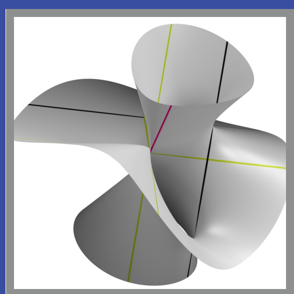
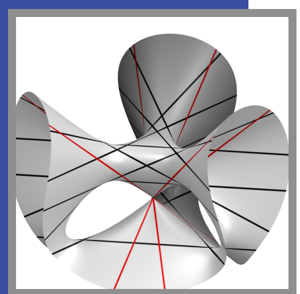
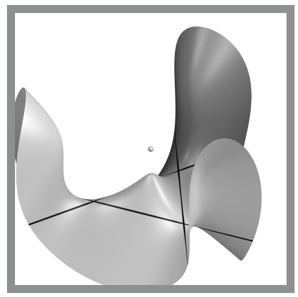
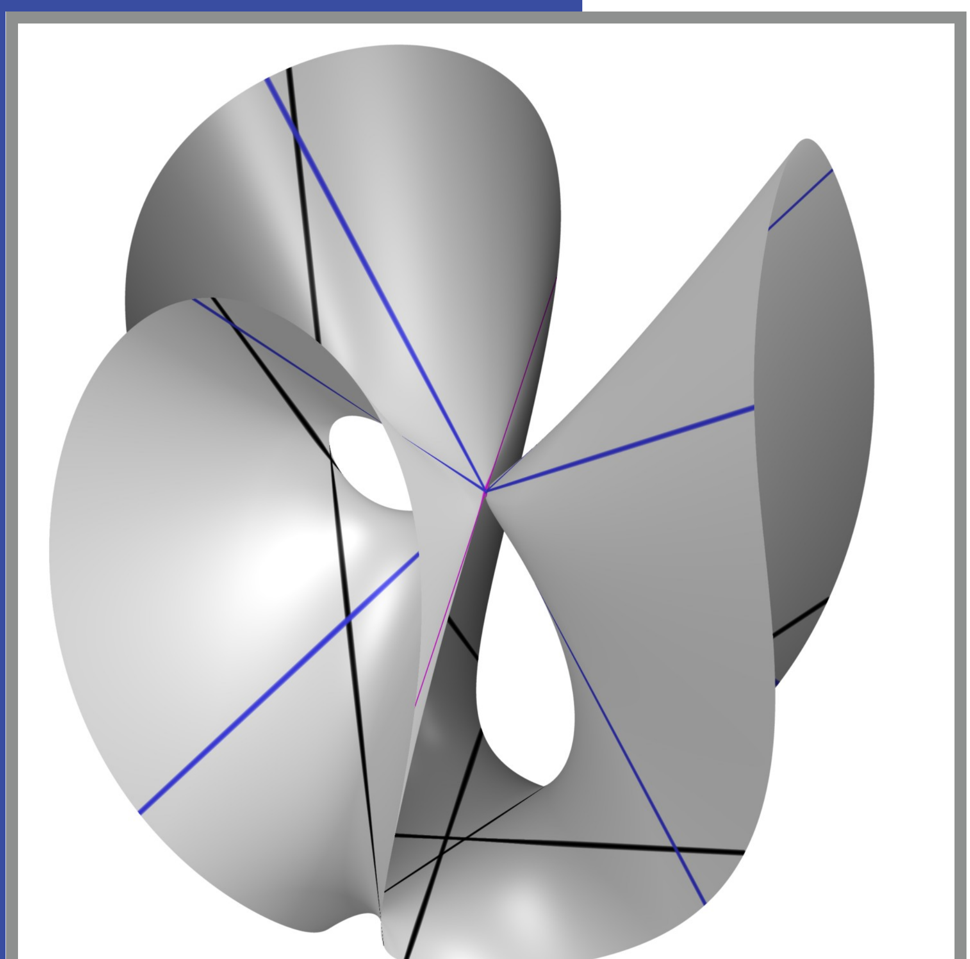
SIMONS FOUNDATION
Mathematics & Physical Sciences

ANNUAL MEETING



2013

NEW YORK

OCTOBER 10-11, 2013

WELCOME

Dear Investigators, Fellows & Colleagues:

We are delighted to welcome you to the first Annual Meeting of the Mathematics and the Physical Sciences (MPS) Division of the Simons Foundation and to congratulate you on your remarkable research achievements! You are here because your work is of extraordinary impact and promise.

The Annual Meeting is an opportunity for you to meet and interact with your peers in Mathematics, Theoretical Physics and Theoretical Computer Science. One of our goals at MPS is to stimulate the flow of ideas across disciplines; we very much hope that new science and new collaborations will result from this meeting.

The Simons foundation is a private foundation established by Jim and Marilyn Simons. The Foundation supports a range of activities, most notably the Simons Foundation Autism Research Initiative (SFARI), a new Simons Center for Data Analysis (SCDA), research into the life sciences, as well as MPS. This package contains information about the activities of the MPS division; here we simply wish to note that our keynote programs --Simons Investigators, Simons Fellows and Collaboration grants in Mathematics are all intended to provide outstanding scientists with the resources needed to do the work they consider to be of the greatest importance.

We are delighted to have the opportunity to get to know you and look forward to hearing about the exciting discoveries you have made and will be making.

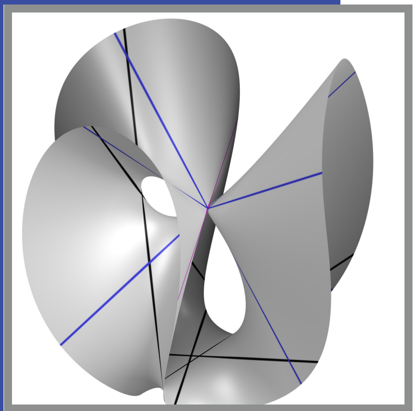
Sincerely,

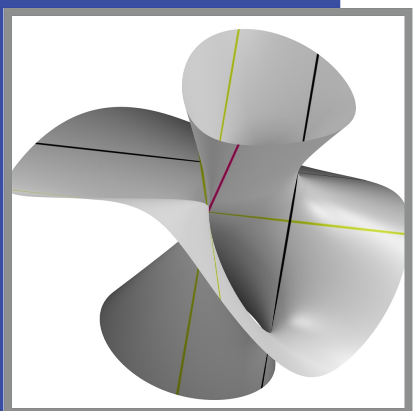
Yuri Tschinkel

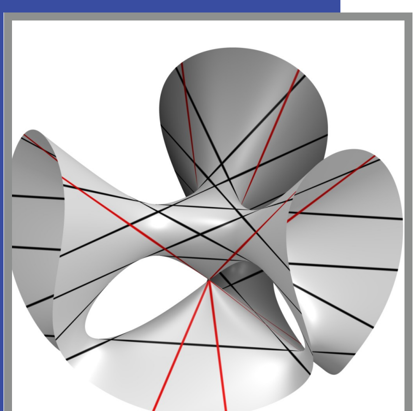
Director of Mathematics and Physical Sciences

