Miller Institute For Basic Research In Science

Tomales Bay

22nd Annual Interdisciplinary Symposium

June 1-3, 2018

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/

2018 SYMPOSIUM COMMITTEE

Kathryn Day, Miller Institute Staff

Simone Ferraro, Astronomy

Peter Hintz, Mathematics

Cassandra Hunt, Physics

Christopher Lemon, Molecular & Cell Biology

Michael Manga, Earth & Planetary Science, Chair of Symposium Cmte.

Andrew Moeller, Integrative Biology

Kelly Nguyen, Molecular & Cell Biology

Jessica Ray, Civil & Environmental Engineering

Sarah Slotznick, Earth & Planetary Science

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University of Arizona

Professor Tim Stearns
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Stanford University

MILLER INSTITUTE
INTERDISCIPLINARY SYMPOSIUM
2018 SPEAKERS

Richard Baraniuk
EECS
Rice University

Danna Freedman
Chemistry
Northwestern University

Paula Hammond
Chemical Engineering
MIT

David Julius
Physiology
UC San Francisco

Nergis Mavalvala
Physics
MIT

Lior Pachter
Computational Biology and Computing
Caltech

Sarah Stewart
Earth & Planetary Science
UC Davis

RICHARD BARANIUK
DEPARTMENT OF EECS AND COMPUTER SCIENCE
RICE UNIVERSITY
richb@rice.edu
http://richb.rice.edu/

Richard G. Baraniuk is the Victor E. Cameron Professor of Electrical and Computer Engineering at Rice University and the Founder/ Director of OpenStax. His research interests lie in new theory, algorithms, and hardware for sensing, signal processing, and machine learning. He is a Fellow of the American Academy of Arts and Sciences, National Academy of Inventors, American Association for the Advancement of Science, and IEEE. He has received the DOD Vannevar Bush Faculty Fellow Award (National Security Science and Engineering Faculty Fellow), the IEEE Signal Processing Society Technical Achievement Award, and the IEEE James H. Mulligan, Jr. Education Medal, among others.

ABSTRACT: "Going off the Deep End with Deep Learning "

A grand challenge in machine learning is the development of computational algorithms that match or outperform humans in perceptual inference tasks that are complicated by nuisance variation. For instance, visual object recognition involves the unknown object position, orientation, and scale, while speech recognition involves the unknown voice pronunciation, pitch, and speed. Recently, a new breed of deep learning algorithms have emerged for high-nuisance inference tasks that routinely yield pattern recognition systems with super-human capabilities. Similar results in language translation, robotics, and games like Chess and Go plus billions of dollars in venture capital have fueled a deep learning bubble and public perception that actual progress is being made towards artificial intelligence. But fundamental questions remain, such as: Why do deep learning methods work? When do they work? And how can they be fixed when they don't work? Intuitions abound, but a coherent framework for understanding, analyzing, and synthesizing deep learning architectures remains elusive. This talk will discuss the important implications of this lack of understanding for consumers, practitioners, and researchers of machine learning. We will also overview recent progress on answering the above questions based on probabilistic graphs and splines.

REPRESENATIVE ARTICLES:

http://science.sciencemag.org/content/349/6245/255.full

https://papers.nips.cc/paper/6231-a-probabilistic-framework-for-deep-learning.pdf

https://www.theatlantic.com/technology/archive/2018/01/the-shallowness-of-google-translate/551570/

DANNA FREEDMAN
DEPARTMENT OF CHEMISTRY: TECHNOLOGICAL INSTITUTE
NORTHWESTERN UNIVERSITY
Danna.freedman@northwestern.edu
http://sites.northwestern.edu/freedman/

Danna Freedman is an Assistant Professor of Chemistry at Northwestern University. The Freedman laboratory's research focuses on applying inorganic chemistry to approach challenges in physics, with specific emphasis on quantum information science, magnetic materials, and emergent phenomena. Her laboratory demonstrated molecular qubits with long coherence times as long as the top candidates, and on the solid-state side, they recently created a new superconductor. Danna began her scientific career performing undergraduate research in Prof. Hongkun Park's laboratory at Harvard University. She then moved to Prof. Jeffrey Long's lab at UC Berkeley for her graduate studies where she studied magnetic anisotropy in single- molecule magnets. She then performed postdoc research in Prof. Daniel Nocera's laboratory at MIT. There, Danna probed geometric spin frustration in kagomé lattices and quantum spin liquids. After completing her postdoctoral research at MIT, Danna started her position as an Assistant Professor at Northwestern University in 2012.

<u>ABSTRACT:</u> "Applying inorganic chemistry to challenges in physics"

Chemical synthesis offers unmatched control over the precise positioning of atoms and enables us to address questions and challenges within physics. Using chemical control, we can position spins in carefully chosen orientations, we can separate different forms of spin, i.e. the spin of an electron vs the spin of a proton, we can even force specific combinations of two atoms to interact to learn about the nature of a chemical bond. Within our research program we seek to synthesize, characterize, and measure new inorganic molecules and materials to address fundamental questions in physics, in an analogous, complementary approach to the successful field of bioinorganic chemistry. We work to answer simply articulated questions using the tools and intuition of synthetic inorganic chemistry. To offer a representative example, one area we pursue relates to the ability of quantum objects to be in a combination of two states at once – a superposition. The mysterious ability of a quantum object to be in two states at once inspired the common albeit flawed idea of Schrödinger's cat as an analogy for the "dead and alive" nature of a qubit superposition. This idea underlies quantum information processing, quantum sensing, and the creation of new emergent materials such as spin liquids. We asked, what is the effect of nuclear spin distance on electronic spin coherence? Phrased in another way, how does the distance of a nucleus, which is itself a tiny magnet, affect the ability of an electron to stay in a combination of up and down? To address this question, we designed and synthesized a series of molecules where we controlled the distance between an electronic spin and a nuclear spin over a series of four molecules. We made the counterintuitive, but theoretically precedented, discovery that the most proximate nuclear spins impacted the electronic spin coherence the least. This talk will focus on the control offered by synthetic chemistry to address a plethora of questions within the realm of physics, and how by using the tools of synthesis we can discover new phenomena.

<u>REPRESENATIVE ARTICLES:</u>

https://pubs.acs.org/doi/10.1021/acscentsci.6b00287
https://pubs.acs.org/doi/10.1021/acs.chemmater.6b05433

PAULA HAMMOND
KOCH INSTITUTE FOR INTEGRATIVE CANCER RESEARCH
DEPT OF CHEMICAL ENGINEERING, MIT
hammond@mit.edu
https://hammondlab.mit.edu/paula-t-hammond

Paula T. Hammond is the David H. Koch Chair Professor of Engineering at the Massachusetts Institute of Technology, and the Head of the Department of Chemical Engineering. She is a member of MIT's Koch Institute for Integrative Cancer Research, the MIT Energy Initiative, and a founding member of the MIT Institute for Soldier Nanotechnology. She recently served as the Executive Officer (Associate Chair) of the Chemical Engineering Department (2008-2011). The core of her work is the use of electrostatics and other complementary interactions to generate functional materials with highly controlled architecture. Her research in nanomedicine encompasses the development of new biomaterials to enable drug delivery from surfaces with spatio-temporal control. She also investigates novel responsive polymer architectures for targeted nanoparticle drug and gene delivery, and has developed self-assembled materials systems for electrochemical energy devices.

