Miller Institute For Basic Research In Science

Tomales Bay

23rd Annual Interdisciplinary Symposium

June 7~9, 2019

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 of Business 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 1,000 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/

2019 SYMPOSIUM COMMITTEE

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Kathryn Day, Miller Institute Staff

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Christopher Lemon, Molecular & Cell Biology

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

Kelly Nguyen, Molecular & Cell Biology

Sarah Slotznick, Earth & Planetary Science

Sho Takatori, Bioengineering

Alex Turner, Chemistry / Earth & Planetary Science

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Earth & Planetary Science

Professor Marla Feller
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Professor Tim Stearns
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Stanford University

MILLER INSTITUTE
INTERDISCIPLINARY SYMPOSIUM
2019 SPEAKERS

Frances Arnold
Chemical Engineering
Caltech

Elizabeth Barnes
Atmospheric Science
Colorado State University

Yi Cui
Materials Science & Engineering
Stanford University

Jessica Lu
Astronomy
UC Berkeley

Sabeeha Merchant
Biochemistry, Biophysics and Structural Biology
Plant & Microbial Biology
UC Berkeley

Terry Plank
Geochemistry
Columbia University Lamont-Doherty Earth Observatory

Corina Tarnita
Ecology and Evolutionary Biology
Princeton University

FRANCES ARNOLD

DEPARTMENT OF CHEMICAL ENGINEERING
CALTECH
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Frances Arnold is the Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry at the California Institute of Technology, where she has been on the faculty since 1986. She is the first American woman to win the Nobel Prize in Chemistry (2018). Arnold pioneered directed protein evolution and has used those methods for applications in alternative energy, chemicals, and medicine. Arnold received the Charles Stark Draper Prize of the US National Academy of Engineering in 2011, the US National Medal of Technology and Innovation from President Obama in 2013, and the Millennium Technology Prize in 2016. She was elected to all three US National Academies of Science, Medicine, and Engineering.

Co-inventor on 58 issued US patents and active in technology transfer, Arnold co-founded Gevo, Inc. in 2005 to make fuels and chemicals from renewable resources, Provivi, Inc. in 2014 to develop non-toxic modes of agricultural pest control, and Aralez, Inc. in 2019 to develop sustainable biocatalytic processes for producing medicines and chemicals. Arnold received her B.S. in Mechanical and Aerospace Engineering from Princeton University and worked at the Solar Energy Research Institute, a national laboratory devoted to alternative energy research (now NREL) before obtaining her Ph.D. in Chemical Engineering from the University of California, Berkeley. Arnold chairs the Advisory Panel of the David and Lucile Packard Foundation Fellowships in Science and Engineering and is a Trustee of the Gordon Research Conferences.

ABSTRACT: "Innovation by Evolution: Bringing New Chemistry to Life"

Not satisfied with nature's vast catalyst repertoire, I want to create new protein catalysts and expand the space of genetically encoded enzyme functions. We use the most powerful biological design process, evolution, to optimize existing enzymes and invent new ones, thereby circumventing our profound ignorance of how sequence encodes function. Using mechanistic understanding and mimicking nature's evolutionary design processes, we have generated whole new families of 'carbene transferases' and 'nitrene transferases' that catalyze chemical reactions not previously known in biology. These capabilities increase the scope of molecules and materials we can build using synthetic biology and move us closer to a sustainable world where chemical synthesis can be fully programmed in DNA.

REPRESENATIVE ARTICLES:

https://onlinelibrary.wiley.com/doi/full/10.1002/anie.201708408
http://cheme.che.caltech.edu/groups/fha/publications/Arnold_Microbe2011.pdf

ELIZABETH BARNES
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http://barnes.atmos.colostate.edu

Elizabeth Barnes is an associate professor of Atmospheric Science at Colorado State University. She joined the CSU faculty in 2013 after obtaining dual B.S. degrees (Honors) in Physics and Mathematics from the University of Minnesota, obtaining her Ph.D. in Atmospheric Science from the University of Washington, and spending a year as a NOAA Climate & Global Change Fellow at the Lamont-Doherty Earth Observatory. Professor Barnes' research is focused on large scale atmospheric variability and the data analysis tools used to understand its dynamics. Topics of interest include jet-stream dynamics, Arctic-midlatitude connections, subseasonal-to-seasonal (S2S) prediction of extreme weather events (she is currently Task Force Lead for the NOAA MAPP Subseasonal-to-Seasonal (S2S) Prediction Task Force), health-related climate impacts, and data science methods for climate research (e.g. machine learning, causal discovery).

