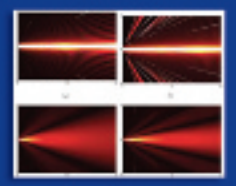
FACULTY

The applied mathematics faculty at UC Merced is dedicated to interdisciplinary research and education. The faculty and their research interests are listed below.

HARISH BHAT

(Ph.D. California Institute of Technology)

Linear and nonlinear waves, with specific applications in fields such as high-frequency circuit design and gas dynamics.



FRANÇOIS BLANCHETTE

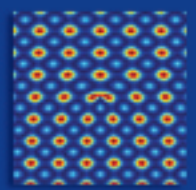
(Ph.D. Massachusetts Institute of Technology)

Fluid mechanics with an emphasis on multi-phase flows.

BOAZ ILAN

(Ph.D. Tel Aviv University)

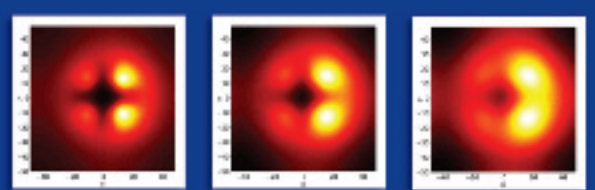
Nonlinear analysis applied to control of intense lasers beams and high-precision measurements of frequency and time



ARNOLD D. KIM

(Ph.D. University of Washington)

Wave propagation in random media applied to biomedical optical imaging and wireless communications



ROUMMEL MARCIA

(Ph.D. University of California, San Diego)

Scientific computation, large scale optimization, interior point methods, numerical analysis, global optimization, mathematical biology, compressed sensing, signal processing

KEVIN MITCHELL

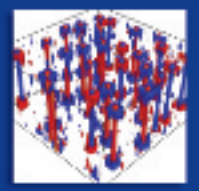
(Ph.D. University of California, Berkeley)

Dynamical systems applied to atomic, molecular and optical physics

MICHAEL SPRAGUE

(Ph.D. University of Colorado, Boulder)

Computational mathematics of fluid and structural mechanics applied to geophysical fluid flow



MAYYA TOKMAN

(Ph.D. California Institute of Technology)

Computational science, numerical analysis, mathematical modeling applied to plasma physics

FOR MORE INFORMATION

E-mail: naturalscience@ucmerced.edu
Web site: naturalsciences.ucmerced.edu

Applied Mathematical Sciences Program

Professor Arnold D. Kim
E-mail: adkim@ucmerced.edu

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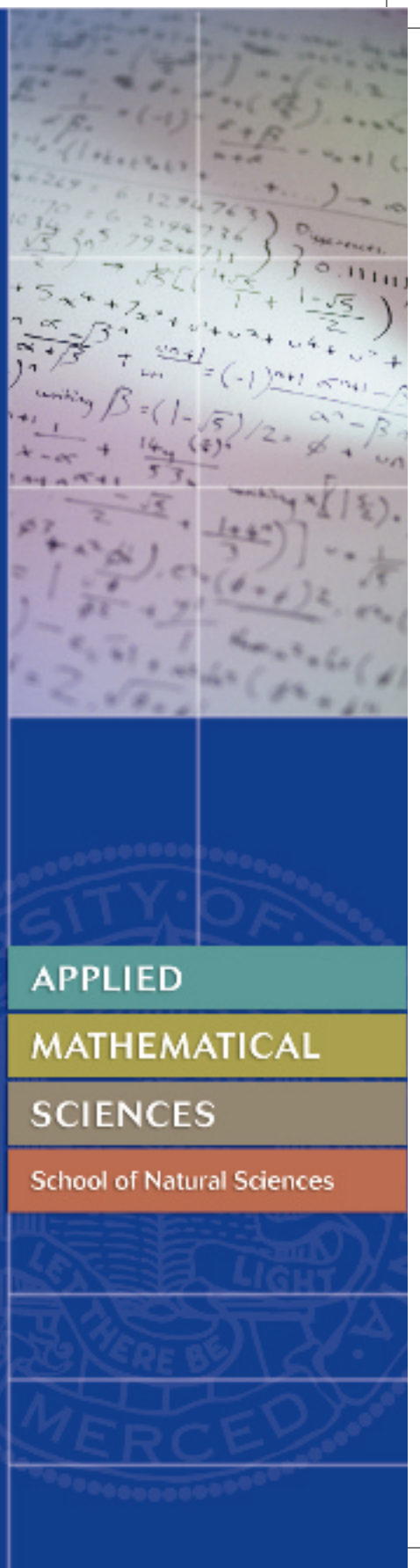


