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NAUTILUS

COLLEGE OF NATURAL SCIENCES AND MATHEMATICS

Advancing Science. Impacting Life.

UNIVERSITY of HOUSTON



ADVANCING SCIENCE. IMPACTING LIFE.

The University of Houston, and in particular, the College of Natural Sciences and Mathematics, is undergoing a renaissance, with growth and increased attention in almost all of its functions and aspirations.

All indicators of success are on the rise - undergraduate enrollment and achievement, graduate education and research, faculty success in garnering sponsored research, and national and international recognition of NSM excellence through awards to our students and faculty. These times present tremendous opportunities.

NSM brings excellence in science not only to our students and our city, but to the global community. An active partner in Houston, NSM impacts education for children and UH students and influences the lives and health of Houstonians. The College's partnerships impact health, energy, the environment, and space exploration, reaching far beyond our city and nation.

Connect with NSM research, programs, and student success and learn how we are advancing science and impacting life.



COLLEGE OF
NATURAL SCIENCES AND MATHEMATICS

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COLLEGE OF NATURAL SCIENCES AND MATHEMATICS

Committed to Excellence

The College of Natural Sciences and Mathematics at University of Houston is committed to excellence in teaching, research, and service in the physical and biological sciences, computer science, and mathematics.

Located in the nation's fourth-largest city, opportunities for our faculty and students abound through close ties to leading global energy companies, the world's largest medical center, and the NASA Johnson Space Center. NSM's cutting-edge research centers and state-of-the-art facilities provide undergraduates, graduate students, and faculty with the room, freedom, and atmosphere necessary to pursue new ideas and develop breakthroughs that impact their field and the world.

The College is committed to student success. Our programs include a one-stop shop for academic advising, peer-to-peer tutoring and workshops, undergraduate research opportunities, and a strong graduate fellowship program.

To ensure NSM's research and education programs remain on a growth path, the College continues to:

- hire high-performing faculty;
- build research capacity and infrastructure by developing strong research core facilities;
- develop a larger and stronger graduate program while increasing the quality of the undergraduate program;
- grow scholarship endowments.

Developing Intelligent Solutions to Global Challenges

The College's highest priority is to prepare the next generation of scientists to solve global health, energy, and environmental challenges. To fulfill this goal, NSM is dedicated to being a leading resource for research and education within Texas and throughout the world.

Our faculty is a key source of our strength. Recognized nationally and internationally, NSM faculty members hold doctorates from some of the world's leading universities and include members of the National Academy of Sciences.

Strong interdisciplinary research - within and among the College's six departments, with other UH colleges, and with other institutions - affords rich opportunities for collaboration. The range of faculty strengths facilitates close matching of student and faculty interests.





Research Focus and Growth

NSM leads all of UH in generating research grant funding with increases in dollars awarded each year. This success is due to efforts to build strong research clusters that compete successfully for federal, state, organization, and foundation grants.

The College is best known for advances in:

- Energy (superconductivity, exploration geophysics, environment, and air quality)
- Biosciences (behavioral genetics, neuroscience, nuclear receptors, evolutionary biology, and biomedical imaging and modeling)
- Materials and Nanoscience
- Networks and Nonlinear Science
- High Performance Computing

Building Collaborative Relationships

In recent years, NSM has emerged as a leading health care and energy research institution. The College is building strong health care collaborations and partnerships with the Texas Medical Center as well as bridging our research expertise into the energy sector in Houston. These collaborations, naturally extending across the globe, are creating tremendous research opportunities and attention.

These relationships afford our students, both undergraduate and graduate, excellent opportunities for research in these fields and for internships and careers within the medical and energy sector.

Collaborations also exist with NASA's Johnson Space Center and the Jet Propulsion Laboratory. NSM scientists are leading research that impacts the exploration of space and enhances our understanding of our own planet through the study of other planets and moons in the solar system.

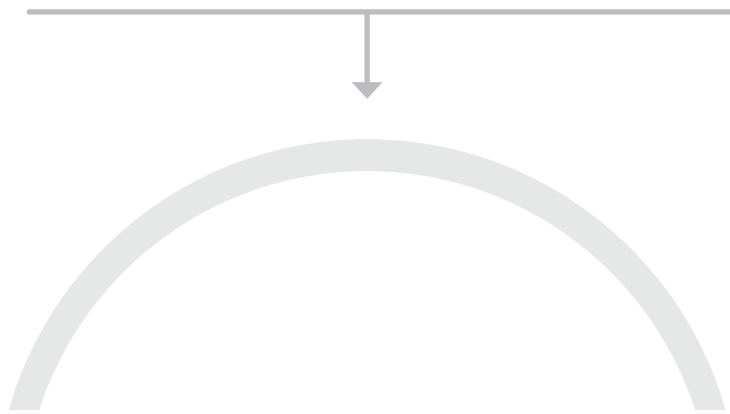
Diverse Student Population

Mirroring the city of Houston, UH and NSM boast a diverse student population. On average, the breakdown of NSM students by ethnicity is 10% African-American, 25% Asian-American, 25% Caucasian, 20% Hispanic, and 20% international or other ethnicities. The ratio of males to females is nearly 1:1. NSM enrolls approximately 6,000 undergraduate, master's, and Ph.D. students. UH is designated a Hispanic-Serving Institution by the U.S. Department of Education Office of Postsecondary Education.



NSM DEPARTMENTS:

- Biology and Biochemistry
- Chemistry
- Computer Science
- Earth and Atmospheric Sciences
- Mathematics
- Physics

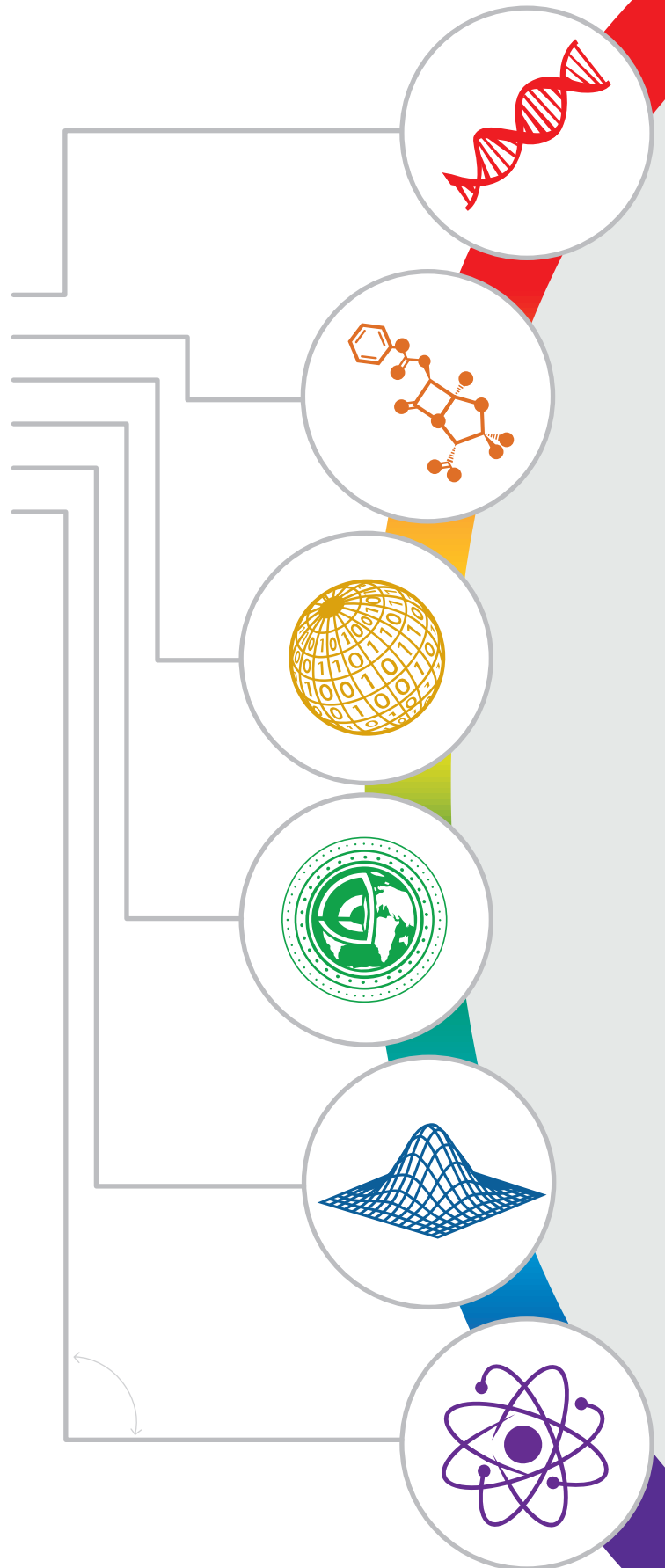


UNIVERSITY of **HOUSTON**
COLLEGE of NATURAL SCIENCES & MATHEMATICS



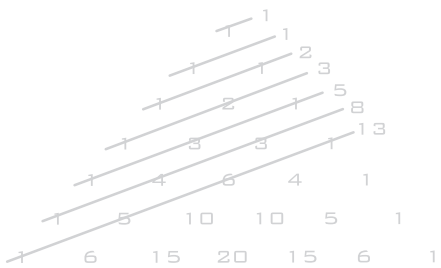
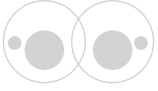
CORE VALUES:

- Outstanding Teaching
- Innovative Science with Global Visibility
- Collegiality and Academic Freedom
- Commitment to Diversity among Faculty and Students
- Academic Excellence





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DEPARTMENT OF BIOLOGY & BIOCHEMISTRY

www.bchs.uh.edu

Biology and Biochemistry at UH covers fields ranging from the molecular to the environmental and includes basic and applied aspects of the biochemical and biological sciences. The research focus is organized into three divisions – Biochemistry, Cell and Molecular Biology, and Ecology and Evolution. Within and across these divisions, faculty members study the mechanisms of action of viruses, bacteria, and mammalian cells, and the interactions of organisms with each other and their environment.

Departmental research impacts the understanding of human health and disease, molecular and microbial evolution, and the structure and function of macromolecules.

From Nano Levels to Ecosystems

The department's broad, diverse, and internationally recognized faculty studies biological systems from nano and cellular levels to entire ecosystems.

Strengths with medical implications:

- Molecular medicine impacting heart disease, cancer, diabetes, and addiction control
- Molecular structure, patterning, and biophysics
- Nuclear receptors and cell signaling pathways involved in pathogenesis

Strengths impacting ecology and evolution:

- Regulation, function, and evolution of biological networks
- Molecular function and evolution
- Marsh system ecology and social insect behavior

Work in cell and molecular biology includes projects that integrate both experimental and computational analyses of biological networks governing neuroscience and behavior, development and differentiation, cell physiology, and gene regulation. These projects often represent multidisciplinary efforts with investigators from other NSM departments.

Opportunities for Students

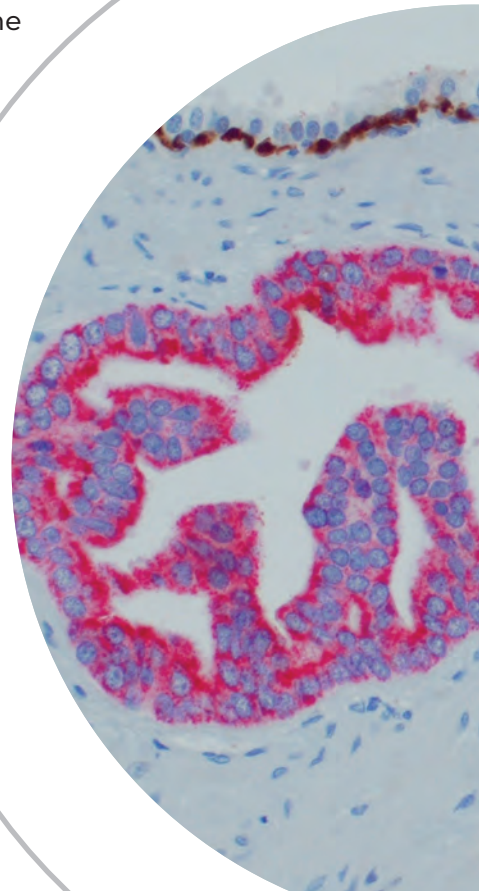
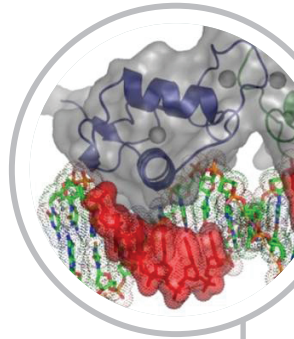
Offering undergraduate and graduate degrees in biology and the biochemical sciences, the department's undergraduate biochemical sciences program is one of the largest in the nation. Several cross-disciplinary student training programs offer unique opportunities.

Chemical Biology Interdisciplinary Program

Allows graduate students in chemistry, biology, or biochemistry to create a hybrid core and elective curriculum comprised of courses offered by the two departments. Chemical biology students obtain training across both disciplines and are better prepared for collaborative areas of research.

Mathematical Biology Undergraduate Program

Jointly sponsored with the Department of Mathematics, this program prepares students to apply mathematical analysis to biological phenomena.



Program Highlights: Impacting Health and Engaging Young Students

Molecular Medicine:

Tackling Genetic and Infectious Diseases and Tissue/Organ Repair

UH has a strong array of biochemists, biologists, chemists, pharmacologists, and other basic and biomedical scientists who work in a collaborative environment to solve the most pressing and formidable problems in biomedical research. Employing an exquisite combination of structural biology, genome sequencing, computational modeling, and biomedical laboratory research, faculty and students are identifying key potential drug targets for genetic and infectious diseases, reprogramming skin cells into heart cell lines, and designing novel and innovative methods for therapeutic discovery.

Biology of Behavior Institute

This group of faculty takes an interdisciplinary approach to the complex problems of why and how animals do what they do. This fundamental experimental work can have significant impact on human health. Some of the most devastating diseases are essentially diseases of behavior (e.g., addiction) or have major impacts on behavior (e.g., Alzheimer's disease).

Biological Networks

The "network" is one of the unifying modeling and theoretical frameworks in biology and biochemistry. Networks are used as representations for biological patterns and processes at multiple levels of organization, from gene regulation to phylogenetic relationships, and from nervous systems to food webs. Our researchers, in collaboration with mathematicians and physicists within NSM, are conducting a range of theoretical and empirical studies to test hypotheses about the structure and function of biological networks.

MicroRNA Drugs:

A Potential for Treating Incurable, Chemotherapy-Resistant Cancers

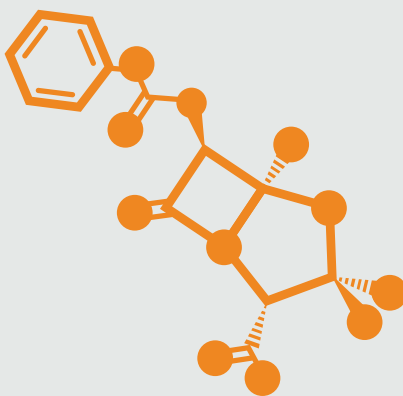
Our researchers are exploring new methods for treating ovarian cancer and are analyzing a class of tiny genetic molecules called microRNAs. Once thought of as "genetic junk," these molecules have the potential to be used to suppress ovarian tumors and other cancerous tissues. In partnership with industry, UH scientists hope to test a means to deliver the tumor suppressor directly to targeted tumors.

Engaging Young Students in Microbiology:

A Museum Partnership

Ongoing outreach efforts include the development of full dome theater shows that target students in grades 7-12. These presentations, prepared in collaboration with the Houston Museum of Natural Science, cover key aspects of microbiology as it relates to NASA's search for life in the solar system.





DEPARTMENT OF CHEMISTRY

www.chem.uh.edu

Faculty members in the Department of Chemistry conduct research in organic, inorganic, and physical chemistry. The department's two major research emphases center on energy and biomedical applications, with both areas drawing from the broader discipline of materials chemistry.

Focus on Energy and Health Sectors

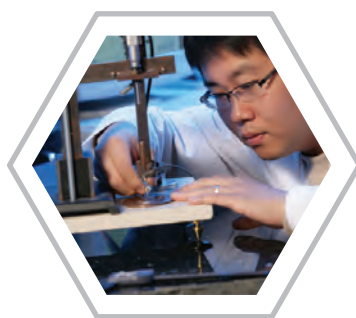
The synthesis of new materials and the study of material properties are needed to address urgent problems in the energy and health sectors. Materials for energy transmission and drug delivery are, for example, two types of materials studied. Faculty members also study chemistry related to biomedical applications, including the development of synthetic methods for preparing libraries of molecules for new drug discovery, the synthesis of complex biologically-active natural products, and the theoretical study of biomolecules.

