Periodic Elements

from the College of Science

Smithsonian and Mason Team Up for Conservation

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COS doctoral students explore rare species through Smithsonian-Mason fellowship program.

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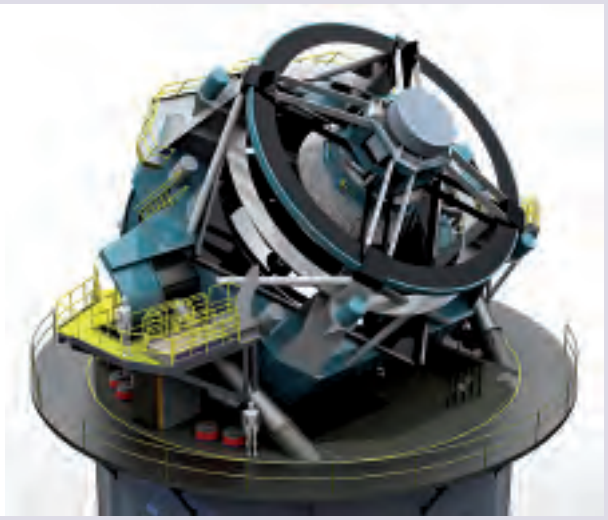

Photo: LSST Corporation/NOAO

Rendering of the LSST, a telescope that will produce an unprecedented survey of the universe.

> "The LSST represents a thousand-fold increase in capability over current facilities, and billions of objects in our universe will be seen for the first time."

New Telescope Project Opens a Window on the Universe

Photo: LSST Corporation

Rendering of the LSST facility to be built atop the Cerro Pachón ridge in Chile.

How did the Milky Way form? What is dark energy? Are there near-Earth asteroids that may threaten our planet? These and many other questions will be studied by astronomers working with the Large Synoptic Survey Telescope (LSST), scheduled to begin operating in 2019.

Kirk Borne, associate professor of astrophysics and computational sciences in the newly formed School of Physics, Astronomy, and Computational Sciences (SPACS), which becomes fully operational effective July 1, 2011, explains that George Mason University was chosen from a select few institutions around the world to participate in the LSST project.

Borne, along with Michael Summers (director of SPACS), wrote a successful proposal to the LSST Board of Directors. "We described Mason's scientists' capabilities, scientific interests, research experiences, and potential contributions to the LSST project." After selecting Mason and one other new member, the LSST project declared a moratorium on adding more members.

The LSST will provide the world's first full-color movie of our universe, an astronomical survey of the skies as seen from the Cerro Pachón ridge in Chile that will enable unique and powerful studies of objects that move or change in brightness. The project has three major components: the telescope to be built in Chile, the camera being built at Stanford University, and the data management system being developed across the country and led by the LSST team in Tucson, Arizona.

The LSST represents a thousand-fold increase in capability over current facilities, and billions of objects in our universe will be seen for the first time. Possible explorations range from exploding massive stars in the distant universe to dark matter and dark energy, which are crucial

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Twenty-Year Smithsonian-Mason Collaboration Yields Lasting Partners for Conservation Research

Fishing cats, elephants, and black-footed ferrets are all in a day's work for students in the Smithsonian-Mason Doctoral Fellowship Program in Conservation Science. First begun informally in the late 1980s, this collaboration between George Mason University and the Smithsonian Institution was formalized in 2004.

> "The Smithsonian has world-class facilities and animal populations, both downtown and at the Front Royal facility."

The fellowships provide students who have degrees in conservation biology or related fields with four years of support for dissertation research projects in conservation biology. The candidates choose a Mason and a Smithsonian mentor, develop plans for their research projects and doctoral degrees, and work side by side with Smithsonian scientists. Students conduct research at the Smithsonian's National Zoo in Washington, D.C., the Smithsonian Conservation Biology Institute (SCBI) in Front Royal, Virginia, or one of the Smithsonian's international field sites.

Photo: Jilian Fazio

Jilian Fazio with a clouded leopard cub at the Khao Kheow Open Zoo in Chonburi, Thailand.

