Quantum Leap

University of South Carolina
Department of Physics and Astronomy

Fall 2007

In with the New

Brett Altschul

Brett Altschul

Brett Altschul received his doctoral degree in applied mathematics, although his thesis advisor was Roman Jackiw, a physics professor. His thesis was on quantum systems with one spatial dimension and how they can be embedded in realistic (3+1 dimensional) physics. After receiving his Ph.D. in 2003 from the Massachusetts Institute of Technology, Brett spent four years as a research associate at Indiana University in Bloomington, Ind.

Brett says, "I am an expert on relativistic quantum field theory. My research focuses on exotic modifications of the standard model, the currently accepted theory of particle physics. I have worked particularly on possible deviations from special relativity—how these could arise and how they could be identified experimentally.

"In the last decade, there has been growing interest in such possible deviations, even though special relativity is one of the most stringently tested theories in all of science. Many candidate theories of quantum gravity, which would unify gravitation and quantum mechanics, suggest inconsistencies with relativity at some level. Systematically searching for small corrections to relativity involves work in many different fields of physics. Important data come from precision atomic clock experiments, particle accelerators, and high-energy astrophysics.

"Outside of physics, I enjoy writing fantasy, high-impact hiking, and listening to folk music. I am an accomplished violist, a brown belt in judo, and a published poet."

Scott Crittenden

Scott Crittenden

Scott Crittenden received his Ph.D. in Physics from Purdue University in April 2004 after defending his thesis, "Scanning Force Microscopy as a Tool for Bioelectronics." Before joining the University, Scott held a postdoctoral position at the U.S. Army Research Laboratory in Adelphi, Md., where he worked on alternative energy sources and Scanning Force Microscopy (SFM).

Scott says, "I am excited to have an opportunity to pursue my research in biophysics and nanoscience. Working to understand the fascinating ability of some bacteria to generate free electrons, besides providing an opportunity for interesting interdisciplinary work among chemists, biologists, and physicists, may result in an alternative energy source and help us transition to a biologically sustainable economy.

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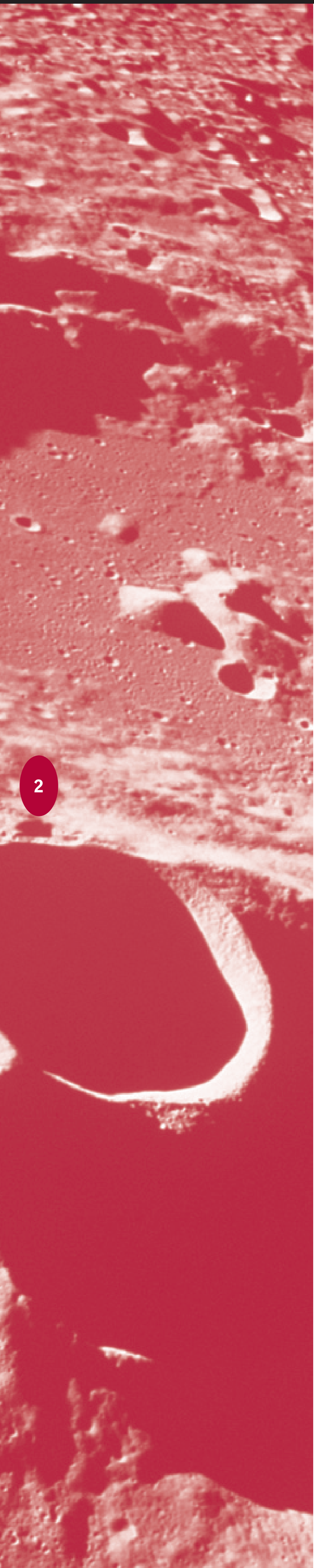
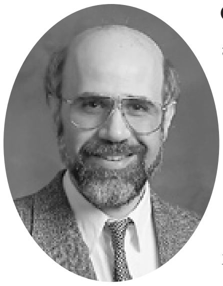
UNIVERSITY OF SOUTH CAROLINA



A Message from the Chair



Chaden Djalali

Greetings to friends and alumni of the Department of Physics and Astronomy at the University of South Carolina. Writing for our annual newsletter is a unique opportunity to reflect upon our past year's accomplishments and our vision for the future. I am delighted to report on a great many positive and exciting developments in the department over the past year.

Perhaps the biggest single development continues to be the hiring of new faculty. During the past year, we have added two new members to our faculty. Brett Altschul, a quantum field theorist, has been hired into our theory group. Brett received his Ph.D. in 2003 from the Massachusetts Institute of Technology and held a postdoctoral research position at Indiana University in Bloomington before joining us this fall. Scott Crittenden is an experimentalist in condensed matter/nanotechnology. Scott received his Ph.D. from Purdue University in 2004 and held a postdoctoral research position at the U.S. Army Research Laboratory in Adelphi, Md., prior to moving to Columbia. Detailed descriptions of their research programs are in this newsletter. I hope you will all join me in welcoming them, and we very much look forward to the excitement, energy, and new directions that they will bring to the department. Our successful recruiting efforts would not have been possible without our dedicated faculty members, who have truly done a remarkable job on the various search committees.

Last year saw the departure of two faculty members. Christina Lacey left for Furman University, and John Palms retired. They were both valued members of our department; we thank them for their many contributions and wish them well in their future endeavors.

The department staff has also seen some changes. Beth Powell is our new administrative coordinator, and Laura Bouknight has joined us as our new graduate program coordinator.

External funding is an important requirement for having an excellent Department of Physics and Astronomy. We are proud that the department continues to have success in competing for extramural funding. In the past few years, the federal funding to support our faculty's research has steadily grown in spite of the very constrained federal funding climate. A truly excellent educational program draws on solid research, and we continue to strengthen our efforts to involve our students in the cutting edge of the research enterprise. This is shown by the increasing number of undergraduate students who are recipients of the USC Magellan Scholar award to carry out undergraduate research projects with our faculty.

In addition, we are excited about the work we have done over the past year to enhance the educational activities of the department. A major initiative is underway to revamp the capstone 500-level physics courses in condensed matter, optics, and nuclear and particle physics. These efforts are spearheaded by Gary Blanpied, Thomas Crawford, and Ralf Gothe, who have successfully secured college funds to buy state-of-the-art equipment for these laboratory-based courses.

As you can see in the awards section of this newsletter, our faculty, alumni, and students continue to bring accolades to themselves and to our department. Congratulations to all of them!

We continue to attract outstanding students to both our undergraduate as well as to our graduate programs. Our department benefits from a recurring annual gift to our graduate program that allows us to offer more competitive stipends, signing bonuses to attract top students and many other graduate program developments. The department would like to further enhance our ability to attract excellent students by raising money for endowed fellowships and scholarships. We will actively pursue this goal over the next few years with the help of the development office in the college.

Our community outreach effort remains strong and continues to grow. Several faculty members are involved in the training and enrichment programs for local schoolteachers. Many others regularly visit classes in elementary, middle, and high schools with

exciting demonstrations. We continue to provide LONCAPA support to many schools in the midlands. The peak of our outreach activity continues to be the very popular Richard L. Childers Midway Physics Day at the State Fair in October. Thousands of middle and high school students attend this event every year.

In September 2007, the department underwent an external review. The review panel was presented with our self-study document, as well as our strategic hiring plan for the next five years. The three main areas where future hiring should occur have been identified as condensed matter/nanotechnology, astronomy/astrophysics, and theory in general. Interdisciplinary efforts growing from grassroots efforts of current faculty will benefit the department on the long term. The University's Faculty Excellence Initiative program is allowing us to build bridges to related fields. These interdisciplinary efforts should be pursued while preserving the strength of the "core activities" needed for a strong Department of Physics and Astronomy. We should soon have the report of the panel together with the recommendations to the dean.

We are deeply indebted to our retired and retiring faculty for their enormous contributions to research and teaching. It is amazing to see how a large majority of them continue to be involved in the life of the department.

We are always glad to hear from our alumni and friends. It is exciting to learn about what is happening in your careers and lives. We are happy to provide this forum to help our graduates stay connected. Don't hesitate to send us your news and visit us in Columbia when you can. I thank all of our friends and alumni who have contributed to the Department of Physics and Astronomy Funds. Your support directly benefits our students and the opportunities we can provide for them. Best wishes to all!

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"Although SFM has been around for 20 years now, its phenomenal progress in new techniques and abilities continues to be rapid. I look forward to both continuing my research into understanding what the SFM probe is really telling us about the sample and to developing new techniques to enable novel experiments in physics, chemistry, and biology, and advances in nanomanufacturing capabilities.

"New technologies are drastically changing the way we live. Our ability to communicate with each other and to access the global collective store of knowledge is becoming ever easier and ubiquitous. New societal and technical challenges are no longer easily met by single discipline techniques. What we teach and the way we teach it must adapt to the times to remain relevant and useful. I look forward to helping to make this happen at USC."

Yaroslaw Bazaliy

Yaroslaw Bazaliy is starting to work as a member of the condensed matter physics group. Yaroslaw says, "One of the main research topics of my interest is 'spintronics,' a part of physics that explores the ways in which electron spin can be used in electronic devices. Apparently, that can be done efficiently only in very small, nanometer size samples. Thus the field of spintronics is a part of the larger field of nanoscience, which is currently at the global forefront of condensed matter research. The proximity of my interests to those of the well-established experimentalists in the group will allow for highly collaborative research projects. I expect that the community spirit of such projects will influence the students who will feel being a part of the larger physics family early on in their careers.

