

# Physics and Astronomy Communique

Autumn 2013

## Award-winning Professors

The faculty in the physics department are regularly recognized for their superior achievements in research and teaching. Over the past year, several faculty members have received university and national accolades for their accomplishments.

### Meera Chandrasekhar



Curators' Teaching Professor of Physics Meera Chandrasekhar has been selected as one of three finalists for Baylor University's

2014 Robert Foster Cherry Award for Great Teaching. The winning professor will be announced in spring 2014.

"This is a great honor," says Chandrasekhar. "I feel like this is a great way to talk about the importance of teaching on a national level."

As a finalist, she received a \$15,000 prize, and the department received \$10,000 to foster the development of teaching skills. Chandrasekhar will present a series of lectures at Baylor during fall 2013 as well as a Cherry Award lecture on the MU campus. The eventual winner of the award will receive \$250,000, an additional \$25,000 for his or her home department, and he or she will teach in residence at Baylor.

The Cherry Award was created by Robert Foster Cherry, a Baylor alumnus. It was designed to honor great teachers and to stimulate discussion in the academy about the value of teaching and to encourage departments and

institutions to value their own great teachers.

Individuals are chosen for the award based on their proven records as extraordinary teachers with positive, inspiring, and long-lasting effects on students, along with their records of distinguished scholarship. Professor Emeritus Henry White nominated Chandrasekhar for those reasons.

"I am familiar with her contributions as an outstanding and inspirational teacher in the department, in her outreach activities, and as a role model to physics teachers and students throughout Missouri," said White in his nomination letter.

Chandrasekhar says that as a graduate student, she really enjoyed teaching and participating in discussions with other students, which motivated her to be a college professor. As the years passed, teaching started to take on a broader perspective, and her interests evolved from teaching college students to developing programs for K-12 students and training for their teachers.

"I began to notice that my students were coming to college with strong misconceptions about physics," says Chandrasekhar. "They seemed to really hate it, and I couldn't figure out why. I realized the problem was the way it was being taught."

The professional development program she started evolved into the Physics First program in 2006, for which she received funding from the Missouri Department of Elementary and Secondary Education and the National Science Foundation. To date, the program

has trained over 140 Missouri teachers to teach a yearlong physics course in ninth grade. The impact of the program is still being studied, but Chandrasekhar says the trend of more students taking physics earlier looks good.

### Ioan Kosztin



Ioan Kosztin, associate professor of physics, received the 2012 Chancellor's Award for Outstanding Research and Creative Activity in the physical and mathematical sciences category. This special recognition is for MU faculty members who are still in the developmental phases of their careers, have made outstanding contributions in research and/or creative activity, and have great promise for achieving wider recognition. The selection committee seeks individuals whose accomplishments are impressive but who are still rising in their fields.

Kosztin received the award for his research in biological physics. His main goal is to understand how living matter is organized and how it functions at different levels. He employs and develops computational methods used in molecular modeling and analytical methods used in theoretical physics for his research.

### Bahram Mashhoon



Bahram Mashhoon is a 2013 recipient of the President's Award for Sustained

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# Chair Chat



Professor  
Peter Pfeifer

To our alumni and friends of the department:

As I write this update, we are well into the fall semester, having welcomed our new and returning students and one new faculty member. The faculty continues to be engaged in exciting new research,

and our student groups, PAGSA, SPS and the Student Astronomical Society are planning activities for a busy year.

I am especially pleased to welcome our new faculty member, Deepak Singh, formerly at NIST, into our condensed-matter research group. You can read more about his background and research on Page 15 of this newsletter.

Please take note that we are announcing our first ever department reunion planned for fall 2014. Our hope is to welcome many alumni back to the department for a weekend of socializing, special tours, and possibly a football game. The year 2014 represents the 50-year anniversary of the official dedication in 1964 of our current building and seems an excellent reason to plan an event and welcome as many alums back as possible. As plans mature, we will keep everyone informed by e-mail and on Facebook, followed with an official invitation early in 2014. We will also keep our Web site up to date with more details as they become available.

Developing strategy for department growth and continued excellence has been a focus of the past year. A recent program assessment report, prepared by the curriculum committee (Dorina Kosztin)

and strategic plan committee (Iolan Kosztin) describes the current state of our department. Based on these documents and the formulation of 10-year objectives for critical areas in the department, our strategic planning committee has undertaken the task of documenting our 10-year vision. A draft plan available later this fall will become our first official strategic plan as we fine-tune our objectives and plans for achieving them.

As part of our effort to grow the number of undergraduate students, we hosted three open houses in the past academic year and plan to repeat with the same targeted groups this year—current MU students, incoming freshmen, and transfer students—all part of looking to our future.

We were invited to provide a department film for the APS spring meeting in Baltimore, which focused primarily on our condensed-matter, biophysics, and education research, topics suggested by the APS. Take a look at the result, “Collaborative Research for Tomorrow,” through the link on our Web site (see Page 4). Also be

We have many professors and students who, as usual, have excelled in the past year. Some of their stories are included here, along with recognitions of various accomplishments. I am especially proud that Meera Chandrasekhar is one of the three finalists for the 2014 Robert Foster Cherry Award for Great Teaching, by Baylor University, and that once again one of our own, Angela Speck, was selected for one of MU’s prestigious William T. Kemper Fellowships for Teaching Excellence.

I anticipate even more and better things for this 2013–14 year, so be sure to continue to check back with us through our Web site. As I stated in our new department video: we are a department where the whole is more than the sum of its parts.

With warmest regards,

*Peter*

Peter Pfeifer  
Professor and Chair



The front entry of the Physics Building.

sure to check out videos of our undergraduate students discussing our department and their research in several of our labs.



# Award-winning Professors

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Excellence given by the University of Missouri System. The award recognizes faculty for distinguished career-long sustained excellence in scholarship, research, or creativity over a period of 15 or more years. Two awards are given each year, and each recipient receives a \$5,000 cash prize.

Mashhoon has been at MU for 27 years and has made lasting contributions to the field of gravitation physics and general relativity during that time.

"His many achievements include the discovery of the spin-rotation-gravity coupling, now known as the 'Mashhoon effect,' and the gravitomagnetic clock effect," says Giovanni Vignale, Curators' Professor of Physics, in a nomination letter.

Following the discovery of the spin-rotation-gravity coupling, Mashhoon's insights into wave phenomena around black holes led to the first theoretical understanding of the ringing modes of black holes—also known as quasi-normal modes.

Four years ago, a *Festschrift* (a collection of original and refereed articles by researchers in his field) honoring Mashhoon was published as a separate volume in the journal *General Relativity and Gravitation*.

"This wonderful collection of papers, written by his many friends, collaborators, and relativity experts around the world, gives testament to the breadth, depth, and scope of his scientific work," says Samuel Werner, Curators' Professor Emeritus of Physics.

