and creative, trying approaches that I might not think of. They might not understand every bit of background that goes into a problem. But we, as mentors, can airlift them to the front lines of the problem," says Dan Margalit about his students. "The training is valuable for them," Margalit says. "It helps give them confidence in their own research and make them marketable for job searches." *Logan White, Jacob Shulkin, Janet Huffman, Ruotong Zhai, Xian Li, and Abby Saladin.

Michael Lacey and Galyna Livshyts with Johannes Hosle: Harmonic Analysis and Covex Geometry.

"Johannes is working on questions of comparing measures of convex bodies depending on the relations between measures of their sections and projections. He has made significant progress and managed to generalize the answer to a question of Milman to an important class of measures," says Galyna Livshyts. Hosle says, "My interest stems from a general interest in analysis. The types of problems in this branch of mathematics seem to resonate most with me."



Other REUs for Summer 2018

Mentor	Student	Dates
John Etnyre	Andrew Sack, Brandon Cosgrove	May 30 - July 10
Wenjing Liao	Andrew Suh	May 21 - June 29
Molei Tao	Gabriell Hall, Huy-Hoang Nguyen	May 21 - June 29

GEORGIA TECH HOSTS ANNUAL HIGH SCHOOL MATH COMPETITION

Every year, Georgia Tech welcomes students who compete at the Georgia Tech High School Math were invited to take part in a proofs exam during the Competition. Accompanied by teachers, coaches, afternoon in order to determine the individual winners and parents, the participants represent high schools One of the easier questions: What is the last digit in the from around Georgia and nearby states. Around 35 base-7 expansion of 3 raised to the 100th power? volunteers* from among the Georgia Tech faculty, A harder question: Find all functions f from the staff and students helped with registration, proctoring, natural numbers to themselves, for which the equality and grading. In 2017, over 300 students from 36 high f(f(m+n))=f(m)+f(n) holds for all values of m and n. schools competed in this annual Georgia Tech tradition, *Special thanks to Chris Jankowski, Sharon McDowell, Sudipa Kolay, dating back to 1958. This year, the 2018 competition George Kerchev, Shane Scott, Prasad Tetali, and Annette Rohrs. challenged over 250 students from 37 high schools to complete the comptetition's four exams in such topics as algebra, geometry, combinatorics, number theory, and basic calculus.



Winners 2018

The 2017 winning teams were:

First: Northview High School Second: Chattahoochee High School Third: Chamblee Charter High School Fourth: GSMST Fifth: Walton High School

The 2017 individual winners were:

First: Kalen Patton, from Chattahoochee High School Second: Lawrence Zhou, from Trickum Middle School Third: Joshua Ani, from Chamblee Charter High School Fourth: Hari Pingali, from Lambert High School Fifth: Irene Zhou, from Northview High School



The top 54 students from the free response exam



2017 competitors in Clough (Photo by Felix Herrmann)



Volunteers and competitors, 2018

The 2018 winning teams were:

First: Northview High School Second: Fulton Science Academy Third: GSMST Fourth: Daniel High School Fifth: Kennesaw Mountain HS, Walton HS (tie)

The 2018 individual winners were:

First: Shawn Im, from Peachtree Ridge High School Second: Holden Watson, from Fulton Science Academy Third: Daniel Chu, from Kennesaw Mountain High School

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GEORGIA TECH UNDERGRAD TAKES HOME AWM MATH PRIZE

Libby Taylor wins 2018 Alice T. Schafer Mathematics Prize

FEATURED UNDERGRADUATE STUDENT LIBBY TAYLOR

The Association for Women in Mathematics (AWM) has named Georgia Tech student Libby Taylor the recipient of the 2018 Alice T. Schafer Mathematics Prize. She will receive a B.S. in Mathematics from Georgia Tech in spring 2018, only two years after she graduated from Wheeler High School, in Marietta, Georgia.

Taylor's advanced mathematical abilities have been evident since high school, according to School of Mathematics Emeritus Professor Tom Morley. As a high-school junior, Taylor took Morley's third-year-college course Combinatorial Game Theory, and she led the team that applied the theory in interesting ways to Gomoku, the classic five-in-a-row game from China.



