Physics and Astronomy
Communiqué
Autumn 2016

Physics Major Romanus Hutchins Speaking of Research

By Maggie Teson

Physics major Romanus Hutchins, an MU sophomore knows it can be challenging to fascinate people with formulas and engage them with equations.

"You can make science sound really interesting," Hutchins says, "and you can also make it sound really boring."

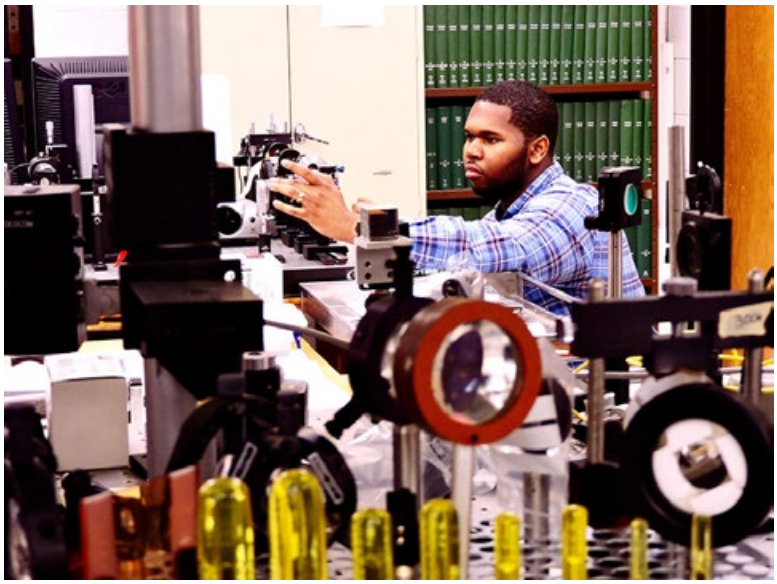
Through his experience as an undergraduate research ambassador, Hutchins has learned how to speak about science in a compelling way as he gives presentations to Freshman Interest Groups, classes, and student organizations about getting involved in undergraduate research.

"A big part of research is public speaking," Hutchins says. "You have to communicate your ideas well enough so people can understand them. As an undergraduate research ambassador, I've been able to sharpen my skills as a communicator."

Michael Cohen, assistant director of the Office of Undergraduate Research, encouraged Hutchins to become an ambassador when he recognized Hutchins' enthusiasm for and motivation to conduct research.

"Romanus is a phenomenal example of a student who sees undergraduate research as a transformational educational experience," Cohen says. "He has the ability to articulate his experience in a context that allows other students to recognize how undergraduate research involvement may positively impact students' educational experiences."

Cohen and Hutchins believe sound speaking skills and captivating presentations play a critical role in inspiring MU students to conduct their own research.



Romanus Hutchins alters the brightness of a laser. His research could lead to the use of lasers to detect cancer cells.

"I used to think research was this big thing that not a lot of undergraduates would be able to do," Hutchins says. "As an ambassador, I know these opportunities exist, but not many people know about them. We have to let people know they have these opportunities, and they should take advantage of them."

Hutchins started conducting research his freshman year. He studies how a laser that was first optically observed in 2007 interacts with biological subjects such as human and animal tissue. He believes the laser could be a useful tool in detecting cancer cells.

In May 2015, Hutchins presented his research at the Conference on Lasers and Electro-Optics (CLEO) in San Jose, California. CLEO is the premier international forum for scientific and technical optics. Attendees, including Hutchins, had the opportunity to share research and ideas and to network with industry leaders.

On March 15, Hutchins used his speaking experience to present his

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Chair Chat

By Sashi Satpathy

Dear colleagues, alumni, and friends:

One of the things that we physicists thrive on is a challenge: The challenge of developing a new theory to explain the latest observation or predict new phenomena, the challenge of designing new experiments to unravel the mysteries of the universe, the challenge of communicating the foundations of our science to young minds and the public at large, and so on. This is what we live for and relish. Day after day. And, we would not have it any other way. As soon as one challenge is overcome, another emerges in its place. A good research paper always generates new questions, even more challenging than the one it solved, and exposes brand new territories, to be explored and conquered.

And so it is also for the department. Events of the past year at the university, largely beyond our control, coupled with the dwindling state funding and a reduction in the student enrollment, have led to many challenges for us and for the university. There has been a dramatic change in the leadership at all levels. Our previous dean, Michael O'Brien, left for Texas A&M University–San Antonio, and Pat Okker is serving as interim dean of the College of Arts and Science. In addition to her, we have also an interim president as well as an interim chancellor, to whom we must communicate afresh our unflinching resolve for excellence and growth.

In the midst of these challenges, the physics department has thrived. Guang Bian, a budding young experimenter, moved from Princeton to join us this fall. We have an ongoing search for an astrophysics faculty member to work in collaboration with the University of Western Cape and the Square-Kilometer-Array in South Africa. Many of our faculty members have received national and international recognition, described in this newsletter. Two of our faculty members were promoted this year. **Debi Hanuscin** was promoted to full professorship and **Haojing Yan** was awarded tenure and promotion to associate professorship. Our congratulations to them, and we wish them all the best in their future endeavors.

Among other departmental news, in October last fall, we had our first department reunion, which was quite successful, with over a hundred alumni and friends attending. We hope to continue doing this periodically, perhaps every five years or so. Other big news is the upcoming total solar eclipse on August 21, 2017, and Columbia is among the handful of towns on the path of the eclipse. Angela Speck is organizing a number of activities in connection with this.

Amid the ongoing challenges, our goals remain unchanged: To excel in the science we do and in the education we provide for our students and to serve the university community and the nation at large. At the same time, we remain committed to nurturing a vibrant, intellectual, collegial, and inclusive atmosphere in the department, where our students receive the best education possible and where the members of our faculty flourish as accomplished researchers and teachers. I wish all of us continued success in the upcoming year.