Mashhoon also dedicates his time to enhancing the knowledge of MU students. Shortly after coming to MU, he started the Astrophysics Relativity seminars that are still held every Tuesday afternoon. The purpose is to provide a platform for the exchange of research findings and ideas between the physics and mathematics departments. Many doctoral students take the opportunity to give talks at the seminars, which helps them practice their skills in organizing their ideas and presenting before a knowledgeable audience.



## Wouter Montfrooij

Wouter Montfrooij, associate professor, is one of two recipients of the 2013 Presi-

dent's Community Engagement Award given by the University of Missouri System. This award honors those who are highly engaged in the community and contribute to an environment that encourages the cultural, spiritual, and social development of its members.

Montfrooij founded Saturday Morning Science (SMS) in 2003, and thanks to his efforts and those of other volunteers, it has grown to be one of the most visible and respected outreach programs in the Columbia community. SMS is a weekly series of informal talks on a broad range of science topics targeted to the lay person.

Montfrooij says that when he started the program, he did not imagine its impact. Receiving this award is beyond anything he could have imagined.

"Thanks to the volunteer work of a great many at MU, we now have a venue that the community appreciates so much that they even went to the effort of writing supporting letters on my behalf," says Montfrooij. "This prestigious award means that we did something right, something of which we can all be proud."



## Angela Speck

adapted from an MU News Bureau story by Nathan Hurst

Professor Angela Speck was awarded a 2013 William T. Kem-

per Fellowship for Teaching Excellence. Kemper Fellowships, which include a \$10,000 check, are awarded to five outstanding teachers at the University of Missouri each year.

From improving scientific literacy among the public to ensuring that the

next generation of scientists is well-trained, Speck focuses on education as the thread that binds her research, teaching, and service responsibilities. Her students and colleagues say Speck has distinguished herself by her accessibility, her love of teaching, and her wide-ranging knowledge of astronomy.

"Professor Speck is a shining star in her field," wrote Caleb Wheeler, a former student who participated in undergraduate research with Speck for three years before enrolling in an astrophysics doctoral program at Arizona State University. "The work that she presents is as cogent as it is brilliant. She is one of the few scientists I have met who understands the importance of showing the relevance of their work to anyone who cares to ask. She is a model for how a scientist can be hard-working, meticulous, family-oriented and still be an outgoing, social person with a warm, strong personality."

Speck says engaging students using learner-centered and peer-instruction techniques is a core part of her teaching philosophy. She was instrumental in the development of a new course that aims to provide science, technology, engineering and math (STEM) graduate students with the tools they need to make their own classrooms accessible to students with physical and learning disabilities. She also reworked the introductory astronomy courses and created a computer-based laboratory course to improve student learning among non-scientists.

## Hak Taub

The Campus Writing Program recognized Haskell Taub, professor of physics and astronomy for his dedication to teaching writing-intensive courses with a 2013

Writing Intensive Excellence Award. Only six MU faculty members are presented with the award each year in



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# New Astrophysics Program Preparing Students for Wide Variety of Career Options

By Jerett Rion, reprinted courtesy of the MU News Bureau

This past spring, three University of Missouri students graduated with degrees in physics with an emphasis in astronomy, or the equivalent of an astrophysics degree. Until now, MU hadn't offered a degree in the field and had been losing Missouri students to bordering states such as Illinois and Kansas. Studying astrophysics prepares students for jobs everywhere from NASA to Wall Street.

"Now that MU has established this astrophysics degree program, it will be the only college in the state to offer a degree of this type," says Angela Speck, director of astronomy at MU. "Before, Missouri high school students who were interested in astrophysics were forced to leave the state. Now, MU can hope to not only stop this brain drain but also attract brilliant physics students from out of state."

Speck notes a major obstacle prevented MU from developing an astrophysics program in the past. A shortage of astronomy faculty made it

difficult for researchers to teach classes and continue their own research at the same time.

"The MU physics department recently hired two new faculty members, former NASA astronaut Pro-

research here at MU, which is something that was not possible before," Speck says. "In fact, one student who graduated this spring is coming back to the program for graduate school to conduct research in the astrophysics field."

Speck says that with a degree in physics, a student's possibilities are unlimited.

"The great thing about obtaining a degree in physics is that the career possibilities are endless and rewarding," Speck says. "A degree in physics gives a student good problem-solving skills that can be used in many different areas such as work in the financial industry or continuing education in medical school. Unlike some other degrees, a physics degree leaves options open for a student after graduation."

Students interested in learning more about a bachelor's degree in physics with an emphasis in astronomy can visit [physics.missouri.edu/undergraduate-program/major-in-physics/plan-of-study-for-bs-in-physics/](http://physics.missouri.edu/undergraduate-program/major-in-physics/plan-of-study-for-bs-in-physics/).



The force is with Professor Angela Speck and her Star Dust Team. Front: Laura Hosmer; back: Sean Baldridge, Matthew Reel, Nelson DeSouza, David Arrant, Bradley Mills, Speck, Lanika Ruzhetskaya, Adam Eshein, and David Nash.

fessor Linda Godwin and Assistant Professor Haojing Yan," Speck says. "Now, MU can offer a degree in physics with an emphasis in astronomy without overwhelming our faculty."

"Because we have more astronomy faculty, students can now conduct

## New Department Videos Available

The Department of Physics and Astronomy was invited to be one of 18 departments to get high-level visibility by way of a five-minute video, at the APS meeting in Baltimore, March 18–22, 2013.

Using funding from the department and The Mizzou Advantage, the department worked with a producer from the company WebsEdge to highlight research associated with condensed-matter physics and developments in teaching methods and

curriculum as these topics were part of the required focus for this opportunity. The March meeting is traditionally oriented toward condensed-matter physics.

The video, "Collaborative Research for Tomorrow," ran in series with the other department videos at the meeting, and it still can be found under APS TV for the March meeting: <http://www.aps.org/meetings/march/services/apstv.cfm>, on YouTube at [www.youtube.com/](http://www.youtube.com/)

[watch?v=JWq3ijjPMUM](http://www.youtube.com/watch?v=JWq3ijjPMUM), and on the department Web site at [physics.missouri.edu/mu-physics-astronomy-aps-tv/](http://physics.missouri.edu/mu-physics-astronomy-aps-tv/)

Additionally, the department now has outstanding video and written testimonials of undergraduates, which have been added to the Web at [physics.missouri.edu/undergraduate-program/testimonials/](http://physics.missouri.edu/undergraduate-program/testimonials/) and also can be found on YouTube at [www.youtube.com/watch?feature=player\\_embedded&v=s\\_9fQqDgvms](http://www.youtube.com/watch?feature=player_embedded&v=s_9fQqDgvms).

# Student Astronomical Society News

*By Amber Sheppard, business administration student*

The University of Missouri's Student Astronomical Society (SAS) is an organization designed for any Mizzou student interested in expanding his or her knowledge about the universe and all it encompasses. The SAS focuses on making its members more aware of all the incredible phenomena and possibilities the vastness of space provides. The organization provides leadership opportunities as well as a great place to meet new people.