Libby Taylor, winner of the 2018 Alice T. Schafer Mathematics Prize

TAYLOR'S WORK, MORLEY SAYS, **"SHOWED MATHEMATICAL** MATURITY WAY BEYOND HER AGE OR EDUCATIONAL BACKGROUND."

Also while in high school, Taylor took the undergraduate Number Theory and Cryptography course taught by School of Mathematics Professor Matthew Baker.

As an undergrad at Georgia Tech, Taylor has been taking graduate-level courses and conducting original mathematics research. Hard working and highly motivated, she regularly attends research seminars, reads math books and papers voraciously, and eagerly gives talks at workshops and conferences in the U.S. and overseas. She learns as much as she can from discussions with graduate students, postdocs, and professors.

Professors describe Taylor as a strong, talented student with staggering potential, who is fearless in learning new topics, asks insightful questions, and is quick to pick up sophisticated ideas. Already she has six preprints published, one manuscript in preparation, and a chapter in a book about categorical representation theory called "Soergel Bimodules."

"I have been continually impressed by her mathematical intellect, her initiative, and her ability to absorb mathematics," says School of Mathematics Assistant Professor Jennifer Hom. "I look forward to seeing what Libby's future holds."

"THE FRIENDLY ATMOSPHERE IN THE GEORGIA TECH SCHOOL OF MATHEMATICS CONTRIBUTED GREATLY TO MY MATHEMATICAL DEVELOPMENT," TAYLOR SAYS. "IT HAS ALWAYS BEEN EASY TO FIND PROFESSORS WILLING TO HELP ANSWER QUESTIONS, SUGGEST FURTHER READING, AND DISCUSS MATHEMATICAL IDEAS WITH ME. THIS ENVIRONMENT IS NOT PRESENT EVERYWHERE; THIS IS SOMETHING SPECIAL ABOUT GEORGIA TECH."

Taylor specifically credits her research mentors, School of Mathematics Professors Matt Baker and William T. "Tom" Trotter, both of whom began advising Taylor on research projects when she was still in high school. "Their mentorship gave me a significant head start in my mathematical education and research," Taylor says.

The Alice T. Schafer Mathematics Prize is named after the former president and founding member of AWM who contributed greatly to women in mathematics. The prize recognizes excellence in mathematics by an undergraduate woman.

Each year, AWM names a winner, a runner-up, and at least two honorable mentions. Among them are the following (on right) with Georgia Tech connections:

ANNUAL TA STUDENT **AWARDS WINNERS:**

- TOP GRADUATE STUDENT AWARD: Mark Bolding
- FESTA FELLOWSHIP AWARD: George Kerchev
- OUTSTANDING TA AWARD: Xin Wang & Yuze Zhang
- BEST PhD THESIS: Yan Wang
- CTL/BP OUTSTANDING GRAD TA NOMINEE: Ben Idle
- CTL/BP OUTSTANDING GRAD INSTRUCTOR NOMINEE: Alex Hoyer



- >> Samantha Petti, 2015 runner-up and now a Ph.D. student at Georgia Tech
- Megan Bernstein, 2010 honorable mention and now a postdoctoral fellow at Georgia Tech
- >> Nicole Larsen, 2009 runner-up when she was an undergrad at Georgia Tech and now a research fellow at the Kavli Institute for Cosmological Physics at the University of Chicago
- >>> Josephine Yu, 2003 runner-up and now an associate professor at Georgia Tech

AWM will recognize the 2018 winner, runner-up, and honorable mentions on Jan. 10, 2018, at the 2018 Joint Mathematics Meeting, in San Diego, Calif.

"This achievement has validated the work I have put into my education over the past few years," Taylor says. "The accomplishments of past recipients motivate me to continue working hard to live up to their examples."

