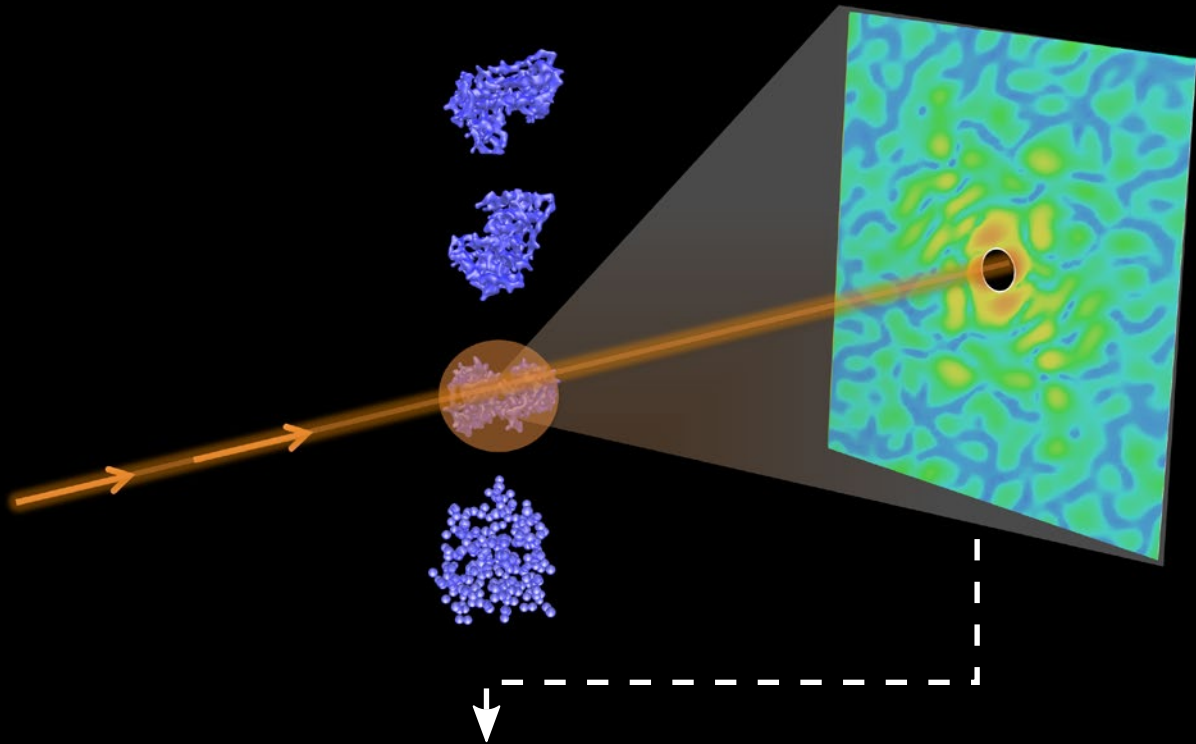


MATHEMATICS + BERKELEY

Fall 2017



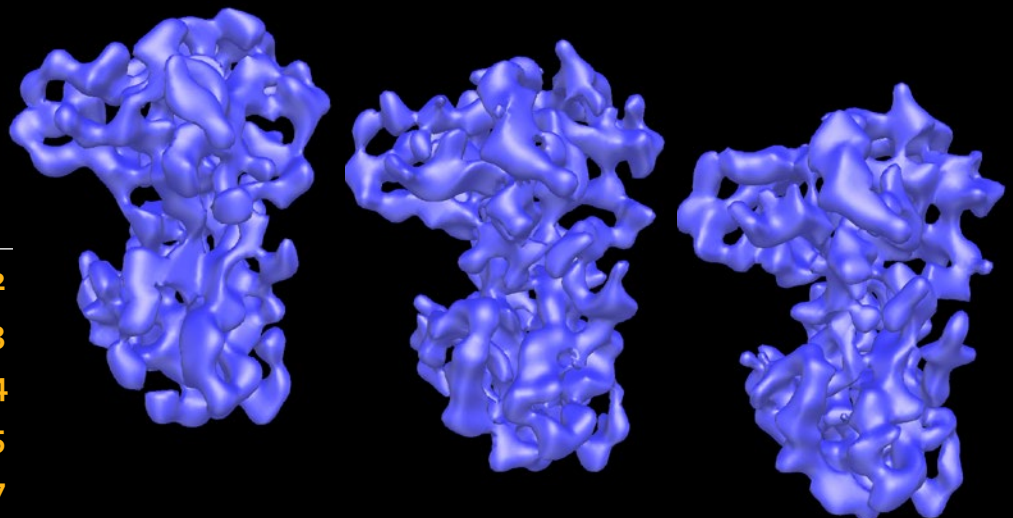
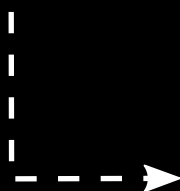
$$I(\mathbf{q}) = \left| \int_{\mathbb{R}^3} \rho(\mathbf{r}) e^{-2\pi i \mathbf{q} \cdot \mathbf{r}} d\mathbf{r} \right|^2 \quad (\widehat{P_M(I)\rho})(\mathbf{q}) = \frac{\hat{\rho}(\mathbf{q})}{|\hat{\rho}(\mathbf{q})|} \sqrt{I(\mathbf{q})}$$

$$J_m^{(k)}(q) = \sum_{l=|m|}^{\infty} \sum_{m'=-l}^l D_{lmm'}(R_k) P_l^m(\cos \theta(q)) I_{lm'}(q)$$

$$\arg \min_{R \in SO(3)} \int_0^{q_{\max}} \int_0^{2\pi} (J(q, \phi) - I^{(R)}(q, \theta(q), \phi))^2 w(q) d\phi dq$$

$$\rho^{(n+1)} = P_{S^*} P_M(I^{(n+1)}) \rho^{(n)}$$

$$I(q, \theta, \phi) = \sum_{l=0}^{\infty} \sum_{m=-l}^l I_{lm}(q) Y_l^m(\theta, \phi)$$



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Letter from the Chair



Chair Martin Olsson (PhD, Berkeley, 2001) has been a member of the math faculty since 2006. His research is in algebraic and arithmetic geometry. He became Chair in Fall 2016.

Dear Friends of Berkeley Math,

Writing this letter gives me the opportunity to look back at the past year, and I am happy to report that we've made great strides in many areas, all while managing tremendous growth in undergraduate and graduate enrollments. I hope you enjoy this edition of our math department newsletter, and that it conveys what an exciting and busy time it is here at Berkeley.

Students

At the undergraduate level, we continue to see an extraordinary interest in mathematics among our students. Each year we seem to reach all-time highs of math majors and enrollments, and this year is no different — last year we reached nearly 800 majors and about 20,000 enrollments in math classes. As one might expect we continue