The group meets the second and fourth Wednesdays of each month. Meetings usually include guest speakers and star-gazing in the Laws Observatory. In addition to meetings, the SAS participates in a variety of events. These include trips, such as a recent invitation to Swan Lake National Wildlife Reserve in Sumner, Mo., where the group camped and gave a

constellation presentation to guests. SAS also teams up with the Central Missouri Astronomical Association to observe astronomical events at Wildhaven, visit Rockbridge Planetarium, enjoy movie nights, and more.

Donations are welcome and would be used 100 percent toward expansion and events. Scholarship opportunities for members is also a goal; donations would certainly be appreciated. At this point, unfortunately, SAS runs on enthusiasm, bake sales, and change found under sofa cushions.

All Mizzou students are invited to join, and alumni are always welcome, so please join us anytime. Please contact our president, Amber Sheppard, to learn more at [afsz82@mail.missouri.edu](mailto:afsz82@mail.missouri.edu). Or visit the SAS Facebook page at <https://www.facebook.com/groups/181426638632760/>.



The Student Astronomical Society. Standing: Luke Ploszek, Amy Spencer, David Litherland, Josh Lewis, Annie Noens, Michael Reed, and Tanner Fortune; kneeling/sitting: Logan Philpott, Jason Briggs, Laura Mikytuck, and Amber Sheppard (president).

## Award Winners

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recognition of their efforts to promote writing across the curriculum.

"As the semester draws to an end, I would like to thank you for being a great teacher," said one student of Taub's writing-intensive course. "In your class, I had to write the longest paper of my life and while it might not be my best paper, I have never been so proud of my work before. Most importantly, working on that paper reminded me of all the reasons I love physics."

Taub's course, Physics 4080: Major Themes in Classical Physics, is a newly converted writing-intensive course.

## Save the Date-ish!

The Department of Physics and Astronomy is planning a fall reunion for 2014. Notification to all alumni will follow when we have a specific date—so please plan to attend. For up-to-date news on activities and new research, please continue to check our Web site: [Physics.missouri.edu](http://Physics.missouri.edu).

# A “New Spin” on Emerging Quantum Technologies

## An update from Carsten Ullrich



Professor Carsten Ullrich et al. had a recent article published in *Physical Review Letters* in October 2012: “Giant Collective Spin-orbit

Field in a Quantum Well: Fine Structure of Spin Plasmons,” written by Florent Baboux<sup>1</sup>, Florent Perez<sup>2</sup>, Carsten A. Ullrich<sup>3</sup>, Irene D’Amico<sup>3</sup>, José Gómez<sup>1</sup>, and Mathieu Bernard<sup>1</sup> (<sup>1</sup>Institut des Nanosciences de Paris, CNRS/Université Paris VI, Paris 75005, France; <sup>2</sup>University of Missouri, Department of Physics and Astronomy, Columbia, Mo. 65211, USA; <sup>3</sup>University of York, Department of Physics, York YO10 5DD, United Kingdom).

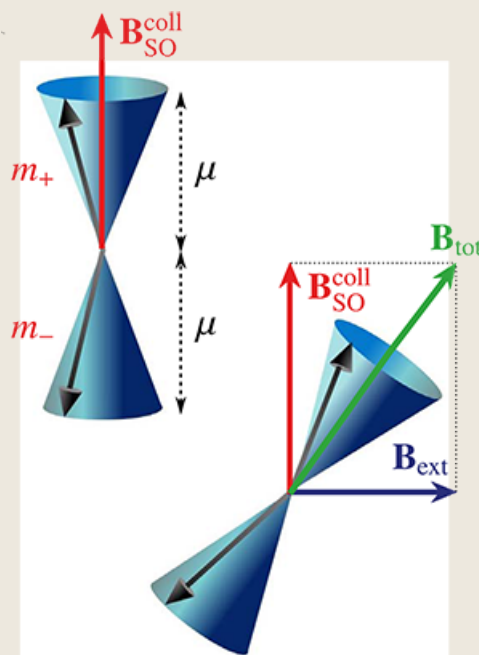
What was particularly significant about this work was that it was an effect theoretically predicted 10 years ago by Ullrich, which now has been experimentally observed.

According to the article abstract, inelastic light scattering was employed with magnetic fields to study intersubband spin plasmons in a quantum well. The researchers were able to demonstrate the existence of a giant collective spin-orbit (SO) field that splits the spin-plasmon spectrum into a triplet. The effect is remarkable as each individual electron would be expected to precess in its own momentum-dependent SO field, leading to D’yakonov-Perel’ dephasing. Instead, many-body effects lead to a striking organization of the SO fields at the collective level. The macroscopic spin moment is quantized by a uniform collective SO field, five times higher than the individual SO field. The article provides a momentum-space cartography of this field.

This international team of scientists has shed new light on a fundamental area of physics, which could have important implications for future electronic devices and the transfer of information at the quantum level.

The images illustrate how collective spin excitations behave under the effect of the spin-orbit field, with and without external magnetic field. The electrical currents currently used to power electronic devices are generated by a flow of charges. However, emerging quantum technologies such as spin-electronics make use of both charge and another intrinsic property of electrons—their spin—to transfer and process signals and information.

The experimental and theoretical work, carried out by researchers from York’s Department of Physics, the Institute of Nanoscience in Paris, and the University of Missouri, could have important implications for spintronics



Images illustrate how collective spin excitations behave under the effect of the spin-orbit field, with and without external magnetic field.

and quantum information technologies.

The team looked at semiconductors’ structures—the base of current electronic devices and of many spintronic device proposals—and the problems

created by internal fields known as spin-orbit fields. In general, these tend to act differently on each electronic spin, causing a phenomenon referred to as ‘spin-decoherence.’ This means that the electronic spins will behave in a way which cannot be completely controlled or predicted, which has important implications for device functionalities.

To address this problem, the scientists looked at semiconductor structures called “quantum wells” where the spins can be excited in a collective, coherent way by using lasers and light scattering.

They demonstrated that these collective spin excitations possess a macroscopic spin of quantum nature. In other words, the electrons and their spins act as a single entity making them less susceptible to spin orbit fields, so decoherence is highly suppressed.

The theoretical work was led by Irene D’Amico, from York’s Department of Physics, and Carsten Ullrich. The project began with their prediction about the effect of spin Coulomb drag on collective spin excitations and developed into a much larger international project spanning over three years, which was funded in the UK by a Royal Society grant, with additional funding from the Engineering and Physical Sciences Research Council (EPSRC).

According to D’Amico, “This work has developed into a strong international collaboration that has greatly improved our understanding at the fundamental level of the role of many-body interactions on the behavior of electron spins.”

“By combining experimental and theoretical work, we were able to demonstrate that through many-body interactions, a macroscopic collection of spins can behave as a single entity with a single macroscopic quantum spin,” she says, “making this much less susceptible to decoherence. In the future, it

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# Faculty Kudos

**Meera Chandrasekhar** was selected as one of three finalists for the 2014 Robert Foster Cherry Award for Great Teaching, by Baylor University.



