Annual Meeting 2021

SIMONS FOUNDATION
Mathematics and Physical Sciences

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Welcome

Dear Colleagues,

Welcome to our first post-COVID Annual Meeting of the Mathematics and the Physical Sciences division!

Our foundation has a new president: David Spergel! David is a distinguished astrophysicist who served on the MPS Scientific Advisory Board and has been directing the Center for Computational Astrophysics (CCA) until assuming the leadership of the foundation on July 1, 2021. Jim and Marilyn Simons have stepped back from day-to-day management but will co-chair the board of the foundation. David has already launched novel initiatives, with major emphasis on diversity and inclusion.

Juliane Dalcanton is the next director of CCA.

SFARI, the Simons Foundation Autism Research Initiative, also has a new director, Kelsey Martin.

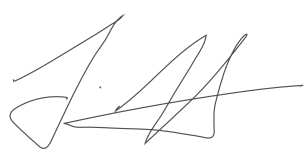
In MPS, we have just announced a new joint effort with NSF, the creation of a National Institute for Theory and Mathematics in Biology.

We all have learned a lot in the last 18 months, and in particular, the value of in-person interactions. The foundation offices have reopened, and we are relaunching in-person meetings with appropriate safety protocols. Over the last summer, we have expanded our meeting space in the main building at the foundation and now have a mini-conference center on the second and third floors.

We wish you success in your scientific endeavors and good health!

Sincerely,

YURI TSCHINKEL
Director of Mathematics and Physical Sciences



GREG GABADADZE
Associate Director for Physics

Meeting information

Meeting Agenda

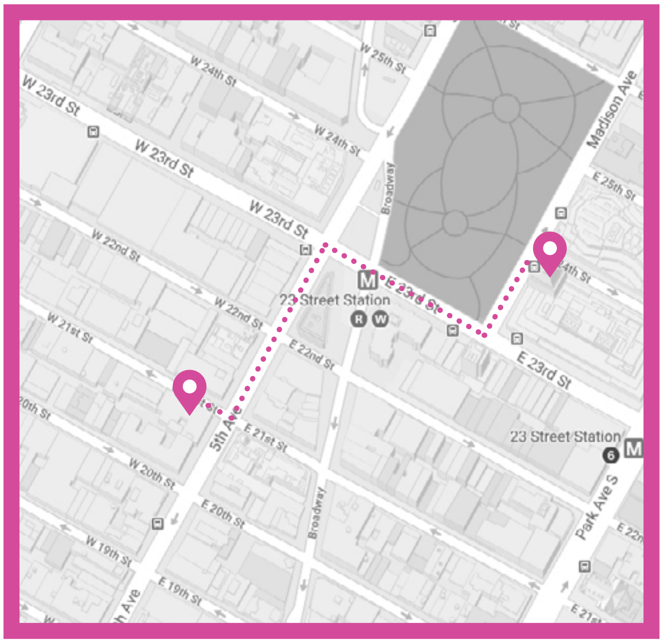
Thursday, October 14, 2021

8:30 AM	Check-in & Breakfast
9:30 AM	**KARIN ÖBERG** Astrochemical Origins of Solar System Compositions
10:30 AM	Break
11:00 AM	**RAHUL NANDKISHORE** Fracton Dynamics
12:00 PM	Lunch
1:30 PM	**BRYNA KRA** Symmetries in Symbolic Dynamics
2:30 PM	Break
3:00 PM	**ELCHANAN MOSSEL** Mathematical Aspects of Opinion Dynamics
4:00 PM	Break
4:30 PM	**ELEONORA PRESANI** arXiv: Reinventing Scholarly Communication for 30 Years
5:30 PM	Scientific Program Concludes
6:00 PM	**COCKTAILS @ GLASSHOUSE CHELSEA**
7:00 PM	**DINNER @ GLASSHOUSE CHELSEA**
9:00 PM	Day 1 Concludes

Friday, October 15, 2021

9:30 AM	**SYLVIA SERFATY** Coulomb Gases and Vortex Systems
10:30 AM	Break
11:00 AM	**JANÉ KONDEV** How Cells Measure Length
12:00 PM	Lunch
1:00 PM	**XIE CHEN** Quantum Error Correction Codes as Exotic Condensed Matter
2:00 PM	Meeting Concludes

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

WI-FI at the Gerald D. Fischbach Auditorium:
Network Name: SimonsGuests
Password: simonsnyc

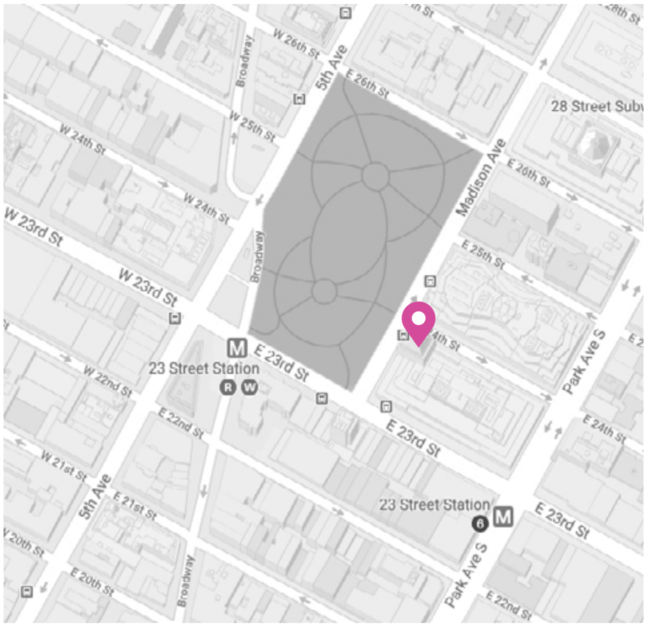
AUDITORIUM
The auditorium is ADA accessible with a microphone and AC power connection located at each seat. Food and beverages are not allowed in the auditorium.

COVID-19 POLICY
To ensure the safety of foundation staff and guests, all in-person guests must be fully vaccinated to enter the Simons Foundation and Flatiron offices and meeting spaces. Furthermore, all in-person guests must be beyond the 14-day inoculation period of the final dose of their World Health Organization (WHO)-approved vaccine, pre-register vaccination and health status via a separate link and show proof upon arrival that pre-registration has been completed. The link to pre-register for building entry will be circulated 24 hours prior to in-person arrivals.

Acceptable forms of proof are a physical copy of the COVID-19 vaccine card/certificate, an electronic image of the COVID-19 vaccine card/certificate or the NYS Excelsior Pass mobile app (NYS residents only).

While at the Simons Foundation, unless eating or drinking, participants are required to wear a mask.

Hotel & Travel Information



THE NEW YORK EDITION HOTEL

5 Madison Avenue
New York, NY 10010
+1 212 413 4200
https://www.editionhotels.com/new-york/

HOTEL ENTRANCE is on 24th Street between Madison and Park Avenues.

WI-FI is complimentary in each guest room and throughout the hotel.

CHECK-IN: 4:00 PM
CHECK-OUT: 11:00 AM

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.

GROUND TRANSPORTATION

Return transportation to NY-area airports will be coordinated for participants departing on Friday, October 15 and Saturday, October 16. A written reminder of your departure itinerary as well as ground transportation information will be delivered to your room shortly after check-in.

MPS staff will be available at the Gerald D. Fischbach Auditorium on Thursday morning for any questions regarding your travel arrangements.

LUGGAGE

Those departing from the Gerald D. Fischbach Auditorium after the conclusion of the annual meeting should bring their luggage to the meeting.

CONTACT INFORMATION

General Meeting Inquiries:
Meghan Fazzi
(646) 706-1007
mfazzi@simonsfoundation.org

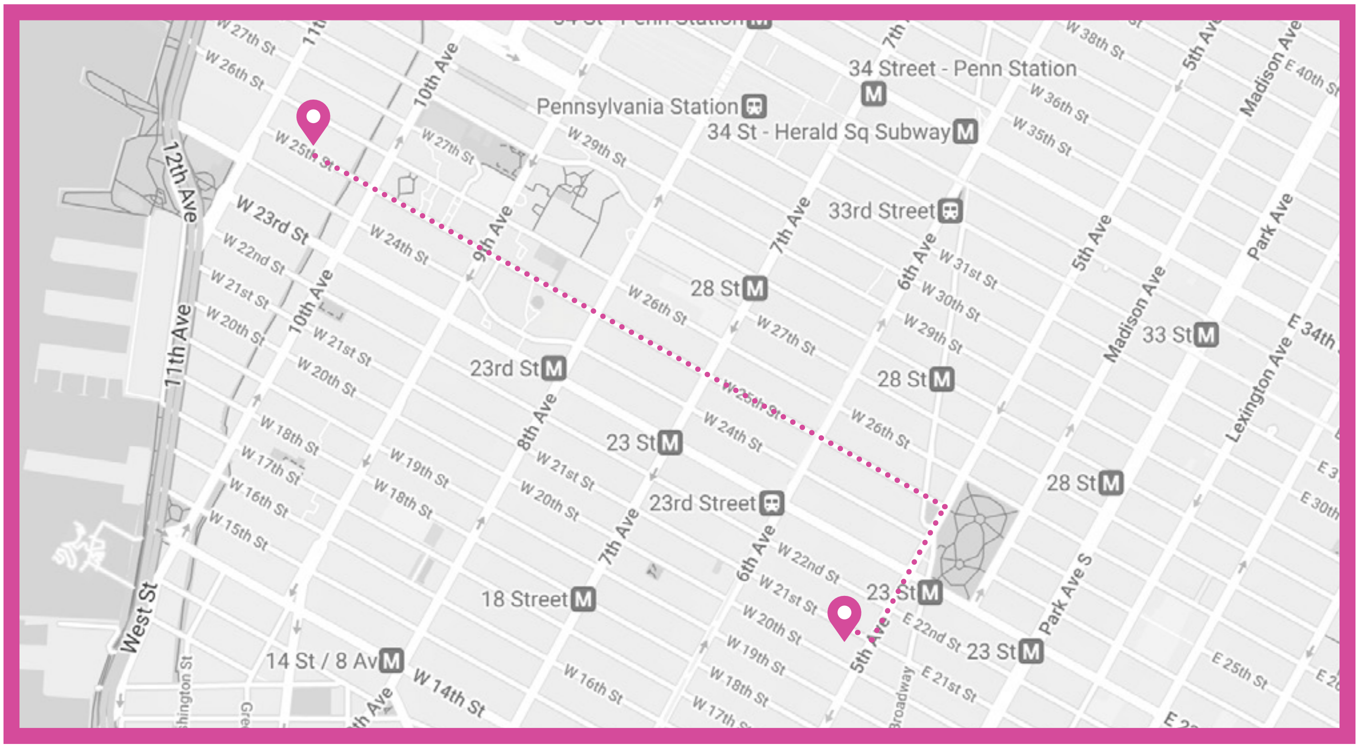
HOTEL AND TRAVEL

Ovation Travel Team
sfnevents@ovationtravel.com
www.ovationtravel.com

GROUND TRANSPORTATION INQUIRIES:

Melanie Shiree, Events Coordinator, MPS
mshiree@simonsfoundation.org

Annual Meeting Dinner



THURSDAY, OCTOBER 14

6:00 PM Cocktails & Dessert, 21st Floor
7:00 PM Dinner, 14th Floor

GLASSHOUSE CHELSEA

545 W 25th St, New York, NY 10001
Between 10th and 11th Avenues

WALKING DIRECTIONS from the Simons Foundation to Glasshouse Chelsea:

1: Head East on 21st Street toward Fifth Avenue
2: Turn left onto Fifth Avenue
3: Turn left onto W 25th St
4: Glasshouse Chelsea will be on the right

Total distance: 1.2 miles

OPTIONAL BUS TRANSPORTATION

Transportation from the foundation to Glasshouse Chelsea will be provided for those who do not want to walk starting at 5:30 PM.