Postdoc News

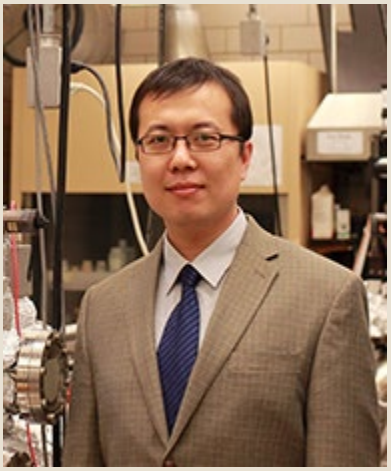
Krishna Sigdel, a postdoctoral researcher in the Gavin King laboratory, received a Burroughs Wellcome Fund Collaborative Research Travel Grant in spring 2016. This program provides support ($5,000) to fund academic scientists' travel to another lab to learn new research techniques or begin or continue a collaboration to address biomedical questions. Sigdel plans to travel to the University of California, Irvine to continue a collaboration with Professor Stephen White and members of his group, which focuses on the fundamental biophysics of peptide-lipid interactions.

CONGRATULATIONS!

Welcome to Guang Bian

Hello everyone, this is Guang Bian. I am so happy to join our Mizzou physics and astronomy family this fall. I have been trained as a condensed-matter experimentalist at the University of Illinois at Urbana–Champaign and Princeton University. Now I am initiating a quantum-materials research group here at MU with the support of our department.

Our research effort focuses on precise fabrication and spectroscopic characterization of low-dimensional quantum systems and novel topological/functional materials. We are interested in various physical properties of these systems, including their growth mechanism, electronic and magnetic structure, surface and interfacial physics, and quantum size effects. Our primary techniques for investigating these systems are angle-resolved photoemission spectroscopy and molecular beam epitaxy. We also perform extensively theoretical modeling and simulation ourselves and in collaboration to gain comprehensive understanding of structural and electronic properties of quantum materials under our measurements. We invite you to visit our lab and seek collaborations in a quest for new physics in solid materials.



Best regards,
Guang

Hutchins Speaking of Research

Continued from front page

research at the Missouri state capitol in Jefferson City. He was part of a group of undergraduate researchers that shared research with legislators and members of the general public as part of University of Missouri Undergraduate Research Day at the Capitol.

"I've made it to a point where I could talk to anyone about my research," Hutchins says. "I know these are busy people, and some of them may not be too interested in what I have to say, but part of my job is to help people understand my research and to make it interesting."

Along with being an undergraduate research ambassador, Hutchins participates in the Exposure to Research for Science Students (EXPRESS) Program, which is an Initiative for Maximizing Student Development (IMSD) program designed to encourage underrepresented minority students to pursue a career in biomedical research.

"There is a need for diversity in science," Hutchins says. "There are always different approaches to problems, and people with different backgrounds and experiences approach problems differently."

Hutchins and other participants attend weekly professional development workshops and receive funding to gain research experience with a faculty mentor in the science department of their choosing.

"I always tell my students that we're not Match.com," Brian Booton, IMSD EXPRESS Program coordinator, says. "We don't match students with a research lab. We give them tools and resources to identify research groups that align with their interests and assist with the interviewing process."

Within EXPRESS, Hutchins is founder and chair of the STEM Community Outreach Initiatives Committee. He and other members of the committee visit Lange Middle School in Columbia once a month to conduct an after-school program for students. Committee members work with MU faculty to create lesson plans and then guide the middle school students through a series of science experiments.

"Romanus has shown tremendous leadership in not only working with school administrators and science teachers to secure volunteer sites, but also in his ability to rally his peers to participate in a meaningful mentoring activity," Booton says.

Both Cohen and Booton agree that Hutchins' leadership and communication skills make him an asset to the programs in which he is involved. "Romanus is a natural-born leader who works to constantly improve himself and develop the people with whom he interacts," Cohen says.

Hutchins' work is done under the mentorship of Ping Yu. Hutchins' abstract "The Size Effect on Optical Scattering of Airy Beam for Biomedical Imaging Application" was accepted by the 2016 Annual Biomedical Research Conference for Minority Students. He will attend and present at the conference November 9–12 at the Tampa Convention Center in Tampa, Florida.

Capturing Wasted Energy

Professor David Singh

By Jordan Yount, College of Arts and Science

Each time you drive your car, about one-third of the gasoline your engine burns is not used to propel the vehicle forward. Instead, that energy just goes out the exhaust pipe in the form of heat. In fact, Professor **David Singh** says about half of all of the energy consumed in the United States results in waste heat. Singh and his colleagues have been trying to find ways to harness that waste heat and convert it into electricity using thermoelectric materials.

Thermoelectric materials are materials that produce usable electrical power when heat flows through them. This solid-state energy conversion does not involve moving parts, and, instead, thermoelectrics are heat engines that use electrons as their working fluid. They can be used for generating power from heat sources, in reverse for cooling applications, or in a mixed mode for precise temperature controllers. Singh has been studying thermoelectrics for more than a decade, beginning with his research for the Navy, which sought cooling systems for submarines.

"The problem with thermoelectrics is that they are not very efficient, so the amount of electricity you get is not that large," Singh says. "The big goal in thermoelectrics research is to find materials that would give you better efficiency." Singh and his fellow researchers have published an article in *Advanced Materials* showing that very low amounts of sulfur doping in a material (bismuth telluride selenide) can improve both the conductivity and the thermal power of a thermoelectric material.

"The challenge in thermoelectrics is you need a material that produces a high voltage and, at the same time, has a low resistance or a high conductivity," Singh says. "You need both of those things, but usually when you do something to a material, you increase one at the expense of the other. Our article reports a way to increase both."

Singh says thermoelectrics are used in a variety of applications, such as power supplies for the *Voyager* and *Pioneer* spacecraft. Those craft carried plutonium pucks that produced heat as they decayed, and that heat was converted to electricity with thermoelectric materials. Some high-end wine coolers, which do not vibrate because there is no compressor, use thermoelectrics. He says that lack of vibration is also important in certain military applications.

Singh and his colleagues are now trying to find other materials that operate in different temperature ranges, and they also are exploring different classes of materials such as oxides and new kinds of semiconductor materials. He says the key to thermoelectrics is that they are scalable.

"That's the special thing," he says, "If you want to make a very small device, thermoelectrics becomes the only way to go. As you scale down most technologies for energy conversion, they stop working. You can't make a tiny air conditioner by scaling down, for example, but you can make a thermoelectric device that small."

Reunion Celebrated 50 Years

The Department of Physics and Astronomy held its first reunion on October 15–16, 2015. About 100 guests, including 30 alumni and past faculty along with their friends and family, came for the two-day event to reminisce and hear about the latest department research and activities.