**Shi-Jje Chen** was elected fellow of the American

Physical Society and was appointed associate editor of the journal *PLoS Computational Biology*.

**Suchi Guha** was promoted to full professor, and she recently received a one-year NSF grant for \$48,081 for December 2013–November 2014.



**Deborah Hanuscin's** (and her team's) publication, "Supporting the Development of Science Teacher Leaders—Where Do We Begin?" was selected for

the National Science Teachers Association's annual list Research Worth Reading. She also received a National Science Foundation grant of over \$2.6 million for preparation of elementary teachers to teach in the physical sciences. The title of the project is "QuEST: Quality Elementary Science Teaching."

**Fred Hawthorne** was awarded a National Medal of Science, the nation's highest honor for scientists in a White House ceremony.

**Kattesh Katti** was elected fellow of the American Association for the Advancement of Science. In August, in Allahabad, India, a new institute was named for Katti: Kattesh Katti Institute of Green Nanotechnology and Agri Nanotechnology. The newly named institute is within the premises of Sam Higginbottom Institute of Agriculture, Technology and Sciences.

**Karen King** was selected for the 2012 Physics Alumni Award.



**Dorina Kosztin** was named outstanding adviser in the



state of Missouri and also was selected to receive the National Academic Advising Association Outstanding Advising Award Certificate of Merit in the faculty advising category.

**Ioan Kosztin** was awarded a 2012 Chancellor's Award for Outstanding Research and Creative Activity.

**Bahram Mashhoon** was selected as this year's recipient of the President's Faculty Award for Sustained Excellence. He also was selected for the 2012 Physics Alumni Award.

**Wouter Montfrooij** was selected as this year's recipient of the President's Faculty Award for Community Engagement. He also published a new book (Kindle edition) titled *Aaargh! Physics!* in August.

**Angela Speck** was appointed as faculty fellow in the Graduate School, as institutional coordinator of MU's participation in the Center of Research, Teaching, and Learning (CIRTL), and she was also awarded the William T. Kemper Fellowship for Teaching Excellence.

**Hak Taub** was selected as a recipient of a Writing Intensive Excellence Award by the Campus Writing Program and was elected to fellowship in the Neutron Scattering Society of America.

**Carsten Ullrich** was promoted to full professor.

**Ping Yu** was recognized as a Siemens Competition mentor for his mentoring of high school students.



## Quantum Technologies

Continued from previous page

may be possible to use these excitations as signals to transport or elaborate information at the quantum level."

After reporting their results in *Physical Review Letters* last year, the team of scientists confirmed and extended the results by considering different materials and type of excitation. The second set of experiments were recently reported in *Physical Review B* (Rapid Communication) and highlighted by the journal as an Editor's Suggestion.

Florent Perez, who led the experimental work with Florent Baboux, at the CNRS/Université Paris VI, says

the results strongly suggest that the quantum nature of the macroscopic spin is universal to collective spin excitations in conductive systems.

"The collaboration with Irene D'Amico and Carsten Ullrich has been particularly powerful to disentangle the puzzle of our data," says Perez. "In our first joint work, we constructed an interpretation of the phenomenon, which was confirmed in a second investigation carried out on a different system. This paved the way for a universality of the effect."

## And One Alum



Alumnus **James W. Seeser**, MS '67, PhD '70, was honored by the St. Louis Planned Giving Council with its Donor Recognition Award at the 2013

St. Louis Legacy Awards.

# UPDATE on Neutron Scattering IGERT

## National Science Foundation IGERT training program sends young scientists to learn neutron scattering at ORNL

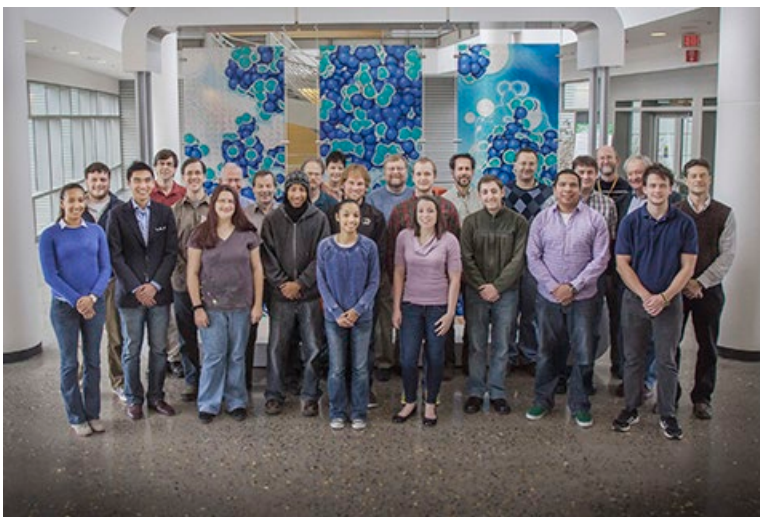
*Edited and reprinted with permission of the press office at Oak Ridge National Laboratory, (originally published March 1, 2013) and with input from Professor Hak Taub, (MU Department of Physics and Astronomy)*

An Integrative Graduate Education and Research Traineeship (IGERT) workshop in neutron scattering was conducted at the Oak Ridge National Laboratory (ORNL) Spallation Neutron Source, Feb. 25–March 1, 2013. The workshop educated the young scientists and their mentors in the benefits of neutron scattering as a powerful tool for three major areas of materials science: biological macromolecules and biomaterials, the structure and dynamics of strongly correlated electronic materials, and the design of artificial nanoscale materials. Several students and professors from MU's IGERT program attended this workshop.

IGERT is the NSF's flagship interdisciplinary training program for educating PhD scientists and engineers from the United States. Since 1998, the program has made 215 awards to more than 100 universities in 41 states, the District of Columbia, and Puerto Rico, providing funding for nearly 5,000 graduate students. Professor Haskell Taub is the director of the five-year \$3-million IGERT project titled "Neutron Scattering for the Science and Engineering of the 21<sup>st</sup> Century." During the last decade, the United States has invested more than \$2 billion in upgrading its facilities for neutron-scattering research at ORNL and the National Institute of Standards and Technology Center for Neutron Research.

The MU IGERT project's principal mission is training the next generation

of "sophisticated users" of our nation's premier neutron-scattering facilities. In its IGERT program, the NSF anticipates



MU students and professors at Oak Ridge National Lab.

that the most-challenging problems in science and engineering will be addressed most effectively by interdisciplinary teams of researchers. The IGERT trainees participate in courses and research internships that promote team efforts in neutron-scattering research that cross traditional disciplinary boundaries.

During the five-day workshop, 13 trainees learned how the latest developments in neutron-scattering techniques are advancing important, new science.

The workshop included lectures, facility tours, and hands-on experience at selected instruments, where staff instrument scientists showed participants sample environment chambers, some specifics about neutron instruments and data analysis, and how they work with users.

