

MILLER INSTITUTE NEWSLETTER

Spring 2006

Miller Fellow Focus: Sasha Turchyn

Sasha Turchyn is a first year Miller Fellow in the Department of Earth and Planetary Science. She is interested in questions of paleoclimatology and paleoceanography, and is working at Berkeley with Professor Don DePaolo.

Geologists are “Earth historians”, using various chemical or physical clues left behind in rocks to reconstruct the history of our planet. When minerals precipitate, they record an array of information about the environment in which they formed; when the mineral becomes part of a rock, that information hopefully is sealed in time. Isotope geochemists are interested in using the isotopic ratios of different elements in minerals to learn about the environment, for example certain isotope ratios tell us about the temperature of formation. Paleoceanographers are interested in minerals that form in the ocean that

allow them to reconstruct how the oceans have changed over Earth History. Biogeochemists are interested in the interaction between biology and chemistry and how these interactions are recorded in minerals. Sasha at times wears each of these hats, using the stable isotope record in ocean minerals to tease out the history of the chemistry and biology of the ocean.

The chemistry of the oceans plays a critical role on Earth today and throughout Earth history. For example, the balance of the major cations and anions in seawater, called alkalinity, is a critical parameter that controls the amount of carbon dioxide in the atmosphere, which directly affects climate. If we could reconstruct changes in ocean alkalinity over time, we might be able to understand changes in climate that we observe through other proxies. Similarly, different elements are very



useful to biology in the ocean and are actively cycled through their reduced and oxidized states as an energy source for bacteria, particularly in the absence of oxygen. This “biogeochemical” cycling can impact the major element chemistry of the ocean.

During her Ph.D., Sasha studied temporal variability in the biogeochemical sulfur cycle. Oceanographers think of the “sulfur cycle”

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Announcement: Call for Nominations

Miller Fellow nominations are due on
Thursday, September 14, 2006

Miller Professor applications are due on
Thursday, September 21, 2006

Visiting Miller Professor departmental nominations are
due on **Monday, September 25, 2006**

Please see the enclosed insert for details on making nominations for the Miller Fellowship program. For complete information on all our programs, visit:
<http://millerinstitute.berkeley.edu>

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as a balance of the sources and sinks of sulfur to the ocean: volcanoes and rivers are the major sources and the burial of various minerals is the major sink. The modern ocean contains a lot of oxygen, and sulfur exists nearly entirely in its most oxidized form, sulfate (SO_4^{2-}). In sediments on the ocean floor, however, oxygen is often depleted through bacterial respiration – the oxidation of organic matter or reduced carbon. When oxygen is no longer available, there are bacteria that “breathe” sulfate, producing the reduced form of sulfur, sulfide (S^{2-}). This process, sulfate reduction though organic matter oxidation, links the sulfur and carbon cycles in the ocean. Because of this connection, understanding temporal variability in the sulfur cycle is important for reconstructing changes in the carbon cycle and therefore changes in Earth’s climate.

Geochemists interested in the study of the sulfur cycle through Earth history have focused largely on measuring stable sulfur isotope ratios in various sulfur minerals; that is the ratio of $^{34}\text{S}/^{32}\text{S}$ in reduced sulfur minerals such as pyrite (FeS_2) and oxidized sulfur minerals such as gypsum (CaSO_4) and barite (BaSO_4). Variations in the sulfur isotope ratios of these minerals tell us information about river inputs to the ocean and how much sulfide is being buried as pyrite.

Sasha focused instead on variations of oxygen isotopes (the ratio of $^{18}\text{O}/^{16}\text{O}$) in marine sulfate, using measurements of barite (BaSO_4) as a recorder of how this ratio has changed over the last 70 million years. She developed a technique for separating barite from sediments collected from the bottom of the deepest part of the ocean, where there is a lot of oxygen and sulfate minerals were likely to be well preserved. She postulated that changes in the ratio of $^{18}\text{O}/^{16}\text{O}$ in barite would yield different information about temporal variability in the sulfur cycle and, coupled with information from sulfur isotope ratios, a more complete picture of the biogeochemical sulfur cycle would emerge.