Professor Hammond is a member of the National Academy of Engineering, the National Academy of Medicine, and American Academy of Arts and Sciences. She is the recipient of the 2013 AIChE Charles M. A. Stine Award, the 2014 AIChE Alpha Chi Sigma Award for Chemical Engineering Research and the DOD Ovarian Cancer Teal Innovator Award.

ABSTRACT: "Nanolayered Particles for Tissue Targeted Therapies"

Layer-by-layer assembly provides an approach that allows complementary secondary interactions to generate a stable thin film coating which can contain a broad range of molecular and macromolecular systems. It can be applied to a range of nanomaterials that are of interest for cancer therapies, from solid nanocrystals that can act as imaging systems to nanometer scale drug containers such as liposomes or polymeric nanoparticles. This kind of approach offers the promise of delivery of a cascade of drugs in sequence, thus allowing for optimized combination therapy of synergistic drugs with therapeutic molecules such as proteins and siRNA. The generation of LbL nanoparticles that can directly target specific tissues such or key organs is dependent on the nature of the outer LbL layer, and its net surface charge, degree of hydration, and type of polyelectrolyte bilayer pair that is adsorbed as the final layers on the nanoparticle. Recent work in which these nanoparticle systems are designed for optimized uptake by advanced serous ovarian cancer cells will be discussed, and the use of these approaches to deliver combination siRNA/ chemotherapy or drug inhibitor combination therapies or to generate imaging systems and theranostic nanoparticles will be addressed. The potential to target other tissues using designed nanoplex systems is discussed, in particular for the case of targeting cartilage to address the early stages of post-traumatic osteoarthritis. The manipulation of outer surface charge and polymer chain functionality, as well as the ability to design these layered nanoscale complexes to respond to micro-environment cues to achieve controlled biodistribution and uptake to targeted cells in vivo will be described.

REPRESENTATIVE ARTICLES:

Layer-by-Layer Nanoparticles for Systemic Codelivery of an Anticancer Drug and siRNA for Potential Triple-Negative Breast Cancer Treatment (pdf available by request)
Tumor-Targeted Synergistic Blockade of MAPK and PI3K from a Layer-by-Layer Nanoparticle (pdf available by request)

DAVID JULIUS
DEPARTMENT OF PHYSIOLOGY
UNIVESRITY OF CALIFORNIA SAN FRANCISCO
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http://physio.ucsf.edu/julius/

David Julius is the Morris Herzstein Chair in Molecular Biology and Medicine, and Professor and Chair of Physiology at UCSF. The Julius lab is interested in understanding how signals are received and transmitted by the nervous system. They have exploited the properties of natural products to discover a family of thermo- and chemo-sensitive ion channels that enable sensory nerve fibers to detect hot or cold temperatures, or chemical irritants. With the aid of genetic, electrophysiological, and behavioral methods, they have determined how these ion channels contribute to pain sensation, and how channel activity is modulated in response to tumor growth, infection, or other forms of injury that produce inflammation and pain hypersensitivity.

Dr. Julius received his undergraduate degree from MIT, where he worked with Alex Rich on the enzymology of tRNA aminoacylation. He moved to UC Berkeley, where he worked with Jeremy Thorner and Randy Schekman to elucidate mechanisms of peptide hormone processing and secretion in *Saccharomyces* yeast. As a postdoc, David joined Richard Axel's group at Columbia University, where his focus turned to neuropharmacology and receptor function.

Dr. Julius is a member of the US National Academy of Sciences, the National Academy of Medicine, the American Academy of Arts and Sciences, and the Hungarian Academy of Sciences (honorary). His awards include the Perl/UNC Prize, the Unilever Science Prize, the Passano Award, the Prince of Asturias Prize for Technical and Scientific Research, the Shaw Prize in Life Sciences and Medicine, the Paul Janssen Prize for Biomedical Research, and the Canada Gairdner International Award.

ABSTRACT: "Natural Products as Probes of the Pain Pathway: From Physiology to Atomic Structure"

We are interested in determining the molecular basis of somatosensation - the process whereby we experience touch and temperature - with an emphasis on identifying molecules that detect noxious (pain-producing) stimuli. We are also interested in understanding how somatosensation is altered in response to tissue or nerve injury. Our approach has been to identify molecular targets for natural products that mimic the psychophysical effects of commonly encountered somatosensory stimuli, such as heat or cold, and to then ask how these molecules are activated or modulated by noxious stimuli or injury.

We have focused on three members of the TRP channel family (TRPV1, TRPM8, and TRPA1) that are expressed by subpopulations of primary afferent sensory neurons and which have been implicated in the detection of thermal stimuli and/or inflammatory agents. Genetic studies support the idea that the capsaicin receptor (TRPV1) and the menthol receptor (TRPM8) function as detectors of heat and cold, respectively, whereas the wasabi receptor (TRPA1) functions as a detector of environmental and endogenous chemical irritants.

From a signal transduction and therapeutics perspective, there is great interest in understanding how these channels are activated (gated) by physical and/or chemical stimuli. We have used a combination of molecular genetics, natural product biochemistry, and biophysics to address these issues and probe mechanisms of stimulus detection, channel activation, and coding logic of the somatosensory system.

REPRESENTATIVE ARTICLES:

https://www.nature.com/articles/nature12823   https://www.nature.com/articles/nature17976

https://www.annualreviews.org/doi/full/10.1146/annurev-cellbio-101011-155833?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed

NERGIS MAVALVALA
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Nergis Mavalvala is the Curtis and Kathleen Marble Professor of Astrophysics and associate head of the Department of Physics at MIT. Her research focuses on the detection of gravitational waves from violent astronomical events. She was a leading member of the team that in early 2016 made history with the first direct detection of gravitational waves from the collision of two black holes, confirming the final prediction of Einstein's general theory of relativity, and introducing a completely new method for observing the Universe.

In addition to her work on gravitational wave detectors, Nergis has conducted pioneering experiments on exotic quantum states of light, as well as laser cooling and trapping of large objects, which make it possible to study the weirdness of quantum mechanics in human-scale systems.

Mavalvala received her bachelor's degree from Wellesley College and her PhD from MIT. She was a postdoctoral fellow and research scientist at CalTech before joining the physics faculty at MIT in 2002. She has received numerous honors, including a MacArthur "genius" award in 2010, and election to the National Academy of Sciences in 2017.

ABSTRACT: "Opening a new window into the Universe: the 100 year quest for Einstein's gravitational waves"

The recent announcements of the first ever detections of gravitational waves from colliding black holes and neutron stars have launched a new era of gravitational wave astrophysics. I will describe the science, technology, and human story behind these discoveries that provide a completely new window into some of the most violent and warped events in the Universe.

