Quantum Leap

University of South Carolina
Department of Physics and Astronomy

UNIVERSITY OF SOUTH CAROLINA

A New Face

Dr. Yanwen Wu will be joining the Department as a new assistant professor in the summer of 2013. She is currently a researcher at the University of Texas at Austin working in the optics lab of Prof X. Li. Dr. Wu received both her Bachelor's degree and her Ph.D. (2007) from the University of Michigan at Ann Arbor, and then spent time at Cambridge University (UK) as a postdoctoral fellow working in the famous Cavendish Laboratory. Dr. Wu was hired by the department after an extensive search process in which about fifty applicants competed for the position. She describes her research area and plans as follows:

The optical properties of solids are not only governed by their atomic constituents but also by the crystal structures they form. That is why a tightly bound group of carbon atoms can dazzle in the form of a diamond while a less "disciplined" arrangement takes on the inky shade of a lump of coal. Nature has a set of pretty strict rules when it comes to how the inter-atomic bonds are formed. These rules limit what materials can exist in stable forms, and, in particular, set the optical properties of naturally occurring materials. While we can't break those rules, it is possible to bend them. And we do this by shrinking the size of the materials down, using the nanometer-sized particles which are smaller than the wavelength of light. In this nanoscale limit, not only the intrinsic optical properties of the materials matter but also the size and shape of the structures start to play a role, modifying light interaction with the material. In a way, we are cheating nature by constructing a whole new class of materials out of nanoparticle "Lego blocks" which are not restricted by nature's bonding rules. We can now bend and manipulate light in ways not intended by nature which can lead to novel applications in sensing, display, solar technology, and even information storage.

I am excited to have the opportunity to start my own lab here at USC. My research group will focus on studying the optical properties of nanoparticles of metals and semiconductors. Specifically I am interested in how light can be used to switch a particular material property on and off, for example, optically inducing magnetic response in non-magnetic materials through clever arrangements of the nanoparticles. While most of the studies to date in this field were done in the classical limit, it is of great interest for me to investigate the quantum nature of the nanoparticle assemblies. My expertise in coherent optical control of quantum systems will certainly shed light, literally, into this new direction.

My enjoyment of building and crafting goes beyond the laboratory. I have recently completed – after three long years of work – a project of building from scratch a replica of the 1716 Stradivarius violin. I enjoy outdoors activities, in particular, hiking and kayaking. I am also pretty good at drawing.

A Message from the Chair

Dear Friends and Alumni,

Welcome to the 2012 issue of Quantum Leap, the newsletter of the Department of Physics and Astronomy! I am pleased to have the opportunity to bring you up to date on the status of our department. I started my role as the new Department Chair in July, and greatly look forward to serving the department!

One of the new developments in the department this year was that Prof. Chaden Djalali stepped down as Department Chair after eight years. Prof. Djalali is leaving USC after 23 years to take up the position of Dean of the College of Arts and Sciences at the University of Iowa. His enthusiastic leadership will be greatly missed!

I am happy to report that we have a new addition, Dr. Yanwen Wu, who is joining our department as an Assistant Professor. Dr. Wu received her Ph.D. at the University of Michigan. Prior to joining USC, and she was a post-doctoral researcher at the University of Texas, Austin. Her research interests are quantum computing and plasmonics in nano-structures. We are delighted to have Dr. Wu as a member of our department! I am also happy to report that both Profs. Brett Altschul and Yaroslaw Bazaliy received tenure and promotion to the rank of Associate Professor.

Our faculty and students continue to be very productive in scholarly activities. The number of publications, presentations, and research proposals generated in our department have been growing steadily. There is also aggressive pursuit of research funding. Our extramural research funding has increased by over 100 percent within the past year! Our graduate student population is also steadily increasing, higher by approximately 30 percent compared to the previous year.

Prof. Milind Purohit and USC First Lady Patricia Moore-Pastides

This year also brought several awards to our department. Two of our professors won the 2012 Mungo awards. Prof. Milind Kunchur won the Michael J. Mungo Distinguished Professor of the Year Award, USC's most prestigious award, while Prof. Milind Purohit won the Mungo Graduate Teaching Award. In addition, Prof. Milind Kunchur was elected a Fellow of the American Physical Society in Fall 2012. The APS decision cites the fundamental papers written throughout his long and productive career in the field of superconductivity, and his recent groundbreaking results in human hearing. Congratulations also to our student award winners: to undergraduate William Cole Franks for winning the Barry M. Goldwater award; to Jason Giamberardino and Aneta Net for winning the Graduate Teaching award; and to Andres Sanabria, Debopam Som, Longfei Ye and Tongtong Cao for winning the Graduate Research Award and the Graduate Student Day Research Award.

Prof. Milind Kunchur

The department's community outreach efforts remain as strong as ever. Many of our faculty and students regularly visit students at local K-12 schools and colleges. Some of these younger students also spend several weeks doing summer research with our faculty. The R.L. Childers Midway Physics Day held in October at the South Carolina State Fair continues to be a major success. The Melton Memorial Observatory also remains active in public nights and special viewing sessions. In addition, several of our faculty continue to engage in community outreach through venues such as Science Café, the Science Fair, and other local events and organizations.

We would truly love to hear from our alumni and friends. We sincerely hope that you have had a wonderful year and wish you another terrific year ahead! Please keep us informed about your latest ventures, and please drop by if you are visiting the Columbia area! We are grateful to all the faculty, staff, students, alumni, and friends who have generously contributed to the Department of Physics and Astronomy Funds. Your support directly benefits our students, and is greatly appreciated!

STAFF NEWS – 2012

Has another year really come and gone? The staff has not seen many changes over this past year. Our big news is that Dee Brown (Graduate Program Coordinator) welcomed Ryleigh Brianna Jacks into the world on June 10, 2012. Ryleigh weighed in at 7 lb. 5 oz. and was 20.5 inches long. Mom and baby are doing great!

When Evelyn Wong (Administrative Assistant) is not at the office, she's busy creating artwork such as the ones that were in her November art show when she was featured as one of the artists in a monthly event in Columbia known as "First Thursdays on Main." We're all really excited for the opportunity to see more of her remarkable work.

Another big piece of news we have is having to say goodbye to Chaden Djalali. It has truly been a pleasure and an honor to work with him. Chaden has always been so supportive of us, and we could never thank him enough for his years of service as Chair. Chaden, we wish you the best of luck as you embark on your new journey. We'll miss you and your family!

With Chaden leaving, that brings us to welcoming our Interim Chair, Varsha Kulkarni. We look forward to working with her over the next year to continue meeting the department's needs and goals. Welcome, Varsha!

That's all for the staff right now. We hope everyone is doing well, and we look forward to receiving updates from all of you.

News from the Director of Undergraduate Studies

By Jeff Wilson

This academic year we continued to maintain our productive undergraduate research program. All of our experimental research groups employ, and actively recruit, undergraduates to work on their projects. We have also had some standout contributions in some of our theory areas, as well. Most of this year's award winners, listed below, worked on research projects in the physics department last year. For the coming year, Prof. Brett Altschul has submitted a proposal to host a NSF Research Experience for Undergraduates in our department to start in summer of 2013. In addition to strengthening our undergraduate research, we hope that this can also be a huge recruiting tool for our Graduate program.

Continuing our recent trend, William Cole Franks was named a 2012 Barry M. Goldwater Scholar, one of three from the University of South Carolina. The Goldwater Scholarship is awarded nationally to sophomores and juniors pursuing bachelor's degrees in natural sciences, mathematics, or engineering and intending to pursue a career in research and/or college-level teaching: virtually all the scholars intend to obtain a Ph.D. in their respective fields. The University, as well as all other institutions of higher education, may only nominate four students for this award. A link to a longer write-up on this award can be found on the Department of Physics and Astronomy home page at www.physics.sc.edu in the news archive.

