

Physics and Astronomy Communiqué

Autumn 2015

Gavin King Wins UM System President's Award

By John Fougere, Chief Communications Officer, University Relations

University of Missouri System Executive Vice President for Academic Affairs, Research and Economic Development Hank Foley awarded the first of 10 UM System President's Awards to be presented to faculty in 2015 to Gavin King, associate professor of physics and biochemistry at the University of Missouri.

Foley—in front of faculty gathered for a weekly physics colloquium—surprised King with the President's Award for Early Career Excellence, which includes a \$5,000 award on April 6. The award recognizes faculty who exhibit exceptional promise within their first seven years with the university as demonstrated through scholarship, research, or creativity.

King joined the MU faculty in 2009 and quickly became an international leader in the field of single-molecule biophysics, a field that explores how individual protein molecules behave on the surface of the cells they inhabit. These behaviors create channels that let

substances such as pharmaceuticals pass in and out through the membranes that hold cells together.

King's laboratory is equipped with a self-modified atomic force microscope (AFM) unlike any in the world. Building on prior AFM

“Dr. King has established a robust and dynamic research program, which is evidenced by his peer-reviewed publications, his external funding, interdisciplinary collaborations, patent applications, and recent recognition for innovation from the microscopy community,” wrote one nominator.

At MU, King's research has been supported by six grants totaling over \$1.1 million in research funding. He is a recipient of the National Science Foundation CAREER Award, and of the very prestigious and competitive Burroughs Wellcome Fund Career Award at the Scientific Interface. He has also been issued seven U.S. patents.

“Dr. King is an innovative and creative young scientist who, at this early stage of his career, has already made important contributions to expanding the ability of interdisciplinary work combining physics and biology to investigate the molecules of life,” another nominator wrote.

Outside of the lab, King has collaborated with MU faculty from



Associate Professor Gavin King receiving his award from Senior Vice Chancellor for Research and Graduate Studies Hank Foley.

technology, he developed a second-generation optically stabilized AFM that creates three-dimensional imaging. As a result of his creation of the world's first 3-D AFM, he was awarded a 2014 Innovation Award by the Microscopy Society of America.

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Chair Chat

By Sasbi Satpathy, Department Chair and Curators' Professor



The start of a new academic year is always exciting, with new ambitions to develop and new ideas to try out. It is also a time to take stock of the progress we have made in the past year and plan for the future with optimism and zest.

This year we recruited Professor David Singh, a world-class condensed-matter theorist, from the Oak Ridge National Laboratory, who joined our department as a tenured professor this fall. At the junior level, Silvia Bompadre joined our department in her new capacity as an assistant teaching professor. Highly regarded for her classroom teaching, she brings in expertise in the teaching of biophysics courses and a fresh interest in revamping the physics classroom demonstrations. This year, we have two ongoing faculty searches in progress, one in radio-astronomy and the second one in experimental condensed-matter physics. The radio-astronomy position is meant to be a strategic hire, with the idea of strengthening our collaboration with the University of Western Cape (UWC) and the Square-Kilometer-Array in South Africa, cementing the several decades of relationship that MU has nurtured with UWC.

Our faculty has achieved considerable success during the past year. The newsletter details some of this impressive progress, but I will mention a few of the highlights here, knowing that I'll miss many, for which I apologize in advance.

Among the many notable achievements, Carsten Ullrich was elected a fellow of the American Physical Society and received the 2014 Chancellor's Award for Outstanding Research and Creative Activity. Carsten's election makes him one of the eight current and three former faculty members in the department who are fellows of the APS.

Meera Chandrasekhar spent the spring 2015 semester at Baylor University as the recipient of the Robert Foster Cherry Award for Great Teaching in 2014, which came with a cash award of \$265,000 for her. Kattesh Katti received the George Hevesy Medal, a premier international award of excellence in radioanalytical and nuclear chemistry, and he was also elected a fellow of the National Academy of Inventors.

Paul Miceli received the 2014 Governor's Award for Excellence in Teaching. Suchi Guha was one of eight plenary speakers at the annual chemistry conference this May in Brazil, the largest in the southern hemisphere. Gavin King received the President's Award from the University of Missouri System.

The faculty has been spending extended amounts of time in collaborative research with international institutions. This summer, Carsten Ullrich visited the Université Pierre et Marie Curie in Paris, working on low-dimensional semiconductors. Suchi Guha spent two months this spring at the Federal University of ABC near Sao Paulo, Brazil, as part of a prestigious research fellowship from the Brazilian government.

Giovanni Vignale spent several months at the National University of Singapore, performing and directing research on graphene and low-dimensional materials. Sergei Kopeikin spent a substantial part of this past summer at The Siberian State University in Russia, collaborating in the area of relativity. Paul Miceli visited the UWC to teach a course and to develop a collaboration that uses x-ray scattering to study silicon solar cells.

Congratulations to Xiaoqin Zou, who was promoted from associate to full professorship this year. We wish her continued success.

The department has two NSF-funded programs for training students in research. Hak Taub leads the IGERT program for graduate student training titled Neturon Scattering for the Science and Engineering of the 21st Century, while Karen King leads the Research Experience for Undergraduates (REU) program in the area of materials and modeling.

We are sad to see the retirement of four of our esteemed colleagues this year, professors H. R. Chandrasekhar, Gabor Forgacs, Bahram Mashhoon, and Haskell Taub. They contributed to the progress of the department in their own unique ways, with a combined 120 years of research and teaching in our department, and they leave behind a legacy that will be difficult to duplicate. We wish them all the best for a satisfying and fruitful retirement.