REPRESENTATIVE ARTICLES:

www.ligo.org

LIOR PACHTER
DEPARTMENT OF BIOLOGY AND BIOLOGICAL ENGINEERING
CALTECH
lpachter@caltech.edu
http://pachterlab.github.io/biography.html

Lior Pachter was born in Ramat Gan, Israel, and grew up in Pretoria, South Africa where he attended Pretoria Boys High School. After receiving a B.S. in Mathematics from Caltech in 1994, He left for MITwhere he was awarded a PhD in applied mathematics in 1999. He then moved to the University of California at Berkeley where he was a postdoctoral researcher (1999-2001), assistant professor (2001-2005), associate professor (2005-2009), and until 2018 the Raymond and Beverly Sackler professor of computational biology and professor of mathematics and molecular and cellular biology with a joint appointment in computer science. Since January 2017 he has been the Bren professor of computational biology at Caltech.

ABSTRACT: **"The benefits of multiplexing "**

I will discuss some recent advances in single-cell genomics technology and survey some of the remarkable molecular biology they have enabled. In particular, I will discuss some of this work from my own lab, work that can be directly traced back to my Miller Professorship in 2010 and that was sparked by the interdisciplinary "multiplexed" approach to science advocated by the Institute.

REPRESENTATIVE ARTICLES:

SARAH STEWART
DEPARTMENT OF EARTH & PLANETARY SCIENCES
UNIVERSITY OF CALIFORNIA DAVIS
sts@ucdavis.edu
http://sarahtstewart.net/

Sarah Stewart is a professor in the Department of Earth and Planetary Sciences at the University of California, Davis. Her research interests include the formation and evolution of planetary bodies with a focus on collisional processes. Previously, Dr. Stewart was a Professor of Earth and Planetary Sciences at Harvard University. She received a Ph.D. in Planetary Sciences from the California Institute of Technology. Dr. Stewart is a recipient of the Presidential Early Career Award for Scientists and Engineers and the Urey Prize from the Division for Planetary Sciences of the American Astronomical Society. She is the current President of the Planetary Sciences section of the American Geophysical Union.

ABSTRACT: "The Origin of the Earth and Moon"

The Moon and Earth share a common origin that has left a distinct chemical imprint on both bodies. The abundance and precision of geochemical and isotopic data has placed tight requirements on the outcome of any model for the origin of the Moon. In contrast, physical models for lunar origin, primarily focused on the giant impact hypothesis, have had great difficulty making chemical predictions or appear to contradict the observations. I will discuss new work on understanding the physics and thermochemistry of giant impacts that revealed substantial gaps in our understanding of planet formation processes. The last giant impact on Earth likely triggered the formation of a newly recognized type of planetary object, named a synestia. The terrestrial synestia provided a thermochemical environment for lunar accretion that may explain the major chemical characteristics of the Moon.

REPRESENTATIVE ARTICLES:

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016JE005239

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2017JE005333 /
2 column version of the paper here: https://arxiv.org/abs/1802.10223)

INTRODUCING THE 2018-2021 MILLER RESEARCH FELLOWS

MICHAEL ABRAMS
MOLECULAR & CELL BIOLOGY
HOST: NICOLE KING

LOU BARREAU (IN ATTENDANCE)
CHEMISTRY
HOSTS: STEPHEN LEONE / DAN NEUMARK

SOONWON CHOI
PHYSICS
HOST: DUNG HAI LEE

ALISON FEDER
INTEGRATIVE BIOLOGY
HOST: OSKAR HALLASTCHEK

XIAOJIN FU
EARTH & PLANETARY SCIENCE
HOST: MICHAEL MANGA

SAMUEL HOPKINS
EECS
HOSTS: LUCA TREVISAN / PRASAD RAHAVENDRA

AMBIKA KAMATH
ENVIRONMENTAL SCIENCE, POLICY & MANAGEMENT
HOST: DAMIAN ELIAS

GEORGIOS MOSCHIDIS
MATHEMATICS
HOST: MACIEJ ZWORSKI

NICHOLAS RODD
PHYSICS
HOST: SURJEET RAJENDRAN

REBECCA TARVIN
INTEGRATIVE BIOLOGY
HOST: RASMUS NIELSEN

YONG ZENG
ASTRONOMY
HOST: DANIEL WEISZ

MILLER INSTITUTE SYMPOSIUM
JUNE 1-3, 2018

Friday, June 1

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 – 11:00 Miller Fellows Posters – Buck Hall

Saturday, June 2 - Buck Hall

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

8:30 - 9:15 Sarah Stewart, UC Davis
"The Origin of the Earth and Moon"

9:15 - 9:45 Discussion

9:45 - 10:00 Break

10:00 - 10:45 Lior Pachter, Caltech
"The Benefits of Multiplexing"

10:45 - 11:15 Discussion

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

1:00 - 1:45 Danna Freedman, Northwestern University
"Applying Inorganic Chemistry to Challenges in Physics"

1:45 - 2:05 Discussion

2:05 - 2:35	Break
2:35 - 3:20	**Richard Baraniuk, Rice University** **“Going Off the Deep End with Deep Learning ”**
3:20 - 3:50	Discussion
3:50 - 4:05	Break
4:05 - 4:50	**Paula Hammond, MIT** **“Nanolayered Particles for Tissue Targeted Therapies”**
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 3 - Buck Hall

7:00 - 8:30 am	Breakfast - Redwood Hall Dining Room
9:00—9:45	**Nergis Mavalvala, MIT** **“Opening a New Window into the Universe: the 100 Year Quest for Einstein’s Gravitational Waves”**
9:45 - 10:15	Discussion
10:15 - 10:45	Break
10:45 - 11:30	**David Julius, UC San Francisco** **“Natural Products as Probes of the Pain Pathway: From Physiology to Atomic Structure”**
11:30 - 12:00	Discussion
12:00 - 1:30	Lunch and close of meeting

Miller Research Fellows

Nikhil Bhatla, 2017-2020
HWNI/MCB Host: Hillel Adesnik
Ph.D. Institution: MIT

For millennia, humans have contemplated how it is that we are conscious, that is, how we have subjective experience or qualia. Blindsight is a neurological condition in which patients lose the conscious experience of seeing but can still accurately locate visual stimuli and guess their properties. Blindsight is caused by damage to primary visual cortex in the human brain, and by manipulating visual cortex function in the mouse brain, I am working on establishing a mouse model of blindsight. Such a model will enable identification of neural circuits that contribute specifically to the conscious component of vision, and ultimately to development of a general theory of why some neural circuits support experience and others do not.

Cara Brook, 2017-2020
Integrative Biology/PMB Hosts: Mike Boots, Britt Glaunsinger
Ph.D. Institution: Princeton
http://carabrook.github.io/

Bats are the purported reservoir hosts for several of the world's most virulent emerging human diseases, including Hendra and Nipah henipaviruses, Ebola and Marburg filoviruses, and SARS and MERS coronaviruses. Bats appear to host these viruses without experiencing extensive morbidity or mortality, leading researchers to ask whether bats might be uniquely adapted for their roles as pathogen hosts. I bridge field ecology, cellular immunology, and quantitative epidemiology to investigate this question, at both within-host and population levels, with a particular focus on viral infections in Madagascar fruit bats.