At the evening’s conclusion buses will transport guests from Glasshouse Chelsea to The New York Edition Hotel starting at 8:30 PM.

Speaker Profiles

Xie Chen

California Institute of Technology

Quantum Error Correction Codes as Exotic Condensed Matter

To achieve more robust computation and communication processes with quantum information, quantum error correction codes were invented to protect the information from noise and decoherence. The codes consist of specifically designed, contrived quantum states, yet some of them have become hot topics in condensed matter physics, an area which is traditionally grounded in measurable phenomena in real-world solid-state materials. Xie Chen will explain how these error correction codes reveal possible novel physics phenomena and inspire the exploration of new phases in condensed matter systems. At the same time, connecting them to real experimental systems provides a path forward to realizing the robust information processing protocols.

Chen studies exotic topological phenomena that can emerge in strongly interacting quantum many-body systems. Her work uses ideas and tools in quantum information to explore topological states of matter and study the relationships between them. She discovered and systematically constructed symmetry protected topological phases in strongly interacting systems in two and higher dimensions. She proposed methods to classify and detect anomalies in symmetry enriched topological phases. Recently, her work on fracton phases generalized the notion of phase and universality to properly capture the unusual “beyond topology” phenomena discovered in certain quantum error correction codes.

Jané Kondev

Brandeis University

How Cells Measure Length

Gulliver noticed 140 years ago that the size of the cell's nucleus is proportional to the size of the cell. In the intervening years, similar observations have been made about other, large structures that self-assemble in the cell. This raises a fascinating question: How does the cell, which is micrometers in length, measure its size with nothing more at its disposal than nanometer-sized proteins that diffuse, on occasion bump into each other, and transiently stick together? In this talk, Jané Kondev will describe quantitative experiments and related theory that reveal general principles of how cells measure their size and control the size of their internal structures. The case of self-assembly of actin cables in budding yeast is particularly interesting in this context, as it provides an example of a cell controlling the length of a large, filamentous structure. Kondev will describe experiments and theory pertaining to this specific problem, which gets at the general question of how cells measure length?

Kondev grew up in New York and Belgrade (Serbia). He completed his doctoral work at Cornell in theoretical physics, and after research fellowships at Brown and Princeton, he settled down at Brandeis, where he is the William R. Kenan, Jr. Professor of Physics and a professor at the Howard Hughes Medical Institute. He is the coauthor of the book Physical Biology of the Cell, which won the Society of Biology Book Award. His group at Brandeis brings together math, physics and biology students united by their interest in developing quantitative models of living systems. Current research in the group focuses on gene expression, cytoskeleton assembly and chromosome dynamics.

Bryna Kra

Northwestern University

Symmetries in Symbolic Dynamics

Symbolic dynamics, originating in the work of Hadamard in the 1890s, is a key tool for studying topological, smooth and measurable dynamical systems. The automorphism group of a symbolic system captures its symmetries, reflecting the dynamical behavior and the complexity of the system. Bryna Kra will give an overview of relations among dynamical properties of the system algebraic properties of the automorphism and measurable properties of associated systems.

Kra is the Sarah Rebecca Roland Professor of Mathematics at Northwestern University. She earned her doctorate from Stanford University and held positions at the University of Jerusalem in Israel, the Institut des Hautes Études Scientifiques in France, the University of Michigan, the Ohio State University and Pennsylvania State University before joining the faculty at Northwestern University in 2004.

Kra was awarded the Centennial Fellowship of the American Mathematical Society in 2006 and the Conant Prize of the American Mathematical Society in 2010 and was elected an inaugural fellow of the American Mathematical Society in 2012. In 2016, she became a fellow of the American Academy of Arts and Sciences, and in 2019, she was elected to the National Academy of Sciences. Kra works in ergodic theory and dynamical systems, particularly on problems motivated by combinatorics and number theory.

Elchanan Mossel

Massachusetts Institute of Technology

Mathematical Aspects of Opinion Dynamics

One feature (bug?) of this time is that our opinions and preferences are analyzed, manipulated and aggregated at an unprecedented scale and sophistication.

This talk will survey mathematical results and models that aim to provide insights on these processes and their outcomes.

Elchanan Mossel is a professor of mathematics at the Massachusetts Institute of Technology. His research spans topics across probability, statistics, economics, computer science and mathematical biology. He is known for his work in discrete Fourier analysis and its applications to computational complexity and social choice theory and for his research of information flow in biological, economic, and inferential networks.

Mossel was previously a Sloan Fellow and is currently a Fellow of the American Mathematical Society, Simons Fellow and Vannevar Bush Fellow.

Rahul Nandkishore

University of Colorado Boulder

Fracton Dynamics

Rahul Nandkishore will introduce a new class of quantum states of matter, known as 'fracton phases.' He will explain how these phases provide a new frontier for quantum dynamics, offering novel routes to ergodicity breaking and subdiffusion. Nandkishore will also comment on how insights gleaned from the study of fractons can be applied to quantum dynamics in broader, non-fractonic contexts.

Nandkishore received his Ph.D. from the Massachusetts Institute of Technology in 2012. He then spent time as a postdoctoral fellow at the Princeton Center for Theoretical Science, before joining the faculty at the University of Colorado Boulder in 2015. He has been in Boulder ever since, receiving tenure in 2020.

Nandkishore is known for his work on interaction and disorder effects in graphene and other Dirac fermion systems, as well as his work on many-body quantum systems out of equilibrium. In the latter context, he is known for introducing the notion of eigenstate order and eigenstate phase transitions, for demonstrating that many-body localization can occur in systems with long-range interactions, and for elucidating the rich quantum dynamics of fracton phases of quantum matter. Nandkishore is the recipient of Young Investigator awards from the U.S. Air Force Office of Sponsored Research and U.S. Army Research Office, of a Sloan Research Fellowship, and of a Simons Fellowship in Theoretical Physics.

Karin Öberg

Harvard University

Astrochemical Origins of Solar System Compositions

Over the past decades, we have obtained more and more precise data on the compositions of solar system bodies: the Galileo and Juno probes have revealed the elemental composition of Jupiter's envelope, the Rosetta mission has provided a very detailed inventory of one comet while ground-based observations of comets have mapped out the range of possible comet abundances, and analyses of meteorites continue to reveal the composition of the building blocks of inner solar system planets, etc. This wealth of data has deepened our understanding of the solar system and its origin. But it has also presented many puzzles, including the origins of Jupiter's envelope, of water-poor comets, of missing carbon in the inner solar system, and of prebiotically interesting molecules in multiple solar system objects. In this talk, Karin Öberg will explore these puzzles from an astrochemical point of view, using astrochemical models, which were often developed to explain observations of exoplanets or of planet-forming disks around other stars. Öberg will also introduce some of the observational and experimental data that have enabled us to benchmark these models.

Karin Öberg is professor of astronomy at Harvard University. Her specialty is astrochemistry and her research aims to uncover how chemical processes affect the outcome of planet formation, especially the chemical habitability of nascent planets. Her research group approaches this question through laboratory experiments, simulating the exotic chemistry that gives rise to chemical complexity in space, through astrochemical modeling and through astronomical observations of molecules in planet-forming disks around young stars.

Dr. Öberg left Sweden for Caltech in 2001, where she matriculated with a B.Sc. in chemistry in 2005. Four years later she obtained a Ph.D. in astronomy, with a thesis focused on laboratory astrochemistry. In 2009, she moved to the Harvard-Smithsonian Center for Astrophysics with a Hubble fellowship, focusing on millimeter observations of protoplanetary disks. In 2013, she joined the Harvard Astronomy faculty as an assistant professor, was promoted and named the Thomas D. Cabot Associate Professor in Astronomy in 2016 and promoted to full professor with tenure in 2017. Dr. Öberg's research in astrochemistry has been recognized with a Sloan fellowship, a Packard fellowship, the Newton Lacy Pierce Award and a Simons Investigator Award.

Eleonora Presani

Cornell University

arXiv: Reinventing Scholarly Communication For 30 Years

Since 1991, arXiv has changed the way researchers communicate with each other. Starting only in high energy physics, today arXiv covers 8 subject areas, with 1.8 million posted articles and over 5 million monthly users. arXiv has filled a need in scholarly communication, allowing researchers to share their work early, quickly and for no charge. After 30 years, these needs are still at the very center of arXiv service. At the same time, it is exciting to look at the next 30 years and imagine how arXiv can transform the lives of researchers worldwide. This presentation will discuss the major current and future plans for arXiv, as well as challenge the audience to consider the most interesting problems that scholarly communication will face in the next decade.

As executive director, Dr. Eleonora Presani leads strategic, technical and business planning for arXiv, the world's premier open research-sharing platform. Her focused, and solutions-oriented approach have led to numerous enhancements and collaborations since she started the position in 2020. Her work to advance open science and sustainable publishing is informed by her previous experience as an astroparticle physics researcher and as a publisher and product manager at Elsevier. Driven by a passion for science, she believes that a combination of technology and empathy are the key ingredients to enable researchers worldwide to sustainably, effectively advance science in an equitable, inclusive environment. Originally from Trieste (Italy), Dr. Presani trained at CERN, University of Amsterdam, University of Trieste and Université Paris Sud XI.

Sylvia Serfaty

New York University

Coulomb Gases and Vortex Systems

Sylvia Serfaty will discuss some mathematical analysis of systems of points with Coulomb (or sometimes more general singular) interactions, which arise in condensed matter physics (superconductors, superfluids, Bose-Einstein condensates), in statistical and quantum mechanics (one- and two-component plasmas, fractional quantum Hall effect, random matrix models) and in approximation theory. They give rise to a variety of questions pertaining to analysis, partial differential equations, probability and number theory.