Among the five days of lectures presented by neutron sciences staff were "Neutron Optics and Instrument Development," by Lee Robertson; "Surfaces and Interfaces—Soft Matter," by John Ankner; "Large-scale Structures in Biology," by Shuo Qian; "Single-crystal Nuclear and Magnetic Structures," by Bryan Chakoumakos; "Diffraction and Engineering Materials," by Andrew Payzant; and "Inelastic Scattering—Hard Matter," by Mark Lumsden.

In addition, Roger Pynn, a soft-condensed-matter materials scientist from Indiana University with a joint appointment at ORNL, presented "Introduction to Small-angle Neutron Scattering," and David Baxter, also from IU, presented "Multilayers: A Prototypical Class of Nanostructured Materials." Greg Smith, of the Biology and Soft Matter Division, gave the Thursday-evening dinner talk, "A Brief History of (Neutron Beam) Time."

Besides tours of the High Flux Isotope Reactor and the Spallation Neutron Source, participants toured the Center for Nanophase Materials Sciences, the Computing and Computational Sciences Directorate's observation deck and EVEREST imaging wall, and the historical Graphite Reactor.

MU faculty attending included Research Professor Helmut Kaiser (MURR), Professor Paul Miceli (MU physics) and Taub. Faculty from Indiana University were Roger Pynn and David Baxter, and Flora Meilieur participated from North Carolina State University (jointly appointed at ORNL). IU and NSCU are sister or-

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# Updates from Organic Optoelectronics

Professor **Suchi Guha** has been working in the area of organic optoelectronics for 10 years, since joining the faculty at MU in 2003. This research program has grown with several applications in displays, sensors, and photovoltaics. She was awarded a new three-year grant from the National Science Foundation for \$320,146, starting June 2013. The project title is "*Polarization-induced Transport in All-polymer Field-effect Transistors*." This grant will fund a flexible electronics program at MU. Guha and Carsten Ullrich received the Brazil-US Professorship from the American Physical Society in 2012. This award allowed them to team-teach a course called Electronic Excitations in Materials: Theory and Applications at Universidade Federal do ABC, Santo Andre, Brazil in July 2012.

**Dhanashree Moghe**, an advisee of Guha, has been working in the area of organic solar cells since 2009. She has set up a novel method for probing charge transfer states in polymer-based solar cells, which appeared in *Applied Physics Letters* **99**, 233307 (2011). She recently presented her dissertation, *Probing Charge Transfer Complex States in Organic Solar Cells*

*Using Photocurrent Spectroscopy*, in a focused session of the 2013 March meeting of the American Physical

Society. Moghe won first prize (and \$200) for her



Dhanashree Moghe, at left.

Danish Adil, at right.



poster, titled the same as the presentation above, in the research competition (energy session) of the Nanofrontiers Symposium held at MU in June.

**Danish Adil**, an advisee of Guha, has been working in the area of organic field-effect transistors (FETs) since 2009. He has co-written more than seven papers since 2010. Adil's dissertation research has enabled a novel technique of generating Raman maps

across the metal-polymer interface in FETs, providing a powerful visualization tool for correlating the device performance to the structural changes of the molecule/polymer. His work on pentacene FETs demonstrates the unique potential of Raman and surface-enhanced Raman scattering for the investigation of physical phenomena at the nanoscale in pentacene-metal interfaces in FETs. This work was published in the *Journal of Physical Chemistry C* **116**, 12779 (2012). Adil defended his dissertation in late spring and started a position as a device engineer at Intel this fall.

**Ndubuisi Ukah**, joined the physics doctoral program in 2009, working with Guha. He defended his dissertation, *Low Dielectric Constant-based Organic Field-effect Transistors and Metal-insulator-semiconductor Capacitors* in fall 2012. He now works as a device engineer for Intel.

**Kehsab Paudel** defended his dissertation: *High-Pressure Spectroscopic Studies of Organic Device Materials* in fall 2012. Paudel worked with Guha and Curators' Professor Meera Chandrasekhar. He is now a postdoctoral fellow at Oregon State University.

## Growing the Department

The Department of Physics and Astronomy held two additional open houses during the 2012–13 academic year following the successful Fall Welcome Open House in September. These events provided an opportunity for prospective physics students to meet and mingle with faculty and students from the department and explore opportunities for physics and physics-education careers.

On February 15, "Explore Physics" welcomed prospective fall freshmen during one of the MU Black and Gold Days. Our students and faculty mixed with the visitors and their families and

provided information on department scholarships and the advantages and value of a degree in physics. Between student visitors and parents, it was a full house. The event culminated with lab tours to emphasize the opportunities for undergraduate research.

March 7 was the final open house for the year, "Launch into Physics." This event targeted prospective transfer students from community colleges, with a special emphasis on Moberly Area Community College. The afternoon began with a general welcome and department and physics career information, followed by a tour of labs and

the observatory. Several of our physics majors participated in a student panel to respond to questions from the visitors and relate their own experiences within the department. The visitors were also given a presentation on the MU TRIG program (Transfer Interest Groups) and financial aid information from the admissions and transfer and financial aid offices. A special tour of the University of Missouri Research Reactor ended the afternoon.

The department plans to repeat these successful events for the current academic year.

Graduate students in the department have been productive this past year as is evident below.

2012 Physics Leaders' Awards for Outstanding Student Presentation, Graduate Level, presented at the Physics Leader's fall meeting: first place—**Matt McCune**, "Predicting the Time Evolution of Fusing Multi-cellular Aggregates via Cellular Particle Dynamics;" second place—**Dhanashree Moghe**, "The Role of Mid Gap States in Organic Solar Cells;" and **Harrison Knoll**, who is currently a graduate student, received first place in the undergraduate category for research done as an undergraduate, "Quantum Entanglement for the Undergraduate Laboratory."

At Mizzou Adventures in Education, a half-day event for K–6 students, the Department of Physics and Astronomy's science outreach booth was awarded the 2013 Chancellor's Award in Public Outreach (1st Place). Participants were **Matt McCune** (team leader), **Kevin Tarwater**, **Justin Grayer**, **Alex St. John**, **Harrison Knoll**, **Zack Buck**, and **Lacey Daniels** (an undergraduate).

At the 30<sup>th</sup> annual Research & Creative Activities Forum (RCAF) by MU's Graduate Professional Council (GPC), graduate students received the following awards in 2013: Biological sciences category—**Jiong Zhang**, first place, "Refinement and Selection

## Graduate Student News

of Near-native Protein Structures;" Physical sciences category—**Andrew Gillespie**, first place, "Measurements of Increased Enthalpies of Adsorption for Boron-doped Activated Carbons;" **Ashkan Shafiee**, second place, "The Power of Printers from Printed Electronics to Organ Printing;" and **Harrison Knoll**, third place, "Quantum Mechanics for the Undergraduate Laboratory."