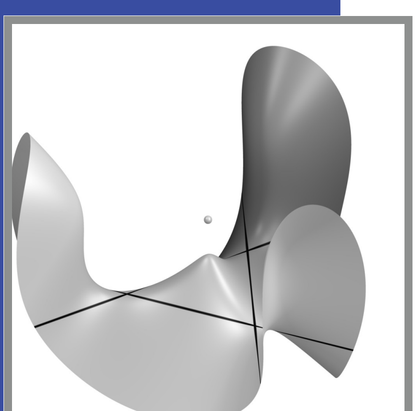
Andy Mills

Associate Director of Physics









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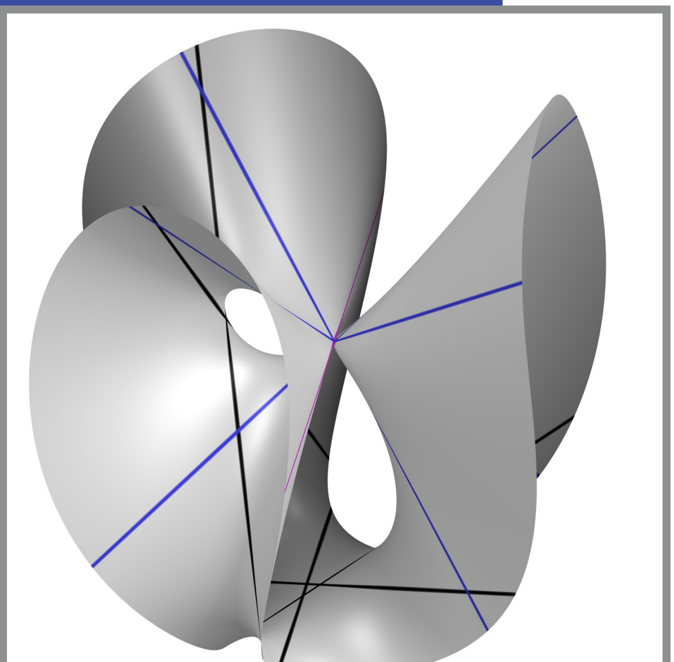


MEETING INFORMATION

HOTEL & VENUE INFORMATION

MEETING AGENDA

KEYNOTE SPEAKER

SIMONS FOUNDATION

Mathematics & Physical Sciences

HOTEL INFORMATION

Carlton Hotel

88 Madison Avenue
New York, NY 10016
T: (212) 532-4100
http://www.carltonhotelny.com/

WiFi is complimentary in each guest room.

Checkout at Noon. You will be automatically checked out and a final bill for any incidentals will be placed under your door on the morning of your day of departure.

Service and Facilities. Business and fitness centers are open 24 hours a day.

Transportation. The day before your departure you will receive in your room a written reminder of your flight time and the time and location of departure to the airport/train station.

Susie Levitz will be available at the Gerald D. Fischbach Auditorium on Friday morning for any questions regarding your travel arrangements.

Luggage. For those departing from the Gerald D. Fischbach Auditorium after the conclusion of Annual Meeting, you should bring your luggage with you to the meeting.

Contact information. For transportation questions, call Susie Levitz at: (917) 880-9600. For meeting questions call Meghan Fazzi at: (646) 706-1007.

VENUE INFORMATION

Gerald D. Fischbach Auditorium, Simons Foundation

160 Fifth Avenue (at 21st Street)
New York, NY 10010
T: (646) 654-0066
www.simonsfoundation.org

WiFi at the Gerald D. Fischbach Auditorium is available. You should be automatically connected to the network. If not, the network is: 160Guests. The password is: simonsnyc.

Auditorium. A microphone and AC power connection are located at each seat. Food and beverages are not allowed in the auditorium.

MEETING AGENDA

Thursday, October 10

8:30 - 9:30 AM	Check-in & Breakfast
9:30 - 10:30 AM	**Daniel Spielman** The Solution of the Kadison-Singer Problem
10:30 - 11:00 AM	Break
11:00 - 12:00 PM	**Joel Moore** Geometrical and Dynamical Structures in Quantum Materials
12:00 - 1:30 PM	Lunch
1:30 - 2:30 PM	**Christopher Hacon** The Geometry of Polynomial Equations
2:30 - 3:00 PM	Break
3:00 - 4:00 PM	**Alice Guionnet** About Topological Expansions
4:00 - 4:30 PM	Break
4:30 - 5:30 PM	**David Donoho** Scientific Transparency in the Era of Massive Computation
6:00 - 9:00 PM	Dinner at Alison Eighteen

MEETING AGENDA

Friday, October 11

8:30 - 9:30 AM	Check-in & Breakfast
9:30 - 10:30 AM	**Hirosi Ooguri** String Theory and Its Applications in Mathematics and Physics
10:30 - 11:00 AM	Break
11:00 - 12:00 PM	**Shafi Goldwasser** Pseudo Deterministic Algorithms
12:00 - 1:30 PM	Lunch
1:30 - 2:30 PM	**Roger Blandford** The Accelerating Universe
2:30 - 3:30 PM	**John Lott** Optimal Transport and Geometry

