Department of Physics and Astronomy

# Communiqué

Autumn 2008

## IEEE Recognizes MU Physics Alumnus James Fergason as Inventor of Liquid-Crystal Technology for Flat-Panel Displays

On September 20, 2008, the IEEE (formerly, Institute of Electrical and Electronics Engineers, Inc.), the world's leading professional association for the advancement of technology, awarded the IEEE Jun-ichi Nishizawa Medal to MU alumnus James Fergason for "pioneering development of twisted-nematic liquid crystal technology." The technology is the display of choice for laptop computers, mobile phones, television sets and hundreds of industrial and consumer products. Co-recipients of the award are Wolfgang Helfrich and Martin Schadt.

The IEEE Jun-ichi Nishizawa Medal is presented for outstanding contributions to material and device science technology, including practical application. The criteria considered in making the award include: quality of the technical achievement, enhancement of technology, impact on the relevant technical community, impact on the profession and benefit to society.

Working separately, Helfrich and Fergason conducted fundamental research that contributed to the establishment of twisted-nematic technology, with Helfrich and Schadt later collaborating on the development of a twisted-nematic cell, which led to the first liquid crystal display components. Twisted-nematic mode enabled the development of a practical flat panel display for a wide range of applications and is considered one of the most important technological achievements of the 20th century.

Dr. Fergason is the founder of Fergason Patent Properties, LLC. Previously, he founded and was president of both the International Liquid Crystal Company and Optical Shields. He holds over 150 U.S. patents and over 500 foreign patents in the field of liquid crystal displays and related devices, including key US patent number 3,731,986 for "Display Devices Utilizing Liquid Crystal Light Modulation." He has received numerous honors including the Lemmelson-MIT Prize (2006), Frances Rice Darnes Award of the Society for Information Display (1986), and was inducted into the National Inventors Hall of Fame in 1998. Of the $500,000 Lemmelson-MIT Prize, he gifted $200,000 to the MU Department of Physics and Astronomy.

# 2007-08 Scholarship/Fellowship Recipients

UNDERGRADUATE SCHOLARSHIPS

**Paul E. Basye Scholarship**
Diana Bolser
Alex Hoban
Nicholas Kullman
Nathanial Moore
Joshua Shocklee
Matthew Taylor
Caleb Wheeler

**Newell S. Gingrich**
Nicholas Criswell
Alex Hoban
Stephen Messenger
Jeffrey Steven Pobst
Anthony Smith

**Clifford W. Tompson Scholarship**
Nicholas Kullman
Caleb Wheeler

**Don & Lona Packwood Scholarship**
Nathaniel Moore

**Ernest Landen Fellowship**
Diana Bolser
Nicholas Criswell
Jeffrey Steven Pobst
Stephen Messenger
Anthony Smith

**Clifford W. Tompson Scholarship**
Nicholas Kullman
Caleb Wheeler

GRADUATE SCHOLARSHIPS

**Ernest Landen Fellowship**
Jhuma Das
Samuel Grinter
Suklima Guha-Niyogi
Mehmet Kahveci
Deepika Menon
Kai Yang

**Harry Hammond Prize in Physics**
Daniel Caputo
Jagat Lamsal
Zhiyong Shen
Yuan Wang
Shulei Zhang

O.M. Stewart Scholarship
David Arrant
Bogdon Barz
Jacob Burress
Raina Cepel
Gengsheng Chen
John Gaddy
Michael Gramlich
Hayden, Shawn Hayden
He, Jiexuan He
Linghui Li
Yonghui Li
Liang, Shunlin Liang
Lin, Haibo Lin
Liu, Liang Liu
Matthew Mower
Keshab Paudel
Marcus Petrovic
Joshua Tartar

# Recent Physics & Astronomy Graduates and Highlights

Congratulations go out to the following physics and astronomy students who earned their degrees in the past year:

Doctorates were awarded to:

- Mohammad Arif, now a postdoc at the University of Central Florida, advised by Prof. Suchi Guha
- Lorant Janosi, now a postdoc at Houston University, advised by Prof. Ioan Kosztin
- Mingzhai Sun, now a postdoc at Princeton University, advised by Prof. Gabor Forgacs
- Harshani Wijewardane, now a postdoc at Hunter College, City University of New York, advised by Prof. Carsten Ullrich
- Zhaoyang Yang, now pursuing a Master's in Finance Engineering at the UC Berkeley business school, advised by Shufeng Zhang.

Master's degrees were awarded to:

- Kevin Johnson, now employed with NAVAIR in China Lake, California, advised by Maikel Rheinstadter.