Ryan Dalton, 2015-2018
MCB Hosts: Diana Bautista, Ellen Robey
Ph.D. Institution: UCSF
https://ryandalton.weebly.com

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

Thibault de Poyferre, 2017-2020
Mathematics Host: Daniel Tataru
Ph.D. Institution: Ecole Normale Superieure

I study partial differential equations arising from fluid dynamics and oceanography. I focus on finding and studying models for water waves near a shore.

Rebecca Duncan, 2016-2019
Integrative Biology Host: Noah Whiteman
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, 2015-2018
Astronomy Host: Uros Seljak
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, 2016-2019
Departments of Statistics & Mathematics, Host: Alan Hammond
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.

Amy Goldberg, 2017-2020
Integrative Biology/Statistics, Host: Rasmus Nielsen
Ph.D. Institution: Stanford
www.goldbergamy.com

Past population migrations and expansions greatly impact modern human genetic and physical variation, as well as disease risk. My research develops and applies quantitative methods to understand the dynamic relationship between humans, their cultures, and their environments during the last tens of thousands of years. Towards this goal, I leverage modern and ancient genetic data, interpreted in the context of paleoenviornmental and archeological records.

Benjamin Good, 2016-2019 (not in attendance)
Physics and Bioengineering, Host: Oskar Hallatschek
Ph.D. Institution: Harvard
https://sites.google.com/site/benjaminhgood/

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.

Douglas Hemingway, 2015-2018
Earth & Planetary Science, Host: Michael Manga
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.

Cassandra Hunt, 2015-2018
Department of Physics, Host: Alessandra Lanzara
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.

Rebecca Jensen-Clem, 2017-2020
Astronomy, Host: James Graham
Ph.D. Institution: California Institute of Technology
astro.berkeley.edu/~rjensenclem

The last twenty years of astronomy have seen a revolution in planetary science, with more than 3000 extra-solar planets discovered orbiting nearby stars. I'm interested in developing new technologies for directly imaging and characterizing the atmospheres of these other worlds.

Louis Kang, 2017-2020
Physics/HWNI, Host: Michael DeWeese
Ph.D. Institution: University of Pennsylvania
http://louiska.ng/

Human cognition ultimately emerges from sophisticated computations performed by networks of neurons. I use and develop tools from theoretical physics and applied mathematics to investigate how our brains make sense of and respond to our dynamic environments. Theoretical neuroscience forms one part of my overall mission to better understand human biology and pathology through quantitative analysis.

Christopher Lemon, 2016-2019
Department of Molecular & Cell Biology,
Host: Michael Marletta
Ph.D. Institution: Harvard University
https://www.marlettalab.org/christopher-lemon

A new paradigm in oncology has emerged that focuses on identifying metabolites associated with specific tumorigenic transformations or oncometabolites. There is a critical need for novel, quantitative diagnostic agents that enable early intervention to improve patient outcomes. I am developing optical sensors that use fluorescent proteins as a compact, biocompatible platform to quantitatively monitor metabolic changes associated with malignant phenotypes. To overcome the weak emission of traditional red fluorescent proteins, I am incorporating a bright, red-emitting cofactor into a stable protein scaffold.

Jeffrey Martell, 2015-2018
Department of Chemistry, Host: Jeff Long
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, 2015-2018
Department of Integrative Biology, Host: Michael Nachman
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, 2016-2019
Department of Molecular and Cell Biology,
Hosts: Eva Nogales and Kathy Collins
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.

Farnaz Niroui, 2017-2020 (not in attendance)
Departments of MSE/Chemistry, Host: Paul Alivisatos
Ph.D. Institution: MIT

Unique properties and phenomena emerge at the nanoscale that can lead to unexplored scientific and technological paradigms. Exploring these opportunities at the few-nanometer regime requires unprecedented precision, resolution and control, not readily feasible through conventional techniques. Working at the interface of device physics, nanofabrication, and materials science, my research aims to study, manipulate and engineer nanoscale devices and systems with unique functionalities.

Jessica Ray, 2015-2018
Department of Civil & Environmental Engineering
Host: David Sedlak
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.

Grant Remmen, 2017-2020 (not in attendance)
Department of Physics, Host: Yasunori Nomura
Ph.D. Institution: CalTech

The quests to understand the properties of black holes, the fundamental nature of spacetime, and the high-energy behavior of gravity have been drivers of immense progress in theoretical physics. My research interests lie at the nexus of quantum field theory, quantum gravity, general relativity, cosmology, and particle physics. Important open problems on which I work include using effective field theory techniques to address field-theoretic questions in quantum gravity, such as characterizing the possible laws of low-energy physics permitted by quantum gravity, including quantum corrections to the Einstein equations. My work also includes investigating the relationship that connects spacetime geometry and gravity with quantum entanglement and information, as well as research in theoretical cosmology.

Alejandro Rico-Guevara, 2017-2020
Department of Integrative Biology, Host: Robert Dudley
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.

Sarah Slotznick, 2016-2019
Department of Earth & Planetary Science,
Host: Nick Swanson-Hysell
Ph.D. Institution: Caltech
http://eps.berkeley.edu/~sslotz/

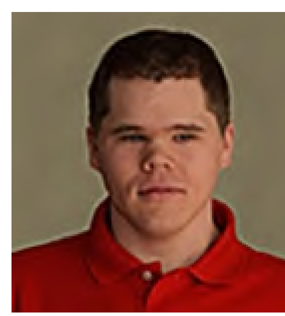
I study iron-bearing minerals in ancient rocks for insights into oceanic and atmospheric chemistry of the early Earth. I combine microscale textural analyses from light microscopy, electron microscopy, and x-ray spectroscopy with bulk magnetic measurements to unravel the primary mineralogy from secondary 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.

Sho Takatori, 2017-2020
Department of Bioengineering, Host: Dan Fletcher
Ph.D. Institution: CalTech

A core feature of many living systems is their ability to move, to self-propel, to be active. From bird flocks to bacteria swarms, to even cytoskeletal networks, "active matter" systems exhibit collective and emergent dynamics owing to their constituents' ability to convert chemical fuel into mechanical activity. I combine experimental and computational methods to demonstrate how activity imparts new behaviors to soft living materials that explain a variety of nonequilibrium phenomena, including intracellular protein transport and the complete loss of shear viscosity in fluid suspensions.

Alexander Turner, 2017-2020
Departments of Chemistry and Earth & Planetary Science
Hosts: Ron Cohen, Inez Fung
Ph.D. Institution: Harvard
https://alexjturner.github.io

My primary research objective is to improve our understanding of the carbon cycle through inverse modeling. Specifically, I'm interested in quantifying greenhouse gas fluxes and understanding the physical processes driving them. To reach this end, I use atmospheric observations from satellites, aircraft, and surface networks and interpret them in the context of atmospheric models (e.g., chemical transport models and particle dispersion models).