This year, we are holding our first department reunion October 16–17, which coincides with the anniversary of 50 years in our building. While this is a good enough excuse to hold the reunion, our real desire is to use this event to strengthen our ties with our alumni. We are proud of our research and teaching and of our students and hope that all of you, not just those who can attend, are interested in what we are doing. You, our alumni, can be invaluable in providing our students with opportunities for mentoring and networking, another benefit we would love to see grow from this gathering.

Last but not the least, we are grateful to our Leaders for their continued support of the department. Last year with the Leaders' financial support, we established two student scholarship funds, the Gerry Fishman Graduate Student Travel Fund and the Carl Anderson Graduate Student Award Fund. Finally, I encourage our alumni to

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Welcome to David Singh



Department chair Sashi Satpathy, Professor David Singh, and Dean Mike O'Brien.

David Singh, recently of Oak Ridge National Laboratory, joined the department at the beginning of the fall semester. He contributed this description of his research activities:

What holds materials together? Why are the properties of materials so diverse? How do we understand the properties of matter using the laws of quantum mechanics at the level of electrons and nuclei? Can we predict the existence of novel phases and states of matter? Can we use understanding at the atomic level to tune to the properties of materials and discover new materi-

als with tailored properties? Are there new quantum states, such as novel forms of superconductivity that can be realized, and can we predict what material will display them? These are questions that have fascinated Professor David Singh since he was a graduate student. Since his student days, he has been developing quantum mechanical methods based on density functional theory and applying such methods to address ques-

tions like these. His work has led to understanding of materials properties including the pairing state in the iron-based superconductors, the behavior of materials on the borderline of magnetism, and the mechanisms by which materials can show high thermoelectric conversion efficiency. He is delighted to join the University of Missouri this fall, where he is establishing his new research group and teaching quantum mechanics.

He is an expert on first principles methods, transport theory, and their application to unravel properties of condensed matter at

a microscopic level. He has made contributions to our understanding of thermoelectric materials, iron-based high-temperature superconductors, and magnetism near quantum critical points. Prior to joining MU, Singh was a corporate fellow at Oak Ridge National Laboratory. He is a recipient of a Gordon-Battelle Prize, an E.O. Hulbert Award, and several other awards. He has published more than 480 papers in the scientific literature, a book on first methods, and is a co-developer of the BoltzTraP code, which is a widely used computer code for electronic transport calculations in materials. He has an h-index of 65 according to ISI, and was named by Thompson-Reuters as a highly cited researcher in the top 1 percent of scientists in his field. Singh is excited about his move to MU, both for the chance to involve students in his research and the new research directions that he can take. He plans to extend his research into new areas, including thermal processes in nanostructures and their growth, while continuing activities on thermoelectric materials, magnetism, and superconductivity.

Chair Chat

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keep us informed about milestones in their careers and personal lives. We love to hear about them and would like to include these in our annual newsletters.

Wishing us all a productive and meaningful academic year, and the best of luck to each of us for accomplishing the individual goals that we have set for ourselves!

Gavin King

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the physics, education and biochemistry departments on a week-long summer camp program, Biophysics and Your Body, for middle school students. The camp's curriculum has been turned into a series of five lesson plans that teachers can incorporate into their classes. King also co-chaired an MU program that offers graduate-level instruction to scientists on how to better engage the public about the research they do.

The UM System President's Awards are presented annually to faculty members across the four campuses of the UM System who have made exceptional contributions in advancing the mission of the university. King was formally recognized by UM System President Tim Wolfe during an awards celebration held in June.

Success in Training Future Users of Nation's Premier Neutron-Scattering Facilities

By Professor Haskell Taub

Fundamental research utilizing neutron-scattering techniques has led to a host of technological advances in such diverse areas as drug design, the development of high-strength metals and cements, novel materials for electronic and magnetic devices, and hydrogen-storage materials. Based on these achievements in science and engineering, recent progress in the design of neutron scattering instrumentation, and the potential for new discoveries, the United States has invested nearly \$2 billion in new facilities for neutron scattering over the past decade. This expansion provides exciting new opportunities for research in areas as diverse as bioscience, chemistry and chemical engineering, materials science and condensed-matter physics, and mechanical engineering.

To maximize the scientific impact of these new capabilities in neutron-scattering research requires innovative methods of training the next generation of scientists and engineers. To meet this challenge, our IGERT project has developed a new paradigm for interdisciplinary training of doctoral students in the application of neutron scattering to interdisciplinary research. In particular, we have addressed a major obstacle in training graduate students in neutron-scattering techniques: the difficulty in mastering the full capabilities of advanced instrumentation at our national neutron-scattering facilities, when they visit them for only one-week allotments of beam time. Our project, led by principal investigator Haskell Taub, addresses this issue by exploiting our university-based neutron source: the University of Missouri Research Reactor (MURR). We are also partnering with our two national laboratories that have neutron sources: the National Institute for Standards and Technology (NIST) Center for Neutron Research in Gaithersburg, Maryland, and the Oak Ridge

National Laboratory (ORNL) in Oak Ridge, Tennessee. Helmut Kaiser, research professor at MURR and adjunct professor in the Department of Physics and Astronomy, supervises

In addition to more formal course work, IGERT trainees collaborate and connect through biweekly meetings. At each session, a trainee presents on his or her interdisciplinary re-



Students at Oak Ridge National Laboratory.

the IGERT trainees in their neutron-scattering research at MURR.