"Before coming to USC, I worked in government [Argonne National Laboratory] and corporate [IBM, Almaden Research Center] research labs. The important difference between those places and the University is the absence of either students or a teaching component. I subscribe to the opinion that teaching makes the scientific life closer to a 'complete' experience: you are surrounded by younger and older generations of physicists and feel that your effort is a part of a living tradition. I am starting to teach Physics 201 this autumn. One of the interesting features of the course is the use of a computer-assisted homework system, the LONCAPA. Systems of this type are probably in their infant stage of development, when the whole paradigm of computer-assisted teaching is shaped. One can say that we live in times that can be compared to the times of transition from the medieval teaching system based on rare, hand-written manuscripts of the pre-Gutenberg era to the 20th century teaching practice based on the abundance of printed textbooks. The possibility to discover the new roles of existing Internet technologies in the teaching process makes university work even more exciting.

"This is my first experience of living in a southern state of the U.S. Before that, I had an opportunity to explore California and the Midwest. Being very different, both regions gave me their own perspectives on American life and an understanding of this country, which can hardly be achieved in a purely academic way. I am looking forward to getting to know the rich traditions of the South through interactions with my colleagues, students, and new friends in Columbia."

Staff News

Everything's the same except for the differences! Since Lynn Waters abandoned us (no, that's supposed to be retired) in September 2006, Beth Powell moved into the administrative coordinator/assistant to the chair position. This was a rather reluctant move, as Beth was a little hesitant to try and fill those shoes. So far, so good, except Beth really misses her regular cat talks with Lynn. Somehow, e-mail is just not the same.

In April, Laura Bouknight joined the department to fill the position of graduate program coordinator. Laura received her B.A. from the University in 2002 and is glad to be back on campus. She's adjusting very well to being the "mom" of 47 graduate students, although she finds her miniature dachshund, Maggie, to be much more agreeable at times.

Ray Edmonds, Richard Hoskins, Mary Papp, Bob Simmons, and Robert Sproul are all still working as hard as ever. Ray continues to work part-time for the department and likes to enjoy his long weekends (Tuesday to Sunday). Richard continues to wear out the road between Columbia and Orlando to see his grandson, Alexander. If you see him, be sure to stay out of his way. Mary has been learning a second language, Two-Years Old, from her son, Will. Fortunately, there are no exams. Bob has been busy trying to make time move faster. The sooner retirement comes, the sooner he can spend much more time with his grandchildren. Robert has been dabbling in the construction business, building a new shed for his backyard. Although it's coming along nicely, the squirrels have been fussing at him for being so close to their trees.

We have been very fortunate to find a great student office assistant, Dominic Cortese. Between assisting in the main office and assisting Robert and Richard with labs, he manages to get in a little class time. We're still trying to talk him into becoming a physics major. We're not winning the argument, yet, but we haven't given up.

A little note on some of our retired staff … Since Lynn's retirement, she has continued taking courses. She is looking forward to receiving her degree next semester, and we're very proud of her. Lynn has also had more time to spend on one of her favorite hobbies—reading. In doing so, she came across a recent article on one of our other retired staff members, Mildred Hedgepath. Mildred has been enjoying her hobby of gardening. She has been featured on the Lexington County Master Gardener garden tour and in the October issue of the Lake Murray-Columbia Magazine.

Theoretical Physics Group

Recent years have seen a flurry of activities having to do with the interface of gravitational and condensed matter physics involving groups in different sub-communities in theoretical physics. The mathematical methods developed in general relativity and quantum field theories (gauge theories) have become a part of the contemporary theoretical condensed matter physics. The central unifying theme in these activities is the notion of emergence. Historically, first superfluidity and later superconductivity have been understood as an emergent phenomena while the high-energy physics and gravitational physics stayed basically "decoupled" from those fundamental developments. It was only later that the Ginzburg-Landau phenomenological model of superconductivity, characterized by the spontaneous symmetry breaking, has been adopted in particle physics under the name of the Higgs mechanism. The observation that Einsteinian gravitation shares some formal aspects with superconductivity on the level of the Ginzburg-Landau model has been around for 30 years now. However, the apparently obvious idea that the phenomenon of gravitation should be described in the framework of the microscopic model based on the concept of heavy constituents has not emerged until relatively recently. The need for understanding the microscopic basis of gravitational phenomena is especially evident at the present time, when it has become clear that the new experimental/observational data indicates that we are at the cross-roads again as far as the theory of gravitation and cosmology is concerned.

The major discovery of the evidence for the "dark energy" and the discoveries of the completely collapsed objects in the centers of galaxies and in certain binary systems point to the need of the major re-thinking of the theoretical basis for gravitation. The idea that Einstein's theory of gravitation may be just another mean field theory valid only to the point when one neglects higher order correlations in the "primordial" condensed matter system has attracted the attention of many researchers. Therefore it should not come to us as a surprise that many researchers working in different areas of theoretical physics interested in "emergent gravitation" responded enthusiastically to the initiative of organizing a workshop on this subject. The idea of organizing the workshop on emergent gravitation came to us during discussions George Chapline, Pawel Mazur, and Jan Zaanen had at the Kavli Institute of Theoretical Physics, University of California Santa Barbara, in early March 2006. The international workshop "Condensed Matter Meets Gravity" took place in the Lorentz Center, Leiden University, The Netherlands, Aug. 27–31, 2007. It was organized by G. Chapline (Livermore), P.O. Mazur (USC), D. Santiago (Leiden), X-G Wen (MIT), G.E. Volovik (Landau) and J. Zaanen (Leiden). There were about 40 participants attending the workshop.

Condensed Matter and Nanoscale Physics Groups

It's been an exciting year for USC's Condensed Matter Physics group. From existing faculty exploring new directions, to new faculty bridging into new-to-S.C. lines of discovery, USC-CMP is full speed ahead with innovation and discovery.

The Department of Energy chose research conducted in Professor Milind Kunchur's group as one of their highlights for the agency's own budget justification. Presented at invited talks in five different countries, Kunchur's research has led to the discovery of new effects in superconductivity at extreme power densities and short time scales, including the hot-electron vortex instability and a new third hybrid category of superconducting behavior that had not been observed before. Kunchur's graduate student, Gabriel Saracila, is trying to observe, in real time, the ballistic acceleration of superfluid: In a "normal conductor" such as copper, a voltage is required to maintain a constant current since resistance has to be overcome. In a superconductor, under certain conditions, there is no resistance, so an applied voltage accelerates the current rather than just maintaining it at a constant value. This acceleration lasts for a very brief duration, since eventually the current exceeds its critical value and the superconductivity vanishes, making this effect difficult to observe. In addition, Kunchur has steered his group into interdisciplinary research in psychoacoustics and the neurophysiology of human hearing. Their recent experiments have shown humans are capable of resolving temporal events on a five microsecond timescale. This result has generated much surprise and controversy in the field. In the words of one editor, Kunchur's research "has brought into question 100 years of research on human temporal resolution." This result was achieved by developing radically different instrumentation and methods for psychophysical testing. Kunchur recently established a collaboration with Professors Eric Healy (Department of Communication Sciences and Disorders in the Arnold School of Public Health) and Antonello Monti (Department of Electrical Engineering in the College of Engineering and Computing) on a project titled "Limits of human hearing and their role in biomedical and audio technologies." This project is currently funded by a grant from the USC Office of Research and Health Sciences Research Funding Program.

In collaboration with several colleagues, Professor Timir Datta is working on two broad themes centered around unconventional solids and gravitation. In particular, Datta's interest is on charge transport in manmade replica opals especially of carbon. These materials are made by CVD using artificial silica opals as templates. After deposition, the silica spheres are dissolved in acid so that a topologically complex 3-D free-standing graphite structure is left behind. Datta and co-workers have reported observation of many quantum phenomena such as Hall-effect under very soft conditions, i.e., temperatures as high as 60K and low magnetic fields. Recently a theoretical paper in PRL cited their work as evidence of a curious relativistic quantum effect. Datta is also studying the overlap regime between electric response of a conductor and earth's pull. The theoretical basis of this type of phenomena was first discussed by Schiff and co-workers in the 1960s, but a large disagreement as to the role of the atomic core was not resolved. The Datta group has measured the dipole moment due to "gravity" of neutral metal spheres and has observed that indeed for light materials such as aluminum, the sign of the charge is electronic, as was predicted by Schiff. However, the magnitude does depend on atomic mass. If confirmed, his results imply that a "hole-conductor" will show opposite behavior, and this may lead to the development of gravito-electronic devices.

The other gravity project that the group is continuing with is the "Nearly-Free Rotation," for measuring Newton's constant, the "Big-G." Remarkably, G, the first constant to be introduced in any physical theory, is also the least precisely known. NFR is a new measurement scheme proposed by the Datta group. It employs a torsion pendulum–based time displacement method (theta vs. t), which incorporates high tensile synthetic fibers including carbon nanotube threads and a novel two-wavelength diffractive goniometry. On dimensional grounds, it can be shown that distance and time need to be measured respectively three and two times as much as mass measurements. The use of two standardized optical wavelengths permits the angle theta to be determined independently free of the pendulum to detector distance. Many of the mechanical parts have already been completed, and optical fabrication and software development are in progress. Datta expects that proof of principle data will be coming out this fall.

The Low Temperature Quantum Electronics group, led by the John M. Palms Bicentennial Professor Richard A. Webb, focuses on basic research in nanoelectronics, which has opened up a realm of possibilities for discovering new physical phenomena, as well as producing new hybrid links for greater functionality in the electronics, computing, and magnetic storage industries. By locally exploiting and controlling quantum coherent couplings and interfaces between one or more nearby atoms, molecules, or other complex structures, it is hoped that new optical and electronic properties can be produced and controlled. The potential for harnessing the electron spin for novel and exciting applications has fueled a tremendous growth in the field of spintronics and led to new devices based on the giant magnetoresistance effect and spin-polarized transistors. It has long been hoped that new nanoscale devices that make use of quantum coherence and entanglement of the orbital and/or spin parts of the electron wavefunction can be developed. Since the electron spin is a two-level quantum system, Webb's

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group is currently attempting to use two coupled spins as the basic building block of a quantum computer. Webb uses electron beam lithography, and a variety of material deposition and controlled growth techniques to create quantum devices in metallic and semiconducting structures with feature sizes ranging from 20 nm to many microns. The group produces one-dimensional wires, nanopillars, quantum point contacts and zero dimensional quantum dots and study their properties in magnetic fields as high as 16 tesla, temperatures as low as 3 mK, and frequencies as high as 26 GHz to investigate their transport properties.

