# PHYSICS

Department of Physics Newsletter / Fall 2010

## IN MEMORIAM – RICHARD E. NORBERG

When Dick Norberg passed away on April 20, 2010, we lost a friend, a colleague, and one of the major figures in our department. Dick was 87.

Dick grew up in Evanston, Illinois, and attended DePauw University in Greencastle, Indiana. During 1942–1946, he served as a meteorologist in the Army Air Corps; his DePauw degree (in chemistry) was awarded in absentia in 1943. He was a graduate student at the University of Illinois at Urbana-Champaign where he obtained his Ph.D. in experimental physics in 1951. He remained there until 1954 when he moved to St. Louis, serving as visiting lecturer for one year before obtaining his appointment as associate professor. During 1955–57, he was an Alfred P. Sloan Fellow.

From his arrival, Dick was active in George Pake's Nuclear Magnetic Resonance (NMR) group, becoming its leader in 1956 when George left to go to Stanford. Dick was promoted to professor in 1958 and became department chairman in 1962 after the departure of Ed Condon who had held that position during 1956–1962. Dick served as chairman until 1991.

This minimal outline does not do justice to Dick as a person, to his career as a physicist, or to his contribution to the department. Beyond his family, Dick had two passions: the department and grand opera.

During Dick's long tenure as chairman, the department flourished. The faculty size increased greatly, as did its physical space and the range of its research interests. Most noticeable was the addition of the Arthur Holly Compton Laboratory of Physics, opened in 1965. The department had long outgrown Crow Hall, completed 30 years earlier. Dick's attention to detail during the design and construction of Compton Lab was clear but often subtle. For example, Dick required that the rooms on the first and second floors of Compton Lab be built with 10 ft. ceilings, so that the floor levels in Crow and Compton matched, allowing heavy equipment to be wheeled between them. Dick's concern for the detail and quality of both buildings continued for many years and included supervision of subsequent renovations.

↑ Richard E. Norberg, Arthur L. Hughes (chairman from 1923–1952), and George E. Pake (chairman 1952–1956). This photo was taken in 1973.

Compton Lab soon became the home of the new James S. McDonnell Center for the Space Sciences, which could not have been accommodated in the old Crow Hall. Another major feature of the new building was the Pfeiffer Library. Its construction was made possible through the generosity of the Pfeiffer Foundation where Ed Jaynes had long-standing friendships and where Dick was involved in the necessary discussions.

Even while carrying the burden of his administrative duties, Dick continued his NMR research, including the design and construction of much of his apparatus. There was close collaboration with Charlie Slichter's NMR group at the University of Illinois, with the two groups visiting each other in alternate years. His most recent research contributed to a better understanding of amorphous semiconductors, metal-hydrogen systems, quantum fluids and solids, impurities and defects in solids, and biological membranes.

In 2004, Dick and his former student Irving Lowe were named co-recipients of the triennial 2004 ISMAR Prize, the highest honor of the International Society of Magnetic Resonance. The award citation made mention of "their discovery and demonstration of the Fourier transform method for obtaining Nuclear Magnetic Resonance spectra in solids and for their contributions to the invention and demonstration of Magic Angle Spinning."

In addition to his significant scientific achievements, Dick was an outstanding chairman of the Department of Physics and a dedicated mentor to 47 graduate students. He retired in 1993 but retained an office and remained active for several years.

A Fellow of the American Physical Society, Dick was on the Council of the International Society of Magnetic Resonance, a member of the editorial board of the *Magnetic Resonance Review*, and served as a consultant to a variety of corporations.

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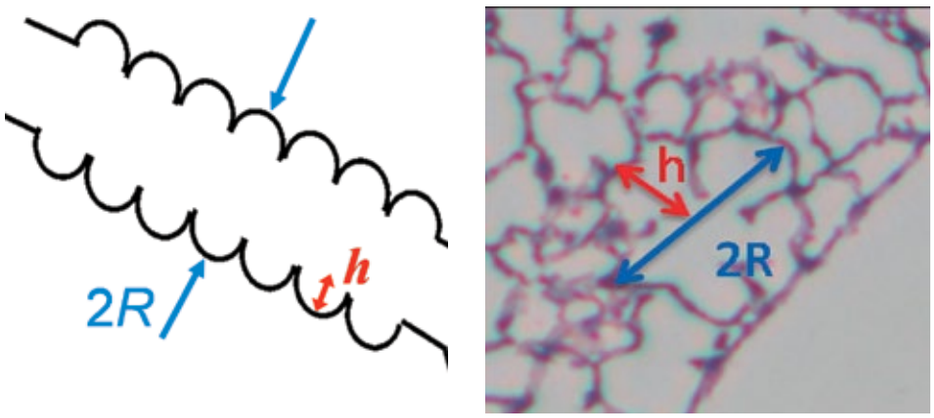
# MAGNETIC RESONANCE GROUP

Magnetic resonance imaging (MRI) has long been used to great effect as a diagnostic and research tool in medicine. Conventional MRI uses the signal from the large number of nucleons in the hydrogen atoms in body tissue to create detailed images. Unfortunately, some areas of the body (such as the lungs) do not have enough tissue density to allow for reasonable hydrogen images, and researchers who wish to study these areas must find another way. One such alternative method used by the Magnetic Resonance Group (Mark Conradi, Jason Woods, and collaborators) is to have subjects inhale an inert, spin-1/2 gas (such as $^3$He) which has been hyperpolarized by optical pumping and spin exchange with an alkali metal, creating an increase in signal by many orders of magnitude.

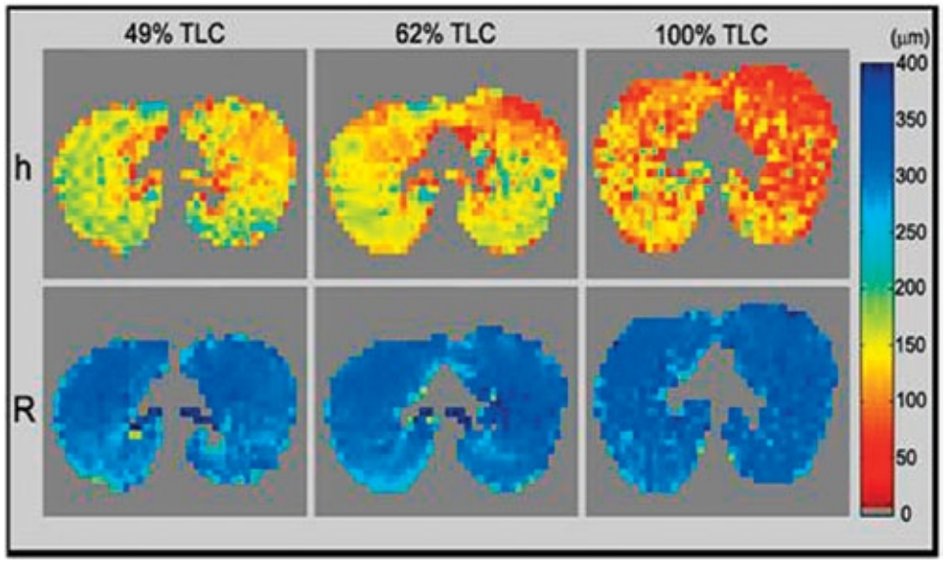
Boltzmann polarization for helium in a 1.5 T MRI magnet (standard for human imaging scanners) is about 4 parts per million. In contrast, helium which has undergone hyperpolarization via optical pumping can have up to 40% polarization or 400,000 ppm, an increase of five orders of magnitude. The process for drastically increasing the signal in the imaging gas is straightforward. The gas is placed in a glass cell with vaporized rubidium and exposed to circularly polarized laser light. Due to selection rules, this polarized laser light selectively pumps the unpaired electrons in the rubidium atoms from the $m_j = -1/2$ level of the $5s_{1/2}$ ground state to the $m_j = +1/2$ level of the $5p_{1/2}$ excited state. When the electrons relax back down to the ground state, they can return to either the $m_j = +1/2$ or the $m_j = -1/2$ level. However, since the electrons are only excited from the $m_j = -1/2$ level, this level becomes relatively depleted. The rubidium atoms pass their electron spin polarization to the helium gas nuclear spins via Fermi contact interactions during collisions. The prepared helium gas is then ready to be used in experiments.

The group has focused on Brownian motion of the gas during short diffusion experiments, in an attempt to quantify lung alveolar structure previously only possible under a microscope. The majority of gas in the lung resides in the terminal airways and alveoli, where gas exchange with the blood takes place (lungs have 3 x $10^8$ alveoli, each about 1/3 mm in diameter). These airways are effectively cylinders encased by bumpy sleeves of alveoli. For gas diffusing through this environment, diffusion is anisotropic and can be characterized by two separate coefficients: a highly restricted one for diffusion perpendicular to the long axis of the airway and a less restricted coefficient for gas diffusing down the long axis. The signal-to-noise ratio of hyperpolarized helium imaging is sufficient to allow measurement of these two distinct diffusion coefficients even though there are thousands of microcylinders within each imaging voxel (volume element) oriented in different directions. The group has shown that these coefficients can be related to physical parameters of the airways such as the airway duct radius (*R*) and alveolar depth (*h*), even though the airways themselves are far too small to be measured by any other in-vivo imaging technique. As a result, an exciting new investigation is underway, where diffusion is measured at different inhalation volumes in hopes of better understanding basic lung physiology: the mechanism of inflation and deflation at the alveolar level.

Another recent branch of research explores the effectiveness of a new therapy for Chronic Obstructive Pulmonary Disease (COPD). One of the characteristic symptoms of COPD is gas trapping inside the lung, where a patient is unable to exhale gas normally and thus retains a large volume of air in the lungs continuously. A proposed treatment for this condition is placing small one-way exit-only valves in the areas of the lung suffering from gas trapping to allow an escape route for gas trapped upon exhalation and avoid subsequent refilling. Hyperpolarized helium images allow quantification of ventilation in regions before and after the valve is applied, allowing researchers to study the effectiveness of the therapy as a whole as well as studying optimal valve placement.




↑ On left: Lung diagram illustrating alveolar duct radius (*R*) and alveolar depth (*h*) in a terminal airway. On right: Microscope image of airway cross section with *R* and *h* labeled. Airway is being viewed down the long axis.




↑ In-vivo human lung maps of alveolar duct radius (*R*) and alveolar depth (*h*) at 49%, 62%, and 100% of total lung capacity as calculated from diffusion. Note that inflation of the lung results in large changes in *h* but only minor changes in *R*.