Bachelor of Science degrees were awarded to Sarah Bird, Daniel Caputo, Justin Riffle, and Theron Rodgers. Justin is now a physics teacher at West Junior High School in Columbia, MO. The other three students continue to pursue their study of physics in graduate school.

# From the Chair

*By Peter Pfeifer*

On August 25, 2008, I officially reported for duty as new Department Chair, and I am pleased to report that many powerful developments have occurred over the past year: record enrollment at MU; record number of new undergraduate Physics majors; record number of new Physics graduate students; record grant funding; generous gifts from our alumnae and alumni; and a long list of achievements, awards, and honors of faculty and students in the department. Some of these are highlighted in this newsletter.

It is a great honor to welcome Robert Duncan, MU's new Vice Chancellor for Research and Professor of Physics, as the most recent faculty arrival in the department. He is a most accomplished expert in critical phenomena and fluid dynamics in microgravity (see, e.g., Reviews of Modern Physics, January 2007).

Several curriculum and outreach innovations have been inaugurated, including the new undergraduate course "Modern Condensed Matter Physics" developed by Carsten Ullrich under his NSF CAREER award, and the Advanced Physics Laboratory course, developed by Suchi Guha and Ping Yu, in which undergraduates go through a program of state-of-the-art experiments on research-grade equipment.

The laboratory course has received national visibility in a presentation by Suchi and Ping at the American Physics Society Meeting in St. Louis, April 2008. The public lecture series "Cosmic Conversations", launched by Angela Speck in September 2007 (see p. x), has become a very popular event.

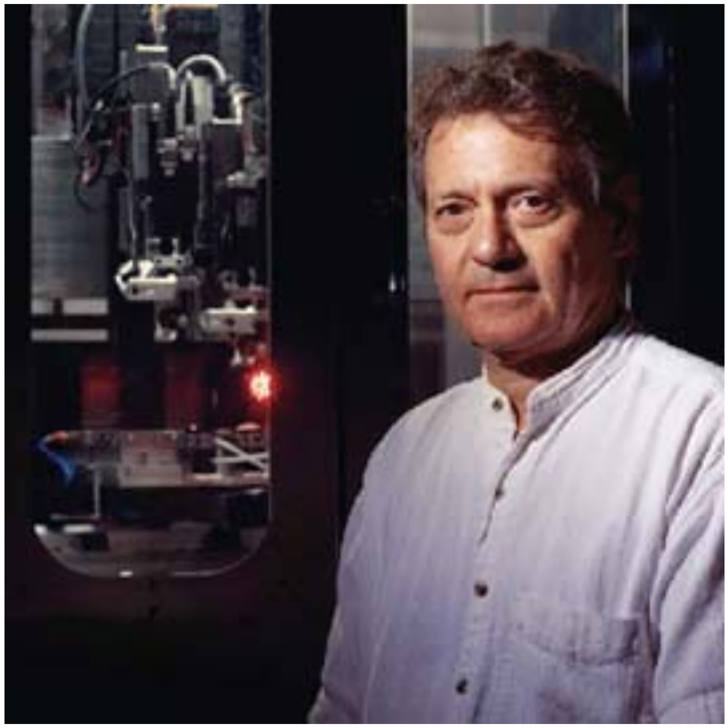
I have also losses to report: Shufeng Zhang took a position at the University of Arizona in August 2008, and Maikel Rheinstädter will be leaving us in December for a position at McMaster University in Canada. Sherry Long, long-time Administrative Associate, has left the department in August to move to Kansas City. They all will be missed. But at the same time, this is an opportunity to congratulate them on the recognition of their talents and success, and to thank them for what they brought to the department.

A change that hardly goes unnoticed is that Henry W. White, Department Chair of many years and architect of much of what the department is today, took retirement as of September 1, 2008, to be able to devote more time to his companies, MOXtronics, Inc., and Nanoparticle BioChem, Inc. Henry received his Ph.D. from the University of California-Riverside in 1969 and joined MU's Physics Department the same year. He was Department Chair 1983-1992 and 1998-2004. His research has focused on a wide range of solid-state materials and their properties, most recently—and the basis of his commercial ventures—growth and development of zinc oxide wide-bandgap semiconductor material for fabrication of light-emitting diodes, laser diodes, and visible and solar blind UV detectors; and production of gold and silver nanoparticles for biomedical and other applications. Honors and awards he received include the Purple Chalk Faculty Award, University of Missouri Alumni Association (1990); the University of Missouri Presidential Faculty Entrepreneur Award (2002); and the Faculty Recognition Award, Science Teachers of Missouri (2003), reflecting that he has been not only an eminent researcher and administrator, but equally a most innovative teacher. Of the proverbial three kinds of people—"those who make things happen, those who watch things happen, and those who wonder what happened"—he belongs only to one category, those who make things happen.