In addition to being the lead of the NOAA MAPP S2S Prediction Task Force, she also serves on the advisory panel for the Atmospheric Chemistry Observations and Modeling (ACOM) Laboratory at NCAR, the NSF Arctic Sciences Section Portfolio Review Committee, the AMS AOFD Committee, is an Associate Editor of Journal of Climate, an Editorial Board Member for npj Climate and Atmospheric Science, and serves as a member of the International Commission on Dynamical Meteorology, a Commission of the IAMAS.

Dr. Barnes was awarded an NSF CAREER grant in 2018. In addition, she won the George T. Abell Outstanding Early-Career Faculty Award in 2016 and was recognized for her teaching and mentoring by being awarded an Honorable Mention for the CSU Graduate Advising and Mentorship Award in 2017 and being named the Outstanding Professor of the Year Award in 2016 by the graduate students of the Department of Atmospheric Science. In 2014 she was the recipient of an AGU James R. Holton Junior Scientist Award.

ABSTRACT: "The Music in the Noise: understanding atmospheric variability and change"

The global atmosphere is a noisy and chaotic place, and we are continually pushing the limits of its predictability. Here, I will explore how this "noise" can confound our ability to quantify the atmospheric response to a range of climate perturbations, e.g. the ozone hole and volcanic eruptions. I will provide examples of how the climate community has made use of identical simulations of state-of-the-art climate models to search for the music (signals) in the noise and what physical insights have resulted. I will then conclude with an example of how machine learning methods are an exciting way forward to understanding the human influence on climate amidst the noise of climate variability and model uncertainty.

REPRESENATIVE ARTICLES:

Deser, C., R. Knutti, S. Solomon, and A. S. Phillips, 2012: Communication of the role of natural variability in future North American climate. Nat. Clim. Chang., 2, 775.

Santer, B. D., and Coauthors, 2018: Human influence on the seasonal cycle of tropospheric temperature. Science, 361, doi:10.1126/science.aas8806. http://dx.doi.org/10.1126/science.aas8806.

YI CUI
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Yi Cui is a Professor in the Department of Materials Science and Engineering at Stanford University. He received his B.S. in Chemistry in 1998 at the University of Science and Technology of China (USTC), and his Ph.D. in 2002 at Harvard University. He was a Miller Postdoctoral Fellow (2003-2005) at UC Berkeley. In 2005 he became an Assistant Professor at Stanford University. He was promoted with tenure in 2010 and to Full Professor in 2016. He is a fellow of Materials Research Society, Electrochemical Society and Royal Society of Chemistry. He is an Associate Editor of Nano Letters and a Co-Director of the Bay Area Photovoltaics Consortium and a Co-Director of Battery 500 Consortium. He is a highly prolific materials scientist and has published ~430 research papers and filed more than 50 patent applications. In 2014, he was ranked NO.1 in Materials Science by Thomson Reuters. His selected awards include Blavatnik National Laureate (2017), MRS Fred Kavli Distinguished Lectureship in Nanoscience (2015), Inaugural Nano Energy Award (2014), Bau Family Awards in Inorganic Chemistry (2014), the Sloan Research Fellowship (2010), KAUST Investigator Award (2008), the Technology Review World Top Young Innovator Award (2004). He founded Amprius Inc. in 2008, a company to commercialize his high-energy battery technology. In 2015, he and Professor Steve Chu co-founded 4C Air Inc., to commercialize their invented technology to remove particle pollutants from the air. In 2017, he co-founded EEnovate Technology Inc., a technology accelerator to commercialize energy and environment technologies.

ABSTRACT: "Reinventing Batteries: What's Possible?"

Increased demands of high energy density, long lasting batteries, low cost and safe batteries for applications in consumer electronics, electric vehicle and grid with renewable energy integration present great opportunities and challenges to the society. This presentation will review the status of existing battery technology and present the challenges, opportunities and promising pathways for the future. Novel battery chemistries and materials are key for revolutionary changes. Fundamental studies with the new tools are critical for understanding of battery operation and failure. Recent science and technology breakthroughs will be highlighted for significantly higher energy density, lower cost, better safety and longer life. Lastly, the availability of resources and recycling of batteries will be discussed.