Award Winners with International Reputations

Though small by national standards, the 26-member faculty consists of highly productive researchers with international reputations in their fields. One measure of their success is the high number of nationally-competitive awards garnered by faculty members. The department has, for example, two Beckman Young Investigator Award winners, eight National Science Foundation CAREER Award winners, five Alfred P. Sloan Research Fellowship recipients, three Fulbright Scholars, and two Guggenheim Fellowship recipients.

Support of Undergraduate Research

The department strongly supports undergraduate research. The best way to learn about the excitement of chemistry is to perform research in a laboratory with experienced graduate students and postdoctoral researchers. Chemistry faculty members welcome undergraduates into their research groups, with approximately 20 undergraduate students hosted in labs each year. Recognized as some of the best teachers on campus, nine of the department faculty members have won university-level and NSM teaching awards. Several have won multiple teaching awards.



Program Highlights: Tackling Problems in the Energy and Health Sectors

Solar Energy Collection, Conversion, and Storage

Research is under way to understand amorphous and disordered materials, paving the way for their use in solar batteries with dramatically enhanced efficiencies. In addition, novel ruthenium complexes are being developed for use as dye sensitizers in high efficiency solar cells. Researchers are testing new light-harvesting solar cells that incorporate nanoparticles for solar-to-thermal energy conversion, while others are designing and synthesizing novel metal-organic frameworks for hydrogen storage.

High Temperature Superconductors for Energy Transmission

Solid-state inorganic synthetic methods are being used to generate new superconducting materials that conduct electricity with little or no loss due to resistance, which plagues traditional metal-based transmission lines. Other work uses nanoscale organic patterning techniques to generate patterned superconducting tapes with enhanced conduction efficiencies.

Antimicrobial Coatings for Implants

Infection-resistant coatings for biomedical implants, such as catheters, are the focus of research involving the design, synthesis, and optimization of carbohydrate ligands for surface modification. Standard antimicrobial approaches are ineffective at preventing venous and urinary-tract infections due to the formation of biofilms of pathogens that are highly resistant to antimicrobial agents and host defenses. This highly promising new strategy seeks to grow living, protective biofilms of benign *E. coli*. By modifying catheter surfaces with carbohydrate ligands that specifically bind the *E. coli*, this approach promotes the growth of the benign biofilms and greatly reduces the colonization of pathogenic bacteria.

Nanoparticles for Therapeutics and Drug Delivery

Nanotechnology is being used for targeted drug delivery, offering major advantages over traditional therapies because it limits damage to normal tissue and minimizes drug resistance. This targeted drug delivery uses nanometer-sized particles - structures that are thousands of times smaller than the diameter of a human hair - to carry and deliver drugs directly to cancer cells.

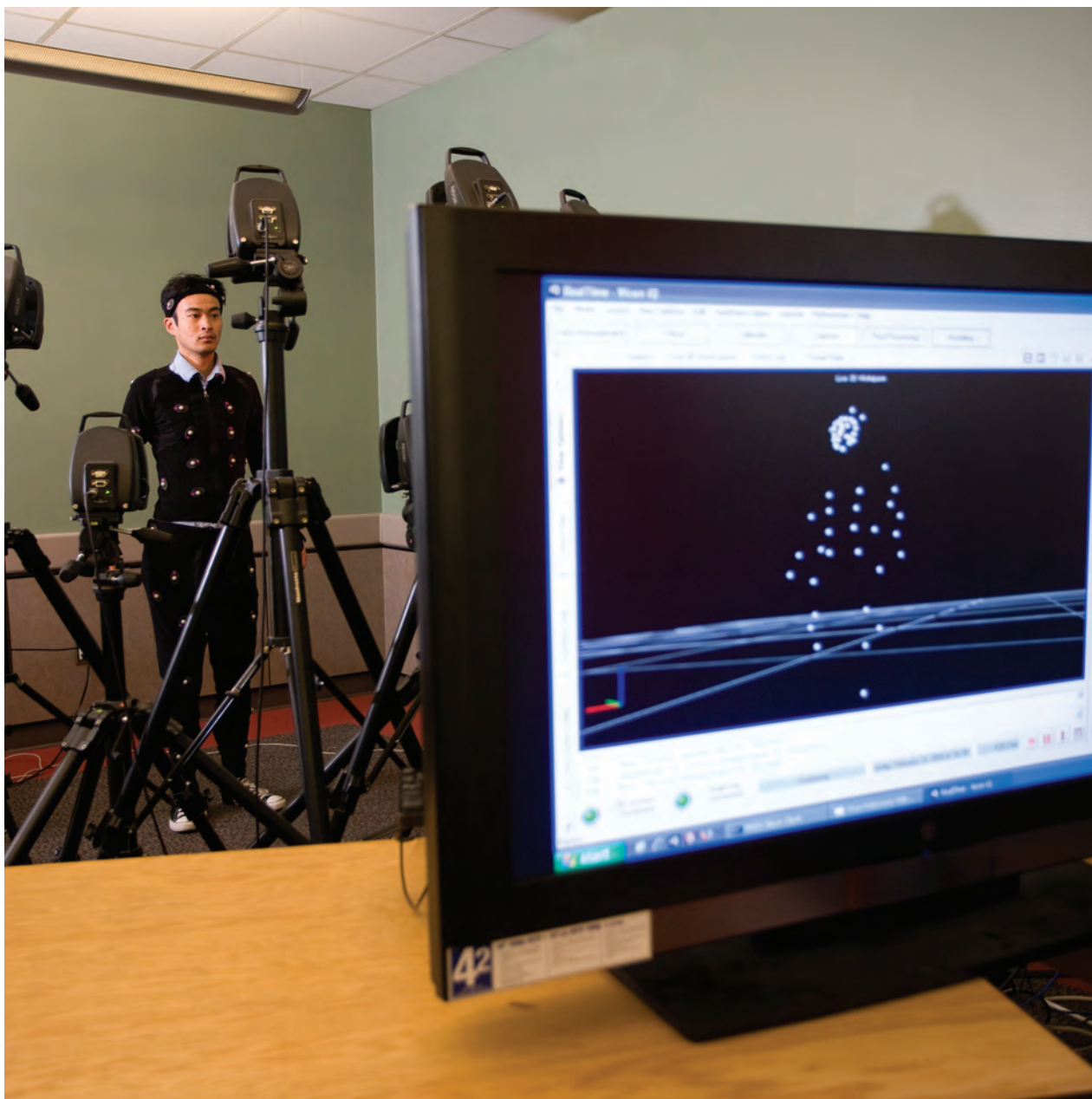
Nanoparticles are drawn to cancer cells based on a complex process of molecular recognition. Recently, UH researchers invented a unique targeted drug-delivery system that incorporates the use of laser light to heat gold-based nanoparticles coated with a drug-embedded polymer gel. When the hybrid nanoparticles are illuminated, they emit heat, collapsing the surrounding gel and releasing the drug to the cancer target. Heat-activated at the discretion of the physician, this system takes targeted drug delivery to a new level: drug delivery on demand.

Drug Design and Synthesis

UH researchers are developing new synthetic methods and materials that address important biological and medical problems. Their projects range from the development of new methods in organic synthesis and the total synthesis of biologically important natural products, to the development and testing of medicinally relevant new compounds. Many projects provide a unique opportunity to test the biological activity of novel compounds and make modifications to improve the activity of existing compounds. Research efforts also seek to develop more efficient routes to existing pharmaceuticals, with the goal to make the drugs more affordable. For this group of scientists, significant collaborations have been established with biomedical researchers in the Houston/Galveston area.



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DEPARTMENT OF COMPUTER SCIENCE

www.cs.uh.edu

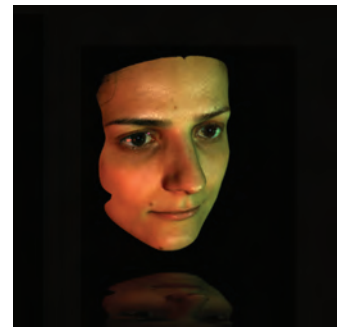
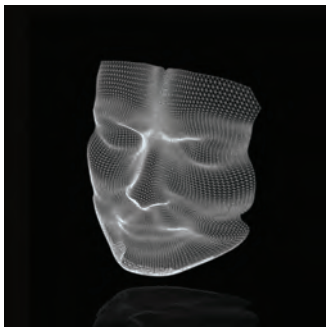
Computing impacts every aspect of life today and is the overwhelming reason why everyday life is continuously changing. The kind of societal change that once took decades now takes only years. Although email, the Internet, social networking, and online shopping are all relatively recent phenomena, it is impossible to imagine life without them. Computing impacts every industry - banking, energy, medicine, entertainment, gaming - in addition to the core software and hardware industries. Department of Computer Science graduates can be found in each of these fields.

