Miller Institute For Basic Research In Science

Tomales Bay

21st Annual Interdisciplinary Symposium

June 2~4, 2017

University of California, Berkeley

THE MILLER INSTITUTE A BRIEF HISTORY

The Miller Institute was established in 1955 after Adolph C. Miller and his wife, Mary Sprague Miller donated just over $5 million dollars to the University. It was their wish that the donation be used to establish an institute "dedicated to the encouragement of creative thought and conduct of pure science." The gift was made in 1943, but remained anonymous until after the death of the Millers.

Adolph Miller was born in San Francisco on January 7, 1866. He entered UC in 1883 and was active throughout his CAL years. After graduation he went to Harvard for Graduate School and then for additional study in Paris and Munich. He returned to the United States and taught Economics at Harvard until he was appointed Assistant Professor of Political Science in Berkeley in 1890. After just one year he moved to Cornell. A year later he moved on to Chicago as a full professor of Finance.

He married Mary Sprague in 1885. She was the eldest child of a prosperous Chicago businessman and perhaps the source of much of the Millers' wealth. In 1902 Miller returned to Berkeley as Flood Professor of Economics and Commerce. He established the College of Commerce, which has grown into the Haas School today.

After 11 years at UC, Miller resigned to become the US Assistant Secretary to the Interior. The following year the Federal Reserve system was established and President Wilson appointed Miller to its Board of Governors. He held that position for 22 years under 5 different presidents.

The Miller Institute has sponsored Miller Professors, Visiting Miller Professors and Miller Research Fellows at different times throughout its history. The first appointments of Miller Professors were made in January 1957. After its 50+ year history the Institute has hosted over 1000 scientists in its programs. For a period of time in the 1980s the Visiting Miller Professorship program did not exist, but it resumed in 1985 and has grown considerably since that time.

In 2008 the Institute created the Miller Senior Fellowship Program and appointed its first recipient. Miller Senior Fellows serve as mentors to the Miller Fellows by leading discussions and participating in Institute events. They are awarded an annual research grant to use at their discretion in support of their research.

The Institute is governed by the Advisory Board, which is comprised of the Chancellor of the University, four outside members, and the Executive Committee. The Advisory Board meets once a year to assist the Executive Committee in selecting Miller Professors and the Visiting Miller Professors. The Executive Committee alone selects the Miller Fellows and the Miller Senior Fellows.

More at: http://miller.berkeley.edu/

2017 SYMPOSIUM COMMITTEE

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Stanford University

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Calico, San Francisco

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Department of Mathematics
University of Pennsylvania

MILLER INSTITUTE
INTERDISCIPLINARY SYMPOSIUM
2017 SPEAKERS

Mike Brown
Geology & Planetary Sciences
Caltech

Paul Corkum
Physics
University of Ottawa

Gilbert Holder
Astrophysics
University of Illinois

Laura Kiessling
Chemistry
University of Wisconsin - Madison
(MIT as of July 1, 2017)

Lauren Meyers
Integrative Biology
University of Texas - Austin

Michael Nachman
Integrative Biology
UC Berkeley

Christos Papadimitriou
Electrical Engineering & Computer Science
UC Berkeley

MIKE BROWN
DEPARTMENT OF GEOLOGY & PLANETARY SCIENCES
CALTECH
mbrown@gps.caltech.edu
www.gps.caltech.edu/~mbrown

Mike Brown is a Professor of Planetary Astronomy at the California Institute of Technology where he teaches classes from introductory physics to the science of the solar system. He is a native of Huntsville, Alabama, where he grew up listening to the tests of the Saturn rockets preparing to go to the moon, and he received his undergraduate degree in physics from Princeton University and his Ph.D. in astronomy from the University of California at Berkeley. He and his research group spend their time searching for and studying the most distant objects in the solar system and drinking coffee.

<u>ABSTRACT:</u> "Planet Nine from Outer Space"

Recent evidence suggests that a massive body is lurking at the outskirts of our solar system, far beyond the orbits of the known giant planets. This object, at a distance approximately 20 times further than Neptune and with a mass approximately 5000 times larger that Pluto, is the real ninth planet of the solar system. I will talk about the observation that led us to the evidence for this Planet Nine and discuss how so massive an object could have been hiding in the outer solar system for so long. Finally I will discuss the international effort to pinpoint this newest member of our planetary family.