## LABORATORY FOR ULTRASONICS

Will the imposition of the fundamental physical requirement of causality significantly increase the value of ultrasonic methods for monitoring improvements in bone quality of patients taking medications designed to reverse the bone loss of osteoporosis? That is what Professor Jim Miller and his collaborators in the Department of Physics' Laboratory for Ultrasonics are determined to find out.

Miller's interest in the causality-imposed Kramers-Kronig relations dates back to the 1970s. The Kramers-Kronig relations, which are usually expressed as integrals over all frequencies from minus infinity to plus infinity or from zero to infinity, connect the frequency dependence of the phase velocity to the frequency dependence of the attenuation coefficient. In collaboration with Edwin T. Jaynes, then the Wayman Crow Professor of Physics, and Matthew O'Donnell, then a research associate in the Laboratory for Ultrasonics and now a member of the National Academy of Engineering and dean of the School of Engineering of the University of Washington, Miller was able to obtain approximate, nearly local Kramers-Kronig relations that permitted their application to experimental data covering less than a decade in frequency. These early publications and their derivatives have since been cited extensively and have been employed in a wide range of ultrasonic studies.

Miller and collaborators made use of these approximate relations to predict the magnitude of dispersion of ultrasonic waves propagating in heart muscle based on experimental measurements of the attenuation coefficient covering the limited range of frequencies (2 to 8 MHz) over which data were attainable in the 1970s. Experimental techniques available at that time did not permit a test of the predicted dispersion, but results from Miller's and many other laboratories over the intervening years confirmed that the nearly local Kramers-Kronig relations had yielded highly accurate predictions.

Matters became less clear about 15 years ago when a highly respected laboratory at the University Pierre et Marie Curie-Paris 6 published experimental results on ultrasonic propagation in bone that exhibited dispersion with a sign (negative) opposite from that predicted by the nearly local approximation to the Kramers-Kronig relations. Soon these observations of anomalous negative dispersion were confirmed by laboratories in Japan and at the U.S. Food and Drug Administration in Washington, D.C. Although some investigators argued that these results were a consequence of the limitations of the approximate forms of the Kramers-Kronig relations, Miller contended that these results were in direct violation of the principle of causality.

In 2006, Miller, with colleagues Mark Holland and Karen Marutyan, published an article in which they argued that the anomalous negative dispersion was a consequence of processing a multicomponent signal, consisting of fast wave mode and slow wave mode components, as if only a single propagation mode were present. Initially with numerical simulation, and subsequently with experimental data on bone-mimicking phantoms, it was shown that the superposition of fast and slow wave modes could lead to apparent negative dispersion. Both the fast and the slow wave modes exhibited positive dispersions consistent with both the sign (that is, positive) and the magnitude of dispersion predicted by the nearly local Kramers-Kronig applied to the measured frequency dependence of the attenuation coefficient.

Miller and collaborators later demonstrated that the properties of the underlying fast and slow wave modes could be extracted from the measured multicomponent signals that had previously led to anomalous negative dispersion by using Bayesian probability techniques pioneered by Professor Jaynes and developed by G. Larry Bretthorst, research associate professor of radiology at the Washington University School of Medicine.

The final confirmation of the validity of these causality-imposed considerations came in collaborations with the Parisian, Japanese, and FDA laboratories that had initially reported the negative dispersion. Data on bone from each of those laboratories were processed with the Washington University Bayesian methods and were shown to yield fast and slow wave modes of positive dispersion in agreement with the nearly local approximations to the Kramers-Kronig relations, even though those same data yielded anomalous negative dispersion when processed conventionally.

Miller and collaborators have been awarded an NIH grant to explore the implications of these results for the detection and monitoring of osteoporosis. Dwight A. Towler, M.D., the Lang Professor of Medicine and director of the Division of Bone and Mineral Diseases at the Washington University School of Medicine, is a collaborator in these investigations. The team hopes to apply their physics-based techniques to data acquired by FDA-approved bone sonometers. Graduate students Chris Anderson and Amber Nelson are playing key roles in linking the results of the physics laboratory investigations to the clinical setting.

Bone sonometry systems should, in principle, provide more information than the current gold standard, Dual Energy X-Ray Absorptometry (DEXA), which provides only a measure of bone mass density. In contrast, bone sonometry should be sensitive not only to bone mass but also to bone structure and the resulting anisotropy, factors that are known to be correlated with fracture risk. Current bone sonometry systems do not offer improved performance over the X-ray method, but the goal of Miller and his colleagues is to show that Bayesian inversion of the data will significantly improve the clinical utility of sonometry.

## UNDERGRADUATE PHYSICS RESEARCH

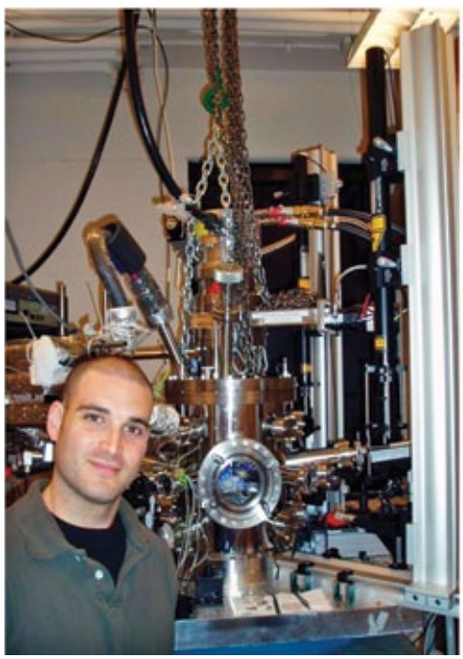
As the University begins to increase opportunities and funding for undergraduate research across all subjects, the Department of Physics has built upon its historic foundation of including undergraduates in research laboratories as preparation for graduate study, and the past few years have resulted in increases in undergraduate research. The spring of 2010 was a banner year for both the interest of students in research and in the number of monetary awards made to support undergraduates. A record number of nine students received support from the Department for summer research in 2010, in addition to the numerous additional students who will be supported by faculty research grants. Two Delos Fellowships were made this year (to Tim Wiser and Joel Sleppy, working for Professors Ogilvie and Buckley, respectively), and seven Physics Undergraduate Research Fellowships were made to Uriel Morone, Ariel Leonard, Nicholas Orlofsky, Jacob Friedlein, Alex Anderson, Wei Jia Ong, and Monatrice Lam. We hope to continue to make research a significant part of our undergraduate curriculum in graduate school preparation.

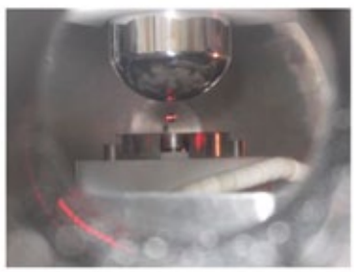
# KEN KELTON'S RESEARCH GROUP BRINGS BIG EXPERIMENT TO WASHINGTON UNIVERSITY… AND THEN TAKES IT ON THE ROAD

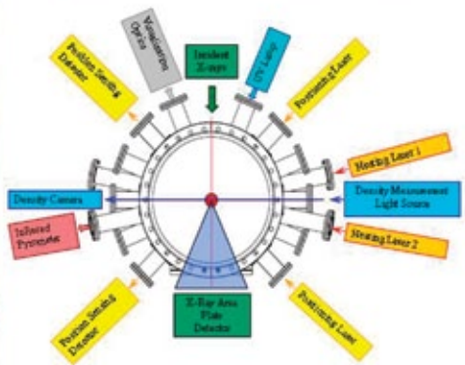
Gas. Liquid. Crystal. Easy to tell the difference, right? Well, not quite; the field of liquids and related phases, glasses, contains many unanswered questions. For years, Professor Ken Kelton and his materials physics group have explored the blurred line between the two traditional condensed phases: liquid and crystal. In 1721, Fahrenheit discovered that under proper conditions water can be cooled to temperatures far below its melting temperature without crystallizing, a phenomenon called supercooling. Since the 1950s, it has been known that liquid metals can also be supercooled. While this phenomenon is now known to be a common property of all liquids, after almost 300 years we still don't understand it completely. If a liquid is cooled to lower temperatures quickly enough to avoid crystallization, it becomes a glass, an amorphous solid that lacks the symmetry and order of crystalline solids. While techniques of cooling and heating through this *glass transition* have been used by glassblowers for centuries, this process is also poorly understood. It has been labeled by some as the most significant outstanding problem in the physics of materials. Glasses are common in the world around us, e.g., window glass, natural glasses such as obsidian, and even in biological systems such as the northern wood frog (*Rana sylvatica*) whose cytoplasm congeals into a glass during hibernation. In the 1960s, it was shown that metallic liquids could also become glasses if cooled extremely quickly. There are now examples of metallic glasses that can be formed at cooling rates comparable to those for the familiar silicate glasses, allowing them to be blown and shaped like these traditional glasses. However, understanding why some metals easily form glasses, while it is more difficult for others, is not well understood.

Understanding the mechanisms responsible for supercooling and glass formation has been a central aim in Kelton's group over the past decade. Recently, Kelton and graduate student Nick Mauro designed and constructed the Washington University Beamline Electrostatic Levitator (WU-BESL), see adjacent photo, to investigate these questions more deeply. The WU-BESL is based on the principle of electrostatic levitation, in which strong electric fields are used to suspend stably a charged sphere between three sets of orthogonal electrodes. Levitated samples can be melted and processed under high vacuum without contamination by container walls. The WU-BESL is the first facility optimized for high energy synchrotron X-ray studies of the structural evolution of supercooled liquids. These structural data can be correlated with crystal nucleation and thermodynamic data that are obtained from noncontact temperature and density measurements of the levitated samples, using techniques developed by graduate student James Bendert. Last year, with the help of the Washington University Department of Physics R&D Machine Shop, WU-BESL was completed and experiments were successfully conducted at the Advanced Photon Source in Chicago. Working in collaboration with colleagues from NASA, Iowa State University, and the German Aerospace Agency (DLR), experiments have already been made on a wide range of samples, including semiconductors and metals such as Cu-, Fe-, Ni- and Zr-based alloys. These studies over a wide temperature range, from 500ºC to 2500ºC, have led to new insights into how liquids resist crystallization upon supercooling and how supercooled liquids form glasses.