Research Impacting Health Care and Industry

Department research is at the crossroads of health and computing with interests spanning the areas of bioinformatics, medical imaging, computational physiology, and psychology. High performance computing and networking is another critical area of research with work in compilers, grid computing, communication systems, volunteer computing, sensor networks, and cloud computing. The department is expanding into new and important research directions, including computer and network security, human/computer interfaces, and robotics.

Keeping Up with Job Market Needs

Offering B.S., M.S., and Ph.D. degrees, the department is laying the foundation to be well positioned to keep up with the rapidly expanding importance of computing in all aspects of life and with the demand for computing expertise in the job market. The bachelor's degree offers tracks in business and science, as well as a new software development track that trains students specifically for the rapidly expanding software industry. The coursework at the master's and bachelor's levels allows students to develop expertise in computer gaming (with courses in game design, gaming art, computer graphics, and image processing) and computational biomedicine (with courses in image processing, biomedical imaging, bioinformatics, and computational physiology). The curriculum for Ph.D. students allows them to begin their research emphasis early in their training.



Program Highlights: Changing Lives Through Computing

Face Recognition Technology: Your Face is Your Password

Everyday life is filled with activities that require passwords and PINs. These tend to be inconvenient to memorize and impractical to safeguard. One solution - tie private information to its owner in a way that cannot be compromised. In a new approach to identity management, researchers in the Computational Biomedicine Lab are using three-dimensional information to obtain a unique, biometric signature of a person's face. With cutting-edge hardware and novel algorithms, they are designing a system that turns a process as effortless as taking a photograph into a powerful authentication protocol. The system determines the characteristics that make each face unique, works with unconstrained data (e.g., with faces showing expression, with tilted heads, and with features such as glasses and make up), and can distinguish identical twins.



Unobtrusive Stress Measurement

The Computational Physiology Lab's research uses innovative sensing and computing methods to study human stress. To better understand stress, it needs to be measured. However, there is a fundamental difficulty in measuring unobtrusively something that is ever present and in continuous flux. This research on unobtrusive stress measurement has broad applications, from improving human performance in surgical training to revolutionizing criminal interrogations. The lab's research is consistently funded through National Science Foundation and Department of Defense grants. The group also has long-term collaborations with the Mayo Clinic and The Methodist Hospital.

Searchable Videos: Enhancing Usability

Educational material on video is becoming increasingly common. UH's Indexed Captioned Searchable (ICS) Videos project addresses the central limitation of video as a medium - the difficulty of quickly accessing the content of interest. ICS videos feature automatic indexing that splits a video lecture into sections on different topics, allowing users to find all sections matching a particular keyword. The captioning feature attaches text captions matching the speech in videos, making the videos accessible to deaf students. More than 30 courses at UH deploy ICS videos each semester. Surveys and evaluations show that the ICS videos' features significantly enhance usability of video content.

Game Design: A Winning Endeavor

Launched in 2007, the department's gaming program is now one of the finest in the country, attracting high-quality students to UH. In particular, our students have dominated the Microsoft Imagine Cup, a national game design contest. UH teams enter and consistently win in the competitions for mobile game design and Windows/Xbox game design. The gaming curriculum consists of courses in the art and technology of game design, in addition to interactive computer graphics and ubiquitous computing.

Image-Guided and Robot-Assisted Interventions: Improving Heart Surgery

A system integrating image-guided and robot-assisted interventions will improve current surgical technology and facilitate new, less-invasive techniques that allow faster patient recovery. The system integrates MRI data and an MRI-compatible robot inside the heart. Images and other data from a patient in an MRI are gathered, processed, and used by a surgeon in real time. The surgeon is immersed into the area of the surgery via a graphical and haptic interface for maneuvering the MRI-compatible robot inside the patient's heart. With such tools, surgeons will be able to perform delicate surgeries efficiently with minimal trauma to the patient. This platform will allow physicians to integrate diagnosis and therapy, leading to enhanced patient management and reduced health care costs.





DEPARTMENT OF EARTH AND ATMOSPHERIC SCIENCES

www.eas.uh.edu

The mission of the Department of Earth and Atmospheric Sciences is to advance our understanding of the Earth, oceans, atmosphere, and solar system. One of the largest, dynamically growing, diverse, and comprehensive geosciences programs in the nation, the department covers all major areas of geology, geophysics, and atmospheric sciences.

Coverage of these disciplines ranges from the environment to energy and natural resource exploration, from solid Earth to its fluid envelopes, and from subsurface to planetary and space sciences. As stewards of the Earth, graduates serve a wide variety of societal needs. These range from education to environmentally-responsible natural resource development and from land-, marine-, airborne-, and satellite-based monitoring of the environment to advanced research on air and water quality and remediation solutions.

Strengths: Ties to Energy Sector and Departmental Research Facilities

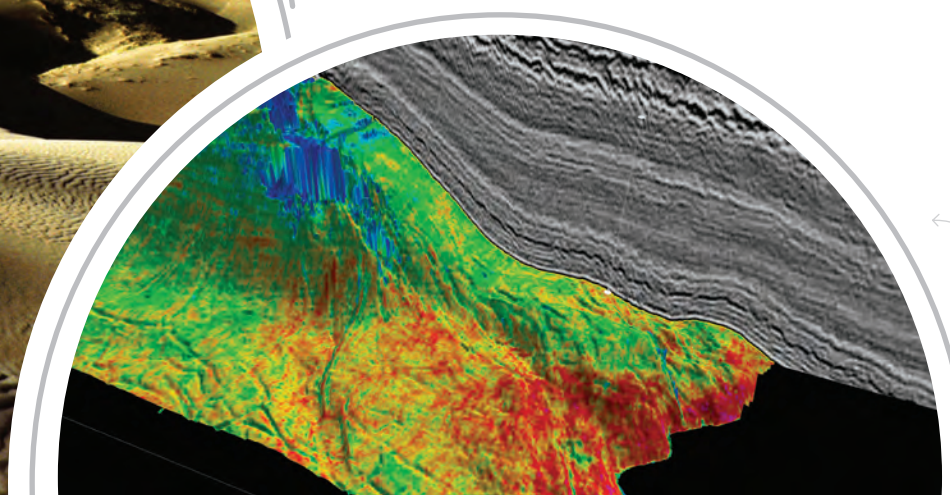
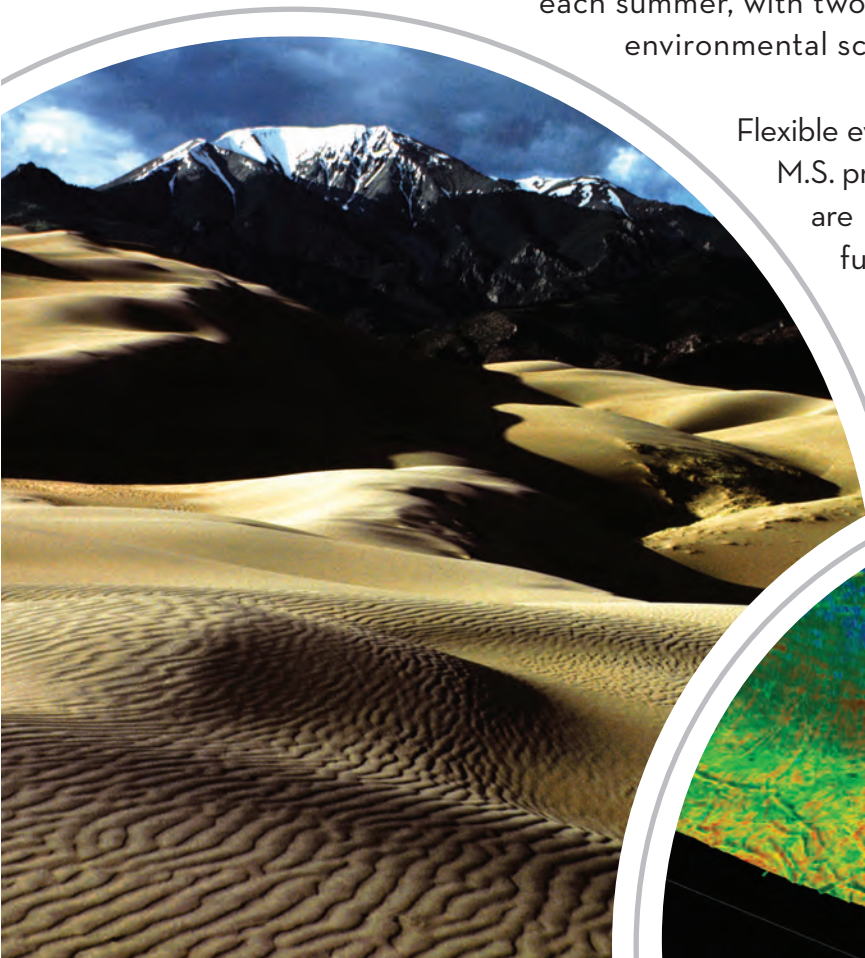
Houston is the energy capital of the world. The Department of Earth and Atmospheric Sciences enjoys close ties with the energy sector via joint research programs, student internships, M.S. professional programs in energy geosciences, scholarships, lecture series, and a myriad of other relationships. Three core facilities support the department's research programs.