to serve huge numbers of students in our lower division calculus courses, but we also have surging enrollments at the upper division level and even in our graduate courses. We work hard to serve all these students, while at the same time providing opportunities for undergraduate experiences outside the traditional large class environment.

At the graduate level we welcomed 31 new students to our PhD program. Our graduate program is one of the largest and most vibrant mathematics PhD programs in the country. Vice Chair Wilkening reports on the graduate program in more detail on page 5.

Our department also connects with K-12 students through the many activities of the Berkeley Math Circle led by Teaching Professor Zvezdelina Stankova. This fall we also hosted the Julia Robinson Math Festival which brought students in grades 6 through 10 to campus for a fun-filled day of mathematical activities. The problems and mathematical activities of the festival provided a unique opportunity for the faculty and Berkeley student volunteers to engage with middle and high school students. Created by a Berkeley alumna and named in honor of former Berkeley math professor Julia Robinson, the festivals take place all around the world and bring mathematics to thousands of children.

Research

The research of our faculty and students continues to be among the best in the world. For example, in the most recent U.S. News and World Report ranking of Best Global Universities for Mathematics we were ranked #5, and in the most recent U.S. News and World Report rankings of Graduate Mathematics programs we tied for #3 with Harvard. The work of the members of our department continues to be recognized with prestigious awards.

See page 4 for discussion of some of these honors.