Visitors enjoyed the hospitality room, lab tours, a campus tour, and *PhD Movie 2* on Friday. The primary social event was the Friday-evening dinner at the Reynolds Alumni Center with plenty of opportunities to share memories of past times in the department. Following Saturday-morning presentations, including meeting with then-A&S Dean Mike O'Brien, visitors and department members concluded the reunion events with a Pies, Brews, and Friends social at Orr Street Studies, a downtown art venue.

Graduate student Matt Prosniewski, Henry White (background), Suchi Guha, and Carsten Ullrich enjoy pie and conversation at Orr Street Studios.

Kattesh Katti: India's Person of the Year

Radiology & physics professor recognized for decades of work with green nanotechnologies

By Diamond Dixon, Media Relations Coordinator, MU Health System

Kattesh Katti stepped foot on the University of Missouri campus 26 years ago, eager and excited for the opportunity to apply his knowledge of chemistry to medicine. Now, the Indian-born scientist is the Curators' Professor of Radiology and Physics, director of the MU Institute of Green Nanotechnology, and Margaret Proctor Mulligan Distinguished Professor of Medical Research at the School of Medicine. He most recently was named the 2016 Person of the Year in Science by *Vijayavani,* the leading daily newspaper in his hometown of Karnataka.

Curator's Professor Kattesh Katti

What sets Katti apart from most scientists in the Western world is his ability to merge the traditional Indian holistic medicine of Ayurveda with the science of green nanotechnology. According to the National Institutes of Health, Ayurvedic medicine, which originated in India, is one of the world's oldest medical systems and uses herbal compounds, special diets, and other unique health practices to combat the spread of certain diseases.

"My latest recognition by *Vijayavani* validates the quality of interdisciplinary translational medical research being carried out at MU," Katti says. "This will help advance nano-Ayurvedic medicine products to applications that can be used to cure and treat patients across the world."

Katti has dedicated his career to discovering new ways to use gold nanoparticles and "green" technologies such as phytochemicals from tea, soy, cinnamon, and other common herbs and fruits, as non-toxic alternatives to treating cancer, arthritis, and other debilitating diseases.

While Katti has spent decades conducting research to prove green technologies are a non-toxic alternative to treating cancer, his journey recently became more personal when his mother was diagnosed with an inoperable tumor.

"Being named Person of the Year in Science is a bittersweet moment for me, as my own mother, who instilled the values of truthfulness and dedication and always saw in me the firepower to rise to the top, has been suffering now from an inoperable tumor," Katti says. "I dedicate this award to my mother, my hero, as she has shaped my life and career."

There is global excitement about Katti's new approach to holistic medicine: Several countries, including Australia, Brazil, Germany, India, Indonesia, Singapore, the Netherlands and more, have recognized him for his pioneering efforts.

One of Katti's research collaborators, **C.M. Joshi,** MD, consulting physician at the Specialty Ayurveda Clinic in Karnataka, India, said Katti's green-nanotechnology research provides a scientific justification to Ayurvedic medicine. Joshi is working with Katti to bring nano-Ayurvedic medicine products to clinics in India.

Katti's future research plans include transitioning from using nano-Ayurvedic treatment methods on small and large animals to human patients in India.

"We already have compelling data from small and large animals that our approach of nano-Ayurvedic medicine through green nanotechnology works highly effectively in treating tumors and other diseases in animals," Katti says. "We are now collaborating with specialist Ayurvedic medicine doctors in India to initiate clinical trials in human patients."

Now, 26 years after accepting the faculty position at MU and tireless efforts to increase awareness of his nano-Ayurvedic approach, Katti says there is a unique opportunity to make MU an epicenter of excellence in holistic, nano-Ayurvedic medicine.

"The best is yet to come," Katti says. "We are on the cusp of creating a renaissance of nano-Ayurvedic medicine through our scientific discoveries in green nanotechnology to save millions of lives across the world."

APS Bridge Program

The department's membership application to the American Physical Society's Bridge Program has been approved! The Bridge Program's goal is to enhance diversity in graduate physics programs (http://www.apsbridgeprogram.org/). Membership allows us to be part of a network of institutions working to improve diversity in physics.

Congratulations to **Silvia Bompadre** who spearheaded the application process and also to **Angela Speck, Carsten Ullrich, Carlos Wexler,** and **Karen King,** who put together the application.

Wexler and Bompadre, who jointly oversee the undergraduate program, will also oversee the Bridge Program.

News from Our Professors

Silvia Bompadre was nominated by student athlete and physics major **Bri Porter** to be recognized for her great teaching at the annual Mizzou Women's Basketball team's Faculty Appreciation Game on Dec. 7, 2015.

Professor Emeritus **Gabor Forgacs** was named a fellow of the National Academy of Inventors, December 2015.

Shubhra Gangopadhya was named a fellow of the National Academy of Inventors, December 2015. Gangopadhyay was also selected to be a program director at NSF through the Intergovernmental Personnel Act. She relocated to the Washington, D.C., area in the fall semester 2016 for the one-year, and possibly two-year, appointment.

Deborah Hanuscin was promoted to full professor.

Fred Hawthorne was named a fellow in the National Academy of Inventors, December 2015.

Kattesh Katti was named India's Person of the Year in Science for 2016. He was awarded the internationally famed Royal Melbourne Institute of Technology Foundation Fellowship for 2016 and was featured in Stanford School of Medicine's winter 2016 edition of *Precision Health* magazine in which he discussed how gold nanoparticles can be used to kill cancer.

Sergei Kopeikin continues to work on the chronometric-leveling problem, which is a new technology for measuring the gravity equipotential surface (geoid) with the help of ultra-precise atomic clocks. The technology uses the basic principles of general relativity because the clock's rate is defined by the strength of the gravity potential. His research team from the Siberian State University of Geosystems and Technology has conducted under his supervision an experiment with atomic clocks in the Altai Mountain area to test the principles of the chronometric-leveling technique. Five papers were published in 2016 on this subject—one of them in *Physical Review D*. In response to the call of NSF, Kopeikin has been working on measuring the universal gravitational constant (Big G) with a team of American and German scientists including **John Anderson** (NASA JPL), **Gerald Schubert** (UCLA), **Virginia Trimble** (UCI), **Claus Laemmerzahl** (ZARM, Bremen), and others. A detailed proposal has been published as a separate paper in the *Journal of Classical and Quantum Gravity*. Kopeikin is a member of the international team of four co-authors (USA, Russia, Ukraine, and Turkey) working on a new book, *Perturbations in Metric Theories of Gravity: Derivation and Conservation Laws*, that will be published by Walter De Gruyter Publishing House at the end of 2016.