APPLIED MATHEMATICAL SCIENCES

School of Natural Sciences

APPLIED MATHEMATICAL SCIENCES

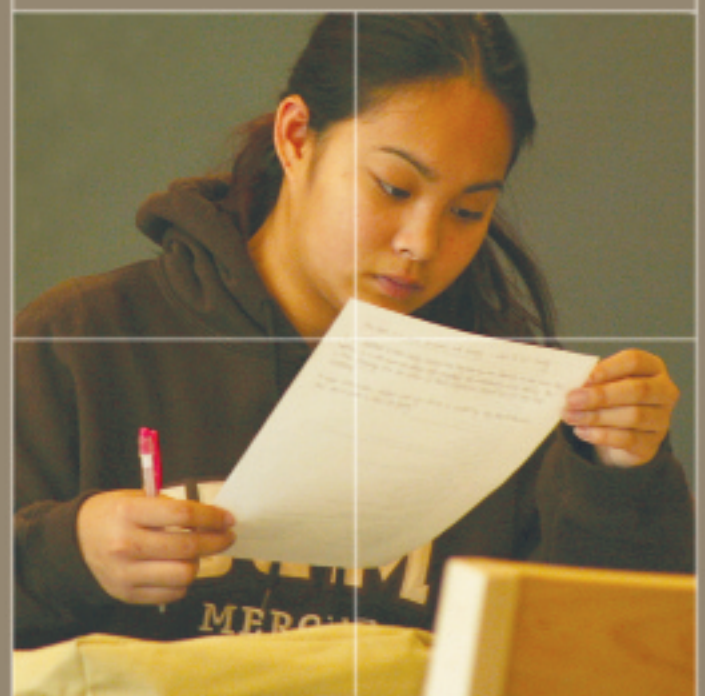
Modeling + Analysis + Scientific Computing + Real-world Problems

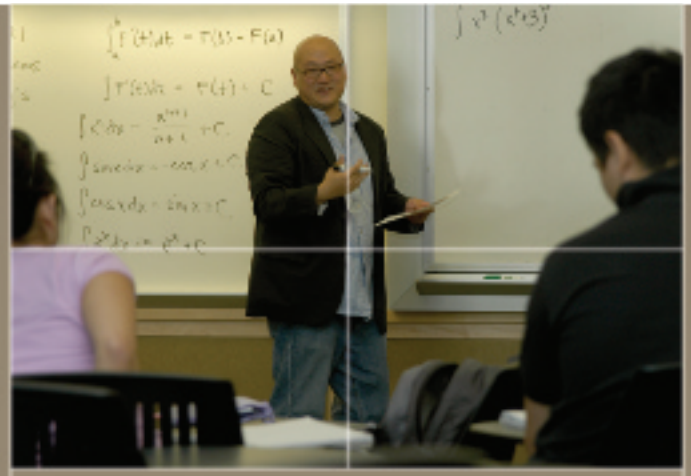
WHAT IS APPLIED MATHEMATICAL SCIENCES?

Mathematics has been a central feature of humanity's intellectual achievements over the past several centuries. It has long provided the underlying framework to develop theory in the physical sciences and engineering and is also increasingly important in the development of new results in the social and life sciences. These new application areas for applied mathematical sciences are undergoing remarkable growth.

THE APPLIED MATHEMATICAL SCIENCES MAJOR AT UC MERCED

The Applied Mathematical Sciences major is in the School of Natural Sciences. This inter-displinary major is for students seeking a deep knowledge of the foundations of applied mathematics: modeling, analysis and scientific computation, and a broad experience in applying that knowledge to solve real-world problems in the natural sciences, social sciences and engineering.





Applied Mathematical Sciences students at UC Merced experience a genuine applied mathematics education. They take a core of courses to study the construction, analysis and evaluation of mathematical models of real-world problems. In addition, they choose an emphasis track in which they learn to apply these fundamental tools in developing a quantitative understanding of an application area. Some examples of emphasis tracks include computational biology, economics, physics, engineering mechanics and computer science, among others.

"We build too many walls and not enough bridges." *- Sir Isaac Newton (1643-1727)*

"Mathematical science is in my opinion an indivisible whole, an organism whose vitality is conditioned upon the connection of its parts." *David Hilbert (1862-1943)*

The Applied Mathematical Sciences major provides a comprehensive core in modeling, analysis and scientific computing. This major also provides flexibility through its emphasis tracks that encourage exploration in other areas of natural sciences, engineering and social sciences. In addition to the core and emphasis tracks, the major allows for study in other areas through development of a minor and several choices for electives.

A Bachelor of Science degree in Applied Mathematical Sciences prepares students in the fundamentals of applied mathematics: modeling, analysis and scientific computing through 24 units of upper division courses. Emphasis tracks provide an opportunity to develop application areas of expertise such as economics, computational biology or physics. Students may also design their own emphasis track with faculty approval. For an emphasis track, a student must complete at least 17 units of approved courses from other programs among which 10 of those 17 units must be upper division courses.

THE APPLIED MATHEMATICAL SCIENCES MINOR AT UC MERCED

The Applied Mathematical Sciences minor at UC Merced is designed to prepare students to use mathematical techniques and computational methods to solve problems within their major field of study. The minor program compliments a variety of majors including biology, chemistry, computer science, engineering, economics, cognitive science and environmental science. It is comprised of a core of courses and upper division mathematics electives to study data analysis, modeling and computing.