Serfaty is Silver Professor at the Courant Institute of Mathematical Sciences of New York University (NYU). Prior to this she has been professor at Sorbonne Université and has held various appointments at the Courant Institute of NYU. She earned her B.S. and M.S. in mathematics from the École Normale Supérieure in Paris in 1995, and her Ph.D. from Université Paris Sud in 1999. She is interested in partial differential equations, mathematical physics and statistical mechanics. She was a plenary speaker at the International Congress of Mathematicians in 2018, the recipient of the European Mathematical Society and Henri Poincaré prizes and is a member of the American Academy of Arts and Sciences.

Simons Investigators

Mathematics

2021 Simons Investigators

GUIDO DE PHILIPPIS

New York University

Guido De Philippis works in geometric measure theory, calculus of variations and partial differential equations. His main interest is the understanding of regularity (or lack thereof) of solutions of geometric variational problems, ranging from minimal surfaces to free boundary problems. Recently, in collaboration with Filip Rindler, he obtained a fine description of the structure of the singular part of measures satisfying a linear partial differential equation (PDE) constraint. By suitably choosing the PDE constriction, the result led to the solution of several open questions: extension of Alberti's rank-one theorem to the space of bounded deformation (BD) functions, converse of the Rademacher theorem and structure of Lipschitz differentiability spaces.

JUNE HUH

Stanford University

June Huh studies discrete objects using geometric methods. An unexpected relation between combinatorics and algebraic geometry found by Huh was used in his proof of Read's conjecture in graph theory. In recent works, he and his collaborators proposed a more general framework that tightens the connection between the two seemingly disparate fields. This led to proofs of several other long-standing problems in combinatorics, such as the ultra-log-concavity conjecture of Mason and the top-heavy conjecture of Dowling–Wilson.

LIN LIN

University of California, Berkeley

Lin Lin is an applied mathematician working in electronic structure theory. With collaborators, he has developed efficient, accurate and scalable algorithms in Kohn–Sham density functional theory, localization theory, many-body perturbation theory and quantum embedding theory. Several new methods have been adopted by electronic structure software packages widely used in quantum chemistry, quantum physics and materials science. Recently, Lin has contributed to neural network-based methods for accelerating molecular simulations, as well as quantum algorithms for solving high-dimensional linear algebra problems with applications to electronic structure calculations.

ASSAF NAOR

Princeton University

Assaf Naor's research focuses on analysis and geometry in high dimensions, with emphasis on understanding the structure of metric spaces, including the extent to which they can be realized in "nicer" geometries. He harnesses such insights for a variety of applications in several areas of pure mathematics (analysis, geometry, probability, combinatorics, group theory), and also in order to chart the possibilities and limitations of algorithms. Much of Naor's work makes progress on the long-standing Ribe program, which is a web of conjectures and analogies between linear and nonlinear geometries that is inspired by a classical rigidity theorem of Ribe.

Physics

2021 Simons Investigators

XIE CHEN

California Institute of Technology

Xie Chen studies exotic topological phenomena that can emerge in strongly interacting quantum many-body systems. Her work uses ideas and tools in quantum information to explore topological states of matter and study the relationships between them. She discovered and systematically constructed symmetry-protected topological phases in strongly interacting systems in two and higher dimensions. She proposed methods to classify and detect anomalies in symmetry-enriched topological phases. Recently, Chen's work on fracton phases generalized the notion of phase and universality to properly capture the unusual "beyond topology" phenomena discovered in certain quantum error-correction codes.

EUGENE DEMLER

Harvard University

Eugene Demler works on quantum many-body systems ranging from electrons in solids to ultracold atoms to photons. His work has had a strong impact on the field of quantum simulations. He has introduced several types of cold-atom simulators and suggested new methods of analyzing them that were widely adopted in experiments. He combines tools of quantum information science and classical machine learning to find applications of quantum simulators in other areas, such as biomedical research. Demler has analyzed the transient properties of superconductors stimulated by terahertz and infrared light, as well as pioneered the study of topological Floquet states in electron systems, ultracold atoms and photonic systems.

SHANHUI FAN

Stanford University

Shanhui Fan works broadly on photonics theory. Fan has made fundamental contributions in temporal coupled mode theory, non-reciprocity as induced by dynamic modulation, photonic gauge potentials, waveguide quantum electrodynamics, solar cell light trapping theory and daytime radiative cooling. Recently, he has been working on concepts of synthetic dimensions as a way to explore Hermitian and non-Hermitian topological physics in photonics.

PETER GRAHAM

Stanford University

Peter Graham is interested in the fundamental laws of nature. Motivated by long-standing mysteries in particle physics and cosmology such as the weakness of gravity and the nature of dark matter, he proposed several new theories for these open questions. Additionally, he helped pioneer the use of ultrahigh-precision technologies for experimentally probing these questions. With experimental colleagues, he proposed novel approaches for detecting dark matter, new forces and gravitational waves. This gave rise to experiments using techniques from atomic physics, nuclear magnetic resonance and quantum information which are poised to shed new light on our universe.

SURJEET RAJENDRAN

Johns Hopkins University

Surjeet Rajendran has invented new experimental methods to detect gravitational waves, dark matter and dark energy. These methods are being implemented by many laboratories around the world. He has also developed theoretical tools to solve outstanding problems of particle physics such as the hierarchy and vacuum energy problems via cosmological evolution. His recent theoretical interests have been in identifying novel gravitational phenomena within general relativity, permitting new experimentally testable approaches to resolving cosmological singularities and solutions to the black hole information problem.

Theoretical Physics in Life Sciences

2021 Simons Investigators

L. MAHADEVAN

Harvard University

L. Mahadevan is a professor of applied mathematics, physics, and organismic and evolutionary biology. His work attempts to understand motion and matter at the observable scale of "middle earth" by integrating experiments, theory and computation. Areas of interest include the patterns of shape and flow of inanimate matter and the dynamics of sentient living matter that can self-organize, perceive and act. His publications range over subjects such as the geometry and physics of soft materials, the mathematics of origami and kirigami, the morphodynamics of cells and organs, and the ethology of collective behavior. Mahadevan is a MacArthur Fellow and a Fellow of the Royal Society.

ILYA NEMENMAN

Emory University

Ilya Nemenman, in close collaboration with experimentalists, works on theoretical understanding of biological information processing, aiming to build models that show physics-level precision agreeing with experimental data. He and his collaborators were some of the first groups to estimate information-theoretic channel capacity of protein signaling pathways, analyze statistical properties of activity of large genetic and neural networks, discover collective cellular sensing in development, decode high-precision timing codes in neural motor control and model dynamics of complex animal behavior, such as a bird learning its song.

Astrophysics

2021 Simons Investigators

JONATHAN FORTNEY

University of California, Santa Cruz

Jonathan Fortney models many aspects of the physics of planets, from rocky worlds to gas giants. His work in planetary theory focuses both on exoplanets that orbit distant stars as well as planets in the solar system. His models have provided a framework to understand the atmospheres of exoplanets, their interior structure and thermal evolution, as well as physical processes like helium "rain" deep within Saturn. Fortney often works closely with observers to interpret spectra of exoplanets to better understand their physics, chemistry and clues to their formation.

YURI LEVIN

Columbia University

Yuri Levin works on astrophysics of neutron stars, black holes and gravitational waves. He is known for computations of thermal and quantum noise in LIGO interferometers, for co-discovering a disc of massive stars orbiting the supermassive black hole at the center of the Milky Way, for developing gravitational-wave search algorithms for pulsar timing arrays, and for his work on the dynamics of magnetized neutron stars. Levin is currently attempting to understand the architecture of stellar clusters near supermassive black holes and figure out the origin of pulsar glitches.

Theoretical Computer Science
2021 Simons Investigators

MARIA-FLORINA BALCAN
Carnegie Mellon University

Maria-Florina Balcan's research spans machine learning, algorithms and algorithmic game theory. She introduced general techniques that helped put modern machine-learning paradigms on solid theoretical foundations, including learning from limited labeled data, distributed learning, noise-tolerant learning and life-long learning. She also provided fundamental contributions to the area of analysis of algorithms beyond the worst-case, by providing both new models of realistic (non worst-case) instances and general techniques for designing and analyzing algorithms derived in a data driven fashion.

AMIT SAHAI
University of California, Los Angeles

Amit Sahai's research proposes fundamental new concepts in cryptography and establishes new feasibility results. He is best known for his works proposing the notions of indistinguishability obfuscation and functional encryption, and for his recent work establishing the feasibility of indistinguishability obfuscation and functional encryption for general computations based on well-studied hardness conjectures.

THOMAS VIDICK
California Institute of Technology

Thomas Vidick's research is at the interface of theoretical computer science, quantum information and cryptography. He is known for his work in the theory of quantum interactive proofs, including results on device-independent cryptography, certified randomness and the complexity of quantum multiprover interactive proof systems. The study of quantum entanglement provides a unifying goal behind all these areas and a focal point for his current research.