Peter Pfeifer reports that the final report for his California Energy Commission project ($1.4 million) was published in June: "Advanced Natural Gas Fuel Tank Project," California Energy Commission, Energy Research and Development Division, Publication No. CEC-500-2016-038. http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2016-038

Congratulations to **David Singh** for the excellent news coverage on his research and for publishing his 500th paper (this milestone accomplished from Mizzou!). http://munews.missouri.edu/news-releases/2016/0505-internationally-recognized-physics-researcher-joins-faculty/

Angela Speck received an MU Faculty Achievement Award in Diversity.

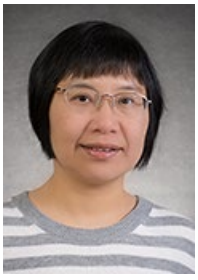
This fall, Professor **Carlos Wexler** is a Fulbright Specialist in Physics Education at the National University of San Luis, Argentina. He will also be an Erasmus Scholar at Aix-Marseille University in France in the Erasmus Mundus Joint Master Degree "Materials for Energy Storage and Conversion" of the European Commission.

Congratulations to **Haojing Yan** for his tenure and promotion to associate professor. Haojing recently had a large observing program approved at NASA's Spitzer Space Telescope. These observations,

News from Our Professors

Continued from previous page

to be made between October 2016 and February 2017, are to carry out a preparatory study for a very large program at the James Webb Space Telescope (JWST), NASA's next-generation space telescope to be launched in 2018. Haojing is a co-investigator on this guaranteed-time JWST program (100 hours), dubbed Webb Medium-Deep Fields (WMDF), whose main goal is to search for the very first batch of galaxies ("First Galaxies") that emerged in the very early universe (likely only one to two hundred million years after the Big Bang). Haojing has also been engaged in a renovation project to make the Laws 16-inch telescope suitable for training our undergraduate students. He obtained a $3,300 grant from MU's Richard Wallace Faculty Incentive Grant to start Phase 1 of the project, which was to equip a CCD camera to the telescope. He is working in close collaboration with two brothers, Valentine and Farrell Germann, both members of the Central Missouri Astronomical Association. They achieved "first-light" on June 29, and Phase 1 will conclude by December 2016.



Congratulations to **Xiaoqin Zou** for being chosen as the recipient of a 2016 Chancellor's Award for Outstanding Research and Creative Activity.

News from REU Group

By Karen King

MU's Research Experience for Undergraduates in Physics: Materials and Modeling hosted 10 interns this summer from 10 different undergraduate institutions. They worked on research projects ranging from modeling star dust, to developing "green" nanoparticles, to creating a patch clamp to measure current across cell membranes. We enjoyed a field trip to Jordan Valley Innovation Center, where the students toured microelectronics facilities, with an enjoyable detour at Ha Ha Tonka park. The REU summer program culminated in oral and poster presentations by the students.

REU physics interns at Ha Ha Tonka, from left: Mitchel Vaninger, Miles Thies, Payton Beeler, Breta Phillips, Emily Koballa, Charlie Winborn, Reed Kolany, Derek Tang, and Zack Miller.

Zack Miller is surprised by the electron microscope's ability to represent Lincoln's statue in the penny.

The All-American Eclipse

Don't get left out of the dark

By Angela Speck

On August 21, 2017, the sky will go dark in the middle of the day for a vast swath of the United States. Mizzou is right in the middle of this once-in-a-generation spectacle.

To understand why this eclipse is so important, we need some perspective. There is a total solar eclipse approximately once a year somewhere on the planet, but the zones of visibility are often over water or over countries which are considered unsafe for travel by westerners. This eclipse is so much more accessible, it will undoubtedly draw big crowds.

Historically Speaking

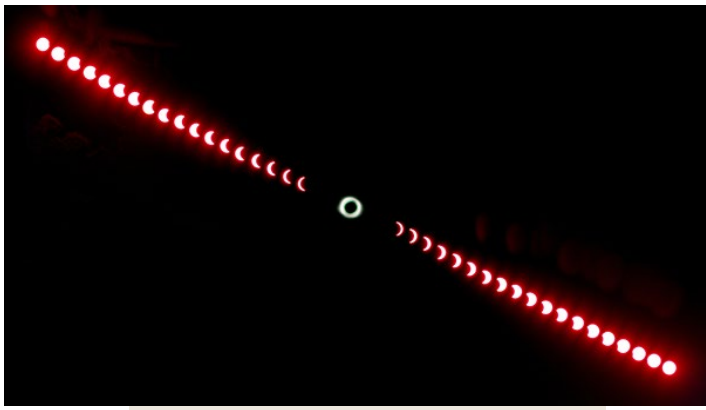
This upcoming solar eclipse is the first to be visible from *only* the U.S. since before the U.S. was a country. There have been a number of total eclipses that have impinged on the continental U.S., but when the path of totality (the zone in which a total eclipse can be seen) is only 100 miles wide, the area covered in each case is small. The last total solar eclipse visible anywhere in Missouri was in 1839, but it could only be seen from the northernmost part of the state. The last total solar eclipse to come near Columbia or St. Louis was in 1442!

For this coming eclipse, the path of totality runs from Oregon's Pacific coast to the Atlantic coast of South Carolina. Twelve million people live in the path of totality; 88 million live within 200 miles! The entire population of the nation is no more than a long day's drive from the path. Even if only 4 percent of the U.S. population outside the path of totality travels to the path, that will double the population in most areas, and this does not include the influx of foreign visitors.

Safety First

Awareness of eye safety is very important when viewing an eclipse. During the total phase of the eclipse, it is safe to watch without any special equipment. The sky is approximately as dark as a full moon night and one will see the outer atmosphere of the sun, the corona, usually invisible to us, along with some of the chromosphere (see Figure 1).