- **Geochemical/Atmospheric Chemical Analytical Facilities:** Comprehensive, state-of-the-art facilities include fundamental research of radiogenic and stable isotopes, trace elements, and major elements in fluids, solids, and gases; geochronology labs; an organic and petroleum geochemistry lab; and a large range of air quality measurement instrumentation to research local, regional, and global air quality.
- **Computational Facilities:** The largest departmental high-performance computing center on campus, capable of accommodating geophysical, geological, atmospheric, and air quality data processing and modeling needs.
- **Geophysics and Rock Physics Facilities:** One of three in the world, the department's seismic acoustic physical modeling lab enables transformational research in seismic imaging. A seismic thumper truck (Minivib), gravity and magnetic sensors, and other geophysical field equipment allow us to obtain a variety of in situ field data.

Student Benefits: Experiential Learning and Programs for Full-Time Professionals

Experiential learning opportunities are an integral part of the student experience through geological field trips and summer capstone courses at the department's field camp near Red Lodge, Montana. UH is the only U.S. school running four field camps each summer, with two camps covering geology and one each on environmental sciences and geophysics.

Flexible evening schedules and a weekend professional M.S. program in Petroleum Geology and Geophysics are offered for non-traditional students working full time in the energy and environmental industries and at NASA.



Program Highlights: **Understanding our Earth, Atmosphere, and Natural Resources**

Understanding the Earth's Formation:

Learning from the Moon and Meteorites

A fundamental question of the geosciences concerns the timing and character of the processes that formed the early Earth. The evidence we have for the history of our planet comes from rocks and their composition and morphology, but the older a rock is, the greater the chance it has been altered or destroyed. UH geologists are working to see through the veil of time by studying moon and meteorite samples, either gathered by Apollo astronauts or that fell from the sky. Formed at the same time as Earth, the samples have gone through little transformation.

Evolution of Mountain Ranges

Scientists at UH are interested in the evolution of the Himalaya and the Tibetan Plateau. This area gives scientists the opportunity to ask questions about the ways continents respond to tectonic stress, the pace of mountain building, the ways in which mountains affect climate, and the relationships between changes in the crust and deeper manifestations of tectonics in the Earth's mantle.

Research at the Bottom of the Ocean

The crust of the oceans is composed of different material than the continents and is formed by different processes. UH geoscientists are involved in international teams that spend many weeks at sea on research vessels using submarines that descend to the ocean floor to observe and sample the rocks of the oceanic crust and mantle. Subsequent lab investigations help us understand the ways the Earth's mantle and crust interact and the ways that oceans grow.

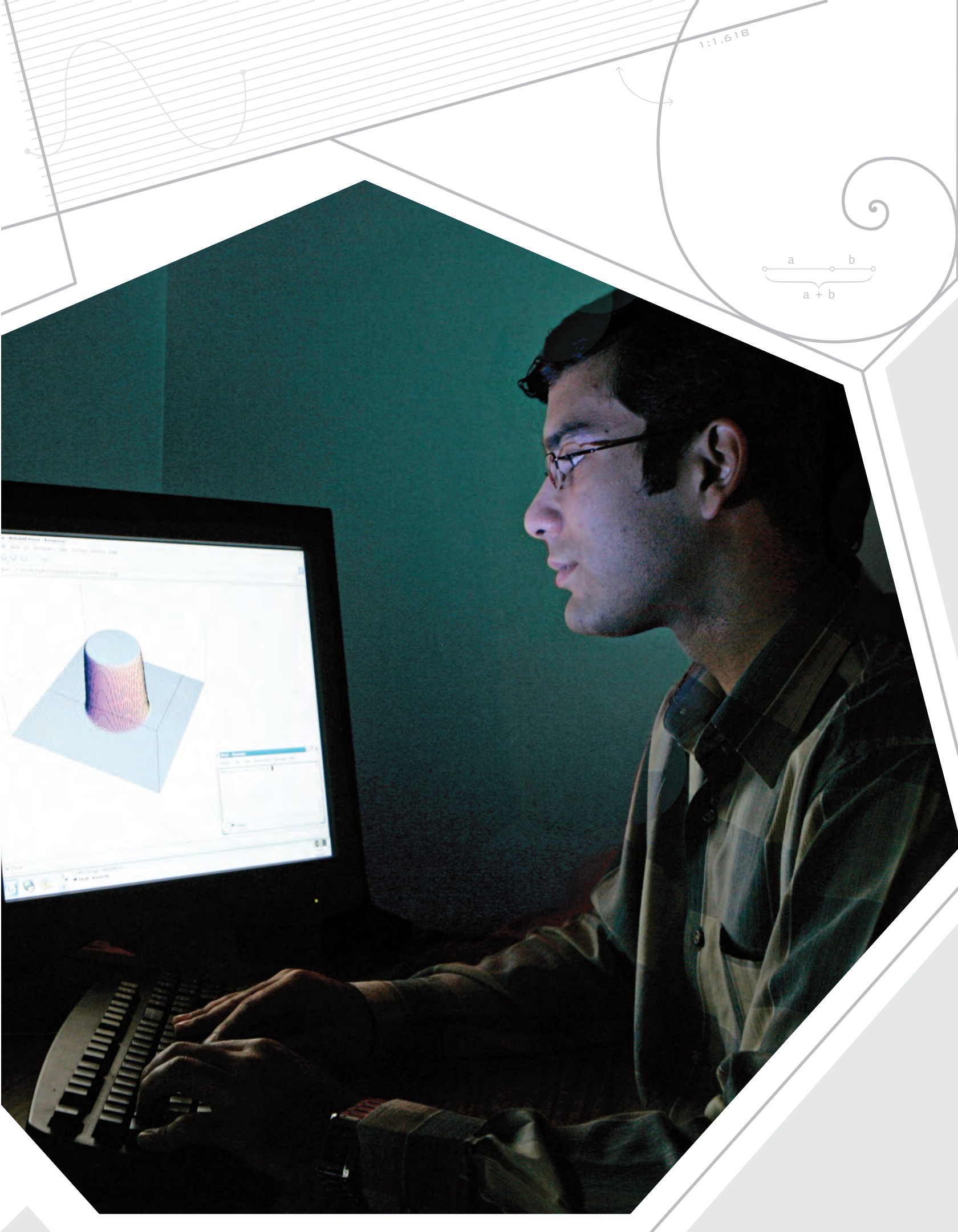
Understanding Air Quality and Climate

UH is a leader in measurement and modeling programs of air quality in Houston as well as other major metropolitan areas around the world, including China. Understanding the interactions between pollution sources, natural phenomena, and local and regional meteorology is critical to best mitigate the effects of the modern world.

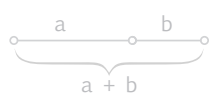
Impacting Energy: Exploring for Natural Resources

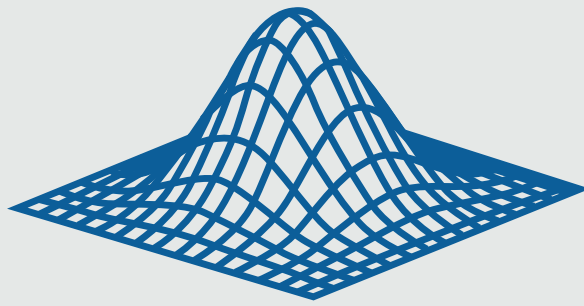
Faculty members and students are focused on processes of oil and gas formation and ways in which we can better explore for these resources. Detailed field studies of sedimentary environments that favor oil and gas are applied to subsurface field production. Tectonic, structural, and geochemical data help to describe and explain the processes that produce the resource. Remote sensing and seismic data of the upper crust are used to help locate oil and gas and allow a better picture of the subsurface.





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DEPARTMENT OF MATHEMATICS

www.mathematics.uh.edu

Mathematics is the language of science and engineering, yet it is also a field unto itself, encompassing both pure and applied studies. Aside from the educational aspects of mathematics, which touch the life of nearly every person, the field is fundamental to almost every aspect of modern life.