Our unique university-based neutron source has allowed us to engage graduate students in in-depth, hands-on training in neutron-scattering techniques. To accompany this laboratory experience, we have implemented three innovative graduate-level theoretical courses encompassing the major interdisciplinary research themes of our project: 1) biological macromolecules and biomaterials, 2) the structure and dynamics of strongly correlated electronic materials, and 3) nanoscale materials and their design. These courses exploit a combined problem-based learning/writing-intensive approach accessible to students from traditionally distinct disciplines. One of the writing assignments is a mock beam-time proposal that allows instructors to mentor trainees on the preparation of proposals to either the NIST or Oak Ridge facilities.

search ranging from energy storage materials, to viruses, to two-dimensional magnetic systems. A trainee from Indiana University and one from North Carolina State University join the seminars by videoconference.

To complement the extended hands-on laboratory experience that our trainees receive at MURR, our project has held two week-long workshops at ORNL in 2013 and 2015. At these workshops, the trainees broaden their experience to include some hands-on time with the state-of-the-art instrumentation available at one of the world's premier neutron-scattering facilities. By shadowing ORNL instrument scientists, the trainees learn about the capability of the various instruments and how to analyze data taken with them. They attend lectures, tour computer and sample fabrication/characterization facilities, and meet prominent scientists. Our workshops have provided an oppor-

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Katti Wins 2015 Hevesy Medal

*From MIZZOU Weekly,
Jan. 22, 2015*

A University of Missouri researcher has won the 2015 Hevesy Medal Award, a prestigious international honor given each year to a scientist for career achievements in nuclear chemistry and radiochemistry. Kattesh Katti, Curators' Professor of Radiology and Physics, formally received the award in August at the Delft University of Technology in the Netherlands.

The award represents Katti's decades of accomplishments in areas of nuclear sciences and medicine, including radiopharmaceutical sciences and nanomedicine using radioactive gold nanoparticles.

Gold nanoparticles—so small that hundreds span the width of a strand of hair—have been useful in medical applications to treat cancer, arthritis, Parkinson's disease, eye degeneration, and other conditions.

However, the process of manufacturing nanoparticles sometimes releases toxic chemicals.

Katti has helped develop ways



Kattesh Katti has been with the University of Missouri since 1990, and he joined the department in 2002.

to produce nanoparticles using “green” technologies, which use nontoxic methods. Nobel Laureate Norman Borlaug cited Katti as the “Father of Green Nanotechnol-

ogy” in recognition of his groundbreaking invention of producing gold nanoparticles by mixing soybeans and gold salt.

“This successful journey to join the illustrious list of former awardees wouldn't have been a reality without the painstaking efforts of my former and current students, postdoctoral fellows, and scores of faculty and scientist collaborators,” Katti said in a statement.

Katti, a senior research scientist at the MU Research Reactor, is a member of the National Academy of Inventors and a fellow of both the American Association for the Advancement of Science and the St. Louis Academy of Science.

The Hevesy Medal Award is named in honor of George de Hevesy (1885–1966), who won the Nobel Prize for Chemistry in 1943.

IGERT

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tunity for the trainees to build group cohesion as well as network with ORNL scientists. Interaction with the scientists has led to one trainee holding a four-month internship at ORNL and another trainee applying for an internship. Our trainees have also received assistance from the ORNL scientists in writing proposals for beam time and in the analysis of their experiments at the Oak Ridge neutron-scattering facilities.

Now, midway in our project, we are seeing consistent, positive evidence that we are succeeding in training future users of our nation's neutron-scattering facilities for interdisciplinary research. Our trainees report to our external evaluator that their communication skills have improved and that they feel more prepared to work in multidisciplinary teams. Trainee

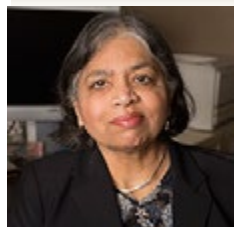
satisfaction is high, and they consistently feel that IGERT is an innovative approach to education.

At this point, three IGERT trainees have completed their doctorates and received postdoctoral positions involving neutron-scattering research. Their postdoctoral research exploits the experience that they have gained in our IGERT project. For example, Matt Connolly has been awarded a prestigious National Research Council fellowship at NIST in Boulder, Colorado. He will be applying his neutron-scattering experience in our IGERT project to studies of hydrogen embrittlement in pipeline steel. Another former MU IGERT trainee, Andrew Miskowicz, now holds a postdoctoral position at ORNL in the Nuclear Science and Engineering Directorate.



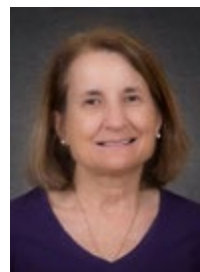
IGERT trainee Matt Connolly prepares for a neutron diffraction experiment on energy storage materials at the University of Missouri Research Reactor.

News from Our Professors



Curator's Professor of Physics **Meera Chandrasekhar** spent the spring 2015 semester

teaching in residence at Baylor University as recipient of the Baylor University Robert Foster Cherry Award for Great Teaching in 2014. The Cherry Award is the only national teaching award presented by a college or university to an individual for exceptional teaching.



Professor **Linda Godwin** completed development of an on-line class, previously developed for the classroom, Physics of Space Exploration.

The online self-paced version is being offered in the fall 2015 semester.



Professor **Su-chi Guha** spent two months in spring 2015 at the Federal University of ABC (UFABC) near Sao Paulo, Brazil, as part of

a prestigious research fellowship (Pesquisador Visitante Especial) from the Brazilian government. This new research collaboration based on functional peptide nanostructures, between her research group and Professor Alves at UFABC, has already resulted in a few publications in top peer-reviewed journals: "Bio-inspired Peptide Nanostructures for Organic Field-effect Transistors" in *ACS Applied Materials and Interfaces* (2014) and "Self-assembled Peptide-polyfluorene Nanocom-

posites for Biodegradable Organic Electronics" in *Advanced Materials Interfaces* (2015). She also gave a plenary lecture at the largest chemistry conference in South America, the 38th annual meeting of the Brazilian Chemical Society in Aguas de Lindoia, which was attended by more than 2,000 researchers.