During the partial phase, as the moon transits across the face of the sun, the sun is too bright to view without protection. One needs to use eclipse glasses or some sort of projection technique (e.g., a pinhole camera). Mizzou eclipse glasses can be purchased through the University Bookstore: https://www.themizzoustore.com/p-203258-eclipse-glasses-umc-consignment-august-2017.aspx



A series of time-lapse photos of the Aug. 1, 2008, total solar eclipse that could be seen from Canada, Greenland, Russia, Mongolia, and China. This imaging was done in Novosibirsk, Russia. Note that the position of the sun in the sky moves from left to right in the photo, i.e., east to west, as Earth rotates while the moon transits across the sun from right to left as it moves in its orbit around Earth. Until totality (the central subimage), safety eyewear is needed to directly view the sun.

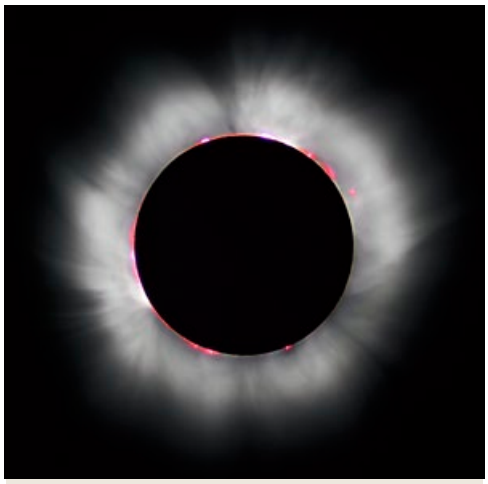


Figure 1: Image of the last total solar eclipse to be visible from the U.K. on Aug. 11, 1999. Photo taken in northern France. The white glowing streamers are the corona; the pink glow comes from H-alpha transitions (n=3→2 in atomic hydrogen) and is the reason for the chromosphere's color.

Citizen Science

Eclipses are significant in history, culture, art, as well as science. Scientists will not only be engaging in cutting-edge science that cannot be achieved any other way, but they will be harnessing the power of the U.S. population through citizen science. There are several science experiments planned that are achievable only because so much of the path of totality is over land. There are several groups that will repeat and enhance the original Eddington experiment to test general relativity, which was published in 1915, and its first experimental test was achieved by Eddington in 1919 observing how stars appear to be shifted as their light passes close to the sun. In 2017, we have much better technology for capturing light, and with the ability to take many images over the 90 minutes that the eclipse will be over land, we can go much deeper and see stars whose light passes even closer

to the sun that ordinarily cannot be imaged. A big citizen science experiment is Citizen CATE (https://sites.google.com/site/citizencate-experiment/), which will have 60 observing locations along the path of totality. The resulting data set of images will allow scientists to probe the dynamics of the magnetic field as manifested in the corona. Another set of experiments will use a similar, but sparser, distribution of observing sites along the path to collect spectroscopic data from the corona and probe the detailed energy structures in the plasma.

The MU Department of Physics and Astronomy is actively involved in educating both the general public and the educational community about this unique event.

Our department welcomes any returning alumni for the eclipse. Please let us know if you are coming by calling 573-882-3335 or by emailing umcasphysics@missouri.edu.

See missouri.edu/eclipse/ for details on the event.

NAI Inducts Three New Fellows from Department

The National Academy of Inventors named 168 leaders of invention and innovation to fellow status. The announcement in December 2015 included three professors associated with the Department of Physics and Astronomy: Gabor Forgacs, Shubhra Gangopadhyay, and Fred Hawthorne.

http://us2.campaign-archive2.com/?u=a29770d10dce5eabc93a56c59&id=7e4d87084c&e=29a78d1edc

Other prior members are Kattesh Katti, selected in 2014, and R. Bowen Loftin, selected in 2012.

By Alec Pickett, PAGSA president

Volunteer Service

In November 2015, members of the Physics and Astronomy Graduate Student Association (PAGSA) spent part of their weekend volunteering at The Food Bank for Central & Northeast Missouri in Columbia. They helped bag snacks for schools in Missouri to supply to children from low-income families. These children may not be able to afford to bring a lunch every day, so the food bank helps out and always welcomes volunteers. PAGSA enjoyed lending a hand and working with other volunteer groups to pack as many snack bags as quickly as they could for a friendly challenge.

Social Events of 2016

2016 has been a great year for social events. The annual fall and spring picnics are enjoyable for everyone in the department. This year, PAGSA organized its very first ski trip to Crested Butte, Colorado. Five members went on this trip, March 27–31, and had a phenomenal time with three full days on the slopes! We will definitely be looking to bring more members in 2017! In addition to the ski trip, PAGSA had its second annual float trip on July 30. Four members, accompanied by 11 friends, went to Blue Springs Ranch outside of Bourbon, Missouri, to float down the Meramec River for a day of fun and relaxation. Participation since last year is up, and we are excited to see how many members we can get involved next year!

PAGSA skiers

PAGSA News

New Students

This fall, we've welcomed eight new graduate students to the department as well as three other students who joined in the spring semester.

Student Awards

PAGSA congratulates members **Masoud Valizadeh, Jesse Kremenak,** and **Matt McCune** on their award wins this past spring. Valizadeh was the recipient of the Teaching Assistant (TA) Choice Award for the second semester in a row. The TA Choice Award is an opportunity for students to recognize a teaching assistant who has gone above and beyond what is expected of a teaching assistant.

From left: Alec Pickett, Zack Buck, Anna Pittman, James Jones, Joe Schaeperkoetter, Erica Hroblak, Alex Daykin, James Torres, Tina Matin, and Matt Prosniewski.

Jesse Kremenak was the recipient of the Sandra K. Abell Science Education Award recognizing the outstanding achievements of a graduate student pursuing doctoral studies in any science discipline who has demonstrated a dual passion for research and teaching. Kremenak has truly shown a commitment to education through his involvement as an instructor with the Quality Elementary Science Teaching (QuEST) program, whose goal is to improve the quality of elementary science teaching.

Matt McCune was the recipient of the GSA Outstanding Graduate Student Award. This award recognizes graduate students who go above and beyond what is expected of a graduate in a particular department, such as how a graduate student exhibits leadership, service, good work ethic, and takes initiative to advance the program. McCune has shown all of this during his time as a graduate student at Mizzou. He has served in a leadership capacity with groups such as the Graduate Professional Council, Graduate Student Association, Associated Students of the University of Missouri, as well as with PAGSA. Nationally, he also serves as the director of legislative affairs in the Southcentral Region, which is an eight-state region, for the National Association of Graduate–Professional Students (NAGPS).