Mathematics

2012–2020 Simons Investigators

IAN AGOL
University of California, Berkeley

ANDRÉ ARROJA NEVES
University of Chicago

MANJUL BHARGAVA
Princeton University

BHARGAV BHATT
University of Michigan

ALEXEI BORODIN
Massachusetts Institute of Technology

SIMON BRENDLE
Columbia University

NGÔ BAO CHÂU
University of Chicago

XIUXIONG CHEN
Stony Brook University

ALEX ESKIN
University of Chicago

BEN GREEN
University of Oxford

LARRY GUTH
Massachusetts Institute of Technology

CHRISTOPHER DEREK HACON
University of Utah

NETS KATZ
California Institute of Technology

LUDMIL KATZARKOV
University of Miami

RICHARD KENYON
Brown University

CIPRIAN MANOLESCU
Stanford University

VLADIMIR MARKOVIĆ
University of Oxford

FERNANDO CODÁ MARQUES
Princeton University

JAMES MCKERNAN
University of California, San Diego

ELCHANAN MOSSEL
Massachusetts Institute of Technology

ANDREI OKOUNKOV
Columbia University

BJORN POONEN
Massachusetts Institute of Technology

IGOR RODNIANSKI
Princeton University

RAPHAËL ROUQUIER
University of California, Los Angeles

PAUL SEIDEL
Massachusetts Institute of Technology

SYLVIA SERFATY
New York University

CHRISTOPHER SKINNER
Princeton University

ALLAN SLY
University of California, Berkeley

KANNAN SOUNDARARAJAN
Stanford University

TERENCE TAO
University of California, Los Angeles

DANIEL TĂTARU
California Institute of Technology

HORNG-TZER YAU
Harvard University

ZHIWEI YUN
Massachusetts Institute of Technology

Physics

2012–2020 Simons Investigators

MINA AGANAGIC
University of California, Berkeley

IGOR ALEINER
Columbia University

ANDREA ALÙ
University of Texas at Austin

ANDREI BELOBORODOV
Columbia University

B. ANDREI BERNEVIG
Princeton University

MICHAEL BRENNER
Harvard University

GARNET CHAN
California Institute of Technology

AASHISH CLERK
University of Chicago

NIGEL COOPER
University of Cambridge

CLAUDIA DE RHAM
Imperial College of Science, Technology and Medicine

ROUVEN ESSIG
Stony Brook University

DANIEL EISENSTEIN
Harvard University

JONATHAN FENG
University of California, Irvine

LIANG FU
Massachusetts Institute of Technology

VICTOR GALITSKI
University of Maryland

SHARON GLOTZER
University of Michigan

MOHAMMAD HAFEZI
University of Maryland, College Park

SEAN HARTNOLL
Stanford University

PATRICK HAYDEN
Stanford University

CHRIS HIRATA
Ohio State University

KENNETH INTRILIGATOR
University of California, San Diego

SHAMIT KACHRU
Stanford University

MARC KAMIONKOWSKI
Johns Hopkins University

CHARLES KANE
University of Pennsylvania

ANTON KAPUSTIN
California Institute of Technology

ALEXEI KITAEV
California Institute of Technology

JANÉ KONDEV
Brandeis University

ANDREA LIU
University of Pennsylvania

JOEL MOORE
University of California, Berkeley

HIROSI OOGURI
California Institute of Technology

FRANS PRETORIUS
Princeton University

ELIOT QUATAERT
Princeton University

XIAOLIANG QI
Stanford University

LEO RADZIHOVSKY
University of Colorado Boulder

LEONARDO RASTELLI
Stony Brook University

GIL REFAEL
California Institute of Technology

SHINSEI RYU
Princeton University

ANDERS SANDVIK
Boston University

EVA SILVERSTEIN
Stanford University

RACHEL SOMERVILLE
Flatiron Institute

ĐÀM THANH SƠN
University of Chicago

ANATOLY SPITKOVSKY
Princeton University

IAIN STEWART
Massachusetts Institute of Technology

SENTHIL TODADRI
Massachusetts Institute of Technology

DAVID TONG
University of Cambridge

MARK VAN RAAMSDONK
University of British Columbia

ASHVIN VISHWANATH
Harvard University

ANASTASIA VOLOVICH
Brown University

NEAL WEINER
New York University

MATTHIEU WYART
École Polytechnique Fédérale de Lausanne

CENKE XU
University of California, Santa Barbara

XI YIN
Harvard University

KATHRYN ZUREK
California Institute of Technology

Mathematical Modeling of Living Systems

2014–2020 Simons Investigators

CLAUDIA CLOPATH
Imperial College London

LUCY COLWELL
University of Cambridge

MICHAEL DESAI
Harvard University

PAUL FRANÇOIS
McGill University

SURYA GANGULI
Stanford University

OSKAR HALLATSCHEK
University of California, Berkeley

ELENI KATIFORI
University of Pennsylvania

KIRILL KOROLEV
Boston University

BENJAMIN MACHTA
Yale University

MADHAV MANI
Northwestern University

M. LISA MANNING
Syracuse University

PANKAJ MEHTA
Boston University

ANDREW MUGLER
University of Pittsburgh

ARVIND MURUGAN
University of Chicago

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Targeted Grants in MPS

Targeted Grants support high-risk projects of exceptional promise and scientific importance for up to five years. The foundation currently supports the following projects:

- Searching for Interactions of Ultralight Axion-like Dark Matter
- FASER: Forward Search Experiment at the LHC
- New Directions in Cosmology and Gravitational Theory: Cosmological Bounces and Bouncing Cosmologies
- Origins of the Universe
- PTOLEMY project: Princeton Tritium Observatory for Light, Early-Universe, Massive-Neutrino Yield
- Revisiting the Turbulence Problem Using Statistical Mechanics

Searching for Interactions of Ultra-Light Axion-Like Dark Matter

The nature of dark matter is one of the most important open problems in modern physics. The Simons Foundation, jointly with the Heising-Simons Foundation, has been funding since 2015 projects aimed to test the hypothesis that axions or axion-like particles might constitute dark matter in the universe. The currently funded project is a collaborative effort between research groups at Boston University (BU) and Princeton University. Alex Sushkov (BU) and Michael Romalis (Princeton) are pursuing an experimental program to search for ultra-light dark matter in the form of axion-like particles. Collectively, the experimental efforts at BU and Princeton will search over a broad range of ultra-light dark matter masses and are sensitive to the three possible interactions of axion-like particles: the electromagnetic coupling, the axion-gluon coupling and the axion-quark coupling. The experiments rely on precision magnetometry and magnetic resonance methods, which makes technical and scientific collaboration between the research teams extremely valuable. This research effort will improve existing limits on axion dark matter as well as develop new experimental techniques for future searches with greatly improved sensitivity.

In the two years of the project, the BU group has built and successfully completed three runs for the Search for Halo Axions using Ferromagnetic Toroids (SHAFT) and CASPEr experiments. the newly attained bounds by the BU group on the axion mass and coupling constant are more stringent in certain regions of the parameter space than any other bounds known before.

The Princeton team improved operation of 21Ne-3He co-magnetometer and developed software to prepare for collection of axion dark matter data in micro-Hz frequency range, analyzed existing 3He-K co-magnetometer data to set limits on axion dark matter in the Hz frequency range and developed theoretical formalism to understand expected axion-spin coupling signal due to galactic dark matter halo.

FASER: Forward Search Experiment at the LHC

FASER, the Forward Search Experiment, is a particle physics experiment designed
to discover new, light and weakly-interacting particles at the Large Hadron Collider (LHC) at CERN in Geneva. The experiment is supported by the Simons Foundation, the Heising-Simons Foundation and CERN host lab contributions. Since March 2020, all detector components have been successfully constructed, and part of the detector was installed underground in November 2020. The rest of the detector was installed in March 2021.

The beginning of Run 3 at the LHC, originally scheduled for fall 2021, is expected to begin in spring 2022, and FASER is on schedule to begin collecting data when Run 3 begins.

The signal of a new particle at FASER is a pair of charged particles that are created by new particles that decay in the detector. Trackers are used to detect charged particles in the detector, and scintillators are used to determine whether these charged particles entered the detector from outside (background), or whether they were created in the detector (signal). The tracking system is composed of three tracking stations, each with three tracking planes, and all three tracking stations have been constructed and tested. Similarly, all scintillators have been completed, and their efficiencies have been determined to be above 99.95 percent, far above the 99 percent efficiency required to effectively eliminate the dominant background from incoming high-energy muons.

New Directions in Cosmology and Gravitational Theory: Cosmological Bounces and Bouncing Cosmologies

The goal of this program is to develop, explore and test theories of the origin, evolution and future of the universe that challenge the standard view that the universe began with a big bang about 14 billion years ago. According to this new paradigm, what has been long believed to be a beginning was actually a transition — known as a 'bounce' — from a preceding period of contraction to the current period of expansion. The observed properties of the universe today trace back to events that occurred during the period of contraction and the bounce. In some of the most interesting versions, space-time exists eternally through regular cycles of expansion, contraction and bounce, driven by the same fields that are responsible for dark energy.

The past year has seen several surprising developments building on the advances made in preceding years establishing the existence of perturbatively, stable smooth, non-singular classical bounce solutions and completing the foundational mathematical steps needed to formulate cosmological evolution equations on a computer to demonstrate fully non-perturbative stability.

A project highlight was the discovery that a cyclic theory of the universe based on ordinary, big bang–type expansion after a bounce followed by a period of slow contraction that lasts until the next bounce is necessarily different — in fact, dramatically different — from any kind of cyclic, periodic or oscillatory model of the universe considered previously. Beginning with Friedmann's 1922 periodic model, every cyclic model based on general relativity since has had the scale factor, a(t), oscillate between zero (a big bang), grow to a large but finite value, and then shrink back to zero (a big crunch/bounce transition). These models are all plagued by four seemingly unavoidable and intractable problems:

- the bang and crunch are singularities of the equations of motion;
- the crunch forces all structures formed in the previous cycle, including black holes, to smash together in dense incalculable mishmash that can potentially prevent a bounce;
- as first explained by Tolman in 1931, periodicity in a(t) is impossible because, following the second law of thermodynamics, entropy must increase from cycle to cycle, preventing bounces from being the same from crunch to crunch; and
- as the scale factor decreases to zero, even the slightest anisotropy grows and triggers chaotic mixmaster oscillations that destroy homogeneity and isotropy and create uncontrollable fluctuations in spatial curvature.

Origins of the Universe

The Origins of the Universe project is designed to advance our understanding of the universe by stimulating theoretical research into mechanisms of cosmogenesis. The project includes three groups: Cosmology Beyond Einstein's Theory, Research in Modern Inflationary Cosmology and Alternatives to Inflation, the latter of which was awarded in 2019.

Research highlights from the Cosmology Beyond Einstein's Theory group include note that the Galileon and conformal Galileon theories offer novel possibilities for the early cosmological evolution of the universe. They could describe either a pre-inflationary epoch smoothly transitioning into an inflationary phase or replace entirely the inflationary stage by genesis or bouncing phases.

The group addressed the problem of "gravitational dressing" of the conformal Galileon theories and found certain novel cosmological solutions of this theory. Those solutions describe a bouncing universe which interpolates between contracting and expanding phases without ever going through a singular regime, or a regime in which the quantum gravity effects would have been important.

The Modern Inflationary Cosmology (MIC) group progressed substantially on their core research program on early universe inflation and discovered new interfaces with other areas.

Large-scale structure (LSS) measurements promise to increase the data available to test early universe theory, but this requires control of nonlinear dynamics. MIC members derived and deployed methods ranging from perturbative expansions to peak patch halo-finding to glean important information from LSS and cosmic microwave background (CMB) data. This led to independent constraints on the cosmological parameters including the Hubble parameter (H0), consistent with the Planck CMB result. This enabled strong constraints on theories aimed at addressing the tension with distance ladder results. Interactions encompassed by primordial non-Gaussianity (NG) offer new tests of inflationary physics using existing as well as future data sets and provide conceptual lessons in quantum field theory and quantum gravity.