During the 2014–15 academic year, Associate Professor **Deborah Hanuscin** was awarded a research leave by the university

to focus on her NSF-funded study of practicum-based professional development models for teachers. The Quality Elementary Science Teaching (QuEST) program provides opportunities for teachers to practice implementing what they learn in workshops before returning to their classrooms through hosting the Summer Science QuEST Program for kids. While on research leave, she was awarded the 2015 MU Faculty–Alumni Award from the Alumni Association, and four of her doctoral advisees complete their degrees. You can learn more about the \$2.6 million grant Hanuscin was awarded and the QuEST program at <http://sciencequest.missouri.edu>.

Curators' Professor of Physics **Kattesh Katti** was elected a fellow of the National Academy of Inventors. The induction ceremony was held at California Polytechnic Institute on March 20, 2015. He was also selected to receive the 2015 Hevesy Medal Award. The George Hevesy Medal Award is the premier international award of excellence in radioanalytical and nuclear chemistry. It is named after George de Hevesy (1885–1966), who received the Nobel Prize for Chem-

istry in 1943 for his work on the use of isotopes as tracers in the study of chemical processes. The George Hevesy Medal is awarded to an individual in recognition of excellence through outstanding, sustained career achievements in the fields of pure as well as applied nuclear and radiochemistry, particularly in applications to nuclear analytical chemistry.

Katti received the Annual Oration and Award by the Society for Cancer Research and Communication.

He was selected as a distinguished professor under the Brazilian Scientific Mobility Program "Ciências sem Fronteiras" of the Brazilian government, the National Council for Scientific and Technological Development of the Ministry of Science, Technology and Innovation (CNPq/MCTI).

Ingram's Magazine selected Katti as one of the 50 Missourians You Should Know for 2015; visit www.ingrams.com/article/50-missourians-you-should-know-2/.

In recognition of Katti's work in nanotechnology, the Sam Higginbottom Institute of Agriculture Technology and Sciences—one of India's premier universities—has established an institute called Kattesh Katti Institute of Green Nanotechnology and Agri Nanotechnology.



Assistant Teaching Professor **Karen King** continues to lead projects related to K–16 physics education. As principal investigator

on the Physics Teacher Education Coalition (PhysTEC) award, King has promoted the recruitment and preparation of future high school physics teachers. This year, con-

gratulations go to MU students Nathan Rhoads and Alex Soper on earning dual BS degrees in physics education and in physics. Both secured physics teaching positions in school districts that participated in MU's former Physics First program led by Professor Meera Chandrasekhar in 2009–2014. Furthermore, Soper will be teaching at Hickman High School in Columbia, Missouri, while participating in the competitive MS fellows program through MU's College of Education. Meanwhile, the PhysTEC project has established a healthy community of 10 physics education majors who interact regularly with King and with the program's teacher in residence (Kory Kaufman in 2014–15, Doug Steinhoff in 2012–14 and 2015–16). The high school Learning Assistant program created by King and Steinhoff has been determined to be an essential feature of recruiting and preparing these future teachers. Indeed, the unique program, which pays undergraduate physics and engineering students to assist in local high school classes, has gained attention from national leaders interested in promoting secondary physics and is described in a chapter of the American Physical Society's publication, "Effective Practices in Pre-service Physics Teacher Education," due to be published and sent to physics departments across the country this fall.

In addition to directing the PhysTEC program, King coordinates the department's NSF-sponsored Research Experience for Undergraduates. This nine-week program, hosted by the MU Department of Physics and Astronomy, engages students in high-quality research on a wide range of topics, such as biological molecules, nanoparticles, star dust, and alternative fuels. The program draws from a national pool of applicants, as well as students from partner institutions that serve underrepresented students. This summer, the group visited Jordan Valley In-

novation Center (JVIC) in Springfield, Missouri, (see Summer REU photo, Page 13) and toured the MU Research Reactor. Tours were led by MU physics professors Hak Taub and Helmut Kaiser. The NSF RED award of \$325,471, directed by Sashi Satpathy (PI) and Karen King (Co-PI) will support 10 students each summer for 2014–2016.

At the elementary school level, King serves as key personnel with Deborah Hanuscin's NFS-sponsored Quality Elementary Science Teaching (QuEST), a research and professional development program for third to fifth grade teachers. King and Hanuscin enjoyed writing new curriculum this year on exploring energy and electricity to align with the Next Generation Science Standards. These lessons will be implemented in Spring 2016 in the physics course taken by pre-service teachers at MU.



Paul Miceli received the 2014–15 Governor's Award for Excellence in Teaching. This award is presented to an outstanding faculty member

at each participating higher education institution in the state. Criteria such as effective teaching and advising, service to the university community, commitment to high standards of excellence, and success in nurturing student achievement are considered for this award.

Professor **Haskel Taub's** principal activities in the last year have involved the Integrative Graduate Education and Research Traineeship project. In September 2011, the department received a five-year, \$3-million grant from the National Science Foundation for a project called Neutron Scattering for the Science and Engineering of the 21st Century. It is a prestigious award—there were only 18 grants made out of over 400 submissions—and it remains the only such one MU has ever received.

The project involves training doctoral students in interdisciplinary research using neutron scattering. A core feature of this project is the use of MU's unique research reactor facility for both research and training of graduate students in neutron scattering techniques.