**Ashkan Shafiee** was selected from among the many award recipients at RCAF to be the keynote speaker at the 2013 GPC Legislative Awards Reception, an annual event honoring four to six state legislators. Chancellor Brady Deaton later gave a presentation at a conference in St. Louis where he highlighted two Mizzou students (one graduate and one undergraduate), and Shafiee was the graduate student highlighted.

Congratulations to **Matt McCune** on receiving the 2013 Life Sciences Week Research Award. He received first place in the bioengineering and

informatics category for presenting "Modeling Biomechanical Relaxation Processes of Multi-cellular Systems via Cellular Particle Dynamics."

Congratulations to **Mohammad Sherafati** on winning the 2013 Donald Anderson Graduate Research Assistant Award. This award recognizes a research assistant demonstrating excellence and lasting impact through contributions to research, future promise as a researcher, originality, imagination, satisfactory progress toward a degree, and research mentoring of peers.

The Public Outreach Award is awarded each semester to a graduate student in the Department of Physics and Astronomy who has made significant contributions to science outreach. **Matt McCune** received the fall 2012 award, and the spring award went to **Kevin Tarwater**.

The Harry E. Hammond Prize in Physics is awarded each semester to graduate students in the department who have made significant contributions to the undergraduate teaching program in the department. Fall 2012 awards went to **Danish Adil** and **Matt McCune**. Spring 2013 awards went to **Nelson de Souza** and **Harrison Knoll**.

**Tina Rezaie Matin**, **Alex St. John**, **Dhanashree Moghe**, **Bradley Mills**, and **Justin Grayer** were inducted into Sigma Pi Sigma: The Physics Honor Society.



Chancellor's Award in Public Outreach winners from the spring Mizzou Adventures: Zach Buck; Kevin Tarwater; George Justice, then dean of the Graduate School; Matt McCune; Alex St. John; and Justin Grayer. Lacey Daniels and Harrison Knoll are not pictured.



Ashkan Shafiee presenting at the GPS Legislative Awards Reception.



# PAGSA 2012–13: A Space Oddity

By Matt McCune and Jesse Kremenak

In 2013, the Physics and Astronomy Graduate Student Association (PAGSA) welcomed four new officers: President Harrison Knoll, Vice President Alex St. John, Secretary Grant Knotts, and Treasurer Andrew Gillespie. The remaining members of the 2013 executive board include faculty adviser Carsten Ullrich as well as the committee chairs: Chris Owens (social events), Yiyao Chen (teaching excellence), and Matt McCune (public outreach).

The Teaching Excellence Committee, chaired by Jesse Kremenak in 2012, developed the TA Mentoring Program to improve the teaching experience of the department's TAs and enhance the quality of education in our classrooms. By pairing new and experienced TAs, the program accelerates the learning curve for new teaching assistants while expanding the teaching skills of all TAs. In 2013, Yiyao Chen took over as the committee chair with high enthusiasm. Chen strives to expand and refine the committee's programs, which include the new TA Mentoring Program, a two-day TA training workshop, and the mid-semester TA evaluations.

In 2012, PAGSA's Public Outreach Committee, spearheaded by Matt McCune, promised to outdo the entomology students and their six-foot pa-

pier-mâché beetle at the 2013 Mizzou Adventures in Graduate Education event. In April 2013, the Department of Physics and Astronomy's booth, Physics Are Phun, fulfilled the committee's promise and was awarded the Chancellor's Award in Public Outreach: 1st Place.

Additionally on April 6th, PAGSA members ran four events for the Missouri Science Olympiad State Tournament: Reach for the Stars, Astronomy, Shock Value and Circuit Lab. In total, 21 students, both graduate and undergraduate, volunteered at the two outreach events to inspire and educate the scientists of tomorrow. PAGSA gives special thanks to Professors Yun Zhang and Dorina Kosztin for their guidance and support; the success of these events would not have been possible without the hard work from these two faculty members.



Harrison Knoll shows students a momentum wheel.

In fall 2012, Chris Owens started a new PAGSA tradition, the Back-to-School BBQ. This event, held in mid-August, provided an opportunity for the incoming graduate students to meet and socialize with the rest of the department before classes began, all while enjoying some burgers and Mis-



New graduate students, fall 2013: Ashutosh Dahal, Milica Utjesanovic, Jialu Yan, Erica Hroblak, Aayush Regmi, Amrit Laudari, Vi-reak Yim, and Brock Summers (Matt Reel, not pictured).

souri sunshine. We had a large turnout in 2012 and expect the event to be a PAGSA fixture for years to come.

PAGSA also recognizes members who have made individual achievements this academic year. Mohammad Sherafati was awarded one of the most prestigious graduate student awards at Mizzou, the Donald K. Anderson Graduate Research Assistant Award. Ashkan Shafiee was selected to present his research, "The Power of Printers from Printed Electronics to Organ Printing," as the keynote speaker at the 2013 Graduate Professional Council's (GPC) Legislative Awards Reception. Jesse Kremenak serves as the GPC national issues coordinator and as the regional director of legislative affairs for the National Association of Graduate-Professional Students. Kremenak meets with members of Congress to advocate for graduate and professional students on important issues like graduate student debt.

The 2012–13 academic year was another successful campaign for PAGSA and its members. As we welcome in a fresh group of talent in fall 2013, we expect an even brighter future of service and achievement ahead.



Lacy Daniels with young visitors at Mizzou Adventures.



# The Physics Leaders—A Success Story

*Don Packwood, PhD '71 physics, tells in his own words how the alumni board in physics came to be and why he thinks it is a successful example of what alumni can help their departments achieve.*

In fall 1996, distinguished alumni from every department in the College of Arts and Science gathered in Columbia for the Third Annual A&S Leaders Conference and Banquet. David Cowan, who at the time was chair of the physics department, had invited a cross-section of alumni to become Physics Leaders and to have the opportunity to meet astronaut Linda Godwin, MS '76, PhD '80 physics, who was a scholar-in-residence at MU that year.

Cowan chose his Leaders well, selecting people who had shown an interest in the department and who had lent their support. He tried to find people who had roots and family in Missouri so they would have reason to return each year. Cowan created a terrific program for his Leaders, asking them to talk to students and emphasize the factors that led to their success. The Leaders came away acquainted with the state of the department, its faculty, and their research. They could see that the department had many needs, and they felt they could help.

Cowan had chosen as the Physics Leaders' first president Gerald Fishman, BS '65 physics, an eminent astro-

physicist who was doing groundbreaking research on the cause of intense gamma-ray bursts originating throughout the universe. Each alum who was being recruited to join Leaders received a letter of invitation from Jerry. When I received mine, I decided to accept, and I called several others who were on the list of prospects and urged them to accept.

Physics Leaders include academic physicists, government lab physicists, industrial physicists, medical physicists, entrepreneurs, and even a lawyer, a retired Air Force general, and a retired NASA astronaut. The late Jim

**“From the beginning, the focus of Physics Leaders was to help the students and faculty.”**

Ferguson, BS '56, ScD '01 physics, the inventor of the first commercially successful liquid crystal displays, which are still used today, and Bill Brinkman, BS '60, MS '62, PhD '65, ScD '87 physics, the director of the Office of Science at the Department of Energy—both are former MU physics students.