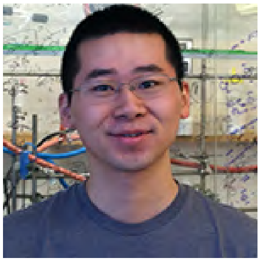
Peter Walters, 2017-2020
Department of Chemistry, Host: Eric Neuscamman
Ph.D. Institution: University of Illinois

Both experimentation and simulation are crucial aspects of science. As the nature of experimentation is constantly evolving and changing, so, too, must the nature of simulation evolve and change. With recent developments in ultrafast experimental techniques, it is now possible to probe, the motions of the molecule's electrons. With this in mind, my research focuses on developing computational techniques for accurately simulating the motions of a molecule's electrons.

Lian Xue, 2016-2019
Department of Earth & Planetary Science
Host: Roland Bürgmann
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.

Yang Yang, 2016-2019
Department of Chemistry, Host: Jeff Long
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.

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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/

2018 SYMPOSIUM COMMITTEE

Kathryn Day, Miller Institute Staff

Simone Ferraro, Astronomy

Peter Hintz, Mathematics

Cassandra Hunt, Physics

Christopher Lemon, Molecular & Cell Biology

Michael Manga, Earth & Planetary Science, Chair of Symposium Cmte.

Andrew Moeller, Integrative Biology

Kelly Nguyen, Molecular & Cell Biology

Jessica Ray, Civil & Environmental Engineering

Sarah Slotznick, Earth & Planetary Science

Executive Committee

Professor Roland Bürgmann
Earth & Planetary Science

Professor Marla Feller
Executive Director, Miller Institute
Molecular & Cell Biology: Neurobiology

Professor Stephen Leone
Chemistry & Physics

Professor Yun Song
EECS / Statistics / Integrative Biology

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Chancellor Carol Christ

Professor Steven Block
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Stanford University

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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.

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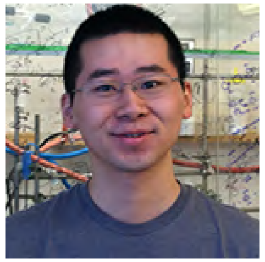

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Paula Hammond
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Richard G. Baraniuk is the Victor E. Cameron Professor of Electrical and Computer Engineering at Rice University and the Founder/ Director of OpenStax. His research interests lie in new theory, algorithms, and hardware for sensing, signal processing, and machine learning. He is a Fellow of the American Academy of Arts and Sciences, National Academy of Inventors, American Association for the Advancement of Science, and IEEE. He has received the DOD Vannevar Bush Faculty Fellow Award (National Security Science and Engineering Faculty Fellow), the IEEE Signal Processing Society Technical Achievement Award, and the IEEE James H. Mulligan, Jr. Education Medal, among others.

ABSTRACT: "Going off the Deep End with Deep Learning "

A grand challenge in machine learning is the development of computational algorithms that match or outperform humans in perceptual inference tasks that are complicated by nuisance variation. For instance, visual object recognition involves the unknown object position, orientation, and scale, while speech recognition involves the unknown voice pronunciation, pitch, and speed. Recently, a new breed of deep learning algorithms have emerged for high-nuisance inference tasks that routinely yield pattern recognition systems with super-human capabilities. Similar results in language translation, robotics, and games like Chess and Go plus billions of dollars in venture capital have fueled a deep learning bubble and public perception that actual progress is being made towards artificial intelligence. But fundamental questions remain, such as: Why do deep learning methods work? When do they work? And how can they be fixed when they don't work? Intuitions abound, but a coherent framework for understanding, analyzing, and synthesizing deep learning architectures remains elusive. This talk will discuss the important implications of this lack of understanding for consumers, practitioners, and researchers of machine learning. We will also overview recent progress on answering the above questions based on probabilistic graphs and splines.

REPRESENATIVE ARTICLES:

http://science.sciencemag.org/content/349/6245/255.full

https://papers.nips.cc/paper/6231-a-probabilistic-framework-for-deep-learning.pdf

https://www.theatlantic.com/technology/archive/2018/01/the-shallowness-of-google-translate/551570/

Sho Takatori, 2017-2020
Department of Bioengineering, Host: Dan Fletcher
Ph.D. Institution: CalTech

A core feature of many living systems is their ability to move, to self-propel, to be active. From bird flocks to bacteria swarms, to even cytoskeletal networks, "active matter" systems exhibit collective and emergent dynamics owing to their constituents' ability to convert chemical fuel into mechanical activity. I combine experimental and computational methods to demonstrate how activity imparts new behaviors to soft living materials that explain a variety of nonequilibrium phenomena, including intracellular protein transport and the complete loss of shear viscosity in fluid suspensions.

Alexander Turner, 2017-2020
Departments of Chemistry and Earth & Planetary Science
Hosts: Ron Cohen, Inez Fung
Ph.D. Institution: Harvard
https://alexjturner.github.io

My primary research objective is to improve our understanding of the carbon cycle through inverse modeling. Specifically, I'm interested in quantifying greenhouse gas fluxes and understanding the physical processes driving them. To reach this end, I use atmospheric observations from satellites, aircraft, and surface networks and interpret them in the context of atmospheric models (e.g., chemical transport models and particle dispersion models).

Peter Walters, 2017-2020
Department of Chemistry, Host: Eric Neuscamman
Ph.D. Institution: University of Illinois

Both experimentation and simulation are crucial aspects of science. As the nature of experimentation is constantly evolving and changing, so, too, must the nature of simulation evolve and change. With recent developments in ultrafast experimental techniques, it is now possible to probe, the motions of the molecule's electrons. With this in mind, my research focuses on developing computational techniques for accurately simulating the motions of a molecule's electrons.

Grant Remmen, 2017-2020 (not in attendance)
Department of Physics, Host: Yasunori Nomura
Ph.D. Institution: CalTech

The quests to understand the properties of black holes, the fundamental nature of spacetime, and the high-energy behavior of gravity have been drivers of immense progress in theoretical physics. My research interests lie at the nexus of quantum field theory, quantum gravity, general relativity, cosmology, and particle physics. Important open problems on which I work include using effective field theory techniques to address field-theoretic questions in quantum gravity, such as characterizing the possible laws of low-energy physics permitted by quantum gravity, including quantum corrections to the Einstein equations. My work also includes investigating the relationship that connects spacetime geometry and gravity with quantum entanglement and information, as well as research in theoretical cosmology.

Alejandro Rico-Guevara, 2017-2020
Department of Integrative Biology, Host: Robert Dudley
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.

Sarah Slotznick, 2016-2019
Department of Earth & Planetary Science,
Host: Nick Swanson-Hysell
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.

DANNA FREEDMAN
DEPARTMENT OF CHEMISTRY: TECHNOLOGICAL INSTITUTE
NORTHWESTERN UNIVERSITY
Danna.freedman@northwestern.edu
http://sites.northwestern.edu/freedman/

Danna Freedman is an Assistant Professor of Chemistry at Northwestern University. The Freedman laboratory's research focuses on applying inorganic chemistry to approach challenges in physics, with specific emphasis on quantum information science, magnetic materials, and emergent phenomena. Her laboratory demonstrated molecular qubits with long coherence times as long as the top candidates, and on the solid-state side, they recently created a new superconductor. Danna began her scientific career performing undergraduate research in Prof. Hongkun Park's laboratory at Harvard University. She then moved to Prof. Jeffrey Long's lab at UC Berkeley for her graduate studies where she studied magnetic anisotropy in single- molecule magnets. She then performed postdoc research in Prof. Daniel Nocera's laboratory at MIT. There, Danna probed geometric spin frustration in kagomé lattices and quantum spin liquids. After completing her postdoctoral research at MIT, Danna started her position as an Assistant Professor at Northwestern University in 2012.