RESTAURANT INFORMATION

Alison Eighteen

15 West 18th Street
New York, NY 10011
T: (212) 366-1818
http://alisoneighteen.com/

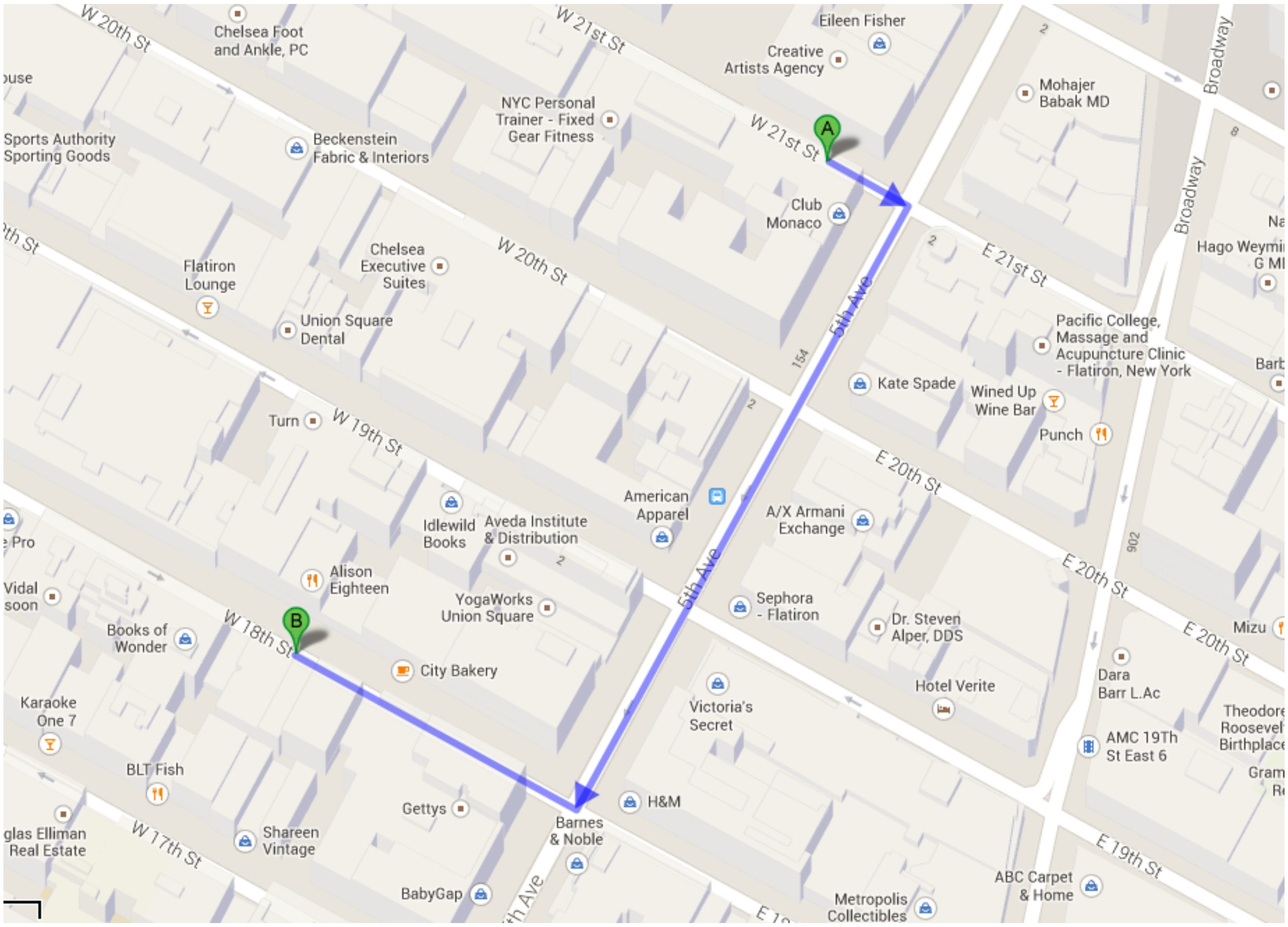
Walking Direction from the Simons Foundation to Alison Eighteen

Head Southeast on West 21st Street toward Fifth Avenue

Turn right onto Fifth Avenue

Turn right onto West 18th Street

Destination will be on the right.



KEYNOTE SPEAKER

David Donoho, Ph.D.

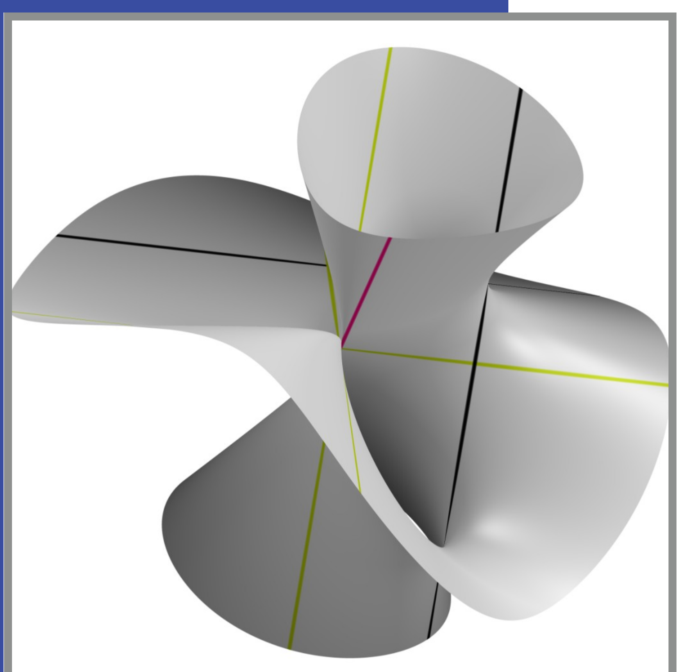
Stanford University

Scientific Transparency in the Era of Massive Computation

Donoho attended Princeton University, where his undergraduate thesis advisor was John W. Tukey. Donoho obtained his Ph.D. from Harvard University in 1983 under the supervision of Peter Huber.

Donoho is a Fellow of the American Academy of Arts and Sciences, a member of the U.S. National Academy of Sciences and a foreign associate of the French Académie des Sciences.

In addition to a MacArthur fellowship, he has received the Committee of Presidents of Statistical Societies (COPSS) Presidents' Award, the John von Neumann Prize of the Society for Industrial and Applied Mathematics (SIAM) and the Norbert Wiener Prize in Applied Mathematics, given jointly by SIAM and the American Mathematical Society. Donoho has also received honorary doctorates from the University of Chicago and from the École Polytechnique Fédérale de Lausanne. He will receive the 2013 Shaw Prize in Mathematical Sciences.



MATH & PHYSICAL SCIENCES DIVISION

SCIENTIFIC ADVISORY BOARD

MPS PROGRAM SUMMARY

FUNDED PROGRAMS

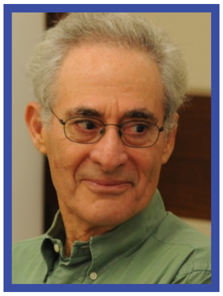
SIMONS FOUNDATION
Mathematics & Physical Sciences

SCIENTIFIC ADVISORY BOARD

MATHEMATICS

Gerard Ben Arous
New York University

Charles Fefferman
Princeton University



Barry Mazur
Harvard University

Dusa McDuff
Columbia University

THEORETICAL PHYSICS

Susan Coppersmith
University of Wisconsin, Madison

Scott Tremaine
Institute for Advanced Study

Cumrun Vafa
Harvard University

THEORETICAL COMPUTER SCIENCE

Kurt Mehlhorn
Max Planck Institute for Computer Science

Eva Tardos
Cornell University

Avi Wigderson
Institute for Advanced Study

MATHEMATICS AND PHYSICAL SCIENCE DIVISION

MPS PROGRAM SUMMARY

The Simons Foundation's division for Mathematics and the Physical Sciences (MPS) seeks to extend the frontiers of basic research. The division's primary focus is on the theoretical sciences, in particular, mathematics, theoretical physics and theoretical computer science.

