

Quanta

A publication for the faculty, staff, students, alumni and friends
of the Department of Physics at Virginia Tech

www.phys.vt.edu

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2011 has been another amazing year for us! Our faculty, students, and staff have won numerous prestigious and competitive awards, on the national scene and within the university. We hosted several major conferences on campus and welcomed three distinguished speakers, including the Deputy Director of Fermilab, Dr. Young-Kee Kim. Our physics freshmen are now taught introductory physics in a completely new setting which greatly encourages discussions and collaborations. Physics education researchers have shown that highly interactive learning environments such as ours help students understand and retain the material far better than the traditional lecture format.

We remember with great affection three inspiring individuals who passed away unexpectedly: Dr. Cliff Lilly, one of our alumni and most faithful supporters, Prof. Hassan Aref, Affiliate Professor of Physics and former Dean of Virginia Tech's College of Engineering, and Prof. Raju Raghavan, an internationally renowned neutrino physicist and active faculty member in our department.

This year's back page outlines a very special request that we would like to make to you, our friends and alumni. The department has established a scholarship honoring Professor emeritus Dr. Royce Zia. We invite your contributions which will support especially creative physics students.

Our latest news and updates are always posted at www.phys.vt.edu.
With best wishes for a wonderful holiday season and a Happy New Year,

Beate Schmittmann

Casey Baker receives Barry M. Goldwater scholarship



Charles "Casey" Baker (class of '12), who is triple majoring in physics, biological sciences, and mathematics, was awarded the Barry M. Goldwater Scholarship for the 2011-12 academic year. He was one of 275 students nationwide to achieve this distinction, and the only winner from Virginia Tech.

Casey's area of interest is computational biophysics, and he has been performing research with Profs. Alexey Onufriev and Rahul Kulkarni.

In addition to earning the Goldwater Scholarship, Casey was named an ACC Undergraduate Research Scholar for 2010-2011.



Prof. Leo Piilonen awarded Hassinger Chair

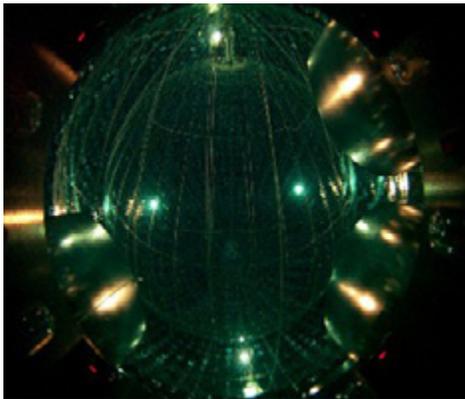


Prof. Leo Piilonen was appointed the William E. Hassinger, Jr. Senior Faculty Fellow in Physics by the Virginia Tech Board of Visitors. The fellowship, which is for three years and can be renewed, supports and rewards research programs that are likely to produce significant scientific breakthroughs of a fundamental or applied nature, thereby bringing prominence to the Department of Physics at Virginia Tech. It was established by William E. Hassinger Jr., an alumnus and ardent supporter of the department.

Prof. Piilonen joined the department in 1987. He has advised nine Ph.D. students and trained seven postdoctoral associates. Leo leads the Institutional Board of the Belle and Belle II collaborations at the KEK National Laboratory in Tsukuba, Japan. The research of the Belle collaboration was cited as the experimental verification of the theoretical predictions honored with the Nobel Prize in Physics in 2008.

Leo also received the university's 2011 William E. Wine Award for teaching excellence, an honor established by the Virginia Tech Alumni Association that is the university's top teaching award.

Spotlight on: Center for Neutrino Physics



The Center for Neutrino Physics at Virginia Tech (CNP) was founded in 2010, and is dedicated to growing and advancing the neutrino science program at Virginia Tech. Directed by **Prof. Leo Piilonen**, the CNP consists of eight full-time professors, five researchers, sixteen graduate students, and one administrative professional.

The center's goals include providing a unified image for the science program in neutrino physics and related fields at Virginia Tech through the use of an integrated organizational structure, coordinated programs, common showcase facilities, and common outreach activities. The group hosts a weekly seminar series, inviting speakers in the fields of high energy physics, nuclear physics, and astrophysics. This year, CNP hosted a

special lecture by Dr. Young-Kee Kim (see *pg. 10*), as well as an international conference on sterile neutrinos (see *pg. 6*).