The Webb group is currently implementing new infrastructure to fabricate nanoelectromechnical systems (NEMS) for use in exploring novel chemical and biological sensors, in addition to the group's efforts towards producing entangled electron spin states in coupled quantum dots, measuring electron transport in a time scale shorter than the phase coherence time of individual electrons. Webb and graduate student Longfei Ye are investigating charge and spin transport in spin valve structures in collaboration with the Crawford group and studying the opto-electronic properties of GaN, InN, and SiC nanowires with the Koley and Sudarshan groups in electrical engineering. Recent Webb group publications include Yuanzhen Chen, and Richard A. Webb, "Full Shot Noise in Mesocopic Tunnel Barriers," Physical Review, B73, 035424 (2006), Yuanzhen Chen and Richard A. Webb, "Positive Current Correlations Associated with Super-Poissonian Shot Noise," Physical Review Letters, 97, 066604 (2006), and S. Garzon, Y. Chen, R.A. Webb, " Enhanced Spin Dependent Shot Noise in Magnetic Tunnel Barriers," in Press Physica E (2007).

The Laboratory for Picoscale Metrology and Nanomagnetics, led by Associate Professor Thomas Crawford, has also had an exciting year. The group currently has three projects underway, spanning a range of fundamental to applied emphasis. Funded by Crawford's previous employer, Seagate Technology, through USC's Centenary Plan, former Webb graduate student and postdoctoral associate Samir Garzon has been promoted to research assistant professor. Garzon, together with Ye (who holds a joint appointment in the Webb and Crawford groups), are exploring the coherence (or lack thereof) spin momentum transfer by switching nanoscale spin valves with ultrafast shaped current pulses. The group has been accepted to present their results at this fall's Magnetism and Magnetic Materials (MMM) Conference. Graduate student Brad Knaus, together with Garzon and Crawford, has been exploring novel magnetism recently discovered in gold films capped with alkanethiol self-assembled monolayers of ~1 nm thickness, which has exhibited giant paramagnetism, with reported moments in the range of 100 Bohr magnetons per Au atom. The group has fabricated multilayers of Co and Au capped with different thiol layers, and has observed a shift in the Co domain peaks upon thiolation. Efforts are currently underway to explain the origins of the magnetism in this brand new, interfacial magnetic system. This project has also been selected for presentation at this fall's MMM conference. Supported by the Army Research Office as part of a threat sensing collaboration between Crawford (nanomagnetism), Webb (NEMS), and Tom Vogt, the USC NanoCenter director (cantilever sensing materials), Knaus has been measuring the sensitivity of Au-thiol magnetism to ambient atmosphere, pure nitrogen, and pure oxygen environments to establish the sensing potential of alkanethiol layers via this magnetic effect.

Finally, funded by the NSF's Nanomanufacturing program, Crawford, together with history professor Ann Johnson, is studying the fundamental spatial limitations of applying magnetic recording to the challenge of manufacturing with nanometer resolution. This project has two hypotheses. The first is that the inexpensive technology we all use to store our data could be adapted to manufacture a whole variety of unique "widgets" with nanometer tolerances, as the regions on a current disk drive confine a magnetic field to ~10 nm long regions. The second is that this technology progressed to the nanoscale unknown to the majority of the nanotechnology community. Crawford will focus on a laboratory demonstration of the first hypothesis, while Johnson will explore the second. This project will make use of the contact write/read recording tester constructed by M.S. graduate, Robert Heaton, who is now with the Space and Naval Warfare Systems Center (SPAWAR) in Charleston; now taken over by graduate student, Jon Stenbeck. Crawford will be giving Heaton's poster at this fall's annual meeting of the American Society for Precision Engineering.

In addition to these ongoing efforts, the group has brand new assistant professors working in USC-CMP: experimentalist Scott Crittenden and theorist Yaroslaw Bazaily. In conclusion, exciting developments are anticipated as this team pulls together and builds enthusiasm around the renaissance of condensed matter and nanoscale physics at USC.

Previous Graduates— Where Are They are Now?

George S. King III—
Savannah River National
Laboratory in Aiken, S.C.

Karen Wu—
Senior Research Associate,
Illinois Institute of Technology
in Chicago, Ill.

High-Energy Physics Group

The heavy quark group has had a very productive and busy year working on the SLAC-based experiment BaBar. Graduate students Hongxuan Liu and Xurong Chen are nearing the end of their Ph.D. research projects. Liu has been working on an analysis of the form factor in D+ semileptonic decays under the guidance of Professor Milind Purohit. He has been presenting his work to an analysis committee at BaBar as the first step toward producing a publication. Chen, who is working with Professor Jeff Wilson, is slightly further along with his search for the hb. He is doing a blind analysis and is working with a review committee in preparation for "opening the box." Both Liu and Chen also spent some time at SLAC during the summer participating in shifts to monitor the BaBar detector during data taking.

Graduate student Ryan White has been developing analysis techniques to do a study of CP violation across the Dalitz plot in Cabibbo suppressed decays of D+ $\rightarrow$ K+K-p+. His analysis seems ready to go, and he has begun processing large samples of data and Monte Carlo events to sift out events of interest. Postdoctoral fellow Woochun Park has finished an intense period of BaBar analysis in which he was the primary author on one publication ("Search for prompt production of cc and X(3872) in e+e- annihilation" [arXiv:0707.1633]) and a major contributor to a second ("Measurement of branching fractions, polarizations, and direct CP-violation asymmetries in B $\rightarrow$ rK* and B $\rightarrow$ f0(980) K* decays") [Physical Review Letters, 97, 201801 (2006)]. He also gave several conference talks related to these papers. Purohit has presented one of the collaboration's major physics discoveries of the year, a measurement of D0-D0 bar mixing, at several major physics conferences.

The heavy quark group is beginning to contribute to the Atlas Collaboration prior to the upcoming turn-on of the LHC at CERN. Purohit, Park, and Assistant Professor Roberto Petti have all spent significant amounts of time at CERN during the last year. Wilson and new student Arjun Trivedi are expected to join the collaboration in the next year, as well. The S.C. group has started to participate in several aspects of commissioning, calibration and reconstruction of the forward muon system. Purohit is contributing to muon performance studies, Park to muon software, and we are all interested in a future upgrade to ATLAS muon detectors when the LHC becomes the super-LHC.

Finally, Purohit is contributing to the world's understanding of charm physics as convenor of the charm subgroup of "HFAG," the Heavy Flavor Averaging Group, which meets weekly.

Advanced Solutions Group

The Advanced Solutions Group (ASG) (www.asg.sc.edu) has just completed a $2.5 million grant with DARPA to investigate potential metrics for describing networks with particular emphasis in metrics that are sensitive to aberrations such as attacks on the internet. This work along with patents and technical papers can be found at www.exasphere.com. It was proved that every possible network topology is isomorphic to the infinitesimal generators of Markov transformations. The resulting metrics utilize (Shannon and Renyi') entropy on the rows and columns, thus having sensitivity to changes in network transmissions into and out of the various nodes. These entropies are expressed as a spectra, which is characteristic of the specific network topology, and the resulting software (in JAVA and Mathematica) is applicable to any type of network such as electrical grids, transportation networks, and financial or social networks. Two associated patents are pending.

ASG is also doing research on a new database system, as well as a new form of game theory that addresses some of the difficulties with standard von Neumann game theory for n-person games and alliances. Patents are pending on both of these areas of work. One patent has just been awarded for a new mathematical foundation for computations with logical and numerical uncertainty, which generalizes Boolean logic and the real number system along with methodologies for dealing with the associated information content (entropy measures). Applications of this work are being studied for measurements in quantum theory. ASG also continues grants and contracts in law enforcement and emergency management as well as developing an extensive new Web-based system for military families to communicate with each other confidentially. The total grant funding of ASG has been about $12 million since 1992. The group is led by Joseph E. Johnson, professor of physics (jjohnson@sc.edu).

Experimental Nuclear Physics Group

In the experimental intermediate energy group, four experimentalists, three postdoctoral research associates, and nine graduate students team up to investigate nuclear matter. Over the past year, the group has also involved seven undergraduate students in various projects—some of them are supported by USC Magellan Scholarships. The group's research program contributes to fundamental questions concerning the role of the strong force in shaping the properties of particles and their interactions. Do exotic particles exist? Do properties of particles change if they are embedded in dense nuclear matter? What do the properties of composite particles teach us about the forces between their constituents? For the group's experiments they employ the multi-GeV photon and electron beams in Halls A and B from the Continuous Electron Beam Accelerator Facility (CEBAF), located at the Thomas Jefferson National Accelerator Facility (Jefferson Lab). The activities concentrate on the in-medium modification of hadronic properties and baryon spectroscopy. In both areas, the group has a strong record of published results, ongoing analyses, upcoming runs, and new proposals in preparation.