<u>REPRESENATIVE ARTICLES:</u>

www.findplanetnine.com
https://arxiv.org/abs/1601.05438

PAUL CORKUM
JOINT ATTOSECOND SCIENCE LABORATORY
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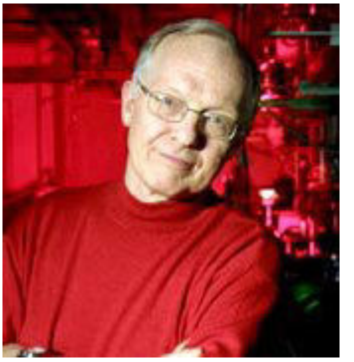
http://jaslab.ca/corkum_e.html



Paul Corkum (OC, FRS, FRSC, FRSP) 1972 Ph.D. Lehigh University, in theoretical physics, joined the National Research Council of Canada in 1973 where he built a world famous group working on the interaction of very short light pulses with matter. Corkum is best known for introducing many of the concepts of how intense light pulses interact with atoms, molecules and solids, and confirming the concepts experimentally. He was the first to show how to make and measure an attosecond pulse and how this new technology could be used to image atomic-scale structure. Corkum holds a Canada Research Chair at the University of Ottawa and directs the Joint NRC/University of Ottawa Attosecond Science Lab. He is a member of the Royal Societies of London and of Canada and a foreign member of the National Academy of Science and of the Austrian Academy of Science. Among his awards are the Canadian Association of Physicists' Gold Medal for Lifetime Achievement in Physics (1996); the Royal Society of Canada's Tory Award (2003); the Optical Society's Charles H. Townes Award (2005); the IEEE's Quantum Electronics Award (2005); the American Physical Societies' Schawlow Prize (2006) and the ACS Zewail Award (2010); the Royal Photographic Society's Progress medal (2013) (the society's highest honour); and the Optical Society of America's Charles Ives award (2014) (the society's highest award). In 2013, Corkum received both Israel's Harvey Prize for Physical Sciences and Saudi Arabia's King Faisal International Prize for Science (Physics). In 2015, he shared the Russian Academy of Sciences Lomonosov Gold Medal for outstanding achievements in the natural sciences & humanities (the Academy's highest award) and was named a Thomson Reuters Citation Laureate, *for researchers whose work is -- "of Nobel class" and likely to earn the Nobel someday.*

<u>ABSTRACT:</u> "Probed Quantum Systems on the Attosecond Time Scale"

Attosecond pulses are generated by electrons that are extracted from a quantum system by an intense light pulse and travel through the continuum under the influence of the electric field of the light. Portions of each electron wave packet are forced to re-collide with its parent ion after the field reverses direction. Upon re-collision, the electron and ion can recombine, emitting soft X-ray radiation that can be in the form of attosecond pulses. This highly nonlinear process occurs in atoms, molecules and solids and on its own, it offers unique measurement opportunities – of the attosecond pulse itself; of the orbital(s) from which it emerged; and the band structure of material in which the wave packets moved.

Attosecond pulse generation is a form of photoelectron spectroscopy but "in reverse". It is different from conventional spectroscopy with an external source because the re-collision electron does not interact with core levels. Thus, we gain different information if we probe materials internally or conventionally with attosecond pulses. I will discuss the attosecond pulses that are created and the spectroscopy that arises.

<u>REPRESENATIVE ARTICLES:</u>

http://www.nature.com/nphys/journal/v3/n6/abs/nphys620.html (doi:10.1038/nphys620)

https://www.osapublishing.org/josab/abstract.cfm?uri=josab-33-6-1081(doi:10.1364/JOSAB.33.001081)

GILBERT HOLDER
DEPARTMENT OF PHYSICS
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http://physics.illinois.edu/people/directory/profile/gholder

Gil Holder is a theoretical astrophysicist and cosmologist who seeks to understand how the complex universe we see today—full of galaxy clusters, galaxies, stars, and planets—evolved from a nearly uniform state having density fluctuations of a few parts per million 300 000 years after the big bang. Professor Holder has worked on a wide range of topics—from the early universe, to the cosmic microwave background, to gravitational lensing, to black holes, to our solar system. He has developed theoretical methods and tools to investigate these astronomical objects, enabling important constraints on the properties of dark matter and dark energy.

Professor Holder received his BSc (1994) in astrophysics and MSc (1996) in physics from Queen's University in Kingston, Ontario, before obtaining his PhD in astronomy and astrophysics from the University of Chicago in 2001. His graduate work on the possibility of discovering new galaxy clusters through their imprints in the cosmic microwave background was a key science motivation for a new generation of large mm-wave survey experiments.

After obtaining his doctorate, Professor Holder was a Keck Fellow at the Institute for Advanced Study (Princeton, New Jersey). Following a short stint as a senior research associate at the Canadian Institute for Theoretical Astrophysics in Toronto, Professor Holder was appointed the Canada Research Chair in Cosmological Astrophysics at McGill University in Montreal in 2005. He joined the Department of Physics at the University of Illinois at Urbana-Champaign in 2016 as a professor of Physics and of Astronomy and is a Faculty Affiliate at the National Center for Supercomputing Applications. He is the Brand & Monica Fortner Chair in Theoretical Astrophysics at UIUC, and is also a senior fellow in the Cosmology & Gravity program of the Canadian Institute for Advanced Research.