The interdisciplinary project includes nine graduate students and their mentors in the MU departments of Physics and Astronomy, Biochemistry, Mechanical and Aerospace Engineering, and Biological Engineering. In addition, there are partnerships with three universities: Indiana University and North Carolina State University, which each have one trainee, and Fisk University, which has had two master's students in the project. Two national laboratories, Oak Ridge and the National Institute of Standards and Technology are also partnering with MU. The trainees perform experiments at their facilities as well as at the research reactor.



Professor **Carsten Ullrich** received the 2014 Chancellor's Award for Outstanding Research and Creative Activity. This year,

he became a fellow of the American Physical Society, and the citation read "For contributions to the development of time-dependent density-functional theory and applications to electronic excitations in condensed matter."

June 8–July 8, Ullrich had a visiting position at the Université Pierre et Marie Curie in Paris, doing research in collaboration with an experimental group studying spin-wave dynamics in low-dimensional semiconductors.

Professor **Ping Yu's** research concentrated on biomedical optical imaging and quantum optics during the past year. His research

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Four Professors Step Down

with contributions by Laura Lindsey

This past year saw the retirement of four professors from the Department of Physics and Astronomy. Together, these four professors represent more than 120 years of teaching and research in the department:



H. R. Chandrasekhar

Chandrasekhar came to MU in 1976 to build a modern optics teaching and research laboratory. Prior to that, he completed post-doctoral fellowships at Purdue University and at the Max-Planck Institut für Festkörperforschung in Germany, where he was engaged in developing a novel double-beam Fourier transform spectrometer.

During his career at MU, Chandrasekhar has successfully mentored seven doctoral students, advised 15 master's candidates, published more than 140 refereed publications, and has given more than 150 invited talks.

Chandra uses the semiconductors' states of electronic and vibrational energy to study their structures and properties. To study them under high pressure, he uses a diamond anvil cell that can be cooled to liquid helium temperatures and can produce pressures common to the interiors of planets and stars.

Chandra's other accomplishments include receiving the Alfred P. Sloan Fellowship—a prestigious award that only a handful of people receive as a result of a national competition in sciences and technology. He served as a consultant to the United Nations Development Program under the Transfer

of Knowledge program where he visited research institutions in India to work with scientists on optical spectroscopy, the study of how an object emits and interacts with light under high pressures and low temperatures.

He also collaborated with MU's Department of Gastroenterology and the Cancer Research Center to test the utility of autofluorescence spectra from pre-malignant and malignant cancer cells. Several papers have been published on his research where spectral signatures were compared to histological data to develop a method of early diagnosis of cancer.

He served as chair of the department for two terms and has influenced numerous physics students through his teaching and research mentoring.



Gabor Forgacs

Gabor Forgacs has held the position of George H. Vineyard Professor of Theoretical Physics since 1999. A theoretical physicist turned bioengineer turned innovator and entrepreneur, he has also served as the executive and scientific director of the Shipley Center for Innovation at Clarkson University and scientific founder of Organovo Inc., and Modern Meadow Inc.

Trained as a theoretical physicist at the Roland Eotvos University in Budapest, Hungary, and the Landau Institute of Theoretical Phys-

ics, Moscow, Forgacs also has a degree in biology. His research interests have spanned topics in theoretical physics to physical mechanisms in early embryonic development.

His research has focused on the physical mechanisms in cell and developmental biology, in particular (both experimentally and by computer modeling) the biomechanical (i.e., viscoelastic) properties of cells and tissues and their relevance to morphogenetic shape transformations. Recently he has concentrated on the application of these physical mechanisms to "organ printing," a fundamentally new approach to tissue engineering, whereby spherical cell aggregates with composition appropriate for the particular organ are delivered (with a modified ink-jet printer) according to the organ's anatomical blueprint into biocompatible scaffolding gels.

Forgacs is the co-author of the celebrated text in the field, *Biological Physics of the Developing Embryo* (Cambridge University Press, 2005) that discusses the fundamental morphogenetic mechanisms evident in early development.

He is the author of over 160 peer-reviewed scientific articles and five books. He has been recognized with numerous awards and citations. In particular, he was named one of the 100 most innovative people in business in 2010 by Fast-Company.

Bahram Mashhoon

In his 29 years at MU, Bahram Mashhoon has made significant contributions to the field of gravitational physics and general relativity, including more than 185 publications.

His many achievements include the discovery of the spin-rotation-gravity coupling, now known as the "Mashhoon effect," and the gravitomagnetic clock effect. In addition, he has developed extensions of Einstein's theory of relativity that are more compatible



with quantum theory. As a pioneer and leading authority in the field, Mashhoon's research has made a lasting impact, and his work has been cited in over 4,000 articles and reports.

Five years ago, a collection of papers honoring Mashhoon, written by his many friends, collaborators, and relativity experts around the world, was published in *General Relativity and Gravitation*, giving testament to the breadth, depth, and scope of his scientific work.

Mashhoon has served on many important international committees and organizations, including the International Society of General Relativity and Gravitation and the International Coordinating Committee of the Marcel Grossman Meetings on General Relativity.

Research aside, Mashhoon has been an active faculty member, serving on dissertation committees and enhancing the student experience. Shortly after coming to MU, Mashhoon started a platform for the exchange of research findings and ideas between the physics and mathematics departments known as the Astrophysics-Relativity Seminars. These seminars provide a forum for doctoral students as well as other experts to practice their skills in organizing their ideas and presenting before a knowledgeable audience.

Mashhoon is a 2013 recipient of the President's Award for Sustained Excellence given by the University of Missouri System. The award recognizes faculty members for career-long sustained excellence in

scholarship, research, or creativity over a period of 15 or more years.

Haskell Taub

Professor Haskell Taub came to MU in 1975 largely as a result of the university's research reactor (MURR)—the nation's highest-powered university reactor. Taub received his doctorate from Cornell.