INSTITUTE WIDE AWARDS:

GEORGIA TECH GTA OF THE YEAR: Ben Idle

GEORGIA TECH UTA OF THE YEAR: Markace Rainey

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RECENT GRADUATES GIVE ADVICE TO INCOMING FRESHMEN

"Georgia Tech offers many amazing opportunities, but they're not going to come to you. You have to go after what you want in order to get it.

The undergraduate years are the best for exploration, academically and socially.

It's not enough to do well in easy classes and excel at easy tasks. Get out of your comfort zone as often as possible – without burning out – and don't be afraid to admit that you don't know how to do something."



Charles Wang



Iban Ariza

"I would encourage students to start working and applying for internships in their early years. Get a feeling of what the market needs and the common jobs for someone with your degree.

In addition:

- Find your passion; talk to your advisors to learn if your passion aligns with the job market
- >> Always get seven to eight hours of sleep
- >> Eat healthy
- >> Go out with friends at least once a week
- >>> Find a way to relieve stress: sports, yoga, walking, traveling
- >> Avoid 8 AM classes
- >> Make use of professors' office hours
- > Stay motivated
- Stay happy and laugh everyday."

"I would advise incoming freshmen to not shy away from challenges, whether it is a harder version of a class or a research opportunity. What fun is there to be in a situation where you don't have to put in any effort to be good? It's also completely okay to not know what you want to do as a freshman. I thought I wanted to study industrial engineering when I first enrolled, but I changed my major at the end of my sophomore year."



GEOMETRIC GROUP THEORY GETS AN INFORMAL TAKE FROM TECH PROFESSOR

Dan Margalit provides expert insight into a complex math theory in new book

Geometric group theory – the study of the symmetries of objects – is a relative newcomer to the math world, having truly become its own area of study in the late 1980s. Georgia Tech School of Mathematics Professor Dan Margalit figured that a different approach is needed to teach undergraduates about the theory. That's why he has co-edited a <u>new book</u>, "Office Hours With A Geometric Group Theorist" (Princeton University Press).

The print version of the book was published on July 11, 2017; a digital version is also available.

"What is most novel about the book is that, unlike most math textbooks, the tone is very informal," Margalit says. "The different chapters – or 'office hours' – are all written by different authors." Margalit wanted his authors to explain these concepts to his students in an accessible, relatable way.

Margalit, who edited the book with University of Arkansas Associate Professor Matt Clay, says geometric group theory has many important applications within mathematics, such as the award-winning University of California, Berkeley mathematician Ian Agol's groundbreaking work into the possible shapes of threedimensional spaces. Real-world applications include the coordination of robots as they move on factory floors, the creation of secure cryptosystems, and even the design of more efficient blenders.

But that's not why Margalit studies geometric group theory. "There is beauty and depth in the symmetries," he says, "that one can only appreciate by taking the time to learn the subject."

As an example, he points to an illustration from the book – a Farey graph. The swirling and folding loops look like something created with a Spirograph toy from the 1970s, but Margalit sees art in its symmetries. "There are many facts about matrix multiplication that you can understand just by considering this beautiful object," he says.

Dan Margalit received his Ph.D. from the University of Chicago and did postdoctoral work at the University of Utah before arriving at Georgia Tech in 2010. He researches the intersection of low-dimensional topology and geometric group theory, focusing on the symmetries of surfaces.

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Dan Margalit's book cover

Office Hours

with a

Group

Theorist

Geometric



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DONOR AWARDS



Bob Price Bob Travel Award

This award has been made possible by a gift from Robert M. Price who obtained an MS degree from the School of Math in 1958.

2018 Awardees: Marc Haerkoenen, Sudipta Kolay, Sergio Mayorga, Stephen McKean, Youngho Yoo, Xiaofan Yuan.

Bob Price

Stelson Lecture Series

Thomas Stelson endowed the School's Stelson lectures in 1988 in honor of his father, Hugh Stelson, who was a mathematician. This year, Jill Pipher discussed some of the history of cryptography and some of the latest ideas in "lattice" cryptography. Pipher is Vice President for Research and Elisha Benjamin Andrews Professor of Mathematics at Brown University.