ABSTRACT: "Mapping Dark Matter Using Light from the Edge of the Universe"

More than 80% of the matter in the universe is in the form of "dark matter," something that must be so weakly interacting with known particles that it is effectively invisible, other than through its gravitational effects. These gravitational effects can be measured, in particular by using the gravitational deflection of light. I will discuss how this can be done using the relic radiation from the big bang, the cosmic microwave background, providing maps of dark matter over virtually the entire sky. These maps can be used to tell us more about dark matter, as well as giving new perspectives on dark energy, an even more mysterious component of the cosmic energy budget.

REPRESENTATIVE ARTICLES:

https://arxiv.org/abs/1705.00743 https://arxiv.org/abs/1303.5048

LAURA KIESSLING
DEPARTMENT OF CHEMISTRY
UNIVESRITY OF WISCONSIN - MADISON
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Laura L. Kiessling currently holds the Steenbock Chair in Chemistry and is the Laurens Anderson Professor of Biochemistry at the University of Wisconsin-Madison. On July 1, she will become the Novartis Professor of Chemistry at MIT. Her honors and awards include a Guggenheim Fellowship and a MacArthur Foundation Fellowship. She is Fellow of the American Academy of Arts and Sciences, a Member of the National Academy of Sciences, and was elected to the American Philosophical Society. She is the founding Editor-In-Chief of *ACS Chemical Biology.* Her research interests focus on elucidating and exploiting the mechanisms of cell surface recognition processes, especially those involving protein–carbohydrate interactions. Her group is probing the assembly of glycans, glycan biological roles, and how to co-opt or inhibit glycan interactions for health and disease.

ABSTRACT: "Checking Cellular IDs with Glycans"

As animals living amongst microbes, we need to distinguish between microorganisms that are generally benign (commensal), beneficial (mutualist/symbiont), or pathogenic. The presence of our microbiome raises a key question: How do we influence which microbes stay and which must go? And for the microbes that stay, how do we protect our organs and tissues from microbial infiltration? To address these questions, we are focusing on a prominent feature of the cell's exterior—the carbohydrate coat. From humans to fungi to bacteria, virtually all cells on Earth possess a carbohydrate coat. One important role of this coat is to serve as an identification card (ID). We have been examining the role of carbohydrate-binding proteins, lectins, in influencing our microbiota and in maintaining tissue border security. This seminar will describe how lectins function as microbial detectors. An understanding of how lectins recognize and influence microbes can lead to alternative methods to combat pathogens, rapid approaches to ID microbiota, and new strategies regulate microbiome composition to promote human health.

REPRESENTATIVE ARTICLES:

http://science.sciencemag.org.ezproxy.library.wisc.edu/content/335/6071/936
http://www.sciencedirect.com/science/article/pii/S1074761314004956
http://www.nature.com/nsmb/journal/v22/n8/full/nsmb.3053.html

LAUREN MEYERS
DEPARTMENT OF INTEGRATIVE BIOLOGY
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http://www.bio.utexas/research/meyers/LaurenM/index.html

Lauren Ancel Meyers is a Professor of Integrative Biology and Statistics & Data Science at The University of Texas at Austin. Trained as a mathematical biologist at Harvard and Stanford Universities, she is known for her pioneering work in developing powerful computational methods for detecting, forecasting, and controlling infectious disease outbreaks. Dr. Meyers' research on influenza, Ebola and SARS has been published in over 80 peer-reviewed publications and her software and analyses have informed global disease control efforts.

ABSTRACT: **"Networks, Data, and the Race against Global Pandemics"**

Infectious diseases are a dynamic and devastating threat to global health. Over the past three years, Zika has dramatically expanded its global reach, Ebola has ravaged West Africa, a deadly avian influenza virus has surfaced in Asia, MERS threatens the Middle East, and the persistent scourge of HIV, malaria and tuberculosis have claimed millions of lives. Professor Meyers will discuss the challenges of tracking and controlling such diseases, and how scientists use network-based mathematical models of human and animal contacts, big data and high performance computing to support public health agencies in the race to detect and contain outbreaks before they emerge on a global scale.

REPRESENTATIVE ARTICLES:

https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-017-2394-9 (blog: http://blogs.biomedcentral.com/bmcseriesblog/2017/05/05/assessing-real-time-zika-risk-in-the-united-states/)

http://www.pnas.org/content/113/8/2194.short
http://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1004928