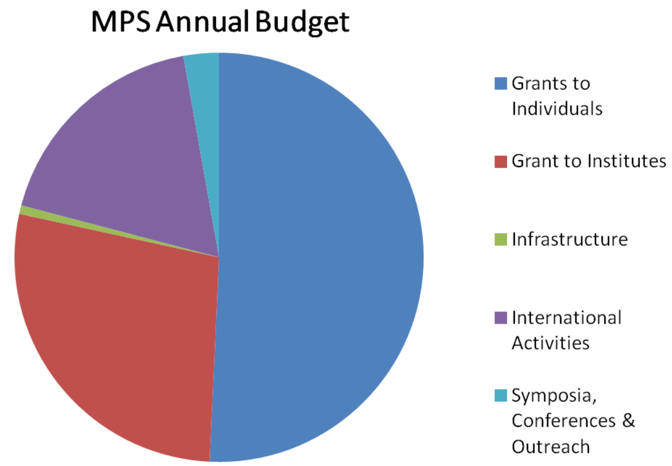
The MPS division aims to determine which types of support will best stimulate fundamental research and to provide such support. A related goal of this division is to enhance the academic and research infrastructure. MPS also strives to promote synergies between academic disciplines, leading to new and unforeseen discoveries.

The MPS division has undertaken a wide variety of projects. Grants to individuals are the core of its grant giving operations. In 2011, the Simons Foundation launched its flagship Simons Investigators program, which provides long-term support for outstanding theoretical scientists, its Simons Fellow program, designed to support researchers during sabbaticals, and its Collaboration Grants for Mathematicians program. The Math+X Encouraging Interactions grants create endowed chairs at U.S. universities that connect mathematics departments with partner departments, and provide generous activity funds for the chair holders.

MPS also awards grants to institutions: it has created the Simons Institute for the Theory of Computing at the University of California, Berkeley, and supports established institutes, such as the Mathematical Sciences Research Institute in Berkeley and the Kavli Institute for Theoretical Physics at Santa Barbara.

Funding decisions are made through a competitive application and nomination-based process. MPS does not accept proposals outside its established programs, though it is interested in suggestions for innovative general programs that could benefit from fundamental research.

Further information about our programs and about the Simons Foundation is available at SimonsFoundation.org.



MATHEMATICS AND PHYSICAL SCIENCE DIVISION

FUNDED PROGRAMS

GRANTS TO INDIVIDUALS

- Simons Investigators in Mathematics, Physics, Theoretical Computer Science, and the Mathematical Modeling of Living Systems
- Simons Fellows in Mathematics and Theoretical Physics
- Collaboration Grants for Mathematicians
- Math+X: Encouraging Interactions
- AMS-Simons Travel Grants (in Mathematics)
- Simons Awards for Graduate Students in Theoretical Computer Science

GRANTS TO INSTITUTES

- Simons Institute for the Theory of Computing, Berkeley
- Mathematical Sciences Research Institute, Berkeley
- Kavli Institute for Theoretical Physics, Santa Barbara
- The Aspen Center for Physics

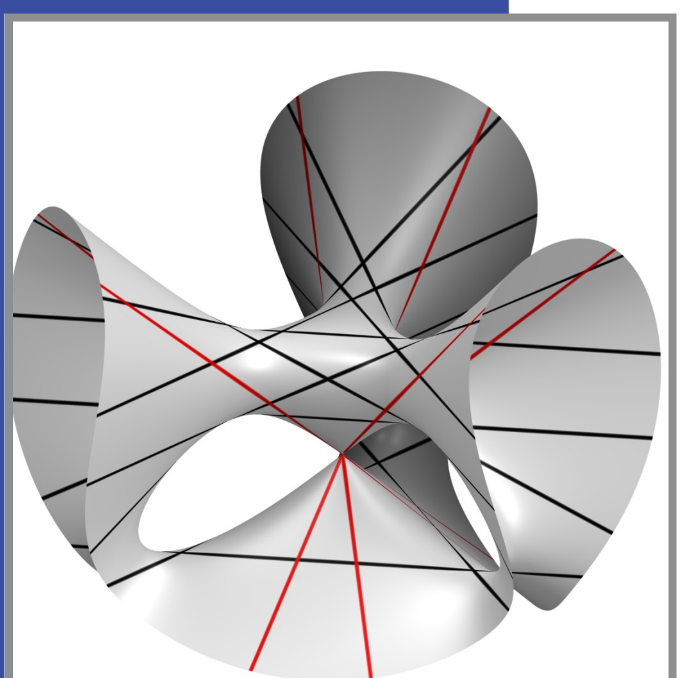
INTERNATIONAL ACTIVITIES

- Institut des Hautes Études Scientifiques, Paris
- American University of Beirut
- Instituto Nacional de Matematica Pura e Aplicada, Rio de Janeiro
- Independent University of Moscow
- Africa Mathematics Project
- Mathematical Research Institute Oberwolfach
- Erwin Schröedinger International Institute for Mathematical Physics, Vienna
- The Abdus Salam International Center for Theoretical Physics, Trieste
- National Centre for Biological Sciences, Tata Institute, Bangalore
- Tsinghua Sanya International Mathematics Forum
- International Mathematical Union

SYMPOSIA, CONFERENCES, and OUTREACH

INFRASTRUCTURE

- arXiv
- MAGMA



SIMONS INVESTIGATORS

INVESTIGATOR PROFILES

MATHEMATICS
COMPUTER SCIENCE
PHYSICS

SIMONS FOUNDATION
Mathematics & Physical Sciences

SIMONS INVESTIGATORS, MATHEMATICS

Ngô Bảo Châu

University of Chicago

Ngô' Bảo Châu's proof of the fundamental lemma, a deep conjecture of Langlands, inaugurated a new geometric approach to problems in harmonic analysis based on arithmetic geometry. His ideas have already inspired work in many areas, including mathematical physics and geometric representation theory.

SIMONS INVESTIGATORS, MATHEMATICS

Manjul Bhargava

Princeton University

Manjul Bhargava pursues algebraic number theory and the geometry of numbers in the tradition of Gauss and Minkowski. Bhargava has inspired an extraordinary resurgence of this field, with wonderful applications. His overarching goal in this work is to count the basic objects of number theory and to make computational conclusions about their asymptotics. For example, it is conjectured that, in a certain natural sense, the average rank of the group of rational points of an elliptic curve defined over the rationals is 1/2. Bhargava and his student Arul Shankar recently showed that it is less than 1. Previously, it was not even known whether the average rank is finite. In joint work with Benedict Gross, Bhargava has also shown that the number of rational points on the majority of hyperelliptic curves is bounded by a certain small number independent of the genus of the curve. This work opens up remarkable new vistas in arithmetic and suggests exciting conjectures.