*Henry,*
*we thank you for all you have brought to life in the department, as Chair, colleague, and friend. We admire and appreciate your service, congratulate you on your achievements, and wish you the best of success with your business enterprises, innovations, and whatever you may choose to undertake for many years.*

# Modern Prometheus

Imagine being able to replace your diseased or worn-out organs with new, laboratory-fresh models made from your own cells. Your heart is failing? New muscle tissue or even an entire heart could be ordered up before a transplant becomes critical. Kidneys not working? Instead of dialysis, you could have a new one implanted. Such is the vision of Gabor Forgacs, MU's George H. Vineyard Professor of Physics.



In Forgacs' laboratory, he is demonstrating that it is possible to "print" blood vessel-like structures. By methodically laying down circles of small spheres packed with human cells and then stacking layers of these circles one on top of another, he is able to create living cylinders of tissue, complete structures with the multiple layers of cells found in actual human veins and arteries. Using the same techniques, he has taken cells from chicken hearts and built them into tissues that pulse just as the heart did. His goal is to make blood vessels that will be useful for surgery and, one day, build entire replacement organs in the laboratory.

Working with a $5 million National Science Foundation grant and a large international team of scientists, Forgacs has pioneered procedures for engineering tissues that differ radically from the conventional methods used by most other researchers in the field.

Classical tissue engineering employs scaffolds, structures in the shape of organs or tissues that are made of biologically friendly materials. The engineers deposit cells on the scaffold, keeping the cells nourished as they multiply and grow to fill the structure. If all goes well, the scaffold eventually biodegrades leaving a fully formed organ. The big challenge to this approach, however, has been to find the right materials for building the scaffolds. Different cells need different environments. Complicating the search further, complex organs are made of a variety of cells.

At the heart of Forgacs' lab is a bioprinter, a custom-built machine about the size of a large refrigerator, that he is using to fabricate blood vessels. The bioprinter delivers millions of cells at a time. To make blood vessels, he cultures the three primary types of cells that make up the cylindrical organs: connective tissue cells called fibroblasts that comprise the outer layer, muscle cells that form the middle layer, and the endothelial cells that line the vessels. Then Forgacs combines the cells in the right proportions and forms them into tiny spheres, each about half a millimeter or less in diameter and containing 10,000 to 30,000 cells.

These spheres, Forgacs' "bio-ink," are packed into micropipettes and loaded into the bioprinter's printer head. Before printing starts, the printer lays down a gel film, the "bio-paper" that will accept the bio-ink. Once the gel sets, the printer pumps out individual spheres, making a circle about three millimeters in diameter. Then it lays down another sheet of bio-paper on top and prints another circle of spheres. The whole process takes about 15 minutes. The stack of printed sheets matures in a "bioreactor," an incubator set to the right temperature and humidity and providing fluids pumped at the right pressure to mimic the environment of a blood vessel. In the bioreactor, nature begins to work its magic. Over the course of about a week, the individual spheres of cells slowly fuse together to form a solid tube.

But do these cells form something comparable to an organ? Forgacs found that indeed they do. When he printed the chicken heart cells, the beating of the cells was unsynchronized at first. But as the spheres melded, the cells began to beat in unison. This experiment demonstrated that, once these spheres of cells merge, they behave just like the tissue they came from. Just as extraordinary, the cocktail of cell types in the spheres turns into the

# Larry Smarr Receives Honorary Degree

Dr. Larry Smarr was bestowed with a degree of Doctorate of Science Honoris Causa at the May 2008 graduation ceremony.

Chancellor Brady Deaton shared Dr. Smarr's vast array of accomplishments with graduating honors students. Dr. Smarr is founding director of the California Institute for Telecommunications and Information Technology, founding director of the National Center for Supercomputing Applications, and the National Computational Science Alliance beginning in 1987. He is a member of the National Academy of Engineering, Fellow of the American Physical Society and the American Academy of Arts and Science. He was a member of President Clinton's informational technology advisory committee, and served on the advisory committee to the director of the National Institutes of Health and the NASA advisory council until last year. Dr. Smarr's views have been quoted in The Wall Street Journal, Time, Newsweek, Science, Nature, among several others.

*From left to right: Henry White, Chancellor Brady Deaton, Larry Smarr, his niece Stephanie Smarr (who graduated with a bachelors with honors), his brother David Smarr, and sister-in-law Karen Smarr.*

Following his introduction, his speech focused on the evolutionary changes of computing since his first exposure to programming in 1966, while a student at the University of Missouri. He then related many of the possibilities to come for the graduating students.