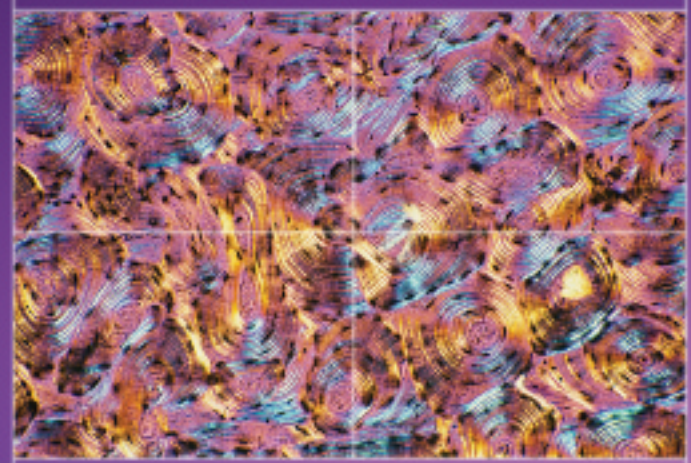
Earning a minor in Applied Mathematical Sciences indicates a deep understanding of mathematical techniques and provides further training in computational methods than a student traditionally receives within their major. To earn a minor, a student must complete a total of 20 units – 4 units lower division and 16 units upper division. Students minoring in Applied Mathematical Sciences will be able to select 12 units of their upper division math courses, which will allow them to tailor the minor to best suit their major field of study.

Human Biology

The Human Biology (HB) emphasis track provides students with a rich education in the scientific principles that underlie modern health sciences. This major is an excellent preparation for entrance into health-related professional careers including medicine, dentistry, pharmacy, genetic counseling, health education, public health, clinical psychology, epidemiology, environmental health sciences and health administration, among others. The Human Biology emphasis track also provides a strong foundation for careers in biomedical research, and includes the courses most broadly required for advanced study in health sciences.

Microbiology and Immunology

Students in the Microbiology and Immunology (MBI) emphasis track study the diversity, structure, evolution, method of transmission, replication, epidemiology and mechanism of pathogenesis of microorganisms and their interplay with the host immune system. Related topics in bioterrorism, environmental microbiology, drug resistance, development of immune system, applications in biotechnology and their political and socioeconomic ramifications are also explored. A student in the Microbiology and Immunology emphasis track will have many career options including work in research, education, the pharmaceutical industry, regulatory agencies or health-related professions.



Molecular and Cell Biology

The Molecular and Cell Biology (MCB) emphasis track provides students with the skills and knowledge to pursue studies in graduate programs and professional schools in preparation for careers in basic and applied biological research and medicine. MCB emphasizes the molecular and cellular principles that underlie all terrestrial life, as well as the genetic and evolutionary concepts explaining the diversity and unity of life. These topics form the foundation of modern health sciences and biomedical research.

FOR MORE INFORMATION

For more information on applying to UC Merced or to arrange a visit,

E-mail: naturalscience@ucmerced.edu
Web site: naturalsciences.ucmerced.edu

For more information on the Biological Sciences Program

Please contact Professor Patricia LiWang
E-mail: pliwang@ucmerced.edu

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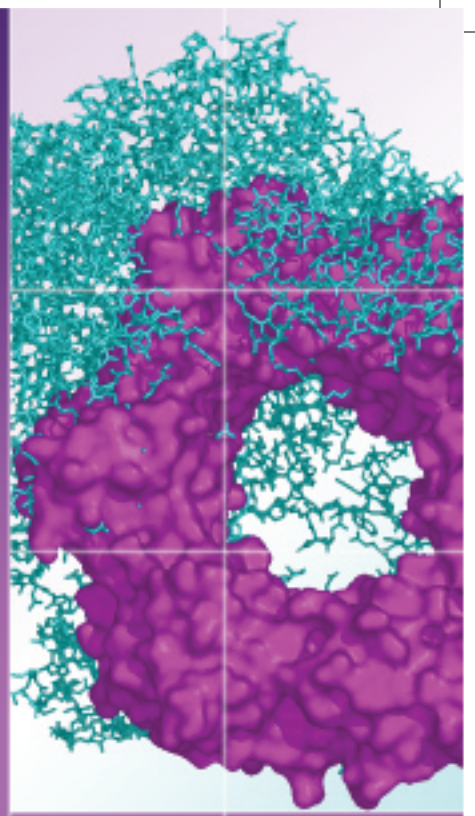