Physics award winners from the Spring 2012 Awards Ceremony: William Cole Franks won the College of Arts & Sciences Rising Senior Award, Reginald Alexander Bain and Weizhi Xiong were awarded the Nina and Frank Avignone Fellowship, and Ronald James Talbert, Jr. won the Rudy Jones Physics Award. In addition to the Physics awards, several physics students won awards from other departments: William Franks won the Thomas Markham Mathematics Scholarship; Ronald Talbert won the Josiah Morse Award (Dept. of Philosophy); Reginald Bain won Jeong S. Yang Award for Excellence in Undergraduate Mathematics and was a recipient of a National Science Foundation Graduate Research Fellowship.

Update from the Director of Graduate Studies

By Richard Creswick

Our graduate program remains strong and presently totals 44 students from 14 countries. This year we welcome seven new graduate students: four from the US, one from China, one from Russia, and one from Afghanistan.

Our graduate students continue to excel: Jason Giamberadino and Aneta Net were awarded the graduate teaching award, and Andres Sanabria, Debopam Som and Longfei Ye were awarded the Graduate Research Award. The physics department was well represented at the Graduate School Research Symposium: Debopam Som won first place; Longfei Ye recieved second place and Tongtong Cao received an honorable mention.

Wondessen Gebreamlak has been named a finalist (one of nine out of 238 submissions) in the Young Investigator Symposium for the American Association of Physicists in Medicine (AAPM). Wondessen received his Ph.D. in May under the supervision of Prof. David Tedeschi. He will present his work on a new method to calculate dose from electron beams used in cancer therapy at the August AAPM conference in Charlotte, NC.

Our graduates continue to find interesting and creative positions in academia and industry. Lorrie Straka, who received her Ph.D. under Prof. Varsha Kulkarni, is going to the University of Chicago as a post-doctoral fellow with Dr. Don York. Seth Newman, who received his Ph.D. under Prof. Frank Avignone, has taken a position as Technical Advisor at Kramer, Levin, Naftalis, & Frankel, LLP in New York. Baowei Liu, who graduated last year, is now a Senior Scientific Programmer at Rochester University.

Congratulations to these graduates:

Doctoral
Wondessen Gebreamlak
Seth Newman
Lorrie Straka

Masters
Ebtisam Aldaais

Experimental Condensed Matter and Nanoscale Physics Groups

Faculty: Thomas Crawford, Scott Crittenden, Timir Datta, Millind Kunchur, and Richard Webb

A New Hire, Graphene, and Weak Localization

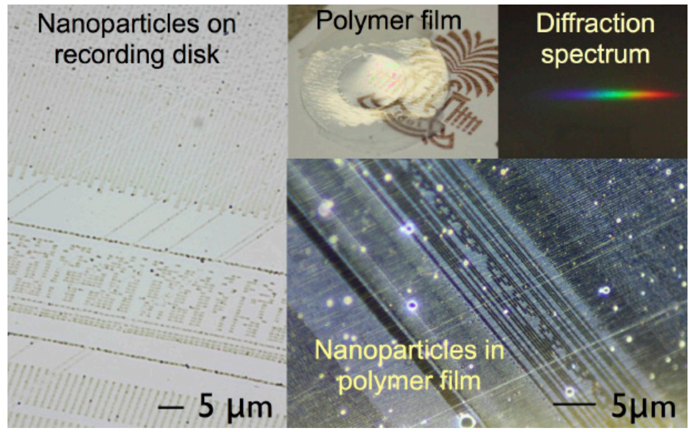
Professor Richard Webb led the successful search for a new condensed matter experimental physicist last year. Yanwen Wu, who is interested in ultrafast nano-plasmonics, accepted our offer and is currently overseeing the upfit of her laboratory space. Meanwhile, she will continue her work in ultrafast optics and as a quantum computing expert at the University of Texas at Austin until August 2013.

Graduate student Bochen Zhong has moved on from the magnetic tunnel junction work mentioned last year and is now studying the properties of graphene in collaboration with Prof. Goutam Koley from Electrical Engineering and Cornell University. Graduate student Ning Lu is working on magnetically induced weak localizaion to enable biological and chemical sensing using nanoscale semiconductor devices in collaboration with Prof. Chris Li from Mechanical Engineering and Prof. Timir Datta here in the physics department.

Magnetic Recording Creates Complex Nanoparticle Patterns

Researchers in Professor Thomas Crawford's group are using magnetic recording not to store data but to create complex materials using individual nanoparticles as building blocks. Using a technique called Pattern Transfer Nanomanufacturing™, developed by Crawford, the "disk" from a disk drive acts as a reprogrammable template. Magnetic nanoparticles are suspended in a liquid, known as a ferrofluid. The disk surface is coated with ferrofluid, and the nanoparticles are pulled to the surface by force of the magnetic field that is emitted from individual "bits" on the disk. After the nanoparticles assemble, the fluid is removed and the disk surface is coated with an air-curable liquid polymer. Once cured, the solid polymer can be peeled from the disk to yield a transparent and flexible film containing the patterned nanoparticles. Crawford states, "Since current magnetic recording technology has spatial resolution below 10 nm, it offers inexpensive and reprogrammable templating that can be used to build large scale materials containing precisely positioned nanoparticles." The figure shows nanoparticles both as patterned on the disk surface and after transfer to a transparent polymer film. The figure also shows a photograph of a 5 mm diameter diffraction grating built entirely from nanoparticles along with a rainbow spectrum obtained by diffracting white light from the grating surface. Crawford expects these films could find application in optics, biotechnology, and novel materials technologies enabled by combining the customizable properties of nanoparticles with user-programmable long-range patterning. In spring 2012, Crawford launched a start-up venture, MagAssemble® LLC, to commercialize the pattern transfer technology.

In addition to nanoparticle patterning, Crawford is collaborating with Prof. Scott Crittenden's group to study novel magnetic behavior at the interface between a gold thin film and a layer of molecules that is self-assembled onto the gold surface.



Superconductivity and Psychoacoustics

Professor Milind Kunchur's group continues to focus on its research in superconductivity. In recent work they found experimental evidence for the vortex explosion transition, an effect that had been theoretically predicted decades ago. An Abrikosov magnetic flux vortex is a tornado of perpetually circulating supercurrents that forms in a superconductor when a magnetic field is applied. Each vortex contains a quantum of magnetic flux. When these vortices are produced in confined geometries, for example a 50 nanometer thick film, the supercurrents get squeezed by the faces of the film. This boosts their density and causes the vortex core to expand. At some point the vortex core explodes catastrophically and an Abrikosov vortex ceases to exist. By experimenting with nanogeometries, Kunchur's group was able to demonstrate this novel regime experimentally for the first time.

Ongoing experiments probe suppression of superfluid density in superconductors at high current densities and the orientation dependence of the pair breaking current in d-wave superconductors.

Prof. Kunchur has continued to develop the Musical Acoustics lecture and laboratory courses, drawing on his research in psychoacoustics and auditory neurophysiology. These courses have become very popular due, in part, to Kunchur receiving this year's Michael J. Mungo Distinguished Professor of the Year award.

Currently one graduate student, Manlai Liang, and one undergraduate student, Elizabeth Minten, are working in Kunchur's group.