In closing, Dr. Smarr told the students that he hoped the world would use the awesome new power of computers and networks to help it deal with all of the challenges to come in the future. He said he was optimistic because the young honors students he was addressing will become the newest leaders of the world and have a much more intuitive approach to the networked world than his generation has. In conclusion, he stated "good luck to you, we're counting on you, don't let us down. "

# Fred Hawthorne Receives Highest Honor from the American Chemical Society

M. Frederick Hawthorne's life work has made him one of the giants in the nano and molecular medicine field. Hawthorne, Director of MU's International Institute of Nano and Molecular Medicine and Professor of Radiology, Chemistry, and Physics, and pioneer in boron chemistry, will receive the 2009 Priestley Medal for his achievements in the field of chemistry. The award is the American Chemical Society's (ACS) highest honor and recognizes distinguished service in the field of chemistry. The ACS, with 160,000 members, is the world's largest professional society.

"I am elated to receive this recognition," Hawthorne said. "I am very lucky to have been at the right place at the right time to begin work on clarifying the chemistry of boron, one of the most versatile elements."

When Hawthorne started his 60-year career working with boron, little was known about the element. His assumption that boron could be used in ways similar to carbon enabled him to create a diverse collection of boranes, which are compounds of boron and hydrogen, and spinoff compounds. He discovered uses for these compounds in applications such as medical imaging, drug delivery, neutron-based treatments for cancers and rheumatoid arthritis, catalysis and molecular motors. One of his significant achievements is the creation of a specific type of nanoparticle that selectively targets cancer cells for boron neutron capture therapy.

"Fred has expressed his creativity over and over again in chemistry," said Sir Fraser Stoddart, a former colleague and a Northwestern University professor. "To many scientists the world over, he has become Mr. Inorganic Chemistry, a legend in his time."

# FACULTY KUDOS

**Suchi Guha** was awarded an international award from the NSF that allowed her to spend three months at the Indian Institute of Science, Bangalore, in Spring 2008. This has opened up great opportunities for future collaborations in the area of novel low bandgap molecules for application in organic optoelectronics. She received another three-year award for $270,000, from the NSF starting September 2008. The project title is “Light scattering studies of organic field-effect transistors”. In addition to supplemental awards, Dr. Guha has secured three regular awards from the NSF as principal investigator since 2004. One of her papers, “Electronic structures and spectral properties of endohedral fullerenes”, that she wrote after joining MU (in 2005) has been recognized as a top “50” most cited Coordination Chemistry Reviews paper (2005-2008).

**Bahram Mashhoon** became 60 years old on September 9, 2007. To mark the occasion, the General Relativity and Gravitation (GRG) Journal devoted the two issues of May and June 2008 to papers by colleagues, friends and former collaborators. To quote from the introductory material, these papers “show the impact of his work on the field of gravitation and relativity theory and on theoretical physics in general.”

**Dorina Kosztin** was awarded the 2008 William T. Kemper Fellowship for Teaching Excellence. This prestigious award is provided once a year to five outstanding educators at MU and includes a $10,000 award. Dr. Kosztin has introduced a multitude of innovations to the calculus-based introductory physics courses for science and engineering majors. In addition to this award, Dr. Kosztin was also a recipient of the 2008 Physics Alumni Awards for Outstanding Teaching.

**Angela Speck** was the recipient of the Provost Outstanding Junior Faculty Research and Creative Activity Award for 2008.

**Haskell Taub** and his research group were recently selected to conduct one of the first experiments at the new Spallation Neutron Source at Oak Ridge National Laboratory. Their proposal received excellent reviews, and they were allocated 4 days of beam time. Collaborating on the experiment were Dr. Siao-Kwan Wang (postdoc), Prof. Flemming Y. Hansen (long-time collaborator), Dr. John Copley (NIST), and Dr. Maikel Rheinstaedter of our department. Their work is supported by the National Science Foundation. Other accomplishments include invitations to attend a Workshop on neutron scattering education in Washington, D. C. last March and to speak on the role of writing in the science curriculum at an NSF-sponsored meeting held at Georgia Tech last April. Dr. Taub will also be speaking at an International Workshop “Nanophenomena at Surfaces: Exotic Condensed Matter Properties” in Sunny Beach, Bulgaria in September.

**Deborah Hanuscin** was the recipient of the Provost’s Outstanding Junior Faculty Teaching Award for 2008. In addition, she received a grant from the Missouri Department of Higher Education in the amount of $124,000 annually for a 3 year project that supports Quality Elementary Science Teaching.