At the core of a successful department is the faculty, and one of our highest current priorities is to grow our research faculty. I am delighted to report that we had two successful recruitments of ladder rank faculty this past year: Assistant Professor Semyon Dyatlov, who got his PhD from Berkeley in 2013, and Associate Professor Song Sun will both be joining us in January. You can read more about Professors Dyatlov and Sun on page 7. The research life of our department continues to be enriched by our postdoc program as well as large numbers of visitors. In addition, we benefit greatly from our connections with the Mathematical Sciences Research Institute (MSRI), the Simons Institute for the Theory of Computing, Lawrence Berkeley National Laboratory (LBNL), and the Miller Institute for Basic Research.

Thanks

As has been widely publicized, this is a difficult time for the University financially and the math department feels the impact of the broader financial issues. While there may have been a time when fundraising was primarily aimed at peripheral activities of the department, it is now a necessary aspect of conducting our core operations of teaching and research. I want to thank those of you who have supported the department in the past, as well as those who may contribute in the future. Simply put, your support is indispensable in maintaining our excellence in research and teaching. I encourage you to reach out to me directly if you are looking for impactful ways to support the department's students and faculty.

One of the terrific things about serving as chair of the department is the view it provides over all aspects of the department. Most importantly, it provides an opportunity to engage with the students, staff, faculty, and friends of the department who contribute to our mission of teaching and research. I want to especially thank our Vice Chairs Olga Holtz (undergraduates), Jon Wilkening (graduates), Nicolai Reshetikhin (faculty), and Fraydoun Rezakhanlou (equity advisor). I also want to thank our department manager, Mary Pepple, for her outstanding service to the department. Mary leads a truly remarkable group of staff whose work is crucial to the success of the department. This past year we had several staff retirements, and we welcomed several outstanding new staff members. I refer you to page 7 for more details.

I hope you enjoy this newsletter and I encourage you to stay connected with the Department and University.



Vice Chairs Nicolai Reshetikhin, Jon Wilkening and Olga Holtz

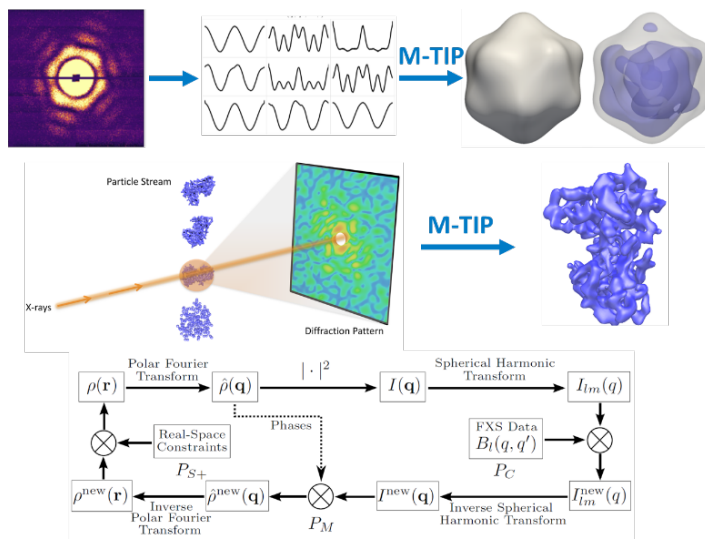
The Center for Advanced Mathematics for Energy Research Applications (CAMERA)

Technological advances have paved the way for a new host of experimental science to be performed. Due to these advances, scientific facilities are now collecting data at increasing rates and higher resolution. However, analyzing this data is becoming a major bottleneck. New mathematics and algorithms are becoming more necessary than ever to extract useful information from these experiments.

To address these growing needs, the Department of Energy established the Center for Advanced Mathematics for Energy Research Applications (CAMERA) at Lawrence Berkeley Lab. CAMERA is a coordinated team of applied mathematicians, computer scientists, beam-line scientists, materials scientists, and computational chemists focused on solving targeted science problems. The CAMERA team's mission is to work with experimentalists to identify areas in experimental science that can be aided by new mathematical insights and algorithmic tools, develop those mathematics and tools, and deliver them as user-friendly software for the experimental community.