REPRESENTATIVE ARTICLES:

https://web.stanford.edu/group/cui_group/papers/Yayuan_Cui_ACCCHEMRESEARCH_2017.pdf

https://web.stanford.edu/group/cui_group/papers/Yuzhang_Cui_SCIENCE_2017.pdf

JESSICA LU
DEPARTMENT OF ASTRONOMY
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Dr. Lu is an Assistant Professor of Astronomy at UC Berkeley. Her research group is conducting a search for free-floating stellar-mass black holes in the Milky Way using gravitational lensing. Her group also studies how stars are born in extreme environments such as in massive star clusters and around the supermassive black hole at the center of the Milky Way. These black hole studies require very high resolution images of the Universe at infrared wavelengths. Prof. Lu helps develop astronomical instruments that deliver sharp views of the sky using adaptive optics systems on large ground-based telescopes. She is the Project Scientist for the ‘imaka and KAPA projects, which aim to expand the reach of adaptive optics to wider fields of view and more places in the sky. Prof. Lu is also a member of international science teams for the future Thirty Meter Telescope and the WFIRST space observatory.

Prof. Lu is originally from Houston, TX and attended the High School for Performing and Visual Arts, majoring in dance. She received her undergraduate degree in physics from the MIT in 2000. She worked as a software engineer in silicon valley for 3 years before returning to academia to pursue her PhD in astronomy and astrophysics at UCLA, which was granted in 2008. After completing her PhD, she was awarded a Millikan Postdoctoral Fellowship in Observational Astronomy at Caltech and an NSF Astronomy and Astrophysics postdoctoral fellow at the Institute for Astronomy (IfA) in the University of Hawaii, Manoa. She joined the IfA faculty in 2013 and then, in the summer of 2016, Prof. Lu joined the faculty of the UC Berkeley astronomy department.

ABSTRACT: “Black Holes, Big and Small - A Laser-Guided Adaptive Optics View ”

Black holes come in at least two varieties. Supermassive black holes lay at the centers of galaxies and, while not theoretically predicted, have been definitively proven to exist using observations of stars' orbits at the heart of the Milky Way. Stellar mass black holes are predicted to exist in large numbers -- 100 million in our Galaxy alone -- but only two dozen have been found, all in binaries. Prof. Lu will present past, current, and upcoming experiments to hunt for the invisible stellar mass black holes and study how the supermassive black hole at the Galactic Center impacts its environment. These experiments utilize the power of the world’s largest telescopes equipped with laser-guide star adaptive optics to correct image blurring from the Earth’s turbulent atmosphere. Prof. Lu will also discuss how advances in adaptive optics will sharpen our view of the Universe for black hole research and beyond.

REPRESENTATIVE ARTICLES:

https://aasnova.org/2016/09/06/through-the-lenses-of-black-holes/

http://hoffman.cm.utexas.edu/courses/History_AO_Max.pdf

SABEEHA MERCHANT
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http://mcb.berkeley.edu/faculty/bbs/merchants

Sabeeha Merchant's discoveries have influenced scholarly thought in diverse disciplines, from biogeochemistry and biological oceanography to photosynthesis, plant biochemistry and human nutrition. Merchant formulated the concepts of elemental sparing and recycling, which operate to sustain life in situations of deficiency by prioritized distribution of the limiting resource. Merchant is known in plant biology for discoveries relating to chloroplast biogenesis and contributions to the genomics of algae. Her accomplishments are recognized by her election to the US National Academy of Sciences, the American Academy of Arts and Sciences and the Leopoldina. Sabeeha Merchant joined the UC Berkeley faculty after holding positions as Director of the Institute for Genomics and Proteomics within the Geffen School of Medicine and Distinguished Professor of Chemistry and Biochemistry at UCLA. She also holds a guest appointment at the Max Planck Institut in Molecular Plant Physiology. Merchant earned degrees in Molecular Biology and Biochemistry from the University of Wisconsin, Madison, and undertook post-doctoral studies at Harvard University. At Berkeley, she is appointed jointly in Plant and Microbial Biology and Molecular and Cell Biology. Her research program emphasizes systems biology and comparative genomics of algae for discoveries related to the environment and bioenergy applications, as well as classical biochemistry and state-of-the-art imaging and spectroscopies for discoveries related to trace metal homeostasis.