SIMONS INVESTIGATORS, MATHEMATICS

Alice Guionnet

Massachusetts Institute of Technology

Alice Guionnet has done profoundly important work on the statistical mechanics of disordered systems (and in particular the dynamics and aging of spin glasses), random matrices (with an emphasis on the combinatorics of maps), and operator algebra/free probability. Her work on large deviations for spectra of random matrices has been highly influential. She has extended the large deviation principle to the context of Voiculescu's free probability theory, and in collaboration with Cabanal-Duvillard, Capitaine and Biane, she proved various large deviation bounds in this more general setting. These bounds enabled her to prove an inequality between the two notions of free entropy given by Voiculescu, settling half of the most important question in the field. With her former students M. Maida and E. Maurel-Segala, and more recently with V. Jones and D. Shlyakhtenko, Guionnet has studied statistical mechanics on random graphs through multimatrix models. Their work with the general Potts models on random graphs branches out in promising directions within operator algebra theory.

SIMONS INVESTIGATORS, MATHEMATICS

Chrisopher Derek Hacon

University of Utah

Christopher Hacon's works are among the most important contributions to higher-dimensional algebraic geometry since Mori's in the 1980s. Hacon and his co-authors have solved major problems concerning the birational geometry of algebraic varieties, including the characterization of irregular varieties, boundedness theorems for pluricanonical maps, a proof of the existence of flips, the completion of the minimal model program for varieties of general type, and bounds for the order of automorphism groups of varieties of general type. His work has also led to solutions of other problems, such as the existence of moduli spaces for varieties of general type and the ascending chain condition for log canonical thresholds.

SIMONS INVESTIGATORS, MATHEMATICS

Matthew Hastings

Duke University

Matthew Hastings was appointed as an Investigator in 2012. He has since transitioned out of his Simons Investigatorship and moved to Microsoft Research. Hastings' work combines physical insight and mathematical power to make profound contributions to a range of topics in physics and related fields. His Ph.D. thesis produced breakthrough insights into the multifractal nature of diffusion-limited aggregation, a problem that had stymied statistical physicists for more than a decade. Hastings' recent work has focused on proving rigorous results on fundamental questions of quantum theory, including the stability of topological quantum order under local perturbations. His results on area laws and quantum entanglement and his proof of a remarkable extension of the Lieb–Schultz–Mattis theorem to dimensions greater than one, have provided foundational mathematical insights into topological quantum computing and quantum mechanics more generally.

SIMONS INVESTIGATORS, MATHEMATICS

Maryam Mirzakhani

Stanford University

Mirzakhani's work is focused on Teichmüller theory and dynamics of natural geometric flows over the moduli space of Riemann surfaces. One of her major results, in joint work with Eskin and Mohammadi, is a proof that stationary measures for the action of $SL_2(R)$ on the space of flat surfaces are invariant, a deep and long-standing conjecture.

SIMONS INVESTIGATORS, MATHEMATICS

Paul Seidel

Massachusetts Institute of Technology

Paul Seidel has done major work in symplectic geometry, in particular on questions inspired by mirror symmetry. His work is distinguished by an understanding of abstract algebraic structures, such as derived categories, in sufficiently concrete terms to allow one to derive specific geometric results. On the abstract side, Seidel has made substantial advances towards understanding Kontsevich's homological mirror symmetry conjecture and has proved several special cases of it. In joint papers with Smith, Abouzaid and Maydanskiy, he has investigated the symplectic geometry of Stein manifolds. In particular, his work with Abouzaid constructs infinitely many nonstandard symplectic structures on any Stein manifold of sufficiently high dimension.

SIMONS INVESTIGATORS, MATHEMATICS

Amit Singer

Princeton University

Amit Singer works on a broad range of problems in applied mathematics, solving specific applied problems and employing sophisticated theory to allow the solution of general classes of problems. Among the areas to which he has contributed are diffusion maps, cryo-electron microscopy, random graph theory, sensor networks, graph Laplacians, and diffusion processes. His recent work in electron microscopy combines representation theory with a novel network construction to provide reconstructions of structural information on molecules from noisy two-dimensional images of populations of the molecule. He works with a widely varied group of collaborators and graduate students in several disciplines. His work is increasing the range of applicable mathematics.

SIMONS INVESTIGATORS, MATHEMATICS

Kannan Soundararajan

Stanford University

Soundararajan is one of the world's leaders in analytic number theory and related areas. His work is focused on understanding the zeros and value distribution of L-functions, and on analyzing the behavior of multiplicative functions. In particular, his work (together with co-authors) has led to weak subconvexity bounds for general L-functions and to the proof of the holomorphic quantum unique ergodicity conjecture of Rudnick and Sarnak.

SIMONS INVESTIGATORS, MATHEMATICS

Terence Tao

University of California, Los Angeles

With over 200 publications in 15 years, spanning collaborations with some 70 mathematicians, Terry Tao has become one of the most penetrating and prolific mathematicians in the field, working in a number of disparate areas, including harmonic analysis, partial differential equations, number theory, random matrices and more. He has made deep contributions to the development of additive combinatorics through a blend of harmonic analysis, ergodic theory, geometry and number theory, establishing this field as central to the modern study of many mathematical subjects. This work has led to breakthroughs in our understanding of the distribution of primes, expanders in groups and various questions in theoretical computer science. For example, Green, Tao and Ziegler have proved that any finite set of linear forms over the integers, of which no two are linearly dependent over the rationals, all take on prime values simultaneously infinitely often, provided there are no local obstructions.

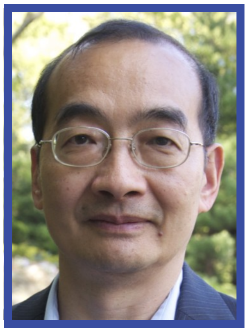
SIMONS INVESTIGATORS, MATHEMATICS

Daniel Tataru

University of California, Berkeley

Tataru's work on nonlinear waves has been deep and influential. He proved difficult well-posedness and regularity results for many new classes of equations. This includes geometric evolutions such as wave and Schrödinger maps, quasilinear wave equations, some of which are related to general relativity, as well as other physically relevant models.

SIMONS INVESTIGATORS, MATHEMATICS

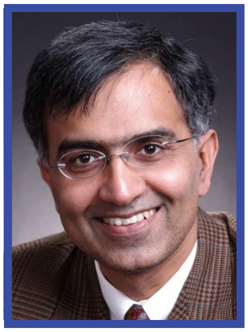


Horng-Tzer Yau

Harvard University

Horng-Tzer Yau is one of the world's leading probabilists and mathematical physicists. He has worked on quantum dynamics of many-body systems, statistical physics, hydrodynamical limits, and interacting particle systems. Yau approached the problems of the quantum dynamics of many-body systems with tools he developed for statistical physics and probability. More recently, he has been the driving force behind some stunning progress on bulk universality for random matrices. With Laszlo Erdős and others, Yau has proven the universality of the local spectral statistics of random matrices, a problem that was regarded as the main challenge of random matrix theory. This argument applies to all symmetry classes of random matrices. In the special Hermitian case, Terence Tao and Van Vu proved bulk universality concurrently. Yau's work has been extended in many directions, for instance in his recent results on invariant beta ensembles with Paul Bourgade and Laszlo Erdős.