This proved to be true; while sulfur isotope ratios tell us about the burial of sulfur minerals and changes in rivers, oxygen isotope ratios in sulfate reflect changes in the biochemical pathways of sulfate reduction and sulfide oxidation. Different bacteria that use sulfur in the ocean, either as an electron acceptor or as an electron donor, thrive under different environmental conditions. Sasha found that over Earth history the ratio of $^{18}\text{O}/^{16}\text{O}$ in barite went up when there was less dissolved oxygen available in the ocean and down when there was more. These changes in the “redox” condi-

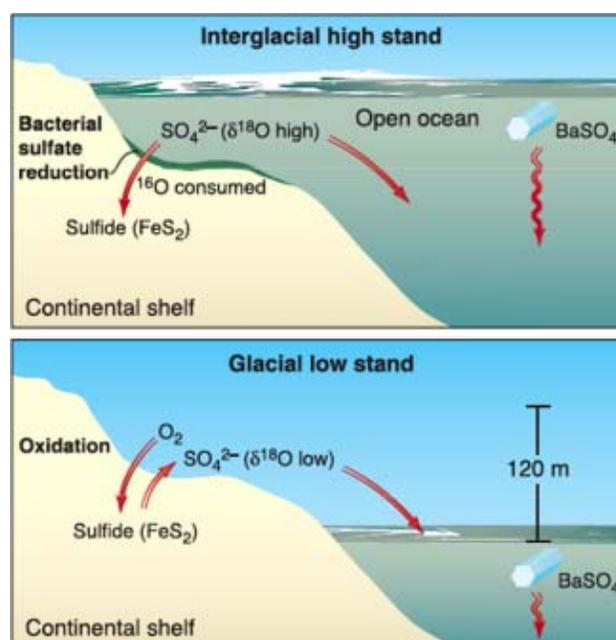


Figure 1

tions in the ocean were particularly dramatic during the glacial/interglacial cycles that have prevailed on Earth over the last 3 million years, which has resulted in a large change in the $^{18}\text{O}/^{16}\text{O}$ in marine sulfate and therefore barite over this time (see Figure 1). The record of oxygen isotopes in sulfate, coupled with the record provided by both sulfur isotopes in sulfate and carbon isotopes in carbonates, allowed a better interpretation of the biogeochemical evolution of the ocean over the past 70 million years.

As a Miller Research Fellow, Sasha is continuing to explore biogeochemistry in the ocean and asking questions about the history of the Earth. One lesson from Sasha’s Ph.D. was that many of the paleoceanographic proxies that we have assumed reflected largely “inorganic” processes within the ocean should be rethought with a better understanding of the influence of microbiology. Every rock from which a geologist retrieves “primary” information about ocean history was originally deposited as mud on the ocean floor. As the mud “lithifies” into rock it can undergo chemical changes that are largely driven by the action of the bacteria that live in the ocean sediments. Understanding both biologically and quantitatively the influence of these chemical changes on the rocks that are ultimately studied is critical for reconstructing Earth history. Geologists, while “Earth historians” are also puzzle solvers and storytellers; however, they work with only a few pieces of the puzzle while trying to put together a somewhat complete story.

Visiting Miller Professorship Awards Spring Competition



The Miller Institute is pleased to announce the recipients of Visiting Miller Professorships from the Spring selection cycle. The purpose of this program is to bring eminent scientists to the Berkeley campus for collaborative research interactions. The following professors were selected for terms ranging from one month to a full academic semester in 2006-07.

Bernhard Blümich <i>RWTH Aachen University, Institute of Technical & Macromolecular Chemistry, Germany</i>	<i>Chemistry</i>
Mostafa El-Sayed <i>Georgia Institute of Technology</i>	<i>Chemistry</i>
Heino Falcke <i>Netherlands Foundation for Research in Astronomy</i>	<i>Astronomy</i>
Katherine Freese <i>University of Michigan</i>	<i>Physics</i>
Chris Greene <i>University of Colorado, Boulder</i>	<i>Physics</i>
Chandrashekhhar Khare <i>University of Utah</i>	<i>Mathematics</i>
Alexander Levitzki <i>The Hebrew University of Jerusalem</i>	<i>Molecular & Cell Biology</i>



This is the last year that we held a spring competition cycle for the selection of Visiting Miller Professors. Starting in the Fall of 2006 for award terms in 2007-08 we will hold a single Visiting Miller Professorship competition each year. The Visiting Miller Professor nominations will be considered during the fall, at the same time we consider Miller Professors and Miller Fellows. By conducting all competitions during the fall, we will be better able to make budget decisions that impact the overall selection process.