BIOLOGICAL SCIENCES

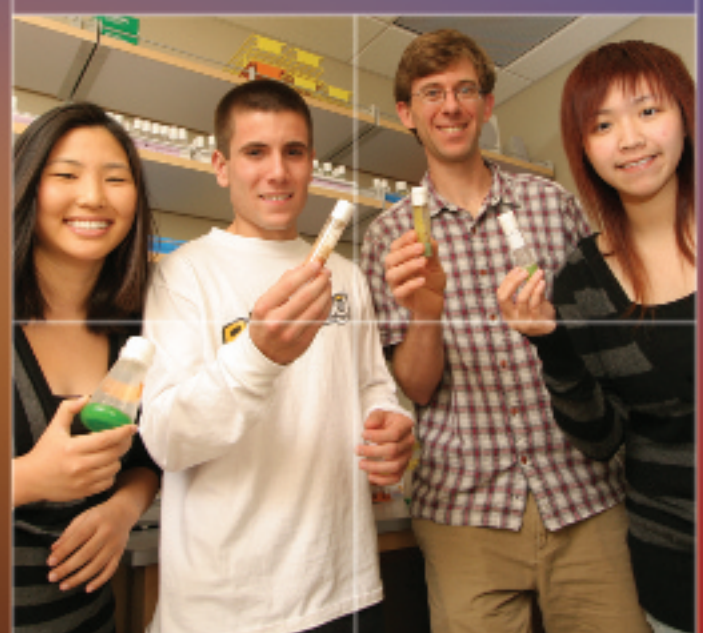
School of Natural Sciences

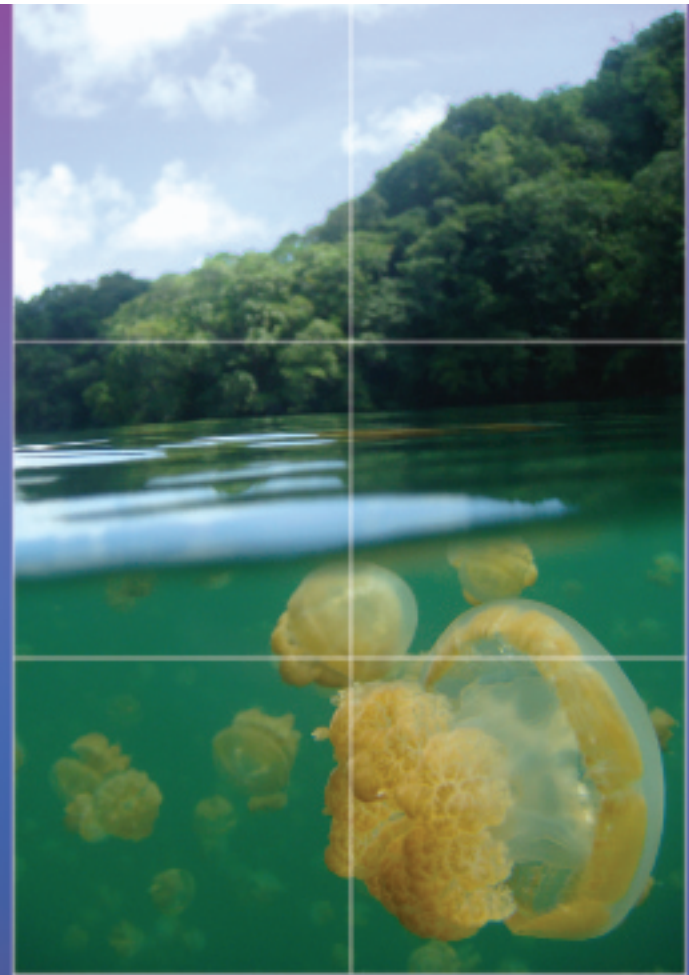
WHAT ARE THE BIOLOGICAL SCIENCES?

The Biological Sciences address many of the most important and fundamental questions about our world: What is life? How does our brain produce our ideas and emotions? What are the limits to human life and physical capabilities? How do we feed the world's growing population? Could medical science ensure that our children won't have to worry about disease?

There has never been a more exciting and important time to study biology. From the mapping of the genome to understanding the molecular basis of human disease to predicting the effects of global climate change on ecosystems to understanding fundamental processes that produce and sustain life on Earth, the Biological Sciences are at the forefront of finding answers to some of society's most vexing problems.

Students majoring in Biological Sciences can choose between five emphasis tracks providing background in different areas of biology: Molecular and Cell Biology, Ecology and Evolutionary Biology, Human Biology, Developmental Biology and Microbiology and Immunology. These emphasis tracks consist of a sequence of five or six upper division courses that are taken in the second, third and fourth years of the program.





WHAT CAN I DO WITH A DEGREE IN BIOLOGICAL SCIENCES?

The undergraduate major in Biological Sciences is an excellent first step towards exciting careers in biology and the health sciences. Graduates of this program will also be well prepared for positions in the biotechnology and pharmaceutical industries, health care, conservation, environmental law and policy, and natural resources management (including forest and park services), as well as careers such as journalism, public policy and business, which increasingly involve the biological sciences. In addition, the breadth and rigor of this program are an excellent preparation for graduates to teach science at the elementary or high school levels.