This is an exciting time in Kelton's research group. The National Science Foundation recently awarded $1.65 million to a project led by Kelton to build an electrostatic levitation chamber that will be installed at the Spallation Neutron Source in Oak Ridge National Laboratory (see news.wustl.edu/news/Pages/20292.aspx). This will complement the WU-BESL. The neutron diffraction studies possible with the new Neutron-ESL (NESL) will allow investigations of chemical ordering in the liquid and most importantly of liquid dynamics, i.e., how the atoms in the liquid move. These studies will lead to a deeper understanding of processes such as diffusion, dynamical transitions, and even of the glass transition itself.








↑ At left: Graduate student Nick Mauro and the WU-BESL. At top right: The electrode assembly and a levitated Zr sphere. At bottom right: A block diagram of the chamber, associated ports, and a schematic of the X-ray optics.

# FROM THE CHAIRPERSON

This has been a great year for the physics department. New colleagues and students have joined the department. Research funding has been made more secure. And the accomplishments of many faculty and students have received national and international attention.

Professor Li Yang joined the faculty in August 2009. His theoretical work in condensed matter physics focuses on first-principle calculations on nanostructures, working to develop a deeper understanding of electron–electron, electron–phonon, and electron–photon interactions in such strongly confined systems. Christina Saldivar joined the physics staff in May 2010 as an accounting assistant. She holds a B.A. in Business Administration from Missouri Baptist College.

With the arrival of new colleagues, some colleagues have left. Christina is filling the vacancy of Trecia Stumbaugh, who became assistant to the director of the McDonnell Center for the Space Sciences. Trecia filled the position previously held by Jan Foster. Becky Trousil, senior lecturer and chair of the Undergraduate Studies Committee, left in July 2010. Becky did an excellent job in teaching one of the three sections of our immensely popular new introductory physics course (Physics 197/198) covering the "Six Ideas that Shaped Physics," based on the ideas of Thomas Moore. She revived the Society of Physics Students (SPS) and improved the sense of community among the physics undergraduates. Mairin Hynes will be transitioning into Becky's position over the summer and fall.

We were saddened by the recent death of Professor Richard E. Norberg on April 20, 2010. We lost a highly recognized colleague, a leader, and a wonderful friend, who loved the department and Washington University. Dick will be remembered as one of the greatest chairs of the Department of Physics at Washington University. He served more than 28 years, leading the department from 1962 until 1991. In the history of the department only one chair, Arthur Hughes, served for a longer period—29 years, from 1923 until 1952. The department grew under Dick's leadership; he increased the size of the faculty and added Compton Hall. Dick was one of the early pioneers of the field of nuclear magnetic resonance; his research contributed to a deeper understanding of amorphous semiconductors, metal-hydrides, quantum fluids, and defects and impurities in solids. Dick was a masterful administrator and a great scientist. He will be missed by many—at Washington University and in the greater scientific community.

↑ Ken Kelton

Our undergraduate program is ever stronger. Renovation was completed for an undergraduate lounge, providing our students a place to leave their books, to study together, and to socialize. We have established a Sigma Pi Sigma (the national physics honor society) chapter, inducting both faculty and students. Jason Woods continues to work with others to increase the opportunities for undergraduate research. A record number of nine students received support for summer research in 2010, two supported by Delos Fellowships and seven supported by Physics Research Undergraduate Fellowships. Additionally, many more were supported by research grants. These opportunities allow students to participate in cutting-edge research, providing invaluable preparation for deciding on graduate schools and eventually their careers.

We are having an explosion of students in our introductory calculus-based physics course. This fall we will completely fill the two sections of our traditional course (117/118) and the three sections of our new course (197/198). If the undergraduate population continues to grow as expected, we will likely be opening another section in the 2011–2012 academic year. We continue to work with our colleagues in the other science departments and in the School of Engineering & Applied Science to explore options for carrying these changes further, creating new courses and possibly new majors.

The graduate program in Physics has undergone significant changes. After extensive consultation with the graduate students and the dean of the Graduate School, we have changed the use of the University Fellowships. Previously these were awarded to relieve first-year graduate students of teaching duties. In the future, students will have no teaching duties in their first and fourth semesters. This will allow them the chance to focus on their classes in their first semester and to become accustomed to the increased rigor of graduate courses. The fourth semester fellowship will give them time to prepare for their Ph.D. qualifying exam. The Ph.D. qualifying exam has also changed. Instead of four written exams over the core areas of physics, students now take a single oral qualifying exam. They research and defend planned studies in an area that may be, but is not required to be, in their field of study for their Ph.D. research. The competitive Summer Teaching Fellowships, instituted in summer 2008, continue to provide students interested in teaching careers the opportunity to teach their own introductory physics course.

It has been a year of significant accomplishments, with new grants and high-profile publications from faculty and students. Experimental confirmations are now coming in of Professor Carl Bender's fundamental research on PT symmetric quantum mechanics (where non-Hermitian Hamiltonians are invariant under space and time reflection). Professors Mark Conradi and Jason Woods have had growing success in lung imaging studies using hyperpolarized helium 3. Professor Jim Miller and co-workers have been awarded an NIH grant to explore the consequences of their intensive investigations into the Kramers-Kronig relation applied to ultrasonic methods for the detection and monitoring of osteoporosis. The cosmic ray group, led by Professors Marty Israel and Bob Binns, is accumulating evidence that the bulk of cosmic rays originate in clusters of massive stars in our galaxy. It has been an exciting year in dark matter. Professor Francesc Ferrer and his collaborators, Professors Nipoti and Ettori from the University of Bologna, have suggested, for example, that the puzzling observations of distant galaxies showing that similar sized objects were more compact in the past could be due to the instability of dark matter particles. Professor Jonathan Katz has continued his studies in how physics can help society, for example, looking at ways of making nuclear fuel proliferation-resistant. Professor Cliff Will may have identified a third independent constant of motion for a body orbiting around a stationary axially symmetric body in Newtonian Gravity; this could reflect a deep feature of Newton mimicking Einstein. I have received an NSF MRI grant to construct a new facility that will be located

***(continued on page 6)***

# NEW FACULTY

↑ Li Yang

**Professor Li Yang** is working on the condensed matter theory and first-principles calculations on nanostructures. His main research interest is to understand the spectroscope properties associated with electron–electron, electron–phonon, and electron–photon interactions in strongly confined structures, such as nanomaterials and molecules. In addition to answering the usual "yes-or-no" questions, his study is trying to provide the accurate values that are in good agreement with real-world experiments.

Studying the electronic structure and optical properties of solids is a desirable and important task because of their profound physics and broad applications. However, efforts to obtain the accurate description of these properties from fundamental quantum mechanics have been impeded by the huge number of correlated electrons in typical solids. With the help of density functional theory (DFT) and the fast advance of computational capability, the first-principles method has been widely used to study the above properties and obtain satisfying results. In particular, its parameter-free character makes it possible to predict various physical and chemical features, which is of great importance for designing novel materials.

Yang is interested in applying the powerful first-principles method to study the atomic structure, electronic structure, and optical response of solids, and to design exotic functional materials. One of his recent research interests is to look for novel approaches to control the electrical and optical responses of silicon and carbon nanostructures. He has developed first-principles simulations to efficiently tune the electronic structure of nanomaterials by varying their environment, such as applying external electric field and strains. These efforts provide extra freedoms to design novel functional materials.

Another of Yang's research interests is to develop the first-principles method beyond the traditional DFT. He has appropriately extended the Green's function formulism to include the spin degree of freedom for studies of spectroscope properties of solids which allows, for the first time, the *ab initio* calculation of the optical response of a magnetic system with many-electron effects included. In particular, he is focusing on the optical properties of correlated magnetic systems, i.e., transition metal oxides. This research is of great help to reveal the interaction between photons and correlated electrons.

At the same time, Yang is interested in novel photovoltaic materials, such as solar cells based on nanostructures and molecules. He is focusing on improving the optical absorption capability and the quantum separation efficiency of electron-hole pairs in such confined systems, which is of key interest for potential high-efficiency and low-cost solar cells.

Yang received his Bachelor and Master of Science degrees from the Beijing Normal University in China (1997 and 2000) and Ph.D. from the Georgia Institute of Technology (2006). Before joining our faculty, he had been a postdoctoral fellow at the University of California, Berkeley and the Lawrence Berkeley National Laboratory (2006–2009), working with Professor Marvin Cohen and Professor Steven Louie.

## CHAIRPERSON'S LETTER *— continued from page 5*

at the Spallation Neutron Source, which will extend my group's structural studies of liquids to include investigations of dynamics. I've also co-authored a book with colleague Professor Lindsay Greer (Cambridge University) entitled, "Nucleation in Condensed Matter—Applications in Materials and Biology."

The high quality of our faculty, students, and staff has been recognized by awards, conferences, and invited lectures. Tim Smolar, research technician in the Space Sciences Group, received an Arts & Sciences Outstanding Staff Award for 2009–2010. Undergraduate majors Tim Wiser and Robert Perkins won 2010 Barry M. Goldwater Scholarships. Graduate student Patrick Johnson received the Dean's Award for Teaching Excellence. Professor Tom Bernatowicz was the inaugural recipient of the David Hadas Teaching Award in Arts & Sciences, given in recognition of his outstanding commitment and excellence in teaching first-year undergraduate students. Professor Ramanath Cowsik, received the 2009 O'Ceallaigh Medal for his outstanding contributions to cosmic ray physics. Professor Carl Bender's accomplishments in PT Quantum Mechanics were the focus of a conference on *Quantum Mechanics in the Complex Domain* held at Washington University in March 2009. Professor Cliff Will began a five-year term as editor-in-chief of *Classical and Quantum Gravity*, considered one of the leading journals in gravitational physics, and he was elected vice chair of the Astrophysics Division of the American Physical Society. You can also catch Cliff's interview on black holes on YouTube. Professor Lee Sobotka (Chemistry and Physics) and several former graduate students of the physics department, Professor Rob Phillips (former student of Anders Carlsson), Rhonda Stroud (former student of Ken Kelton and Pat Gibbons), and Professor Matt Visser (former postdoc in the high-energy theory group), were inducted as Fellows of the American Physical Society. Christopher Spitzer, a postdoc with Professor Francesc Ferrer, was named a Congressional Science Fellow for 2010–11. Many professors have given invited and plenary lectures at international conferences. For example, Professor Mark Alford has given several invited lectures on his fundamental studies of quark matter and neutron stars. Professor Mike Ogilvie gave an invited talk on the theory of quark confinement at a U.S. Department of Energy Institute for Nuclear Theory workshop on renormalization group methods in nuclear, particle, and condensed matter physics held at the University of Washington.