MIC members have discovered several essential features of the primordial wavefunction and probability distribution. This includes calculations of the statistics and observational search methods for non-adiabatic effects, a proof of the factorial enhancement of quantum multipoint correlators related to the tail of the distribution and use of NG to diagnose the quantum nature of the origin of structure. MIC members derived the infrared structure of the wavefunction for perturbations in the interacting quantum theory (both globally and in an observer patch) and discovered new, leading contributions to the wavefunction of the universe, in the context of specific proposals for its definition (for example, the Hartle–Hawking no-boundary proposal).

PTOLEMY project: Princeton Tritium Observatory for Light, Early-Universe, Massive-Neutrino Yield

At approximately one second after the big bang, the neutrinos decoupled from the rest of the expanding dense matter and radiation that ended up forming the universe observed today. These neutrinos evolved independently of the other particles since then forming the relic neutrino cosmological background. The major goal of the PTOLEMY project is to help detect the relic neutrinos. This project addresses five major technological issues for the detection of the relic neutrinos: (1) high-precision electromagnetic filtering, (2) a radio-frequency (RF) tracking system, (3) molecular smearing limitations, (4) the magnetic transport interface of the target with the RF system and (5) the precision energy resolution of the micro-calorimetry to separate the relic neutrino signal from the tritium beta-decay background.

The past year's research highlights include a new publication in progress that resolves a long-standing discrepancy between two approaches to computing the cosmic neutrino background (CNB) anisotropies. A well cited work using line-of-sight methods appears to predict a more isotropic non-relativistic CNB flux compared to massless, relativistic neutrinos. This result is counterintuitive given that one would expect the nonrelativistic neutrinos to lie somewhere between the photons and the dark matter. Indeed, an error was found in the first published calculation (Michney and Caldwell) in how the density of states evolves under Hubble expansion. The corrected line-of-sight calculation agrees with the computationally intensive approach of using coupled differential equations to solve the Boltzmann hierarchy, with expected deviations of up to 10 percent for neutrino masses of 0.1 eV. The line-of-sight method has shown to be as powerful a physics tool for understanding CNB as it is for the cosmic microwave background (CMB) anisotropies.

On the experimental side, a major obstacle in the design of the electromagnetic filter has been overcome. A paper is in preparation that shows the full end-to-end simulation of tritium endpoint electrons produced from relic neutrino capture propagating through the filter and ending in the calorimeter.

Revisiting the Turbulence Problem Using Statistical Mechanics: Theoretical Studies on Transitional and Turbulent Flows

The richness of turbulence continues to pose a major challenge to theoretical physics. Due to the wide range of length and time scales intrinsic to the problem, the number of degrees of freedom in three dimensions makes detailed simulations of real turbulent flows challenging. This project uses novel statistical mechanics approaches to explore how fluids become turbulent, as well as their properties in the strongly fluctuating turbulent state itself. Turbulence has two potentially universal scaling regimes: transitional (presumably a critical phenomenon) and high Reynolds number (presumably an asymptotic regime controlled by anomalies and associated phenomena). Thus, the coalition of researchers led by principal investigators Nigel Goldenfeld, Gregory Eyink, Gregory Falkovich and Björn Hof, will approach turbulence by detailed exploration of these two scaling regimes and connect these limiting cases by advancing the understanding of turbulence-mean flow/large-scale flow interactions to form a complete narrative of turbulence from nonequilibrium statistical mechanics.

This project is loosely organized along four main directions: transitional flows, mean-flow turbulent interactions, fully developed turbulence and experimental studies. PI Goldenfeld and team made progress on the extension of the predator-prey model for single puffs to include streamwise shear. There are two main approaches for the laminar-turbulence transition in pipes. One approach treats the pipe as a (primarily deterministic) one-dimensional excitable medium and is motivated by understanding the way in which streamwise shear drives puff dynamics. The second approach attempts to capture the stochastic flow interactions that constrain and energize a single puff. The first approach successfully accounts for some aspects of single puff behavior and captures the weak/strong slug behavior remarkably well. The second approach does not incorporate streamwise shear interactions and so until now has not been able to be applicable to the entire flow phase diagram. The group has now included the streamwise shear into the stochastic model, and the resulting description describes single puff decay, splitting and weak/strong slug regimes.

Gregory Eyink and his team made progress on their goal to develop a large-deviations framework for mean-flow/turbulence interactions and effective models to describe turbulent fluctuations. They published a paper on the path large deviations associated to the Boltzmann equation and obtained the large deviation action function associated to the Landau equation and the Lenard–Balescu equations (plasma and particles with long range interactions). There is a deep, close analogy between the kinetic theory of plasmas and the kinetic theory of wave mean-flow interactions in two-dimensional turbulence. Practically, this means that the results on the large deviation action for the 2D-stochastic Navier–Stokes equations and the quasi-geostrophic models shall be obtained soon. Such an achievement will be the basic building block of a complete theory of mean flow-turbulence interaction, as it would describe comprehensively the most probable mean-flow, dynamical relaxation to this most probable flow, Gaussian fluctuations and rare fluctuations that lead to crucial extreme events.

The main programmatic milestone accomplished by Gregory Falkovich and his team is the development of the entropic and information theory approach to the wave turbulence. Namely, they considered a set of weakly interacting waves and asked: How weak is such weak turbulence? They have analyzed turbulence of weakly interacting waves using the tools of information theory. It offered a unique perspective for comparing thermal equilibrium and turbulence. The mutual information between modes is stationary and small in thermal equilibrium yet was shown by Falkovich and team to grow with time for weak turbulence in a finite box. The team traced this growth to the concentration of probability on the resonance surfaces, which can go all the way to a singular measure. The surprising conclusion is that no matter how small the nonlinearity is and how close to Gaussian the statistics of any single amplitude are, a stationary phase-space measure is far from Gaussian, as manifested by a large relative entropy. This is a rare piece of good news for turbulence modeling: the resolved scales carry significant information about the unresolved scales. The mutual information between large and small scales is the information capacity of turbulence cascade, setting the limit on the representation of subgrid scales in turbulence modeling. They have also shown that the analysis of mutual information explains the direction of the formation of turbulence cascade.

In Björn Hof's group, they set out to test model predictions in experiments, and, depending on outcomes, extend the measurements to other flow geometries like plane Poiseuille flow. With this goal in mind, over the past year the team tested model predictions in pipe flow. They have carried out experiments in plane Poiseuille flow with a particularly large aspect ratio and quantified the microscopic processes. Surprisingly, the lifetime of the turbulent stripes that occur in channel flow are not exponentially distributed and, unlike puffs in pipe flow stripes, age. Moreover, stripe splitting above the critical point is also not memoryless. Hence, these processes are fundamentally different from those in pipe and Couette flow, which strongly suggests that channel flow is not in the directed percolation (DP) universality class, or if it is, the DP scaling would be limited to a minute range close to critical, not accessible by the largest experiments built to date

Simons Array and Observatory

The Simons Array (SA) is a large-scale astrophysical project led by UC San Diego and UC Berkeley under the sponsorship of the Simons Foundation jointly with the National Science Foundation, the Gordon and Betty Moore Foundation, the Templeton Foundation and participating institutions. The project is in its final phase of outfitting the three Cosmic Microwave Background telescopes located in the Atacama Desert in Chile with modern receivers and readouts. The SA observational and discovery program is expected to be complete by summer 2024.

The Simons Observatory (SO) is a flagship observational astrophysics project supported by the Simons Foundation, jointly with the Heising-Simons Foundation and participating institutions. The project continues its progress in its multiple locations around the world. Notably, the first platform for the Small Aperture Telescope Platform (SATP) has been manufactured in Estonia and shipped to Germany for factory acceptance testing. The SATP program is rapidly progressing toward a first-deployment-ready telescope, while maintaining pace through parallel work on all four SATPs. The SATP1 cryogenic receiver has been fully validated and the various subsystems have been integrated and tested. The second delivered SATP has been converted into the Large Aperture Telescope Receiver optics tube tester configuration and was successfully cooled to base sub-Kelvin temperatures. While the work on various components of the SO slowed down because of direct and indirect issues brought up by COVID-19, nevertheless, there is a continuous impressive progress on the key aspects of the detectors, readouts and data pipeline developments. The work at the site in Chile took a new momentum. The SO team has just hired Gary Sanders, a distinguished large-scale science project manager, as the executive project manager of the observatory.

Simons Junior Faculty Fellows

In response to the COVID-19 crisis, the MPS-launched Simons Junior Faculty Fellows program is providing additional funding to institutions in response to their plans to hire junior tenure-track faculty members to start in the fall of 2021 in each of the following three fields: mathematics, theoretical physics and theoretical computer science. The foundation will provide funding for up to one position per field and each position will be funded at $250,000 per year for three years. The supported institutions are Princeton University, Rutgers University, Columbia University, New York University and Stony Brook University.

Grants to Institutions

Simons Bridge for Postdoctoral Fellowships

The Simons Bridge for Postdoctoral Fellowships was created in response to the COVID-19 crisis and will provide additional funding to institutes to support postdoctoral positions in mathematics, theoretical physics and theoretical computer science starting in the fall of 2021 and 2022, for a total commitment of $12 million.

Targeted Grants to Institutes

This program supports centers of excellence in their effort to extend and enhance their mission. Funding is provided to help establish and strengthen contacts with the international scientific community. Currently, the foundation supports 36 institutes, including two new awards and one renewal in 2021.

2021 Targeted Grants to Institutes Awardees

ICTP South American Institute for Fundamental Research (SAIFR)
The Simons Foundation will again provide funding to the ICTP-SAIFR to supplement funding to two Simons-FAPESP (São Paulo State Research Funding Agency) tenure-track professors for three additional years.

MATRIX
MATRIX is a residential research institute for the mathematical sciences. The Simons Foundation funding will support a variety of MATRIX-Simons programs, including extended visits of international scholars, the participation of early-career researchers in MATRIX programs, engagement with other institutions and external partners, and travel assistance for researchers and their families to MATRIX.

Center for Discrete Mathematics and Theoretical Computer Science (DIMACS) at Rutgers University

The foundation's award will support the Simons Postdoctoral Leadership Initiative, which, over a three-year period, will host four Simons Postdoctoral Leaders to conduct research in either theoretical computer science or the foundations of data science and artificial intelligence.