Miller Research Fellowship Awards 2006-2009

The Miller Institute is pleased to announce the 2006-2009 Miller Research Fellows. Each year, the Miller Institute seeks to discover individuals of outstanding talent and to bring to Berkeley young scholars of great promise. Candidates are nominated for these awards and are selected on the basis of their academic achievement and the potential of their scientific research. They will be working with Berkeley faculty for a three-year term beginning in the 2006 academic year.

Szu-Yu “Sophie” Chen

Ph.D. Princeton University

Berkeley Department: Mathematics

Faculty Sponsor: Craig Evans

The main areas of Dr. Chen’s research interest are partial differential equations and applications to problems in geometry. The focus of her research is to study the boundary behaviors of solutions to fully nonlinear equations and the geometry near the boundary.

Mark Dayel

Ph.D. University of California, San Francisco

Berkeley Department: Molecular & Cell

Biology / Integrative Biology

Faculty Sponsor: Nicole King

Cells are the building blocks of life, working together to produce tissues, organs and whole animals like ourselves. But how do cells coordinate with one another? How does a cell decide where it needs to be relative to its peers? How do cells know how many of them are required to build a particular structure? Cnidarians are one of the simplest multicellular animals; using them as model organisms, Dr. Dayel is working to understand the social rules that cells have developed that enable them to work in harmony to give rise to whole tissues and organisms.

Joseph Dufek

Ph.D. University of Washington

Berkeley Dept: Earth & Planetary Science

Faculty Sponsor: Michael Manga

Multiphase flows shape the landscape of all terrestrial planets and dictate interactions at the interface of the solid surface and the atmosphere. One of the aims of Dr. Dufek’s research is to understand how the cumulative expression of numerous particle-particle and particle-fluid interactions produce emergent meso-scale

structure and self-organization. His research focuses on the dynamics and deposit architecture of turbulent, explosive volcanic eruptions on Earth and other planets as a high energy end-member of multiphase flow. His approach uses a combination of computational, field-based and remote observations to link the dynamics of past eruptions to their deposits as well as developing a framework for predictive modeling of future scenarios.

Reimundo Heluani

Ph.D. Massachusetts Institute of Technology

Berkeley Department: Mathematics

Faculty Sponsor: Edward Frenkel

Dr. Heluani is interested in representation theory and its applications to algebraic geometry and mathematical physics. In particular, he works with algebraic objects called vertex algebras. These objects, when suitably "glued" over manifolds, allow us to obtain global information of the latter.

Adi Livnat

Ph.D. Princeton University

Berkeley Dept: Electrical Engineering & Computer Science / Economics

Faculty Sponsors: Christos Papadimitriou / Christine Shannon

Dr. Livnat is interested in questions at the interface between biology, computer science, and economics. Each of these fields gives us a window into the emergence and behavior of complex systems. Two lines of research are currently pursued. One uses circuit models and game theory to explore counterintuitive properties of brain and behavior, such as internal conflict and irrational choice. The other examines evolutionary questions from a computer science perspective.

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May 2006

MILLER RESEARCH FELLOWSHIPS FOR 2007-2010

Nomination Receipt Deadline: 14 September 2006

Dear Colleague:

The Miller Institute for Basic Research in Science invites department chairs and faculty advisors to assist the faculty scientists at the University of California at Berkeley in nominating candidates for Miller Research Fellowships in the basic sciences. The Miller Institute seeks to discover and encourage individuals of outstanding talent, and to provide them with the opportunity to pursue their research on the Berkeley campus. Fellows are selected on the basis of their academic achievement and the promise of their scientific research. Each Miller Fellow is sponsored by an academic department on the Berkeley campus and performs his or her research in the facilities provided by the host department. The Fellowships are intended for brilliant young women and men of great promise who have recently been awarded, or who are about to be awarded, the doctoral degree.

The deadline for receipt of nominations is 4:00 p.m. September 14, 2006. Early nominations are encouraged to allow the candidate more time to prepare their application materials and request references by the deadline. A Nomination Form is available on our website. Submit nominations by email, fax or mail to the address above and to the attention of the *Selection Committee*.

Nominations can also be a letter that must include the following information:

- 1) Nominee's full legal name
- 2) Nominee's complete and current E-mail address, current mailing address and telephone & fax numbers
- 3) Nominee's (expected) Date of Ph.D. and Ph.D. Institution
- 4) Recommendation and judgment of candidate's promise by the nominator.