R. Christian Jones, director of the Mason Center for Conservation Studies and professor of environmental science and policy in the College of Science, describes how Mason students interact with their mentors. "The students must have their research plans approved by their mentors," he explains. "During the first two years of the program, the students are taking as well as teaching classes, developing a formal research proposal, and initiating their dissertation research. In the third and fourth years, they work full-time with their research mentors to complete their research and write their dissertations." The ability to work closely with some of the leading practicing conservation scientists using the latest techniques and focusing on some of the most pressing research questions in conservation biology is a distinctive feature of the Smithsonian-Mason program.

The first Mason student to work with the Smithsonian in this area of research, Steven Monfort, is now the director of SCBI; he essentially began the informal collaboration. Monfort received his doctorate in environmental biology and public policy from Mason in 1993. He speaks to the unique opportunities that the program provides, saying, "The Smithsonian has world-class facilities and animal populations, both downtown and at the Front Royal facility. Students can also study at field research sites nearby on the Chesapeake and as far away as Asia, Africa, and Central and South America. With access to these exceptional sites, some of our fellows are researching species that are almost completely unknown."

Rachel Santymire, a 2005 graduate of the Smithsonian-Mason program, appreciated the opportunity to do research into rare species. "I was able to work with one of the rarest mammals in North America, the black-footed ferret," she says. "There aren't many people who work with this species—in the world. Most researchers use a model species, such as domestic cats, as a substitute for their endangered counterparts (like cheetahs) to develop techniques for the endangered species. I got to work directly with the endangered species."

> "The heart of the Smithsonian is research, and there's no better place to learn."

Santymire is now a research associate with SCBI in its Center for Species Survival, director of the Davee Center for Epidemiology and Endocrinology at the Lincoln Park Zoo in Chicago, and a faculty member on the University of Chicago's Committee on Evolutionary Biology. She values her participation in the Smithsonian-Mason program as well for preparing her for public speaking, teaching her what it takes to conserve wildlife from care and husbandry to research and education, and showing her how research results are actually used in wildlife management and conservation. She

Photo: Creative Services

Elizabeth Freeman with Ambika, one of the oldest Asian elephants in North America, age 63.

points out the extraordinary combination of SCBI's talented scientists and its state-of-the-art facilities. "The expertise of the Smithsonian staff and my fellow doctoral candidates was essential to my research, as were the facilities at Front Royal," she says. "Even now, I continue to ask them for advice." Santymire has since worked with Elizabeth Freeman, a fellow colleague, on research on the black rhinoceros in South Africa.

Elizabeth Freeman, also a 2005 graduate of the Smithsonian-Mason program, is now an assistant professor of conservation studies in New Century College at Mason. She agrees with Santymire about the collaborative relationships that the program helps develop. "The graduate students formed a close bond, and some of us (Dr. Santymire and I) continue working together today," says Freeman. "I've also traveled with Smithsonian staff and fellow students to national and international conferences, for example, helping conduct a training course on monitoring hormones in wildlife in Thailand and Australia."

Freeman chose the fellowship because she wanted a doctoral program that combined her interests in wildlife, reproduction, and behavior. Conducting her research through the National Zoo, she pursued a multidisciplinary approach that incorporated hormones and behavior to examine reproductive issues in female African elephants. "I'd always thought it would be a fascinating place to work," Freeman says. "I met with some of the SCBI scientists and was impressed by the research they conducted and their commitment to working with and training graduate students."

In addition to her faculty position at Mason, Freeman continues as an SCBI research associate, working on projects with Asian elephants, Kori bustards, and red pandas. She also serves as a research advisor to the International Elephant Foundation, sharing the expertise in wild elephants that she has developed through her doctoral and postdoctoral work at the zoo. The combination of Mason's multidisciplinary, forward-thinking curriculum coupled with SCBI's cutting-edge research facility and world-renowned scientists "provided me with the best of both worlds," says Freeman.