In last year's letter I noted that while the deterioration of the economy brought new challenges, it also brought new opportunities. My faith in the quality of our faculty, students, and staff made me confident that the department would emerge stronger than before. The accomplishments and recognition described in this newsletter demonstrably confirm that faith.

***– Ken Kelton***

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## FACULTY AWARDS AND RECOGNITION

A conference on Quantum Mechanics in the Complex Domain was held at Washington University, March 27–28, 2009. The conference, held in the Great Hall at Lopata House, was attended by over 50 physicists from around the world. The main topic of the conference was the use of complex analysis in the exploration of quantum systems, a subject pioneered by Professor **Carl Bender**, the Wilfred R. and Ann Lee Konneker Distinguished Professor of Physics. In the last decade, Bender's research has focused on PT symmetry, based on a discovery made by Bender and his former graduate student, Stephan Boettcher. Professor Boettcher, now a member of the physics faculty at Emory, spoke at the conference. At the conference banquet, where Chancellor Emeritus William H. Danforth gave an after-dinner address, Bender was honored by his colleagues for his many contributions to physics.

Professor **Thomas Bernatowicz** was the inaugural recipient of the David Hadas Teaching Award in Arts & Sciences presented in September 2009. This award honors an outstanding tenured faculty member in Arts & Sciences who demonstrates commitment and excellence in teaching first-year undergraduate students. It was established in 2008 by Pamela W. Hadas in honor of her late husband, David Hadas, who spent nearly 40 years at Washington University. He was a renowned professor of both English and religious studies in Arts & Sciences.

**Ramanath Cowsik**, professor of physics and director of the McDonnell Center for the Space Sciences, received the 2009 O'Ceallaigh Medal for his "outstanding contributions to cosmic ray physics over an extended career." The International Union of Pure and Applied Physics' Cosmic Ray Commission and the Dublin Institute for Advanced Studies sponsor the award, which is named for the late Cormac O'Ceallaigh, a physics professor at the Dublin Institute who made many significant contributions in the field of cosmic rays. He was considered one of the most distinguished physicists in Ireland. Cowsik, considered one of the world's preeminent astrophysicists, has made numerous major contributions to cosmic ray astrophysics.

The Charles Hohenberg Symposium, in honor of Professor **Charles Hohenberg's** 70th birthday, took place in May 2010. Speakers included colleagues and former students in celebration of his significant accomplishments and contributions.

**Lee Sobotka**, professor of chemistry and physics, has received the Glenn T. Seaborg Award for Nuclear Chemistry sponsored by the American Chemical Society (ACS), Division of Nuclear Chemistry and Technology. This award was presented February 2010 at the spring meeting of the American Chemical Society in San Francisco. The award citation reads: "For contributions to the understanding of complex nuclear reactions and for the creation of novel detectors and signal-processing technologies for basic and applied nuclear science." A symposium in his honor attracted many colleagues who paid tribute to his many accomplishments.

**Clifford Will**, the James S. McDonnell Professor of Physics, has been elected vice chair of the Astrophysics Division of the American Physical Society. He will serve in that post for one year and then ascend to chair-elect for one year, and then to chair of the division.

## LEARNING WHERE COSMIC RAYS COME FROM

The cosmic ray group, led by Research Professor Bob Binns and Professor Marty Israel, working with collaborators at NASA's Goddard Space Flight Center, Caltech, JPL, the University of Minnesota, and Katharina Lodders of the Washington University Department of Earth & Planetary Sciences, is accumulating mounting evidence that the bulk of cosmic rays originate in clusters of massive stars (called OB associations) in our galaxy. In a paper published last summer in the *Astrophysical Journal* (B.F. Rauch, et al., Ap.J. 697, 2083, 2009), they report that the elemental composition of cosmic rays heavier than nickel, measured by their Trans-Iron Galactic Element Recorder (TIGER) in two Antarctic balloon flights, shows a source that is a mixture of about 80% "normal" solar-system-like composition and about 20% outflow from massive stars. This result is consistent with indications from the isotopic composition of cosmic rays lighter than nickel measured by their Cosmic Ray Isotope Spectrometer (CRIS), which has been returning data since its launch on the Advanced Composition Explorer (ACE) spacecraft in August 1997.

The group is now constructing an enlarged SuperTIGER instrument, about four times bigger than TIGER, which is scheduled for launch on an Antarctic balloon in December 2012. In addition to current graduate students and staff of the Washington University Laboratory for EXperimental AStrophysics (LEXAS), collaborators in the SuperTIGER program include former Washington University graduate students Richard Mewaldt (Caltech), Georgia deNolfo (GSFC), and Jason Link (GSFC).

## RICHARD E. NORBERG *— continued from page 1*

A final word—Dick was an extremely knowledgeable opera enthusiast with an enormous collection of recordings in many formats. For many years, he made a pilgrimage to New York to enjoy performances at the Metropolitan Opera. Most recently, the Union Avenue Opera in St. Louis was the center of his opera interest.

There was no funeral service. Dick requested that his body be donated to the Washington University School of Medicine. The department held a memorial gathering in Crow Hall on June 1. Introductory remarks by Ken Kelton, chairman of the Department of Physics, were followed by "Reflections on Richard Norberg" by Chancellor Emeritus William Danforth. Further reminiscences were offered by members of the Norberg family, and then by some of Dick's former graduate students: Jim Burgess (GR 55), Irving Lowe (GR 57), Joe Ganem (GR 89), Mark Conradi (GR 77), and Dan Leopold (GR 83). Operatic selections were played before the start and at the conclusion of the program.

Dick is survived by his wife, Jeanne O'Brien Norberg of St. Louis; a daughter, Karen Norberg of St. Louis and of Cambridge, Massachusetts; two sons, Craig Norberg-Bohm of Boston and Peter Norberg of Ferguson, Missouri; a stepson, Richard O'Brien of St. Louis; two stepdaughters, Kathleen O'Brien of St. Louis and Anne O'Brien of Sebastopol, California; and six grandchildren. His first wife, Patricia L. Norberg, died in 1977.

# FACULTY NEWS

In fall 2009, after six years at Washington University, Professor **Mark Alford** had his first experience teaching the University's non-physics majors. He was given responsibility for the "Physics and Society" course, which attracted 80 students, ranging from freshmen to seniors. He used the *Physics for Future Presidents* textbook written by Richard Muller from U.C.-Berkeley and was able to cover topics such as energy, heat, power generation, and climate change. The students asked a stream of stimulating questions in lectures, forcing Alford to explain, and in some cases recant, the simplifications he had made in an effort to make the material accessible to non-physicists. The course received very good evaluations, and Alford will be teaching it again in fall 2010.

Washington University asked Alford to give a "Faculty Spotlight" lecture at Fall Orientation 2009. He described his research to an audience of about 100 newly arrived freshmen. A few days later, he gave a "Scholars Program" seminar, explaining particle physics to Washington University students with scholarships.

He was also active in outreach to the general public. In November 2009, he gave one of the physics department's "Saturday Science Lectures" (http://physics.wustl.edu/Events/Docs/SaturdayMorningSeminar.php), a series of lectures for the general public. Alford described the current state of our knowledge of "Cosmology and Particle Physics" to an audience of about 200 people. Later, in March 2010, he gave a similar lecture to the St. Louis Mensa Society.

In 2009 and early 2010, Alford traveled inside and outside the United States presenting his research work to professional audiences. In spring 2009, Alford was invited to give a plenary talk at the 2009 Quark Matter Conference in Oak Ridge, Tennessee. He also gave the opening talk of the Gordon Nuclear Physics Conference and invited presentations at two neutron star conferences in Santa Fe, New Mexico, and State College, Pennsylvania. In March 2010, he was asked to give a special one-hour seminar as part of an international workshop at the Yukawa Institute of Kyoto University. This was Alford's third visit to Kyoto, and he hopes very much to receive more invitations from the Yukawa Institute.

In the past year, Professor **Carl Bender** gave invited colloquia at the University of Arkansas (Fayetteville); the University of Connecticut (Storrs); the University of Oklahoma (Norman); the University of Missouri (Rolla); the University of Washington (Seattle) [the Boeing Colloquium]; University of Heidelberg (Germany); University of Pittsburgh and Carnegie-Mellon University (joint colloquium); Case Western Reserve University (Cleveland); University of Louvain (Belgium); Dalhousie University (Halifax, Nova Scotia) [the Blundon Lecture]; University of Kent (UK); Renaissance Technologies (Long Island, New York); and City University London.


↑ Poster for a conference in honor of Carl Bender.

He also presented invited seminars at the University of Oklahoma (Norman); the University of Louvain (Belgium); the University of Montreal (Canada); Dalhousie University (Halifax, Nova Scotia); the Tata Institute (Mumbai, India); Kings College London; and Brookhaven National Laboratory (New York).

Bender presented invited plenary talks at these conferences: University of Miami ["Miami 2009"]; the Bhabha Institute, Mumbai, India; Sardinia, Italy ["Nonlinear Evolution Equations and Dynamical Systems"]; Paris, France ["Paris Conference on Nonperturbative QCD"]; Bregenz, Austria ["Symmetries in Science Symposium"]; Marseille, France ["Approximation and Extrapolation of Convergent and Divergent Sequences and Series"]; Pisa, Italy ["Asymptotics in Dynamics, Geometry, and PDEs; Generalized Borel Summation"]; and Nice, France ["Nice Workshop on Nonperturbative QCD"].

He gave extended advanced graduate courses at Imperial College, London (five lectures on PT quantum mechanics), the University of Heidelberg, Germany (four lectures on nonlinear waves and shocks), and the Perimeter Institute, Waterloo, Canada (10 lectures on summation theory). Bender is a professor at both Imperial College (Applied Mathematics) and the University of Heidelberg (Physics).

He gave several talks locally in St. Louis: two talks at the Illinois Metro-East Saturday Scholar Program at O'Fallon High School and Edwardsville High School; a "Science on Tap" talk at the Schlafly Brewery; a Greenhouse Warming talk at the Saint Louis Zoo (arranged by the University of Missouri–St. Louis). In March 2009, a conference in his honor was organized at Washington University: "Quantum Mechanics in the Complex Domain."

Bender's research on PT quantum mechanics was given a big boost—articles appeared in November 2009 (*Physical Review Letters*) and January 2010 (*Nature Physics*) which presented clear experimental evidence of the PT phase transition that he predicted. There have now been a dozen international conferences in the past few years on his work, the most recent conference in Mumbai, India. The next three conferences will be in Prague and Hangzhou (China) in summer 2010 and in Dresden in 2011. A flurry of articles on PT quantum mechanics has appeared in *Physical Review Letters*. The DOE grant funding of the theory group at Washington University has increased this year by one-third.