CAMERA is directed by Berkeley Professor of Mathematics James Sethian and includes many other math department members, such as Assistant Professor Lin Lin, Berkeley alumnus and current affiliate Jeff Donatelli, and graduate student Zixi Hu.

"Computational capability is now more powerful than ever due to an explosion of recent advances in areas such as discrete math, continuous math, partial differential equations, statistics, graph theory, computational harmonic analysis, and optimization theory," says Sethian. "New mathematics can make significant contributions and help extract scientifically relevant information from experimental data."



Highlight of results enabled by CAMERA's M-TIP algorithm. Top: Fluctuation X-ray scattering reconstruction. Middle: Single-particle imaging. Bottom: Flowchart description of the M-TIP algorithm.



CAMERA members Peter Zwart, Kanupriya Pande, and Jeff Donatelli. Pande holds a 3D-printed model of a virus reconstructed from experimental data using CAMERA's M-TIP algorithm. (Photo: Marilyn Chung, Berkeley Lab)

CAMERA has developed new mathematics, algorithms, and software for areas such as ptychographic imaging, grazing incidence small-angle X-ray scattering, reconstruction and analysis of imaged materials, chemical informatics for analysis of crystalline porous materials, fast methods for electronic structure calculations, and reconstruction methods for emerging experiments at X-ray free-electron lasers.

In one such example, CAMERA algorithms were recently used to enable the first successful 3D reconstructions of viruses from a fluctuation X-ray scattering experiment, solving a 40 year old open problem [1-3]. This breakthrough was enabled by new mathematics that relates the angular correlations of experimental images to the underlying molecular structure through a combination of hyper and scalar phase problems. The associated inverse problem for determining the structures was solved using CAMERA's multi-tiered iterative phasing (M-TIP) algorithm, which exploits the mathematical structure of the problem using a series of computationally efficient projection operators.

"Emerging experimental science offers very exciting opportunities for new mathematics to be developed that can make a real difference," says Donatelli. "These new experiments provide interesting mathematical challenges in modeling the experiment, overcoming noise and artifacts, making sense of increasingly complex and bigger data, and designing robust computational tools to quickly provide meaningful results."

References:

- [1] Kam Z (1977) Determination of macromolecular structure in solution by spatial correlation of scattering fluctuations. *Macromolecules* 10(5):927-934.
- [2] Donatelli JJ, Zwart PH, and Sethian JA (2015) Iterative phasing for fluctuation X-ray scattering. *PNAS*, 112(33):10286-10291.
- [3] Kurta RP, Donatelli JJ, Yoon CH et al. (2017) Correlations in scattered X-ray laser pulses reveal nanoscale structural features of viruses. *PRL*, 119(15): 158102.

DEPARTMENT NEWS

Distinguished Lectures

- The 2016-17 Serge Lang Undergraduate Lecture was given on September 22, 2016 by **Ravi Vakil** of Stanford University, on “*The Mathematics of Doodling*.” The 2017-18 Serge Lang Lecture was given on November 2, 2017 by **Keith Devlin** of Stanford University, with a lecture entitled “*When the precision of mathematics meets the messiness of the world of people*.”
- The 2016-17 DiPerna Lecture was given on March 9, 2017 by **Herbert Koch** of University of Bonn, on “*Regularity and asymptotics of solutions to the porous medium equation*.” The 2017-2018 DiPerna Lecture will be given by **Wilhelm Schlag** of University of Chicago, on January 25, 2018.
- The 2017 Alfred Tarski Lectures were given by **Lou van den Dries** of the University of Illinois at Urbana-Champaign. The series of three lectures, given on April 10, 12 and 14, were entitled “*Model Theory as a Geography of Mathematics*”, “*Orders of Infinity and Transseries*” and “*Model Theory of Transseries: Results and Open Problems*.”
- The 2016-17 Chern Lectures were given on January 31–February 3, 2017 by **Sergiu Klainerman** of Princeton University, with a series entitled “*On the Mathematical Theory of Black Holes*.” The 2017-2018 Chern Lectures will be given by **Martin Hairer** of the University of Warwick, during the week of March 19, 2018.
- The 2016-2017 Bowen Lectures were given on February 22, 23 and 24, 2017 by **Michael Harris** of Columbia University, on “*Automorphic Galois representations and Langlands correspondences*.” The 2017-2018 Bowen Lectures will be given by Avi

Wigderson of the Institute for Advanced Study, on February 7, 8 and 9, 2018.