The basic structure of particles as three quark or quark-antiquark combinations has remained unchallenged for almost 40 years. In fall 2002, a Japanese research group announced evidence for an exotic particle composed of four quarks and one antiquark. Following this announcement, research groups around the world searched their existing data sets for evidence of this "pentaquark" particle. The CLAS collaboration at Jefferson Lab published possible evidence for the "Theta+" from an experiment that bombarded a deuterium nucleus with high-energy gamma rays. However, at the present time the existence of the Theta+ pentaquark is unclear. Positive signals from the analysis of individual data sets are marginal due to low statistics, yet the null results reported do not rule out the possibility of an exotic S=1 resonance. In response to the unclear experimental situation, USC's experimental intermediate energy group has conducted new experiments with the CLAS detector configured to search for exotic particles. One experiment on deuterium (g10) and the other on hydrogen (g11) improve the signal statistics for the Theta+ by an order of magnitude. Additionally, they are analyzing data from an experiment to search for exotic Cascade particles (eg3). This endeavor will verify and search for further members of the pentaquark family of which the Theta+ is the lowest mass "anti-decuplet" state. These high-statistics experiments will provide reliable results that can be used not only to address the question of the existence of the exotic pentaquark states but also to significantly improve the baryon spectroscopy database.

The group's current picture of nucleons made of quarks interacting by exchanging gluons has been very successful in explaining many experimental results and is also predicting new states of matter at high density and temperatures, namely, the quark-gluon plasma (QGP) and more recently the perfect quark-gluon fluid. Large accelerators, such as RHIC and LHC, have been built to look for the QGP. Preliminary results seem to suggest that the onset of the QGP has been observed, and one of the indicators is the observation of an excess of electron-positron pairs in the mass region of vector mesons (such as the rho meson). The main explanation put forward is the modification of the mass and the width of the vector mesons at high nuclear densities. If this important observation is true, they should see some modifications already occurring at normal nuclear density, in actual nuclei. Results from Japan and Germany seem to indicate that medium modifications are indeed occurring, but both experiments are in need of more statistics to reach a definite conclusion. In their current experiment, the group has measured electron-positron pairs from the decay of the vector mesons. These data provide the most direct and clean experimental test of the assumption of medium modification of vector mesons properties. They have finalized the analysis of their photoproduction data of vector mesons off nuclei (g7) and submitted the results for publication. Their final results contribute to their understanding of the impact of nuclear matter on particle properties.

For decades, nuclear physicists have wondered whether nucleons change their properties when bound inside a nucleus. This possibility was first considered seriously with the discovery of the "nuclear EMC effect"

Nuclear Theory Group

For many years, Fred Myhrer has been investigating the origin of the spin of the nucleon (the proton and nucleon are jointly called the nucleon). The nucleon has spin 1/2. In the simplest picture, a nucleon consists of three quarks, each having spin 1/2, so one may expect that the nucleon spin comes from these three quarks whose spins are cleverly arranged to give total spin 1/2. But a surprising experimental fact is that a large part of the nucleon spin is carried by something other than the quarks, i.e. the famous "nucleon spin crisis," a domain in which Fred is an expert. He has recently come up with a new idea on how to solve this long-standing problem. Another member of the group, Kuniharu Kubodera, is further pushing his calculations on the neutrino-nucleus reaction cross sections. He gave an invited talk, "Quarks, Nuclei and Universe," at the APCTP International Workshop in Korea in November 2006.

some twenty years ago, in which electron scattering from quarks inside a nucleus was discovered to differ significantly from electron scattering on quarks in a free nucleon. Previous data from Jefferson Lab and the Mainz Microtron comparing the properties of protons bound inside the Helium-4 nucleus with those of a free proton (a hydrogen nucleus) provide hints that it may be more economical to describe nuclei in terms of nucleons that differ in size from free nucleons. In fall 2006, the experimental intermediate energy group successfully ran their most recent recoil-polarization experiment at Jefferson Lab in Hall A (E03-104). Their experiment provides them with precise data, which will allow a more detailed study of the knock-out reaction on the bound proton. Preparations for an experiment proposal to extend our measurements in Hall C are underway.

The publication of first (e1-6) results of transition form factors up to four momentum transfers of Q2 = 4 GeV2 for several baryon resonances is under collaboration review and the group is now focusing on the analysis of scaling phenomena, Transition Distribution Amplitudes (TDA), and the resonance search at higher invariant masses. As this is now well underway, they start focusing on the g9-Frost run, which was scheduled to start in October 2007. They are taking advantage of the vast amount of data residing on tape at Jefferson Lab to address open physics questions such as coherent $\phi(1020)$ meson photoproduction (results submitted for publication). Moreover, they are pursuing the development and design of a new addition to the Time-of-Flight spectrometer for the 12 GeV upgrade at Jefferson Lab. The group has taken the sole responsibility for the construction of the new ToF12 detector panel. The 12 GeV upgrade at Jefferson Lab will allow them to push the transition form factor measurements up to Q2 = 12 GeV2 and thus to investigate the transition from constituent quark to partonic degrees of freedom with unprecedented accuracy.

Particle Astrophysics Group

Faculty: Frank T. Avignone, Richard Creswick, Horacio Farach, and Carl Rosenfeld; postdoctoral research associate: Iulian Bandac; Graduate Students: Todd Hossbach, Carlos Martinez, Leila Mizouni, and Seth Newman

Particle astrophysics focuses on phenomena in astrophysics and cosmology associated with the properties of elementary particles ranging from neutrinos to Weakly Interacting Massive Particles (WIMPS), hypothesized as the Cold Dark Matter (CDM). The USC group was early in the field when it made the first terrestrial CDM search. CDM is needed to explain the dynamics of galaxies and certain features of cosmological models used to explain the evolution of the universe. The gravitational effects of CDM on the velocity distribution of stars in spiral galaxies is well established. It was motivated by Fritz Zwicky's discovery in 1933 that far more mass than appears in stars and dust is needed to explain the dynamics of Globular Clusters. In 1985 the USC group, inspired by the astrophysics group at Max Planck Institute in Munich, led the first terrestrial search for the CDM in the Homestake goldmine, with a unique detector developed with the Pacific Northwest National Laboratory (PNNL). This collaboration remains active today. The first experiment was able to eliminate heavy Dirac Neutrinos as the major component of the CDM. These searches have now become popular throughout the world with vast improvements in detector technology.

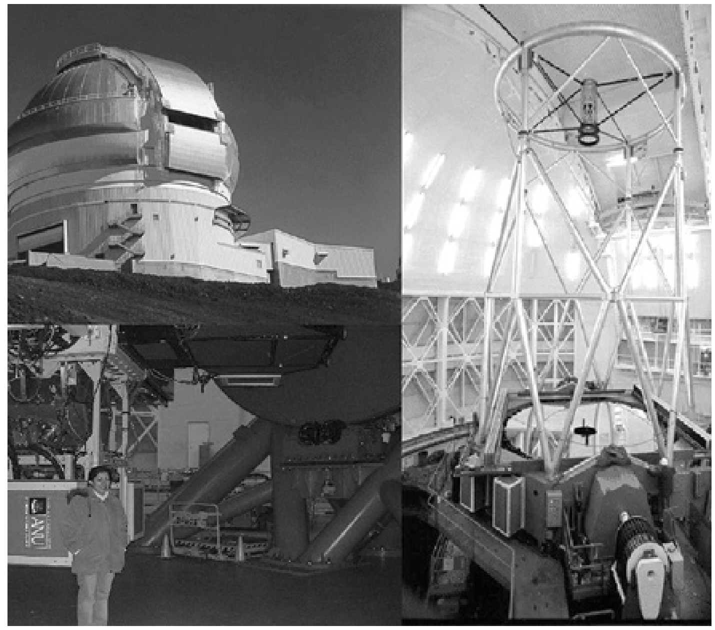
The USC group played a leading role in searches for elementary particles, called axions, emitted by the sun. Axions result in the theory by Roberto Peccei and Helen Quinn that explains why the strong interactions of quantum chromodynamics do not violate charge-parity (C-P) symmetry. The experiment was based on an analysis developed at USC by an international collaboration led by Richard Creswick. It uses the coherent Bragg conversion of axions to photons in single crystals when the line from the detector to the solar core satisfies a Bragg condition. Later, it was used by other groups worldwide.

The USC group now concentrates on two searches for the exotic zero-neutrino nuclear double-beta decay only possible if neutrinos have mass and are their own antiparticles (Majorana particles). It also violates the law of lepton-number conservation. Neutrino oscillation experiments imply that neutrinos may well have enough mass to allow this decay to be measurable, but they can only measure mass differences. The measurement of the decay rate would determine the absolute masses of all three neutrino flavors.

The USC group has been involved in the CUORICINO double-beta decay experiment in the Gran Sasso laboratory in Assergi, Italy, from the beginning. It has now set a lower limit on the half-life for the zero-neutrino double-beta decay of 133Te of . CUORICINO is an array of ~42 kg of TeO_2 cryogenic detectors operating at ~0.008 K. The current effort, however, is in the construction of a 760 kg version called CUORE. The group's main responsibility is the production of the electronic system, led by Carl Rosenfeld. The USC group also played a key role in establishing the Majorana 76Ge double-beta decay project, which will eventually be a one-ton experiment in the U.S. Deep Underground Science Laboratory (DUSL). This experiment is further in the future. All these activities are supported by major grants from the National Science Foundation.

Astronomy Program

Professor Varsha Kulkarni, along with three graduate students, Soheila Gharanfoli, Joseph Meiring, and Lorrie Straka, continued research in extragalactic astronomy and cosmology. Their research uses optical, infrared, ultraviolet, and X-ray facilities, and is funded by the NSF and NASA. The group's research resulted in seven refereed publications and one unrefereed publication within the past academic year. Another submitted paper is currently being refereed, while several more are in preparation. New observations were obtained with the Very Large Telescope (VLT) and the Magellan Clay Telescope in Chile, Gemini-North and Keck telescopes in Hawaii, the Apache Point Observatory (APO) in New Mexico, and the Spitzer Space Telescope. The group's goals are to measure element abundances, sizes, and star formation rates in galaxies producing quasar absorbers and their implications for galaxy evolution over the past ~10 billion years. With VLT and Magellan, they have discovered several quasar absorber galaxies at intermediate redshifts with near-solar or super-solar metallicity, which may help in part to solve the "missing metals puzzle." With Spitzer, the group also made the first detection of silicate absorption from interstellar dust in a distant galaxy.