ABSTRACT: "Applying inorganic chemistry to challenges in physics"

Chemical synthesis offers unmatched control over the precise positioning of atoms and enables us to address questions and challenges within physics. Using chemical control, we can position spins in carefully chosen orientations, we can separate different forms of spin, i.e. the spin of an electron vs the spin of a proton, we can even force specific combinations of two atoms to interact to learn about the nature of a chemical bond. Within our research program we seek to synthesize, characterize, and measure new inorganic molecules and materials to address fundamental questions in physics, in an analogous, complementary approach to the successful field of bioinorganic chemistry. We work to answer simply articulated questions using the tools and intuition of synthetic inorganic chemistry. To offer a representative example, one area we pursue relates to the ability of quantum objects to be in a combination of two states at once – a superposition. The mysterious ability of a quantum object to be in two states at once inspired the common albeit flawed idea of Schrödinger's cat as an analogy for the "dead and alive" nature of a qubit superposition. This idea underlies quantum information processing, quantum sensing, and the creation of new emergent materials such as spin liquids. We asked, what is the effect of nuclear spin distance on electronic spin coherence? Phrased in another way, how does the distance of a nucleus, which is itself a tiny magnet, affect the ability of an electron to stay in a combination of up and down? To address this question, we designed and synthesized a series of molecules where we controlled the distance between an electronic spin and a nuclear spin over a series of four molecules. We made the counterintuitive, but theoretically precedented, discovery that the most proximate nuclear spins impacted the electronic spin coherence the least. This talk will focus on the control offered by synthetic chemistry to address a plethora of questions within the realm of physics, and how by using the tools of synthesis we can discover new phenomena.

REPRESENATIVE ARTICLES:

https://pubs.acs.org/doi/10.1021/acscentsci.6b00287
https://pubs.acs.org/doi/10.1021/acs.chemmater.6b05433

PAULA HAMMOND
KOCH INSTITUTE FOR INTEGRATIVE CANCER RESEARCH
DEPT OF CHEMICAL ENGINEERING, MIT
hammond@mit.edu
https://hammondlab.mit.edu/paula-t-hammond

Paula T. Hammond is the David H. Koch Chair Professor of Engineering at the Massachusetts Institute of Technology, and the Head of the Department of Chemical Engineering. She is a member of MIT's Koch Institute for Integrative Cancer Research, the MIT Energy Initiative, and a founding member of the MIT Institute for Soldier Nanotechnology. She recently served as the Executive Officer (Associate Chair) of the Chemical Engineering Department (2008-2011). The core of her work is the use of electrostatics and other complementary interactions to generate functional materials with highly controlled architecture. Her research in nanomedicine encompasses the development of new biomaterials to enable drug delivery from surfaces with spatio-temporal control. She also investigates novel responsive polymer architectures for targeted nanoparticle drug and gene delivery, and has developed self-assembled materials systems for electrochemical energy devices.

Professor Hammond is a member of the National Academy of Engineering, the National Academy of Medicine, and American Academy of Arts and Sciences. She is the recipient of the 2013 AIChE Charles M. A. Stine Award, the 2014 AIChE Alpha Chi Sigma Award for Chemical Engineering Research and the DOD Ovarian Cancer Teal Innovator Award.

<u>ABSTRACT:</u> "Nanolayered Particles for Tissue Targeted Therapies"

Layer-by-layer assembly provides an approach that allows complementary secondary interactions to generate a stable thin film coating which can contain a broad range of molecular and macromolecular systems. It can be applied to a range of nanomaterials that are of interest for cancer therapies, from solid nanocrystals that can act as imaging systems to nanometer scale drug containers such as liposomes or polymeric nanoparticles. This kind of approach offers the promise of delivery of a cascade of drugs in sequence, thus allowing for optimized combination therapy of synergistic drugs with therapeutic molecules such as proteins and siRNA. The generation of LbL nanoparticles that can directly target specific tissues such or key organs is dependent on the nature of the outer LbL layer, and its net surface charge, degree of hydration, and type of polyelectrolyte bilayer pair that is adsorbed as the final layers on the nanoparticle. Recent work in which these nanoparticle systems are designed for optimized uptake by advanced serous ovarian cancer cells will be discussed, and the use of these approaches to deliver combination siRNA/ chemotherapy or drug inhibitor combination therapies or to generate imaging systems and theranostic nanoparticles will be addressed. The potential to target other tissues using designed nanoplex systems is discussed, in particular for the case of targeting cartilage to address the early stages of post-traumatic osteoarthritis. The manipulation of outer surface charge and polymer chain functionality, as well as the ability to design these layered nanoscale complexes to respond to micro-environment cues to achieve controlled biodistribution and uptake to targeted cells in vivo will be described.

<u>REPRESENTATIVE ARTICLES:</u>

Layer-by-Layer Nanoparticles for Systemic Codelivery of an Anticancer Drug and siRNA for Potential Triple-Negative Breast Cancer Treatment (pdf available by request)
Tumor-Targeted Synergistic Blockade of MAPK and PI3K from a Layer-by-Layer Nanoparticle (pdf available by request)

Kelly Nguyen, 2016-2019
Department of Molecular and Cell Biology,
Hosts: Eva Nogales and Kathy Collins
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.

Farnaz Niroui, 2017-2020 (not in attendance)
Departments of MSE/Chemistry, Host: Paul Alivisatos
Ph.D. Institution: MIT

Unique properties and phenomena emerge at the nanoscale that can lead to unexplored scientific and technological paradigms. Exploring these opportunities at the few-nanometer regime requires unprecedented precision, resolution and control, not readily feasible through conventional techniques. Working at the interface of device physics, nanofabrication, and materials science, my research aims to study, manipulate and engineer nanoscale devices and systems with unique functionalities.

Jessica Ray, 2015-2018
Department of Civil & Environmental Engineering
Host: David Sedlak
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.

Christopher Lemon, 2016-2019
Department of Molecular & Cell Biology,
Host: Michael Marletta
Ph.D. Institution: Harvard University
https://www.marlettalab.org/christopher-lemon

A new paradigm in oncology has emerged that focuses on identifying metabolites associated with specific tumorigenic transformations or oncometabolites. There is a critical need for novel, quantitative diagnostic agents that enable early intervention to improve patient outcomes. I am developing optical sensors that use fluorescent proteins as a compact, biocompatible platform to quantitatively monitor metabolic changes associated with malignant phenotypes. To overcome the weak emission of traditional red fluorescent proteins, I am incorporating a bright, red-emitting cofactor into a stable protein scaffold.