- The 2017 Chern-Simons Research Lectures were given on April 3, 5 and 7 by **Ivan Corwin** of the Columbia University on “*Stochastic Quantum Integrable Systems*.”

Faculty Honors

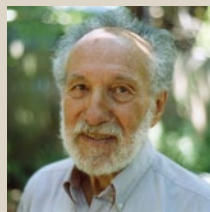
- Professors **Thomas Scanlon** and **Maciej Zworski** received 2017 Simons Fellowships in Mathematics.
- Assistant Professor **Pierre Simon** received a 2017 Sloan Research Fellowship.
- **Peter Hintz** became a 2017 Clay Research Fellow.
- Assistant Professor **Lin Lin** won a 2017 Early Career Research Award from the Department of Energy and the 2017 SIAM CSE Early Career Prize.
- Morrey Visiting Assistant Professor **Kathryn Mann** received the 2016 Mary Ellen Rudin Award by the journal *Topology and its Applications*.
- Professor **Kenneth Ribet** won the 2017 Brouwer Medal of the Royal Dutch Mathematical Society.
- Professor **Michael Hutchings** received the Humboldt Research Award by the Alexander von Humboldt Foundation.
- Professor **Vera Serganova** was elected to the American Academy of Arts and Sciences.
- Professor **James Sethian** gave the 2017 Martin Meyerson Berkeley Faculty Research Lecture.

In Memoriam



Prof. **Paul Robert Chernoff** (1942-2017) was a member of our department for nearly five decades. He is recognized for the Chernoff Theorem, a result in functional analysis and Lie algebras which supports the Feynman path integral formulation of quantum mechanics, and for a lucid presentation of the Groenwald-van Hove “no go” theorem, relating classical mechanics to quantum mechanics.

Prof. **Jacob Feldman** (1928-2017) received his PhD from the University of Chicago in 1954. In 1957, he joined the Berkeley Mathematics department, where he worked until retirement in 1993. His research field was in ergodic theory and stochastic processes.



Prof. **Marina Ratner** (1938-2017) was educated in Moscow, obtained her doctoral degree at the Moscow State University, emigrated to Israel in 1971, and joined the Berkeley Mathematics Department in 1975. Her work was mainly in ergodic the-

ory and its connections with other parts of mathematics, and earned many honors, including the Ostrowski Prize and the John J. Carty Award, and she was a member of the National Academy of Science. She was also an outstanding and beloved teacher and cared deeply about mathematics education.

Prof. **Donald E. Sarason** (1933-2017) received his PhD from the University of Michigan in 1963. He was a mathematics professor and researcher at UC Berkeley for over 50 years. As talented a mathematician and dedicated a teacher as he was, he will be remembered most for his humility, kindness, gentleness and generosity. He retired in 2012.



Prof. **Jack H. Silver** (1942-2017) was born in Missoula, Montana. He received his PhD from UC Berkeley in 1966 under the supervision of Robert Vaught. In 1967, he joined the Department of Mathematics at UC Berkeley where he also became a member of the Group in Logic and the Methodology of Science. His mathematical interests included set theory, model theory, and proof theory. Silver retired in 2010.

GRADUATE PROGRAM NEWS

Our graduate program remains one of the top-rated graduate programs worldwide (tied for 3rd in the most recent *U.S. News and World Report* ranking of math graduate programs), and the top graduate program among public universities in the United States. The excellence, energy, and creativity of our graduate students continue to be key success factors for the department in research and teaching. This past year we welcomed 31 new PhD students (25 Pure, 3 Applied, 3 Logic) to our program, 12 of whom were international students. This cohort was selected from an extraordinarily talented group of applicants, and includes some of the most promising young mathematicians in the country and world. Last year we awarded 22 PhDs and 2 Masters degrees. Many of these degree recipients went on to academic postdoctoral positions in mathematics, including prestigious positions at many of the top institutions around the world. We also saw several of our graduate students take their mathematical skills into industry positions. Our graduate students have won numerous awards and fellowships; several of them were also honored with departmental prizes at last year's commencement ceremony.