Professor **Francesc Ferrer** reports that this has been a very exciting year for the study of the nature of the dark matter (DM), missing mass, in the universe. Two experimental collaborations, CDMS and Cogent, have reported evidence of collisions of DM particles. In addition, the new results from the Fermi satellite put constraints on the possible interactions of these particles. While attending a DM workshop in Florence, Italy, he started a collaboration with C. Nipoti and S. Ettori from the University of Bologna. They suggested that the puzzling observations of distant galaxies showing that similar sized objects were more compact in the past could be due to DM particles being unstable. The results were presented at the annual international conference COSMO 09, that took place at CERN, Geneva, Switzerland. Ferrer joined the DM task group of the VERITAS col-

laboration and gave invited talks at the conference, "TeV Particle Astrophysics," at Stanford University and at the collaboration meeting in Tucson, Arizona.

Chris Spitzer joined his group as a postdoctoral researcher in fall 2009. He is an expert on particle physics models of DM and, together with Ferrer, they have studied the dark sector in supersymmetric extensions of the standard model of particle physics. Their investigations on nonminimal scenarios were recently presented at The Ohio State University.

Graduate student Daniel Hunter is working on particle astrophysics with Ferrer. Hunter is developing a new analysis method for the Fermi data release that will improve the constraints on gamma-ray emission from DM annihilations. Working jointly with Professors Clifford Will and Ferrer, graduate student Laleh Sadeghian studies the rotation of the black hole in the galactic center. The effects on the DM distribution in the galaxy could have important implications for the indirect detection of dark matter.

Professor **Jonathan Katz** published a paper that addresses what is possibly the oldest puzzle in physics, the "Mpemba Effect." This is the observation, first reported by Aristotle, that hot water freezes before cold (it is named for a Tanzanian high school student who rediscovered it in the early 1960s). He hypothesizes that it is the result of freezing point depression (the same effect that makes salt melt ice) by solutes in "hard" water, combined with concentration of these solutes as a freezing front moves into the water, and the fact that pre-heating softens hard water by precipitating solutes as "kettle fur" or "boiler scale." Quantitative data are scarce, but he looks forward to an experiment to test this.

Pursuing an avocation in "recreational physics," Katz calculated the sound made by a bouncing basketball (or any ball that is inflated by pressurized air, such as a soccer ball, volleyball, or beach ball). This sound consists of two parts. The first is a surprisingly loud dull "thump," whose source is monopole emission by the changing volume of the ball as it squishes against a hard surface. Monopole emission is not found in electromagnetism or gravity because charge and mass-energy are conserved, but it is found in acoustics because volume is not conserved; the deafening blast of an explosion is another example of monopole emission. Just as in electromagnetism, the lower the multipole order, the greater the radiated power, all else being equal. The second part of the sound is a high-pitched (1000 Hz for a basketball) "ring" that persists for about a second. It results from the up-and-down oscillation of the air inside the ball that makes the ball itself oscillate (momentum is conserved, so if the air goes up, the ball goes down); this is a dipole source of sound.

Katz's research broadened to "Physics and Society" issues, including the possible relationship between nuclear bomb test moratoria and proliferation (he found no statistical evidence for any relationship) and means of making nuclear fuel proliferation-resistant. He presented these ideas at conferences in Rome and Como, Italy, and published a paper in the journal *Comparative Strategy*, one of its few physicist contributors.

Katz was appointed to the National Ignition Campaign Review Committee that is reviewing the progress of the U.S. effort to "ignite" thermonuclear fuel in a tiny capsule at the National Ignition Facility in Livermore, California, the world's largest and most powerful laser. His involvement with this effort began in 1970, when he worked as a plasma physicist at Livermore.

Katz served on the Gamma-Ray Burst section of the Very High Energy Gamma-Ray Astronomy panel of the NSF Astronomy Decadal Review.

Professor **Ken Kelton** and Professor A. Lindsay Greer from Cambridge University, UK, have published a book, *Nucleation in Condensed Matter—Applications in Materials and Biology*. The book, published under the Pergamon imprint of Elsevier, appeared in May 2010. This book presents a unified treatment of key theories and a detailed discussion of experimental measurements. While intended primarily for a materials physics and materials science audience, it also crosses to other fields, giving case studies of nucleation in diverse systems, including biology, medicine, and food. Kelton has presented the results of his studies of liquids and glasses in invited lectures at the TMS and APS meetings, Oak Ridge National Laboratory, Brookhaven National Laboratory, and Boston University. He is a member of an ESA team that will be carrying out studies on the international space station; he was recently invited to participate in a workshop entitled, "Electromagnetic Levitation and Precision Measurements on ISS: Status Quo and Future Perspectives," Friedrichshafen-Immenstaad, Germany. In January 2010, Kelton gave two lectures at an International School on Glass Formers and Glasses, held at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India: "Liquids and Glasses-Structures and Properties" and "Nucleation of First-Order Phase Transitions."

***(continued on page 10)***

## PHYSICS OUTREACH

Professor Pat Gibbons and Jack Wiegers, from the Washington University Science Outreach Office, co-presented a two-day workshop on materials and activities for ninth-grade Physics First classes, along with two representatives from CPO Science, a vendor of high-quality materials for activities and a textbook for Physics First. They continued their work with ninth-grade teachers of Physics First in the Hazelwood School District with a three-day workshop at Hazelwood East High School in August 2009. They hosted a Saturday morning joint meeting of the Missouri Section and the St. Louis Section of the American Association of Physics Teachers in October 2009. For that, Gibbons found a way to make a ten-power Keplerian telescope for a unit cost of just $4. Dollar Store reading glasses make a fair objective lens for a very low cost. Gibbons, Wiegers, and Ann McMahon, from Science Outreach, presented a talk, "Learning How We Know What We Know in an Astronomy Course," at the spring 2010 meeting of the Missouri Academy of Science in April. Gibbons is the chair of the Physics Senior Section this year, as well as the chair of the Missouri Section of the American Association of Physics Teachers.

Gibbons is chair of the Physics Outreach Committee, a group of four graduate students and two faculty members. The students are Ben Burch, Evan Groopman, Sarah Thibadeau, and Kasey Wagoner. They have designed and presented physics activities in the Exxon-Mobil Bernard Harris Summer Science Camps in summers 2008 and 2009. These are two weeks long and have the middle-school participants living on campus, with a visit home over the weekend. In December 2009, they invited families to come to Crow Hall on a Saturday morning for Physics Family Funday, using some of the best of the summer camp activities.

## FACULTY NEWS — *continued from page 9*

This past year, Karyn Bondi finished her Ph.D. thesis work in Kelton's group on the topic "Analysis of the Effects of Microalloying on Glass Formation in Al-Y-Fe Alloys by Fluctuation Electron Microscopy and Other Techniques." Victor Wessels also completed his Ph.D. thesis on the topic "Phase Formation, Liquid Structure, and Physical Properties of Amorphous and Quasicrystal-Forming Alloys." Wessels joined Professor Jörg Löffler's group in Metal Physics and Technology at ETH Zurich, where he is engaged in metallic glass research. Kanai L. Sahoo, National Metallurgical Laboratory, Jamshedpur-831007, India, was a visitor in Kelton's research group in 2009.

Professor **Michael Ogilvie** was an invited speaker at a workshop on "New Applications of the Renormalization Group Method in Nuclear, Particle, and Condensed Matter Physics" at the U.S. Department of Energy Institute for Nuclear Theory at the University of Washington, Seattle. Ogilvie spoke on the theory of quark confinement. Quarks are constituents of nuclear particles like the proton and are confined inside these particles by a force of about 15 tons. Also presenting at the workshop were postdoctoral fellow Kai Schwenzer and graduate student Hiro Nishimura. Ogilvie was an invited speaker at a workshop on Large-N Gauge Theories at the Maryland Center for Fundamental Physics in May 2009 and at the Aspen Center for Physics in June 2009. At Aspen, he participated in a program on Critical Behavior of Lattice Models in Condensed Matter and Particle Physics.

In January 2009, Professor **Cliff Will** began a five-year term as editor-in-chief of *Classical and Quantum Gravity*, published by the Institute of Physics (UK). Second only to *Physical Review D15*, it is considered one of the leading journals for research papers in gravitational physics.

He served on the Cosmology and Fundamental Physics Science subpanel of ASTRO2010, the decadal survey of astronomy and astrophysics carried out by the National Research Council at the behest of NSF, NASA, and DOE.

In spring 2010, he was elected vice chair of the 2,300-member Astrophysics Division of the American Physical Society. He will serve for one year, then become chair-elect, and then chair of the Division, which promotes astrophysical investigations, organizes sessions on astrophysics at APS meetings, and supports the community of researchers at the interface between physics and astronomy.

Will gave a number of lectures around the world, including a summer school course in Como, Italy, sponsored by the Italian general relativity society; two lectures at a workshop on fundamental physics in space in Campos do Jordao, Brazil; and a public lecture, "Einstein, avait-il raison?" (Was Einstein Right?) at the Institut d'Astrophysique of Paris (a video of this lecture can be found at download.sfrs.fr/media-1/sfrs/Mpg4/IAP/IAP020609.mp4).

In the February 13, 2009 issue of *Physical Review Letters*, he pointed out that a body orbiting around a stationary axially symmetric body in Newtonian gravity has, in addition to the usual conserved energy and angular momentum, a third, independent constant of motion, if and only if the multipole moments of the central body's gravitational field satisfy a specific equation. That equation turns out to be identical to the equation satisfied by the analogous multipole moments for the Kerr geometry, the general relativistic exact solution for a rotating black hole. Whether this is a complete fluke or reflects some deep feature of Newton mimicking Einstein remains to be seen. One Newtonian potential that has this property is that produced by two point masses held a fixed distance apart. Ironically, this is a very old problem in celestial mechanics (it is commonly called the Euler problem) and is a rare example in classical mechanics of a non-spherical, completely integrable system. The work was featured in a commentary by *Science News* (sciencenews.org, March 28, 2009).

Will can also be found on YouTube, being interviewed on black holes as part of a series of outreach interviews put together by the Albert Einstein Institute in Golm, Germany. Just search on "Clifford Will YouTube"; the video is rated 5 stars! Will also brought the musical stylings of the internationally reviled singing group Bernie and the Gravitones to Washington University, singing a solo rendition of "PT Goodbye" (sung to the tune of "As Time Goes By"') at Carl Bender's Fest in March 2009. Mercifully, no recording of the performance is known to exist.