From top: Masoud Valizadeh, Jesse Kremenak and Associate Vice Chancellor for Graduate Studies Leona Rubin, and Matt McCune and GSA President Kenneth Bryant Jr.

Scholarship Recipients

Many scholarships, awards and other funds have generously been established and supported by our alumni. These students are the recipients of those funds and awards for the academic year 2016–17:

Undergraduate Students

Rose Marie (Rice) Dishman Endowed Scholarship in Physics
Romanus Hutchins

Eli Stuart Haynes and Nola Anderson Haynes Scholarship Fund
Frederick Cropp and Peter Kampschroeder

Melvin Y. Mora Undergraduate Scholarship Fund
Olivia Ledford, Kara Schrand, and Abigail Warden

Donald L. and Lona Lewis Packwood Endowed Undergraduate Scholarship Fund in Physics
Ian Crawford-Goss, Brendan Marsh, and Michelle Wickman

Guy Schupp Scholarship Fund
Adam Smith

Clifford W. Tompson Scholarship in Physics
Pierce Bloebaum, Abuzar Mahmood, and Conner Wolenski

Dr. Eugene B. Hensley Scholarship Fund in Physics
Joshua Miles and Supawadee Pongsua

Ernest W. Landen Fellowship in Physics
Zachary Jermain

Paul E. Basye Undergraduate Scholarship
Brett Heischmidt, Richard McClure, Angelynn Simenson, Kolton Speer, and Sarah Van Hoesen

Newell S. Gingrich Physics Scholarship Fund
Jonathan Becker

Nine physics undergraduate students also received College of Arts and Science scholarships in 2016–17:
Pierce Bloebaum
Ian Crawford-Goss
Frederick Cropp
Michael Dotzel
Brett Heischmidt
Zachary Jermain
Abuzar Mahmood
Abigail Warden
Conner Wolenski

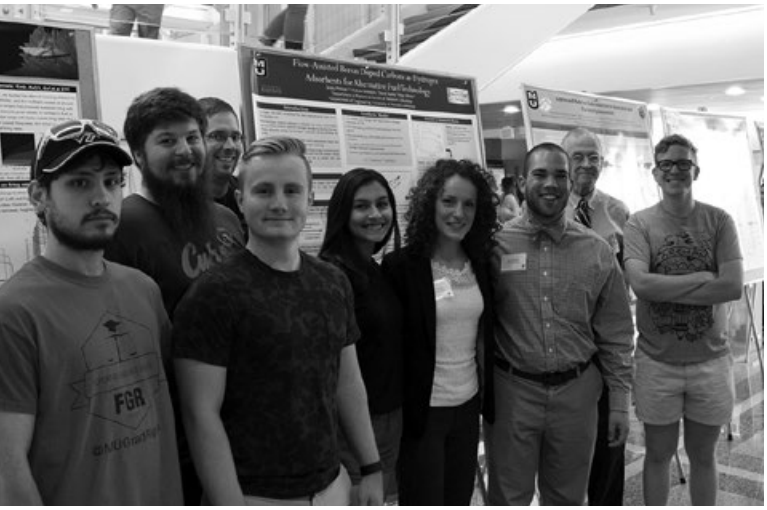
Graduate Students

Fishman Graduate Student Travel Fund
Jacob Brown
Zack Buck
Nagaraju Chada
Ashutosh Dahal
Andrew Gillespie
Shahrzad Karimi
Scott Kissinger
Amrit Laudari
Zhiyuan Ma
Tina Rezaie Matin
Matt McCune
James Runge
David Stalla
James Torres
Mohammad Valizadeh

Harry E. Hammond Prize in Physics
Gregory “Scott” Kissinger

O. M. Stewart Summer Scholarship
Sean Baldridge
Arka Banik
Nagaraju Chada
Kanokporn Chattrakun
Ashutosh Dahal
Alexander Daykin
Kelly Gnadinger
Cory Honer
James Jones
Chenxiaoji Ling
Eddie Maldonado
Anna Pittman
Matt Prosniewski
Mohammad Valizadeh
Fengfei Wang
Richard Williams

Peter Pfeifer Receives FastTrack Award

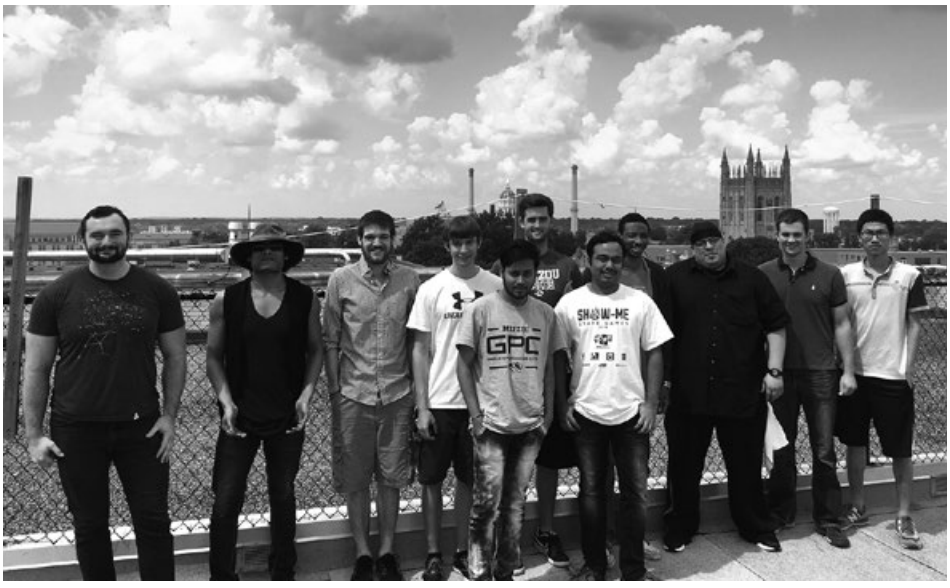


Peter Pfeifer's research group in front of the REU display. From left: MU physics graduate students Matt Prosniewski, Ernie Knight, and Andrew Gillespie; MU physics undergraduates Kolton Speer and Amrit Bal; REU students Breta Phillips and Zack Miller, Professor Peter Pfeifer, and MU physics undergraduate Adam Smith.