SIMONS INVESTIGATORS, COMPUTER SCIENCE



Sanjeev Arora

Princeton University

Sanjeev Arora has played a pivotal role in some of the deepest and most influential results in theoretical computer science. He started his career with a major contribution to the proof of the PCP theorem, widely regarded as the most important result in complexity theory in the last 40 years. The PCP theorem states roughly that every proof, of any length, can be efficiently converted into a special format, in which correctness can be verified with high probability by reading small parts of it. The PCP theorem revolutionized our understanding of optimization problems and opened new directions in coding, cryptography and other areas. Arora is also known for his breakthroughs in approximation algorithms, having solved longstanding open problems. Notable examples include his algorithms for the Euclidean traveling salesman problem and for the sparsest cut in a graph. Arora has made important contributions on many other topics, including the unique games conjecture (a conjectured strengthening of the PCP theorem) and the power and limitations of hierarchies of linear and semidefinite programs.

SIMONS INVESTIGATORS, COMPUTER SCIENCE

Rajeev Alur

University of Pennsylvania

Rajeev Alur is a leading researcher in formal modeling and algorithmic analysis of computer systems. A number of automata and logics introduced by him have now become standard models with great impact on both the theory and practice of verification. His key contributions include timed automata for modeling of real-time systems, hybrid automata for modeling discrete control software interacting with the continuously evolving physical environment, and visibly pushdown automata for processing of data with both linear and hierarchical structure, such as XML documents.

SIMONS INVESTIGATORS, COMPUTER SCIENCE

Shafrira Goldwasser

Massachusetts Institute of Technology

Shafi Goldwasser has had tremendous impact on the development of cryptography and complexity theory. Starting with her thesis on 'semantic security,' she laid the foundations of the theory of cryptography. She created rigorous definitions and constructions of well-known primitives, such as encryption schemes (both public and private key versions) and digital signatures, and of new ones that she introduced, such as zero-knowledge interactive proof systems invented with Micali and Rackoff. Continuing her work on interactive proofs, which allow a probabilistic polynomial time algorithm to verify mathematical proofs via interaction with a powerful prover, Shafi and her co-authors extended the notion of interactive proofs to two-prover systems, whose expressive power is non-deterministic exponential time. The original motivation was cryptographic, but they turned out to be of great significance in complexity theory, paving the way to the equivalent formulation of PCP (probabilistically checkable proofs). Furthermore, Shafi and her co-authors showed the connection between a scaled-down variant of these systems and the hardness of approximation results for NP-hard problems, which led to the PCP theorem. On the algorithmic front, a problem of great significance is that of recognizing (and generating) prime numbers. Shafi and Kilian designed efficient probabilistic primality provers, which output short proofs of primality, based on the theory of elliptic curves. Together with Goldreich and Ron, Shafi originated the field of combinatorial property testing, devising a class of sub-linear algorithms to test properties in dense graphs.

SIMONS INVESTIGATORS, COMPUTER SCIENCE

Russell Impagliazzo

University of California, San Diego

Russell Impagliazzo has made many deep contributions to cryptography and complexity theory. Russell and collaborators showed that one-way functions exist if and only if pseudorandom generators exist. In other words, one can generate sequences of bits for which it is computationally hard to predict the next bit with accuracy much better than random guessing if and only if there are easy-to-compute functions that are hard to invert on the average. Russell also showed that there are worlds in which certain cryptographic primitives are strictly inequivalent. For example, there are worlds where one-way functions exist but public-key encryption is not possible. One of Russell's major contributions in complexity theory is the exponential-time hypothesis and its implications. The hypothesis states that there are problems where it is hard to speed up the brute-force solution even by a small amount. Russell helped establish the first complete problem for this class. In joint work with Avi Wigderson, Russell showed that if there are problems in exponential time that require exponential-sized circuits to solve, then any efficient algorithm that uses randomization has an equivalent, efficient one that does not.

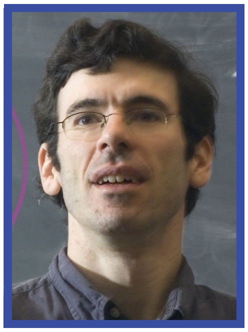
SIMONS INVESTIGATORS, COMPUTER SCIENCE

Piotr Indyk

Massachusetts Institute of Technology

Piotr Indyk is noted for his work on efficient approximate algorithms for high-dimensional geometric problems. This includes the nearest neighbor search, where given a data point, the goal is to find points highly similar to it without scanning the whole data set. To address this problem, he co-developed the technique of locality sensitive hashing, which proved to be influential in many applications, ranging from data mining to computer vision. He has also made significant contributions to sublinear algorithms for massive data problems. In particular, he has developed several approximate algorithms for massive data streams that use very limited space. Recently, he has co-developed new algorithms for the sparse Fourier transform, which compute the Fourier transform of signals with sparse spectra faster than the FFT algorithm.

SIMONS INVESTIGATORS, COMPUTER SCIENCE



Jon Kleinberg

Cornell University

Jon Kleinberg is best known for his contributions in establishing the computational foundations for information retrieval and social networks. His information retrieval work includes the use of link analysis (e.g., hubs and authorities) for ranking, identification and classification of web communities, the web as a graph, and understanding the success of latent semantic analysis. His seminal work in algorithmic social networks includes the understanding of "small worlds" and decentralized search, analysis of bursty streams and influence spread in social networks. Kleinberg has done work in many other fields, as well, including approximation algorithms, communications networks, queuing theory, clustering, computational geometry, bioinformatics, temporal analysis of data streams, algorithmic game theory, online algorithms and distributed computing. His influence is augmented by popular papers in *Science* and *Nature* and by two widely used texts, one with Tardos, *Algorithm Design*, and one with Easley, *Networks, Crowds, and Markets: Reasoning about a Highly Connected World*.

SIMONS INVESTIGATORS, COMPUTER SCIENCE

Daniel Spielman

Yale University

Daniel Spielman's work has been important to three distinct research communities: theoretical computer science, applied mathematics and operations research. His work on smoothed analysis of linear programming provides mathematical justification for why the simplex method to solve problems works well in practice even though worst-case analysis shows that there are instances in which it takes exponential time. A small random perturbation converts any linear programming instance into one that with high probability is solved efficiently by the simplex algorithm. Similar perturbation results hold for many other problems and provide an alternative to worst-case analysis, which may be too pessimistic. His codes based on expander graphs achieve near-optimal performance. In joint work with Teng, Spielman gave a method of preconditioning a Laplacian matrix A, which yields a near-linear-time algorithm for solving the system Ax = b. This leads to highly efficient algorithms for circuit analysis and network flow computations.