<u>ABSTRACT:</u> "Elemental economy in biology"

More than 80 of the 92 naturally occurring elements are found in living organisms, but 12 of the low mass elements, which are also high abundance elements on Earth, constitute > 99% of the biomass. Yet, the others, despite their occurrence at trace levels, are essential for life because they enable the diverse chemistries of living cells. Organisms use metals like copper, iron, manganese, molybdenum, vanadium, which have multiple stable oxidation states, for reducing nitrogen gas to ammonium, for using light to convert carbon-dioxide and water to carbohydrate, and for extracting energy from inorganic or organic chemicals to sustain life. At the same time, their reactivity can make these very elements harmful in the biological environment, especially in the presence of oxygen. Too little means that enzymes that use the trace metals as catalytic cofactors will not function, and too much means that the metals may react promiscuously. For this reason, there are homeostatic mechanisms to maintain elemental quotas in biology. One evolutionary adaptation to limitation in a particular element is the reduce, reuse, recycle paradigm. For instance, when faced with Fe deficiency, an organism can reduce its inventory of iron-containing proteins by replacing them with iron-independent catalysts. In situations of Fe starvation or sustained deficiency, an organism can remove Fe from one protein and reuse it in a different - more critical for life - protein. These mechanisms have been discovered through classical genetics and biochemistry in multiple microbes, revealing metabolic signatures for elemental economy. Comparative genomics and metagenomics indicate widespread utilization of these economies in nature.

<u>REPRESENTATIVE ARTICLES:</u>

https://www.sciencedirect.com/science/article/pii/B9780123982643000024?via%3Dihub

https://www.sciencedirect.com/science/article/pii/S1369526616302175?via%3Dihub

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Terry Plank is the Arthur D. Storke Professor in the Department of Earth and Environmental Sciences of Columbia University and the Lamont-Doherty Earth Observatory. She received her A.B. from Dartmouth College (where she also received an Honorary Doctor of Science in 2015), and her Ph.D. in Geoscience from Columbia University. She is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, and was a MacArthur Foundation Fellow from 2013-2017. Her research focuses on the volatile contents of magmas, timescales of magma ascent and eruption, recycling of carbon at subduction zones, and integrating petrological and seismological observations of melting regions in the mantle.

ABSTRACT: "At the Speed of Volcanic Eruptions"

What happens under volcanoes in the months leading up to eruption? How does the magmatic system prepare for an eruption? And why are some eruptions more explosive than others? Crystal clocks are providing some answers to these questions. Chemical zonation preserved inside crystals and their inclusions are some of the fastest clocks in geology. These timescales of chemical diffusion operate over minutes to years prior to eruption. This talk will examine new constraints on volcanic run-up, forecasting and eruption dynamics.

REPRESENTATIVE ARTICLES:

"Crystal clocks" Rosen, Science (2016) Vol. 354, Issue 6314, pp. 822-825
https://science.sciencemag.org/content/354/6314/822.summary

Rasmussen, D.J., Plank, T., Roman, D.C., Power, J.A., Bodnar, R.J. and Hauri, E.H. (2018) When does eruption run-up begin? Multidisciplinary insight from the 1999 eruption of Shishaldin volcano. Earth and Planetary Science Letters, 486: 1–14.
https://www.sciencedirect.com/science/article/pii/S0012821X18300050

CORINA TARNITA
Department of Ecology and Evolutionary biology
Princeton University
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https://scholar.princeton.edu/ctarnita

Corina joined the Princeton faculty in February 2013. Previously she was a Junior Fellow at the Harvard Society of Fellows (2010-2012) and a postdoctoral researcher with the Program for Evolutionary Dynamics, Harvard University (2009-2010). She obtained her B.A.('06), M.A.('08) and PhD ('09) in Mathematics from Harvard University. She is an Alfred P. Sloan Research Fellow, a Kavli Frontiers of Science Fellow of the National Academy of Sciences, and an ESA Early Career Fellow. Her work is centered around the emergence of complex behavior out of simple interactions, across spatial and temporal scales.