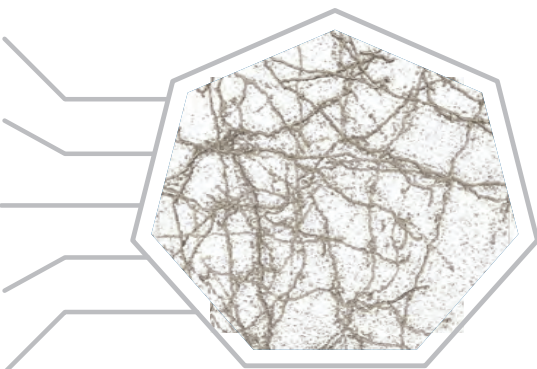
Mathematics is essential in trading strategies of financial markets; designs of shapes and materials; recovery of oil; analysis of weather patterns; the study of complex biological function, blood flow, and aneurysms; and the design of medical equipment. It is a key element in computer simulation and design, development of encryption and compression algorithms, improvements in computer-aided visualization used in medical imaging, and statistical analysis of complex systems.

Innovation in Research, Teaching, and Teacher Training

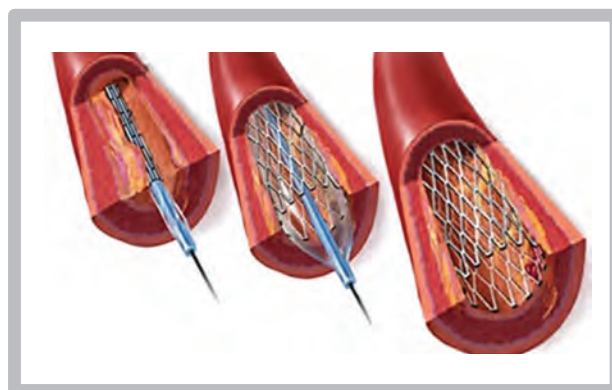
The Department of Mathematics consistently exhibits strength and innovation in research, teaching, teacher training, and outreach. We are one of the few departments in the country with such vast contributions in these areas. The department's research activity is substantial, and in recent years, our primary strengths have been in Mathematical Biology, Numerical Computation, and Mathematical Analysis. These research areas impact studies in medical imaging, blood flow, design of endovascular stents, forensics, genetic circuits, atmospheric modeling, pedestrian traffic, oil recovery, seismic imaging, fingerprint analysis, facial recognition, and algorithms for data loss in signal transmission.

Meeting the Needs of Students

To meet the needs of a wide variety of students, the department designed specialized course management software (CourseWare) and a face-to-face tutoring and secure testing center, the Center for Academic Support and Assessment. In addition, we offer extensive libraries of streaming videos, online undergraduate and graduate courses, an online master's program, and personalized instruction at advanced levels from internationally recognized researchers.



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Program Highlights: Math = Solutions in Health, Engineering, Biology

Development of Coronary Stents

Mathematics faculty members, in collaboration with the Texas Heart Institute, are working to model the mechanical properties of endovascular stents and use 3D meshes to design new stents. By developing complex mathematical models to evaluate how blood flows in pulsating arteries and how artery stents behave, devices can be better designed to keep arteries open. The researchers' published work led to the development of new, improved stent designs, and their novel approach was highlighted in National Science Foundation Discoveries.

Biomedical Imaging: From Coronary Arteries to Facial Recognition

Math, computer science, and chemistry faculty members are joining forces to study a number of important biomedical imaging problems ranging from the visualization of atherosclerotic plaque in coronary and carotid arteries, to facial recognition. Their work associated with visualizing plaque led to algorithm and software development that enables the visualization of soft plaques residing within the arterial walls and the detection of inflamed plaques.

Impacting Neuroscience, Systems Biology, and Evolution

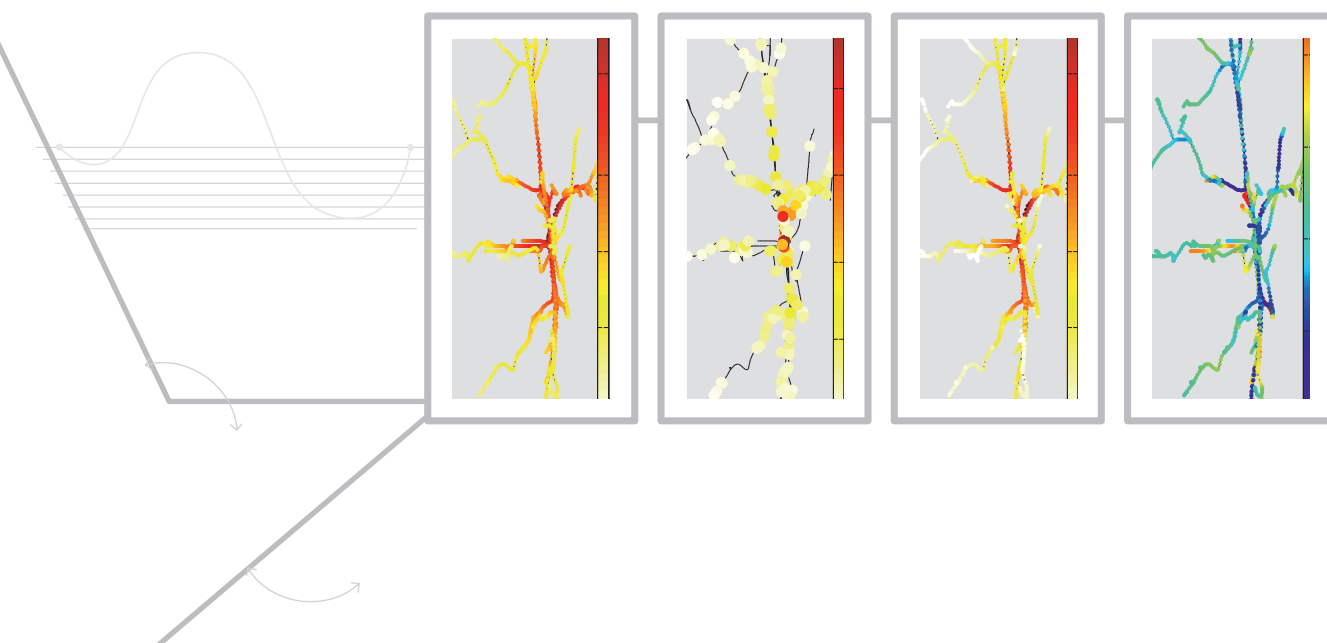
UH faculty members from mathematics, physics, and biology, collaborating with Texas Medical Center researchers, are applying mathematical theory and simulations to problems in neuroscience, systems biology, and evolution. One of the research efforts, published in the Proceedings of the National Academy of Sciences, has the lofty goal of understanding cell behavior by assembling synthetic gene circuits to control gene expression. This effort may yield breakthroughs in diseases like cancer and diabetes. By applying the theory of deterministic and stochastic dynamical systems, researchers are working on quantifying the impact of correlated information that neural tissue carries about a stimulus, propagation of correlated behavior through neuronal networks of different types, modeling reduction techniques for large signaling networks, modeling of cancer radiotherapy, and using hybrid numerical methods in stochastic simulations of populations of widely different sizes.

Mathematical Solutions to Electrical Engineering Problems

UH, Texas A&M University, and Rice University are working on a National Science Foundation-funded project to formulate, analyze, and implement tuning-free adaptive multilevel discontinuous Galerkin methods for coupled interior/exterior domain problems associated with the time-harmonic Maxwell equations. This work will develop a reliable algorithmic tool, of optimal computational complexity, that can be used for the numerical solution of challenging real-life problems in electrical engineering applications. The methods developed have numerous technical and scientific applications, such as semiconductor simulation or particle accelerator design.

Training the Next Generation of Math and Science Teachers

The department is leading UH's efforts to impact the training of the next generation of secondary teachers in science, technology, engineering, and math (STEM) fields through management of the teachHOUSTON program, a partnership between NSM and the College of Education. Students in teachHOUSTON have hands-on exposure to teaching beginning in their freshman year and learn valuable teaching skills from UH master teachers and mentor public school teachers. Approximately 400 UH students are enrolled in teachHOUSTON. The first graduates entered the teaching profession in the fall of 2009.