MICHAEL NACHMAN
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Michael Nachman is Director of the Museum of Vertebrate Zoology and Professor in the Department of Integrative Biology and Program in Computational Biology at U.C. Berkeley. He grew up in Riverside, California, received a B.A. from U.C. Berkeley in Zoology in 1983, and a Ph.D. from the University of Michigan, Ann Arbor, in 1990. He was an NSF-NATO postdoctoral fellow at Oxford University with Jeremy Searle and an NIH-NRSA postdoctoral fellow with Chip Aquadro before starting his faculty position in the Department of Ecology and Evolutionary Biology at the University of Arizona in 1996. He directed the University of Arizona NSF-IGERT Program in Comparative Genomics from 2001-2013 before moving to U.C. Berkeley. Michael has a long-standing interest in understanding the forces generating patterns of DNA sequence variation across the genome in humans and in mice. He documented the widespread effects of selection at linked sites in shaping human nucleotide diversity and provided one of the first detailed estimates of the human mutation rate per nucleotide. His lab also discovered that mutations at the *Mc1r* gene are responsible for color differences in naturally occurring populations of mice that live on light and dark rocks. This was one of the first examples where the mutations underlying an adaptive trait had been identified in a specific ecological context. More recently he has focused on the role of gene regulation in adaptation and speciation. He provided the first direct evidence that hybrid male sterility is associated with disruption of gene regulation on the X chromosome. These studies are helping to identify the genetic basis for the origin of new species. His discoveries reflect the talent and hard work of his students and postdocs, fifteen of whom now hold faculty positions. He is a fellow of the American Association for the Advancement of Science and of the California Academy of Sciences.

<u>ABSTRACT:</u> "Gene Regulation and the Genetic Basis of Speciation and Adaptation in House Mice, *Mus Musculus* "

In 1975, Berkeley Professor Allan Wilson and his student Mary Claire-King made the provocative suggestion that differences in the regulation of genes account for the evolutionary changes between chimpanzees and humans. The striking similarity of the proteins between humans and chimps led them to conclude that changes in the amount of gene product, rather than changes in the structure of proteins, could best account for the observed differences in traits. New methods in genomics now provide an opportunity to examine the role of gene regulation in evolution in unprecedented detail. Evolution consists of two parts: the origin of new species (speciation) and the change in lineages over time (adaptation). I will discuss the role of gene regulation in both of these processes using mice as an example. First, I will show how differences in gene regulation account for reproductive isolation between two subspecies of house mice that meet and form a hybrid zone in Europe. Second, I will describe the genetic basis of adaptation to new environments in house mice that recently colonized North and South America from Europe. Changes in gene regulation appear to play a major role in both speciation and adaptation in mice.

<u>REPRESENTATIVE ARTICLES:</u>

http://genome.cshlp.org/content/early/2016/02/01/gr.195743.115.full.pdf+html
http://www.cell.com/trends/genetics/pdf/S0168-9525(16)30150-0.pdf

CHRISTOS PAPADIMITRIOU
DEPARTMENT OF ELECTRICAL ENGINEERING &
COMPUTER SCIENCE
UC BERKELEY
christos@cs.berkeley.edu
https://people.eecs.berkeley.edu/~christos/

Christos H. Papadimitriou is the C. Lester Hogan Professor of Computer Science at UC Berkeley. Before joining Berkeley in 1996, he taught at Harvard, MIT, NTU Athens, Stanford, and UCSD. He has written five books, including standard textbooks on Combinatorial Algorithms, the Theory of Computation, and Computational Complexity, and many articles on algorithms and complexity, and their applications to optimization, databases, control, AI, robotics, economics and game theory, the Internet, evolution, and the brain. He holds a PhD from Princeton, and eight honorary doctorates. He is a member of the National Academy of Sciences of the US, the American Academy of Arts and Sciences, and the National Academy of Engineering. He is the recipient of the Knuth prize, the Goedel prize, the EATCS award, the von Neumann medal, and in 2013 the president of Greece named him commander of the order of the phoenix. He has also written a book of essays (in Greek) and three novels: "Turing", "Logicomix" and "Independence" (2017)

ABSTRACT: "A Computer Scientist Thinks About the Brain"

Looking at scientific problems at large from the point of view of computation often results in unexpected insights. In this talk I will discuss examples of such research from the theory of equilibria in the social sciences, as well as from the evolution of genotypes in a sexual population, but I will mainly focus on approaches to a computational understanding of the Brain, arguably the ultimate scientific frontier of our time, and the one with the closest affinity to computation. In particular, I will propose that the emergence of memories in the medial temporal cortex, and the creation of associations between such memories, together with the closely related challenge of language, may be an opportune domain for algorithmic modeling and analysis.

REPRESENTATIVE ARTICLES:

http://www.igi.tugraz.at/psfiles/LNCS-10000-Theories_006_v1.pdf

INTRODUCING THE 2017-2020 MILLER RESEARCH FELLOWS

NIKHIL BHATLA
HELEN WILLS NEUROSCIENCE INSTITUTE
MOLECULAR & CELL BIOLOGY

CARA BROOK
INTEGRATIVE BIOLOGY
PLANT & MICROBIAL BIOLOGY

THIBAULT DE POYFERRE DE CERE
MATHEMATICS

AMY GOLDBERG
INTEGRATIVE BIOLOGY
STATISTICS

REBECCA JENSEN-CLEM
ASTRONOMY

LOUIS KANG
PHYSICS
HELEN WILLS NEUROSCIENCE INSTITUTE

FARNAZ NIROUI
CHEMISTRY
MATERIALS SCIENCE & ENGINEERING

GRANT REMMEN
PHYSICS

SHO TAKATORI
BIOENGINEERING

ALEXANDER TURNER
CHEMISTRY
EARTH & PLANETARY SCIENCE

PETER WALTERS
CHEMISTRY

MILLER INSTITUTE SYMPOSIUM
JUNE 2-4, 2017

Friday, June 2

3 - 6:00 pm Arrival and registration - Seagull Check In

4 - 6:00 Informal gathering - Happy Hour - Buck Hall

6:00 – 7:30 Dinner & Welcome - Redwood Hall Dining Room

7:30 – 12:00 Miller Fellows Posters – Buck Hall

Saturday, June 3 - Buck Hall

7 - 8:30 am Breakfast - Redwood Hall Dining Room

8:30 - 9:15 Lauren Meyers, University of Texas - Austin
"Networks, Data, and the Race Against Global Pandemics"

9:15 - 9:45 Discussion

9:45 - 10:00 Break

10:00 - 10:45 Gilbert Holder, University of Illinois at Urbana-Champaign
"Mapping Dark Matter Using Light from the Edge of the Universe"

10:45 - 11:15 Discussion

11:30 - 12:45 Group Photo followed by Lunch

1:00 - 1:45 Paul Corkum, University of Ottawa
"Probed Quantum Systems on the Attosecond Time Scale"

1:45 - 2:05 Discussion

2:05 - 2:35 Break

2:35 - 3:20 Laura Kiessling, University of Wisconsin-Madison
"Checking Cellular IDs with Glycans"

3:20 - 3:50 Discussion

3:50 - 4:05 Break

4:05 - 4:50 Michael Nachman, University of California Berkeley
"Gene Regulation and the Genetic Basis of Speciation and Adaptation in House Mice, Mus Musculus"

4:50 - 5:20 Discussion

7:00 – 8:45 Dinner - Redwood Hall Dining Room

9:00 – 11:00 At the Movies & Social Time at Buck Hall

11:00 - After hours lounge - Pine Lodge

Sunday, June 4 - Buck Hall

7:00 - 8:30 am Breakfast - Redwood Hall Dining Room

9:00—9:45 Mike Brown, Caltech
"Planet Nine from Outer Space"

9:45 - 10:15 Discussion

10:15 - 10:45 Break

10:45 - 11:30 Christos Papadimitriou, University of California Berkeley
"A Computer Scientist Thinks About the Brain"

11:30 - 12:00 Discussion

12:00 - 1:30 Lunch and close of meeting

Miller Research Fellows

ELAINE ANGELINO
Department of EECS, 2014-2017
Ph.D. Institution: Harvard University
http://www.eecs.berkeley.edu/~elaine/

A central tool for scientific data analysis is inference, the process of uncovering structure in data. However, traditional inference procedures have not scaled to handle massive datasets or complex mathematical representations of structure. My research lies at interface of computer science and statistics, and is focused on developing new algorithms and theory to make large-scale inference feasible.

MICHELLE ANTOINE
Depts of MCB/HWNI, 2014-2017
Ph.D. Institution: Albert Einstein College of Medicine

Autism Spectrum Disorder (ASD) is currently defined as a genetically heterogeneous neurobehavioral disorder as several hundred genetic variants have been identified that confer susceptibility to ASD. However, how these genetic variants might confer susceptibility and whether there is any functional link between them remains a mystery. My research is therefore centered on understanding whether ASD can be more homogenously defined by one or a few common motifs of neural circuit dysfunction.

INBAL BEN-AMI BARTAL
Depts of Psychology & Helen Wills Neuroscience, 2014-2017
Ph.D. Institution: University of Chicago
http://www.inbalbartal.com/

Empathy, the ability to recognize and share the emotional state of another, is the foundation of life in social groups. Empathy leads to helping behavior, cooperation, and social learning, and strengthens the group as a whole. The empathic response is rooted in evolutionarily ancient processes, and shared across diverse mammalian species. I research the neurophysiological mechanisms underlying the empathic response. Using an integrative approach that includes data from humans and rodents, I seek to explain the means by which observing another in distress activates a stress response in the observer, and engages pro-social motivation.

CARSON BRUNS
Department of Chemistry, 2014-2017
Ph.D. Institution: Northwestern University
http://www.carsonbruns.com/about/

Nature has optimized the efficiency of photosynthesis by evolving an exquisite hierarchical protein network that arranges hundreds of pigments in circular arrays, which absorb sunlight and efficiently transfer the energy to neighboring arrays and reaction centers. My research involves the modification of virus capsid proteins with synthetic molecules and pigments to create light-harvesting arrays inspired by Nature's example. These synthetic modifiers are rationally designed with self-assembling and photophysical properties that impart the corresponding virus-based light-harvesting arrays with the ability to (i) self-assemble into predetermined nanostructures, and (ii) efficiently harvest and transfer solar energy. This strategy for constructing protein-based biomimetic materials is relevant to emerging applications ranging from nanofabrication to artificial photosynthesis.