From the beginning, the focus of Physics Leaders was to help the students and faculty. Leaders gave career seminars, offered mentoring and advice to the students, and sponsored undergraduate and graduate student research presentations with cash prizes for the top papers

in each category. They gave advice to the faculty on the curriculum and advice to the dean on the department's needs. The ability to give money has never been a factor in our recruitment of new members for the Physics Leaders, nor is a donation ever required for membership. Despite the lack of emphasis on monetary giving, the Leaders have been generous when they have seen departmental needs. Most recently, the Leaders mounted a campaign to establish a \$500,000 endowed fund for faculty-compensation enhancement. We are partway to our goal, and the fund is making a huge difference.

We found at our first meeting a department that produced good research but was small—far smaller than other physics departments at major research universities. We found a department that was focused mainly on producing future professors. The industrial physicists in the group pointed out that there were simply not enough professorships available for all the graduates being produced and that most would wind up in alternative careers, so the department needed also to prepare its graduates to be

able to succeed in these other career paths. The Leaders as a group, and in some cases individually on their own initiative, began to lobby the dean about the department's need to expand. The dean at the time, Richard Schwartz, responded by approving the department's expansion into the field of biological physics, and the department began to grow. The growth of the department has continued under the present dean, Mike O'Brien. The department is approximately twice the size that it was when the Leaders started—certainly more in keeping with that of a major research university. It has strengthened and broadened its program in many areas.

While the Leaders cannot take complete credit for all this, surely we have played an important role. Physics is now a department that prepares its students broadly for whatever path

*Continues on next page*



Gerald Fishman after the Lloyd B. Thomas lecture in 2012.

Continued from previous page  
their careers may take them, even to the extent of establishing a joint physics/electrical engineering degree. The



Compton Gamma Ray Observatory launch in April 1991.

Leaders have been very gratified that so many of their recommendations have been acted upon. It gives us all a sense of accomplishment and

satisfaction and keeps us coming back each year.

The Leaders found that one of the physics department's strengths was the unusually large percentage of students who were women. This is not the case in most physics departments around the country. Most are unwelcoming, some even hostile to women. We felt it was a competitive advantage that our department is female friendly, and we encouraged even stronger outreach to women. At present, MU is a national leader among physics departments in terms of the percentage of the faculty and students who are women. One-

third of the physics faculty are women, and over a quarter of the department's graduates are women.

One of Dean O'Brien's goals has been to encourage all of the departments in the college to create alumni boards that are similar in scope to the Physics Leaders. Helping in that effort is the main thing I can contribute as a member of his Strategic Development Board. In the beginning, this was a hard sell for reasons I simply did not understand, considering the benefits the physics department received as a result of our collective efforts. Surely, I thought, all the departments would want to gain the support of their alumni and derive similar benefits. It took years of beating the drum, but I now am seeing real change on the horizon as department chairs and their faculty members are seeing the benefits.

I have written this article in the hope that some

of the A&S alums who read it will decide that they, too, want to enjoy the satisfaction of helping students and faculty. I encourage you to contact the chair of your department to see if you can join such a group, or perhaps help get a group organized. You will have a rewarding experience.

My thanks to my wife, Lona, and to Linda Cunningham, wife of Physics Leader Robert Cunningham, MS '66, PhD '70 physics, for many helpful suggestions as I was writing this.



The crew of the space shuttle *Atlantis* in 1991: front, Jerry Ross, Professor Linda Godwin, and Jay Apt; back, Instructor Steve Nagel and Ken Cameron.

## Neutron Scattering IGERT

Continued from Page 8

ganizations on the MU IGERT grant, along with Fisk. There were eight students from MU, two each from IU and Fisk University, and one from NCSU.

Taub helped organize the week's program, previewed the lectures, and advised the speakers on the material they should present. Miceli served as coordinator for the IGERT theory course on nanostructured materials. Two of the lectures were recorded at ORNL and sent to MU so that students here in Columbia could "attend."

Students gave the workshop rave reviews. They were excited to get to see

everything in a very short period and to network and make contacts for the internships they will seek two years from now. They were also able to participate in an important poster session to which the ORNL scientific staff were invited. Thanks to the session on proposal writing and discussions with staff, the MU students were able to submit five beam-time proposals for the next ORNL cycle. The call for proposals ended March 6, with 582 total submissions, about 40 more than the past call.

The students learned a lot about the technique of neutron scattering

and the science that can be done with it from world experts like those at ORNL. In Taub's opinion, this workshop provided great motivation for the students' doctoral research and enhanced the training of a new generation of "sophisticated users" of our nation's state-of-the-art neutron-scattering facilities.



# The Physics Leaders 2012 Fall Meeting

The Physics Leaders attended the fall 2012 department meeting on Sept. 27–28. On the Thursday evening prior to the event, early arrivals enjoyed fellow leader Jerry Fishman's Arts and Science-sponsored Lloyd B. Thomas Lecture titled "Modern Astronomy," presented to the public in Jesse Wrench Auditorium.

On Friday morning the leaders received updates on the status of the department, the undergraduate and graduate students, and the student organizations PAGSA, Sigma Pi Sigma, and the Society of Physics Students.

Specific updates of note included the recently approved official dual major between physics and electrical engineering initiated by Dorina Kosztin, and Karen King's emphasis on producing more qualified physics teachers, a joint effort with the College of Education.

Professor Rob Duncan, who is also vice chancellor of research, presented an overview of MU's Sidney Kimmel Institute for Nuclear Renaissance that has been established at MU and has laboratories in the Physics Building.

The leaders enjoyed the following student presentations:

*Undergraduate research—*

Chris Blessing and Sean Sweany: "Record-breaking Methane Storage Capacity on Nano-engineered Graphene Adsorbents"

Nathan Frey: "Atomic Force Microscopy Tip Deconvolution and Image Analysis"

Harrison Knoll: "Quantum Entanglement for the Undergraduate Laboratory"

*Graduate research—*

Yiyao Chen: "In Situ X-ray Scattering Investigation of Ag Nano-islands on Si(111)7x7"

Matt Connolly: "Adsorbate-induced Pore Expansion Carbon in Graphene Oxide Framework Materials"

Matt McCune: "Predicting the Time Evolution of Fusing Multi-cellular Aggregates via Cellular Particle Dynamics"

Dhanashree Moghe: "The Role of Mid Gap States in Organic Solar Cells"

Mohammad Sherafati:

"Gutzwiller Variational Method for Strongly Correlated Materials"

XiaoJun Xu:

"Kinetic Mechanism of Conformational Switch Between Bistable RNA Hairpins"

All the talks were excellent, and the Leaders had a difficult

time deciding on the following winners for outstanding student presentations, which were awarded at the Friday-evening dinner:

*Graduate category—*First prize: Matt McCune; second prize: Dhanashree Moghe. *Undergraduate category—*First prize: Harrison Knoll, second prize: Nathan Frey and Chris Blessing/Sean Sweany.