His research at MURR and other national facilities utilizes different



scattering techniques such as neutron scattering, x-ray diffraction, and electron microscopy to study the physical properties of thin, quasi-two-dimensional films.

He looks at the effect that changes in molecular shape or conformation, induced by heating, may have on the molecules' ability to stick to a surface in the gas, liquid, or solid phase. These properties are relevant to phenomena such as the evaporation of thin lubricant films from the surfaces of magnetic storage disks, the desorption of alkanes from catalytic surfaces, and the lubricating characteristics of alkane films.

Taub's research team is benefiting from additional funding by the National Science Foundation through a program called the Integrative Graduate Education and Research Traineeship.

The MU-led program, directed by Taub, is implementing a new paradigm for interdisciplinary training in neutron-scattering research in three major themes: biological macromolecules and

biomaterials, the structure and dynamics of strongly correlated electronic materials, and the design of artificial nanoscale materials. The curriculum uses problem-based learning and writing and will combine hands-on training at MURR with innovative theoretical courses encompassing the three major research themes. On-campus research and training is paired with research experiences at Oak Ridge National Laboratory and the National Institute of Standards and Technology. In addition to training leaders for future interdisciplinary university-based research, the project will provide a pool of potential users and employees of both national research facilities.

The Campus Writing Program recognized Taub for his dedication to teaching writing-intensive courses with a 2013 Writing Intensive Excellence Award.

Taub has made a huge contribution to neutron-scattering research in the department, both in his research and in training future researchers.



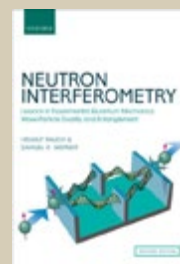
Mizzou lies within the path of totality for the upcoming eclipse on August 21, 2017, which means about 35,000 students will experience the longest totality of the event around lunch time on the first day of the 2017 fall semester. Columbia will be one of many go-to places for researchers and enthusiasts worldwide. Professor Angela Speck is coordinating scientific talks, experiments, and community outreach and is part of a national AAU effort planning science and amateur astronomer outreach workshops and ways to communicate safe viewing of the eclipse.

The 2017 eclipse will be visible across most of the United States, but only a small swath from Oregon to South Carolina, including Columbia, Missouri, will lie in the path of totality with 100% of the sun covered. As the moon's shadow races across Missouri at about 1,900 miles per hour, folks in Columbia will observe about 20 minutes and 30 seconds of totality beginning at 1:13 CDT.

Follow on Facebook: Total Eclipse - Columbia, Missouri - 21 August 2017

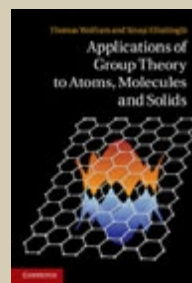
The last time the United States experienced a total solar eclipse was 26 years ago, in 1979.

Faculty Bookshelf



The second edition of the book *Neutron Interferometry* by Professor Emeritus Sam Werner and co-author Helmut Rauch was recently

published by Oxford University Press.



Applications of Group Theory to Atoms, Molecules and Solids, by former department chair Thomas Wolfram and alumnus Sinasi Elliatoglu, was

published last year by Cambridge University Press.

American Physics Society Fellows in the Department

Meera Chandrasekhar
Shi-Jie Chen
Gabor Forgacs (Emeritus)
Kattesh Katti
Peter Pfeifer
Sashi Satpathy
David Singh
Hak Taub (Emeritus)
Carsten Ullrich
Giovanni Vignale
Samuel Werner (Emeritus)

Recent Degrees Awarded

Master of Science in Physics

Fall 2014

Alex St. John
Fengfei Wang

Spring 2015

Erica Hroblak
Matt Reel
Joe Schaeperkoetter
Mohammad Valizadeh
Jialu Yan
Vireak Yim

Summer 2015

Hannah Groom

Doctorate

Fall 2014

Matt Connolly
Shawn Hayden
Tyler Rash
Ashkan Shafiee
Yuchoong Soo

Spring 2015

Elmar Dohnke
Raghavendar Sanganna Gari
Miao Zhang

Summer 2015

Chris Owens

Bachelor of Arts in Physics

Fall 2014

Eric Fox
Austin Yates

Spring 2015

Benjamin Bolin

Bachelor of Science in Physics

Spring 2015

Richard Barber
Christian Boyd, *magna cum laude with honors, department honors*
Sean Brown
Colby Delisle, *cum laude*
Brian Lasley
Haeli Leighty
Michael Lever, *magna cum laude*
Jessica Lucero
Nathaniel Nichols
Dan Paterson
Ezekiel Piskulich, *magna cum laude, department honors*
Dylon Register, *magna cum laude*
Joshua Russell, *summa cum laude*
Parker Russell, *department honors*
Hiroki Takahashi
Daniel Van Hoesen, *summa cum laude, department honors*

Summer 2015

Devin Christman

Physics Leaders' Awards

By Bell Johnson

The MU Department of Physics and Astronomy held its annual Physics Leaders meeting on Friday, Oct. 17, and Saturday, Oct. 18, 2014. The two-day event recognizes students, faculty, and alumni and their contributions to the department and allows alumni to learn of recent news and developments.

A reception and banquet held Friday evening brought the department and alumni together to recognize the achievements of students and faculty. Professor Sashi Satpathy, department chair, together with Carl Anderson, the presi-

dent of the Physics Leaders, presented the awards.

The recipients of the 2014 Alumni Faculty Fellow awards were Professor **Paul Miceli**, who was recognized for his dedication to teaching, and Professor **Haojing Yan**, an assistant professor of astronomy, recognized for his involvement in research.