Pictured is the "Gemini Observatory/AURA;" panel 1, top left: exterior view of the Gemini North telescope, at Mauna Kea, Hawaii panel 2, right: interior view of the Gemini North telescope. The telescope structure with the primary mirror is seen in the picture panel 3, bottom left: Soheila Gharanfoli while observing with Gemini North telescope, January 2007.

Soheila Gharanfoli has nearly completed her Ph.D. thesis work on high-resolution imaging and spectroscopic confirmation of quasar absorber galaxies. Joseph Meiring is well on his way to completing his Ph.D. thesis on element abundances in the absorbers. Lorrie Straka is working on emission-line imaging of galaxies in quasar fields. Four conference presentations were given by Professor Kulkarni and Joseph Meiring at the "At the Edge of the Universe" meeting in Sintra, Portugal, in October 2006, at the Meeting of Astronomers in South Carolina in Greenville in April 2007, and at the American Astronomical Society meeting in Honolulu in May 2007. Professor Kulkarni also gave eight invited seminars/colloquia at various institutions. Among other news, in April 2007, Professor Kulkarni hosted a visit to USC by Professor John Huchra, President Elect of the American Astronomical Society and Doyle Professor of Cosmology at Harvard University. Professor Huchra gave the Harlow Shapley public lecture on "The State of the Universe" that attracted a large audience.

Pictured are the twin 6.5 meter diameter Magellan I and Magellan II optical telescopes at the Las Campanas Observatory in Chile. Situated on the peak of Cerro Manqui, 7,600 feet above sea level, in the southern reaches of Chile's Atacama desert, the Magellan telescopes are among the world's ten largest optical telescopes. Professor Varsha Kulkarni and graduate student Joseph Meiring are carrying out observations of quasars with the Magellan Inamori Kyocera Echelle (MIKE) spectograph on the Magellan II telescope (seen on the left), also known as the Landon Clay telescope.

New Parents in 2007

Graduate student Baowei Liu and his wife, Alin Yang, gave birth to a baby girl, Caroline Liu (nickname at home is Cari—they have not picked a Chinese name for her yet because it's been a hard decision), on July 24, 2007, at 9:29 a.m. at Palmetto Health Richland Hospital in Columbia, S.C.; she weighed 7 pounds, 10.2 ounces, and her height was 21 inches. Baowei and Alin said, "So far Cari is nice to her parents. She sleeps much longer than we expected, and maybe we should not have been surprised with this because both of us are sleepers. She sleeps from 1 a.m. to 5 a.m., which makes Alin and myself very happy!"

Neil A. Jacobs, Ph.D.

Chief Atmospheric Scientist, AirDat LLC

Well, since you asked ... In 1994, I cut the tip of my finger off on the 4th floor while greasing a bike chain. The blood down the hall and in the elevator was mine. I denied that for years. I took an incomplete in PHYS 509 due to a bike wreck, and spent the summer making it up. My lease on Blossom Street ran out May 1, so I slept in a 2nd-floor lab storage room on a piece of foam and took showers at the gym for two months. The water on the lab floor was not from a pipe leak. I got carried away with Dave Frost (fellow USC physics grad) while spraying water from a sink hose in the dark and visually isolating the droplets with an adjustable strobe light. Two of my roommates used a 4-track to record some songs in the sound-proof room at night ... and the whole SPS club used to play laser tag in PSC at night. Wow, just like confessional! I feel so much better!

My life after USC physics:
It has been a really long time, but I was a physics major there from 1992 to 1997, and president of the SPS 1994 to 1996. I used to be the lab set-up guy that worked with Robert Sproul.

Well, here is the super-summarized version.... I went to North Carolina State University (NCSU) for an M.S. in air-sea interaction with a focus on atmospheric boundary layer and surface thermodynamics. I graduated in 2000 and decided to stay for a Ph.D. in atmospheric physics. My research involved mesoscale and microscale dynamics, numerical weather prediction, and modeling of surface flux relations and boundary layer dynamics as a function of enhanced thermal gradient grid resolution. I received a Ph.D. for this work in 2005.

I currently work at a place called AirDat in North Carolina not far from NCSU. It is pretty much a glorified postdoc with a private sector company, which is partially funded through NOAA, NASA, and the FAA. We have developed a new technology called TAMDAR. It is a sensor that mounts on commercial airlines and collects atmospheric data (including water vapor) among other parameters. The data supplements RAOBs in space and time. We have been collecting the data and testing it with NCAR and GSD/FSL for the last 2 years. By the end of 2007, we will have more than 425 planes equipped, which will provide about 5,000 daily soundings. Below are links to a recent AP video and story. I oversee experiments on how the data is assimilated into the models. Even though it is a private company, I still get to write papers, so it is good for my career. I would like to end up at a university somewhere because my true love is teaching. I do adjunct a few classes at NCSU and Meredith College, which is fun.

http://video.ap.org/v/en-ap/fv/fv.htm?f=PAPHQ&g=8590C80B-AA67-4053-A8C6-9783B0457216&p=&t=s78
www.wired.com/news/wireservice/0,72030-0.html?tw=rss.index

On a nonschool note ... I got married two years ago. My wife (Jennifer Modliszewski) is in the chapter-writing phase of a Ph.D. in plant genetics at Duke, which is about the extent of my understanding of what she does. I still race bicycles and run a lot. I keep in touch with Dave Frost. He is married and lives in North Carolina also. He had a bout with cancer, but is in the clear now. I haven't been to Columbia in a while, but I hope all is well there.

Chase Boulware with a statue of Max Planck that used to be where he worked but is now in front of the Humboldt University in downtown Berlin

Chase Boulware

postdoc in Berlin, Germany for DESY

Chase Boulware received his B.S. in Physics in 1999 from the University of South Carolina, and was a member of the Honors College. This year, Chase received his Ph.D. in physics from Vanderbilt, where he also received a master's in 2004. Chase writes, "My advisor there was Professor Charles A. Brau, and my dissertation was on needle photocathodes for a table-top free-electron laser. The laser never worked, but we published several papers on the theory of the Smith-Purcell free-electron laser, and my thesis contains that and the work on the photocathode development. I learned through my advisor about my current postdoc in Berlin, Germany. I am working for DESY at the photoinjector test facility in Zeuthen, a small town just outside Berlin. We are testing low emittance cesium telluride photocathode guns for the European X-ray FEL to be built at DESY in Hamburg. I married Sarynna Lopez Meza in December 2004. I met her while we were both graduate students at Vanderbilt. Our 'European experience' has been really rewarding, as we are traveling a lot and learning about Germany and Europe in general. Unfortunately, the German language has been coming along slowly, but we are working on that, too. Being far away has its difficulties, too, of course. I have a newfound appreciation and respect for all the great people I know in the United States who are visiting or have moved from another country. Physics is a particularly international venture, isn't it? I feel very much a part of that these days. The picture shown is of me with a statue of Max Planck that used to be where I work but is now in front of the Humboldt University in downtown Berlin."

Dean Mary Anne Fitzpatrick, College of Arts and Sciences, and Sam Finklea

Samuel L. Finklea III

Outstanding Graduate Alumnus Award

Samuel L. Finklea III, a Columbia native, graduated from Duke University. He then obtained his M.S. and Ph.D. in solid state physics from the University of South Carolina's physics department. He was active as a teaching assistant, a member of the physics graduate student organization, and an avid fan of Coach Frank McGuire's basketball teams.

Finklea began his career in the Department of Health and Environmental Control's Bureau of Radiological Health. As a member of the Conference of Radiation Control Program Directors (CRCPD), he received the CRCPD Board of Directors Award for Outstanding Achievement in the Field of Radiation Protection, and he continues to serve on national committees as an emeritus member.

While at the bureau, he received his J.D. from the USC School of Law and was inducted into to the Order of the Coif. He then took a position in DHEC's Office of General Counsel, concentrating on environmental quality control. He has received the highest Peer Review rating recognized by Martindale-Hubbell. He is an accomplished editor and author and has also taught environmental law at the USC School of Law. Finklea currently represents DHEC's Office of Public Health Preparedness in the State Law Enforcement Division's South Carolina Information Exchange Fusion Center where he coordinates DHEC's contributions to the center's counterterrorism mission.

After more than 34 years in the South Carolina Air National Guard and Air Force Reserve, Finklea retired as a colonel. He is active in the Air Force Association and twice received the Exceptional Service Award from the group's S.C. chapter. He chairs the Tax and Finance Committee of the National Guard Association of South Carolina and received its Distinguished Service Award.

He still has the slide rule he used in the 1960s and remains a scientist at heart, quick to whip out his calculator (a habit that annoyed his engineer clients but which he considered a fair trade for their expression of legal opinions). He is a graduate of Leadership South Carolina, a member of the USC College of Arts and Science Alumni Council, a sailor, a self-taught student of Spanish, the despair of his piano teacher, and a gentleman farmer.

Faculty

James Knight received the Excellence in Teaching award for 2006–2007 from USC's Alpha Chapter of Mortar Board.

David Tedeschi received the 2007 Michael J. Mungo Undergraduate Teaching award.

Joseph Johnson received the "You Light Up USC" award from the ALD Honor Society.

Graduate Students

Roger Crazy Wolf received the Graduate Student Teaching award for 2006–2007.

Nathan Baltzell and **Karen Wu** received the Graduate Student Research award for 2006–2007.