AFRICA

Université des Sciences et Techniques de Masuku
Gabon

University of Botswana
Botswana

Université Cheikh Anta Diop de Dakar
Senegal

Mandelstam Institute for Theoretical Physics, University of the Witwatersrand
South Africa

ASIA

Simons Centre for the Study of Living Machines, National Center for Biological Sciences
India

International Centre for Theoretical Sciences, Tata Institute of Fundamental Research
India

Institute of Mathematics, Vietnam Academy of Science and Technology
Vietnam

AUSTRALIA

MATRIX
Australia

EUROPE

Niels Bohr International Academy, University of Copenhagen
Denmark

Centre International de Mathématiques Pures et Appliquées (CIMPA)
France

Oberwolfach Research Institute for Mathematics
Germany

International Mathematical Union, Commission for Developing Countries
Germany

Hamilton Mathematics Institute, Trinity College Dublin
Ireland

International Centre for Theoretical Physics
Italy

Galileo Galilei Institute
Istituto Nazionale di Fisica Nucleare
Italy

Banach Center of the Institute of Mathematics of the Polish Academy of Sciences
Poland

Independent University of Moscow
Russia

Saint Petersburg Department of V.A. Steklov Institute of Mathematics of the Russian Academy of Sciences
Russia

Steklov Mathematical Institute of the Russian Academy of Sciences
Russia

P.N. Lebedev Physical Institute of the Russian Academy of Sciences
Russia

Institut Mittag-Leffler of the Royal Swedish Academy of Sciences
Sweden

Isaac Newton Institute for Mathematical Sciences
United Kingdom

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Centre de Recherches Mathématiques, Université de Montréal
Canada

Perimeter Institute
Canada

Fields Institute for Research in Mathematical Sciences
Canada

Instituto de Matemáticas at the Universidad Nacional Autónoma de México
Mexico

Simons Institute for the Theory of Computing
United States

Aspen Center for Physics
United States

Kavli Institute for Theoretical Physics
United States

Mathematical Sciences Research Institute
United States

Institute for Pure and Applied Mathematics, University of California, Los Angeles
United States

Institute for Computational and Experimental Research in Mathematics, Brown University
United States

American Institute of Mathematics
United States

Center for Discrete Mathematics and Theoretical Computer Science, Rutgers University
United States

Institute for Nuclear Theory, University of Washington
United States

Institute of Mathematical Sciences of the Americas at the University of Miami
United States

SOUTH AMERICA

ICTP South American Institute for Fundamental Research
Brazil

Centre de Recerca Matemàtica
Brazil

Grants to Individuals

Simons Investigators

The Simons Investigators program supports leading scientists in the fields of mathematics, physics, theoretical computer science and mathematical modeling of living systems by providing generous and flexible funding for five to ten years.

Funding received by Simons Investigators is used to support their work during the most active time in their careers, allowing them the freedom to focus on their current research or initiate new research directions as well as cultivate collaborative connections with junior scientists and colleagues by hiring postdocs, hosting visitors and coordinating workshops. The foundation currently supports 138 investigators.

Since their appointments, several Simons Investigators have been elected to membership of the American Academy of Sciences and National Academy of Sciences and won such prestigious awards as the Fields Medal, the Rolf Nevanlinna Prize and the Dannie Heineman Prize for Astrophysics. Below are this year's distinctions.

NATIONAL ACADEMY OF SCIENCES

Larry Guth, Massachusetts Institute of Technology
Alexei Kitaev, California Institute of Technology

AMERICAN ACADEMY OF ARTS AND SCIENCES

Daniel Spielman, Yale University
Ashvin Vishwanath, Harvard University

MICHAEL AND SHEILA HELD PRIZE

Daniel Spielman, Yale University

BLAVATNIK NATIONAL AWARDS FOR YOUNG SCIENTISTS

Andrea Alù, Graduate Center, the City University of New York

GRUBER COSMOLOGY PRIZE

Marc Kamionkowski, Johns Hopkins University

L'ORÉAL-UNESCO FOR WOMEN IN SCIENCE AWARD

Shafrira Goldwasser, Simons Institute for the Theory of Computing

NEW HORIZONS IN MATHEMATICS PRIZE

Bhargav Bhatt, University of Michigan
Rouven Essig, SUNY at Stony Brook

Simons Fellows

Simons Fellowships in Mathematics and Simons Fellowships in Theoretical Physics enable the extension of sabbatical leaves from a semester or quarter to a full year, allowing awardees to spend substantial time away from teaching and administrative duties, focusing only on their research. Since its launch, the foundation has awarded 409 fellowships in math and 134 fellowships in physics. Fellows have been appointed to the National Academy of Sciences and the American Academy of Arts and Sciences and won prestigious awards such as the Nobel Prize and Henri Poincaré Prize, among others. Below are this year's distinctions.

NATIONAL ACADEMY OF SCIENCES

Joan S. Birman, Columbia University

AMERICAN ACADEMY OF ARTS & SCIENCES

Vicky Kalogera, Northwestern University
Kavita Ramanan, Brown University
Scott Sheffield, Massachusetts Institute of Technology

Collaboration Grants for Mathematicians

The ability to work with colleagues both near and far is an essential ingredient for the advancement of ideas and research in mathematics. The Collaboration Grants for Mathematicians program provides support to researchers for travel and hosting collaborators who do not otherwise have access to funding.

The program began in 2011 and has since supported over 1,700 mathematicians. Collaboration Grants for Mathematicians is one of MPS's most popular grants, with over 5,000 applications received since 2011. In 2021, MPS made 135 awards. Awardees receive support for up to five years.

AMS-Simons Travel Grants

The Simons Foundation, in partnership with the American Mathematical Society, provides early-career mathematicians (within four years of receiving their Ph.D.) the opportunity to travel to conferences and visit current and potential collaborators in their fields. Since 2011, the AMS-Simons Travel Grants have funded almost 2,000 trips by more than 500 recent Ph.D.s.

Simons Collaborations

The aim of the Simons Collaborations in MPS program is to stimulate progress on the fundamental scientific questions of major importance in the broad areas of mathematics, theoretical physics and theoretical computer science. Supported collaborations address questions both concrete and conceptual with the hope that with answers come major scientific milestones. Among research activities of these collaborations are small workshops and annual meetings held at the foundation. Collaborations are supported initially for four years.

In 2021, the foundation awarded two new collaborations and concluded the Simons Collaboration on Algorithms and Geometry after seven years.

Simons Collaboration on Learning the Universe

Director: Greg Bryan, Columbia University

The evolution of our universe is determined by its initial conditions and the physical laws that govern it. However, neither of these are open to direct determination, but must be inferred from observations. This collaboration plans to carry out this inference using a Bayesian forward modeling approach, where we repeatedly sample a set of initial conditions, predict the observational consequences of that set, compare results to the real observations of galaxies and gas, and then compute the likelihood of those initial conditions, either explicitly or implicitly. In practice, constructing the posterior distribution of the initial conditions like this is an extremely challenging endeavor because galaxy formation simulations are costly and still only incompletely understood. Furthermore, the dimensionality of the initial parameter space is enormous, so standard inference techniques fail.

To address these challenges, the collaboration will employ a three-pronged approach. First, we will develop improved galaxy formation simulations using novel sub-grid models for the influence of stars and black holes. The new models will be built on knowledge gained from detailed, high-resolution simulations of individual star-forming regions or accreting black holes that resolve the relevant physical processes. These improved sub-grid models will be implemented in cosmological simulations and can be used to make direct observational predictions for a significant (but still limited) number of samples of initial conditions. Second, the collaboration will use the emerging power of machine learning, which can speed up the forward modeling by factors of millions or billions by training on the relatively small samples of full simulations produced in the first step. Third, we will develop and enhance fast, physically motivated, neural-net likelihood, simulation-based or likelihood-free inference techniques that have the potential to fully exploit the enormous amount of information from upcoming observational surveys. By harnessing this pending explosion of data, we anticipate generating posterior distributions of not just the cosmological parameters, but the initial conditions and even the uncertain astrophysical parameters.

Simons Collaboration on Global Categorical Symmetries

Director: Constantin Teleman, University of California Berkeley

This collaboration brings together a group of physicists and mathematicians, working across disciplinary boundaries, to unlock the power of symmetry in its broadest, most general form.

Symmetry is a powerful tool for organizing physical phenomena and anchors our understanding of the laws of nature. The notion of symmetry, however, has evolved dramatically since the emergence of groups and representations as the language for describing symmetries in geometry and mechanics. Galvanized most recently by advances in mathematics and physics, much of this evolution has been driven by the quest to achieve a deeper understanding of quantum field theory — the universal language of modern theoretical physics.

From a modern point of view, quantum field theory associates to every symmetry a topological defect, which acts on local and extended observables. This connection to topology has recently led to the discovery of new higher notions of symmetry, which in turn has shed new light on some of the most mysterious and profound phenomena described by quantum field theory, including color confinement in non-abelian gauge theories, duality and other phenomena.

The deep link between symmetry and topology finds its natural expression in the mathematics of topological quantum field theory, such as the modular tensor categories that describe invariants of knots and the long-distance physics of anyons. Recent advances have centered on the rich categorical structure of various defects and how it encodes the fundamental idea of locality, as expressed by the cobordism hypothesis. Our collaboration grows out of the synergy between these areas of physics and mathematics, weaving together cutting-edge developments.

Simons Collaborations in MPS

ALGORITHMS AND GEOMETRY
Director: **Assaf Naor,** Princeton University

ARITHMETIC GEOMETRY, NUMBER THEORY, AND COMPUTATION
Director: **Brendan Hassett,** Brown University

CRACKING THE GLASS PROBLEM
Director: **Sidney R. Nagel,** University of Chicago

EXTREME WAVE PHENOMENA BASED ON SYMMETRIES
Director: **Andrea Alú,** Advanced Science Research Center at The Graduate Center, CUNY

GLOBAL CATEGORICAL SYMMETRIES
Director: **Constantin Teleman,** University of California Berkeley

HIDDEN SYMMETRIES AND FUSION ENERGY
Director: **Amitava Bhattacharjee,** Princeton University

HOMOLOGICAL MIRROR SYMMETRY
Director: **Tony Pantev,** University of Pennsylvania

IT FROM QUBIT
Director: **Patrick Hayden,** Stanford University

LEARNING THE UNIVERSE
Director: **Greg Bryan,** Columbia University

LOCALIZATION OF WAVES
Director: **Svitlana Mayboroda,** University of Minnesota

MANY ELECTRON PROBLEM
Director: **Andrew Millis,** Simons Foundation/Flatiron Institute & Columbia University

NONPERTURBATIVE BOOTSTRAP
Director: **Leonardo Rastelli,** Yang Institute for Theoretical Physics, Stony Brook University

SPECIAL HOLONOMY IN GEOMETRY, ANALYSIS AND PHYSICS
Director: **Robert Bryant,** Duke University

THEORY OF ALGORITHMIC FAIRNESS
Director: **Omer Reingold,** Stanford University

ULTRA QUANTUM MATTER
Director: **Ashvin Vishwanath,** Harvard University

WAVE TURBULENCE
Director: **Jalal Shatah,** New York University

NSF-Simons Collaborations

NSF-Simons Research Centers for Mathematics of Complex Biological Systems

The NSF-Simons Research Centers for Mathematics of Complex Biological Systems (MathBioSys) initiative created innovative, collaborative research centers at the intersection of mathematics and molecular, cellular and organismal biology, establishing new connections between mathematical sciences and biological sciences and promoting interdisciplinary education and workforce training. The project involves the following groups.