The leaders, faculty, students, guests, and family enjoyed a Friday-night dinner at Reynolds Alumni Center.

During the business part of the program, Peter Pfeifer and Jim Seeser presented the 2012 Physics Leader's Awards for Outstanding Student Presentation, and Pfeifer presented the outstanding faculty awards to Bahram Mashhoon and Karen King. Pfeifer also recognized recent gifts to the department from Gerald Fishman, Pat Danner, and Rose Marie Dishman.

A slide show of photos depicting various events and people from past times in our department ran throughout the dinner and was followed by a panel discussion on department history by former professors, including Henry White, Cliff Tompson, Guy Schupp, and Bob Hurst. They shared their memories of the department and provided a personal perspective of de-



The Physics Leaders at the 2012 meeting. Front: Gerald Fishman, Linda Godwin, Paul Leath, Don Packwood, and Jim Seeser; back: Henry White, Bill Kennedy, Dan Voss, Mohammed Salehpour, John Bognador, Chris Wallace, Rosalie Graves, and Carl Anderson.

partment history, as did others in attendance.

Discussions with Dean Michael O'Brien on Saturday morning centered on the need for a strategic plan for the department, which should be available by the fall 2013 meeting.

The dean explained that MU has slipped in university rankings and that the university is about to begin a \$billion-plus fundraising campaign—we currently are in a silent period. Kosztin and Pfeifer were to produce a project request for renovating undergraduate labs, which was approved, and renovations began this past summer.

Strategies for startup funds and the size of the department and the ability of professors to handle additional graduate students were discussed, and the dean also talked about how to increase the Faculty Enhancement Fund and general fundraising.

CD copies of Charles Peterson's History of the Department were distributed.

Carl Anderson was selected to serve as chair-elect with Philip Chumbley continuing for another year as chair.



## Undergraduate Student News

The department is very proud of its students, and the accomplishments of these undergraduates will make it obvious why they are destined for great things in their futures.

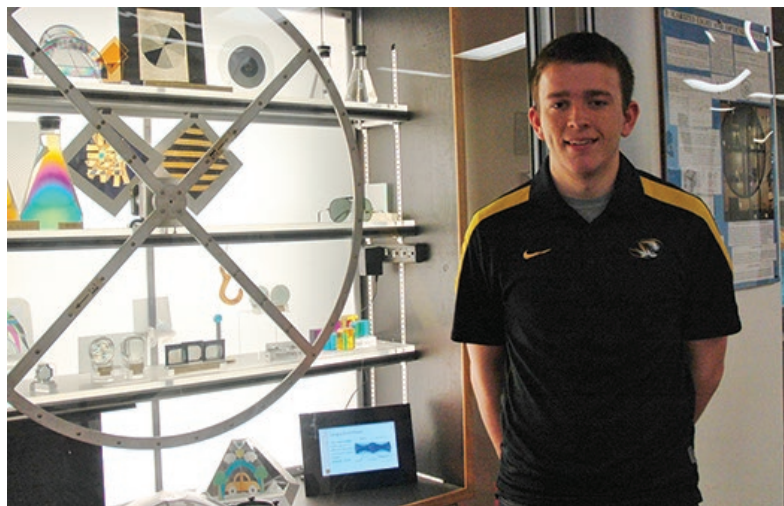
2012 Physics Leaders' Awards for Outstanding Student Presentation, Undergraduate Level, presented at the Physics Leader's fall meeting: second place—a tie between **Nathan Frey**, "Atomic Force Microscopy Tip Deconvolution and Image Analysis," and co-presenters **Chris Blessing** and **Sean Sweany**, "Record-breaking Methane Storage Capacity on Nano-engineered Graphene Adsorbents." First place was awarded to graduate student Harrison Knoll for his undergraduate research—see graduate student awards.

**Travis Hurst** received the Honors College Research Grant. This award

is given to only one student each year whose research project and academic record merit recognition. Hurst also received a Life Sciences Undergraduate Research Scholarship.

**Nathan Frey** was selected to present research at the state capital in Jefferson City, "Correcting Distortions to Improve Atomic Force Microscopy Images."

**Marc Canellas** was the primary author of a paper with Sergei Kopeikin,



Scholarship recipient Daniel Van Hoesen.

"Development of Planetocentric Reference Frames to Model the Flyby Anomaly," published in the *Journal of Young Investigators*.

2012–13 scholarships awarded: Donald L. and Lona Lewis Packwood Endowed Undergraduate Scholarship in Physics: **Christopher Lutsch** and **Scott Melenbrink**.

Gingrich Endowment: **Nathan Frey**.

Paul E. Basye Undergraduate Scholarship: **William Cleeton**, **Nicholas Parmley**, **Gary Gasperino**, **Cody Allard**, **Michael Andrade**, **Laura Hosmer**, and **Lacey Daniels**.

Clifford Thompson Scholarship in Physics: **Sean Sweany**, **Colby Johnson**, **Dylon Register**, and **Daniel Van Hoesen**.

Eugene B. Hensley Scholarship in Physics: **Richard Barber**.

## New Face in the Department

The department is very pleased to welcome Assistant Professor Deepak Singh as its newest member. He brings a wealth of research experience to the condensed-matter research group.

Singh was formerly with the National Institute of Standards and Technology Center for Neutron Research, in Gaithersburg, Md. He graduated with his doctorate in physics from the University of Massachusetts Amherst, and performed postdoctoral research at MIT with Professor Young S. Lee.

Singh's many research interests have included nanofabrication of topographical nano-engineered materials and research into their magnetic caloritronics properties, the physics of unusual spin glass and spin ice phenomena in pyrochlore oxides (geometrically frustrated magnetic materials), and investigation of magnetic quantum fluctuations in intermetallic compounds using neutron-scattering measurements and other macroscopic probes.



Deepak Singh

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

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## Congratulations to our Recent Graduates

### Fall 2012/Spring 2013 BS in Physics

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Cody Allard  
Luke Andrea  
Jonah Bates  
Ryan Bornaman  
Tyler Cary  
Ryan Cleeton  
Laura Hosmer (emph. in astronomy)  
Michael Jaris  
Scott Melenbrink  
David Nash (emph. in astronomy)  
Elizabeth Overcash

Nicholas Parmley  
Matthew Reel (emph. in astronomy)  
Jacob Williams

### Fall 2012 MS in Physics

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Lindsey Ortiz  
Ashkan Shafiee

### Fall 2012 PhD in Physics

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Liang Liu  
Keshab Paudel  
Ndubuisi Ukah

### Spring 2013 MS in Physics

---

Nelson DeSouza  
Justin Greyer  
Jesse Kremenak  
Alex Miller

### Summer 2013 PhD in Physics

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Jagath Gunasekera  
Mohammad Sherafati