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Sung Ha Kang

Herman K Fulmer Faculty Teaching Award

memory of Professor Herman Fulmer, his former mathematics professor. This year Prof. Sung Ha Kang recieved the award in recognition for her exceptional work in teaching Differential Equations over the last decade, having impacted nearly every studdent taking DiffEQ through her work in the classroom, as well as on course content and format, mentorship of other instructors, and pedagogical outlook...

Howard Woodham (Georgia Tech alumnus, Engineering '48) created this award in

FESTA Fellowship

Funded by a gift from John R. Festa, this award recognizes graduate students who exhibit superior academic and leadership skills. This year's award goes to George Kerchev, a PhD student in the SoM who has risen as an outstanding instructor, researcher, and peer mentor.



The PhD offerings in the School of Math constitute one of the exemplary programs within the Institute, having achieved the highest satisfaction rating by graduate students in a comprehensive 2016 survey covering the more than 20 schools from across the campus.

The School has awarded 64 PhD degrees (or 10.7 per year), which has been the highest total during any five-year period in the history of the program. Of these, 69% immediately secured academic positions after graduation, while the rest went to work in government or industry (there has been 100% employment immediately after graduation).

THE PHD PROGRAM HAS GROWN SUBSTANTIALLY FROM 75 STUDENTS TO JUST OVER 100 THIS FALL.

All PhD programs in the School have three basic requirements: course work (including a minor concentration), comprehensive exams, and a dissertation.

During this period all students also work with the School's coordinator for all TAs, Klara Grodzinsky, who continues teaching the TA workshop throughout the first semester. At the same time, most of the international TAs also enroll in a class with Mo Burke to improve their language skills. The School takes pride in its TA training program, as our PhD students have won three extremely competitive annual Institute-wide teaching prizes since 2013.

Dearees Offered

- Algorithms, Combinatorics, and Optimization (ACO)
- >>> Computational Sciences and Engineering (CSE)
- >>> Quantitative Biosciences (QBioS)
- Machine Learning (ML)

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PHD PROGRAM



Navin Goyal, a visitor in the ACO program

The demographics	for the most	recent adr	nission cycle:
rito dorriographico		1000111 0.011	1001011 090101

2017 Admissions	Applied	Admitted	Enrolled	Admission Rate
Male	197	74	24	0.38
Female	51	19		0.37
Domestic Male	77	36	12	0,47
Domestic Female	22	10		0.45
African American	5	2	1	0.40
Hispanic (US)	5	3	0	0.60



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EVENTS



Introduction to Dynamical Systems Methods for Space Mission Design

"If we could make the mathematical details very explicit, we can make these work to our advantage," <u>de la Llave says</u>. "We could move spacecraft with very small amounts of fuel. We could extend the life of satellites – or send robots to the moon – inexpensively."

2018 Meeting on Applied Algebraic Geometry

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MAAG is a regional gathering that attracts participants primarily from the Southeast of the United States. Previous meetings took place at Georgia Tech in 2015 and at Clemson University in 2016.





Mathematics in Motion at the Atlanta Science Festival

Mathematics in Motion is an Atlanta Science Festival performance in which mathematicians team up with dancers to give an artistic interpretation to the public of some mathematicians and some mathematical concepts. This year's show will have an emphasis on graph theory.

Tech Topology Conference

Invited Speaker: Balazs Strenner



Plenary Roles 2017: M. Damron (Random Growth Models); M.Baker (Hodge Theory in Combinatorics) <u>Plenary Events 2018</u>: E.Croot (Cap Set Conjecture); D.Randall (Emergent Phenomena in Random Structures)



Vladimir Koltchinskii





Matt Baker Simons Fellowship

Amalia Culiuc Teaching Effectiveness





Chris Heil Teaching Effectiveness

Anton Leykin CoS Cullen-Peck Scholar





Larry Rolen PROSE Award

Balazs Strenner Mary Ellen Rudin Award

*Not Pictured: Klara Grodzinsky (Teaching Effectiveness Award)