The prizes for the best student presentations went to **Brendan Marsh** (undergraduate category, faculty adviser Professor Gavin King), and **Grant Knots** (graduate category, faculty adviser Professor Suchi Guha). **Melissa Compton**,

an education and physics major, received special recognition for her presentation on learning assistants, and has worked with Professor Karen King.

The State of PAGSA in 2015

By Erica Hroblak, PAGSA President

In 2015, a new set of officers and committee chairs volunteered to serve on PAGSA's executive board. President Erica Hroblak, Vice President Alessandro Mazza, Treasurer Alec Pickett, Secretary Kiandokht Amiri, Teaching Excellence Chair Scott Kissinger, Social Events Chair Joe Schaeperkoetter, and Public Outreach Chair Lisa Shepard took their positions for the first time. Professor Carsten Ullrich continues to serve in his position as faculty adviser. Grant Knotts and Tina Matin volunteered as

A couple of the previous outreach events that PAGSA had been involved in during the spring were canceled, but we were able to participate in the Benton Elementary School STEM science fair. Jacob Brown and a few other volunteers set up a table of physics demonstrations to educate while entertaining the Benton Elementary fifth graders. This fall, PAGSA also hosted a table with physics demonstrations for the Arts and Science Fall Welcome. Undergraduate students flocked to our table to see hovering beach balls, floating magnets, and glowing plasma. In the future, PAGSA hopes to become more involved in the community and has planned to volunteer at a local food bank.

Over the summer, PAGSA began the tradition of a graduate student float trip. This provided an exciting team-building exercise as graduate students had to work together to set up tents, build a fire, and maneuver canoes down the beautiful Meramec River in southern Missouri.

PAGSA was able to fund some of the food costs for the trip by selling physics-themed travel mugs. The mugs are still available for purchase, while supplies last, by contacting PAGSA President Erica Hroblak or Treasurer Alec Pickett.



Matt McCune demonstrating a polymer chain to an undergraduate student.



Joe Schaeperkoetter canoeing down the Meramec River on the PAGSA float trip.

the department GPC and GSA representatives.

One of PAGSA's goals last semester was to increase graduate student involvement in the department colloquiums. We encouraged participation by providing the graduate students an opportunity to personally meet with the colloquium speaker over lunch, and also by giving the students a chance to invite speakers specific to their area of research or interest. The graduate students reported that meeting with the speaker over lunch was a positive and rewarding experience, so we plan to continue this practice. We also plan to invite more speakers with research especially interesting to the graduate students. We thank Department Chair Sashi Satpathy and Professor Suchi Guha for their support and assistance with this activity.



Graduate students gathered around the physics table at A&S Fall Welcome.



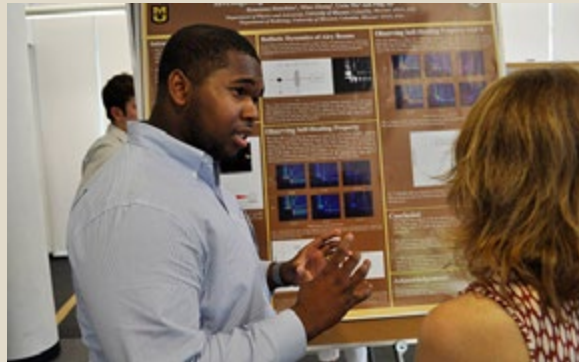
Joe Schaeperkoetter, Alec Pickett, and James Torres at the first PAGSA-sponsored float trip.

Student Recognition

Every semester the department gives out Harry Hammond Awards to two graduate students in recognition of their excellence in undergraduate teaching.

Awards for the fall 2014 semester went to graduate students **Bradley Mills** and **Miao Zhang**. The 2015 spring semester recipients were **Jacob Brown** and **Milica Utjesanovic**. The award comes with a \$200 monetary reward. Congratulations to **Brendan Marsh**, undergraduate physics major, for receiving the prestigious Goldwater Scholarship award. Two students from MU were selected as Goldwater Scholars. The purpose of the Barry Goldwater Scholarship and Excellence in Education Founda-

tion is to provide a continuing source of highly qualified scientists, mathematicians, and engineers by awarding scholarships to college students who intend to pursue research careers in these fields.



Romanus Hutchins discussing a concept in his poster presentation.

Romanus Hutchins, a freshman physics major, won an undergraduate award in the Life Science & Bio-medical Engineering Technology & Information Category at MU's Life Sciences Week. In addition, he was awarded the IMSD EXPRESS Fellows scholarship for the summer 2015 and the academic year 2015–16.

Hutchins conducts research in the lab of Professor Ping Yu.

Physics Leaders' Awards

Undergraduate Award—Brendan Marsh

Graduate Award—Grant Knotts

Special Recognition—Melissa Compton



Summer REU

Our summer Research Experience for Undergraduates traveled to Springfield to visit the Jordan Valley Innovation Center. 2015 interns at JVIC—first row: Marques Gulley (Lincoln University) and Renna Yi (William Jewell College); second row: Joshua Steffen (Iowa State University), Todd Lombardi (St. Mary's University), Jacob Mieso (San Jose State University), Hannah Huhman (University of Missouri–Kansas City), Zoe Lemon (University of Missouri–Kansas City), and Brett Heischmidt (University of Missouri); third row: Matthew Brown (Hastings College) and John Barron (Southern Illinois University–Carbondale).



New Graduate Students, Fall 2015

Left to right: Jimmy Ling, Alexander Daykin, Richard Williams, Anna Pittman, James Jones, Kanokpron Chattrakun, Matthew Prosniewski, and Kelly Gnadinger.