# STAFF NEWS

### Departmental Office

**Christina Saldivar** joined the Physics staff on May 1, 2010 as an accounting assistant. She is a native St. Louisan who currently lives in St. Charles with her husband, Vicente, and their two-year-old son, Dominic. Christina graduated with a B.A. in Business Administration from Missouri Baptist College. She is fluent in Spanish and has used this skill throughout her career. Christina brings with her experience in accounting, accounts receivable and payable, collections, and customer service spanning the hotel, banking, and chemical industries. Christina will be handling billing, purchasing, and travel documents. Christina is filling the vacancy **Trecia Stumbaugh** left when she became the assistant to the director for the McDonnell Center for the Space Sciences.

### Arts & Sciences: Outstanding Staff Awards for 2009–2010

**Tim Smolar** has worked as a research technician in the Space Sciences Group in the Department of Physics for 12 years. His responsibilities include maintaining and troubleshooting all of the high-tech equipment such as the nanoscale secondary ion mass spectrometer and scanning electron microscope, making specimen mounts, designing and building electronic and high-vacuum apparatus, among many other essential duties. Tim's work ethic is evident in the absolute devotion that he has to his work and to his colleagues, many times coming to the lab in the middle of the night or on the weekend to solve some problem—not because he was required to do so but because of his own standards of excellence. Tim's cheerful attitude, devotion, kindness, and sincerity make him a pleasure to work with.

# STUDENT NEWS

## GRADUATE STUDENTS

Since the last newsletter, 17 of our students have received their Ph.D. degrees. They are listed below, along with their thesis titles, faculty advisors, and current positions.

**Mathiewos T. Debessai**, "Superconductivity in Selected Elements and Compounds Under Extreme Pressure," February 13, 2009 (Professor Schilling), Institute for Shock Physics, Washington State University (postdoctoral associate)

**Karyn Spence Bondi**, "Analysis of the Effects of Microalloying on Glass Formation in A1YFe Alloys by Fluctuation Electron Microscopic and Other Techniques," April 9, 2009 (Professor Kelton), (currently raising a family)

**Wei Zhang**, "Kinematic Model-Based, Noninvasive and Invasive In-Vivo Characterization of Left Ventricular Filling Efficiency, Stiffness, and Viscoelastic Attributes," April 10, 2009 (Professor Kovacs), Shook, Hardy and Bacon, Kansas City, Missouri (research analyst)

**Adam Q. Bauer**, "The Role of Phase in Ultrasonic Measurements of Phase Aberrating Media using Piezoelectric Receivers," April 22, 2009 (Professor Miller), Washington University School of Medicine, Optical Radiology Lab (postdoc)

**Allyson A. Gibson**, "Backscatter and Attenuation Characterization of Ventricular Myocardium," August 20, 2009 (Professor Miller), Stereotaxis (biomedical research engineer)

**Adam T. Eggebrecht**, "Mechanisms of Feedback in the Visual System," August 24, 2009 (Professor Wessel), Washington University School of Medicine, Radiology (postdoc)

**Victor Wessels**, "Phase Formation, Liquid Structure, and Physical Properties of Metallic Glass- and Quasicrystal-Forming Alloys," August 28, 2009 (Professor Kelton), ETH Zurich (postdoctoral researcher)

**Frank Gyngard**, "Isotopic Studies of Presolar SiC and Oxide Grains as Probes of Stellar Nucleosynthesis and the Chemical Evolution of the Galaxy," September 1, 2009 (Professor Bernatowicz), Carnegie Institution of Washington (postdoctoral fellow)

**Mew-Bing Wan**, "Properties of Neutron Star Critical Collapses," September 22, 2009 (Professor Suen), The Chinese Academy of Sciences, Beijing (postdoctoral researcher)

**Jennifer Mabry**, "Solar Wind Helium, Neon, and Argon in Genesis Aluminum Collectors," October 8, 2009 (Professors Hohenberg and Meshik), Centre de Recherches Pétrographiques et Géochimiques (CRPG), Nancy, France (postdoc)

**Jing Shao**, "The Mechanisms and Roles of Feedback Loops for Visual Processing," November 2, 2009 (Professor Wessel), Max Planck Institute of Neurobiology, Munich, Germany (postdoc)

**Hare Krishna**, "Pattern Formation and Magnetism in Pulsed Laser-Induced Self-Organized Nanostructures from Single and Bilayer Metallic Films," March 25, 2010 (Professors Kalyanaraman and Kelton), Intel Corporation, Portland, Oregon (process engineer)

**Gerald J. Good**, "Determining the Properties of Dense Matter: Superconductivity, Bulk Viscosity, and Light Reflection in Compact Stars," April 28, 2010 (Professor Alford), Boeing Aircraft (electrophysics engineer/scientist 4)

**Tianyu Zhao**, "A Free Lung Motion Model," May 3, 2010 (Professors Low and Conradi), University of Florida Proton Therapy Institute (medical physics resident)

**Kasey Wagoner**, "Laboratory Investigations of Short-Range Gravity," May 4, 2010 (Professor Cowsik), Washington University, McDonnell Center for the Space Sciences (postdoc)

**Xining Du**, "The Staggered Chiral Perturbation Theory in the Two-Flavor Case and SU(2) Chiral Analysis of the MILC Data," May 11, 2010 (Professor Bernard), LPSC–France (Laboratoire de Physique Subatomique et de Cosmologie) (postdoc)

**Timothy M. Ivancic**, "NMR Search for Mobile, Aluminum-Bearing Species during Reactions of Sodium Alanate," May 25, 2010 (Professor Conradi), Sensient Colors, Inc., St. Louis, Missouri (quality analyst)

### 2009 Seniors

Eighteen seniors graduated in May 2009. Many have entered physics graduate programs, while some have switched to other disciplines.

**Carolyn Auchter**—Culver Academies: Teacher

**Jeremy Diepenbrock**—Department of Defense: Mathematician

**Jared Fuchs**—Washington University: Mathematics

**Evan Groopman**—Washington University: Physics

**Jonathan Mueller**—Duke: Physics

**Kimberly Venta**—University of Pennsylvania: Physics

At press time, we had no information on the plans of the following students:

**Tanwa Arpornthip**

**Alexander Cloninger**

**Erin Dowty**

**Andrew Gavinski**

**Matt Gregg**

**Joseph Hutchings**

**Alexander Jeffrey**

**Rebecca Levy**

**Paul Mazuski**

**Christopher Rinaldi**

**Melanie Veale**

**Huajia Wang**

### New Graduate Students

For the 2009–10 academic year, the department admitted 13 new graduate students:

**Matthew Blodgett** (University of Wisconsin, River Falls)

**Evan Groopman** (Washington University)

**Mahlega Hassanpour** (University of Tehran)

**Jun Han** (Shanghai Jiao Tong University)

**Blake Leonard** (University of Missouri–St. Louis)

**Jinhyuk Lim** (Western Illinois University)

**Yufeng Liang** (USTC–China)

**Mohammad Mahzoon** (Shiraz University)

**Ryan Murphy** (Northwestern University)

**Jeffrey Pobst** (University of Missouri–Columbia)

**Adam Vogt** (Truman State University)

**Ruizhe Wang** (Xiamen University)

**Fletcher Werner** (Southern Illinois University–Edwardsville)

## STUDENT AWARDS

**Robert Perkins** and **Tim Wiser**, junior physics majors, were selected as 2010 recipients of a Barry M. Goldwater Scholarship. The purpose of the Foundation is to provide a continuing source of highly qualified scientists, mathematicians, and engineers by awarding

scholarships to college students who intend to pursue careers in these fields. Wiser carried out research on PT symmetry in statistical mechanics during summer 2009 with Professor **Michael Ogilvie**. He was awarded a Delos Fellowship to continue this research in summer 2010. Perkins plans to teach and do research in astrophysics. Wiser's goal is to do research in mathematical and theoretical physics, and teach at the university level.

### Putnam Competition

Each year, there is the national Putnam Mathematics Competition for undergraduate students, and Washington University has a remarkable record. The University's 2009 team consisted of **Tim Wiser**, **Alex Anderson**, and **Ari Tenzer**. The team placed 13th in a field of 439 teams from colleges and universities across the United States and Canada. Steve Krantz and Richard Rochberg from the Department of Mathematics and **Carl Bender** from the Department of Physics ran practice sessions during the fall 2009 term to help students prepare for the examination.

In the Missouri Collegiate Mathematics Competition, the University's team—**Alex Anderson**, **Andy Soffer**, and **Tim Wiser**—won first place in the 15th annual competition held in April 2010.

### Departmental Awards to Students: May 2009 and 2010

Each year the department awards prizes for outstanding performance.

### Undergraduate Students

**Varney Prize**

Named to honor Robert Varney, a member of our faculty for many years. Varney and Dick Norberg taught an introductory course, then named Engineering Physics, Physics 211/212. Awarded to one or more outstanding students in introductory physics courses:

2009: **Alex G. Anderson**, **Jacob T. Friedlein**, **Fady S. Riad**

**Senior Prize**

Awarded to the outstanding senior physics majors:

2009: **Carolyn Auchter**, **Jonathan Mueller**, **Huajia Wang**

2010: **Emily Lebsack**

**Greg Delos Summer Research Fellowships**

Endowed by his family in memory of Greg Delos, an undergraduate who passed away during his junior year. Awarded to outstanding undergraduates for summer research in physics:

2009: **Hunter Banks**

2010: **Joel Sleppy**, **Tim Wiser**

**Undergraduate Research Fellowships in Physics**

Awarded to undergraduate students with proposed outstanding summer research projects:

2009: **Ross Ladau**, **Sean Lourette**, **Josh Moloney**, **Laura Rayhel**

2010: **Alexander Anderson**, **Jacob Friedlein**, **Hiu Yue Monatrice Lam**, **Ariel Leonard**, **Uriel Morone**, **Wei Jia Ong**, **Nicholas Orlofsky**

### Graduate Students

During the 2009–2010 academic year, **Patrick Johnson** received the **Dean's Award for Teaching Excellence**. The annual university-wide award recognizes graduate teaching assistants who have demonstrated exemplary skill and commitment to the craft of teaching during their graduate training. Johnson is a fourth-year Ph.D. student. He is a superb veteran graduate TA who has assisted in introductory labs, served as head laboratory TA, and in spring 2010 was chosen to TA an upper-level optics lab. His teaching prowess is rooted in his intuitive understanding of how to motivate and challenge students while simultaneously fostering a nonthreatening environment in which students are comfortable taking intellectual risks. His ability to convey to his students that he has a vested interest in their success garners their respect and admiration.