BIOLOGICAL SCIENCES EMPHASIS TRACKS

Developmental Biology

The Developmental Biology (DB) emphasis track provides students with an understanding of the mechanisms that govern the generation of unique cell types and the assembly of cells into complex organisms. In addition to a strong foundation in genetics, cell biology and molecular biology, students can choose specialized courses covering topics such as immune system development, nervous system development, and the evolution of developmental mechanisms. Training in DB prepares students for careers in all aspects of the health sciences and biological research, particularly in the fields of stem cell biology, cancer biology, evolutionary biology, and regenerative medicine.

Ecology and Evolutionary Biology

The Ecology and Evolutionary Biology (EEB) emphasis track prepares students for careers in areas of biology that lead to a more comprehensive understanding of biological processes that range across the mechanistic, organismal, population, community and ecosystem levels. Ecology and Evolutionary Biology incorporates multidisciplinary approaches to address biological questions in an evolutionary framework. Areas of research in Ecology and Evolutionary Biology include behavioral ecology, biomechanics, comparative anatomy and physiology, conservation biology, developmental genetics, ecology, population genetics, plant biology, molecular evolution, organismal interactions (e.g., plant-animal), paleobiology, phylogenetics, quantitative genetics and systematics.

CHEMICAL SCIENCES FACULTY

HENRY J. FORMAN
(Ph.D. Columbia University)
Molecular biology and biochemistry of signal transduction and cellular adaptation to oxidative stress related to respiratory diseases.
faculty.ucmerced.edu/hforman

ANNE MYERS KELLEY
(Ph.D. University of California, Berkeley)
Linear and nonlinear Raman spectroscopies, experiment and theory; surface enhanced spectroscopies.
faculty.ucmerced.edu/amkelley

DAVID F. KELLEY
(Ph.D. University of Washington)
Ultrafast dynamics and spectroscopy of semiconductor nanoparticles for solar energy conversion.
faculty.ucmerced.edu/dfkelley

ANDY LIWANG
(Ph.D. University of Washington)
The structural and biochemical basis of rhythmicity of the circadian clock, which is used for time-keeping in life cycles.
faculty1.ucmerced.edu/aliwang

PATRICIA LIWANG
(Ph.D. Harvard University)
Biochemistry and biophysics; structural biology of chemokines; applications to HIV and inflammatory diseases.
faculty.ucmerced.edu/pliwang

ERIK MENKE
(Ph.D. University of California, Irvine)
Materials chemistry directed toward solar energy capture and storage as chemical fuels.
faculty.ucmerced.edu/emenke

MATTHEW MEYER
(Ph.D. Texas A&M University)
Mechanisms of organic and biochemical asymmetric reactions; spontaneous symmetry breaking; new methods for asymmetric synthesis and mechanism.
qsb.ucmerced.edu/faculty/mmeyer

MENG-LIN TSAO
(Ph.D. Ohio State University)
Bio-organic chemistry, chemical biology, protein chemistry and vaccine technology.
faculty1.ucmerced.edu/mtsao

TAO YE
(Ph.D. University of Pittsburgh)
Scanning probe microscopy study of interfaces; nanoscale machines on surfaces; single molecule analysis of biopolymers.
faculty.ucmerced.edu/tye

FOR MORE INFORMATION

Apply to UC Merced or arrange a visit:
E-mail: naturalscience@ucmerced.edu
Web site: naturalsciences.ucmerced.edu

Chemical Sciences Program
Professor Anne Myers Kelley
E-mail: amkelley@ucmerced.edu
Phone: (209) 228-4345

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CHEMICAL SCIENCES

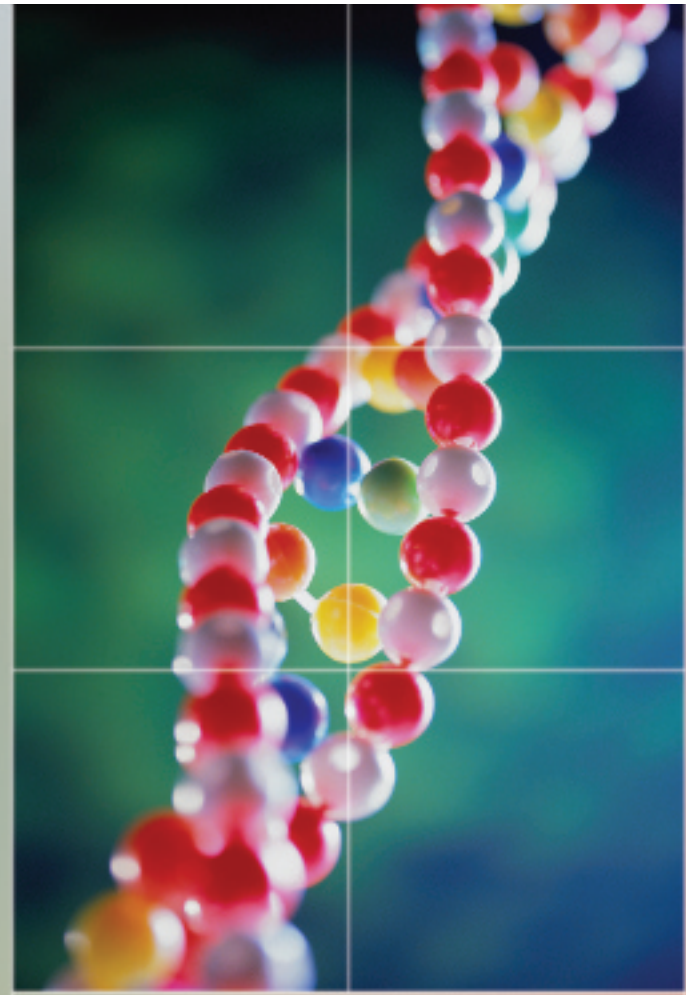
School of Natural Sciences

CHEMICAL SCIENCES

WHAT IS CHEMISTRY?