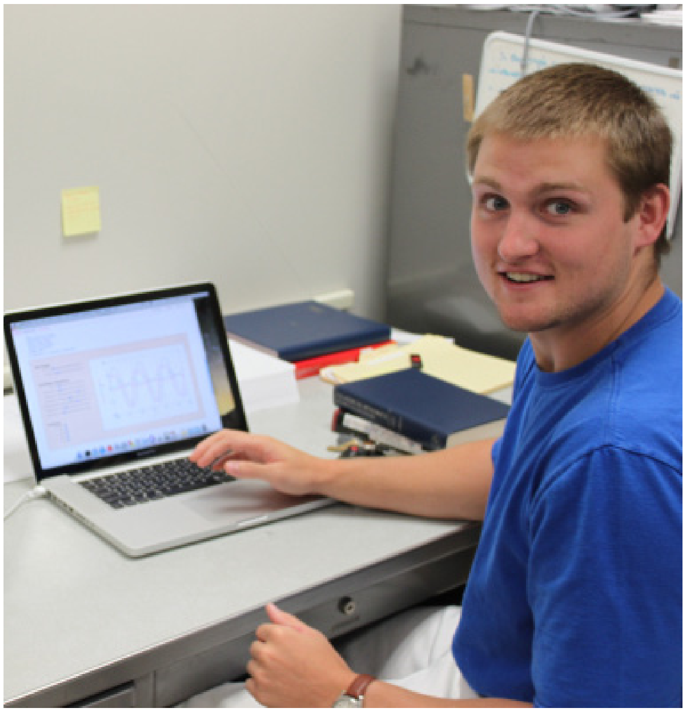
Molecular Forces and Molecular Monolayers

Professor Scott Crittenden's group is about the same as it was last year, containing six researchers: Dr. Bharat Kumar Kulkarni (Ph.D., Physics, 2009 C.V. Raman Institute, Bangalore, India), Fiona Oxsher (graduate student, Chemistry), Jason Giamberardino (graduate student, Physics), Kevin Wood (undergraduate student, Physics), Chris Pasco (undergraduate student, Physics), and Nestor Peralta (undergraduate student, Biology). In addition, there is the customary diffuse group of part time undergraduates fitting in a little research between coursework.

Nestor (biology undergrad) is preparing to innoculate a microbial fuel cell

Bharat has finished his previous U.S. Army grant to study the conductivity of bionanowires produced by some electrogenic bacteria. He, as well as Jason and Kevin, are now working on the new Department of Defense MURI grant received last year to study the interactions of biomolecules with non-biological surfaces. As part of the developing collaboration on surface mediated transport in low dimensional metals with Profs. Crawford and Webb, Fiona is working on the magnetic effects of single-layer molecular films on gold. In addition, she serves as the group's chemist in residence, assisting virtually everyone else with chemical questions. Nestor continues his attempts to understand Microbial Fuel Cells, and Chris's work on supercapacitors has shifted to the hunt for biodegradable materials from which to construct them. Finally, over the summer, Robert Link, a Masters student who will soon be leaving us to teach high school physics, spent time developing a series of laboratory experiments in geometric optics suitable for both undergraduates and high school students.

Ning (physics graduate) is using the wire bonding machine to bond gold wire into the sample.



Kevin (physics undergraduate) is excited that his model for an atomic force microscope cantilever is now producing accurate results.

The USC Particle Astrophysics Group

Faculty: Frank Avignone, Richard Creswick, Horacio Farach, Carl Rosenfeld and Jeffrey Wilson; Graduate Students: Nicholas Chott, Dawei Li, Katarina Mizouni, Camilo Posada and Clint Wiseman; Recent Ph.D Graduates: George S. King (2007), Todd Hossbach (2009), Carlos Martinez (2009), and Seth Newman (2011).

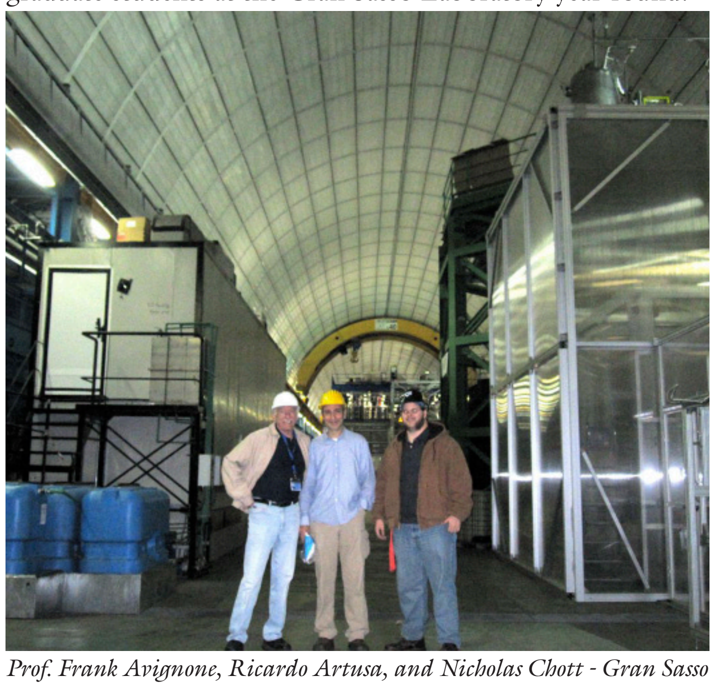
Particle astrophysics focuses on the study of phenomena in astrophysics and cosmology associated with the properties of elementary particles such as neutrinos and Weakly Interacting Massive Particles (WIMPS), one candidate for Cold Dark Matter (CDM). In 1933 Fritz Zwicky discovered that far more mass is needed to explain the dynamics of clusters of galaxies than can be accounted for by stars, gas, and dust alone. The gravitational effects of CDM on the velocity distribution of stars in spiral galaxies is also well established. The USC group was a pioneer in particle astrophysics when, in 1985, it led the first terrestrial search for CDM in the Homestake goldmine in Lead, South Dakota using a unique detector developed in collaboration with the Pacific Northwest National Laboratory (PNNL). This experiment was able to eliminate heavy Dirac neutrinos as the major component of CDM over a very large range of neutrino masses. The collaboration between USC and PNNL remains active today and several PhDs from the particle astrophysics group are on the staff at PNNL.

The Silver Jubilee of the publication of the seminal paper resulting from this experiment was celebrated in an international conference at the Pacific Northwest National Laboratory in June 2012. Following the publication of these first results, dozens of dark matter searches have been carried out all around the world, with vast improvements in detector technology. In 1994, Frank Avignone was awarded the Jesse Beams Medal of the American Physical Society for his leadership role in the first experiment. The Beams Medal is sponsored by the Southeastern Section of the APS.

The USC Group has also led several searches for elementary particles called axions emitted by the sun. Axions are predicted by the theory of Roberto Peccei and Helen Quinn that explains why the strong interaction, described by quantum chromodynamics (QCD), does not violate charge-parity (C-P) symmetry. Without the Peccei-Quinn solution or some alternative one, the C-P-violation predicted by QCD would lead to an electric dipole moment of the neutron about ten orders of magnitude larger than the experimental bound. The USC-led axion search was based on an analysis developed at USC by an international collaboration led by Prof. Richard Creswick. It uses the coherent Bragg conversion of axions to photons in single crystals to predict a characteristic time-dependent event rate. This technique has been and is being used by other groups worldwide. It will be applied to the data from the Cryogenic Underground Observatory for Rare Events (CUORE) under construction in the Gran Sasso Laboratory in Assergi, Italy.

The USC group is currently concentrating on two searches for the exotic zero-neutrino nuclear double-beta decay, which is only possible if neutrinos have mass and are their own antiparticles (Majorana particles). The decay mode also violates the law of lepton-number conservation. Neutrino oscillation experiments imply that neutrinos have mass, but they can only measure mass differences. The measurement of the rate of decay would determine the absolute masses of all three neutrino-mass eigenstates.

The USC group was heavily involved in the CUORICINO double-beta decay experiment in the Gran Sasso Laboratory from the very beginning until it was discontinued in July 2008. CUORICINO was an array of approximately 42 kg of TeO_2 cryogenic detectors operating at approximately 0.008 K, and it set a lower limit on the half-life for the decay of ^{130}Te. Currently the Particle Astrophysics Group is involved in the construction of CUORE, a 760-kg detector using the same low-temperature technique. The group's main responsibility is the production of the electronic system led by Prof. Carl Rosenfeld, and the construction and operation of the first tower of CUORE (CUORE-Zero). which will begin operation in the summer of 2012. The USC group maintains research associates and graduate students at the Gran Sasso Laboratory year-round.