This letter of nomination need not be lengthy, but must include all of the information requested above in order to ensure that nominees receive notification of the nomination and advice of subsequent procedures for completion of the fellowship application process. In addition to the above items, the Executive Committee also finds it helpful in the nomination letter to have the candidate compared with others at a similar stage in their development. Suitable nominees will be invited to submit documentation supporting their nomination. Such materials will be accepted only following an invitation from the Institute. Direct applications are not accepted. ***Please note that persons already in positions on the Berkeley campus are not eligible for nomination or receipt of an award. Also, nominees who are non-US citizens are contingent upon eligibility for obtaining J-1 Scholar visa status for the duration of the Miller Fellowship. The Miller Institute does not support H1B visa status.*** The Institute will provide an annual stipend of \$50,000 and a research fund of \$12,000 per annum. There is provision for travel to Berkeley for Miller Fellows and their immediate families and a maximum allowance of \$3,000 for removal of personal belongings. The Miller Institute also provides benefits including medical, dental, vision and life insurance. Fellowships are awarded for three years, generally beginning August 1, 2007 and ending July 31, 2010. Approximately eight to ten Fellowships are awarded each year. Candidates will be notified of the results of the competition in January 2007, and a general announcement of the awards will be made in the spring.

We are grateful for your thoughtful participation in this process and hope that you regard the time you may devote to this effort justified by the contribution you will be making to the careers of distinguished young scientists.

Sincerely,

Jonathan Arons
 Professor of Astronomy,
 Professor of Physics
 and Executive Director,
 Miller Institute for Basic Research in Science

Dustin Rubenstein
Ph.D. Cornell University
Berkeley Department: Integrative Biology
Faculty Sponsor: Roy Caldwell

Dr. Rubenstein's research integrates studies in evolutionary biology, endocrinology, and molecular ecology to determine why animals live in complex family groups and how individual reproductive roles within these groups are governed. His past projects include studies of avian migration using stable isotopes, the life history and physiology of reproductive decisions in the Galapagos marine iguana, and the evolution of complex social systems in African starlings. As a Miller Fellow, he will study a family of social sponge-dwelling shrimp to experimentally examine how social and environmental factors influence group-living and how hormones influence reproductive decisions, dominance hierarchies, and sex change.

Jason Stajich
Ph.D. Duke University
Berkeley Dept: Plant & Microbial Biology
Faculty Sponsor: John Taylor

Dr. Stajich is interested in the evolution and molecular basis of adaptation in fungi. He previously worked to develop methods in comparative genomics for the study fungal genome evolution. His research as a Miller Fellow will utilize comparative, computational, and experimental approaches to study the evolution and speciation of closely related pathogenic and non-pathogenic fungi.

Jesse Thaler
Ph.D. Harvard University
Berkeley Dept: Physics
Faculty Sponsor: Lawrence Hall

From the discovery of the W and Z bosons in 1983 to the most recent measurements taken at the Tevatron, the standard model of particle physics has survived two decades of precision tests. But starting in 2007, particle physicists will probe new phenomena at the high energy frontier with the Large Hadron Collider (LHC), a proton-proton accelerator being built along the French-Swiss border. Dr. Thaler studies both the theoretical frameworks and possible LHC signatures for physics beyond the standard model, hoping to gain insight into the origin of mass, the weakness of gravity, and the symmetry structure of our universe.

Yue Wu
Ph.D. Harvard University
Berkeley Dept: Chemistry
Faculty Sponsor: Paul Alivisatos

Dr. Wu's research will focus on the syntheses, structural characterization, physical properties, and device applications of semiconductor nanomaterials.

Yuanbo Zhang
Ph.D. Columbia University
Berkeley Department: Physics
Faculty Sponsor: Michael Crommie

Dr. Zhang's area of research is experimental condensed matter physics. He is particularly interested in the electronic properties of a novel two-dimensional system, graphene. It has been discovered that the quasiparticles in graphene is "relativistic" massless Dirac fermion, which leads to an unusual quantum Hall effect. He will further explore the physics of graphene combining transport and scanning probe techniques.

Awards & Honors



Walter Alvarez (Miller Professor 1986-87, 2001-02) received the Nevada Medal from the Desert Research Institute of Nevada. The award is given in recognition of outstanding science or engineering.

Laurence Barron (Visiting Miller Professor Spring 1995) was elected Fellow of the Royal Society in 2005.