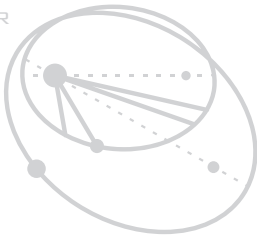


$$\left(H^2 - \frac{8}{3} \pi G \rho \right) R^2 = -kc^2$$

$$\left[\left(\frac{1}{R} \frac{dR}{dt} \right)^2 - \frac{8}{3} \pi G \rho \right] R^2 = -kc^2$$

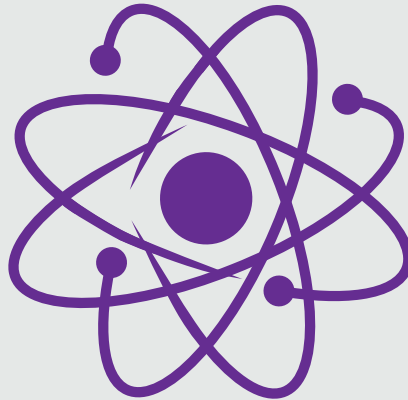


KEPLER



$$U_t + UU_x + P_x = \square,$$

$$P - P_{xx} = 2KU + U^2 + \frac{1}{2} U_x^2$$



DEPARTMENT OF PHYSICS

www.phys.uh.edu

Physics is the most fundamental of all the sciences and provides the underlying basis for the natural laws that govern the structure of the universe. The boundaries between physics and all other sciences are seamless. There is a branch of physics associated with each one (e.g., biophysics, geophysics, and physical chemistry). Physics also includes materials science, astronomy, particle physics, general relativity, non-linear dynamics, statistical mechanics, and optics. Physicists are typically classified as theorists or experimentalists, depending on their choice of activities within their various subjects of interest.

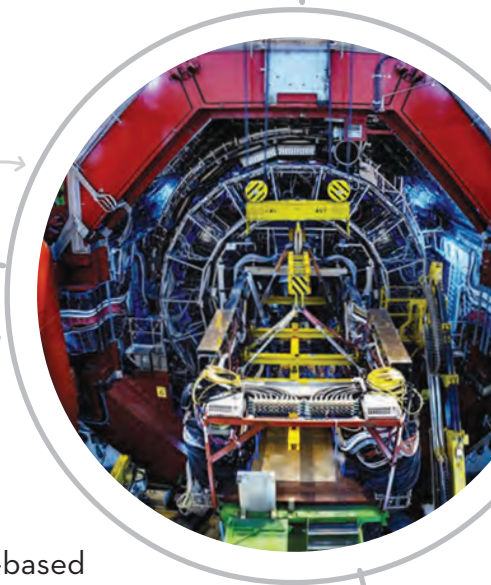
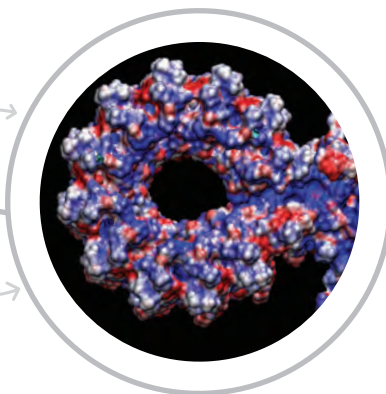
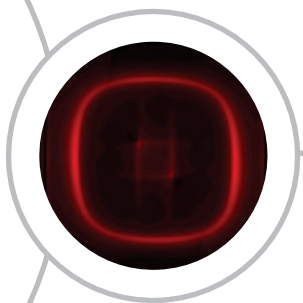
Program Institutes and Strengths

The physics department is home to several major institutes, including the Texas Center for Superconductivity at UH, the Center for Advanced Materials, the Institute for NanoEnergy, and the Mission-Oriented Seismic Research Program. The department boasts strong programs addressing materials science, statistical physics, seismic physics, optics, relativistic heavy ion physics, neutrino oscillation physics, dark matter searches, space physics, space radiation physics and dosimetry, theoretical and experimental biophysics, and a unique program in econophysics.

Student Research Opportunities and High School Outreach

Beginning at the undergraduate level, students in the Department of Physics have numerous opportunities to participate in internationally visible scientific programs. Due to the diverse activities of the faculty and the relatively small number of physics majors, undergraduates are often given the chance to work during the summer at laboratories around the world. These undergraduate research experiences position our students for admission to top graduate programs.

Our department partners with Rice University's physics department to implement the largest Quarknet program in the U.S. A National Science Foundation-sponsored outreach program, Quarknet focuses on high school physics teachers, with the goal of exposing more students to physics, cutting-edge research, and career opportunities. Activities include a summer program for teachers, "Saturday Physics" for students and teachers, and presentations at schools. In part due to this successful program, entering physics majors at UH have the highest average SAT scores of all entering freshman majors in NSM.



Program Highlights: Ties to Energy, Health, and Space Research

Addressing Pressing Challenges in Exploration Seismology

The Mission-Oriented Seismic Research Program (M-OSRP) is a research-based petroleum industry consortium that develops fundamentally new and more effective seismic capability. The program seeks solutions to technical problems and challenges that have been identified as a serious impediment to the ability to locate and produce hydrocarbons. One challenge is the inability to locate and define hydrocarbon targets beneath complex media such as salt, basalt, and karsted sediment. M-OSRP is developing new, effective methods for imaging at depth beneath complex media. Other efforts focus on inverting, for changes in Earth material properties, across structurally and lithologically complex targets, such as curved, dipping, corrugated and/or diffractive reflectors, and/or large material contrasts.

Developing Organic Solar Cells

UH physics is advancing solar power through work on organic photovoltaics, or solar cells. Research at the Institute of NanoEnergy involves thin-film solar cells that are lightweight and flexible. The technology used to produce the cells makes it possible to print the cells on a variety of surfaces. Thin-film solar cells have the potential to revolutionize the cost and use of solar power in many applications, such as minicells, flexible arrays in buildings, and eventually as the third-generation solar technology, replacing silicon. Researchers are improving the thin-film organic cells' efficiency in power generation and increased sunlight absorption, so the cells are competitive with silicon cells. Made of plastic-based materials, these solar cells are aligned vertically so light is channeled into the materials to improve solar absorption; the architecture and technology was first developed at UH. The method enables longer solar cell life, greater sunlight absorption, and greater durability than standard flat-panel, plastic devices.

Impacting Health Care: Understanding Protein Folding

Complex computer simulations of protein folding are leading to better understanding of the functionality of many fundamental protein activities in cells. Understanding the impact of a crowded cell on the structure and dynamics of proteins can help researchers design efficient therapeutics that will work better inside cells, with the goal of preventing, curing, or managing diseases at the molecular level. Recent studies on the impact of crowded cell conditions on the structure, function, and folding of phosphoglycerate kinase (PGK) are providing new information on the workings of PGK, a crucial protein that, when malfunctioning, may cause Alzheimer's disease and cancer.

Real-Time Radiation Monitoring: Impacting Earth and Space Health

In the realm of improving cancer treatment, UH physics is working with radiation therapy centers to provide tools based on particle physics and nuclear physics technology that will enable real-time monitoring of the radiation dose delivered to tumors using predictions of PET images. To assist human space exploration, researchers developed a new generation of active, wireless, battery-powered space radiation dosimeters for use on the International Space Station (ISS) and for future human missions beyond low-Earth orbit. The first generation of these devices was delivered for testing on the ISS in 2012. The results of the space-tested dosimeter will lead to improvements to dosimeters currently used for medical workers in hospitals and patients undergoing radiotherapy.

Particle Physics:

Relativistic Heavy Ion Physics, Dark Matter, and Neutrino Oscillations

The Relativistic Heavy Ion Group is a member of the STAR experiment at Brookhaven National Laboratory's Relativistic Heavy Ion Collider and the ALICE experiment at the Large Hadron Collider at CERN, the European Organization for Nuclear Research. Members of the Particle Physics Group collaborate on the DARKSIDE Dark Matter Search and the Daya Bay Neutrino Oscillation Experiment, exploring the extreme frontiers of knowledge about the nature and structure of the universe. Through these experiments, we hope to learn about the fundamental beginnings of our universe and the forces that bind it together.





RESEARCH CENTERS AND FACILITIES

The College of Natural Sciences and Mathematics leads the University of Houston in generating research grant funding. Numerous cutting-edge research centers and facilities allow our faculty to engage in interdisciplinary, collaborative research within UH and with other organizations such as the Texas Medical Center and industry. Centers with significant NSM involvement include:

Allied Geophysical Laboratories (AGL)

The AGL's mission is to create and apply new geophysical means of imaging and understanding the subsurface. AGL is particularly dedicated to conscientious resource discovery and recovery. Faculty members work with the energy industry, professional societies, and other institutions to develop advanced technologies and help educate the next generation of geoscientists. AGL uses scaled laboratory measurements, field surveys, numerical modeling, and digital processing to develop novel methods of subsurface analysis.