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AWARDS



Wilfrid Gangbo Chancellor's Professorship in Mathematics



Zaher Hani NSF CAREER grant



Galyna Livshyts NSF CAREER grant



Joe Rabinoff CTL/BP Teaching Award





Prasad Tetali Regents' Professor



Lutz Warnke Sloan Research Fellow



RESEARCHERS DETERMINE ROUTES OF RESPIRATORY INFECTIOUS DISEASE TRANSMISSION ON AIRCRAFT

FEATURED ARTICLE: FLYHEALTHY STUDY

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FlyHealthy research study, lead by SoM Professor Howie Weiss, is a research collaboration between Georgia Tech School of Mathematics and colleagues at Emory University, Delta Airlines, and the J. Craig Venter Institute, and sponsored by Boeing. The goal is to understand the rates and routes of transmission of infectious diseases during air travel and devise mitigation strategies.

The first manuscript containing results of phase I was recently published in PNAS. The authors investigated and quantified several key drivers of direct transmission of large droplet mediated respiratory infectious diseases on long US domestic flights. On ten flights between Atlanta and west coast cities, the 14 member research team collected 230 air and surface samples, as well as chronicled the movements and behaviors of all individuals during flight.

The movement data was then used to create a temporal network of close proximity interactions for each flight. These data informed a transmission model, which was simulated for influenza transmission. The simulations indicated that if a susceptible passenger is seated further than a meter from an infectious passenger, and practices good hand hygiene, then she is unlikely to become infected with flu during flight.

Furthermore, each of the 230 environmental samples were qPCR assayed for 15 common respiratory viruses, and all results were negative, even though eight of the flights were doing influenza season.



Chart of passenger contacts

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Documenting passenger movement on aircraft

THE FLYHEALTHY ARTICLE WAS FEATURED IN MORE THAN 200 INTERNATIONAL NEWS STORIES INCLUDING: NY TIMES, THE WASHINGTON POST, TIME, NEWSWEEK, SCIENCE FRIDAY, WIRED, AND even a limrick on the NPR weekend radio show WAIT WAIT...DON'T TELL ME.

MEMBERS OF SOM AT THE HELM OF NATIONAL RESEARCH PROGRAMS



For the last 35 years, NSF has supported national institutes that organize the research in Mathematics. These Mathematical Sciences Institutes are comprised of <u>eight U.S.-based institutes</u> that receive funding from the National Science Foundation (NSF), an independent U.S. government agency that supports research and education in all non-medical fields of science and engineering.

Every semester, each of these Institutes picks an important topic, and invites the top experts in these fields to come interact, give lectures, workshops, and to train postdocs. These semesters are very influential and set the direction of research nationally and internationally.

In recent years, our collegues in the SoM have been selected as organizers of several of these institutes, confirming the global leadership of the School of Mathematics here at Georgia Tech in several important areas of Mathematics.

ICERM Nonlinear Algebra Program (Picture courtesy of Cynthia Vinzant and Anton Leykin)

and Anton Leykin) Last year, Prof. P. Tetali and adjunct Prof. D. Randall were Co-PI's of a successful grant to organize an "<u>Transdisciplinary Research Institute for Advancing Data Science</u>" for the NSF.

In Fall '18, Prof. A. Fathi will be the lead organizer and Prof. R. de la Llave will be an organizer of a "jumbo" program on "<u>Hamiltonian systems, from topology to applications through analysis</u>" at MSRI. `

In Fall '18, Prof. A. Leykin will be the lead organizer of a program in "Nonlinear Algebra" for ICERM.

In Spring '17, Prof. M. Lacey was one of the lead organizers of a program in "<u>Harmonic</u><u>Analysis</u>" at MSRI.

In Fall '14, and again in Spring '15, Prof. P. Tetali was one of organizers of the program on "Discrete Structures: Analysis and Applications" at IMA.

DISCRETE MATH/COMBINATORICS MOVES UP TO NO. 2 IN US NEWS GRADUATE SCHOOL RANKINGS

The Georgia Institute of Technology continues to make progress in the graduate school rankings published each spring by U.S. News and World Report.