Jilian Fazio, doctoral candidate in the environmental science and public policy program, also values the relationship between the Smithsonian and Mason in global conservation research. "The collaborative efforts that exist between the two facilities lead to some of the best conservation strategies in the world," Fazio says. She has been working at the National Zoo for seven years, part of that time as an animal keeper, while pursuing first her master's degree and now her doctoral degree through this exclusive partnership.

Photo: Jordana Meyer

Elizabeth Freeman (left) and Rachel Santymire process genetic samples from black rhinos in Addo Elephant National Park in South Africa.

Fazio's master's project was on the clouded leopard, and her doctoral project is on the fishing cat. The Smithsonian-Mason program appealed to her because SCBI houses the country's largest collection of clouded leopards, and the Smithsonian's long-term relationship with the Khao Kheow Open Zoo (KKOZ) in Thailand enabled her to include their fishing cats in her work. "Their associations open up a lot of doors," Fazio notes. "By working with SCBI and KKOZ, I was able to get a large sample size of twenty-four cats for my research."

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***New Telescope Project**, from page 1*

to understanding the fundamental forces and building blocks of nature.

With the world's largest digital camera (3.2 billion pixels) capturing images through an 8.4-meter telescope, the LSST promises to gather 30 terabytes of data each night. Astronomers will use artificial intelligence to help analyze the enormous data sets. The data management system will organize the massive database—a total of 100 petabytes over the ten-year life of the project—into easily accessible catalogs of data. The LSST project is to be open source, and the information will be available to anyone.

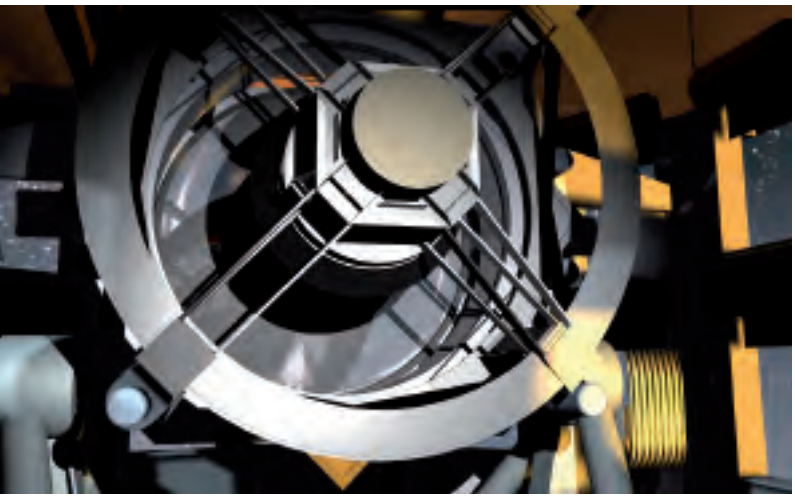

Photo: Todd Mason, Mason Productions Inc. / LSST Corporation

Rendering of the LSST up close.

Borne has been instrumental in developing an entirely new branch of astronomy, astroinformatics, which uses artificial intelligence to analyze and process data in astronomy research and education. As an originator of astroinformatics, Borne gives dozens of public lectures at conferences and universities on the subject, putting Mason on the map in this new field of research. Because the LSST project was ranked as a top priority for the next decade by the National Academy of Sciences, it has high visibility among government officials, policy makers, and other scientific institutions. Borne notes, "Everyone in the world knew about the Hubble Space Telescope project, and now LSST is on the verge of the same level of fame and popularity."

Participating in the LSST project is truly a once-in-a-lifetime research opportunity for Mason astronomy and physics faculty and students. Because Mason is an institutional partner, Mason scientists can easily join one of the eleven LSST teams that is helping with the design and planning of scientific research projects with the data. Outside scientists must write an entire proposal and go through the selection process, held once a year at most, with about a 50/50 chance of acceptance. "However," Borne points out, "our scientists can send a couple of paragraphs to the team lead scientist, explaining who they are, what they will contribute, and why they can help the LSST project—and the chances of acceptance are very high."