Prof. Frank Avignone, Ricardo Artusa, and Nicholas Chott - Gran Sasso

The USC group is also playing a leading role in MAJORANA, a 21-million dollar research and development project designed to establish the feasibility of building and operating a one-ton ^{76}Ge double-beta decay experiment. The principal technology being used in MAJORANA is a vastly improved version of the IGEX experiment, also led by the USC group in the 1990s. Funding for the one-ton experiment will depend on the level of success of the Demonstrator project. All the USC activities are supported by major grants from the National Science Foundation.

This year, Jeff Wilson has joined the USC Particle Astrophysics Group. He brings computational expertise including Monte Carlo simulations using GEANT codes as well as the most up to date data analysis techniques. He most recently worked on data analysis for the BaBar experiment at the Stanford Linear Accelerator Collider (SLAC) facility. Presently, and for the past few years, the USC Group has been deeply involved in the major construction issues for CUORE-0, CUORE and Majorana. Upon their commissioning, the role of the group will transition to mainly running shifts and analyzing data. In addition, the group is introducing a new concept of using the inner detectors of the CUORE array to study the decay of ^{130}Te to the first excited 0_+ state in ^{130}Xe. The decay to the excited 0_+ state is follwed by a gamma-ray cascade to the ground state; by tracking these gamma rays it is possible to eliminate a large part of the background. Wilson will lead the team in carrying out the complex simulations needed to compute the efficiencies of the many possible gamma-ray interaction scenarios, and the design of the associated data analysis codes.

This field continues to produce exciting research opportunities and has attracted excellent funding support for faculty and student participation.

Computational Condensed Matter

Faculty: Yuriy Pershin and Yaroslaw Bazaliy

Professor Yuriy V. Pershin and his team investigate memory effects in nanoscale structures. In this area, it is of great importance to understand underlying fundamental physical mechanisms responsible for memory. In particular, by employing the well-known theory of response functions and microscopic derivations, it is possible to show that memory effects in resistors, capacitors and inductors emerge as a natural response of the systems to external perturbations. These studies demonstrate that the properties of such “memristors” and other similar elements are much less restricted that it has been argued in the literature before us. In particular, the so-called diverging and non-crossing input-output characteristics are physically possible in all these memory elements, both in quantum and in classical systems. For similar reasons, it is not surprising to find memcapacitances and meminductances that acquire instantaneous negative values, contradicting the standard passivity criterion that requires resistance to be non-negative at any given time. These results will be of importance for future potential applications of memory devices in such areas as neuromorphic and massively-parallel analog computing.

Our group is also actively contributing to the exciting field of semiconductor spintronics, a part of physics that explores the ways in which electron spin can be used in electronic devices. This can only be done efficiently in very small systems. Together with Mr. Ibrahim Savran, a graduate student at USC’s Department of Computer Science and Engineering, and Prof. Valeriy Slipko from Kharkiv University, Ukraine, computational and analytical studies of spin relaxation in confined geometries are performed. Recently, we have shown that the sample boundaries can surprisingly modify the electron spin relaxation. We continue these studies considering multiple possible spin relaxation channels. During the last year, Prof. Pershin received National Science Foundation and University of South Carolina grants, which provide funding for the next three years to continue his research in the area of memory devices and their applications.

Prof. Valeriy Slipko

Particle Theory Group

Faculty: Brett Altschul, Vladimir Gudkov, Pawel Mazur, and Matthias Schindler

The past year has been an exciting time for members of the Theoretical Physics Group: graduate student Alejandro Ferrero received his Ph.D. and moved to Barcelona, Spain; graduate student Andres Sanabria won first place in the Graduate Student Research Awards; Prof. Altschul received tenure and was promoted to Associate Professor; Prof. Mazur went on a sabbatical leave; and Prof. Schindler co-authored a graduate-level textbook, to name just a few of the exciting events. Additionally, there was plenty of interesting research to focus on.

The biggest story in particle physics in 2011 was the reported discovery that neutrinos seemed to be moving faster than light. Neutrinos produced by decaying pions at CERN in Geneva were timed on their way to the OPERA detector at Gran Sasso in Italy, and the initial measurements seemed to show they were moving about 2.5 x 10^{-5} faster than light. It appears that this measurement was probably in error, and the Particle Theory Group played an important role in demonstrating why the initially reported result was extremely problematic.

Particle Theory Group cont. on pg.8

Two main theoretical arguments were put forward that OPERA's observation of superluminal neutrinos was actually ruled out already by a wealth of existing data. It was rapidly pointed out that faster-than-light neutrinos could lose energy through a process analogous to the phenomenon of Cerenkov radiation (which is emitted by charged particles moving faster than the speed of light in a material) or, even more familiarly, the phenomenon of the sonic boom (emitted by objects moving through the atmosphere faster than the speed of sound). This energy loss process did not seem to occur for the OPERA neutrinos, leading to grave doubts about the result.

Another approach was taken by Prof. Altschul and frequent visitor Shmuel Nussinov. Working independently and using somewhat different techniques, they looked at the pion decays that produced the neutrinos involved. Having a modified energy-momentum relation that broke the usual Lorentz symmetry of special relativity would change the decay rates for the energetic pions responsible for producing the neutrinos. In fact, if the speed modification found by OPERA was correct, the pions involved would have decayed much more slowly than expected, so that there would not have been enough superluminal neutrinos produced to even make the measurement!

Researchers of the OPERA experiment have since found technical problems that were previously unaccounted for, and it is now highly likely that there is no discrepancy between theory and experiment.

The Large Hadron Collider at CERN has been at the center of attention in the particle physics community as it offers the opportunity to study elementary particles at energies never before realized in a laboratory. However, the push to higher energies is not the only promising avenue to discover new and exciting physics. A large workshop with several hundred participants was held in Washington, D.C., in December to explore the "intensity frontier." The aim of this research direction is to perform high-precision measurements to find deviations from the predictions of established theories. If these discrepancies between expectations and actual measurements are found, they indicate the existence of new physics and point the way to how existing theories should be modified. Among the participants of the workshop were Profs. Gudkov and Schindler. Their research is aimed at describing the violation of fundamental symmetries such as parity and time reversal invariance which are extremely difficult to detect. They are supported in their work by postdoc Young-Ho Song. The parity and time invariance violation processes that Gudkov, Schindler, and Song are studying require a high-intensity source of neutrons, which is provided by the the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory. They are eagerly awaiting results from the NPDGamma experiment which will be an important step in the understanding of parity violation.

While the hard work regarding parity violation is ongoing, future high-intensity experiments at the SNS are also in the planning stage. Prof. Gudkov is heavily involved in these preparations, providing crucial theory support. He is currently contributing to a white paper that explores the possibilities of neutrino reactions at the SNS. In addition to providing intense neutron beams, a large number of neutrinos is also created at the SNS. Due to their energy distribution and time structure, the neutrinos produced at the SNS are ideal for studying neutrino-nucleus scattering. These measurement are important to our understanding of the role neutrinos play in supernova processes and in nucleosynthesis.