ABSTRACT: "Self-organization and robustness in biological systems "

Understanding and managing complex adaptive systems (CAS)---characterized by emergent, self-organized patterns at scales larger than those of the interacting parts---has crystallized as one of the most pressing problems of our time, from biology to sociology, from medicine to financial markets. Faced with a range of challenges throughout evolutionary history that have led to a diversity of robust solutions, biological systems are ideal for the study of CAS, and solutions inferred from biology have successfully been applied to system design and management in other fields. It is therefore imperative not only to study individual biological CAS but also to compare the organizing principles and emergent properties of diverse CAS. My lab uses mathematical and empirical approaches to study the organization and emergent properties and behaviors of CAS at multiple scales, from single cells to entire ecosystems. In this talk, I will give an overview of our work.

REPRESENTATIVE ARTICLES:

https://www.nature.com/articles/nature20801

https://www.pnas.org/content/114/42/11018

INTRODUCING THE 2019—2022 MILLER RESEARCH FELLOWS

Allison Gaudinier
(in attendance)
Plant & Microbial Biology / Statistics
Host: Benjamin Blackman

Reza Gheissari
Mathematics / Statistics
Host: Alistair Sinclair

Yu He
Physics
Host: Robert Birgeneau

Daniel Ibarra
Earth & Planetary Science
Host: Daniel Stolper

Pengfei Ji
(in attendance)
Chemistry
Host:
John Hartwig

Seyedeh Mahsa Kamali
Bioengineering / EECS
Hosts: Aaron Streets & Connie Chang-Hasnain

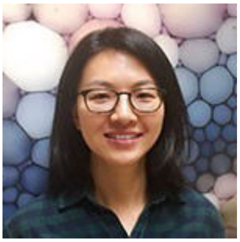
Naomi Latorraca
Molecular & Cell Biology
Host: Susan Marqusee

Aavishkar Patel
Physics
Host: Ehud Altman

Ekta Patel
Astronomy
Host: Daniel Weisz

Danqing Wang
Material Science Engineering
Host: Junqiao Wu

Qiong Zhang
(in attendance)
Bioengineering / Plant & Microbial Biology
Hosts:
John Dueber / Brian Staskawicz



MILLER INSTITUTE SYMPOSIUM
JUNE 7-9, 2019

Friday, June 7

3 - 6:00 pm	Arrival and registration - Seagull Check In
4 - 6:00	Informal gathering - Social Time - Buck Hall
6:00 – 7:30	Dinner & Welcome - Redwood Hall Dining Room
7:30 – 11:00	Miller Fellows Posters – Buck Hall

Saturday, June 8 - Buck Hall

7 - 8:30 am	Breakfast - Redwood Hall Dining Room
8:30 - 9:10	**Jessica Lu, UC Berkeley** **"Black Holes, Big and Small - A Laser-Guided Adaptive Optics View"**
9:10 - 9:40	Discussion
9:40 - 10:00	Break
10:00 - 10:40	**Frances Arnold, Caltech** **"Innovation by Evolution: Bringing New Chemistry to Life"**
10:40 - 11:10	Discussion
11:10 - 12:45	Group Photo followed by Lunch
1:00 - 1:40	**Elizabeth Barnes, Colorado State University** **"The Music in the Noise: understanding atmospheric variability and change"**
1:40 - 2:10	Discussion

2:10 - 2:40	Break
2:40 - 3:20	**Corina Tarnita, Princeton University** **"Self-organization and robustness in biological systems"**
3:20 - 3:50	Discussion
3:50 - 4:20	Break
4:20 - 5:00	**Terry Plank, Columbia Lamont-Doherty Earth Observatory** **"At the Speed of Volcanic Eruptions"**
5:00 - 5:30	Discussion
7:00 – 8:30	Dinner - Redwood Hall Dining Room
8:45 – 1:00am	Movies / Posters / Music and Social Time at Buck Hall