Students can work with faculty on these teams, which are starting research projects now in preparation for the LSST data. This multidisciplinary research, a very important facet of any scientist's training, involves astronomy, data mining, computer science, statistics, applied math, and more. Once the telescope is operational in 2019, scientists and students can then use the massive LSST data catalogs to study projects involving variable stars, quasars, supernovae, black holes, dark matter, dark energy, near-Earth asteroids, galaxies, moving groups of stars, colliding galaxies—the list goes on.

Mason scientists will also research science data mining and management, studying new mathematical algorithms that can be used by any researcher in any discipline to discover hidden patterns in large databases and to assess data quality. Because they have been involved with the LSST project from its start, they can become familiar with the tools, access mechanisms, research analysis programs, and the data itself—all skills and knowledge that will help them "hit the ground running," says Borne, "and get rapid early science results from the LSST data. When LSST goes online, we'll have immediate access to everything on the first day of operations."

> "Scientists and students can use the massive LSST data catalogs to study projects involving variable stars, quasars, supernovae, black holes, dark matter, dark energy, near-Earth asteroids, galaxies, moving groups of stars, colliding galaxies—the list goes on."

The LSST education team, of which Borne is a member, is developing programs for formal education at the K–12 and undergraduate levels; informal education for museums, planetaria, and science centers; citizen science (online research by the general public using the LSST database); and outreach to the general public through web portals, iPhone apps, and more. Thus Mason faculty and students can get involved in a range of opportunities: astronomical research, data mining research, and educational program development.

Mason's participation in the LSST project will increase its reputation as a world leader in astroinformatics. The current and future contributions that Mason researchers are making to the LSST project exemplify the College of Science's mission to provide world-class scientific leadership.

Faculty Spotlight: Kylene Kehn-Hall

Seeking AIDS Therapies through Research

Today, infectious diseases such as HIV/AIDS, SARS, West Nile virus, and avian and swine influenza present some of the greatest threats to human health. As the global population continues to swell and people travel more among nations, the threat spreads farther.

"Viruses are amazing," says Kylene Kehn-Hall, a College of Science (COS) infectious diseases researcher working at the new Biomedical Research Laboratory (BRL) on the Prince William Campus. When we catch a virus, that "virus encodes very few proteins, but it has the power to take over our bodies. My job is to figure out how this happens."

Photo: Creative Services

Kylene Kehn-Hall

Kehn-Hall came to Mason eighteen months ago and is excited to be part of this state-of-the-art research campus. The new facility will ultimately employ about fifty staff members and researchers, as well as a large number of student researchers. The BRL is administered by the COS National Center for Biodefense and Infectious Diseases (NCBID), whose mission is to address the ongoing challenges to national and international security posed by the threats of bioterrorism and emerging infectious diseases.

She says, "Coming to this lab was a perfect fit for me. I did my postdoc work at the FBI Counterterrorism and Forensic Science Research Laboratory."

One of her areas of interest is HIV/AIDS. Kehn-Hall, in collaboration with Donald Poretz, one of the founders of the Clinical Alliance for Research and Education of Infectious Diseases, is working on a two-year grant to study a special HIV/AIDS population. She explains that there is a small group of patients who are HIV positive but who have never developed AIDS, termed "Long-Term Nonprogressors." Their bodies have a natural ability to fight the virus.

Kehn-Hall adds that her work benefits from the efforts of Lance Liotta and Emanuel Petricoin, scientists in the COS Center for Applied Proteomics and Molecular Medicine (CAPMM). "We have access to their technology and insights, and we are looking at this population's microRNA. I'm personally driven by the questions: What is unique about these people, and what can we learn?"

Kehn-Hall brings this curiosity to her students. She teaches a class on emerging infectious diseases. "I really enjoy working with students, and they are always in the lab with me," she says.

> "When we catch a virus, it has the power to take over our bodies. My job is to figure out how this happens."

Kehn-Hall is a positive role model to women in science, as well. She says that she came to science late. "I entered Virginia Commonwealth University undecided about what I wanted to study. I became fascinated by biology." She laughs a bit as she describes one female professor who taught cell biology. "I was really struggling in her class, and she actually discouraged me from continuing on in biology. I didn't listen to her and obviously got through it."