↑ Patrick Johnson

**Michelle Milne**, graduate student in Professor Conradi's group, was awarded a **Dissertation Fellowship** from the Graduate School for the academic year 2009–2010.

The **Franklin B. Shull Prize** in honor of Franklin Shull, longtime member of our faculty, recognizes outstanding teaching by graduate students in the physics department:

2009: **Mark Burnett**

2010: **Ben Burch**

### Sigma Pi Sigma

The following students were elected to Sigma Pi Sigma, the national physics honor society, in April 2010: **Hunter Banks**, **Emily Lebsack**, **Andrea Linville**, **Sara Rajaram**, **Thomas Shimizu**, and **Robert Zheng**.

## SATURDAY SCIENCE

From 1994 until 2004, we had Saturday Science lectures annually. But the lectures have been so popular and our audience so loyal that since 2005 we have had lectures every semester. All are held in the Hughes Lecture Room, Crow 201, which has a capacity of close to 200 and is filled most weeks.

To commemorate the 400th anniversary of Galileo's first astronomical discoveries, the International Astronomical Union and UNESCO designated 2009 as the International Year of Astronomy. The Year was celebrated in many countries and in many different ways. There were celebrations at the University of Padua where Galileo made his discoveries in 1609 and 1610. In our Saturday Science lectures for spring 2009, Galileo was the focus of our lectures.

For the fall 2009 lecture series, we chose to highlight topics of great current interest, with presentations by members of our faculty talking about their own research subjects: Ernst Zinner, "Production of the Elements: Evidence from Fossils Older than the Solar System"; Clifford Will, "Roll Over Galileo: The New Astronomy of Gravitational Waves"; Henric Krawczynski, "Radio and Gamma-Ray Observations of Supermassive Black Holes"; and Mark Alford, "Cosmology and Particle Physics."

The theme of Saturday Science lectures during spring 2010 was *A Crowd of Atoms: Collective Behavior in Liquids and Solids*. Liquids and solids have their atoms very closely packed. As with a crowd of people, their collective behavior can be surprising but illuminating. Examples are critical behavior, superconductivity, condensed matter, and biosciences. In these lectures, members of the Physics faculty described some of their own research: Anders Carlsson, "Active Materials in Biological Cells"; Stuart Solin, "The Impact of Geometry on the Physical Properties of Solids at Macroscopic, Microscopic, and Nanoscopic Scales"; Ken Kelton, "From Liquids to Glasses"; and James Schilling, "The Role of High Pressure in Basic, Materials, and Life Sciences."

# IN MEMORIAM

**Harry W. Fulbright (LA 40, GR 44)** died in May 2009 in Rochester, New York. He had been a member of the faculty at the University of Rochester since 1950 and had retired in 1989. Fulbright was a 1936 graduate of University City High School.

Our physics library contains a copy of his 1942 M.S. thesis that described the construction of the Washington University cyclotron. However, we have no copy of his 1944 Ph.D. dissertation. As Fulbright described it in a 1998 letter to the Washington University archivist, "wartime secrecy had prevented its normal appearance… the thesis topic was a study of Neptunium 239 decaying to Plutonium 239…to establish an energy level scheme for Plutonium. The topic was suggested to me by Dr. Glenn Seaborg, the person in charge of the Metallurgical Laboratory of the University of Chicago whose group was the principal user of the uranium that we bombarded for them (at Washington University) under contract." When the thesis was completed in 1944, "it was approved in absentia by several Washington University professors engaged in war work at other laboratories; no professor qualified to pass judgment was still at home."

Fulbright was a group leader in the Manhattan Project during 1944–46 and then an assistant professor at Princeton University until 1950. He then joined the University of Rochester, where one of his earliest tasks was the modernization of that university's 26-inch cyclotron. During 1956–57, he held Guggenheim and Fulbright Fellowships at the Institute for Theoretical Physics in Copenhagen.

**J.P. (Jack) Davidson (GR 52)** died in Lawrence, Kansas, in January 2010. He entered the University of California, Berkeley, but from 1943 to 1946 he served in the Army Signal Corps in the European Theater of Operations until he was honorably discharged as a first sergeant. Returning to Berkeley, he graduated in 1948 with highest honors in physics.

As a graduate student at Washington University in 1949, he worked with Mary Rieser and others to organize the Student Committee for the Admission of Negroes (SCAN). (Ed.: historical note: The 1952 full desegregation of Washington University came after a slow and complex process, described in detail by Provost Ralph Morrow and Candace O'Connor in their histories of Washington University.) Jack and Mary were married in September 1949. Jack received his Ph.D. in 1952, working under Eugene Feenberg, then did postgraduate work at Columbia University, and eventually published more than 40 research papers, a monograph, and encyclopedia entries.

He taught at Tsing Hua University in Taiwan, the Brazilian Center for Physical Research in Rio, and at the Joint Establishment for Nuclear Energy Research in Lillestrom, Norway. His research for the Norwegian merchant marines on the possibility of outfitting the fleet with nuclear reactors included the possibility that the reactor core might breach containment and melt down through the hull. This was the first use of the term "melt-down" in nuclear reactor literature.

**Newton Bernardes (GR 59)** died in Campinas, Brazil, in November 2007, at the age of 76. One of Brazil's physicists most often quoted in international journals, he produced original contributions, especially regarding solid state physics, released in publications such as *Physical Review* and *Physical Review Letters*.

Having graduated from the University of Sao Paolo (USP) in the early 50s, Newton spent some time in the United States, where he completed his Master of Science degree at the University of Illinois and his Ph.D. at Washington University. He was a student of Henry Primakoff. From 1960–62, he headed the Group of Physics of Solids at the Atomic Research Institute of the Atomic Energy Commission in the United States.

After returning to Brazil, Professor Mario Schenberg invited him to help establish and develop the Solid State Physics Department at USP. From 1976–1982, he was on leave of absence from USP and taught at the Gleb Wataghin Physics Institute at the Universidade Estadual de Campinas (Unicamp). He retired from USP in 1993 and became a collaborating professor at Unicamp, where he continued to research the fundamentals of physics.

↑ Rolf Woldseth

**Rolf Woldseth (GR 65)** passed away in October 2008. Rolf was born in Trondheim, Norway, in 1930 and graduated from the Technical University of Norway in 1955. For the next year, he worked for the Joint Establishment for Nuclear Energy Research, then came to Washington University for his graduate study, where he was a student of Alec Pond.

**Sam Lachterman** died in July 2009. He was 85. Sam was not a physics alumnus, but we include him here because he was a presence in our department for many years. Sam probably took some advanced physics courses, for he appears (in the back row) of our annual department photograph for 1946–47.

Sam completed his Ph.D. in mathematics at Washington University in 1963. His faculty advisor was Allen Devinatz, and his thesis subject was *Exponentially Convex Functions of a Cone in a Lie Group*.

## APS NEWS

Four physicists associated with our department were inducted as Fellows of the American Physical Society in 2009. Our congratulations to all!

**Rob Phillips (GR 89)** professor at California Institute of Technology (former graduate student of Anders Carlsson)
For fundamental contributions to the theoretical understanding of the influence of mechanical forces on biochemical processes, and for teaching physics in biological settings through workshops and textbook authorship. (Division of Biological Physics)

**Lee Sobotka**, professor of chemistry and physics, Washington University
For his contributions to the understanding of complex nuclear reactions, most notably the production of intermediate mass fragments, and for the creation of novel detector systems and signal processing technologies for both basic and applied nuclear science. (Division of Nuclear Physics)

**Rhonda Stroud (GR 96)** Naval Research Laboratory, Washington D.C. (former graduate student of Ken Kelton and Pat Gibbons)
For contributions to the structure of synthetic and natural materials including quasicrystals, aerogel nanocomposites, spin-polarized thin film devices, and stardust. (Division of Condensed Matter Physics)

**Matt Visser**, professor at Victoria University of Wellington, New Zealand (former Washington University postdoc in high energy theory group)
For contributions to gravity theory, especially the effects of energy condition violations and the development of analog models of black hole and cosmological spacetimes. (Division of Gravitational Physics)

# ALUMNI NEWS

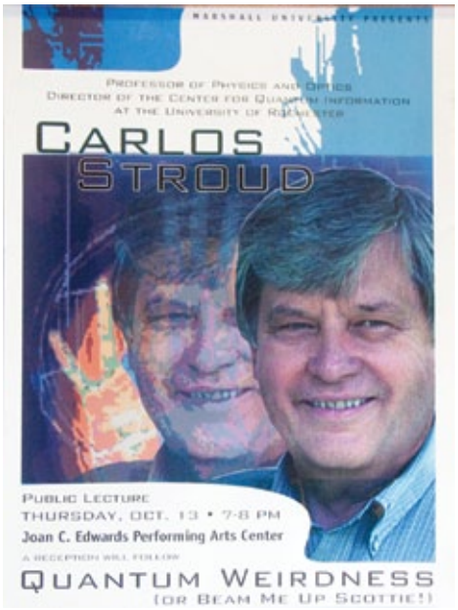
It is always good to read your letters and e-mails. Please continue to send us your news. We continue to find that there are some errors and gaps in our master list of alumni addresses. This is where you can help us: obviously, if you read this, then you have received the Newsletter. But ask your alumni friends, and let us know of any whom we appear to have missed. Send us their e-mail and mailing addresses and we'll be happy to add them to our list. Michael Friedlander (mwf@wuphys.wustl.edu) or Patrick Gibbons (pcg@wuphys.wustl.edu).

In September 2009, Washington University was host to the First Symposium on Nanotechnology for Public Health, Environment, and Energy. The occasion was the opening of Washington University's Nano Research Facility that is supported by the National Science Foundation. One of the four special guests was **Larry Goldberg (BS 61)**, Senior Engineering Advisor at NSF. Larry received his Ph.D. at Cornell in 1966 and has been at NSF since 1985. Other special guests were Mark Wrighton, chancellor of Washington University, George Whitesides of Harvard University, and Thomas F. George, chancellor of the University of Missouri–St. Louis.

**Harry Ringermacher (BS 68, GR 80)** was a Plenary Speaker at the Quantitative Nondestructive Evaluation annual conference held in Newport, Rhode Island. Harry described inspection techniques that use e-m radiation, from microwave through IR to gamma rays. He has now been elected as a Fellow of the QNDE Society.