**Kattesh Katti** was selected to be one of ‘25 Most Influential Molecular Imaging Scientists’ in the world. In addition to this award, on March 4 2008, he was bestowed with the ‘Outstanding Missourian’ award for his research developments in nanomedicine.

**Ping Yu** won the NSF CAREER Award for $429,309 for his research entitled, "Dynamic Holography for Functional Imaging of Site-Specific Drug Delivery.” This is the third such award in our department; previous awardees were Angela Speck and Carsten Ullrich.

**Giovanni Vignale** is part of a $6.5 million grant from the Department of Defense, entitled, “Hybrid Computer Materials May Lead to Faster, Cheaper Technology.” The primary goal for this project is to find new ways of using magnetic materials with materials such as organic semiconductors to create energy efficient devices.

**Carsten Ullrich** was a recipient of the 2008 Physics Alumni Awards for Outstanding Research.

**Peter Pfeifer** is principal investigator of two grants, “Advanced Nanoporous Carbon for Reversible Hydrogen Storage: Fabrication and Demonstration of a Prototype Tank with Capacity of 0.5 kg of Hydrogen—Phase II” from the U.S. Department of Defense ($1.1 million) and “Multiply Surface-Functionalized Nanoporous Carbon from Corncob for Vehicular Hydrogen Storage” from the U.S. Department of Energy ($1.9 million), beginning September 2008. The DOE award is one of ten projects the Office of Energy Efficiency and Renewable Energy (EERE) selected in August 2008 for funding for hydrogen storage and development, as

# Fifth Year of Physics Open House

For the past five years, the department has been hosting an annual Physics Open House. This event, typically held in April, is free and open to the public. Over the years, there has been a steady increase in the number of people attending the event. Activities, demonstrations and displays are for the enjoyment of children of all ages and their parents. The event is run by Prof. Meera Chandrasekhar and Dorina Kosztin, with the help of dedicated undergraduate and graduate students. The event is advertised to all elementary, middle and junior high schools, through Columbia radio stations, university mass email and our website.

The event consists of a variety of hands-on activities, a fun-filled demonstrations of physics concepts, and displays of physics equipment. For the last two years, the Department of Chemistry has joined the Dept. of Physics in presenting spectacular chemistry reactions during the show and hands-on activities. A few middle and/or junior high school students are also involved in the show by helping with the demonstrations. For more pictures and a schedule of events for the previous Open House events, please visit our website at **www.physics.missouri.edu**.

*Tomas Wexler, checking to see which ball will win the race.*

# Igniting Girls' Interest in Science

Deborah Hanuscin, Assistant Professor in the Department of Learning, Teaching, and Curriculum and Department of Physics and Astronomy, had a high-visibility spot in the monthly section "Education Forum" of the journal Science, March 21, 2008, with her article "Igniting Girls' Interest in Science," co-authored with Sheryl Tucker in MU's Department of Chemistry and Constance Bearnes, Girl Scouts—Heart of Missouri Council, Jefferson City. The article reports the success of the "Magic of Chemistry" Program, now 10 years old and having served more than 2500 girls, in which Junior Girl Scouts (4th though 6th grade) are brought to campus for a day of discovery and chemistry experimentation. The goal of the program is to create a positive association with science, to encourage young girls' interest in scientific discovery at a critical time in their educational development. According to the research results, 81 percent of participants are interested in studying science and scientific careers after the program. And more than 40 percent come back for a second or even third workshop. Not everyone who wants to come back gets to; spots in the popular workshops are assigned through a lottery system.

Learning outcomes reflect the program's goal of teaching girls about science and its relevance to their daily lives. Although the majority of participants gave examples of activities and experiments as learning outcomes, they also cited scientific facts and concepts, as well as real-world applications of science. Beyond these primary outcomes, girls also noted learning laboratory techniques and how to use scientific equipment, a need for girls that has been documented. Representative responses from these ten to twelve years olds ranged from "cool experiments" to "polymers have units that are connected" and "magnets work through plastic."

# MU Nanotechnology Winning The Fight Against Cancer

Dr. **Kattesh Katti**, Professor of Radiology and Physics, Senior Research Scientist at the MU Research Reactor (MURR) and Director of MU's Cancer Nanotechnology Platform has collaborated with various faculty within MU Radiology, Physics, Veterinary Sciences to produce a new method of detection and treatment for cancer and other diseases.