Center members collaborate on various neutrino projects world-wide, including the Borexino project in Italy; MiniBooNE in Illinois, LENS in Blacksburg, VA, and Daya Bay in China. Other nuclear and particle experiments are being conducted at Jefferson Lab in Newport News, VA and at the KEK laboratory in Tsukuba, Japan. Additionally, the CNP runs the Kimballton Underground Research Facility in nearby Giles County, Virginia.

We need more good high school physics teachers!



All of us who are physicists or who have kids in high school know that an enthusiastic and competent physics teacher can make a huge difference in a young person's life. Good physics and science teaching is also a national priority: Two recent reports from the National Academies have emphasized that the United States must take action to improve K-12 science education, in order to remain competitive in our global economy. Yet, even though the number of high school students taking physics has substantially increased, qualified physics teachers remain in short supply. To heed this call to action, faculty from the Department of Physics and the School

of Education at Virginia Tech are partnering with the national Physics Teacher Education Coalition (PhysTEC) to recruit, educate, and support outstanding physics teachers. Our vision is to establish a vibrant hub for physics teacher education in the Commonwealth of Virginia with significant impact on the neighboring states and the nation. Our project will focus on pre-service education involving targeted and intense freshmen recruiting, changes to pedagogy in the physics undergraduate curriculum, early field experiences for future teachers, courses in physics pedagogy taught by an experienced physics teacher in residence at Virginia Tech, and the development of a network of program alumni. We just received funding from PhysTEC, along with generous support from Virginia Tech, and our project launched in August 2011. It seems as if we walked through open doors - the response and interest from our students has already been amazing!

Say hello to...

Alma Robinson graduated from the department in 2002 and received her Master's degree in Education in 2003. As a physics student, she was able to share her enthusiasm for physics and teaching through the outreach program and was an active member of the Society of Physics Students. After leaving Virginia Tech, she spent eight years teaching incredible students an array of different physics courses ranging from calculus-based AP Physics to hands-on, conceptual physics at the remarkably diverse Wakefield High School in Arlington, VA. After suffering through years of Carol Lee donut withdrawal, she's excited to return to Virginia Tech as the first PhysTEC Teacher in Residence and embraces the opportunity to work with both the Physics Department and the School of Education to help prepare our pre-service physics teachers for their future classrooms. When she's not teaching students about physics, she uses physics to play guitar, take photos, and train for triathlons (so she doesn't have to kick that Carol Lee habit).



Chenggang Tao joined the department as an assistant professor in August 2011. He did his postdoctoral work at the University of California, Berkeley. Before moving to the west coast, he obtained his Ph.D. from the University of Maryland, College Park in 2007. His research interests are to explore the structural, electronic and thermodynamic properties of energy related materials at atomic or submolecular scale by using scanning probe microscopy. Chenggang's hobbies include tennis, photography, skiing and hiking.

Prof. Randy Heflin collaborates on biosensor testing



Prof. Randy Heflin, in collaboration with Thomas Inzana of the Virginia-Maryland College of Veterinary Medicine at Virginia Tech, is developing nanoscale optical fiber biosensor tests for a multitude of pathogens, including Methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA is a bacteria that causes infections in different parts of the body and is tough to treat because it is resistant to some antibiotics. Dr. Heflin and his team have been able to detect as few as 100 cells of MRSA in one milliliter of water in under an hour in clean samples. The team is now working on getting a clean result from “dirty” samples by testing mice and student athletes who may be carriers of MRSA. If they are successful in developing a test with no false positives, these rapid tests could be used in hospitals in as soon as three years.

Prof. Heflin’s young daughter was infected with MRSA last summer. He is motivated to see this project succeed so that doctors can identify MRSA cases in an hour or less instead of the current two-to-three day turnaround.

Prof. Heflin’s team has also received a grant to develop a test for elk who may be infecting cattle with *Brucella*, a bacteria that spreads among livestock that can cause disease in other animals, even humans. Such disease is rare in the United States, but is more common in countries with poor sanitation and animal health policies.