Undergraduate Students

Mary Kathryn Keane is a Fulbright Scholarship award winner for 2006–2007.

2007 Arts and Sciences Alumni Award Winners

Dr. Samuel L. Finklea III
Thomas Strange

Thomas Strange

Distinguished Alumnus Achievement Award

Dean Mary Anne Fitzpatrick, College of Arts and Sciences, and Thomas Strange

Thomas Strange has an extensive background in materials science and is the author of 34 patents and numerous papers over the last two decades, covering all aspects of capacitor development, with an emphasis on foil development for aluminum electrolytics. Following his undergraduate degree in physics at the University of South Carolina, he joined Philips Components as a member of the research staff.

During his 15 years with Philips Components in Columbia, S.C.; two years with Acrovox Inc. in Huntsville, Ala.; and a decade at St. Jude Medical in Pickens, S.C., he participated in or led the research activity involving development of electrochemical and AC film capacitors, and the development of the first medical-grade flat capacitor for implantable defibrillators. He was named creative innovator of the year for North American Philips Corporation in 1985.

In 1998, Strange was the recipient of the St. Jude Medical Hendrickson Award for his work on development of flat capacitors. On Nov. 6, 2001, he and his research team were awarded the 2001 InnoVision Award for technology development in the upstate of South Carolina. In 2002, Strange was appointed economic ambassador for Pickens County by Governor Jim Hodges. He also serves on the board of directors for the Pickens Chapter of the American Red Cross, Pickens County Health Partners, South Carolina Research Authority, Clemson Advanced Research and Development Institute, InnoVision Technology Awards, and Greenville Museum of Art.

Alumni/Friend of the Month—November 2006

The College of Arts and Sciences selected **Dr. and Mrs. Kuniharu Kubodera** as the friends of the month for November 2006. The Kuboderas have supported the College of Arts and Sciences, in particular the Department of Physics and Astronomy, consistently for the past 15 years. They have given at a level that qualifies them for the Horseshoe Society. To date, there are more than 400 members of the Horseshoe Society, an elite group of people who know the significance of private support. Dr. Kubodera has stated, "It is only natural that we would support the University."

Dr. Kuniharu Kubodera received his Ph.D. from the University of Tokyo in 1970 and has been a faculty member in the USC Department of Physics and Astronomy since 1989. His research interests are theoretical nuclear physics and nuclear astrophysics. In 2003, Dr. Kubodera was awarded the Russell Research Award for his work in neutrino physics. He is also a fellow of the American Physical Society. In honor of Dr. Kubodera's 60th birthday in 2004, many world experts on nuclear and hadronic physics gathered at the KEK Workshop on Nuclear Chiral Dynamics to pay tribute to him. This international conference was held at the High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan. Nuclear chiral dynamics is one of several fields in which Dr. Kubodera's contributions are particularly famous.

On a personal note, Dr. Kubodera and his wife are dedicated ballroom dancers, participating in competitions and performing exhibitions. Dr. Kubodera is also an avid butterfly collector. Mrs. Barbara Kubodera joined the USC faculty in the English Programs for Internationals (EPI) program in 1990. EPI faculty members are qualified teachers of English as a second language with considerable training and experience. Mrs. Kubodera, a testing coordinator with EPI, has the following degrees and certifications: Juris Doctorate, Master of Arts, and Teacher of English as a Foreign Language. She is a specialist in oral communication, grammar instruction, and testing. The Kuboderas selflessly give not only money, but their time as well. Over the years, they have adopted foreign exchange students who have needed a helping hand while in America. They know the difficulties people face for the first time when coming to America. For their generosity and contributions to the College of Arts and Sciences, USC, and the overall community, the College of Arts and Sciences was very pleased to announce Dr. and Mrs. Kuniharu Kubodera as Friends of the Month.

Retirement of John M. Palms, Distinguished President Emeritus

By Frank T. Avignone III

Dr. John Palms retired from the Department of Physics and Astronomy at the end of the academic year of 2006–2007 after a long and distinguished academic career. His record from 1966 until 2007 was filled with outstanding accomplishments as a teacher, research physicist, and administrator. He stepped down as president of the University in 2002 and continued as distinguished professor of physics until his retirement this year as distinguished professor emeritus.

Born in the Netherlands, Dr. Palms came to the United States at the age of 16. He graduated from The Citadel as Distinguished ROTC Graduate in 1958 with a B.S. in physics. Dr. Palms obtained his M.S. degree from Emory University in 1959 and served as an officer in the U.S. Air Force from 1958 until 1962. While serving as a scientific officer, Dr. Palms became involved in research in nuclear physics at the Los Alamos National Laboratory (LANL). From 1962 until 1966 he was a staff member at LANL; he then received his Ph.D. from the University of New Mexico. Dr. Palms was one of the pioneers of the now-famous germanium gamma ray detectors in common use in many venues from physics laboratories to hospitals.

Dr. Palms's first academic experience was as a professor at the U.S. Air Force Academy during the academic year of 1961–1962. In 1966 he joined the physics faculty at Emory University and in 1969 became chair of the department. Dr. Palms served as dean of the College of Science and Mathematics from 1974 until 1980 and in several vice president positions until 1982, when he became vice president of academic affairs, a position he held until 1988, when he stepped down and was appointed Charles Howard Chandler Professor of Physics. In his unique style, Dr. Palms stepped down from every administrative position before becoming a candidate for a higher one.

All of the time Dr. Palms was on the faculty of Emory University, he was the leader of one of the best experimental inner-shell atomic physics groups. From the mid 1960s the group of Palms, Rao, and Wood made some of the most precise measurements of Auger probabilities, X-ray sub-shell emission ratios, and Koester-Kroenig yields. While this research is very fundamental, Dr. Palms applied the same techniques to environmental radioactivity measurements, becoming one of the nation's best recognized experts. As one example, he led the evaluation of the environmental aftereffects of the Three Mile Island reactor melt down and led the writing of the final report.

Dr. Palms has received too many honors to list here, but among them were: The Thomas Jefferson Award, the highest award for leadership and service at Emory University; The Richard A. Rempel Faculty Award by USC Student Government; The James F. Zimmerman Outstanding Alumni Award from the University of New Mexico; The Radiation Protection Professional of the Year Award (2001); The First Abbay Mepkin Wisdom Award in 2004; and The Ambassador K. Kerry Dornbush Award of the Netherlands-America Foundation. He holds honorary doctoral degrees from the University of South Carolina and The Citadel.

Naturally, such a distinguished academic is frequently called on as an advisor to government. John Palms was no exception. Since 1988, he has served on the Board of Trustees of the Institute for Defense Analysis and as its chair since 2002. He served on the Defense Science Summer Study Task Force, the Environmental Protection Agency Panel for the Review of Computerized Radiological Risk Investigation, the Federal Advisory Commission on the Consolidation and Conversion of Defense Research and Development Laboratories, the Oak Ridge National Laboratory Health and Safety Research Division Advisory Committee to the Director, the National Academy of Science Panel on Semiconductor Detectors, and the President's Commission on White House Fellowships.

Despite all of his honors, awards, and positions in high places, John Palms has always been down to earth, humble, and approachable. When he was being interviewed for the presidency, he would naturally be tenured as professor of physics. I was the chair of the department at that time(April 1991), and the interim president, Arthur Smith, told me to see to it that Dr. Palms would be tenured in physics. Dr. Palms took the phone and spoke very clearly, "Frank," he said, "we have been friends and colleagues since 1966. I want to go through the entire tenure process as would any other full professor you would hire from outside." That is his style. No special treatment. I obtained a copy of his CV and circulated it to the full professors in the department. I called a faculty meeting; we deliberated and voted unanimously to grant tenure. What an opportunity, a physicist as president, and one who would have qualified for tenure in any case.

I worked very closely with Dr. Palms in the middle 1990s, when he supported my coordination of a $10 million multi-departmental proposal for a Department of Defense grant that allowed the University to complete the construction of the Graduate Research Center. There were risks involved, and he showed courage and vision in supporting what some called a foolish gamble. The University won, as it did so many times during his tenure as president.

Dr. Palms and his wife, Norma Lee, reside on the Isle of Palms; their home is marked by a plaque that says "Villa Palms," one we had made in Jaca, Spain, when we traveled there together to visit the experimental site in Canfranc, where my students and I worked for almost a decade. He continues to serve on several boards, and he and Norma Lee surround themselves with their many grandchildren every opportunity they have. They had a significant and lasting impact on the University and have a legacy that will not be forgotten.

Pictured on the far left is Jeff Wilson, instructing middle school teachers.

A Physics Phenomenon for Middle School Teachers

For the past three summers, Professor Jeff Wilson has instructed middle school teachers in the finer points of work and energy, using simple machines as concrete examples. The teachers are introduced to physics in a "phenomenon first" environment, basically by seeing a principle of physics at work before attempting to explain it. They are given an example of a simple machine, and they use the scientific method to gather data and use the data to explain how the machine works. Undergraduate physics students would recognize the activities as being based on some of the classic physics demos—inclined planes, levers, and pulleys. A strange feature of this teaching method is that when it works well, the students are very engaged in the activity and the instructor may seem to be unnecessary.

The Summer Institute is a multidisciplinary endeavor involving Christine Lotter from the College of Education, Bob Feller from the Center for Science Education, Dave Barbeau from geology, and Jeff Wilson from physics. The institute was started by Jon Singer of the College of Education in order to give middle school teachers the content knowledge necessary to teach the science topics required by South Carolina. One very important feature is that it is integrated with a local middle school's summer program and uses real middle school students as subjects. The Summer Institute manages to be an enrichment program on many levels.