Chemistry is the study of molecules, the fundamental building blocks of most matter—their physical properties, synthesis, reactions and analysis. Chemistry is often called "the central science" because of the key position it occupies in modern science and engineering. Most phenomena in the biological and earth sciences can be described in terms of the chemical and physical behavior of atoms and molecules, and chemical principles also underlie much progress in medicine and engineering. Chemical systems are also fascinating and beautiful in their own right.

Currently active areas of research in the chemical sciences include devising novel methods to determine how the atoms in molecules move during a chemical reaction, rationally designing new drugs to prevent or cure diseases, inventing improved materials for efficient and inexpensive solar energy conversion and developing laser-based methods for imaging the biochemical composition and disease conditions in living tissues.



CHEMICAL SCIENCES MAJOR AT UC MERCED

The program is based on a "core plus emphasis" structure that enables students to specialize in a particular subfield while completing a set of core courses designed to meet the requirements for American Chemical Society accreditation.

Emphasis Tracks in Chemical Sciences

- Biological Chemistry
- Materials Chemistry
- Environmental Chemistry
- Pure Chemistry

WHAT CAN I DO WITH A DEGREE IN CHEMICAL SCIENCES?

A degree in the chemical sciences opens the door to a wide variety of careers in industry or government service such as environmental testing, policy and regulation, forensic chemistry in crime laboratories, commercial fields such as patent law, scientific writing, technical sales and marketing and teaching high school science. Many chemistry majors go on to graduate study to prepare for careers in teaching and/or research at the college or university level, or research positions in the chemical, pharmaceutical, electronics or other high-tech industries. A major in chemistry is also an excellent foundation for medical school or other careers in the health sciences.

UNDERGRADUATE RESEARCH

Independent research under the guidance of a faculty member is an integral part of the chemical sciences major. Each of our tracks requires at least two units of supervised research. Independent research is an exciting and excellent learning experience, and can lead to publications in the scientific literature.

PHYSICS FACULTY CONTINUED

AJAY GOPINATHAN
Ph.D. University of Chicago

Research focuses on a variety of problems in biophysics, soft condensed matter and the interface between the two fields. My main interestlies in understanding the inter-relationship between the non-equilibrium nature, structure, mechanical properties and function in biological systems. Current research involves using methods from soft condensed matter physics (statistical mechanics, polymer physics, elasticity) to address various issues such as different aspects of cell motility including force generation and membrane dynamics, protein translocation across membrane pores, kinetic control of the cytoskeletal network and the structure and function of biopolymer aggregates.

LINDA HIRST
Ph.D. Manchester University

Our research group is interested in problems in soft condensed matter physics, including biophysics, bio-inspired materials and liquid crystal physics. Current projects include the effects of cholesterol and polyunsaturated lipids on biological membrane structure, self-assembly of protein networks and studies of novel bent-core liquid crystal materials. We are an experimental research group and use x-ray diffraction techniques, microscopy, calorimetry and electrical measurements to study soft materials.

KEVIN MITCHELL
Ph.D. University of California, Berkeley

Nonlinear dynamics and classical/quantum chaos, with applications to atomic and molecular physics; semi-classical phase-space techniques; topological and geometric methods for low-dimensional systems; the geometric/Berry phase and gauge theory.

JAY SHARPING
Ph.D. Northwestern University

Research involves building a fundamental understanding of, and developing technology and applications for ultrafast laser technology. Ultrafast lasers promise to provide the ability to capture extremely short snapshots in time and to measure frequencies with unprecedented precision and accuracy. The research pursued will result in transferable technological advances, which will have a broad impact in physics, chemistry and biology.

MICHAEL SCHEIBNER
Ph.D. University of Wuerzburg

Experimental research focuses on light-matter interaction of nanostructured materials such as quantum dots and quantum dot molecules--effectively, artificial atoms and artificial molecules. The goal is to build a fundamental understanding of the physics and use it to control electrons with photons and vice versa down to the single particle level. Controllably interacting quantum systems will impact progress in a broad range of fields from quantum information and sensors to energy technologies.

LIN TIAN
Ph.D. Massachusetts Institute of Technology

Quantum optics and quantum information in nanoscale systems. Research focuses on the study of coherence effects in nanoscale devices including superconducting qubits, nanomechanical systems and semiconductor photonic systems. Study focuses on quantum information processing, cooling and measurement in the quantum limit, and quantum many-body effects with these devices.