Jeffrey Martell, 2015-2018
Department of Chemistry, Host: Jeff Long
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, 2015-2018
Department of Integrative Biology, Host: Michael Nachman
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.

DAVID JULIUS
DEPARTMENT OF PHYSIOLOGY
UNIVESRITY OF CALIFORNIA SAN FRANCISCO
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David Julius is the Morris Herzstein Chair in Molecular Biology and Medicine, and Professor and Chair of Physiology at UCSF. The Julius lab is interested in understanding how signals are received and transmitted by the nervous system. They have exploited the properties of natural products to discover a family of thermo- and chemo-sensitive ion channels that enable sensory nerve fibers to detect hot or cold temperatures, or chemical irritants. With the aid of genetic, electrophysiological, and behavioral methods, they have determined how these ion channels contribute to pain sensation, and how channel activity is modulated in response to tumor growth, infection, or other forms of injury that produce inflammation and pain hypersensitivity.

Dr. Julius received his undergraduate degree from MIT, where he worked with Alex Rich on the enzymology of tRNA aminoacylation. He moved to UC Berkeley, where he worked with Jeremy Thorner and Randy Schekman to elucidate mechanisms of peptide hormone processing and secretion in *Saccharomyces* yeast. As a postdoc, David joined Richard Axel's group at Columbia University, where his focus turned to neuropharmacology and receptor function.

Dr. Julius is a member of the US National Academy of Sciences, the National Academy of Medicine, the American Academy of Arts and Sciences, and the Hungarian Academy of Sciences (honorary). His awards include the Perl/UNC Prize, the Unilever Science Prize, the Passano Award, the Prince of Asturias Prize for Technical and Scientific Research, the Shaw Prize in Life Sciences and Medicine, the Paul Janssen Prize for Biomedical Research, and the Canada Gairdner International Award.

<u>ABSTRACT</u>: "Natural Products as Probes of the Pain Pathway: From Physiology to Atomic Structure"

We are interested in determining the molecular basis of somatosensation - the process whereby we experience touch and temperature - with an emphasis on identifying molecules that detect noxious (pain-producing) stimuli. We are also interested in understanding how somatosensation is altered in response to tissue or nerve injury. Our approach has been to identify molecular targets for natural products that mimic the psychophysical effects of commonly encountered somatosensory stimuli, such as heat or cold, and to then ask how these molecules are activated or modulated by noxious stimuli or injury.

We have focused on three members of the TRP channel family (TRPV1, TRPM8, and TRPA1) that are expressed by subpopulations of primary afferent sensory neurons and which have been implicated in the detection of thermal stimuli and/or inflammatory agents. Genetic studies support the idea that the capsaicin receptor (TRPV1) and the menthol receptor (TRPM8) function as detectors of heat and cold, respectively, whereas the wasabi receptor (TRPA1) functions as a detector of environmental and endogenous chemical irritants.

From a signal transduction and therapeutics perspective, there is great interest in understanding how these channels are activated (gated) by physical and/or chemical stimuli. We have used a combination of molecular genetics, natural product biochemistry, and biophysics to address these issues and probe mechanisms of stimulus detection, channel activation, and coding logic of the somatosensory system.

<u>REPRESENTATIVE ARTICLES:</u>

https://www.nature.com/articles/nature12823 https://www.nature.com/articles/nature17976

https://www.annualreviews.org/doi/full/10.1146/annurev-cellbio-101011-155833?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed

NERGIS MAVALVALA
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Nergis Mavalvala is the Curtis and Kathleen Marble Professor of Astrophysics and associate head of the Department of Physics at MIT. Her research focuses on the detection of gravitational waves from violent astronomical events. She was a leading member of the team that in early 2016 made history with the first direct detection of gravitational waves from the collision of two black holes, confirming the final prediction of Einstein's general theory of relativity, and introducing a completely new method for observing the Universe.

In addition to her work on gravitational wave detectors, Nergis has conducted pioneering experiments on exotic quantum states of light, as well as laser cooling and trapping of large objects, which make it possible to study the weirdness of quantum mechanics in human-scale systems.

Mavalvala received her bachelor's degree from Wellesley College and her PhD from MIT. She was a postdoctoral fellow and research scientist at CalTech before joining the physics faculty at MIT in 2002. She has received numerous honors, including a MacArthur "genius" award in 2010, and election to the National Academy of Sciences in 2017.

ABSTRACT: "Opening a new window into the Universe: the 100 year quest for Einstein's gravitational waves"

The recent announcements of the first ever detections of gravitational waves from colliding black holes and neutron stars have launched a new era of gravitational wave astrophysics. I will describe the science, technology, and human story behind these discoveries that provide a completely new window into some of the most violent and warped events in the Universe.

REPRESENTATIVE ARTICLES:

www.ligo.org

Cassandra Hunt, 2015-2018
Department of Physics, Host: Alessandra Lanzara
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.

Rebecca Jensen-Clem, 2017-2020
Astronomy, Host: James Graham
Ph.D. Institution: California Institute of Technology
astro.berkeley.edu/~rjensenclem

The last twenty years of astronomy have seen a revolution in planetary science, with more than 3000 extra-solar planets discovered orbiting nearby stars. I'm interested in developing new technologies for directly imaging and characterizing the atmospheres of these other worlds.

Louis Kang, 2017-2020
Physics/HWNI, Host: Michael DeWeese
Ph.D. Institution: University of Pennsylvania
http://louiska.ng/

Human cognition ultimately emerges from sophisticated computations performed by networks of neurons. I use and develop tools from theoretical physics and applied mathematics to investigate how our brains make sense of and respond to our dynamic environments. Theoretical neuroscience forms one part of my overall mission to better understand human biology and pathology through quantitative analysis.

Amy Goldberg, 2017-2020
Integrative Biology/Statistics, Host: Rasmus Nielsen
Ph.D. Institution: Stanford
www.goldbergamy.com

Past population migrations and expansions greatly impact modern human genetic and physical variation, as well as disease risk. My research develops and applies quantitative methods to understand the dynamic relationship between humans, their cultures, and their environments during the last tens of thousands of years. Towards this goal, I leverage modern and ancient genetic data, interpreted in the context of paleoenviornmental and archeological records.

Benjamin Good, 2016-2019 (not in attendance)
Physics and Bioengineering, Host: Oskar Hallatschek
Ph.D. Institution: Harvard
https://sites.google.com/site/benjaminhgood/

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.

Douglas Hemingway, 2015-2018
Earth & Planetary Science, Host: Michael Manga
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.

LIOR PACHTER
DEPARTMENT OF BIOLOGY AND BIOLOGICAL ENGINEERING
CALTECH
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http://pachterlab.github.io/biography.html

Lior Pachter was born in Ramat Gan, Israel, and grew up in Pretoria, South Africa where he attended Pretoria Boys High School. After receiving a B.S. in Mathematics from Caltech in 1994, He left for MITwhere he was awarded a PhD in applied mathematics in 1999. He then moved to the University of California at Berkeley where he was a postdoctoral researcher (1999-2001), assistant professor (2001-2005), associate professor (2005-2009), and until 2018 the Raymond and Beverly Sackler professor of computational biology and professor of mathematics and molecular and cellular biology with a joint appointment in computer science. Since January 2017 he has been the Bren professor of computational biology at Caltech.