Professor **Peter Pfeifer** received a 2015 FastTrack award, under which the University of Missouri System Office of Research and Economic Development funds "development, testing, prototype construction, or specific market research" to move university inventions farther down the commercial pipeline. The $50,000 award is for an upgrade of the adsorbed natural gas tank for low-pressure storage on next-generation clean vehicles, which Pfeifer's team built and put into service in 2014 under a $1.3-million California Energy Commission contract. The core of the tank is monolithic carbon, originally made from corncob, with world-record storage capacity. Two patents have been issued for the production of such carbon and have generated two licenses. The licenses are for on-board, low-pressure storage of natural gas as engine fuel on vehicles and for large-scale transport of natural gas in virtual pipelines, respectively. The FastTrack award funds an upgrade of the 2014 tank to a test rig for measurements of heat transfer, adsorbent durability, fueling rates, etc. It will support current and future licensees (aerospace, maritime shipping of natural gas, portable power sources) in first-to-market commercial products.

The tank technology for low-pressure storage of natural gas on vehicles, developed in Peter Pfeifer's lab, was showcased at the sixth annual Missouri Tech Expo, Oct. 15, 2015. Adsorbed Natural Gas Products, Inc., holds a license for commercialization of the technology for light-duty and heavy-duty vehicles. Bob Bonelli, founder and CEO of ANGP, gave a keynote presentation, "The Next Big Thing," about the roadmap for the first commercial fuel tanks to reach the market in 2016.

Numerous graduate and undergraduate students have worked in Pfeifer's lab. He supported two Research Experience for Undergraduates students for summer 2016: **Breta Phillips,** of University of Kansas, and **Zack Miller,** of Furman University.



Our New Graduate Students

From left: Cory Honer, Arka Banik, Alex Bretaña, Sean Fayfar, Pratik Suha, Griffin Johnson, Aditya Putatunda, Rodney Helm, Eddie Maldonado, Travis Hurst, and Yuanzhe Zhou. Honer, Maldonado, and Banik joined the department for the spring 2016 semester, the others joined the department this fall.

QuEST Program

The MU Quality Elementary Science Teaching (QuEST) program, funded by the National Science Foundation held its summer institute for fifth-grade teachers July 11–22. QuEST is unique in that it is a practicum-based professional development program. A kids' summer camp, held the mornings of July 18–22, served as a practice-teaching experience for teachers to collaborate and implement their new knowledge and skills. 100 elementary-age students from the Columbia area participated, including 15 students from the Columbia Housing Authority's Moving Ahead Program. This year's topic was Properties and Changes in Matter, a focus of the newly adopted Missouri Science Learning Standards. The QuEST program, which began in 2007 with a grant from the Missouri Department of Higher Education, is now in its third year of NSF funding, which is supporting a longitudinal research study of the program's impact on teachers and their students. Principal investigator **Deborah Hanuscin,** jointly appointed in the Department of Physics and Astronomy and the Department of Learning, Teaching, and Curriculum in the College of Education, collaborated with Assistant Teaching Professor **Karen King** and doctoral students **Jesse Kremenak** and **Rik Williams** to provide content instruction to teachers. The curriculum they developed, which is designed specifically for teachers as adult learners, has the potential for use in undergraduate science courses for education majors.

Elementary students attended a week-long science camp to learn about matter from teachers who participated in the NSF-funded Quality Elementary Science Teaching program.

Alumni News

Congratulations to **Pencheng Dai,** PhD '93, who received the Neutron Scattering Society of America 2016 Sustained Research Prize with the citation: "For his sustained and foundational contributions, which have elucidated the magnetic properties of iron-based superconductors, cuprates, and other correlated electron materials."

Dai earned his doctorate under the direction of Professor Emeritus **Hak Taub** and is a professor at Rice University in the physics department working in condensed-matter physics.

Researchers Take First Steps to Create Biodegradable Displays for Electronics

By Sheena Rice, MU News Bureau

Americans, on average, replace their mobile phones every 22 months, junking more than 150 million phones a year in the process. When it comes to recycling and processing all of this electronic waste, the World Health Organization reports that even low exposure to the electronic elements can cause significant health risks. Now, University of Missouri researchers are on the path to creating biodegradable electronics by using organic components in screen displays. The researchers' advancements could one day help reduce electronic waste in the world's landfills.

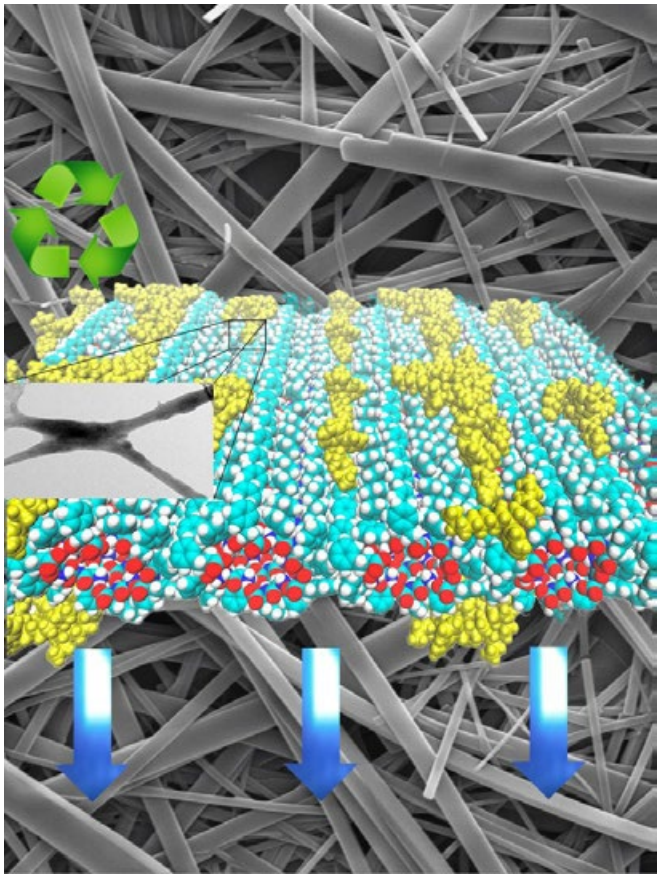
"Current mobile phones and electronics are not biodegradable and create significant waste when they're disposed," says **Suchismita Guha,** professor in the Department of Physics and Astronomy. "This discovery creates the first biodegradable active layer in organic electronics, meaning—in principle—we can eventually achieve full biodegradability."