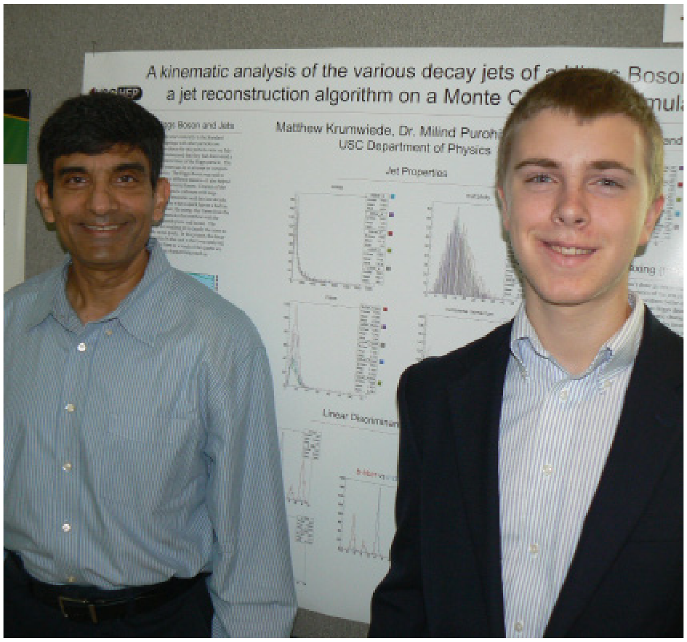
Prof. Mazur is continuing his research on fundamental problems in gravitation and cosmology. In particular, he is interested in problems such as the final state of gravitational collapse of (quantum) matter, the origin of primordial energy density fluctuations in our universe and their correlations, and the explanation of the entropy of our universe. He has made substantial progress on these problems, especially during his sabbatical leave of absence, which he spent at the Jet Propulsion Laboratory (JPL, NASA) at the California Institute of Technology in Pasadena and at the Ecole Polytechnique and Ecole Normale Superieure (ENS) in Paris. Mazur's collaborative work with I. Antoniadis and E. Mottola conducted during the sabbatical leave has resulted in concrete predictions concerning the origin and nature of the primordial energy density and temperature of Cosmic Microwave Background (CMB) fluctuations. They have discovered that it is the postulated presence of dark energy in the early universe which leads to the particular pattern of these fluctuations. Their origin is due to macroscopic effects of quantum gravity on the cosmological horizon and the prediction is that these fluctuations are characterized by the intrinsic property of non-Gaussianity.

These fluctuations later evolved to the cosmological era of recombination where (and when) they were imprinted on the CMB. They are now measured with great precision by the PLANCK satellite which was launched three years ago. If detected, the presence of non-Gaussianity in the CMB will have far reaching consequences for the theoretical description of the early universe and it may require an introduction of a completely new cosmological paradigm.

High Energy Experimental Group

Faculty: Sanjib Mishra, Raberto Petti, Milind Purohit, Carl Rosenfeld, and Jeff Wilson

This year the ATLAS physics group at USC saw a few changes. Woochun Park, our longtime post-doc, moved on to a local computing position and a new post-doc, Rishi Pravahan, has joined. Graduate student Anton Kravchenko has also joined ATLAS. Both Rishi and Anton worked at CERN over the summer, and Rishi is now based there to work more closely with colleagues and the ATLAS detector. We were joined for six weeks by high school student Matt Krumwiede, who took a stab at Higgs decays (simulated, of course). With the Higgs so much in the news he had a blast and his parents were very impressed too! This year we finally had a positive indication in ATLAS data of the Higgs boson, with a mass around 126 GeV—a tour de force of statistical method.



Prof. Milind Purohit and Matt Krumwiede

Nuclear Theory Group

Faculty members: Professors Fred Myhrer and Kuniharu Kubodera

In Spring 2011 our postdoctoral fellow of almost two years, Dr. Udit Raha, was invited to join the Physics faculty at the Indian Institute of Technology at Guwahati in the province of Assam in India. We were extremely pleased that Udit has received recognition as a scientist in his home country. In January 2012 Dr. Saori Pastore at Argonne National Laboratory outside Chicago gave a seminar at USC and she was invited to be part of our research group. She had several job offers but we were lucky and she agreed to join the University of South Carolina family and our research group in December 2012.

We were honored to be invited to join one of our previous students, Dr. Ivan Danchev, in a research project regarding nuclear matter. Ivan is teaching physics at Mount Olive College in North Carolina. He has visited us several times during the last couple of years to discuss the research project. During the last year we learned that Jim Talbert, an undergraduate student in our group, was awarded a Barry M. Goldwater Scholarship in 2011. Jim graduated in May 2012, and he is looking forward to continue his graduate physics studies at Oxford University in England.

Our group just finished a research project related to the highly consequential neutrino-oscillation experiments currently under way at the Daya Bay reactor in China, at the Chooz reactor in France, and at the RENO facility in Korea. These large experimental groups involve scientists from many countries including the US. The experiments utilize anti-neutrinos generated in nuclear reactors to determine an important angle that describes a mixing of different neutrino species. The first experimental results have been published in 2012, showing that indeed the anti-electron neutrino do indeed oscillate into other neutrino species (the mixing angle θ_{13} is different from zero). The envisaged accuracy of θ_{13} requires a detailed study of what is known as radiative corrections. The USC group is in a unique position to be able to evaluate these radiative corrections very accurately with the use of an effective-field-theory approach. The first paper of our evaluation has been published.

Another application of this powerful effective-field-theory approach, outlining a high-precision calculation of radiative corrections for muon capture on the deuteron, is currently being prepared in collaboration with Dr. Young-Ho Song and Prof. Vladimir Gudkov. The rate of this reaction is currently measured with unprecedented accuracy at the Paul-Scherrer Institute (PSI) in Switzerland. It is noteworthy that this experiment will allow the accurate determination of a certain parameter (a low-energy-constant in our jargon) that affects the rates of several other nuclear reactions that are of great importance in astrophysics and particle physics. For example, the proton-proton fusion reaction rate, which is the primary process in solar burning, is sensitive to this parameter. The expected precision of the PSI experiment is such that the relevant radiative corrections need to be evaluated very accurately in order to allow an accurate extraction of the value of the above-mentioned parameter from the PSI data. Reflecting the established international recognition of our group, we were solicited to contribute a review articles for the *International Journal of Modern Physics* on pion production from nucleon-nucleon collision. Our group has investigated this topic for years. During the last few years, in a new collaboration with German and Russian scientists, we have made headway in the understanding of this fundamental two-nucleon reaction, which has consequences for the interpretation of the basic nuclear potential.

Life at The Large Hadron Collider

A First Person Account by Rishiraj Pravahan

Rishirhaj Pravahan(left), Milind Purohit (middle), and Anton Kravchenko(right)

There is that familiar breeze that blows from the north over the lake of Geneva into the city as I hop onto Tram 14 from 'Gare Cornavin,' the main train station, toward CERN, the European Centre for Nuclear Research, situated at the outskirts of the city. A new tramline is bing built to connect the center of the city to CERN, all in anticipation of one thing : the starting of the LHC.

The LHC

The Large Hadron Collider, also known as the LHC, is a marvel of modern physics and engineering. Spanning territories in both France and Switzerland, a 27 km tunnel contains a pipe that hosts two beams of proton traveling so close to the speed of light that each of the protons can attain an energy, 4000 times their own mass. To keep them in a circular path the most powerful magnets are used, which in turn require temperatures colder than outer space. If you think the whole thing is out of some sci-fi novel you would have probably been right a decade ago. It is the reality of today. The LHC was created by physicists and engineers from all over the world to understand the nature of matter, and to venture into answering questions that a few decades ago were considered as part of philosophy or theology.

The First Day of Collisions

It is November 20, 2009. After recovering from a somewhat disastrous start a year ago due to an accident, the LHC is about to restart. I happen to be a shifter at the ATLAS control room, ATLAS (A Toroidal LHC ApparatuS) being the largest general purpose detectors at the LHC.

The high energy protons from the LHC are focused and made to collide with each other at the center of the ATLAS detector. The debris from each collision leaves a 'physics signature' in the detector. The rest is detective work in terms of data analysis to find all sorts of physics.

Rumors had been rampant. Some from the fearmongering press painting a doomsday picture of 'miniature black holes created at the collision' imploding first Geneva and subsequently the world! Other rumors that worried me were that the 'fixes' to the LHC machine were temporary and another inevitable accident would jeopardize the whole experiment. Such rumors are painful for graduate students on their fourth year of a Ph.D. program waiting for the data to finally write up a dissertation. I fell for the rumors at the time, at least partially.