SIMONS INVESTIGATORS, COMPUTER SCIENCE

Salil P. Vadhan

Harvard University

Salil Vadhan has produced a series of original and influential papers on computational complexity and cryptography. He uses complexity-theoretic methods and perspectives to delineate the border between the possible and impossible in cryptography and data privacy. His work also illuminates the relation between computational and information-theoretic notions of randomness, thereby enriching the theory of pseudorandomness and its applications. All of these themes are present in Vadhan's recent papers on differential privacy and on computational analogues of entropy.

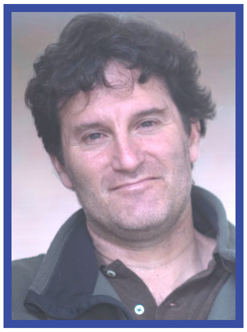
SIMONS INVESTIGATORS, PHYSICS

Igor Aleiner

Columbia University

Igor Aleiner is an influential leader of condensed matter theory research, renowned both for his fundamental contributions to our understanding of the quantum mechanical interplay of electron-electron interactions and disorder in condensed matter systems (in particular many-body localization) and for the theoretical power displayed in his tour de force calculations. He has used a variety of quantum field theoretic and random matrix methods to obtain profound results in the theory of quantum chaos, the study of mesoscopic fluctuation effects in interacting electron systems, the theory of transport in interacting disordered systems, and the properties of graphene.

SIMONS INVESTIGATORS, PHYSICS



Michael Brenner

Harvard University

Michael Brenner is a versatile theoretical physicist whose diverse contributions involve collaborations with biologists, physicists and engineers from a variety of subfields. His work integrates analytical and computational approaches to solve problems ranging from fundamental issues in fluid mechanics to engineering design to the evolution of protein functionality, and from the aerodynamics of whale flippers to the ejection of fungal spores. He is known for generating creative and original questions and answers. Particularly noteworthy are his achievements in understanding the singularities and nonlinearities that control how droplets, jets and sheets of fluid change shape and break up. His work in this area has potential impact for optimizing devices ranging from inkjet printers to cell sorters. His research has also led to the development of general methods for simplifying the dynamical models of many coupled oscillators that arise in contexts such as atmospheric chemistry.

SIMONS INVESTIGATORS, PHYSICS

Victor Galitski

University of Maryland

Victor Galitski has made many important contributions to diverse areas of quantum many-body physics, including applications of quantum theory to cold atomic gases, the theory of exotic spin models, topological insulators and topological superconductivity, quantum fluctuation phenomena, and the dynamics of periodically pumped systems. He is particularly known for his predictions of topological Kondo insulators (supported by recent experiments in samarium hexaboride), as well as his proposals for using multiple laser beams to realize spin-orbit physics in cold atomic gasses, which led to the discovery by Spielman and collaborators of the spin-orbit coupled Bose-Einstein condensates he predicted.

SIMONS INVESTIGATORS, PHYSICS

Sharon Glotzer

University of Michigan

Sharon Glotzer is a leader in the use of computer simulations to understand how to manipulate matter at the nano- and mesoscales. Her work in the late 1990s demonstrating the nature and importance of spatially heterogeneous dynamics is regarded as a breakthrough. Her ambitious program of computational studies has revealed much about the organizing principles controlling the creation of predetermined structures from nanoscale building blocks, while her development of a conceptual framework for classifying particle shape and interaction anisotropy (patchiness) and their relation to the ultimate structures the particles form has had a major impact on the new field of 'self-assembly.' Glotzer recently showed that hard tetrahedra self-assemble into a quasicrystal exhibiting a remarkable twelve-fold symmetry with an unexpectedly rich structure of logs formed by stacks of twelve-member rings capped by pentagonal dipyramids.

SIMONS INVESTIGATORS, PHYSICS

Chris Hirata

California Institute of Technology

Chris Hirata is an outstanding young cosmologist and astrophysicist whose research ranges from purely theoretical investigations to original data analysis. He is known for his sophisticated analysis of radiative transfer through the Epoch of Reionization. He has also shown that primordial dark matter fluctuations can impact contemporary observations. His work with experimental and observational groups on systematizing the extraction of cosmological data from cross correlation of different extragalactic surveys is having an important impact on precision cosmology.

SIMONS INVESTIGATORS, PHYSICS

Randall Kamien

University of Pennsylvania

Randall Kamien is a leading figure in the theory of topological effects in condensed matter physics, known for the mathematical rigor he brings to his work and in particular for the use of sophisticated and elegant geometrical methods to obtain insight into fundamental aspects of the structure of polymers, colloids, liquid crystals and related materials and into the topological defects occurring in these materials.

SIMONS INVESTIGATORS, PHYSICS

Charles Kane

University of Pennsylvania

Charles Kane and co-workers showed, extending earlier work by Thouless and collaborators, that the electronic band structures of all crystals could be classified in terms of the momentum space topology of the electronic states, and that as a consequence there exist protected states at interfaces between topologically nontrivial crystals and topologically trivial crystals. Along with related work by Shoucheng Zhang and others, Kane's results have created a large and vibrant research field focused on the search for and measurement of topologically nontrivial materials, including materials that are topologically nontrivial as a result of broken symmetries. Kane's recent work has turned towards applications: for example, the use of interfaces between topological insulators and ordinary superconductors to achieve a solid-state realization of Majorana fermions and the exploration of possible applications of these excitations in topological quantum computing.

SIMONS INVESTIGATORS, PHYSICS

Joel Moore

University of California, Berkeley

Joel Moore is one of the leaders in the study of the topological aspects of electronic physics, particularly known for this work with Balents on strong topological insulators and his work with Orenstein and Vanderbilt on magnetoelectric couplings and optical responses induced by geometric and topological terms in various material classes. He has also obtained significant results on nonequilibrium dynamics of interacting quantum systems, significantly elucidating the role of quantum entanglement in these phenomena.

SIMONS INVESTIGATORS, PHYSICS

Hirosi Ooguri

California Institute of Technology

Hirosi Ooguri is a mathematical physicist and string theorist of exceptional creativity and breadth. His work on Calabi–Yau manifolds has yielded important new insights into the D-brane structures crucial to string theory, while his work on the relationship of supersymmetric gauge theories to string theory and to gravity has fostered the rapid development of the AdS/CFT correspondence, which relates quantum properties of gauge theories to solutions of higher-dimensional classical field equations in the presence of black holes and curved space-time. He is perhaps best known for his innovations in the use of topological string theory to compute Feynman diagrams in superstring models.