In the College of Sciences, Chemistry jumped four to No. 20, Mathematics moved up two to No. 26, Physics moved up one to No. 28, Earth Sciences moved up four to No. 38, and Biology moved up one to No. 54. Within mathematics, the discrete math/combinatorics specialty had Georgia Tech at No. 2, up two positions.



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////RESEARCH

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FACULTY PROFILES

Georgia Tech Geometry and Topology (GTGT) group

PI: John Etnyre. Co-PI: Igor Belegradek, Jen Hom, Dan Margalit, and Kirsten Wickelgren. Senior Personel: Stavros Garoufalidis, Thang Le, and Mohammad Ghomi

We provide a diverse and fertile ground for training undergraduate and graduate students and postdoctoral fellows in the Georgia Tech community, with the ultimate goal being the creation of a highly visible center for geometry and topology in the Southeast. With a recent \$2.1 million NSF Research Training Group grant over the next 5 years, we will be providing comprehensive training to graduate students and postdocs through fellowships and dedicated professional development courses and seminars, as well as engaging undergraduate students in REU projects, directed reading programs, special topics classes and seminars about applying to graduate school.



John Etnyre

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Galyna Livshyts



I work in the area of High-dimensional convex geometry. Our experience in two and three dimensions seems to suggest that when dimension is large, the geometry is more complicated. However, it turns out that in high dimensional spaces miracles happen: with large number of variables comes not chaos, but structure and regularity. One of the most important (and difficult) questions in high-dimensional convexity is the so called slicing problem: given a convex set of volume one in an n-dimensional space, is it possible to find a hyperplane section of this set which has area at least 0.01?

I work in probability theory, specifically models from statistical mechanics like percolation and random growth models. These systems model situations as diverse as fluid flow in porous media and the spread of infections. A typical question has to do with the large-scale geometry of random growth. If a bacterial colony sits on a point of a square grid, and spreads across the edges of this grid according to random passage times, taking time t_e to cross an edge e, what is the shape of the infected region at a large time? The answer depends on the distribution of the times t_e, and despite decades of work, there is little known about the asymptotic ``shape.'' Further questions involve the statistical properties of infection times (the random time it takes for the infection to reach a certain distance) and the geometrical properties of time-minimizing infection paths, or geodesics.

Jen Hom



I am a low-dimensional topologist primarily using Heegaard Floer homology to study knots and surfaces in 3- and 4-dimensional manifolds. There is a natural way to add together two knots, called the connected sum, which modulo an appropriate equivalence relation turns the set of knots into a group, and I am particularly interested in understanding the structure of this group. For example, it is well-known that this group contains infinitely many elements of order two, but it is an open question whether or not there is other torsion (elements of finite order) in the group.

Kirsten Wickelgren



I work in algebraic topology and arithmetic geometry. Algebraic topology provides a framework for understanding maps between spheres and explains how the solutions to certain counting problems can be naturally understood in terms of these maps. It turns out that a certain map between spheres created from solutions to polynomial equations leads to a notion of counting not in the numbers 1,2,3,..., but with quadratic forms of dimensions 1,2,3 etc. This naturally records if the solutions to the defining equations are defined over the real numbers, or complex numbers, or are quotients of integers.

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ProofReader

NEW FRONTIERS BECKON MATH AND BIOLOGY IN MULTIMILLION DOLLAR NSF-SIMONS PROJECT

TEASER: MULTI-MILLION DOLLAR NSF-SIMONS PROJECT FOR MATH AND BIOLOGY

If physics were to hand the other sciences the best arrow in its quiver, that arrow would probably be mathematics.

A new national project, which includes the Georgia Institute of Technology, aims to convey the benefits of physics' age-old intertwining with math upon biology, a science historically less connected with it.

The National Science Foundation and the Simons Foundation have launched a large collaboration of bioscientists and mathematicians to advance both fields. The project will have a total of four centers funded with a total of \$40 million, one of which is headquartered at Georgia Tech and will receive a fourth of the funding.