Getting to know... Biophysicist Read Montague



Name: Read Montague

Position: Professor in the Department of Physics at Virginia Tech since 2010; director of the Human Neuroimaging Lab at the Virginia Tech-Carilion Research Institute

Area of interest: Computational Neuroscience

Recent publicity: Read and his postdoctoral fellow discovered the brain’s mechanisms for deceit (bluffing). This research was featured in *USA Today*, the BBC, and other international media outlets. Also, his work on understanding the basis of economic bubbles was covered by the *New York Times* magazine, as well as *Wired.com*.

Other notable works: His research on Buddhist meditators’ brain areas when confronting unfair choices was featured in *Frontiers in Decision Neuroscience*. Dr. Montague is also the author of *Why Choose This Book? How We Make Decisions*.

Prof. Beate Schmittmann awarded Beams Medal



Prof. Beate Schmittmann, chair of the department, was the first woman to receive the Jesse Wakefield Beams Research Award and Medal of the Southeastern Section of the American Physical Society (SESAPS). Beate earned this award for her “deep and pervasive contributions to nonequilibrium statistical mechanics and its applications and for inspiring world-class research in the southeastern United States.” The Beams Medal was first awarded in 1973 and is named for Jesse Wakefield Beams, a former president of the APS who received the National Medal of Science in 1967. This prestigious medal honors those whose research has led to the discovery of new phenomena and who have earned the critical acclaim of their peers nationally and internationally.

Prof. Vito Scarola receives DARPA’s Young Faculty Award

Prof. Vito Scarola will receive a \$300,000 Young Faculty Award (YFA) from the Defense Advanced Research Projects Agency (DARPA). Of 407 applicants, Dr. Scarola was one of only 39 chosen for this honor. He is the first-ever recipient from Virginia Tech since the program started in 2006.

Through YFA, DARPA identifies outstanding junior faculty members and exposes them to the Department of Defense (DoD), its needs and DARPA’s program development process. YFA combines funding, mentoring and networking with industry and DoD early in a recipient’s career to help them in framing future research in the context of defense needs. YFA recipients are expected to make one or more visits to military sites or exercises to help connect their research to Defense needs.



Vito’s research topic was Quantum Science and Technology, and his submission was titled *Emulating Strongly Interacting Quantum Matter with Optical Lattices*.

Department honored with Excellence in Access and Inclusion Award

The Department of Physics at Virginia Tech was nominated and selected to receive the 2011 Excellence in Access and Inclusion Award given by the Services for Students with Disabilities Office (SSD). According to SSD, recipients of this award “go the extra mile to make life on campus more accessible and equitable for students, employees, and the community.” Individuals singled out for contributing to an inclusive and accessible environment were: **Prof. Nahum Arav**, **Prof. Beate Schmittmann**, **Prof. John Simonetti**; staff members **Diane Walker-Green** and **Betty Wilkins**; and students **Kristen Brown**, **Chris Martin**, and **Marc Pomeroy**. Certificates were awarded at a reception held in Torgersen Hall on April 25, 2011.

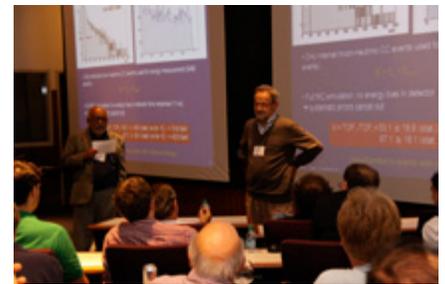
Department plays host to three diverse conferences



The 15th International Conference on Narrow Gap Systems was held in Hancock Hall on August 1-5, 2011. Local organizers included co-chair **Prof. Giti Khodaparast** (pictured) and **Prof. Jean Heremans** of the Physics department, and Prof. Louis Guido (Materials Science and Engineering, Virginia Tech). Attended by 90 researchers from 9 different countries, the conference's scope encompassed both scientific advances and technological applications. Narrow-gap systems harbor unique physical phenomena and lend themselves to distinctive applications, as infrared detectors and sources, and for high-frequency electronic devices. Hence, in addition to crystal growth

and fabrication methods, the program addressed newly discovered physical phenomena as well as device applications, and their interface. The conference included an excursion to Monticello and Michie Tavern in Charlottesville, where attendees took in the sights and sounds of colonial times in America.