Marc Davis (Miller Professor 1986-87, Spring 2000) has been awarded the 2006 Dannie Heineman Price for Astrophysics by the American Institute of Physics.

Tamas Hausel (Miller Fellow 1999-2002) was recently awarded a Royal Society University Research Fellowship at the Mathematical Institute of Oxford University.

Simon Levin (Visiting Miller Professor 2003) won the 2005 Kyoto Prize in Basic Sciences, a prestigious award of international recognition.

Jun Korenaga (Miller Fellow 2001-02) will be awarded the Macelwane Medal from American Geophysical Union this Fall.

Karl Pister (Miller Professor 1962-63) has been named the California Alumni Association's Alumnus of the Year.

Jasper Rine (Miller Professor Fall 1993) has been named a Howard Hughes Medical Institute Professor. This professorship will grant him a million dollars to create a class that will introduce Berkeley undergraduates to the modern world of experimental biology.

J. Peter Toennies (Visiting Miller Professor Fall 2005) has been awarded the 2006 Benjamin Franklin Medal in Physics by the Franklin Institute Awards Program, one of the oldest and most prestigious comprehensive science and technology awards programs in the world.

Gerald Westheimer (Miller Professor 1975-76) was awarded an honorary M.D. degree (Dr. med.h.c.) by the University of Tuebingen.

Bin Yu (Miller Professor Spring 2004) was awarded a Chang Jiang Chair Professorship at Peking University. She has also co-founded the Microsoft Lab on Statistics and Information Technology at Peking University. She was also elected a fellow of the American Statistical Association.



Miller Members In The News

The research of **Adrian Bejan** (Miller Fellow 1976-78) has been featured in articles published in SEED Magazine and NASA's Astrobiology Magazine. Constructal theory predicts all animal locomotion: flying, running, swimming, and the locomotion speeds, forces and frequencies of body movement (flapping, hopping and fishtailing). This is the latest example of how this new law of physics predicts design in nature.

The research of **William Dietrich** (Miller Professor 1998-99) on how life expresses itself geomorphologically was featured in an article in The Berkeleyan in February 2006.

Mimi Koehl (Miller Institute Executive Committee member and Miller Professor 2000-01) was the subject of one of the "Women's Adventures in Science" books. This series is published by the National Academy of Sciences and is targeted to middle-school-aged girls, encouraging them to study science.

Neil Shubin (Miller Fellow 1987-89) was named ABC World News's Person of the Week on Friday, April 7 for his discovery of a 375 million-year-old fossil that is thought to be the missing link between sea and land dwellers. His discovery was also featured in Newsweek, National Geographic and a number of other prominent publications.

Birth Announcements



Congratulations to Miller Fellow Sasha Turchyn and her husband Vitaliy on the birth of their daughter, Alina. Alina was born on April 13, 2006.

Congratulations to former Miller Fellow Tom Juenger and his wife Maria on the birth of their daughter, Cecilia Camille Juenger. Cecilia was born on January 20, 2006.

Congratulations to former Miller Fellow Jun Korenaga and his wife Tomoko on the birth of their daughter, Marin. Marin was born on October 30, 2005.

In Memoriam

Leopold Schmetterer (Visiting Miller Professor Spring 1959) passed away on August 24, 2004. He was 84.



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Publications

The following Miller Institute members have recently published works resulting from research during their Miller Institute terms. For more information about these publications, please visit the Miller Institute's website at: <http://millerinstitute.berkeley.edu/news/publications.htm>

Stéphane Bodin

Miller Fellow, 2002-2005

William Dietrich

Miller Professor, 1998-99

Jiaxing Huang

Miller Fellow, 2004-2007

Edwin Levitan

Visiting Miller Professor, Fall 2002

Sébastien Merkel

Miller Fellow, 2004-2006

Christos Papadimitriou

Miller Fellow, 1978-79
Miller Professor, Fall 2005

Ellen Simms

Miller Professor, 2003-2004

Sergio Speziale

Miller Fellow, 2003-2006

Lars Stixrude

Visiting Miller Professor, Spring 2005

Alex Thompson

Miller Fellow, 2003-05

Rory Waterman

Miller Fellow, 2004-2006

The Miller Institute is “dedicated to the encouragement of creative thought and the conduct of research and investigation in the field of pure science and investigation in the field of applied science in so far as such research and investigation are deemed by the Advisory Board to offer a promising approach to fundamental problems.”