<u>ABSTRACT:</u> "The benefits of multiplexing "

I will discuss some recent advances in single-cell genomics technology and survey some of the remarkable molecular biology they have enabled. In particular, I will discuss some of this work from my own lab, work that can be directly traced back to my Miller Professorship in 2010 and that was sparked by the interdisciplinary "multiplexed" approach to science advocated by the Institute.

<u>REPRESENTATIVE ARTICLES:</u>

SARAH STEWART
DEPARTMENT OF EARTH & PLANETARY SCIENCES
UNIVERSITY OF CALIFORNIA DAVIS
sts@ucdavis.edu
http://sarahtstewart.net/

Sarah Stewart is a professor in the Department of Earth and Planetary Sciences at the University of California, Davis. Her research interests include the formation and evolution of planetary bodies with a focus on collisional processes. Previously, Dr. Stewart was a Professor of Earth and Planetary Sciences at Harvard University. She received a Ph.D. in Planetary Sciences from the California Institute of Technology. Dr. Stewart is a recipient of the Presidential Early Career Award for Scientists and Engineers and the Urey Prize from the Division for Planetary Sciences of the American Astronomical Society. She is the current President of the Planetary Sciences section of the American Geophysical Union.

ABSTRACT: "The Origin of the Earth and Moon"

The Moon and Earth share a common origin that has left a distinct chemical imprint on both bodies. The abundance and precision of geochemical and isotopic data has placed tight requirements on the outcome of any model for the origin of the Moon. In contrast, physical models for lunar origin, primarily focused on the giant impact hypothesis, have had great difficulty making chemical predictions or appear to contradict the observations. I will discuss new work on understanding the physics and thermochemistry of giant impacts that revealed substantial gaps in our understanding of planet formation processes. The last giant impact on Earth likely triggered the formation of a newly recognized type of planetary object, named a synestia. The terrestrial synestia provided a thermochemical environment for lunar accretion that may explain the major chemical characteristics of the Moon.

REPRESENTATIVE ARTICLES:

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016JE005239

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2017JE005333 /
2 column version of the paper here: https://arxiv.org/abs/1802.10223)

Thibault de Poyferre, 2017-2020
Mathematics Host: Daniel Tataru
Ph.D. Institution: Ecole Normale Superieure

I study partial differential equations arising from fluid dynamics and oceanography. I focus on finding and studying models for water waves near a shore.

Rebecca Duncan, 2016-2019
Integrative Biology Host: Noah Whiteman
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, 2015-2018
Astronomy Host: Uros Seljak
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, 2016-2019
Departments of Statistics & Mathematics, Host: Alan Hammond
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.

Miller Research Fellows

Nikhil Bhatla, 2017-2020
HWNI/MCB Host: Hillel Adesnik
Ph.D. Institution: MIT

For millennia, humans have contemplated how it is that we are conscious, that is, how we have subjective experience or qualia. Blindsight is a neurological condition in which patients lose the conscious experience of seeing but can still accurately locate visual stimuli and guess their properties. Blindsight is caused by damage to primary visual cortex in the human brain, and by manipulating visual cortex function in the mouse brain, I am working on establishing a mouse model of blindsight. Such a model will enable identification of neural circuits that contribute specifically to the conscious component of vision, and ultimately to development of a general theory of why some neural circuits support experience and others do not.

Cara Brook, 2017-2020
Integrative Biology/PMB Hosts: Mike Boots, Britt Glaunsinger
Ph.D. Institution: Princeton
http://carabrook.github.io/

Bats are the purported reservoir hosts for several of the world's most virulent emerging human diseases, including Hendra and Nipah henipaviruses, Ebola and Marburg filoviruses, and SARS and MERS coronaviruses. Bats appear to host these viruses without experiencing extensive morbidity or mortality, leading researchers to ask whether bats might be uniquely adapted for their roles as pathogen hosts. I bridge field ecology, cellular immunology, and quantitative epidemiology to investigate this question, at both within-host and population levels, with a particular focus on viral infections in Madagascar fruit bats.

Ryan Dalton, 2015-2018
MCB Hosts: Diana Bautista, Ellen Robey
Ph.D. Institution: UCSF
https://ryandalton.weebly.com

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

INTRODUCING THE 2018-2021 MILLER RESEARCH FELLOWS

MICHAEL ABRAMS
MOLECULAR & CELL BIOLOGY
HOST: NICOLE KING

LOU BARREAU (IN ATTENDANCE)
CHEMISTRY
HOSTS: STEPHEN LEONE / DAN NEUMARK

SOONWON CHOI
PHYSICS
HOST: DUNG HAI LEE

ALISON FEDER
INTEGRATIVE BIOLOGY
HOST: OSKAR HALLASTCHEK

XIAOJIN FU
EARTH & PLANETARY SCIENCE
HOST: MICHAEL MANGA

SAMUEL HOPKINS
EECS
HOSTS: LUCA TREVISAN / PRASAD RAHAVENDRA

AMBIKA KAMATH
ENVIRONMENTAL SCIENCE, POLICY & MANAGEMENT
HOST: DAMIAN ELIAS

GEORGIOS MOSCHIDIS
MATHEMATICS
HOST: MACIEJ ZWORSKI

NICHOLAS RODD
PHYSICS
HOST: SURJEET RAJENDRAN

REBECCA TARVIN
INTEGRATIVE BIOLOGY
HOST: RASMUS NIELSEN

YONG ZENG
ASTRONOMY
HOST: DANIEL WEISZ

MILLER INSTITUTE SYMPOSIUM
JUNE 1-3, 2018

Friday, June 1

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 – 11:00   Miller Fellows Posters – Buck Hall

Saturday, June 2 - Buck Hall

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

8:30 - 9:15   Sarah Stewart, UC Davis
"The Origin of the Earth and Moon"

9:15 - 9:45   Discussion

9:45 - 10:00   Break

10:00 - 10:45   Lior Pachter, Caltech
"The Benefits of Multiplexing"

10:45 - 11:15   Discussion

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

1:00 - 1:45   Danna Freedman, Northwestern University
"Applying Inorganic Chemistry to Challenges in Physics"

1:45 - 2:05   Discussion

2:05 - 2:35   Break

2:35 - 3:20   Richard Baraniuk, Rice University
"Going Off the Deep End with Deep Learning "

3:20 - 3:50   Discussion

3:50 - 4:05   Break

4:05 - 4:50   Paula Hammond, MIT
"Nanolayered Particles for Tissue Targeted Therapies"

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 3 - Buck Hall

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

9:00—9:45   Nergis Mavalvala, MIT
"Opening a New Window into the Universe: the 100 Year Quest for Einstein's Gravitational Waves"

9:45 - 10:15   Discussion

10:15 - 10:45   Break

10:45 - 11:30   David Julius, UC San Francisco
"Natural Products as Probes of the Pain Pathway: From Physiology to Atomic Structure"

11:30 - 12:00   Discussion

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