In the past, progress has been hindered by the difficulty of making biocompatible gold nanoparticles in a stable, nontoxic form. This obstacle has been recently overcome through Dr. Katti's ground breaking discovery which involves the application of the antioxidant properties of phytochemicals in soybeans. The discovery, which represents the first true "100% Green Nanotechnological" process, involves simple interaction of gold salts, soybeans and water in a chemical reaction that produces gold nanoparticles and has far reaching implications. These gold nanoparticles have extraordinary biocompatible properties for use in a variety of biomedical applications.

Dr. Katti's discoveries in green nanotechnology have won him national and international awards including the 'Outstanding Missourian Award' by the Missouri House of representatives(in March 2008) and the '25 Most Influential Molecular Imaging Scientists in the world award' in September 2008.

This unique green nanotechnological discovery interfaces plant science, chemistry and nanotechnology and has generated world wide interest as gold nanoparticles are used in a myriad of applications including medicine, as catalysts in hydrogen gas production in alternative energy, in fuel cells, etc. For the design of cancer specific gold nanoparticles, Dr. Katti has conjugated them with molecular vectors (called proteins or peptides) which have high affinity toward prostate (and various other) cancers. Such tumor specific design of gold nanoparticles allows them to be attracted to a protein abundant on cancer cells; once in vivo (inside the body), they migrate directly to cancerous tissues and thus enable efficient diagnosis and therapy of cancer on a cellular level. These studies have shown excellent results in animal studies with no consequent toxic side effects. The process uses only naturally occurring elements and does not harm other organs in the body. Targeting individual cells for diagnostic imaging or therapy is made possible through nanoparticles due to their high surface area to size relationship. They have a high surface reactivity and an extreme high affinity to the proteins within cancerous tumors. In a related investigation, the nanoparticles release radioactive energy from inside cancerous cells, thus causing efficient destruction of cancerous cells selectively.

Gold nanoparticles, produced through green nanotechnology, could function as in vivo sensors, photoactive agents for optical imaging, drug carriers, contrast enhancers in computer tomography and x-ray absorbers in cancer therapy. It can also be used in the production of "smart" electronic devices, treatment of certain genetic eye diseases, and the development of "green" automobiles. Dr. Katti is also spearheading efforts to commercialize these technologies by working with Dr. Henry White (MU Physics), Dr. Raghuraman Kannan, and Kavita Katti (MU Radiology).

Prof. Kattesh Katti

# Summer REU Notes from Students

*By Nicholas Criswell*

Anyone who has ever tried to build a sandcastle without water knows that wet things don't behave in the same way as dry things. In particular, the aggregation of dry particles is vastly different from the aggregation of wet ones. I spent this summer at Indiana University working with Professor Dobrin Bossev and a post-doc, Garfield Warren, on the issue of aggregation of wetted particles in solution. We were primarily trying to show that there is a capillary force responsible for this aggregation. Using in-house synthesized silica particles in the sub-micron size range, we attempted to build capillary bridges of water on these particles which we had dissolved in a solution with tunable polarity. The study is so exciting because capillary forces have never been studied in solution; they are well understood in dense granular media, (such as those found in a sandcastle) but this was the first study to observe capillary bridges between particles in a dilute solution. Using light-scattering techniques we were able to observe the chaining of these particles in solution and have obtained strong evidence that a capillary force is responsible for this chaining.

The REU at Indiana University also included a short workshop in which we all learned to work in a machine shop. I found this part of the program in which we spent one week building a hammer out of aluminum and brass to be the most exciting part of the REU. In addition, bi-weekly seminars, a camping trip and a tour of Fermi Lab were also included in the program. However, I did not spend my entire day doing physics this summer. I also had

*By Anthony Smith*

This summer I was one of the students selected to attend the Arecibo Observatory Research Experience for Undergraduates program (REU) in Puerto Rico, a program run by Cornell through the National Science Foundation. My advisor was Dr. B. Murray Lewis and my project was to find the phase difference in the light coming from either side of the expanding dust cloud around OH/IR stars. OH/IR stars are evolved main sequence stars that are in the Asymptotic Giant Branch (AGB) phase of their lives. AGB stars have a pulsation sequence and low surface gravity that combine to cause them to lose mass to the circumstellar environment. Once this material is far enough from the star it condenses into dust in a shell around the star. This dust shell is initially optically thick enough to protect forming molecules from interstellar UV radiation. As the shell continues to get pushed out by radiation pressure though, the density decreases until the molecules are no longer protected. This leads to a series of OH MASERs in the OH/IR stars as water molecules are destroyed. We've undertaken a six year study of the emissions from IRAS 19396+2338 to find the phase shift between the blue- and red-shifted peaks that are coming from the near and far side of the dust shell, respectively. With that we'll be able to work out the size of the circumstellar dust shell and get an excellent measurement of the star's period. One problem with a long term study is the calibration of the telescope you're using so this summer I wrote a FORTRAN code to give the proper calibration values for the telescope as a function of time based on the cal values for the six year period. We also plan to use the ratio of the fluxes of the two peaks rather than the absolute fluxes as much as possible because this quantity is independent of the calibration. The dust shell size and stellar period are crucial inputs into both radiative transfer modeling and models of stellar evolution.