News from Professors

Continued from Page 7



group has developed several innovative imaging modalities for high-speed spectroscopy and extended field of view in co-

herence-domain biological tissue imaging. The coherence-domain imaging uses a low coherent interferometer and high-speed camera to get 3-D images under the surface of biological tissues. The techniques have a great potential in clinics.

The spectroscopic imaging technique is called Fourier domain optical coherence tomography (FD-OCT). It provides depth-resolved

spectroscopic imaging with enhanced tissue contrast. Yu's group designed a new dual-band full-range FD-OCT imaging system that has been used to differentiate breast and prostate cancer tissues. The high-speed imaging technique uses a new graphic processing unit to accelerate the imaging processes. The technique was used to image living mice where all moving artifacts can be removed in each image frame.

A fundamental research can benefit the development of optical imaging technique. Yu's group uses a low-diffraction beam, called Airy, to extend the depth of field (DOF) in coherent-domain biomedical optical imaging. By using the Airy beam, DOF is highly improved in comparison with traditional systems using focused Gaussian beam.

In quantum optics, Yu and his collaborators worked on an entanglement criterion for continuous bi-

partite quantum states. The separability of bipartite non-Gaussian states was studied by applying the realignment criterion with the technique of functional analysis. The realignment criterion was given as one inequality in contrast to the infinitive number of inequalities based on the moments.



ties based on the moments.

Congratulations to **Xiaoqin Zou** for her promotion to full professorship.



Truman finds Peter Pfeifer enjoying lunch at Memorial Union during the 2014 picnic for the Summer Undergraduate Research Program.

Keep in Touch!

As this newsletter goes to press, the department is eagerly awaiting the reunion on October 16–17. Look for news and photos from that event in the next online newsletter. If you are not receiving the quarterly e-newsletter, begun early in 2015, please send your e-mail address to

physicsalumni@missouri.edu.

Looking Back

By Linda Godwin

50 years ago, Stewart Hall was home to the Department of Physics. That structure was completed in 1912, and named for the chair at the time, Professor O. M. Stewart, a name still familiar to students today as his legacy continues in the O. M. Stewart Fellowships presented to many students each year.

The current building was designed in 1964; architectural consultants were Neville, Sharp, and Simon in Kansas City, Missouri.



The newly constructed Stewart Hall, 1912. Courtesy of UMC Archives, C:6/32/4.



Stewart Hall viewed through the Memorial Tower archway, prior to that building's North Wing addition in 1950. Courtesy of UMC Archives, C:6/32/4.

Construction began in 1964, and the building was in use in 1965, although the building dedication did not occur until 1967. At the dedication on April 22, 1967, George Hoagland Vineyard, associate director of Brookhaven National Laboratory, gave the main address titled "The Relevance of Physics," along with Dale Raymond Corson, the provost of Cornell University, who talked about "The Importance of Being Non-professional." Professor L. V. Holroyd was chair of the department at the time.

Today, 50 years later, the department continues to grow. The name was changed to Department of Physics and Astronomy in the mid 1980s. Primary research areas include astrophysics and general relativity, biological physics, condensed-matter experiment, and condensed-matter theory.

The department consists of 27 regular faculty, 3 teaching faculty, and 31 adjunct and emeritus faculty members, with an annual enrollment of approximately 85 undergraduate students and more than 50 full-time master's and doctoral candidates in the graduate program.



A recent sunset view across campus from the Physics Building roof following a successful afternoon and evening as part of the campus ArtiFACT Museum and Gallery Crawl.



Architect's concept for the new building—nice car! Courtesy of UMC Archives, C:1/25/6.



North side of our building, perhaps in the late 1960s. Courtesy of UMC Archives, C:0/47/6.



Many alumni and professors will remember the old parking lot on the south side, a space now occupied by the Bond Life Sciences Center. Courtesy of UMC Archives, C:0/47/6.

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Melody Galen

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

2015–16 Undergraduate Scholarship Awards

Paul E. Basye Undergraduate Scholarship

Zachary Jermain
Kara Schrand
Michelle Wickman
Connor Wolenski

Dishman Scholarship in Physics
Abuzar Mahmood

Gingrich Endowment
Lacey Daniels

Newell S. Gingrich PHYSICS Scholarship

Jonathan Becker
Gary Gasperino
Kristin Gooden
Brett Heischmidt
Richard McClure
Angelynn Simenson

Samuel S. Laws Fund
Eric Cropp

Melvin Y. Mora Undergraduate Scholarship
Brendan Marsh

Donald L. and Lona Lewis Packwood Endowed Undergraduate Scholarship in Physics

Gregory Jenkins

Clifford Tompson Scholarship in Physics

Ian Crawford-Goss
Aylecia Lattimer

2015–16 Graduate Scholarship Awards

Spring 2015

Harry E. Hammond Scholarship

Jacob E. Brown
Milica Utjesanovic

Summer 2015

Newell S. Gingrich Scholarship

Hannah Groom
Erica Hroblak
Soma Khanra
Alex St. John

Harry E. Hammond Scholarship
Gregory Kissinger

Eli Stuart Haynes & Nola Anderson Haynes Scholarship
Zuleyha Yuksek

Ernest W. Landen Fellowship in Physics

Sean Baldrige
Yiyao Chen

O. M. Stewart Scholarship

Matthew Anderson
Ernest Knight
Alessandro Mazza
Bradley Mills
Marat Musin
Kian Panjtan-Amiri
Alec Pickett
Eddie Pluhar
Aayush Regmi
Lisa Shepard
Milica Utjesanovic
Mohammad Valizadeh
Fengfei Wang
Chenhan Zhao

Fall 2015

Horace Danner Fellowship
Kelly Gnadinger