As I stepped out of the tram to change to the bus towards CERN, I caught myself shivering partly from the cool north wind that creeps in through the buttonholes of your overcoat and partly out of anticipation and excitement. I was going to be there when they start this amazing machine up again. Everything was at stake for me and 10,000 of my other colleagues at the LHC experiments, some of whom had worked for decades to usher in this day.

At around 7 p.m. we had our first 'scraping events.' The instrument displays all lit up with 'events'. Loud shouts erupted, 'there's a muon', 'jets-jets,' and with general exaltation of success. The anticipation was still palpable, although we had restarted the LHC, without destroying it or the world! This was a milestone for physics. No one knew what we will find in the next few years of taking data but whatever it would be, we were ready for it.

My life and ATLAS

I had a dream as a child that I was working underground with thousands of others building a city. In the summer of 2007 I took my parents to visit the ATLAS cavern, a gigantic hole 100 meters underground housing ATLAS, a machine the size of a six story building weighing 7000 tonnes. At the time we were at the final stages of commissioning ATLAS and the sight of ATLAS in the cavern was daunting. During the visit my mother recounted this dream of mine from childhood and emphatically claimed that I had a vision. It wasn't a vision in the sense she meant it but ever since I had learned about the branch of physics that proclaimed to investigate the nature of the universe and how it all fits in, I was hooked. The vision was what I set for myself, to study physics at a level where I would be able to be a part of this great experiment! My life was from then on dedicated to physics.

I feel most of my colleagues at CERN must have had similar experiences at an early age. I sense this passion when I am talking, collaborating or even sharing a beer at the CERN cafeteria with my colleagues. The life of the physicist is that of lifelong passion and dedication for finding the truth. The truth lies in our data, from our experiments. But it is not easy to find, and thus so much more gratifying when one does find it, finally.

The Higgs Discovery

Fast forward to July 4, 2012. The LHC has been colliding protons relentlessly and ATLAS, CMS (Compact Muon Solenoid: another independent, general purpose detector experiment at the diametrically opposite end of the ring from ATLAS) and the other detectors have been recording all interesting events diligently for the previous two and a half years.

We now had enough data to start seeing interesting things above the background of known physics. The engineers did a fantastic job of running the LHC and the detectors, the physicists have been analyzing the data, having meetings, presentations, discussions, debates, football matches, and everything else that physicists do day in and day out to analyze the multitude of data while staying sane. Back to July 4th, the day the two experiments decide to go public on a physics result we have been working on for a while. It was a sensation with Nobel Laureates to undergraduate physics majors all gathered together for the great announcement. Both ATLAS and CMS has seen a resonance at a mass range where the Higgs was expected — the announcement claimed a discovery independently verified by ATLAS and CMS. This was a dream come true for many and the most important day of my professional life and possibly that of all high energy physicists of my generation. It had been 17 years since the last major discovery, that of the top quark, was announced by the Tevatron experiments at Fermilab. In all the fanfare and champagne, I remembered my father who visited ATLAS during the last few months of his life with my mother and I and at the end of the tour while sipping coffee at the CERN cafeteria told me he was glad thatI did not join the "rat race" and chose to pursue fundamental science. Next, I thought of my daughter, born exactly ten months ago. I rejoiced that she will grow up in a world that knew a lot more about how the universe worked than my father had the chance to. Her generation will reap the fruit from the seed of knowledge we plant. It was a step for mankind by mankind, an extraordinary saga of teamwork, passion and dedication towards a cause with uncertain ends and barely any personal benefits.

A Bright And Exciting Future

I joined the ATLAS group at University of South Carolina (pictured) in January 2012 as a postdoctoral fellow after writing my dissertation on the data collected in early 2010. And in case you were wondering, all the rumors about the vulnerability of the LHC were just that. I obtained my PhD as many others did and we were well on our way towards a discovery. Various groups from universities and institutes around the world are contributing towards hardware, computing and physics analyses at ATLAS. The grid computing system makes it easy to analyze the data whether one is at Columbia, South Carolina or South America, Berkeley, Brookhaven, Belfast, Budapest or Beijing! Yet one needs to interact with the machine itself, fix hardware problems, improve performance, take shifts in running things, or present one's findings in a presentation physically at CERN. As a postdoc the needs are too great to be away from the experiment. Students usually travel during summer enjoying the great weather and festivals of Switzerland while taking intensive courses and accomplishing critical tasks. The environment is electric, with deep respect for the opinion of others without regard to position or degrees. Ideas come from undergrads to veteran physicists. A sense of cooperation as well as competition is always pushing everyone to give 110 percent.

The Higgs discovery is expectedly the beginning of a long journey of discoveries at the LHC. We at the USC ATLAS group at LHC are involved in many different aspects of this project and hope to soon be part of the next discovery. The potential is endless and the hard work to realize it is absolute. However, all of us who work for ATLAS welcome this prospect and seek to challenge ourselves as well as the currently established knowledge and wisdom about our world with us in it.

Experimental Nuclear Physics Group

The Experimental Intermediate-Energy Nuclear Physics Group (ENPG) is a large research group in the Department of Physics and Astronomy. We are five faculty members: Chaden Djalali, Ralf Gothe, Yordanka Ilieva, Steffen Strauch, and David Tedeschi. Other members of our group include two postdoctoral researchers, ten graduate students, and many undergraduate students. This past year was very full of events and accomplishments for us and we are happy to share the latest ENPG news.

The study of the atom's nucleus and its constituents on the quark level is the core of our research. We are leading eleven experiments at one of the flagship facilities for nuclear physics research in the U.S., the Thomas Jefferson National Accelerator Facility (Jefferson Lab). We are also engaged in collaborative research at the J-PARC proton accelerator in Japan, the electron accelerator MAMI in Mainz, Germany, and the Paul Scherrer Institute (PSI) in Switzerland. Our studies focus on Quantum Chromodynamics and Nuclei and are recognized as U.S. nuclear science frontiers. The main questions addressed by our research are: What is the internal landscape of the nucleon, how do the properties of strongly interacting particles change in the nuclear medium; what governs the transition of interacting quarks and gluons to pions and nucleons, and what is the nature of the nuclear force that binds quarks into protons and neutrons and nucleons into nuclei? In the past year alone, the members of our group presented our research and findings on these topics at 30 invited talks and seminars at national and international levels — a token of the international recognition of our group, as is the fact that we published dozens of articles on our collaborative research.

We are happy to welcome our new post-doc, Nicholas Zachariou, who joined our group in January 2012. Nick received his Ph.D. from George Washington University and is contributing to our investigation of the properties of the strong force when strange quarks are involved. Congratulations to our postdoctoral fellow Mike Paolone who successfully moved to the next step of his career and is now a research-assistant professor at Temple University. Congratulations also to our undergraduate student Weizhi Xiong, who graduated from the Honors College in May 2012. For his outstanding academic and research performance he won the Nina and Frank Avignone Fellowship from the Department of Physics and Astronomy as well as the Outstanding Graduating International Student Award from USC.

One of our most significant accomplishments in the past year was our success in securing continued funding of our program from the National Science Foundation for the next three years. Three independent reviewers and a panel in a highly competitive merit-review process reviewed our proposal. The funding allows us to continue our well-established program at Jefferson Lab, and our projects abroad.

We continue to be extra active during the summer months. In May 2012, Chaden Djalali and Steffen Strauch co-organized an international workshop on Hadrons in the Nuclear Medium at the European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT). The workshop brought together renowned experimentalists and theorists from high-energy, nuclear, and atomic physics studying medium modifications of hadron properties in the nuclear medium and created synergy between these fields. The workshop was supported by the ECT and HIC for FAIR. In July 2012 we hosted the USC Summer Academy on Non-Perturbative Physics, which was organized by Prof. Ralf Gothe and supported by USC. The academy consisted of a graduate-student summer school on non-perturbative physics that Gothe co-organized with Prof. Richard Webb, and an international workshop on Nucleon Resonance Structure in Exclusive Electroproduction at High Photon Virtualities. The three-week summer school on Dyson-Schwinger Equations to tackle non-perturbative physics, their applications in Quantum Chromodynamics and Condensed Matter Physics, and their mathematical connection to the Hopf algebras was taught by four world experts in the field. The workshop provided new opportunities to present and discuss in depth future developments and preliminary results on the continuous exploration of hadronic physics towards smaller distances.