Sterile Neutrinos at the Crossroads (SNAC) was held at the Inn at Virginia Tech and Skelton Conference Center on September 25-28, 2011. The goal of the workshop was to bring together experts in the various sub-disciplines, such as nuclear theory and experiment, cosmology, neutrino phenomenology, in order to critically review the evidence for and against sterile neutrinos and to discuss the need or otherwise to pursue dedicated new experiments and possibly new strategies. **Profs. Patrick Huber** and **Jonathan Link** co-chaired the local organizing committee. One highlight of the conference was a special public lecture by Yves Delais of the Gran Sasso laboratory in Italy, who presented recent findings of research to measure the speed of neutrinos. The week before the conference, it was announced that Dr. Delais' research team, known as OPERA (short for Oscillation Project with Emulsion-Tracking Apparatus), had observed neutrinos traveling faster than the speed of light. This created quite a buzz at the SNAC conference, resulting in a high turnout for the public lecture.



The late Prof. Raju Raghavan (left) introduces a speaker at SNAC



Session chair and alumnus Dr. Michael Kavic (middle) chats with Chris Thomas (right) and an another attendee

The Hotel Roanoke in Roanoke, VA was the setting of the **78th Annual Meeting of the Southeastern Section of the American Physical Society (SESAPS)**, held October 19-22, 2011. A near-record crowd of 300 scientists from all facets of physics attended the sessions. Awards were given to the best undergraduate oral presentations and posters. The conference included a panel discussion titled "The Under-Represented Majority", as well as a banquet. The keynote speaker at this year's banquet was Ronald Mickens, who discussed his book on Edward Bouchet, the first African American to receive a Ph.D. in physics from a United States institution.

Undergraduate coordinator receives COS Diversity Award



Diane Walker-Green, the department's undergraduate program coordinator, received the College of Science Diversity Award for 2010-11. The COS Diversity Committee was especially impressed with her dedication and the ways in which she went above the call of duty in fostering a welcoming, helpful environment for students in the Department of Physics and beyond. The College Diversity Committee formally recognized Diane with the award at the Fall COS Reception.

Physics Outreach team recognized by COS



The Physics Outreach team, mentored by **Josh Peebles** (pictured) and **Byron Wiedeman**, received the College of Science Outreach Award. This marked the first time that the award honored a team. The Physics Outreach program was established in 1995 by then-professor Lay Nam Chang to encourage science education in rural areas of Virginia. For more information, read the Outreach feature article from last year's *Quanta* newsletter: <http://www.phys.vt.edu/newsletters/QuantaFall2010.pdf>

Please welcome... Sherri Collins and Sharon Proffitt



Sherri Collins joined the department in June 2011 as a Fiscal Technician. Since then, she has completed the Virginia Tech Research Administrator Program Level II certificate. In her spare time, Sherri enjoys rooting for the Christiansburg Blue Demons football team.



Sharon Proffitt has joined the department as a Program Support Technician for the Center for Neutrino Physics. Sharon has 13 years of experience here at Virginia Tech. During her tenure at Virginia Tech, Sharon has been an Office Service Specialist, Fiscal Tech, Fiscal Tech Senior, Executive Secretary, Administrative Assistant and now a Program Support Technician. She graduated from Radford University with a degree in education and a minor in anthropology. She has two daughters who are the joy of her life. Co-workers describe Sharon as hard working, dependable, reliable, a quick learner, able to adjust to changes and new situations, team player, self confidence in her abilities, organized, and able to prioritize. Sharon is looking forward to meeting everyone in the department.

In her own words: Dr. Beth Reid (class of '03)



I can offer the highest compliment to the faculty of the Virginia Tech physics department-- eight years and counting of following in their footsteps. Following a failed attempt at biophysics in my first year as a graduate student at Princeton (I prefer spherical cows, thank you), I switched to cosmology, thanks largely to Friday afternoon chats in Professor Chang's office and Professor Simonetti's astrophysics course. Both left me astonished about how much we are able to understand about our universe given a few hundred years of exploring the laws of nature from our pale blue dot. For instance, within the first three minutes of the big bang, the universe expanded and cooled enough to form nuclei, whose relative abundances we can predict! And yet, there are enormous puzzles left -- why is there

more matter than antimatter in the observable universe at all?