Professor Jon Wilkening, Vice Chair for Graduate Affairs

Graduate Student Honors

- **Alexis Drouot** and **Matthew Harrison-Trainor** received the 2016-17 Herb Alexander Prize, awarded for outstanding dissertations in pure mathematics.
- The 2016-17 Bernard Friedman Memorial Prize in Applied Mathematics was awarded to **Joe Kileel**.
- **Steven N. Karp** and **Gus Schrader** received the Kenneth Ribet & Lisa Goldberg Award in Algebra.
- **Andreas Voellmer** was awarded the 2016-17 Nikki Kose Memorial Teaching Prize.
- **Nic Brody, Catherine Cannizzo, Benjamin Castle, Kai-Chieh Chen, Alexis Drouot, Dan Daniel Erdmann-Pham, Christopher Eur, Elizabeth Ferme, Matthew Harrison-Trainor, Archit Kulkarni, Christopher Policastro, Meredith Shea, Franco Vargas Pallete, Ben Wormleighton, Zhengyi Zhou, and Theodore Zhu** received 2016-2017 Outstanding Graduate Student Instructor Awards.

2017 Commencement

The Department of Mathematics' 2017 Commencement Ceremony took place on May 18th in Zellerbach Auditorium. This year's commencement speaker was Phillip Griffiths Distinguished Professor of Mathematics Robert L. Bryant of Duke University. The ceremony saw 336 mathematics and applied mathematics majors receive undergraduate degrees, while 22 graduate students received Masters and PhDs; a number of departmental prizes (both graduate and undergraduate) were also awarded during the ceremony.



Professor Robert L. Bryant
(Photo: GradImages)

Undergraduate Student Honors

- Class of 2017 Valedictorian **Binglin Song** was awarded the 2016-2017 Departmental Citation and the 2017 Chernoff Award. This new award was created in the honor of our late colleague Paul Chernoff by his brother Don Chernoff.
- **Unpil Baek, Sky Cao, Laura Harker, Donovan Lieu, Joelle Sze Min Lim, Brandon Pickering, Haowen Wu, and Albert Zheng** were awarded the Dorothea Klumpke Roberts Prize in Mathematics in recognition of their truly exceptional scholarship.
- **Raj Agrawal, Eduardo Amaral, Yidong Chen, Yiqun Chen, Aaron Doman, Weiyi Liu, and R. Loek Van Heyningen** were awarded the Percy Lionel Davis Award for Excellence in Scholarship in Mathematics.
- Congratulations to **Brian Burks, Lewis Chen, and Hua Wang** for earning Honorable Mention honors in the 2016 William Lowell Putnam Mathematical Competition. Other UC Berkeley students finishing in the top 200 (out of 4,164 competitors) were **Aaron Doman, Xingyou Song, and Jonathan Xia**. UC Berkeley had more students place in the top 200 than any other public school in the United States.
- **Sameera Vemulapalli** was named Runner-Up for the 2018 Schafer Prize sponsored by the Association of Women in Math.



Photos: Alex Carney

Congratulations to our students who received their PhDs this past academic year!

David Anderson “Reliable and Efficient Algorithms for Spectrum-Revealing Low-Rank Data Analysis” under Ming Gu and Per-Olof Persson. David is now an equity strategist at Goldman Sachs.

Daniel Appel “Theory of Real Bundles on the Projective Line” under David Nadler.

Anastasia Chavez “Posets, Polytopes, and Positroids” under Lauren Williams and Federico Ardila. Anastasia is now a postdoc at MSRI.

Alexis Drouot “Stability of Resonances under Singular Perturbations” under Maciej Zworski. Alexis is now a postdoc at Columbia University.

Andrew Dudzik “Quantaes and Hyperstructures” under Martin Olsson and Matt Baker. Andrew is now a research engineer at Google DeepMind.

Kuan-Ying Fang “Geometric Constructions of Mapping Cones in the Fukaya Category” under Denis Auroux.