NSF-SIMONS SOUTHEAST CENTER FOR MATHEMATICS AND BIOLOGY

Georgia Institute of Technology
Christine Heitsch, PI/Director
Hang Lu, Co-I/Associate Director

The Southeast Center for Mathematics and Biology (SCMB) is a regional center whose defining mission is connecting mathematical theory with biological data. This mission is being realized through SCMB's Seed Project Research and Cross-disciplinary Training initiatives, as well as support for Convening Research and Educational Outreach activities. Each of these programs addresses different aspects of a fundamental scientific challenge: how to build math-bio research capacity?

The signature SCMB program is its Seed Project research initiative. The NSF-Simons funding catalyzed seven math-bio research teams where the problems are grounded in data on complex biosystems, and the solutions advance mathematical theory and its applications. The focus is on understanding emergent properties at critical genome-to-phenome junctures. To promote a "phase transition" in understanding the complex biosystems, SCMB is actively pursuing new applications of foundational mathematics, i.e., algebra, geometry and topology, as well as combinatorics, graph theory and probability.

SCMB is also building capacity at the math-bio interface through the Cross-disciplinary Training of biosystems Ph.D. students and mathematics postdoctoral scholars.

NSF-SIMONS CENTER FOR MATHEMATICAL AND STATISTICAL ANALYSIS OF BIOLOGY

Harvard University
Andrew Murray, PI/Chair and Center Director

The NSF-Simons Center at Harvard is dedicated to developing causal, predictive models of key biological abilities, such as self-organized morphogenesis, cellular decision-making and biological adaptation, which are the hallmark of living systems.

NSF-SIMONS CENTER FOR MULTISCALE CELL FATE RESEARCH

University of California, Irvine
Qing Nie, PI/Director

The NSF-Simons Center for Multiscale Cell Fate Research made progress on many of their research goals. Through an integrated mathematical and experimental approach, the center investigates the emergent properties of cell fate in multiscale systems, with a focus on: cellular complexity and plasticity in skin (in vivo mouse), stochastic dynamics and migration of neural crest cells (in vivo zebrafish) and epigenetic control of stem cell specification through DNA methylation (in vitro). To address the mathematical, statistical and computational challenges, the Center has a Mathematics Core to focus on developing new methods driven by specific cell fate questions as well as broader biological applications.

NSF-SIMONS CENTER FOR QUANTITATIVE BIOLOGY

Northwestern University

Richard W. Carthew, PI/Center Director

This past year, NSF-Simons Center for Quantitative Biology made major progress on Embryonic Development, led by Drs. Carole LaBonne and Madhav Mani, and Growth and Environment, led by Drs. Erik Andersen and Niall Mangan, which had both been established at the genesis of the center.

The project on Developmental Dynamics, which focuses on how epithelial tissues undergo growth, patterning and morphogenesis to create the final functional form of an organ, maintained its high productivity with several interesting findings.

NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning

The NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning (MoDL) initiative awarded two collaborations designed to support research activities focused on a particular set of topics involving some of the most challenging questions in the general area of mathematical and scientific foundations of deep learning.

COLLABORATION ON THE THEORETICAL FOUNDATIONS OF DEEP LEARNING

Peter Bartlett, Director, University of California, Berkeley

The success of deep learning has had a major impact across industry, commerce, science and society. But there are many aspects of this technology that are very different from classical methodology and that are poorly understood. A theoretical understanding will be crucial for overcoming its drawbacks.

The Collaboration on the Theoretical Foundations of Deep Learning aims to address these challenges: understanding the mathematical mechanisms that underpin the practical success of deep learning, using this understanding to elucidate the limitations of current methods and extending them beyond the domains where they are currently applicable, and initiating the study of the array of mathematical problems that emerge.

COLLABORATIVE RESEARCH: TRANSFERABLE, HIERARCHICAL, EXPRESSIVE, OPTIMAL, ROBUST, INTERPRETABLE NETWORKS (THEORINET)

René Vidal, PI/Director, Johns Hopkins University

Transferable, Hierarchical, Expressive, Optimal, Robust, and Interpretable NETworks (THEORINET) seeks to develop a mathematical, statistical and computational framework that helps explain the success of current network architectures, understand its pitfalls and guide the design of novel architectures with guaranteed confidence, robustness, interpretability, optimality and transferability.

Simons Conferences in MPS

January 19, 2021	COLLABORATION ON ARITHMETIC GEOMETRY, NUMBER THEORY AND COMPUTATION ANNUAL MEETING
Organizer	**Brendan Hassett,** Brown University
January 22, 2021	SIMONS COLLABORATION ON ULTRA QUANTUM MATTER ANNUAL MEETING
Organizer	**Ashvin Vishwanath,** Harvard University
February 12, 2021	SIMONS COLLABORATION ON THE MANY ELECTRON PROBLEM ANNUAL MEETING
Organizer	**Andrew Millis,** Simons Foundation
February 19, 2021	SIMONS COLLABORATION ON LOCALIZATION OF WAVES ANNUAL MEETING
Organizer	**Svitlana Mayboroda,** University of Minnesota
March 26, 2021	SIMONS COLLABORATION ON HIDDEN SYMMETRIES AND FUSION ENERGY ANNUAL MEETING
Organizer	**Amitava Bhattacharjee,** Princeton University
September 9–10, 2021	SIMONS COLLABORATION ON SPECIAL HOLONOMY IN GEOMETRY, ANALYSIS AND PHYSICS THIRD ANNUAL MEETING
Organizer	**Robert Bryant,** Duke University
September 30–October 1, 2021	NSF-SIMONS RESEARCH COLLABORATIONS ON THE MATHEMATICAL AND SCIENTIFIC FOUNDATIONS OF DEEP LEARNING ANNUAL MEETING
Organizer	**Peter Bartlett,** University of California, Berkeley **René Vidal,** PI/Director, Johns Hopkins University
October 6, 2021	SIMONS SOCIETY OF FELLOWS ALUMNI SYMPOSIUM
October 21–22, 2021	SIMONS COLLABORATION EXTREME WAVE PHENOMENA BASED ON SYMMETRIES ANNUAL MEETING
Organizer	**Andrea Alù,** Advanced Science Research Center at The Graduate Center, CUNY

October 27–29, 2021	MPS CONFERENCE ON HIGH-DIMENSIONAL EXPANDERS
Organizer	**Alexander Lubotzky,** Hebrew University
November 11–12, 2021	SIMONS COLLABORATION ON THE NONPERTURBATIVE BOOTSTRAP ANNUAL MEETING
Organizer	**Leonardo Rastelli** Stony Brook University
November 18–19, 2021	SIMONS COLLABORATION ON HOMOLOGICAL MIRROR SYMMETRY ANNUAL MEETING
Organizer	**Tony Pantev,** Pennsylvania State University
December 2–3, 2021	SIMONS COLLABORATION ON WAVE TURBULENCE ANNUAL MEETING
Organizer	**Jalal Shatah,** New York University
December 9–10, 2021	SIMONS COLLABORATION ON IT FROM QUBIT ANNUAL MEETING
Organizer	**Patrick Hayden,** Stanford University

Simons Symposia

Simons Symposia are meetings on exciting developments in mathematics, theoretical physics and theoretical computer science. For one week, top researchers are brought together for discussions and collaborations in a relaxed yet scientifically stimulating atmosphere. Symposia are normally a series of three meetings held every second year. The foundation awarded two new symposia: Multiscale Physics and Geometry of Arithmetic Statistics. The first meetings were supposed to take place in spring 2020. However, in response to the COVID-19 crisis, all 2020 and 2021 Simons Symposia were postponed to 2022 and will take place at Schloss Elmau in Krün, Germany, and Gleneagles Hotel in Perthshire, Scotland.

Symposium Years: 2019, 2022
Organizers

ALGEBRAIC, COMPLEX AND ARITHMETIC DYNAMICS
Laura DeMarco, Northwestern University
Mattias Jonsson, University of Michigan

Symposium Years: 2019, 2022
Organizers

AMPLITUDES MEET COSMOLOGY
Nima Arkani-Hamed, Institute for Advanced Study
Daniel Baumann, University of Amsterdam
John Joseph Carrasco, Northwestern University and the Institute for Theoretical Physics (IPhT, CEA-Saclay)
Daniel Green, University of California, San Diego

Symposium Years: 2012, 2014, 2016
Organizers

ANALYSIS OF BOOLEAN FUNCTIONS/DISCRETE ANALYSIS BEYOND THE BOOLEAN CUBE
Elchanan Mossel, Massachusetts Institute of Technology
Ryan O'Donnell, Carnegie Mellon University
Krzysztof Oleszkiewicz, University of Warsaw

Symposium Years: 2014, 2016, 2018
Organizers

FAMILIES OF AUTOMORPHIC FORMS AND THE TRACE FORMULA
Werner Müller, Mathematical Institute of the University of Bonn
Sug Woo Shin, University of California, Berkeley
Nicolas Templier, Cornell University

Symposium Years: 2014, 2016, 2018
Organizers

GALACTIC SUPERWINDS: BEYOND PHENOMENOLOGY
Andrew Benson, Carnegie Observatories
Juna Kollmeier, Carnegie Observatories

Symposium Years: 2022
Organizers

GEOMETRY OF ARITHMETIC STATISTICS
Alina Bucur, University of California, San Diego
Jordan Ellenberg, University of Wisconsin, Madison
Ila Varma, University of Toronto
David Zureick-Brown, Emory University

Symposium Years: 2012, 2015, 2016
Organizers

GEOMETRY OVER NONCLOSED FIELDS
Fedor Bogomolov, New York University
Brendan Hassett, Brown University
Yuri Tschinkel, Simons Foundation

Symposium Years: 2013
Organizers

THE KARDAR–PARISI–ZHANG EQUATION
Alexei Borodin, Massachusetts Institute of Technology
Jeremy Quastel, University of Toronto
Herbert Spohn, Technische Universität München

Symposium Years: 2012
Organizers

KNOT HOMOLOGIES AND BPS STATES
Davide Gaiotto, Perimeter Institute
Sergei Gukov, California Institute of Technology
Mikhail Khovanov, Columbia University
Jacob Rasmussen, University of Cambridge

Symposium Years: 2018, 2022
Organizers

ILLUMINATING DARK MATTER
Rouven Essig, Stony Brook University
Jonathan Feng, University of California, Irvine
Kathryn Zurek, California Institute of Technology