As many of you have heard, half of the Nobel Prize in Physics this year was awarded to Saul Perlmutter "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae." Since gravity is the dominant force on cosmological scales and is thought to be purely attractive, the expansion of the universe should be decelerating. Cosmologists have dubbed this observational fact "dark energy", and it has been confirmed by a host of complementary cosmological observations. So far, dark energy is well described by a constant energy density permeating the universe that does not deplete as space expands; however, its amplitude is 10^{120} too small.

Professor Perlmutter's office is just down the hall from me. It was such a joy to be in Berkeley for the Nobel prize announcement! Many of the scientists involved in the discovery were there to reminisce about the "longest AHA! in history;" it took the team four months to convince themselves that they weren't just seeing an observational artifact.

I am currently a Hubble Fellow at the Lawrence Berkeley Lab, where I've joined forces with members of SDSS-III's Baryon Oscillation Spectroscopic Survey (BOSS) to examine the phenomenon of "dark energy" in more detail by mapping an unprecedented volume of galaxies back in time to half the universe's present age. Cosmologists are now considering the possibility that rather than an additional, exotic fluid dominating the energy budget of our universe, "dark energy" instead pinpoints a need for a modification to Einstein's theory of gravity. One potential way to distinguish these two possibilities is to look at a snapshot of how gravity is pulling mass together in the universe by measuring the velocities of galaxies as they fall towards overdense regions and are pushed out of underdense regions. These velocities are imprinted in the



redshifts we measure for individual galaxies, since the observed redshift includes both uniform Hubble flow from the expansion of the universe, as well as the local “peculiar” motions resulting from inhomogeneities in the distribution of matter. More broadly, I am coming of age in the era of “precision cosmology” -- we are seeking to determine the parameters describing our universe at the 1% level, which is no small task in a field traditionally battling factor of 2 uncertainties. My years of grueling problem sets have more than prepared me to face 6-dimensional integrals and Feynman diagrams that quickly pop up in perturbative calculations in cosmology, and I am grateful for all of my mentors at Virginia Tech for that.

'Thanks to Dr. Chang, “The First Three Minutes” by Steven Weinberg has made me a lifelong devotee to “Big Bang Nucleosynthesis.”



Beth as a freshman



Dr. Reid delivers the keynote address at the department's 2011 Awards Luncheon

What's your story? Gotten married? Added a new member to the family? Landed your dream job? If so, we'd love to share your good news in future issues. Visit www.phys.vt.edu for contact information, or use the form below. Mail your completed form to: **Department of Physics at Virginia Tech, 123 Robeson Hall, Blacksburg, VA 24061.**

NAME: _____
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YOUR GOOD NEWS: _____



Keep up with all of the Physics department happenings with a scan from your smartphone!

Guest lecturers inspire, entertain audiences



Dr. Aziza Baccouche, also known as “Dr. Z.” gave a public lecture on March 17, 2011, which was sponsored by the Department of Physics, the College of Science, the Office of the Vice-President and Dean for Undergraduate Education and Women in Leadership and Philanthropy. Dr. Baccouche is an accomplished physicist and science television producer who lost her sight at the age of eight as a result of a brain tumor that affected her optic nerve. Her talk, titled *Seeking Vision*, used a multimedia presentation to spotlight the capabilities of blind people in hopes of changing public perception of the visually impaired. During her visit, Dr. Z. also met with university leaders, including a representative from the Office of Services for Students with Disabilities. The department hosted a lunch with Dr. Z., giving undergraduate students the opportunity to engage with her. One such student was Chelsea Cook, a sophomore physics major with ambitions of becoming an astronaut, who is also blind. Chelsea met with her one-on-one, discussing what college life is like for the visually impaired, as well as her future career goals.



On April 12, 2011, **Dr. Young-Ke Kim**, the Deputy Director of Fermilab, gave a free public lecture at the Inn at Virginia Tech and Skelton Conference Center. Titled *Emc²: Opening Windows on the World*, Dr. Kim’s lecture traced the path from where we are now and what we need to do to take the next step towards understanding the nature of time and space. The talk was sponsored by the Department of Physics, the College of Science, the Center for Neutrino Physics at Virginia Tech, and AdvanceVT, in hopes of strengthening research and the partnership between Fermilab and the university.