Guha, along with graduate student **Soma Khanra,** collaborated with a team from the Federal University of ABC (UFABC) in Brazil to develop organic structures that could be used to light handheld device screens. Using peptides, or proteins, researchers were able to demonstrate that these tiny structures, when combined with a blue-light-emitting polymer, could successfully be used in displays.

"These peptides can self-assemble into beautiful nanostructures or nanotubes, and, for us, the main goal has been to use these nanotubes as templates for other materials," Guha says. "By combining organic semiconductors with nanomaterials, we were able to create the blue light needed for a display. However, in order to make a workable screen for your mobile phone or other displays, we'll need to show similar success with red- and green-light-emitting polymers."

The scientists also discovered that by using peptide nanostructures they were able to use less of the polymer. Using less to create the same blue light means that the nanocomposites achieve almost 85 percent biodegradability.

"By using peptide nanostructures, which are 100 percent biodegradable, to create the template for the active layer for the polymers, we are able to understand how electronics themselves can be more biodegradable," Guha says. "This research is the first step and the first demonstration of using such biology to improve electronics."



The illustration shows a theoretical simulation of the distribution of the polymer on peptide nanotubes and an electron microscopy image of the nanocomposite. Courtsy of Suchi Guha, University of Missouri

The study "Self-assembled Peptide-polyfluorene Nanocomposites for Biodegradable Organic Electronics" recently was published as the inside cover article in *Advanced Materials Interfaces.* The work was supported by the National Science Foundation (Grant IIA-1339011) and CNPq (400239/2014-0). The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Tommi White, assistant research professor of biochemistry, and **Thomas Lam,** both with the Microscopy Core Research Facility at MU, contributed to the study. Other collaborators include **Wendel A. Alves** and **Thiago Cipriano,** professors of supramolecular chemistry at UFABC; and **Eudes E. Fileti,** a professor of physics at the Federal University of São Paulo, Brazil.

Read more at: http://phys.org/news/2015-10-biodegradable-electronics.html#jCp.

Alumni Focus:
The Automation of the Physics Department

By Robert Cunningham, MS '66, PhD '70 physics

The big boxed item pictured in the bed of the physics department pickup truck is a computer that was built by Digital Equipment Company in Boston in 1970. I was in a postdoctoral activity working with the dual arm neutron diffractometer at the MU Research Reactor. The electronics for the diffractometer used a punched paper tape to control the change of the scattering angles.

The Department of Physics ordered a computer that could be programmed to punch a paper tape for the diffractometer as well as to assist with other automation needs in the department. In August 1970, I went to Boston to learn how to program the computer and to bring it back. It had 8 KB of memory. The people in Boston didn't think it was a good idea to put it on a skid in the back of an open truck, but I had taken along tools and parts, such as a drill, bolts, nuts, rope, etc., from the shop to bolt it and tie it to the truck. Digital Equipment Company covered it in plastic. I had to be careful not to drive into a parking area, gas station, underpass, etc., with a low-hanging roof and hit the computer. It stood about 8 feet tall on the skid.

I arrived back on campus late at night. With a few phone calls, I got the maintenance department to come and unlock one of their buildings with a tall door to park the pickup with the computer in it for the night. I had to promise to get it out of the building the first thing in the morning.

When I arrived at the Physics Building loading dock, the question was, "Who is going to drive the forklift to move the computer to the third floor in the building?" It had come this far without an incident, and no one wanted to be the person that might accidently run the forks through the computer. However, it did safely make it to its new home in the northwest corner of the third floor.

Robert Cunningham and the arriving new PDP computer.

There was no easy programming language. Everything had to be done in octal code. I kidded people about what came after seven in octal and usually had to tell them that after seven comes 10. Communication with the computer was through a teletype, which, along with the diffractometer, would read the punched paper tape from the computer and change the angle settings. Research labs in the Physics Building could also be connected to the computer for data gathering and analysis. Bob Hurst, a physics professor, was very disappointed that it could not be easily programmed. But the computer and I became good friends.

The Department of Mathematics had a large central computer, and input into this computer was made by inserting punched paper cards coded in a language called Fortran. Eventually, remote communication to the central computer from the physics building became possible via telephone lines and teletypes. Before I left to go to work at McDonnell–Douglas, I put a teletype with a telephone line in each teaching lab room so students could do lab calculations quickly before lab class was over.

At last, the physics department was automated with its own computer in a room on the third floor, use of the computer in the math building, and terminals in the teaching labs.

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The department appreciates hearing from alumni and friends. Send announcements or milestones to the address listed above.

Recent Graduates

Fall 2015

BS in Physics

Devin Christman
Lacey Daniels, Cum Laude and Certificate in General Honors
Kristin Gooden, Cum Laude
Gregory Jenkins, Magna Cum Laude
Fadi Muqeem
Dan Paterson
Samantha Sweet

Spring & Summer 2016

BA in Physics

Cody Long
Sean Qureshi

BS in Physics

Melissa Compton, Cum Laude
Anthony Ewen
Nicholas Gardner
Gary Gasperino
Matthew Guerrieri, Magna Cum Laude
Scott Hodnefield
Levi Holmes
Katherine Inhat, Magna Cum Laude and Certificate in General Honors
Alexander Kiehl
Aylecia Lattimer, Magna Cum Laude, Certificate in General Honors, and Departmental Honors
Drew Lemke
Nicholas Madison, Cum Laude
Derrick McCarty
Charles Meyer II, Summa Cum Laude
Jack Penning
Brian Rowe
Mark Sweany, Cum Laude and Departmental Honors

For Reference:
3.7–3.799 Cum Laude
3.8–3.899 Magna Cum Laude
3.9–4.0 Summa Cum Laude
Departmental honors requires >3.5 GPA in physics courses, completion of six credit hours of research, and a publication or presentation (oral or poster).
A certificate in general honors requires students to complete 20 or more honors credit hours and have a 3.3 MU GPA