Cristian-Dan Gavrus “Global well-posedness and parametrices for critical Maxwell-Dirac and massive Maxwell-Klein-Gordon equations with small Sobolev data” under Daniel Tataru. Cristian-Dan is now a postdoc at UC Berkeley.

Steven Karp “Total positivity for Grassmannians and amplituhedra” under Lauren Williams. Steven is now a postdoc at University of Michigan.

Alvin Kerber “Quasi-Fuchsian surface subgroups of infinite covolume Kleinian groups” under Ian Agol.

Joe Kileel “Algebraic Geometry for Computer Vision” under Bernd Sturmfels. Joe is now a postdoc at Princeton University.

Eugenia Kim “Numerical methods for the Landau-Lifshitz equation in micromagnetics: the mimetic finite difference method and the mass-lumped finite element method” under Jon Wilkening. Eugenia is now a postdoc at NYU / Courant.

Bo Lin “Combinatorics and Computations in Tropical Mathematics” under Bernd Sturmfels. Bo is now a postdoc at University of Texas, Austin.

George Melvin “Crystals and Mirror Constructions for Quotients” under Constantin Teleman. George is now a Lecturer at Harvard University.

Christopher Miller “Methods for Optimal Stochastic Control and Optimal Stopping Problems Featuring Time-Inconsistency” under Craig Evans. Christopher is now an associate at Goldman Sachs.

Amelia Spivak “Multisymplectic Geometry in General Relativity and other Classical Field Theories on Manifolds with Boundaries: A Deobfuscating Role” under Nicolai Reshetikhin.

Doosung Park “Triangulated Categories of Motives over fs Log Schemes” under Martin Olsson.

Eugenia Rosu “Integers that can be written as the sum of two rational cubes” under Xinyi Yuan. Eugenia is now a postdoc at University of Arizona.

Gus Schrader “Quantum groups, character varieties and integrable systems” under Nicolai Reshetikhin. Gus is now a Ritt Assistant Professor at Columbia University.

Emmanuel Tsukerman “Combinatorial Analysis of Continuous Problems” under Lauren Williams and Bernd Sturmfels. Emmanuel is now working for Zitovault.

Ethan Van Andel “Eulerian Simulation of Elastic Membranes and Shells” under James Sethian.

Markus Vasquez “Essays in Mathematical Economics” under Robert Anderson.

Qiao Zhou “Applications of Toric Geometry to Geometric Representation Theory” under David Nadler. Qiao is now a postdoc at the Perimeter Institute.



Commencement 2017 (Photo: Michael Wan)

New Faculty



Semyon Dyatlov

Assistant Professor Semyon Dyatlov comes to our department in Spring 2018. Dyatlov applies techniques from microlocal analysis, dynamical systems, and more recently harmonic analysis, fractal geometry, and additive combinatorics (combined to obtain a fractal uncertainty principle) to

problems in quantum chaos, dynamical systems, and general relativity. Dyatlov obtained his PhD from UC Berkeley in 2013 under the supervision of Maciej Zworski. He has been a Clay Research Fellow at MIT since 2013 and an Assistant Professor at MIT since 2015.



Song Sun

Associate Professor Song Sun comes to Berkeley from Stony Brook University. Sun's research area includes differential geometry and its connection with algebraic geometry. Sun obtained his PhD at the University of Wisconsin-Madison in 2010, under the supervision of Xiuxiong Chen.

After spending three years as a Research Associate at Imperial College London, he joined the faculty at Stony Brook University in 2013. Sun was awarded a Sloan Research Fellowship in 2014, and is an invited speaker at the International Congress of Mathematicians in Rio de Janeiro 2018.

Faculty Promotions

Professor **Jon Wilkening** was promoted to Full Professor.

New Morrey Visiting Assistant Professors

Carolyn Abbott (Geometric Group Theory and Low-Dimensional Topology), PhD University of Wisconsin-Madison, 2017.

Charles Hadfield (Global Analysis and Analysis on Manifolds), PhD École Normale Supérieure, 2017.

Tim Laux (Mathematical Analysis), PhD Max Planck Institute for Mathematics, 2017.

New Visiting Faculty and Postdocs

Alexander Alldridge (Algebra), U. Cologne. Visiting scholar and Heisenberg fellow.