<u>Sunday, June 9 - Buck Hall</u>

7:00 - 8:30 am	Breakfast - Redwood Hall Dining Room
9:00—9:40	**Yi Cui, Stanford University** **"Reinventing Batteries: What's Possible?"**
9:40- 10:10	Discussion
10:10 - 10:40	Break
10:40 - 11:20	**Sabeeha Merchant, UC Berkeley** **"Elemental economy in biology"**
11:20 - 11:50	Discussion
12:00 - 1:30	Lunch and close of meeting

Miller Research Fellows

Michael Abrams, 2018-2021
Mol and Cell Bio Hosts: Nicole King, Richard Harland
Ph.D. Institution: Caltech
mjabrams@berkeley.edu

While doing my PhD in biology at Caltech, my advisor, Lea Goentoro, and I, used the phylogenetic position, self-repair capacity, and behavior of the moon jellyfish, Aurelia aurita, to better understand animal self-repair strategies. Simultaneously, in a collaboration between three labs at Caltech, we determined that a different species, the upside-down jellyfish, Cassiopea xamachana, displays a sleep-like state. These findings make Cassiopea an attractive system for better understanding how evolutionarily the sleep-like state is controlled, the role of sleep in an animal without a brain, and the extent to which sleep affects self-repair. The overall aim of my research is to tackle these questions in this early branching metazoan lineage, so that we may continue to demystify the ancient origins of sleep.

Lou Barreau, 2018-2021
Chemistry   Hosts: Steve Leone / Dan Neumark
Ph.D. Institution: CEA-NCRS Paris
Lou.barreau@berkeley.edu

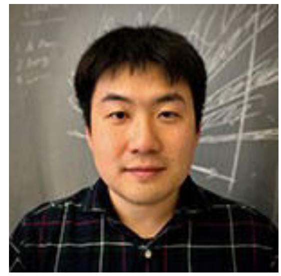
Much of chemistry is governed by the electron motion among molecular orbitals that define the making and breaking of chemical bonds, occuring at the attosecond timescale (10^-18 s). I am interested in understanding, and eventually controlling, the ultrafast fundamental processes at play when an organic molecule absorbs light. To this end, my research uses ultrashort pulses in the soft X-ray domain, produced in the laboratory, to probe coupled electronic and nuclear dynamics in gas-phase species.

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

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.



Soonwon Choi, 2018-2021
Physics Hosts: Dung Hai Lee, Norman Yao
Ph.D. Institution: Harvard
soonwon[at]berkeley.edu

My research interests lie at the interface of quantum many-body dynamics and information science. Combining tools from theory, numerical methods and experiments, I am interested in out-of-equilibrium quantum dynamics and their potential applications.

Thibault de Poyferre, 2017-2020
Mathematics Host: Daniel Tataru
Ph.D. Institution: Ecole Normale Superieure
tdepoyfe@math.berkeley.edu

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   (not in attendance)
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 address the hypothesis that bacteria in the gut and on host plants facilitate host plant detoxification. In doing so, I will help address the 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.

Alison Feder , 2018-2021
Integrative Biology
Hosts: Oskar Hallastchek, Montgomery Slatkin
Ph.D. Institution: Stanford
affeder@berkeley.edu

Whereas most empirical and theoretical work has considered populations evolving to a single challenge, in nature, these challenges are often multiple and sometimes orthogonal. To understand evolution under complex and realistic circumstances, I combine genomic data and evolutionary theory to create biologically-grounded models of evolution to explain real world observations. I am particularly interested in how evolution in structured environments may allow populations to achieve evolutionary outcomes impossible in well-mixed populations.

Xiaojing "Ruby" Fu , 2018-2021
EPS Host: Michael Manga
Ph.D. Institution: MIT
Erubyxfu@berkeley.edu

Ruby has a strong interest in understanding the physics of multiphase fluid mechanics and how it shapes our environment in constructive or destructive ways. Her approach is often mathematical and computational, and she collaborates closely with experimentalists and field scientists. Ruby's work is applied to a wide range of geoscience problems, including gas hydrate systems, geologic carbon sequestration, volcanology and hydrology.

Benjamin Good, 2016-2019
Physics and Bioengineering, Host: Oskar Hallatschek
Ph.D. Institution: Harvard
https://sites.google.com/site/benjaminhgood/
Benjamin.h.good@berkeley.edu

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.