C. Djalali (right) and our former postdoc M. Paolone (left) at our ECT Workshop on Hadrons in the Nuclear Medium, which was held in Trento, Italy.

Looking towards the future, our group has joined the JLab R&D efforts related to building an Electron Ion Collider (EIC) in the U.S. Such a facility would allow us to probe the properties of strongly interacting particles at even smaller distance scales than currently possible. In particular, we will contribute to the installation of a dedicated test facility at Jefferson Lab where performance of sensors in high magnetic fields can be evaluated and will perform a series of tests of

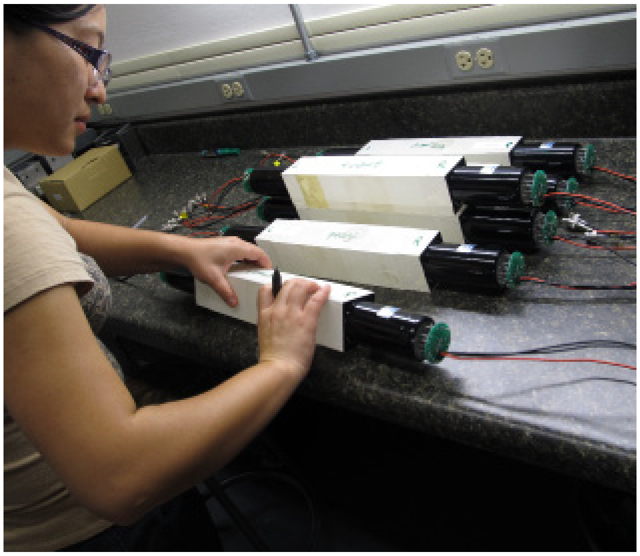
Silicon and other sensors in fields of up to 5 T. We have secured funding for this activity through the collaborative proposal DIRC-based PID for the EIC Central Detector (Yordanka Ilieva, co-spokesperson). The facility is one of its kind as no other research testing facility provides such high magnetic fields, and once established, it will be of long-lasting value not only for nuclear physicists but, for example, also for colleagues developing instrumentation for PET scans for small-animal or organ-specific imaging where the interest of using silicon sensors as readout elements is growing. This is yet another project of our group, which provides an opportunity for USC students to work in a diverse international research environment and to obtain first class training in experimental nuclear physics research and instrumentation.

With respect to JLab at 12 GeV, our group has a major part in the upgrade project with the development and construction of a new addition to the Time-of-Flight (TOF12) spectrometer for the CLAS detector in Hall B (Ralf Gothe), and the development of a kaon detection system for Hall C (Yordanka Ilieva). Testing, prototyping, and construction of TOF12 detector elements have been performed in our own lab in the Neutron Generator Building (NGB) at USC. In the past year we have begun production, and as of June 2012, 30 percent of the detector elements are completed. We expect to complete construction within the next year and will be busy with TOF12 installation at Jefferson Lab in Summer 2013.

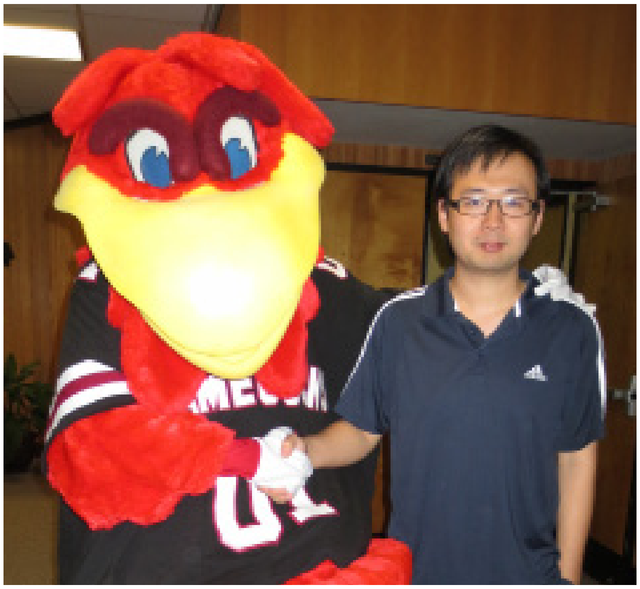
Thanks to our continued funding from the National Science Foundation and a funding support that we succeeded to negotiate with Jefferson Laboratory, we continue a strong tradition of providing unique research opportunities and mentorship to not only postdoctoral fellows and graduate students, but also to USC undergraduates. In Fall 2011, our students Weizhi Xiong and Kevin Wood presented the results of their research under the supervision of Prof. Y. Ilieva at the annual meeting of the Division of Nuclear Physics (DNP) in East Lansing, MI. In Summer 2012, our student Rachel Kuprenas supported our continued efforts at Jefferson Lab on the construction of the kaon detector for the Hall-C upgrade to 12 GeV. At our own detector laboratory on USC-Columbia campus, seven undergraduate students have been helping with the construction of the scintillator paddles for the TOF12 project. Two of these students are supported through USC scholarship programs such as SCAMP and SC Steps to STEM.

Last but not least, we want to share a word about mentoring and training of junior personnel, into which we have invested quite a significant effort in the past years. We are very proud to say that we have accomplished the building of a well functioning and well integrated research group with a healthy mix of postdocs, graduate, and undergraduate students, at various levels of their preparation in which everyone is continuously and actively engaged in building and sharing expertise. Through regular weekly meetings and rigorous sessions throughout each year, we not only ensure that each student is progressing well in their research, but also provide training in preparation and delivery of oral and poster presentations as well as in writing competitive funding proposals. We encourage and support our students to participate in conferences appropriate for their level where they can network with other professionals in the field, promote their work, and enhance their visibility. In the past year alone, our students have presented at meetings, such as USC Graduate Student Day, USC Discovery Day, collaboration meetings, the semi-annual meetings of the Division of Nuclear Physics of the American Physical Society, the Gordon Research Conference, and many more. Our dedication and hard work has paid off, as our students have established a strong record of wining awards and scholarships, of presenting their research at national and international meetings, and of being well placed at the next level of their careers.

With the long shutdown of Jefferson Lab for the 12-GeV upgrade that began in June 2012, our involvement in detector construction, and commitment to publishing the 6-GeV physics results, we are looking forward to another intense and productive year.



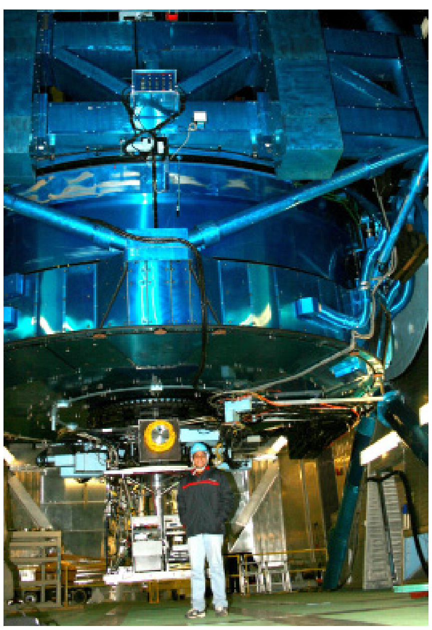
Graduate Student Ye Tian performing lab work



Cocky and Weizhi Xiong at the Student Awards Day.