She continued on to George Washington University where she earned her master's and doctoral degrees. She says that there are a lot of women working in biological sciences, and it's a trend she'd like to see continue.

In addition to HIV/AIDS research, she is also working on Rift Valley Fever Virus (RVFV), an emerging infectious disease that affects both livestock and humans, mainly on the African continent. Kehn-Hall is collaborating with Ceres Nanosciences, a biotechnology company founded on discoveries from CAPMM labs, on a project recently funded by the National Center for Foreign Animal and Zoonotic Disease Defense (FAZD) utilizing the Ceres Nanotrap™ technology to improve diagnostic assays for RVFV.

She admits she likes being part of a brand-new lab and having input on NCBID's research agenda and future direction. Kehn-Hall recognizes the value of her work and of this new facility, and hopes the cutting-edge research leads to potential therapies and cures.

New Paleontology Minor Really Rocks

It is well understood that there is a lot to learn from the past. The new Undergraduate Minor in Paleontology in the College of Science (COS) takes the idea of geological history to a new level, rounding out science education for biologists, geologists, and earth scientists.

"There are only a few thousand paleontologists in the whole United States," says Mark D. Uhen, assistant professor in the Department of Atmospheric, Oceanic, and Earth Sciences (AOES). "The minor here at George Mason University is the only one on the East Coast and one of the few in the nation."

This lizard fossil from the Late Jurassic-Early Cretaceous geological time scale was found in Liaoning Province, China.

Uhen arrived at the college in 2009. He's a world-renowned paleontologist in his own right who specializes in mammals of the Cenozoic Era, specifically whales. When he began teaching, he recognized that there was no vertebrate paleontology class. When AOES administrators reviewed all the available classes and the addition of vertebrate paleontology, they quickly recognized that they had something special to offer—a new minor.

Paleontology is the study of the history of life on Earth, and Uhen is quick to point out how biologists, geologists, and climatologists, as well as anyone interested in education, can benefit from this minor. "My current vertebrate paleontology class is split between biology and geology students," he says. "Each group brings something unique to the class. The biologists look at ecology and fossil anatomy. The geologists look at what can be learned from the rocks that the fossils are found in and how species have evolved over millennia. The discussions and interactions between these two groups enhance how each looks at their own disciplines."

And while Virginia may not be seen as a leading hot zone for fossil research compared to the western states, Uhen emphasizes that the school is next door to the Smithsonian Institution, which houses the world's largest fossil whale collection and state-of-the art research facilities. Student field trips and a behind-the-exhibit look at the collection, as well as original research, are all part of this new minor.

"We're excited to offer this new minor in the AOES department," says Uhen. "Most people are first introduced to science as children when they learn about dinosaurs. This minor is a way to keep that early curiosity and passion alive."

Photo: Creative Services

Paul Cooper studies astrophysical ice in the AIMIS Lab.

Astrochemical Research: Life Under Ice in the Outer Solar System

Paul Cooper brings space science down to Earth—literally. In the Astrophysical Ice and Matrix-Isolation Spectroscopy (AIMIS) Laboratory on the Fairfax Campus, Cooper and his students are studying how chemistry and physics processes occur in space, particularly on icy planetary bodies in the outer solar system.

Their research focuses on how conditions, such as extreme cold and radiation, on these bodies affect chemical processes. By learning why and how certain molecules develop, they hope to be able to predict what molecules may form before being detected by astronomers. Their findings could shed light on whether living organisms could exist on these outer planetary bodies such as the moons of Jupiter and Saturn. "Many of these bodies are exposed to radiation," Cooper explains, "which can alter the chemical composition of the ice on the surfaces. Such radiation-induced processes are thought to be responsible for generating the weak atmospheres that surround the satellites and possibly producing ice volcanoes on Enceladus (a moon of Saturn)."