WIL VAN BREUGEL
Ph.D. Leiden University

Distant massive galaxies, the effects of their central super-massive black holes on the galaxy-formation process, and the formation and evolution of the largest structures known in the universe; galaxy clusters.

ROLAND WINSTON
Ph.D. University of Chicago

Solar power and renewable energy, elementary particle physics, non-imaging optics.

FOR MORE INFORMATION

For more information on applying to UC Merced or to arrange a visit:

E-mail: naturalscience@ucmerced.edu
Web site: naturalsciences.ucmerced.edu

For more information on the Physics Program
Please contact Professor Kevin Mitchell at kmitchell@ucmerced.edu

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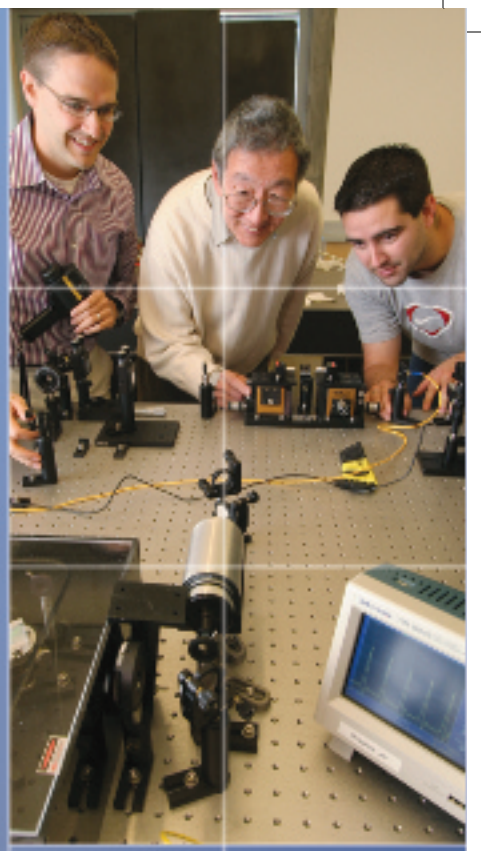

PHYSICS

School of Natural Sciences

PHYSICS

WHAT IS PHYSICS?

Physics is the study of nature at its most fundamental. Its scope covers everything from the tiniest pieces of matter and energy – molecules, atoms, photons and nuclei – to the large-scale structure of the universe.

Physics seeks to reduce complex phenomena to elemental principles: What causes an object to fall? What makes molecules stick together? What is light? What causes electricity? Is there a speed limit in the universe? What is the nature of matter?

Far from being purely academic questions, these inquiries have revolutionized our society. It is nearly impossible to imagine an area of science or engineering that has not been profoundly affected by developments in physics. The harnessing of electricity, the invention of the transistor and the discovery of the laser are prime examples.

Current and future advances in physics will continue to impact our society and view of the very essence of nature.

THE PHYSICS MAJOR AT UC MERCED

An education in physics provides students with a deep understanding of the properties of the natural world. It also emphasizes the broad impact physics has on the scientific and technological communities.

That impact is reflected in the major's core-plus specialization model. The core is a rigorous grounding in fundamental physical principles, including electricity and magnetism, thermodynamics and quantum and classical mechanics.

Students may choose a specialization from one of four tracks of interest:

- Atomic, molecular and optical physics
- Biophysics
- Mathematical physics
- Condensed matter and materials physics

WHAT CAN I DO WITH A DEGREE IN PHYSICS?

The physics program at UC Merced emphasizes analytical and quantitative reasoning and is excellent training for a wide range of technically sophisticated careers such as aerospace, biotechnology, computers and engineering, as well as education, law and business.

PHYSICS FACULTY

RAYMOND CHIAO

Ph.D. Massachusetts Institute of Technology

Nonlinear and quantum optics, in particular: (1) Berry's phases in optics, (2) two-photon, Einstein-Podolsky-Rosen interference effects (3) experiments on faster-than-c optical phenomena and (4) experiments on the interacting Bose gas, i.e., 1D and 2D photon fluids inside nonlinear optical cavities, and their relationship to optical solutions. Recent research interests: Low-temperature experimental physics applied to study of the interface between quantum mechanics and general relativity, specifically, to the study of the interaction of coherent quantum systems.

SAYANTANI GHOSH

Ph.D. University of Chicago

The ability to control and manipulate the magnetic properties of solid state systems has formed the basis of technological applications for several decades. However, at the basis of the macroscopically evident magnetism observed in materials is a quantized unit of magnetic moment – the "spin" of an atom or electron. The study of this quantum aspect forms the basis of several emergent research fields such as spintronics and quantum information processing. Current research involves studying spin dynamics in different systems and using ultrafast time-resolved spectroscopic techniques.

Continued on back

Earth Systems Science at UC Merced: A Science Major for the 21st Century

EARTH SYSTEMS SCIENCE FACULTY

ROGER BALES
Ph.D. California Institute of Technology
Mountain and snow hydrology, climate change impacts on water resources.