Center for the Mathematical Biosciences

Bringing together researchers in applied and computational mathematics and statistics, researchers in biomedical sciences, and clinicians, the Center is defining new frontiers and solving problems that require multi-scale modeling and analysis of biological systems. The work applies to clinical medicine, cardiovascular sciences, cancer research, and neuroscience. This collaborative group forms a bridge between several interdisciplinary clusters at UH and the strong biomedical research programs at the Texas Medical Center and Rice University.

Center for Nuclear Receptors and Cell Signaling (CNRCS)

CNRCS researchers are involved in many aspects of nuclear receptor research, all focused on understanding the roles of these receptors in health and disease. The faculty members are making breakthrough discoveries on the aberrant functioning of cell signaling which leads to uncontrolled cell growth or behavior, and are working toward the goal of finding new treatments for an array of significant diseases, including cancer, diabetes, and obesity.

Institute for Climate and Atmospheric Science (ICAS)

ICAS is a diverse group of researchers committed to using premier scientific instrumentation and modeling tools to understand better the complex issues of air quality and climate change. The efforts address many critical components, including emission sources, meteorology, and atmospheric chemistry.

Institute for Molecular Design

The Institute is a research and educational center dedicated to bridging theoretical and experimental approaches to biomolecular structure and function. Through the implementation and acquisition of cutting-edge computational and experimental technologies, the Institute facilitates collaborations spanning the science, mathematics, and engineering disciplines at UH and in the Houston/Galveston area.

Mission-Oriented Seismic Research Program (M-OSRP)

M-OSRP is a UH-based research program and petroleum industry consortium founded in 2001. The program addresses seismic exploration and production challenges and generates solutions that positively impact the ability to locate and produce hydrocarbons.

Texas Center for Superconductivity at UH (TcSUH)

TcSUH is a large, multidisciplinary university-based superconductivity and advanced materials research center, with more than 200 faculty, postdoctoral fellows, graduate, and undergraduate students. The Center's interdisciplinary personnel create and develop high temperature superconducting and advanced materials and further their fundamental understanding and their applications in energy and medicine.

Texas Learning and Computation Center (TLC²)

The Center provides cyber infrastructure and targeted support services to enhance research and communication among UH faculty, students, and the broader academic community. The Center provides state-of-the-art computation, visualization, and educational facilities to affiliated researchers from a wide range of disciplines. TLC² initiates collaborations among some of the world's leading research groups in areas such as data compression, visualization technology, signal processing, fundamental physics and geophysical phenomena, molecular structure, engineering design, and biomedical science.



Core Research Facilities

DNA Sequencing Facility

The state-of-the-art DNA sequencing facility is used to study bacterial evolution and to discover functionally important molecules, including functional microRNAs, with therapeutic applications to a number of human diseases, including several types of cancer.

Materials Characterization Laboratory

Located at TcSUH, the lab provides a wide array of materials characterization techniques, including electron microscopy and x-ray diffraction, supported by necessary sample preparation techniques.

NMR Spectrometers

Nuclear Magnetic Resonance (NMR) spectroscopy is one of the principal methods for studying structural and dynamic aspects of organic molecules and their interactions in solution. Several NMR spectrometers, ranging from 400- to 800-megahertz capability, are available to NSM research endeavors.

X-Ray Crystallography Facility

X-ray crystallography, the science of determining the arrangement of atoms within a crystal, is the chief method for characterizing the atomic structure of solid materials. This technique can be used to shed light on chemical interactions and processes or to serve as the basis for designing pharmaceuticals. Synthetic chemists find crystallography to be an important tool in analyzing the products of their experiments. The facility includes both powder and single-crystal X-ray diffractometers, with low temperature capability. Organic, organometallic, and inorganic compounds can be examined, and the facility management has the expertise to solve structures involving severe internal disorder and crystal twinning.



STEM SUPPORT AND OUTREACH

Impacting Science Education: Supporting Students of All Ages

The College of Natural Sciences and Mathematics is committed to providing support to our students to ensure their success. Through several innovative programs, the College is laying the foundation for undergraduate and graduate students to meet and exceed their expectations. Many of the support programs are housed in the NSM Center for Academic Success.

As a member of the educational community, NSM supports programs designed to engage young students in science, engineering, technology, and mathematics (STEM) concepts. Part of this commitment involves a partnership program that trains math and science majors to be top-notch elementary and secondary teachers.



Support Programs for Undergraduate and Graduate Students

Undergraduate Advising Center

The Undergraduate Advising Center (UAC) serves all undergraduate students pursuing or interested in a degree in the sciences and/or mathematics and is part of NSM's Center for Academic Success. The UAC's advisors assist students with course selection, offer referrals to various services on campus, and help students navigate their degree requirements. In addition, the UAC is responsible for the orientation of NSM freshmen and transfer students every summer and winter. UAC programming focuses on initiatives that will assist the College's efforts to increase retention and graduation rates, and improve the overall academic experience of all NSM students. Our academic advisors make more than 50,000 student contacts each year.

Scholar Enrichment Program

The Scholar Enrichment Program (SEP) is a support program for undergraduate students that focuses on academic enhancement and retention of students. While most students participating in SEP are science, mathematics, or engineering majors, the program offers assistance to all UH students enrolled in STEM courses. As part of NSM's Center for Academic Success, SEP creates a learning community for students in high-risk classes, with peer-to-peer workshops designed to enhance learning and problem-solving skills.

Each year, SEP workshops help nearly 1,200 students succeed in basic science and math courses. SEP is impacting the academic experience of students, producing higher retention rates and fewer withdrawals or failures. Students participating in SEP consistently earn higher grades as a group than non-SEP students. With support from the Houston-Louis B. Stokes Alliance for Minority Participation, SEP also funds approximately 175 STEM majors at UH each year.

Center for Academic Support and Assessment (CASA)

CASA provides academic support to undergraduate students enrolled in many types of courses, including mathematics, chemistry, physics, and biology. Each semester, nearly 15,000 students use the Center's online course management system, and CASA provides secure testing for three to four exams per semester for most of these students. Through CASA, students also access electronic learning materials and receive face-to-face math tutoring. During a typical fall semester, students take more than 600,000 online tests and quizzes, and more than 40,000 student visits are made for tutoring.

CASA also provides assistance to high school math students and teachers through math placement testing, orientation scheduling, online practice AP Calculus exams, Pre-Calculus assessment materials, and Algebra II end-of-course practice exams. High school teachers can participate in Algebra I and AP Calculus workshops.

Friends of NSM Graduate Fellowship Program

The Friends of NSM Graduate Fellowship Program pairs generous donors with promising doctoral students. Through annual gifts of \$5,000 or more, donors support high-caliber students recruited to NSM through this competitive fellowship program. The generosity of Friends of NSM donors is enabling NSM to increase the number of outstanding Ph.D. students entering our programs, directly impacting research productivity, faculty recruitment, and doctoral degrees awarded each year.



Outreach Programs: Impacting Science Education for Students and the Community

teachHOUSTON: Preparing Future Science and Math Educators

teachHouston, a partnership between NSM and the College of Education, is changing the way future math and science teachers are trained. Instead of one “student teaching” experience in their senior year, teachHouston students have teaching opportunities throughout their four years at UH with rotations at local elementary, middle, and high schools. Students learn valuable teaching skills from master teachers at UH and from mentor public school teachers. With nearly 400 students enrolled in teachHOUSTON, the goal is to graduate 100 secondary math and science teachers each year.

Science Engineering Fair of Houston

The Science Engineering Fair of Houston (SEFH) promotes the learning and application of science and technology through the development and presentation of science/engineering projects. SEFH serves as the regional fair for all public, private, charter, and home school students, grades 7-12, in Harris County and the 22 surrounding counties in Southeast Texas. Co-sponsors of SEFH include UH, the Engineering, Science & Technology Council of Houston, Greater Houston Partnership, Consumer Energy Alliance, and the Houston Museum of Natural Science.

Friends of NSM Distinguished Lecture Series

The Friends of NSM Distinguished Lecture Series is an event for community and corporate leaders, supporters of NSM, and the general public. Each year, the lecture series focuses on a central theme and includes five to six lectures delivered by leading experts and eminent scholars. Through the series, NSM wants to share our breakthroughs with the community and give Houstonians a front-row seat to the science and technology developments impacting medical care, energy, the environment, and daily living.





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To learn more about the College of Natural Sciences and Mathematics, visit our website, www.nsm.uh.edu, or contact the Dean's Office.

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