For centuries, together mathematics and physics have shifted paradigms in science and rattled human perception by predicting planetary orbits, theorizing relativity or explaining how one particle can be in two places at the same time. Can theoretical math and biosystems team up to similarly shake the foundations of knowledge?

"We certainly think it's possible," said Christine Heitsch, a professor in Georgia Tech's School of Mathematics who leads the new regional center. "But our immediate goals are more realistic," she said. "Our first step is getting more mathematicians and bioscience researchers working together in research collaborations."



"THE NEW SCMB WILL BE A REGIONAL CENTER PROMOTING THE INTERACTION OF THE MATHEMATICAL AND BIOLOGICAL SCIENCES WITH A DEFINING MISSION OF CONNECTING MATHEMATICAL THEORY WITH BIOLOGICAL DATA."

Bio-math synergy

On an everyday basis, that means the Southeast Center for Mathematics and Biology (SCMB) headquartered at Georgia Tech will tackle open questions in biology using novel math.

"Math can potentially change the way we do our experiments," said Hang Lu, a professor in Georgia Tech's School of Chemical and Biomolecular Engineering who co-leads of the center. "If you model your data with topology (a field of mathematics) you see that your data can have a shape," Lu said. "And that can make you go look for different kinds of data."

"It will be a two-way street," Heitsch said. "Math always benefits when it's challenged by reality."

Over time, the math-bio spiral could lead to eureka moments.

"Biological systems can look overwhelmingly complex, and that just means we haven't found the right way of looking at them yet," Heitsch said.

NSF-Simons vision

The SCMB is one of four NSF-Simons Research Centers for Mathematics of Complex Biological Systems. The other three are based at Harvard University, at the University of California, Irvine, and at Northwestern University. Together, they will not only advance the math-biosciences synergy but also spread their knowledge to hundreds of undergraduate and K-12 students throughout the region through educational outreaches.

The SCMB comprises 14 researchers, including collaborators throughout the Southeastern United States. Tulane University, the University of Florida, the University of South Florida, Clemson University, and the Oak Ridge National Laboratory are each contributing a mathematician, and one bioscientist is based at Duke University.

"This project has visionary potential to shake up the way we view biological systems, and also expand mathematics," said Julia Kubanek, Associate Dean of Research in Georgia Tech's College of Sciences. "The National Science Foundation

and the Simons Foundation have shown tremendous foresight in creating these three centers, and I think headquartering one at Georgia Tech is a great fit because cross-connecting research disciplines is already one of our core missions."



"The mathematical expertise among the seed projects is equally diverse with graduate training in commutative algebra, group theory & generalizations, dynamical systems and ergodic theory, algebraic topology, convex and discrete geometry, calculus of variations & optimal control, and probability theory & stochastic processes. However, all have experience with cross-disciplinary research collaborations, ranging from a 1 year postdoc to almost 2 decades in the field. Five are at other institutions around the southeast. However, georgia tech's location in atlanta, which is the regional transportation hub, makes in-person meetings almost as easy as online ones."



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PROOFREADER ARTICLE PICKED UP BY NOTICES OF AMERICAN MATH SOCIETY

An expanded version of Mohammad Ghomi's article on Durer's unfolding problem for convex polyhedra, which had originally appeared in the 2014 issue of ProofReader, has been published in the January 2018 issue of notices of AMS.

The Notices article includes recent progress achieved in a joint paper of Mohammad Ghomi with Nicholas Barvinok who was an REU student in the School of Math during the Summer of 2017.



www.ams.org/journals/notices/201801/rnoti-p25.pdf

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DONATE TO SOM

SOM PROFESSOR CALLED TO GIVE EXPERT TESTIMONY IN JURY SELECTION CASE

FEATURED ARTICLE: EXPERT TESTIMONY BY SOM PROFESSOR

Prof. Michael Lacey of the SoM has been called to be a expert witness in a recent case where prosecuters in several capital crime trials have been accused of striking black jurors discrimenently. We had a chance to speak with Michael Lacey about this very important case, and this is what he said.