The BIG "R"

By Ronald D. Edge

What do you do after you retire? Boredom! Well, I found that I was busier after retiring than before. There were all those things that I wanted to do but never had time. The big advantage was that I did not have to attend faculty meetings. No more of those tedious debates about insignificant events. Why are faculty meetings so contentious?... Because the stakes are so small.

Anyway, I had always wanted to spend more time on my hobby, church bell ringing. You might wonder what the connection is between bell ringing and physics, but apart from the motion of the bells themselves, about which there is quite a lot of engineering and mathematics, and the acoustics—my friend Tom Rossing has written books about that (he was originally into drum acoustics, but has lovely laser interference pictures of bells and ancient Chinese gongs sounding)—there is the theory of the changes themselves. Church bells weigh tons, and ringing by rope without hanging yourself is quite a skill. In physics, we know Galileo showed the period was constant—but only for small oscillations. Ringers swing the bell through 360 degrees, upside down to upside down. The solution to this motion is an elliptic integral. Even in practice, it is difficult to change the period much. In ringing, the bells strike sequentially, with eight bells in an octave, one ringer per bell. They can be shifted one place at a time, each time they ring, so we might move from 12345678 to 21436587. This is called a "change." There are factorial seven changes on seven bells, 5040, and a peal consists of ringing all of these without mistake. It takes about three hours, and there are still problems existing in peal construction. Only recently has a peal of Stedman (a principle of ringing) been constructed without "singles" (which change the permutations from odd to even) by a ringing friend of mine employing a powerful IBM computer. When I immigrated here, there were no bells south of Boston. Now there are more than a dozen rings—two in Washington, D.C., itself (the bells of the cathedral are the highest point in Washington, and the bells in the Old Post Office Tower on the Mall were a bicentennial gift from England), and four in Charleston—starting with St. Michael's, where the bells had not been rung for well over a hundred years (after the war between the states). Many peals have been rung in Charleston since the bells were rehung. I found most of the ringers at the old North Church in Boston (Paul Revere rang there) are women physics students from MIT. New York City received its first ring of bells (Trinity Church on Wall street) a couple of months ago.

Retirement gives the ability to delve into problems with no financial support. I had always been interested in the physics of surfing, but no federal agency would give you a grant to go off to Hawaii to investigate it. I wrote the first physics article on surfing for the Physics Teacher, and there was quite a lot of interest. My last article was on the downdraft from a helicopter.

Updates From the Director of Undergraduate Studies

Gary S. Blanpied

We have continued developing meaningful capstone experiences for our physics majors by acquiring significant equipment for our 500-level laboratories. Professor Ralf Gothe was able to get companies to donate detectors and electronics valued at more than $75,000. However, we found that our antiquated power supplies were not up to the task. We have obtained college funds to order power supplies and other equipment for the nuclear and particle physics lab this spring (PHYS 511). All of the equipment for the condensed matter course (PHYS 512) has arrived in time, and the laboratory has been upgraded by Professor Thomas Crawford. A large group of undergraduate and graduate students will benefit from the state-of-the-art equipment.

We have a large demand from students for an advanced laboratory-based optics course (PHYS 514) but haven't been able to offer it because of a lack of laboratory equipment. We have some funds to buy some equipment and will ask for additional college funds for a pulsed laser in 2008.

Two of our recent faculty hires in condensed matter physics, who are also associated with the Nanocenter (Crittenden and Bazaliy), have a strong interest in biophysics. This will hopefully give us an opportunity to develop a biophysics track. It would require more large equipment for a lab, and this may be what we push for in 2009.

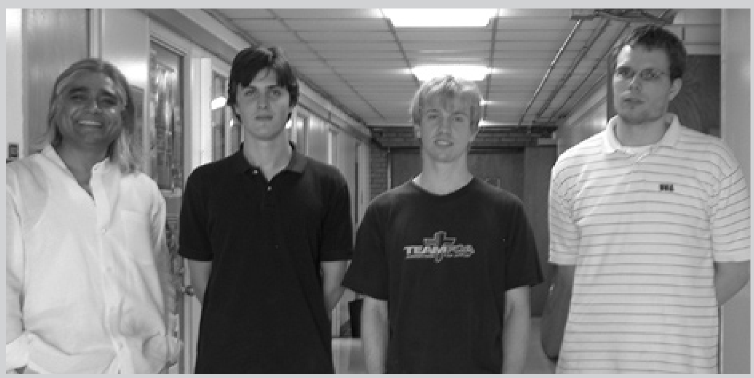
Our BS production has been suffering from low enrollments, but it's gradually rising. In 2006, we had two students graduate with a BS in physics. This year, we will have eight graduates, including two female students. Ten additional students are expected to graduate in May 2008. Congratulations to Jon Stenbeck and Abe Pernicka (May 2006); Ben Coates, Mary K. Keane, Jordan Meredith, and James Stapleton (May 2007); Eugenia Senn (August 2007); and Forrest Clark, Brandon Eubanks, and Luay Hammami (December 2007). Jon and Abe are currently in our own graduate program; Jordan went into flight school with the U.S. Marines; Mary K. Keane has a Fulbright Grant to teach English in Spain and is applying to medical schools; James is in the physics graduate program at Ohio State University; Eugenia is pursuing religious studies in graduate school; and Ben is working in Raleigh for Aprimo and wants to eventually become a patent lawyer.

Magellan Scholars

The Magellan Scholar program (www.sc.edu/our/magellan.shtml) was created to enrich the academic experience of Carolina's undergraduates through research opportunities in all disciplines, from science, technology, and medicine to theatre, music, and art. By providing access to faculty mentoring relationships and a professional research experience, this program enables students to creatively explore their interests at a more in-depth level than can be attained in the classroom. The Magellan Scholar program provides opportunities for undergraduates to build a competitive edge in the job market.

Jonathan DeGange is a junior. He is majoring in chemistry with a minor in mathematics, and he wants to attend graduate school in nuclear engineering. Jon met Professor Steffen Strauch at church, where he plays the piano. He would spend time after church discussing physics over dinners with Strauch. Wanting to get involved, he asked Strauch if there was anything that he could do. Professor Strauch mentioned the Magellan Scholarship and a correlating project to study the

see Magellan, pg. 18



Left to right: Professor Sanjib Mishra, Drew Dimmery, Kevin Ludwick, and Matthew Seaton

Left to right: Professor Steffen Strauch and Jonathan DeGange

Pictured is Lewis Graham visiting the Sacsayhuaman ruins outside of Cusco; they have Peruvians waiting with llamas so you can have your picture taken with them.

Seventh Latin American Symposium on Nuclear Physics and Applications

By Michael Paolone

After a long trip of sleeping uncomfortably on a transcontinental flight and again on benches in the Lima airport, our USC physics graduate student envoy (consisting of Nathan Baltzell, Lewis Graham, and myself), sent to Cusco, Peru, to attend the 7th Latin American Symposium on Nuclear Physics and Applications, finally arrived at our destination city. First impressions were that of a rich Incan culture, with architectural influences in the construction of the airport and even performers singing and dancing in the lobby. Once we left by shuttle to reach our hotel, the scenery changed to the narrow, dirty streets of a third-world country. Central Cusco was built directly over the old Incan capital, and many of the stones that the Incans carved for their roads and walls still stand functional today in Cusco. This gave a mystic quality to the city, seemingly stuck between the ancient and modern world. In noticeable contrast to the prevailing Incan architecture, many old European Spanish-style churches towered from squares and parks throughout the city.

On our second day in Peru, we attended the first session of the weeklong symposium. The conference was similar to ones I've attended in the States. It was held at the local university with roughly 100 attendees, plenary sessions in the mornings, and parallel sessions in the afternoons. The topics covered most of modern nuclear physics, from computational lattice QCD to excited baryon states, neutron detection, and string theory. All three of us presented our research mid-week, and each talk was in turn well-received. The conference also gave us a chance to talk to graduate students from South America who would, in general, freely share their perspectives on international physics, politics, and culture.

In addition to the conference, we were able to visit many Incan ruins and museums, plus walk in a parade during the "Celebration of Cusco," which was conveniently taking place the week of our stay. Visiting the various ruins was especially interesting. We went to Sacsayhuaman, which was an Incan fort just outside Cusco, and Machu Picchu, one of the new seven wonders of the world. To get to Machu Picchu from Cusco required a half-day bus/train ride into the virtually untouched Peruvian wilderness. The Incan city was built atop a mountain and left untouched by the European world from

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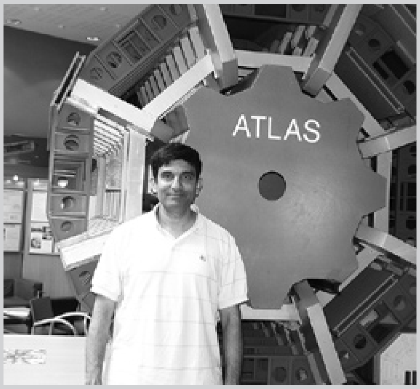
How I Spent My Sabbatical

By Milind V. Purohit



Milind Purohit with a scale model of the ATLAS detector

During 2006, I was lucky enough to get the fall semester off from teaching in order to focus on a new experiment. Anyone who keeps up with science news knows that there is a big accelerator being built in Europe called the Large Hadron Collider at CERN, near Geneva in Switzerland. The promise is mind-boggling: we could produce black holes in the lab! We could enter extra dimensions! Or discover the famed gravitons, carriers of the gravitational force! We might stumble across dark matter! Discover Supersymmetry! The allure of this physics is irresistible. I couldn't imagine doing anything better.

The experiment called ATLAS, which I wished to join, already has roughly 3,000 physics collaborators. How does one join such a large collaboration? How do we form a team that contributes effectively to this project? What are the obstacles we might face? These were the questions uppermost in my mind as I bravely (foolishly?) ventured to CERN to see the lab and detector for myself and find out how South Carolina could best contribute and participate in this ground-breaking science project.