KESTUTIS CESNAVICIUS
Department of Mathematics, 2014-2017
Ph.D. Institution: MIT
https://math.berkeley.edu/~kestutis/

I study arithmetic geometry, which is an area of mathematics that lies at the interface of number theory and algebraic geometry. Specifically, I employ techniques from algebraic geometry to analyze the arithmetic of abelian varieties.

RYAN DALTON
Department of MCB, 2015-2018
Ph.D. Institution: UC San Francisco

I am interested in how the extraordinary diversity in cell types found in animals arises. As a Miller Fellow I aim to apply molecular genetic techniques to uncover the gene regulatory logic behind diversification of somatosensory neurons.

TIJMEN de HAAN
Department of Physics, 2014-2017
Ph.D. Institution: McGill University

Galaxy clusters are the largest gravitationally collapsed structures in the universe. Their abundance is a powerful tracer of the underlying properties of the universe. Using the 10-m South Pole Telescope, I study the subtle distortions in the cosmic microwave background to discover hundreds of new galaxy clusters and their impact on our knowledge of the expansion history and energy content of the universe.

REBECCA DUNCAN
Department of Integrative Biology, 2016-2019
Ph.D. Institution: University of Miami

Herbivory, a diet consisting solely of plants, is a key driver of animal diversification despite the fact that it is also a major evolutionary hurdle, in part because most plants deter herbivores by producing toxic chemicals like nicotine, caffeine, morphine, and mustard oils. Many of these chemicals are easily metabolized by bacteria that may partner with animals to facilitate herbivory, but surprisingly little is known about the role bacteria play in degrading host plant toxins. Using the emerging model herbivorous fly Scaptomyza flava, I aim to address the hypothesis that bacteria in the gut and on host plants facilitate host plant detoxification. In doing so, my research will help address the long standing question of the extent to which bacteria facilitate the evolution of herbivory, illuminating a mechanism to one key life strategy that contributes to the incredible biodiversity on Earth.

SIMONE FERRARO
Department of Astronomy, 2015-2018
Ph.D. Institution: Princeton University
http://astro.berkeley.edu/researcher-profile/2855189-simone-ferraro

I study cosmology, that is the birth and evolution of the Universe as a whole. In my thesis I have focused on using the present-day distribution of galaxies to infer the physics of the very early Universe. Recently I have become excited about using galaxy velocities to study astrophysics and the elusive properties of dark energy, and I am developing new tools to do so.

SHIRSHENDU GANGULY
Departments of Statistics & Mathematics, 2016-2019
Ph.D. Institution: University of Washington
http://www.stat.berkeley.edu/~sganguly/

My research focuses on probability theory and applications, in particular on understanding various phenomena in statistical physics, random matrices, probabilistic combinatorics and high dimensional geometry. A central theme in my research is the study of Interacting particles systems. Based on non rigorous heuristics, remarkable conjectures about particle behavior exist in the literature. Understanding these models and making progress towards formal verification of these conjectures forms the core of my research. This involves applications of ideas and tools from several other areas of mathematics. In another direction, I am looking into questions related to understanding the geometry of random graphs, forced by certain rare events, in the context of large deviations.

BENJAMIN GOOD
Departments of Physics and Bioengineering, 2016-2019
Ph.D. Institution: Harvard

I am interested in understanding how evolution works at a quantitative level, with enough precision to eventually predict the rates of different microevolutionary outcomes. To study this process, I combine theoretical tools from population genetics and statistical physics with empirical data from rapidly evolving viruses and bacteria. During my PhD, I focused on patterns of DNA sequence variability in some of the simplest models of microbial evolution, as well as computational methods for testing these models using experimentally evolved bacteria in the lab. As a Miller Fellow, I plan to extend these quantitative evolutionary models to communities of microbes in their natural habitat, by analyzing the DNA sequences of bacteria that inhabit the human gut.

DOUG HEMINGWAY
Department of Earth & Planetary Science, 2015-2018
Ph.D. Institution: UC Santa Cruz
http://eps.berkeley.edu/~djheming/

My research in planetary geophysics combines theoretical modeling with observations to constrain the evolution of solid body surfaces and interiors. I use the shapes and gravity fields of planetary bodies, especially icy satellites, to learn about their internal structures, helping to place constraints on how they formed and evolved, and on what governs their behavior today. I am also interested in planetary magnetism and in how space weathering processes interact with magnetic fields on the surfaces of airless bodies like asteroids, Mercury, and the Moon.