“The Flying Circus of Physics” came to life on April 15, 2011 when world-renowned science educator and author **Jearl Walker** presented real-world answers to scientific phenomena before a near-capacity crowd in Hahn Hall-North. Prof. Walker, who once hosted a science television show for children on PBS titled *Kinetic Carnival*, teaches at Cleveland State University. His lectures emphasize the need for science education. During his public talk, Prof. Walker did not perform his famous demonstrations on how physics works. Instead, he used video footage of demos he has performed throughout his career, including one on how to walk on a hot bed of coals. Another popular point of discussion was whether a person is safer staying inside an automobile during a lightning storm. As a visual, Dr. Walker showed the now-famous picture of commentator Lee Corso’s rental car being struck by lightning during the Virginia Tech-Georgia Tech game in 2000, after Corso had predicted Georgia Tech would win. (Ironically the crowd would have been safer in their cars than in Lane Stadium!) The lecture was sponsored by Wiley Publishing, who having been publishing editions of *The Flying Circus of Physics* since 1975.

Prof. Ramaswamy (Raju) Raghavan

Sadly, the department has said goodbye to a great teacher, researcher, and friend. **Prof. Ramaswamy (Raju) Raghavan** passed away unexpectedly on October 20, 2011. He is survived by his wife, Pramila.



Raju (middle) at student Derek Rountree's Ph.D. defense

Raju began his graduate research in nuclear physics at the Tata Institute of Fundamental Research in Mumbai, India before obtaining his Ph.D. from Purdue University in 1964. He worked for Bell Laboratory for 32 years before joining the

Department of Physics at Virginia Tech in 2004, where he was a professor and the director of the Institute for Particle, Nuclear, and Astronomical Sciences (IPNAS).

An innovator in his field, Raju founded the Borexino experiment at Gran Sasso Laboratory in Italy in 1988 to study low energy solar neutrinos. He invented a unique direct counting technique for the spectroscopy of the fundamental proton-proton solar neutrinos, which is being developed as the LENS experiment at Virginia Tech.

Revered as a creative mind with a heart of gold, Raju's wisdom and joie de vivre will be deeply missed by his friends and colleagues world-wide.

Dr. A. Clifton Lilly



Cliff Lilly of Chesterfield, Virginia, who earned his Ph.D. from the Department of Physics in 1989, passed away on August 16, 2011. He retired as vice-president of technology assessment at Phillip Morris USA with 38 years of service.

Cliff remained a constantly active alumnus, serving on advisory boards in the Department of Physics, as well as on the Dean's Roundtable in the College of Arts and Sciences, and eventually the College of Science, which named a faculty fellowship in his honor.

Dr. Lilly is survived by his wife, two children, and four grandchildren.

Prof. Hassan Aref



Prof. Hassan Aref, the Reynolds Metals Professor in Engineering Science and Mechanics and an affiliate professor in the Department of Physics, passed away on September 9, 2011 at the age of 60.



Quanta 2011

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The Physics Department Annual Fund



One person can make a big difference!



Many of you will remember Prof. Royce Zia – as a teacher, as a research mentor, or as an enthusiastic, creative, and playful physicist and faculty member. Some of us would say that he entered “retirement” in December 2009, but Royce himself calls it the “duty-free” state. He continues to do research, advise students, and share his physics insights with friends and colleagues at Virginia Tech and all over the world.

In his honor, the department has established the Wan-Zia Scholarship in Physics which will be awarded to particularly creative undergraduate or graduate students in physics. The scholarship will be funded in perpetuity from the proceeds of an endowment which currently stands at approximately \$32,000. In order to award the scholarship for the first time, we need to exceed the amount of \$50,000. Please help us reach this level! Your contributions will honor Prof. Zia and support some of our brightest and most promising

students.

Please visit our “Giving to Physics” webpage at <http://www.phys.vt.edu/giving/>, or call us at (540) 231-7472. When you receive letters or phone calls from Virginia Tech or the College of Science, please earmark your support for the Physics Department. Simply note it on the gift card or let the caller know that you want to direct your donation to the Wan-Zia Scholarship in the Department of Physics. You are also welcome to direct your donation to other physics scholarships or to the department general fund. Every amount makes a difference, and we thank you very much for your support!

Physics in Your Neighborhood!

Alumni Reunion – 2012 March Meeting of the APS- February 28, 2012– Boston, MA (restaurant TBD)

For more information, go to <http://www.phys.vt.edu/events.html>