Astronomy News

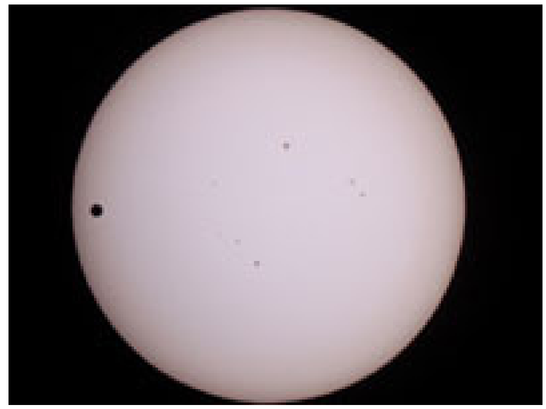
Professor Varsha Kulkarni continued research in extragalactic astrophysics along with her collaborators, postdoctoral research associate Dr. Monique Aller, and graduate students Sean Morrison, Camilo Posada-Aguirre, Debopam Som, and Lorrie Straka. The group uses primarily optical, infrared, and ultraviolet facilities in space and on the ground, with the goal of investigating the evolution of galaxies and the intergalactic matter over the past approximately ten billion years. Recently we discovered the most gas-rich galaxy detected to date via its absorption line signatures on the spectrum of a background quasar. We also discovered that the interstellar silicate dust in distant galaxies may be crystalline, as opposed to the almost entirely amorphous silicate dust found in our Galaxy. We have started to study the structure of a rare class of galaxies known as polar ring galaxies, that can help to map the distribution of dark matter in galaxies. In addition, we have recently embarked on a collaboration with several theoretical physicists to obtain improved spectral diagnostics of heavy elements at high redshift through modeling. Our work is funded by the NSF and NASA. During the past academic year, we received two new grants from NASA and one from NSF. Our research resulted in five publications within the past academic year, with three papers currently under review, and more papers in preparation.



Debopam at the Subaru Telescope in Hawaii

During the past year, our team obtained new data with the Gemini-North telescope in Hawaii, the Large Binocular Telescope in Arizona, the Magellan Clay telescope and the European Southern Observatory's Very Large Telescope in Chile. We also obtained new data with NASA's Hubble and Spitzer Space Telescopes, and the Herschel Space Telescope operated by the European Space Agency and NASA.

Graduate student Lorrie Straka gave her Ph.D. thesis defense in Summer 2012 on observations of quasar absorber galaxies and quasar-galaxy pairs. She will be starting a postdoctoral fellowship at the University of Chicago in Fall 2012. Graduate student Debopam Som continued his work on element abundances in high-redshift absorbers using the Subaru Telescope in Hawaii. New additions to our group in the past year are graduate students Sean Morrison and Camilo Posada-Aguirre. Sean is working on far-infrared observations of molecules at high redshifts with the Herschel Space Observatory, while Camilo is beginning to work on photoionization modeling of interstellar gas in distant galaxies. Postdoctoral fellow Dr. Monique Aller is carrying out studies of interstellar dust in distant galaxies, as well as the rare but fascinating polar ring galaxies with the Gemini and Spitzer telescopes. Several members of our team gave presentations at national and international institutions and conferences.



Transit of Venus, image by Alex Mowery

In other news, Mr. Alex Mowery and Dr. Dan Overcash continued their excellent outreach efforts at the Melton Memorial Observatory, where public viewings are held on all clear Monday nights. Our most recent outreach event was the viewing of the transit of Venus, which was enjoyed by a crowd of over 700, and over 1500 persons following our live broadcast online. Alex is now the Vice-President of the Midlands Astronomy Club in Columbia. As Director of the Astronomy Center, Dr. Soheila Gharanfoli continued her excellent undergraduate teaching work. Prof. Kulkarni was elected President of the South Atlantic Section of the American Association of Physics Teachers (SACS-AAPT), and our department was host to the Fall 2012 SACS-AAPT Meeting.

The public viewing of the transit of Venus

A New Perspective on Physics

By Katarina Leila Mizouni

I never thought physics would one day save my life.

Up until last summer, the hardest thing I had ever accomplished was passing the Ph.D. candidacy exams after a stressful summer of continuous studying. My hard work paid off; I ranked third. I admit I was extremely proud of myself, as I was the only woman to pass the quals that year.

I guess, as our good old friend Einstein would say, that everything is indeed relative. What I endured back then was nothing compared to what was waiting for me in 2011.

That summer I was preparing to defend my thesis and busy planning the next stage of my life. I had just traveled to Greece to present my research at a nuclear physics conference. I had filed for graduation in the fall. Everything was looking great. That is, until I suffered a seizure out of the blue on July 27, 2011.

Upon closer examination, it was discovered a grade 3 brain tumor was nested in the right frontal lobe of my brain. What scared me the most wasn't whether or not I would survive (after getting over the initial shock, I became possessed with an enraged will to live); it was in what mental condition I would be left after undergoing surgery and radiation. Physics has always been a passion of mine. How would I go on living life if I could no longer grasp the beloved notions of quantum, nuclear, and the physics of the universe? How would brain surgery change me– the Leila I had grown into over the years?

I still remember what my sister told me a year ago: "If anyone can beat cancer, it's you." So I fought through all of it. I fought through two surgeries, nausea, pain, fear, anger and many tears. Knowledge is power. I sat down colleague-to-colleague with the physicist assigned to my case while undergoing six weeks of atrocious radiation at Johns Hopkins. I asked questions about MRI spectroscopies while studying the physics behind these procedures in my spare time. I fought through the side effects of subjecting my body to a mixture of different chemo agents over the course of the last year. I fought through hell. Along the way, some 'friends' disappeared, while others shined and became more prominent in my life. I looked for inspiration in people who had undergone much worse things in their lives. I definitely had my share of bad days, but I still smiled and joked with my doctors and underwent every radiation treatment wearing a pair of pink heels– a little reminder to never let cancer define who I am.

A year later, my scans are clean and stable. I only have three more rounds of chemo left. I am back to working full-time on my Ph.D. and am looking forward to living the rest of my life. I am not only thankful for the support I received throughout this ordeal, but also for being so lucky: lucky that the tumor could be removed; lucky that I had the strength to fight off cancer; lucky that I remained cognitively and physically intact; and finally, lucky to have been born in a century where the complex field of medical physics is advanced enough to treat such a horrible diagnosis.

R.L. Childers Midway Physics Day at the S.C. State Fair

With the generosity of the organizers of the S.C. State Fair, we have the opportunity to provide physics demonstrations and teach high school students about the physics of amusement rides at the S.C. State Fair every October. This past October, we saw a record number of students and high schools participating in the event, with over 3,000 students and nearly 60 high schools from across the state. As the students entered the WLTX tent to check in with us, they had the chance to watch and participate in various physics demonstrations.

One of our more popular demos was the angular momentum activity using the spinning platform in concert with the bicycle wheel. This activity gave students a chance to experience the effect of "tucking" to produce a faster spin; the bicycle wheel demonstrated how the space shuttle is able to change it's orientation without being able to push on anything. Other popular activities involved freezing everyday object with liquid nitrogen and observing huge changes in material properties with temperature. Combining the liquid nitrogen with the ring launcher (a demonstration of Farday's Law) was able to propel the ring more than 20m in the air.

For our students, Midway Physics Day was an opportunity for them to be actively involved in our outreach efforts with the community, and share their experiences with possible prospective students. They look forward to this as much as the high-school students who are eager to experience physics demonstrations first-hand!

The local television station WLTX stopped by and did a very nice video piece on the Midway Physics Day event. You can find that video here: http://www.wltx.com/news/story.aspx?storyid=205676. Please check it out!

All in all, the Physics Department put on another successful and well-attended Midway event.

Quantum Leap

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Space Elements imaged by Alex Mowery from the Melton Observatory

Thousands of high school students from across the state came to participate in the R.L. Childers Midway Physics Day at the SC State Fair.