Sylvie Corteel (Combinatorics), U. Paris – Diderot /CNRS. Visiting Miller Professor.

Cristian Dan Gavrus (Mathematical Analysis), PhD UC Berkeley 2017. Postdoc.

Barbara Fantechi (Algebraic Geometry), Scuola Internazionale Superiore di Studi Avanzati. Chancellor's Professor, visiting spring 2018.

Jeremy Lovejoy (Number Theory), U. Paris - Diderot /CNRS. Lecturer.

Thibault de Poyferre (Mathematical Analysis), PhD École Normale Supérieure. Miller Fellow.

Dmitry Tonkonog (Symplectic Geometry and Topology), PhD University of Cambridge, 2016. Simons Collaboration Visiting Assistant Professor.

Martin Vogel (Mathematical Analysis), PhD Université de Bourgogne, 2015. Postdoc, Erwin Schrödinger Fellow.

Staff news

There were three departures among our staff in the month of July. **Kim Oyler** retired after working 10 years as math's Academic HR Analyst with 27 years of UC Berkeley service. **Kathy Santos** retired after working 12 years as math's Facilities Coordinator with 28 years of UC Berkeley service. **Monica Warde** accepted a lateral transfer to physics after two years in math.

There are five new staff members. In June, **Jasan Fujii** joined the department as the Facilities Coordinator. He has ten years of UC experience and previously worked for the Campus Movers. In July, **Alev Hatay** and **Emma Lindley** joined the Chair's office, as Academic HR Analysts. Alev Hatay is responsible for Non-Senate academic personnel matters. She has 10 years of UC experience and most recently worked for Campus Shared Services. Emma Lindley is responsible for Senate academic personnel matters. She has four years of UC experience and formerly worked for the Academic Personnel Office. In October, **Brandon Eltiste** joined the department as the Information Systems Analyst. He has six years of UC experience and previously worked for the UC Library. **Maria Perez** joined Math's CSS Research Administration staff in October. She previously worked as an Assistant Producer for a small recording studio in LA.

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FALL 2017 NEWSLETTER



Entering class of graduate students 2017 (Photo: Vicky Lee)

A Note on Strategic Priorities

The Department of Mathematics is working hard to maintain its excellence in all aspects of research and education and to bridge the resource gap that separates us from our better-funded peers. For this we continue to rely on donations from alumni and friends of the department. Here are some of the department's current top priorities:

- **Graduate Student Fellowships** are needed to enable the department to make competitive, attractive offers to the very strongest applicants to our graduate program, who are often being lured by our private peers with offers of higher stipends and lower teaching loads.
- **Endowed Faculty Chairs** are needed in order to improve the department's ability to make competitive offers for the recruitment and retention of world-class faculty.
- **Research Visitor Funds** make it easier to invite high-profile visitors to come to Berkeley to deliver lectures in our department or collaborate with our faculty. These intellectual exchanges are of tremendous value to our research and education.

Besides these specific goals, we welcome gifts to the department's discretionary fund, which give the Chair of the department much-needed flexibility in funding graduate student recruitment, parts of the faculty recruitment process, research travel for graduate students, and many other initiatives that make our program competitive and rewarding.

We invite you to join us in keeping UC Berkeley Mathematics strong through your gifts to the department. All donations, large or small, are greatly valued. You may choose whether to direct your gift toward a specific goal of your choice or to have your donation used for our most pressing needs at the department's discretion.

For further information, please contact Development Directors Nicholas Cole, e-mail: ncole@berkeley.edu or Maria Hjelm, e-mail: mhjelm@berkeley.edu, or Department of Mathematics Chair Prof. Martin Olsson, e-mail: chair@math.berkeley.edu.

Newsletter Contributors: Editor: Per-Olof Persson. Thanks to Martin Olsson, Gina Spindler, Maria Hjelm, Jeff Donatelli, Denis Auroux, Jon Wilkening, Vicky Lee, Jennifer Sixt, and Mary Pepple. *Photography:* mostly George Bergman, some from the Archives of the Mathematisches Forschungsinstitut Oberwolfach. *Cover:* Jeff Donatelli, illustration of single-particle reconstruction using CAMERA's M-TIP algorithm.

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