In the AIMIS Lab, students use sophisticated vacuum, cryogenic, and spectroscopy instruments to study ices for research that is rarely done in labs in this country or elsewhere in the world. Cooper works directly with his students, providing hands-on experience using these instruments. "It takes about a semester for a student to be comfortable running an experiment by themselves," says Cooper. "So working in the [AIMIS] lab provides valuable training in these techniques."

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NanoNotes

Elements of Distinction about the College of Science, its Faculty, Staff, and Students

Sandra Page, Biosciences doctoral student, presented "A Novel Serum-Based Biomarker Panel for NASH and NASH-Related Fibrosis" at the Graduate Student Research Forum held in Richmond at the Library of Virginia. Sponsored annually by the Virginia Council of Graduate Schools, the forum gives selected students the opportunity to present their research before the public, legislators, and the business community. Page's research involves the development of a tool for diagnosing nonalcoholic fatty liver disease (NAFLD) from blood samples, which would provide a safe alternative to a liver biopsy and a tool that physicians could use to diagnose NAFLD.

Peggy Agouris and **John Kwiatkowski**, Center for Earth Observing and Space Research (CEOSR), are principal investigators on a four-and-a-half-year, $11,575,025 award from the Arctic Slope Regional Corporation through a contract from NASA. Their successful proposal, "Microwave Remote Sensing for Measuring Precipitation and Supporting NASA's Goddard Space Flight Center Sensor Missions," calls for CEOSR scientists to provide expertise in both basic and applied research ranging from remote sensing and earth science to computer science and data visualization.

Chris Parsons, Environmental Science and Policy, was re-elected president of the Marine Section of the Society for Conservation Biology and appointed to a second term on the society's Board of Governors.

Harold Geller, the newly formed School of Physics, Astronomy, and Computational Sciences (which becomes fully operational effective July 1, 2011), was elected to the Advisory Council of the Friends of Arlington Planetarium. He was also elected treasurer of the Chesapeake Section of the American Association of Physics Teachers.

Michael Summers, the newly formed School of Physics, Astronomy, and Computational Sciences (which becomes fully operational effective July 1, 2011), was a co-organizer of the second Next-Generation Suborbital Researchers Conference held recently in Orlando, Florida. Sponsored by the Commercial Spaceflight Federation, the conference featured discussions on the research and educational applications of commercial reusable suborbital vehicles. Participants included several hundred scientists, educators, and space industry representatives.

Faculty and staff are encouraged to send their NanoNotes to cosnews@gmu.edu.

***Smithsonian-Mason**, from page 3*

The expanse of the SCBI facility (3,200 acres) makes it ideal for a variety of animal research topics because whole herds, flocks, and groups of animals can reside together. Fazio explains, "For most of the world's endangered species, their conservation depends on successful captive management. The ability to house many individuals and study their behavior is often key to this success." She describes the benefits of the Smithsonian-Mason program, including the expertise, experience, and support of her mentors and other scientists. "The heart of the Smithsonian is research, and there's no better place to learn how," says Fazio.

The Smithsonian-Mason collaboration is poised to take a quantum leap in support of the recently initiated Smithsonian-Mason Global Conservation Studies Program. Currently housed in the existing training center at SCBI, undergraduate and graduate/professional courses have been piloted for the past several years. Groundbreaking is expected in May for a major new training center to accommodate semester-long undergraduate programs in conservation studies, and shorter intensive classes for graduates, postgraduates, professionals, and practitioners. Mason is building a 120-bed residential hall, and SCBI is extensively renovating an existing building for classrooms, labs, and offices. The new training center and residential hall together with the renovated building will provide a joint facility for this innovative, forward-thinking conservation studies program.

The new facility and programs will continue the relationship between the Smithsonian and Mason that has evolved over the past twenty years. "The Smithsonian offers the world's top conservation scientists, along with world-class facilities and access to animal populations that is unparalleled," says Monfort. "Mason is a strong academic partner with experienced faculty who are truly enthusiastic about training the next generation."