Potential reasons to strike a juror are manifold, influenced by a number of considerations. Under ideal circumstances, the reasons for striking a juror should be generally race neutral. Namely the reasons for striking a juror should be as prevalent in the pool of gualified white jurors as in the pool of black jurors. Put differently, knowing that a juror is struck should give us very little information about the race of the struck juror.

In a jury trial, there is a pool of jurors which are selected randomly from the county in which the trial is to take place. The lawyers on each side have a certain number of strikes, which they may use to remove potential jurors from the pool. Whomever is left after all the strikes are used are the jurors which will sit on the trial.

In the cases under question, Prof Lacey was called to determine if the likelihood of an all white or nearly all white jury was statistically probable given the potential jury pool in each case.

Prof Lacey uses a deck of cards and elementary counting principles to illustrate the likelihood that all of the potential black jurors in a jury selection pool are struck.



We have a deck of 48 cards, 4 of which are Red Ace cards. Draw a hand of 12, which are the 12 strikes by the prosecution. If the hand of 12 contains all 4 Red Aces, then the prosecution has struck all 4 gualified black jurors. These are the sorts of probabilities that a poker player would be well acquainted with. They are easy to calculate, and part of a standard course in statistics.

In the seven cases under question, each jury that went to trial was deemed statistically unlikely to occur for race neutral reasons. Taken together, the likelihood that the jury selection process occurred for race neutral reasons was astronomically small, Prof Lacey says.

FOR MORE READING ABOUT THE CASES SEE THE RECENT FEATURED ARTICLE IN THE ATLANTA JOURNAL-CONSTITUTION: click here

We look forward to future opportunities to stay in touch with you. We're very grateful for help in all forms, large and small, from our friends. Here are some ways you can stay involved with the School of Math, along with our Friends of the School of Math and our Alumni:

Give to the School of Math:

Your gift can have a large impact on the education and research efforts of the School of Mathematics. Below are some of the many ways this can happen.

Undergraduate Scholarships: Everyone knows that college affordability is a serious issue for many families. Funds for undergraduate scholarships help support deserving students as they work toward a Math degree, a very valuable degree whose worth increases every day.

Our graduate students and postdoctoral researchers are the future of the discipline, integral to all of the efforts of the School-from teaching to research to outreach. Supporting them with fellowships, thesis/research prizes, travel-and professional-expense funds or other types of support has a large impact on their professional development, the School, and the discipline. The School's increased quality and quantity in postdoc and graduate recruitment illustrates how a named fellowship attracts and promotes top talent.

The High School Mathematics Competition is an inspiring event where students gather with others interested in mathematics and compete for scholarships. It is run entirely by undergraduate and graduate student volunteers, with scholarships to bring these talented high school students to Georgia Tech. Contributions toward prize money or operating expenses ensures and expands the on-going inspiration and impact of this event http://hsmc.gatech.edu The School also runs a large distance learning program for High School students, with potential for many areas of growth.

Recognize Teaching, Research, and Leadership in Mathematics

A central part of the mission of the School of Mathematics is teaching, with very talented and dedicated teaching faculty, as well as an extensive training program in teaching for our graduates and postdocs. Recognizing the best of them through awards for excellent teaching and mentoring underlines the importance of these efforts and encourages increased excellence. A named award would be a great way to remember an alumnus, former faculty member, or previous instructor who had a big impact on your life. Likewise, School members are leading research efforts, events, and training at Georgia Tech and around the world, so you may want to recognize their impact.

Through an endowed professorship, a donor creates an enduring tribute that realizes their vision of mathematical excellence, provides exceptional opportunities for students and researchers at all levels, and promotes connections locally and globally.

We ask all alumni, past visitors, and friends of the School to please update your contact information along with your news, with an email to <u>comm@math.gatech.edu</u>. More info on our <u>webpage</u>. We hope to hear from you soon!

Or even better, deliver your story in person by visiting the School. We especially welcome opportunities for visits from alumni to stop by and connect with our students and School members.



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