On top of that I had a wonderful time in Puerto Rico. I'd have to say my favorite trip was to the El Yunque rainforest. Myself and 4 other REU students went there and we got to visit with the Biology REU students that were doing research there and they showed us the side of the mountain tourists don't get to see and took us up in the canopy. After that we all went swimming in a nearby pool underneath a waterfall. Then we went over to the tourist side and hiked up to the summit of one of the mountains. We pushed through the cloud layer and it was just absolutely beautiful up there. Other fun trips took us to El Morro (a 500 year old Spanish fort in Old San Juan), a bioluminescent bay, the island of Culebra, and various other beautiful

*By Stephen Messenger*

I spent last summer doing research in astronomy for my Research Experience for Undergraduates (REU) program. I worked with Dr. Vladimir Strelnitski at the Maria Mitchell Observatory, which is located on the island of Nantucket. I researched possible lasing in Fe II lines in gas and dust condensations around the star Eta Carinae in the southern constellation Carinae. I discovered an alternative and simpler explanation for the observed phenomenon, one that does not require complicated processes like previous explanations. My favorite aspect of the REU experience was the variety in the training that I received along with the variety of experiences I had. My REU helped me discover how professional research is conducted, but it did not stop there: I also learned valuable public relation skills, e.g. how to explain my research for the public's enjoyment. I also benefited from visiting and researching at Kitt Peak, which is home to many research telescopes. I also enjoyed meeting and forming lasting friendships with my fellow interns. To top off my whole experience, I spent the entire summer on the beautiful island of Nantucket, with wonderful beaches and amazing walking/biking trails. The REU experience provided me with an excellent opportunity to conduct research and relax at the same time. I am forever grateful for my experiences with the Maria Mitchell organization and I strongly recommend this REU to anyone interested in the field of astronomy.

# Student Accomplishments

**Lanika Ruzhitskaya** and **Josh Tartar** receive the Chambliss Astronomy Achievement Student Award through the American Astronomical Society.

**Jeff Pobst** presents "Undergraduate Research Poster on the Hill". In the *MU News Bureau Release*, May 13, 2008, the honor was described as follows.

As gas prices continue to rise, so does the buzz around alternative fuels. Recently, MU Physics Major Jeff Pobst had a chance to talk to a couple of Missouri legislators about a project that could open the door to widespread use of natural gas as a gasoline alternative.

Jeff Pobst has already completed enough hours to be considered a junior but refers to himself as a sophomore since he's "only in his second year." He instructs a physics lab and contributes to a research project to make the use of natural gas in automobiles more palatable to consumers and car companies.

Pobst was the only student from Missouri selected to participate April 28-30, 2008, in "Undergraduate Research Posters on the Hill" in Washington, D.C. A national committee selected 60 students to present poster presentations to more than 300 registered participants at the U.S. Capitol. Pobst also met with Reps. Kenny Hulshof and Ike Skelton.

Natural gas typically needs to be stored in heavy-walled, high pressure gas tanks at 3600 pounds per square inch. The tanks take up space equivalent to a back seat or trunk.

Enter technology developed by Peter Pfeifer, Pobst's mentor, and colleagues in the Collaborative Research in Alternative Fuel Technology (ALL-CRAFT) program. Their discoveries allow the gas to be stored in a smaller tank under much lower pressure – 500 pounds per square inch. Pobst jokes that in the first lecture he attended with Pfeifer, he kept thinking the physicist was mispronouncing the word "absorption." Pfeifer wasn't.

Adsorption -- the process that Pfeifer spoke about and one that plays a key role in storing natural gas at lower pressure -- is when a gas or liquid adheres to a surface. In this case, natural gas adsorbs to millions of tiny pores in corncobs with chemically activated carbons.

As part of Pobst's work in the lab, he treats the corncobs, tests how much the carbons store and tries to obtain information about pore-size distribution. Pobst says the best pore size is one in which two methane molecules fit side-by-side. If a pore is too small, both won't fit; if it's too large, the non-surface space is wasted.

The type of chemicals, heat and amount of time all play a role in the variation in pore size. "We can tailor our carbons such that the pore size we want is the most probable one or the one that shows up the most," Pobst says.