PETER HINTZ
Department of Mathematics, 2015-2018
Ph.D. Institution: Stanford University
https://math.berkeley.edu/~phintz/

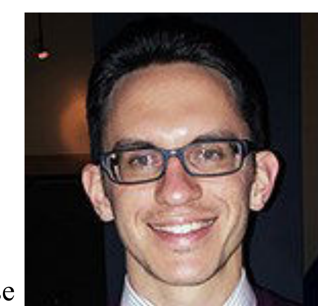
The evolution of many physical systems, like those arising in Einstein's theory of general relativity, quantum mechanics or electromagnetism, are described by partial differential equations. I study systems which exhibit wave-like properties, in particular aiming to understand how their long-time behavior depends on properties of the space on which the waves evolve. The correspondence principle, captured mathematically by microlocal analysis, is a powerful perspective for understanding the underlying equations, and it interacts in fascinating ways with other branches of mathematics such as Lorentzian and Riemannian geometry, dynamical systems and topology.

CASSANDRA HUNT
Department of Physics, 2015-2018
Ph.D. Institution: University of Illinois at Urbana-Champaign
http://cassandrahunt.com/

Ultrafast techniques can explore material properties on the fundamental timescale of the electron and phonon interactions, spin excitations, etc., which govern their macroscopic behavior. My research interests center on using targeted light excitation to perturb the lattice and electronic properties of correlated systems and materials with novel spin behavior. Selective perturbation can be used to identify important properties of the equilibrium system, but it can also be used to generate new phases that cannot be accessed in equilibrium.

CHRISTOPHER LEMON
Department of Molecular & Cell Biology, 2016-2019
Ph.D. Institution: Harvard University

The efficacy of chemotherapeutics may be increased if an external stimulus, such as light, is used to activate drug release directly at a tumor. My research focuses on the development of dual functional probes that combine imaging and therapeutic agents in a single construct. In this way, an organ or tissue will first be imaged to locate the tumor and then localized light will be applied to release a drug selectively at the tumor, minimizing damage to healthy tissue.



JEFFREY MARTELL
Department of Chemistry, 2015-2018
Ph.D. Institution: MIT

Many important chemical reactions in energy conversion, such as the oxidation of methane to methanol, are impractical to implement on an industrial scale, in large part because existing synthetic catalysts for these reactions operate slowly, display poor selectivity, and require high temperatures. By contrast, nature has produced metalloenzymes that catalyze many of these same reactions with high efficiency and selectivity under mild conditions, but most metalloenzymes deactivate quickly and are too expensive to be produced on a large scale. Metal-organic frameworks (MOFs) are porous synthetic materials with highly-ordered internal cavities whose sizes and shapes can be engineered. Drawing inspiration from nature, my research will focus on synthesizing MOFs with pores resembling the active sites of metalloenzymes and evaluating the catalytic properties of these materials.

ANDREW MOELLER
Department of Integrative Biology, 2015-2018
Ph.D. Institution: Yale University
http://www.andrewhmoeller.com/

Each human is an ecosystem containing over 100 trillion bacteria. Since the earliest animal ancestors, this 'microbiome' has evolved to house specific sets of bacterial taxa that guide development, aide in nutrition, and protect against disease. The vast majority of the evolutionary history of the microbiome is unknown: it is unclear how the environmentally derived microbes that first inhabited animal ancestors became the complex, highly integrated microbial communities that dwell within us today. My current research seeks 1) to delineate the evolutionary transitions in the composition of the microbiome across the tree of vertebrate life and 2) to evaluate how host-microbe associations evolve in natural populations of hosts.

KELLY NGUYEN
Department of Molecular and Cell Biology, 2016-2019
Ph.D. Institution: University of Cambridge

Chromosomes are capped with repetitive DNA sequences called telomeres which protect chromosomes from end-joining and from end-replication issues. Telomeres are shortened after each round of cell division due to incomplete genome replication. Once telomere length is critically shortened, cells undergo proliferative senescence or cell death. Telomerase is a ribonucleoprotein that synthesizes the telomeric repeats at the chromosome ends and thus maintains telomere length. Telomerase activity is undetectable in somatic cells while germ cells, stem cells and cancer cells have active telomerase, making it an attractive therapeutic target against cancer and ageing. My research focuses on understanding the molecular mechanism of human telomerase using an integrated biochemical and structural approach.

JESSICA RAY
Dept of Civil & Environmental Engineering, 2015-2018
Ph.D. Institution: Washington University St. Louis

Stresses on global drinking water continue to rise due to population growth and consequential economic and energy demands resulting in the need to replenish drinking water sources via water and wastewater treatment. I will be investigating engineered geomedia and other technologies used to treat organic contaminants in storm water to reduce negative effects on receiving waters. The transport and transformation of contaminants will be tested at Research Center for Reinventing the Nation's Urban Water Infrastructure (ReNUWIt) center sites in efforts to manage urban water systems.

ALEJANDRO RICO-GUEVARA
Department of Integrative Biology, 2017-2020
Ph.D. Institution: University of Connecticut
http://www.alejorico.com/Home.html

As a functional anatomist, the goal pervasive to all my research is to describe the links among the structures (e.g. organismal morphology), underlying mechanisms (e.g. biomechanics), and the emergent phenomena (e.g. performance, ecological and evolutionary patterns) in live organisms. My Miller project focuses on the trade-offs among ventilation, drinking, and locomotion in a group of animals that pushes the limits in all of those biological functions: hummingbirds.