**Carlos Stroud (GR 69)** was selected by the Division of Laser Sciences of the American Physical Society as Distinguished Traveling Lecturer in the Program in Laser Science. A little more than 10 years ago, the DLS set up a program in which Distinguished Lecturers would make two-day visits to smaller colleges and universities presenting a program that might include a colloquium, an evening lecture for the general public, and a number of meetings with classes and student groups.

The program proved so popular that it continues today with a list of 10 lecturers including Nobel Laureate Eric Cornell. Carlos was one of the original lecturers when the program was set up, and although the terms are nominally for two years, his lectures have been popular enough that he is currently serving his 12th year.




↑ Carlos Stroud

A notable feature of these visits has been the inclusion of an evening public lecture, which is usually something along the lines of "Quantum Weirdness: Technology of the Future?" These lectures have proved surprisingly popular with the general public, with audiences of 200–300. Carlos tells us that "the Huntington, West Virginia, lecture was particularly memorable since the local Marshall University Theater Arts Program wanted to stage the lecture in a rather unusual way. Since my lecture was to touch on quantum teleportation they decided to set up a Dr. Who-type telephone booth portal to teleport me in to give the lecture. So, I entered the stage from a mock English telephone booth complete with smoke, flashing lights, and appropriate sound effects—wearing Spock ears! Then I gave an hour's lecture on quantum mechanics. The local television station interviewed an attendee and asked how she liked the lecture, she replied that it was pretty good, but she especially liked the first part."

Carlos has been elected vice chair of DLS, beginning a four-year commitment to the leadership of this APS division, so that he may have to curtail future lectureships. "But" as he notes "it has been fun, and I feel strongly that we should support the smaller physics departments that are so important in keeping the supply of young talent entering the field."

**Steve Sutton (BS 71, GR Earth & Planetary Sciences 84)** is a senior scientist at the University of Chicago with a joint appointment in the Department of Geophysical Sciences and the Center for Advanced Radiation Sources. Steve tells us that he spends the majority of his time at the Advanced Photon Source synchrotron at Argonne National Laboratory where he is co-project manager for the GeoSoilEnviroCARS beamlines. Their beamlines are supported primarily by NSF-Earth Sciences and DOE-Geosciences. He also manages an X-ray microprobe beamline at the National Synchrotron Light Source at Brookhaven National Laboratory in New York. He has three kids and five grandkids all living in the Chicago metropolitan area.

**John Wefel (GR 71)** has been on the faculty at Louisiana State University for many years and continues to be active in cosmic ray research. He is professor and director of the Louisiana Space Consortium and is one of the senior scientists with the balloon-borne Advanced Thin Ionization Calorimeter (ATIC) which is designed to detect cosmic ray electrons and positrons. These might be produced in the annihilation of dark-matter particles, and the ATIC group reported detecting these particles in greater numbers than expected from other sources. Also detecting these particles but in smaller numbers, is the NASA Fermi Gamma-Ray Space Telescope.

John is the director of the International School of Cosmic Ray Astrophysics that holds biennial courses for graduate students and young researchers that stress the interrelationships between subdisciplines in astrophysics, particle physics, and cosmology. This School is based at the Ettore Majorana Center for Scientific Culture in Erice, Sicily, Italy.

Last year, **Simon Igelniek (GR 74)** was among only six staff at Washington University who were recognized for their 40 years of service. Simon is director of Information Systems in the Library at the School of Medicine.

It is always a pleasure when one of our alumni visits and speaks at our department's weekly colloquium. **W.E. Moerner (AB 75, BS 75)** was our speaker in February. His topic was "Single-Molecule Biophysical Imaging, Superresolution, and Trapping," in which he told us about recent work by members of his group at Stanford. He described his group's research in this way: "We have built a new type of trap for molecules in solution which suppresses Brownian motion to enable study of each single molecule for an extended period, and this device has been used to observe complex photo-induced changes in a fluorescent antenna protein."

**Suzanne Gronemeyer (GR 79)** has been awarded the prestigious Margaret Hay Edwards Medal recognizing her extraordinary achievements in contributions to cancer education. Information on the award is online at AwardsHonors_mhe.html and AwardsHonors_mhe_2009.html.

At SUNY Plattsburgh, **George Flynn (GR 82)** served as the team leader of the Preliminary Examination Team doing Chemical Analysis for Project Stardust.

The NASA Stardust Mission captured dust when it passed through the tail of Comet Wild in 2004 and brought them back to Earth. The JPL website notes that these particles could be more than 4 billion years old. Analysis may provide clues to the origin of the Earth and other planets of the solar system. The Stardust spacecraft also carried interstellar dust collectors, and George is a member of the team performing the preliminary search for interstellar grains in those collectors.

For many years, George has studied the chemistry of meteorite and cosmic dust samples, using facilities at Brookhaven National Lab on Long Island and Argonne National Laboratory near Chicago. He is an avid photographer, especially of landscapes and butterflies.

The eighth book by **Ken Croswell (AB 83)**, *The Lives of the Stars* (Boyds Mills Press, 2009) has received a very warm review in the April issue of the *Journal of the Royal Astronomical Society of Canada*. Ken has made a career in writing books on astronomy that are aimed at a general readership. To a fluid writing style, Ken adds his thorough training in astronomy (Ph.D. from Harvard). The result, as the recent review notes, is that he "brings a much-needed breath of fresh air…any of his books provides a wonderful source of information for novices, and the writing is highly commendable."

**Scott Barthelmy (GR 85)** was featured in *NASA Tech Briefs* July 2009. Scott is a research scientist in the Laboratory for High Energy Astrophysics at NASA's Goddard Space Flight Center, close to Washington, D.C. He is the PI for the Burst Alert Telescope (BAT) which is one of three gamma-ray detecting systems on the NASA SWIFT spacecraft that was launched in 2004. BAT was designed to be much more sensitive than previous gamma-ray-burst detectors. A major feature is its ability to distinguish between cosmic gamma-ray bursts and gamma rays that might come from local non-astrophysical sources. (www.techbriefs.com/podcast)

**Rob Caldwell (AB 87)** and **Marc Kamionkowski (AB 87)** are authors of a popular review essay on "Dark Matter and Dark Energy" in *Nature* (2 April, 2009). Rob is still at Dartmouth College and Marc at Caltech. For their longer and more detailed paper, see the *Annual Reviews of Nuclear and Particle Physics* (2009).

Another alumni visitor and colloquium speaker this past year was **Brad Dalton (BS 87)**. Brad is based at the Jet Propulsion Lab in Pasadena and received his Ph.D. in geophysics from the University of Colorado, Boulder. At JPL, his interests are the formation and evolution of planets and their satellites in the solar system. His research is based on spacecraft observations, laboratory measurements, and field studies. His September colloquium was on "The Surface Composition of Europa."

Last year, we noted the book by **Joe Ganem (GR 89)**, *The Two-Headed Quarter*, has received good reviews and its subject is the focus of a full-page op-ed piece that Joe has written published in the *APS News* of October 2009. In this op-ed, "A Math Paradox: The Widening Gap Between High School and College Math," Joe noted that "As more states strive to improve math curricula and raise standardized test scores, more students show up to college unprepared for college-level math." He ends with the comment "Memorizing a long list of advanced techniques to appease test scorers does not constitute an understanding." Joe is a member of the faculty at Loyola University Maryland in Baltimore.

**Robert Behnken (EN 92)** graduated with degrees in both physics and mechanical engineering, and received his Ph.D. in mechanical engineering from Caltech. While at Washington University, Bob was in ROTC and he subsequently became an astronaut. In February 2010, he was aboard the space shuttle Endeavour for a mission to the space station. You can find a pre-flight interview at: www.nasa.gov/mission_pages/shuttle/shuttlemissions/sts130/interview_behnken.html.

**Rhonda Stroud (GR 96)** is currently serving as head of the Nanoscale Materials Section of the Materials Science and Technology Division of the Naval Research Laboratory. Her research focus is the relationship of structure and composition to materials properties and formation conditions. Recent projects include the investigation of short-range order in magnetic thin films and structure-isotope studies of the remnant organic materials from the formation of the solar system.

Last year, we mentioned that **Erika Eggers (AB 97)** is now an assistant professor in the Department of Physiology at the University of Arizona, with a joint appointment in Bioengineering. Her laboratory studies retinal signaling at the synaptic level as a way to understand retinal signal processing.

After **Judd Bowman (BS 98)** was awarded his B.S. in physics and B.S. in electrical engineering, he continued his studies at MIT where he received his Ph.D. in 2007, with a thesis on redshifted 21 cm HI emission, a prime subject of radio-astronomical observation. As an undergraduate, Judd worked in Ray Arvidson's group in the Department of Earth & Planetary Sciences. At Caltech, he is now a postdoctoral scholar and Hubble Fellow. In his website (www.astro.caltech.edu/~jdbowman), Judd notes that his research is "focused on developing and deploying the technologies and techniques to enable observational probes of hydrogen throughout cosmological time."

University of Missouri–Kansas City (UMKC) physics professor **Elizabeth (Libby) R. Stoddard (GR 00)** received the 2009 Governor's Award for Excellence in Education, one of 15 educators from colleges and universities around the state selected for the honor. In addition to her teaching skills, Stoddard's research in theoretical nuclear physics has been published in numerous journals.

**Carlo Barbieri (GR 02)** recently accepted a position as senior lecturer at the University of Surrey in Guildford, UK. After postdoctoral research at TRIUMF National Laboratory, Vancouver, Canada; GSI, Darmstadt, Germany; and finally RIKEN, Tokyo, Japan, he will move to Guildford in June 2010. One of his recent papers is a sole-authored *Physical Review Letters* (prl.aps.org/abstract/PRL/v103/i20/e202502) in which he further develops and applies the Faddeev random phase approximation conceived during his thesis work at Washington University. Carlo plans to continue to collaborate with his thesis advisor, Professor Willem Dickhoff, in his new position.

**Aaron Mertz (AB 06)** tells us that in June 2009, he completed his M.Phil. in History of Science, Medicine, and Technology at the University of Oxford while on a Rhodes Scholarship. Thereafter, he returned to Yale University for the second year of his Ph.D. program in physics and is now working in the interdisciplinary field of biophysics. He is researching the mechanics of tissue formation and writes that he "is having a great time collaborating with researchers in biology, engineering, and medicine." Not surprisingly, he is still playing cello and recently formed a string quartet with some other students.

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# DEPARTMENT OF PHYSICS NEWSLETTER / 2009–2010

↑ Members of the Department, spring 2009

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During the year, refer to our website (www.physics.wustl.edu) for up-to-date news.