The location of CERN couldn't be beat. It is just minutes from the international airport, even closer to the airport than Fermilab is to O'Hare, so a physicist can spend all of his/her time at the lab and skip the Alps. Geneva itself is a relatively small city, with only banking and the UN headquarters to keep it from being completely obscure, and has no allure over the countryside around CERN. But lurking beneath the farmland is a giant excavated ring, 27 km in circumference and tilted at four degrees to the horizontal. The experiment, ATLAS, is closest to the main CERN site, while other experiments dot the ring at various locations in France and Switzerland.

We are now working on finding and using muons in ATLAS. After getting used to things, I am writing software that is being used to study "muon performance," meaning distinguishing real muons reconstructed in the detector from fake ones. Our postdoc, Woochun Park, is studying the behavior and reconstruction of muons using "CSCs," the cathode strip chambers used to detect the very highest energy muons on ATLAS. He is now training our new graduate student, Arjun Trivedi, in the ways of ATLAS and muons.

Getting back to my visit to CERN, I found that it was a success. We are now a part of this experiment, with its mammoth and complex detector and thousands of collaborators, and will soon see beam. That is the moment of truth we await now: Will the CSCs work well? Will we find muons with no problems? More importantly, where is the Higgs? And Supersymmetry? And all that other particle candy that theorists have promised us? Time will tell, and I can't wait!

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Instrumental Asymmetries in the Focal-Plane Polarimeter. Jon jumped at this wonderful opportunity. He attended the 2007 Annual Meeting of the Division of Nuclear Physics of the American Physical Society from October 10–13, 2007, in Newport News, Va., where he presented his poster in the CEU (conference experience for undergraduate students) Poster Session.

Matthew Seaton is a junior who has been working with Professor Sanjib Mishra in the Neutrino Group since January 2006. He has led the analysis of the Neutrino Neutral-Current induced Coherent and Single Neutral-Pion production. Matt has produced the first signal of Eta-production in neutrino interactions, and his is the most precise determination of photon content of neutral- and charged-current interactions, a measurement of crucial importance for future neutrino oscillation experiments. Matt is going to be the lead author on the publication of these three results.

Kevin Ludwick is a senior. He joined the Neutrino Group in November 2005. Kevin has been working on the MIPP project with Professors Sanjib Mishra and Carl Rosenfeld. His research focus is on the strange hadron production in hadron-nucleus collision. Kevin has succeeded in producing a distinct signal for strange meson, called K-short, in MIPP. This result will affect the precision of the electron-neutrino appearance search via oscillation in the MiniBoonE and MINOS projects.

Drew Dimmery is a sophomore. He joined Professor Sanjib Mishra's group in November 2006. Working with Matt Seaton, Drew has significantly contributed to the coherent and single neutral-pion production. The research is being written up for publication in Physics Letter B.

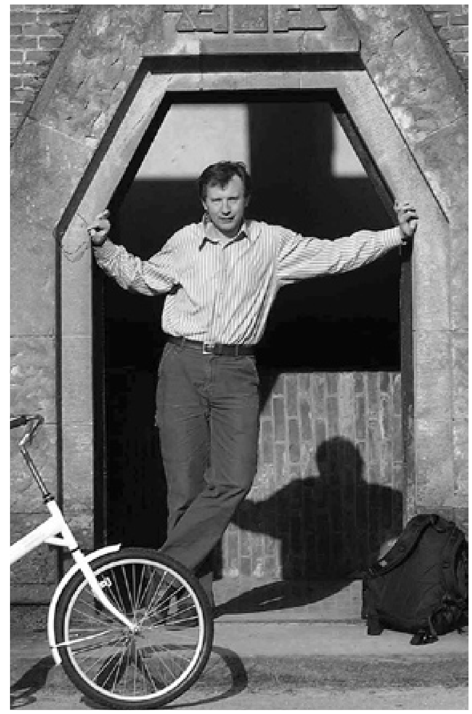
One Year as a Visiting Professor in the Netherlands

By Yaroslav Baziliy

Since I joined the department in 2006, I spent the academic year as a visiting professor at Leiden University in the Netherlands. This European country has a long and impressive tradition of research in physics. It is enough to say that Lorentz of "Lorentz transformation" worked at Leiden (and his name is presently recognized by a majority of Dutch people), and Kamerling Onnes obtained first liquid helium and discovered superconductivity in the Leiden downtown building which now bears his name. The city even has a popular bar founded a long time ago by physics graduate students. The place still maintains a special connection to the physics department: you can find copies of current Ph.D. thesis works among the glossy magazines on the stand.

In the beginning of the 21st century, condensed matter physics in Holland is still outstanding. The amount of world-renowned groups from this small country is large and growing. This success seems to come from the openness of Dutch society and the traditions of collaboration with scientists from other countries. For example, Leiden University supports the Lorentz Center. This program hosts dozens of workshops that attract the world's best physicists to the university, each spending weeks working with local groups. It is hard to overestimate the influence of the Lorentz Center on undergraduate and graduate students in physics. Holland is a small country with many physics centers distributed all over it. Due to relatively short distances, scientists meet regularly to discuss their research and maintain good communication. I found this experience very encouraging as a model for interactions between different universities here in South Carolina.

My own research in Holland was conducted at the Lorentz Institute (the theory division of the physics department at Leiden) and dealt with the new material called "graphene." Graphene is the two-dimensional form of graphite contemplated for a long time but synthesized only a few years ago in the UK (incidentally, by a group that moved there from the Netherlands). As it happened before with other new forms of carbon, graphene proved to be a fascinating object. The mobility of electrons in this conducting sheet remains extremely high, even at room temperatures, and one can easily observe a number of effects that were previously possible only in ultra-cold environments. This fact alone makes graphene a material of choice for many industrial and metrology applications. The physics of graphene is a rapidly growing field, and I hope to bring a taste of it back to Carolina.



Yaroslaw Bazaliy in the old center of Leiden near the Kamerlingh-Oness Laboratory building, where liquid helium was first produced in 1908. In the Netherlands, bikes are the most popular type of transportation, and they come in all styles, colors, and sizes.

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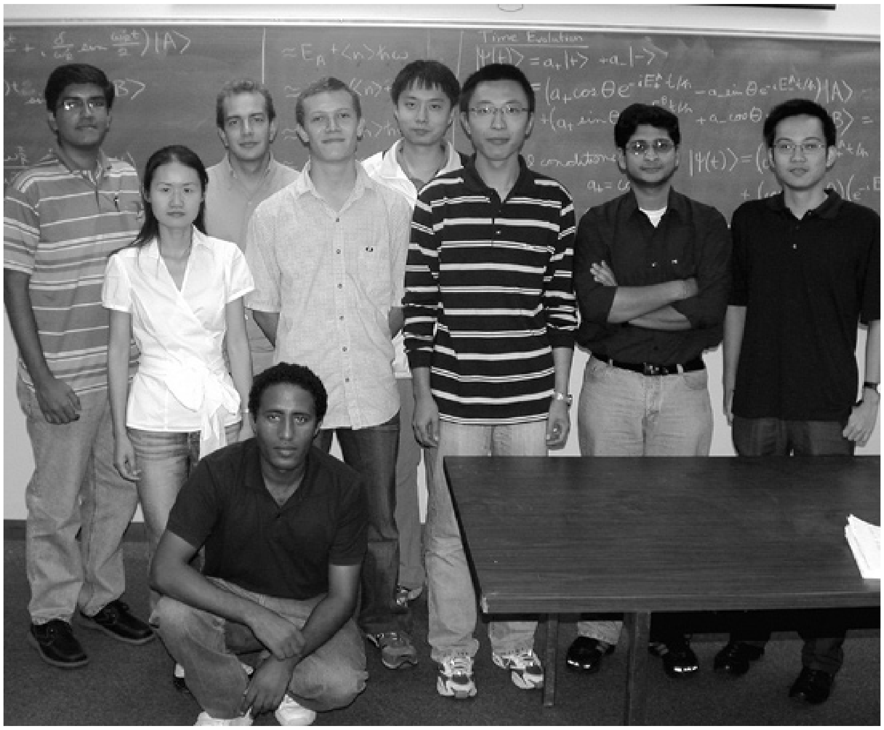
the 15th to the 19th centuries. The view from the city was amazing, and the site was incredibly well-preserved. We left near nightfall, and the combination of the new moon, unlit countryside, and high altitude made the Southern Cross and Milky Way stunningly visible. All in all, I don't think any of us were quite ready to leave Peru when our weeklong stay came to an end, and we were again restlessly fighting an airline seat for a little sleep on the long flight home.

Left to right: Lewis Graham, Nathan Baltzell, and Michael Paolone, at the entrance of Macchu Picchu and getting ready to board buses to ride up the mountain to the entrance of the trail

Updates From the Director of Graduate Studies

Our graduate program remains strong and presently totals 47 students with the addition of ten new students this academic year. Our research efforts continue to grow, with 25 students participating in projects supported by federal grants or fellowships. I would like to extend a special thank you to visiting Research Assistant Professor Alonso Botero, from Universidad de Los Andes, Bogota, Colombia. Dr. Botero has helped attract many outstanding young scientists from South America to our program. Presently studying with us are Alejandro Ferrero, Carlos Martinez, Vladimir Montealegre, Andres Sanabria, and Inti Sodemann. We look forward to continuing our collaboration with the Universidad de Los Andes.



Left to right (back row): Shakil Mohammed, Alejandro Ferrero, and Jing Yang; (middle row): Yunjin Wang, Inti Sodemann, Yuquig Mao, Debopam Som, and Bochen Zhong; (bottom row): Wondessen Tassew Gebreamlak; not pictured: Eric Graham

Quantum Leap

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