JULIAN SHUN
Departments of Statistics / EECS, 2015-2017
Ph.D. Institution: Carnegie Mellon University
http://www.eecs.berkeley.edu/~jshun/

The rapid growth in data sizes has raised many challenges in how to efficiently and accurately analyze large data. Using fast algorithms and parallel machines to perform analysis can provide significant speedups in computation time, and using statistical techniques can improve the accuracy and usefulness of the analysis. I am interested in studying fundamental theoretical and practical questions at the interface between computer science and statistics for large-scale data analysis.

SARAH SLOTZNICK
Department of Earth & Planetary Science, 2016-2019
Ph.D. Institution: Caltech
http://eps.berkeley.edu/~sslotz/

I study iron-bearing minerals in ancient rocks for insights into oceanic and atmospheric chemistry of the early Earth. I combine microscale textural analyses from light microscopy, electron microscopy, and x-ray spectroscopy with bulk magnetic measurements to unravel the primary mineralogy from secondary overprints. My research currently focuses on Proterozoic rocks in the 1.5 billion years after the rise of atmospheric oxygen during which eukaryotes and complex life evolved.

RYAN TRAINOR
Department of Astronomy, 2014-2017
Ph.D. Institution: Caltech
http://w.astro.berkeley.edu/~trainor/

The evolution of galaxies to the present day was driven by complex interactions of dark matter, stars, gas, and black holes. I use optical and infrared telescopes to quantify the results of these interactions, including the production of elements synthesized through star formation. In particular, my research focuses on galaxy formation in the neighborhoods of extremely active supermassive black holes, or quasars, where the energy released from accreting matter can both violently terminate star formation and illuminate protogalactic gas clouds that would otherwise be undetectable with current instruments.

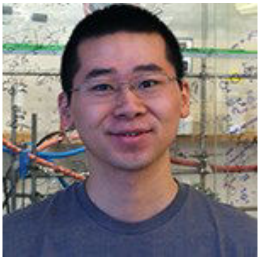
LIAN XUE
Department of Earth & Planetary Science, 2016-2019
PhD. Institution: UC Santa Cruz
https://websites.pmc.ucsc.edu/~seisweb/people/lian.php

I study fault behavior through earthquake cycles by using hydrogeology and geodesy. I investigate fault zone hydrogeologic architectures using water level tidal response and ground deformation using GPS and InSAR.

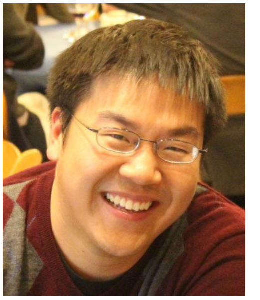
DA YANG
Department of Earth & Planetary Science, 2014-2017
Ph.D. Institution: Caltech
http://web.gps.caltech.edu/~dyang/

Moist convection - in essence, thunderstorms - is a fundamental process on Earth, yet it is one of the most difficult processes to model and one of the least well understood. I am interested in developing quantitative theories of moist convection by building idealized mathematical models of moist convection and simulating its interaction with large-scale atmospheric flows. These studies will help to improve the representation of moist convection in climate models and renew our confidence in climate forecasting.

YANG YANG (not in attendance)
Department of Chemistry, 2016-2019
Ph.D. Institution: MIT



Hydrocarbons are produced on an enormous scale from petroleum and natural gas processing. Unfortunately, to separate these hydrocarbon mixtures into value-added fuels and feedstock chemicals, a series of distillations with tremendous energy consumption is required. Through the development of novel porous materials as effective and selective hydrocarbon absorbents, my research seeks to deliver low-energy techniques for the separation of hydrocarbons.



NORMAN YAO (not in attendance)
Department of Physics, 2014-2017
Ph.D. Institution: Harvard
http://physics.berkeley.edu/people/faculty/norman-yao

Statistical mechanics is the formalism that connects thermodynamics to the microscopic world. It governs familiar every day processes ranging from heat transport and electrical conductivity to the diffusion of gases. In isolated quantum systems, the breakdown of statistical mechanics is known as many-body localization. I am interested in the understanding the associated phase transition and in proposing both systems and observables with which to probe this phenomenon. The realization of such a phase of matter may enable the protection of exotic topological orders and holds potential as a strongly-interacting, disordered, many-body quantum computer.

RACHEL ZUCKER
Department of Materials Science, 2015-2017
Ph.D. Institution: MIT
http://www.asta.mse.berkeley.edu/group_members/Rachel.php

Surfaces are as fundamental as chemical composition in determining material properties. They also give nanomaterials their extraordinary characteristics. I will be working at the junction between materials science and applied mathematics, developing models that connect material interface structures to bulk properties. These models could help design micro- and nano-scale systems, including semiconductor devices and energy storage materials.

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