With a running start on a research career, Pobst says he plans to keep working in Pfeifer's lab. Eventually he wants to be a physics professor, but he's not sure he will continue to study nanoporous materials and adsorption. "All areas of physics, the more I hear about them, the more exciting they get," he says.

# Cosmic Conversations


In September 2007, the Department of Physics & Astronomy inaugurated a new public lecture series called "Cosmic Conversations," in conjunction with the Laws Observatory and the Central Missouri Astronomical Association. The aim of the series is to share the depth and breadth of astronomical inspirations across all areas of human endeavor. Topics covered so far include the Moon, Mars, Saturn, meteorite impacts and extinctions, the lives and deaths of stars, the origin of the elements, archaeoastronomy, astrochemistry, the history of the space shuttle program and the cultural impact of astronomy. Upcoming talks will include speakers on night time photography, Galileo and the sun-centered universe, astronomy and religion, and many other topics. Following each "conversation", the Laws Observatory is open for first-hand viewing of the night sky. "Cosmic Conversations" will provide an excellent venue for involving the public in astronomy during the International Year of Astronomy 2009.

### Gabor Forgacs
*continued from page 4*

distinct tissues of a blood vessel. The fibroblasts migrate to the exterior of the cylinder, the endothelial cells travel to the interior walls, and the muscle cells find their way in between. "The cells know what they are supposed to do," Forgacs says. "This is nature. We just use what nature can do."

Forgacs and his colleagues made a further advance in fabricating blood vessels: printing vessels that branch out from each other as actual blood vessels do. "Nothing prevents us from branching," he says. "There's no method, other than ours at present, than can produce a branched tube." Being able to create systems of branching blood vessels is a critical step towards the goal of fabricating new organs. It's not enough to grow tissues with the shape and function of organs; to survive, new organs must have the vasculature necessary to stay nourished with blood. "It is our most challenging task," Forgacs says. The first use he sees for vascularized organ tissues is as a means for testing the toxicity of new drugs. He is now working with a start-up company, Organovo, Inc. that would market these types of engineered organ tissue to pharmaceutical companies.

(Adapted from *Illumination*, Spring 2008.)

### Fred Hawthorne
*continued from page* 5

Hawthorne attended the Missouri University of Science and Technology from 1944 to 1947, which was then known as the Missouri School of Mines. He received his undergraduate degree from Pomona College in 1949 and his doctorate degree in physical-organic chemistry from the University of California-Los Angeles in 1953. He began to synthesize and study boranes in 1956 while working at Rohm and Haas, one of the largest manufacturers of specialty chemicals. He has held professorships at the University of California-Riverside, UCLA and MU. He also was a long-term editor of Inorganic Chemistry, an international journal published by the ACS. Hawthorne came to MU in 2006 to become the director of the International Institute of Nano & Molecular Medicine. He has been a member of the National Academy of Sciences since 1973 and has won many other awards and honors, including the 2003 King Faisal Prize in Science presented in Riyadh, Saudi Arabia.

"The Priestley Award is a wonderful award to recognize one of the giants of inorganic chemistry," said Richard Eisenberg, a chemistry professor at the University of Rochester who succeeded Hawthorne as editor-in-chief of Inorganic Chemistry in 2001. "It's rare for a chemist to create a field of research and excel in it the way that Hawthorne has done with boron, and he continues to exhibit the incredible enthusiasm for science that serves to make him a great force in chemistry."

The award, which consists of a gold medal and certificate, will be presented to Hawthorne at the time of his Priestley address to members at the Spring 2009 American Chemical Society meeting. The address will describe the work for which he is being recognized, as well as current research activities at MU.

The official dedication of the International Institute of Nano and Molecular Medicine research building and thermal neutron beam line at the MU Research Reactor (MURR) will be held Monday, October 20, 2008. The new thermal neutron beam line at MURR will allow the Institute to explore new chemistry, biology and radiomedicine relevant to boron neutron capture therapy (BNCT) of cancer and dual use in rheumatoid arthritis radiotherapy.

(Adapted from *MU News Release*, June 25, 2008.)

### Peter Pfeifer
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part of President Bush's Hydrogen Fuel Initiative. Co-investigators include physics faculty members **Carlos Wexler** and **Frederick Hawthorne**; Professor Galen Suppes (MU Chemical Engineering); Professor David Robertson (MURR Associate Director for Research); and, through a subcontract, a team of engineers at the Midwest Research Institute (MRI) in Kansas City. Through the DOE award, the University of Missouri has become a member of the DOE Hydrogen Sorption Center of Excellence (HSCoE), led by the National Renewable Energy Laboratory, of the DOE's National Hydrogen Storage Project.

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