Samuel Hopkins, 2018-2021
EECS Host: Luca Trevisan / Prasad Raghavendra
Ph.D. Institution: Cornell
hopkins@berkeley.edu

Extracting useful information from large, high-dimensional, and noisy data sets is a major computational challenge. I study algorithms for such statistical inference problems from a mathematical perspective, to understand which can be accomplished with limited computational resources, which cannot, and what principles underlie this distinction.

Rebecca Jensen-Clem, 2017-2020
Astronomy, Host: James Graham
Ph.D. Institution: California Institute of Technology
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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.

Ambika Kamath, 2018-2021
ESPM Host: Damian Elias
Ph.D. Institution: Harvard
ambikamath@berkeley.edu

I am a behavioral ecologist broadly interested in the consequences of individual variation in behavior for the ecological and evolutionary trajectories of populations and species. I study how animals use and move through the space they occupy, because an animal's movement how easily and how often it encounters other individuals or particular habitats, and thus dictates the selective pressures it faces. My postdoctoral research explores questions of coevolution between animal architecture and collective behaviors in Stegodyphus social spiders, to understand if the spatial environments these animals build for themselves facilitate the adaptive social interactions that help their colonies succeed.

Louis Kang, 2017-2020
Physics/HWNI, Host: Michael DeWeese
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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
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clemon@berkeley.edu

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.

Georgios Moschidis , 2018-2021
Mathematics Host: Maciej Zworski
Ph.D. Institution: Princeton
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According to the general theory of relativity, gravity is perceived as the effect of the warping of the geometry of spacetime on the motion of observers; the spacetime geometry, in turn, depends on the distribution of matter through the celebrated Einstein's field equations. Recently, my research has focused on the study of instability phenomena associated to the Einstein equations in the presence of a negative cosmological constant. I am also interested in the stability properties of the scalar wave equation (a linear toy model for the Einstein equations) on a broad class of isolated, self-gravitating systems.

Kelly Nguyen, 2016-2019
Department of Molecular and Cell Biology,
Hosts: Eva Nogales and Kathy Collins
Ph.D. Institution: University of Cambridge
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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.

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
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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.

Nicholas Rodd, 2018-2021
Physics   Host: Surjeet Rajendran
Ph.D. Institution: MIT
E-mail: nrodd@berkeley.edu

Dark matter is a substance that permeates the universe and is more than five times as abundant as regular matter, yet we have no idea what it is. My research looks to uncover the nature of dark matter by searching for the unique fingerprints it might leave in the datasets collected by telescopes looking out at the universe. Sitting right at the intersection of particle physics and astrophysics, my work involves making precise predictions for what these instruments should see, as well as talking to experimentalists to help them optimize their search strategies.

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

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.

Rebecca Tarvin, 2018-2021
Integrative Biology Host: Rasmus Nielsen
Ph.D. Institution: University of Texas Austin
rdtarvin@berkeley.edu

Every major branch of life has evolved chemical defenses of some kind, despite the potential cost of utilizing toxic compounds. Naturally occurring toxins have been called keystone molecules because of their ability to influence organisms and the ecosystems in which they live. My aim is to experimentally evolve toxin-sequestering fruit flies to reveal the genetic processes and physiological trade-offs that drive the origins of this intriguing ecological adaptation.

Alexander Turner, 2017-2020
Dept of Chemistry and Earth & Planetary Science
Hosts: Ron Cohen, Inez Fung
Ph.D. Institution: Harvard
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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
pwalter2@berkeley.edu

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.

Yong Zheng, 2018-2021 (not in attendance)
Astronomy Host: Daniel Weisz
Ph.D. Institution: Columbia
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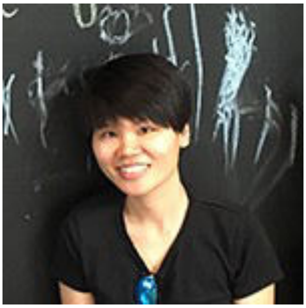

Spiral galaxies form, grow, and evolve. Their disks are actively forming stars, while their halos are large reservoirs full of ionized plasma surrounding the star-forming disks. In theory, the disks thrive on inflows from the halos while the halos are enriched and heated by outflows from the disks. My research focuses on understanding how inflows feed the galaxies' disks and outflows stir their halos via observations with Hubble Space Telescope and ground-based instruments.

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