Symposium Years: 2023
Organizers

MULTI-SCALE PHYSICS
Alexander Schekochihin, Oxford University
Eliot Quataert, Princeton University
Laure Zanna, New York University

Symposium Years: 2013, 2015, 2017
Organizers

NEW DIRECTIONS IN APPROXIMATION ALGORITHMS
Sanjeev Arora, Princeton University
Michel Goemans, Massachusetts Institute of Technology
Uriel Feige, Weizmann Institute of Science
David Shmoys, Cornell University

Symposium Years: 2019, 2022
Organizers

NEW DIRECTIONS IN THEORETICAL MACHINE LEARNING
Sanjeev Arora, Princeton University
Maria-Florina Balcan, Carnegie Mellon University
Sanjoy Dasgupta, University of California, San Diego
Sham Kakade, University of Washington

Symposium Years: 2013, 2015, 2017	NON-ARCHIMEDEAN AND TROPICAL GEOMETRY
Organizers	**Matthew Baker,** Georgia Institute of Technology
	Sam Payne, University of Texas at Austen
Symposium Years: 2017, 2019, 2022	P-ADIC HODGE THEORY
Organizers	**Bhargav Bhatt,** University of Michigan
	Martin Olsson, University of California, Berkeley
Symposium Years: 2018, 2022	PERIODS AND L-VALUES OF MOTIVES
Organizers	**Jean-Benoît Bost,** University of Paris
	Gisbert Wüstholz, UETH and University of Zurich
	Shou-Wu Zhang, Princeton University
Symposium Years: 2013, 2015, 2017	QUANTUM ENTANGLEMENT
Organizers	**Shamit Kachru,** Stanford University
	Hirosi Ooguri, California Institute of Technology
	Subir Sachdev, Harvard University
Symposium Years: 2012, 2014	QUANTUM PHYSICS BEYOND SIMPLE SYSTEMS
Organizers	**Boris Altshuler,** Columbia University
	Vladimir Falko, Manchester University
	Charles Marcus, Niels Bohr Institute

Infrastructure

arXiv

As a well-known curated research-sharing platform open to anyone, arXiv has been a pioneer in digital open access for 30 years. Today, arXiv.org hosts more than 1.89 million scholarly articles in eight subject areas, curated by a strong community of volunteer moderators who balance content quality and distribution speed. arXiv offers solutions for a broad range of services for researchers: article submission, compilation, production, retrieval, email distribution, search and discovery, mobile and web accessibility, and API distribution for machine-readability, together with content curation and archiving. Our emphasis on openness, collaboration and scholarship provide the strong foundation on which arXiv thrives. 2020 was a year of many changes. The arXiv team welcomed its first executive director, Elenora Presani, amidst a pandemic. arXiv received 178,329 submissions, a 14 percent increase from 2019. Computer science submissions comprised 30 percent of total submissions, and math 20 percent. Articles were downloaded 335 million times by readers around the world. Two-thirds of the top thirty institutional users were outside the United States.

Magma

Magma is a large, well-supported software package designed for computations in algebra, number theory, algebraic geometry and algebraic combinatorics. The Simons Foundation bought a site license that covers all academic and nonprofit research users in the United States.

At the start of 2021, there were 235 participating entities (sites) in the Simons-Magma scheme, an increase of 13 over the year. Of the 13 sites that joined the scheme this year, 8 have never held a Magma subscription while only one of the remaining five held a subscription for Magma at the time of joining the Simons-Magma scheme.

Simons Society of Fellows

Junior Fellows

Initiated in 2013, the Society of Fellows strives to create a community of scholars and to encourage intellectual interactions across disciplines and across research centers in the New York City area. Junior Fellows are selected by a group of Senior Fellows in collaboration with Simons Foundation senior scientists. Since its inception, the Society of Fellows has appointed 81 Junior Fellows and has seen five classes of Junior Fellows graduate.

Naama Aviram
Rockefeller University

Begüm Aydin
Rockefeller University

Jarosław Błasiok
Columbia University

Abigail Bodner
New York University

Kathryn Bonnen
New York University

Philipp Brand
Rockefeller University

Mariana Cardoso
New York University

Rosemary Cater
Columbia University

Ashley Chui
New York University

Raphael Cohn
Columbia University

Benem-Orom Davids
Columbia University

Aravind Devarakonda
Columbia University

Aleksander Doan
Columbia University

Robert Fernandez
Columbia University

Michele Fornea
Columbia University

Emanuele Galiffi
City University New York

Carla Golden
New York University

Dorri Halbertal
Columbia University

Leah Houri-Zeevi
Rockefeller University

Jiaoyang Huang
New York University

Patrick Kennedy
Columbia University

Tim Large
Columbia University

Emily Mackevicius
Columbia University

Jennifer Merritt
Columbia University

Amy Norovich
Columbia University

Maria Pokrovskii
Memorial Sloan-Kettering Cancer Center

Fedor Popov
New York University

Joan Pulupa
Columbia University

Kaia Tombak
Hunter College of CUNY

Pooja Viswanathan
Mount Sinai

Sebastian Wolff
New York University

Songtian Zhang
Columbia University

Alumni

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Columbia University

Gilad Asharov
Cornell University

Arkarup Bandyopadhyay (Banerjee)
New York University School of Medicine

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Rockefeller University

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Columbia University

Y-Lan Boureau
New York University

Michal Breker-Dekel
Rockefeller University

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New York University School of Medicine

Jennifer Bussell
Columbia University

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Columbia University

Sylvain Carpentier
Columbia University

Eric Castillo
Hunter College

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Columbia University

Jairo Diaz
New York University

Sara Fenstermacher
New York University

Logan Grosenick
Columbia University

Arbel Harpak
Columbia University

Benjamin Harrop-Griffiths
New York University

Keith Hawkins
Columbia University

Keith Hawkins
Columbia University

Colin Hill
Columbia University

Kohei Inayoshi
Columbia University

Bianca Jones Marlin
Columbia University Medical Center

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Columbia University

Dion Khodagholy
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Columbia University

Boris Leistedt
New York University

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New York University

Rafael Maia
Columbia University

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Rockefeller University

Krista Perks
Wesleyan University

Antigoni Polychroniadou
Cornell University

Ilya Razenshteyn
Columbia University

Carlotta Ronda
Columbia University

Aditi Sheshadri
Columbia University

Mijo Simunovic
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James Stafford
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New York University

Yi Sun
Columbia University

Xin Sun
Columbia University

Lisa Tran
Columbia University

Li-Cheng Tsai
Columbia University

Jonathan Ullman
Columbia University

Victoria (Ashley) Villar
Columbia University

Michael Waskom
New York University

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New York University

Moses Chao
New York University

David Hirsh
Columbia University

Carol Mason
Columbia University

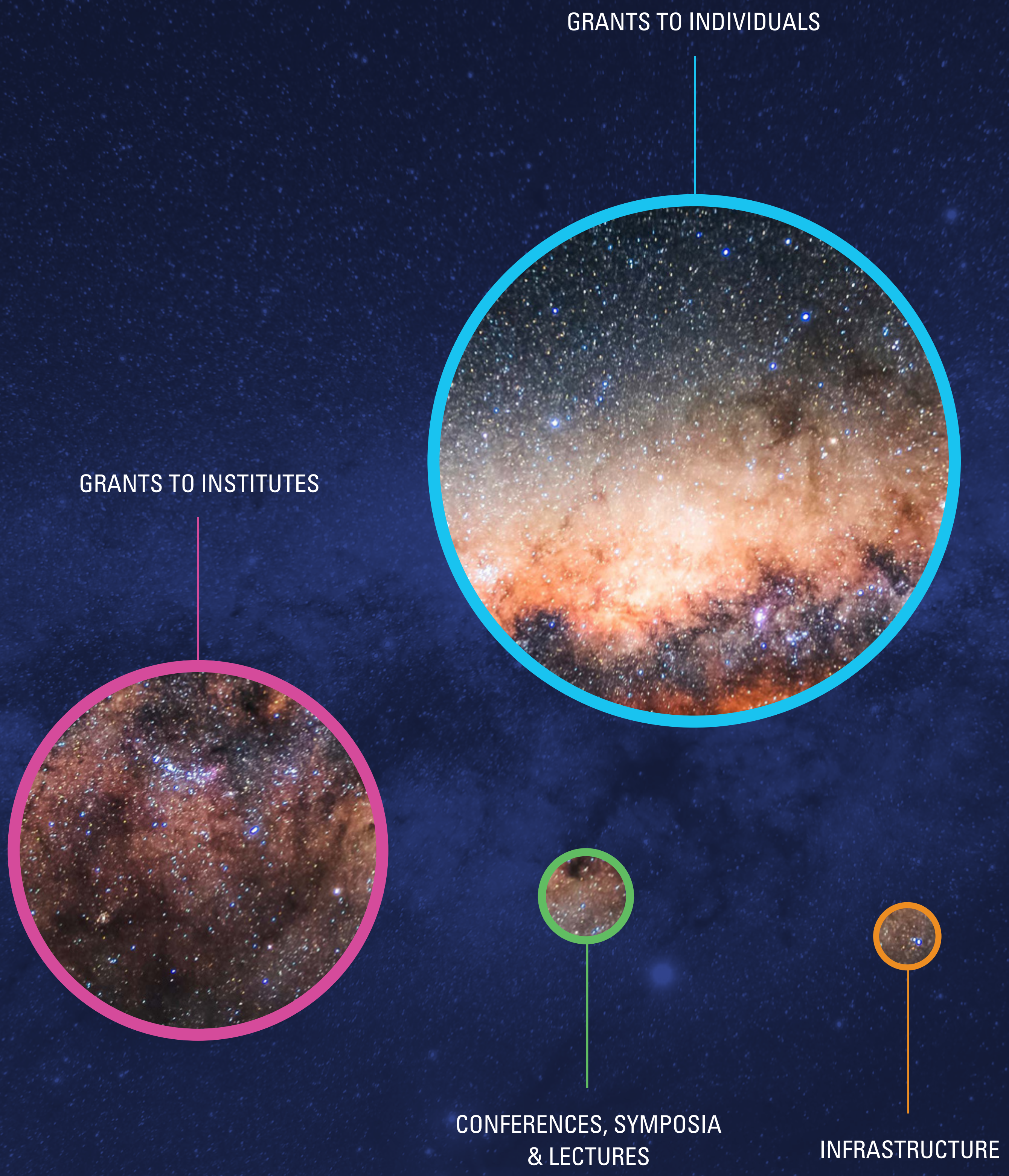
John Morgan
Columbia University

Tony Movshon
New York University

Andrei Okounkov
Columbia University

Margaret Wright
New York University

MPS Budget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INFRASTRUCTURE


SIMONS FOUNDATION
Mathematics and Physical Sciences