MICHAEL BEMAN
Ph.D. Stanford University
Marine microbial ecology, biogeochemistry of nitrogen and carbon, coastal processes.

ASMERET ASEFAW BERHE
Ph.D. University of California, Berkeley
Soil biogeochemistry, soil erosion and carbon cycling, terrestrial carbon sequestration.

ELLIOTT CAMPBELL
Ph.D. University of Iowa
Ecological biofuel design, climate-ecosystem interactions, atmospheric chemistry.

YISHU CHEN
Ph.D. The Johns Hopkins University
Energy and environmental policy and economic analysis.

MARTHA CONKLIN
Ph.D. California Institute of Technology
Biogeochemistry, metal cycling, surface water/shallow groundwater interactions.

BENOÎT DAYRAT
Ph.D. University of Paris, France
Biodiversity, systematics, and evolution; Sierra Nevada aquatic invertebrates.

TEAMRAT GHEZZEHEI
Ph.D. Utah State University
Soil physics and hydrology, multiphase flow, pore-scale modeling and dynamics.

QINGHUA GUO
Ph.D. University of California, Berkeley
Geographical information science, remote sensing of environment and environmental change.

THOMAS HARMON
Ph.D. Stanford University
Flow and mass transport in soil, groundwater and surface water; environmental observation, modeling and management.

STEPHEN HART
Ph.D. University of California, Berkeley
Terrestrial ecosystem ecology and biogeochemistry, ecosystem structure and function.

LARA M. KUEPPERS
Ph.D. University of California, Berkeley
Regional climate modeling, land-use change and ecosystem function.

MONICA MEDINA
Ph.D. University of Miami
Genomic approaches to marine ecology and evolution, coral reef biology.

PEGGY O'DAY
Ph.D. Stanford University
Environmental geochemistry, speciation, bioavailability and biogeochemical cycling.

WOLFGANG ROGGE
Ph.D. California Institute of Technology
Air pollution science and engineering, chemistry, fate and transport of air pollutants.

SAMUEL J. TRAINA
Ph.D. University of California, Berkeley
Surface, colloidal and complexation chemistry in soils, sediments and natural waters.

ANTHONY WESTERLING
Ph.D. University of California, San Diego
Applied climatology, climate-wildfire interactions, climate change impact assessment.

FOR MORE INFORMATION

STUDENTS:
Apply to UC Merced or arrange a visit
E-mail: ess@ucmerced.edu

TEACHERS:
You can arrange to have a UC Merced faculty member visit your high school or college or arrange a field trip to UC Merced.
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EARTH SYSTEMS SCIENCE

School of Natural Sciences

EARTH SYSTEMS SCIENCE

WHAT IS EARTH SYSTEMS SCIENCE?

Over the last 30 years, there has been increasing recognition that the Earth is an intricately interwoven system comprised of oceans, atmosphere, land and the terrestrial and marine biota that inhabit these environments. No one discipline can adequately encompass this diversity.

The need to study the Earth as an integrated system requires a new way of training students who are interested in Earth processes, environments and ecosystems, and who want to use their knowledge in practical ways to preserve, sustain and manage our natural resources.

Earth Systems Science is a rapidly growing discipline for students interested in a challenging, dynamic field with many career avenues.

EARTH SYSTEMS SCIENCE MAJOR AT UC MERCED

Earth Systems Science prepares students to understand and solve critical challenges facing our environment including:

- Climate change
- Water, soil and air pollution
- Conservation of biological diversity
- Management of natural resources

The major is highly interdisciplinary, integrating the study of fundamental physical, chemical and biological processes that shape our environment with practical applications to real-world problems. Core courses within the major provide students with a firm foundation in the fundamentals of chemistry, biology, hydrology, ecology and Earth sciences, while upper division elective courses allow students the flexibility to pursue a variety of topics related to Earth and environmental systems. This major emphasizes an integrated approach to Earth Systems Science, incorporating field studies, laboratory experiments and computer applications. Coursework in the social sciences will help students see the political, economic and societal implications of human interactions with the environment. Students participate in research, internships or service learning activities with faculty as part of their undergraduate studies.

Our campus location in the San Joaquin Valley and its proximity to the Sierra Nevada offers a real-world laboratory for studying the natural environment and how it is affected by human activity. UC Merced's Sierra Nevada Research Institute provides a wealth of faculty expertise and opportunities for undergraduate research and internships.

WHAT CAN I DO WITH A DEGREE IN EARTH SYSTEMS SCIENCE?

A bachelor's degree in Earth Systems Science will prepare students for graduate school, industry or government jobs in environmental conservation and consulting; ecosystem and natural resource science and management; sustainable developments and agricultural sciences. Earth Systems Science is also a great foundation for careers in law, policy and administration that increasingly involve environmental sciences. A background in the interdisciplinary study of real-world science is excellent preparation for pursuing a teaching credential in elementary or secondary school science education.