SIMONS INVESTIGATORS, PHYSICS

Frans Pretorius

Princeton University

Frans Pretorius has made seminal contributions to the numerical solution of the equations of general relativity, in particular inventing a new computational scheme based on harmonic decomposition of the Ricci tensor, which is now a textbook method in the field. Thanks in large part to Pretorius' innovations, accurate computer simulations of such general relativistic phenomena as the merger of two black holes have become possible for the first time after several decades of effort. These results enable the calculation of expected gravitational-wave signals that may be detected by present or planned gravitational wave observatories. Pretorius has also contributed to mathematical issues in general relativity such as the no-hair theorem in higher dimensions and the Gregory–Laflamme instability of black strings.

SIMONS INVESTIGATORS, PHYSICS

Eliot Quataert

University of California, Berkeley

Eliot Quataert is a theoretical astrophysicist whose research combines many areas of physics, including gas dynamics, plasma physics, radiative transfer and nuclear physics. He is also known as a particularly effective mentor of students and postdocs. He has made fundamental contributions to the theory of astrophysical turbulence and transport properties in hot plasmas, as well as to stellar and black-hole astrophysics.

SIMONS INVESTIGATORS, PHYSICS

Dam Thanh Son

University of Chicago

Dam Thanh Son is a theorist whose work has deep impact across several subfields of physics. He has written important papers in quantum chromodynamics, theoretical nuclear physics, condensed matter physics and atomic physics. Perhaps the most significant of his many contributions concern the duality between black holes in anti-de Sitter space and strongly interacting fluids. His initial work with Policastro and Starinets on the viscosity of the quark-gluon plasma opened new research directions in heavy ion physics and in string theory, and his subsequent work with Sachdev, Herzog and others established the AdS/CFT duality as a crucial theoretical tool of condensed matter physics.

SIMONS INVESTIGATORS, PHYSICS

Senthil Todadri

Massachusetts Institute of Technology

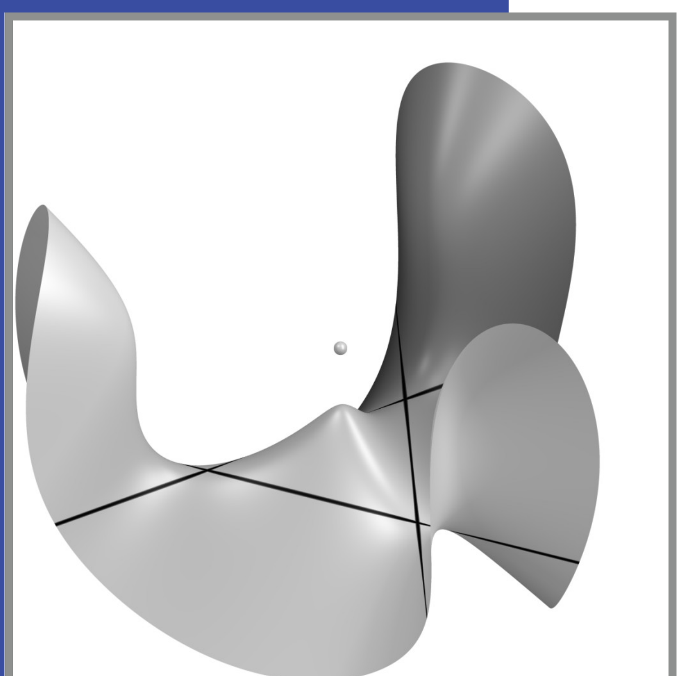
Senthil Todadri's work with Fisher on Z2 topological order in models of spin liquid states provided key insights and initiated the systematic investigation of gauge structures in many-body systems, now a vital subfield of condensed matter physics. Senthil and co-workers also pioneered the theory of deconfined quantum criticality as a new paradigm for some phase transitions. Senthil and collaborators also introduced the concept of fractionalized Fermi liquids and developed a theory of continuous electronic Mott transitions. His most recent work in the theory of symmetry-protected topological phases and on combining ideas of quantum entanglement and many-body physics continues to move the boundaries of the field of quantum many-body physics.

SIMONS INVESTIGATORS, PHYSICS

Xi Yin

Harvard University

Xi Yin is one of the outstanding members of the new generation of theoretical physicists, known for his work on fundamental problems of quantum gravity, including new insights into black hole entropy, for his work with Giombi on higher spin gravity, and for helping to establish the Klebanov–Polyakov conjecture and extensions of the gauge/gravity dualities. He is also credited with important work on supersymmetric Chern–Simons theories and associated connections to M-theory.



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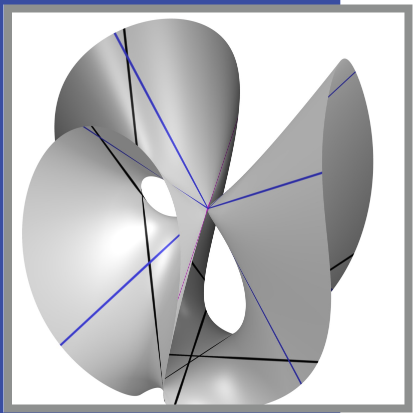

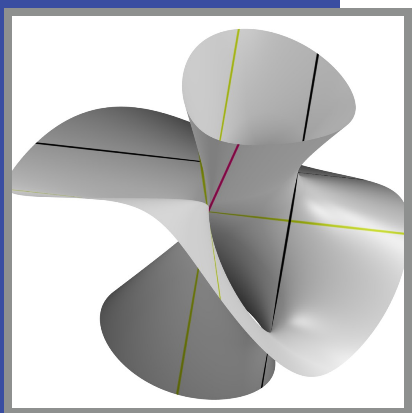

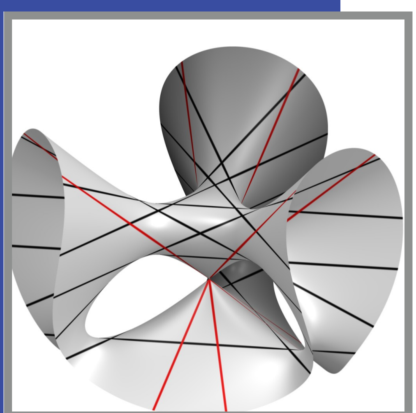

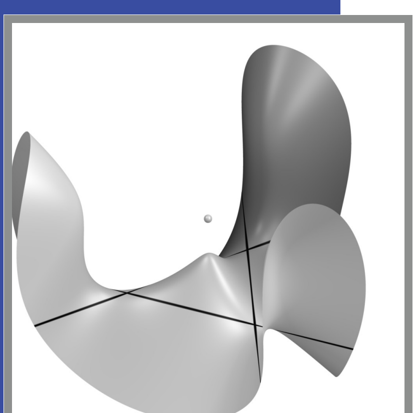

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