(Editor's note: New Smithsonian-Mason fellowships were recently awarded to Mirain Tsuchiya Jerep from Pontifícia Universidade Católica do Rio Grande do Sul in Porto Alegre, Brazil, and Parker Pennington from Louisiana State University in Baton Rouge, Louisiana. Both women will begin the environmental science and public policy doctoral program in the College of Science this fall.)

Astrochemical Research, *from page 6*

Cooper received his doctorate in chemistry from The University of Western Australia, where he studied infrared matrix-isolation spectroscopy, looking specifically at how water molecules bond with other small molecules. He then came to the United States for a postdoctoral fellowship at NASA's Goddard Space Flight Center, where he began investigating how conditions on icy satellites in the outer solar system affect the production and stability of oxidants such as oxygen and hydrogen peroxide. Cooper wanted to move to academia and found his Mason faculty position in physical chemistry, where he is now assistant professor in the Department of Chemistry and Biochemistry in the College of Science.

"Since starting at Mason, I've worked with a number of undergraduates on various astrochemistry projects in the lab," says Cooper. In addition to astrophysical ice research, students use matrix-isolation spectroscopy, a technique that produces certain chemical complexes and traps them in gases in extremely low-temperature solid form for observation and analysis.

Cooper and his students have also received funding to work with NASA's Jet Propulsion Laboratory at Caltech on an astrobiology project. In particular, an undergraduate student is looking at how the irradiation of methane and water ice produces methanol.

Chemistry students aren't likely to consider careers in space research, because chemistry is often thought of as something that happens only on Earth. "Well, chemistry happens everywhere," notes Cooper, "even in galaxies many millions of light years away. Working on projects that are relevant to NASA and space exploration is really a cool thing. And the space research community needs good chemists to do good lab work in support of observations returned by spacecraft missions and telescopic observations."

Cooper sees undergraduate research as beneficial for students, professors, the college, and the university as a whole. Students get to participate in research beyond their normal coursework along with invaluable experience with world-class professors. Professors gain research partners working alongside them in the lab, getting results that lead to publications and grants. The program becomes an excellent recruiting ground for graduate students because of its visibility in the astroscience fields.

Through his research and expertise, Cooper has participated on a number of NASA review panels. Recently, he gave NASA his scientific evaluation of several proposed $400-million spacecraft missions, one of which will fly later this decade. His professional contributions to this process help raise the awareness and visibility of Mason science on an international level.

Dean's Message

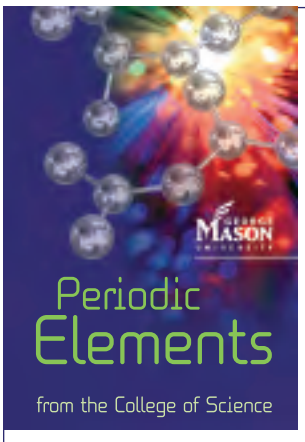
Photo: Creative Services

Vikas Chandhoke
Dean, College of Science

In the College of Science, we embrace the world as our classroom, and we are developing a learning environment unlike any in the country. With the nation's capital as our backdrop, our students have access to world-renowned scientists, the latest in technologies and facility design, and unparalleled learning opportunities and experiences. Through this issue of *Periodic Elements*, we offer another snapshot of how we encourage our students to explore these resources.

Mason is now designated as a residential university by the Carnegie Foundation for the Advancement of Teaching, and the bustling Fairfax Campus has become a miniature city of 24/7 activity. At the Prince William Campus, students can delve into leading-edge medical and biological research. Outside these campus settings, student scientists can explore the world through unique conservation programs jointly offered by the college and the Smithsonian Institution, both locally and at a variety of international locations. And in a few years, the skies as seen from the Cerro Pachón ridge in Chile will become a new laboratory for us as our astronomers and students become part of an exclusive research team with access to the Large Synoptic Survey Telescope, soon to be constructed on the Chilean ridge.

Universities open a window to the future. Inside Mason's research centers, classrooms, and labs, mind-changing questions are posed, and students and professors work to understand the natural world. And while we believe in the importance of teaching the classics of math and science, we also see our students changing the world through programs that put those foundations into practice.



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