

Schrödinger's Tiger



The Clemson University Physics and Astronomy Newsletter

Spring 2008

Volume 2, Issue 2

Prestigious NSF Career Award Goes to Dr. Pu-Chun Ke

- Dr. Pu-Chun Ke & NSF Career Award
- Chairman's Message
- Properties of Small Carbon Structures
- Important Reminder
- The Science Cafe
- Physics & Astronomy Welcomes Dr. Jian He
- Drs. Manson & Larcom to Retire
- Dr. Meredith Newby & Italian Program
- Dr. Terry Tritt Wins Governor's Award
- Astronomy Students View Lunar Eclipse
- Students in the News...
- Physics Students Travel to Washington, D.C.
- Clemson Students See the Stars
- Department News

Dr. Pu-Chun Ke is one of this year's recipients of the prestigious Career Award from the National Science Foundation (NSF). The title of this award is "Understanding Carbon Nanoassembly in Biological and Environmental Systems", and it will provide \$400,000 towards his research program for the next five years.

Dr. Ke has been a professor of biophysics at Clemson since 2003. Much of his career research focus has been on biophysics, materials, and physical chemistry. His lab at Clemson is the "Laboratory of Single-Molecule Biophysics and Polymer Physics" and currently has four graduate students and two undergraduate members. Ke first demonstrated RNA delivery using nanotubes, provided the first theoretical study of nanotoxicity, and was the first to discover the food chain transfer of nanomaterials. Since joining Clemson Dr. Ke has authored eighteen high-impact journal papers, as well as two book chapters, three review articles, twenty-two conference papers, as well as holding two international patents. Moreover, he consistently receives superb evaluations by the students whom he has taught.

Ke's research profile was recently featured on the website www.Nature.com. Of additional note, the website "Live Science" highlighted Dr. Ke's group's image of the uptake of nanowires by daphnia. Daphnia are water fleas and are aquatic organisms often used for toxicity tests. This image won the group a semifinalist honor at the 2007 International Science & Engineering Visualization Challenge, sponsored by NSF and *Science Magazine*. A finalist honor was given to Dr. Ke's group in the 2006 competition



Dr. Pu-Chun Ke

for another image called the "Curious Eye".

His research paper in *The Journal of Physics Chemistry B*, co-authored with Clemson physics professors **Emil Alexov** and **Apparao Rao**, holds the distinction of being one of the top-ten most accessed articles of that journal in the first quarter of 2006. His review article in *Journal of Physics: Condensed Matter*, was recently selected as a Top Paper 2007 of that journal.

Dr. Ke's research at Clemson has been highlighted over twenty times, including the influential *Materials Research Science Bulletin* (2005), *Biophotonics International* (2005), *Nanowerk Spotlight* (2006 & 2007), *Live Science* (2007), *Nova Science* (2008), and *Nature.com* (front page, 2008).

The Department would like to congratulate Dr. Ke on this outstanding achievement. Previous winners of the NSF Career Award in Clemson's Physics and Astronomy Department have been Drs. **Jeremy King** and **Chad Sosolik**.



**Dr. Peter Barnes, Chairman
Physics & Astronomy**



A Message from the Department Chair

The Department is having a remarkable year. As we go to press, we have learned that two of our undergraduates have won prestigious NSF graduate research fellowships. Moreover, Dr. Pu-Chun Ke is our third NSF Career Award winner in four years. We have had and will have many interesting field experiences for undergraduates--three students will present papers at an ACC undergraduate conference this month. One of our students spent ten weeks at a radio telescope observatory in Perú. Another grad student has won a Materials Research Society award, a first for Clemson University. Dr. Terry Tritt has garnered the South Carolina Governor's Award for excellence in research. These are among many of our outstanding accomplishments as we conclude this academic year.

These successes have occurred despite shrinking budgets and the prospect of deep cuts in the coming year. We are critically under funded and need funds to continue the development of our research programs. Of all the departments in the College of Engineering & Science, we receive the smallest share of donations. If all of our alumni contributed a mere \$100, we would have almost \$90,000 - a sum large enough to start an endowment. To this end, I would ask you to think about how you can help. Please know that any financial help you can give to our department in these difficult times will certainly be appreciated.

**Peter A. Barnes, Professor and Chair
Department of Physics and Astronomy
Clemson University, Clemson SC 29654-0978
Voice: (864)656-3416/e-mail: peterb@clemson.edu**

Creating a Legacy...Giving to Clemson Physics & Astronomy

You can create a lasting legacy through your donation to the Clemson University Physics and Astronomy Department Foundation. The State of South Carolina can guarantee only that Clemson provides a basic level of education. Endowments to Clemson assure the best faculty, the brightest students and the most creative research projects. A substantial endowment can transform a good university into a great one.

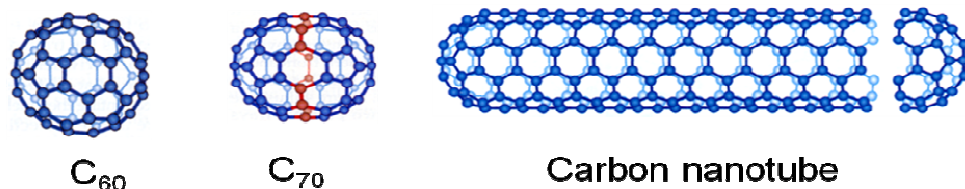
The support of loyal Clemson friends has been instrumental in building a record of excellence in education, research and public service. Clemson's share of state funds supports less than 38 percent of the university's operating budget each year. Through gifts to the Clemson University Physics and Astronomy Department Foundation, donors share in a proud tradition of commitment that helps the department achieve greater distinction year by year.

As a non-profit organization, the foundation is exempt from federal income tax under Section 501(c)(3) of the 1986 Internal Revenue Code, as amended. The foundation has been classified by the IRS as a public charity operated for the benefit of a state university as defined in the Internal Revenue Code of 1986 Section 170(b)(1)(A) (iv). Contributions to the university through the foundation by individuals, corporations, organizations and other foundations qualify as tax deductions. The Internal Revenue Service identification number assigned to the Clemson University Foundation is 57-0426335.

Manufacturing and Probing Properties of Small Carbon Structures

In 1959 Nobel Laureate Richard Feynman gave an inspiring talk to the attendees of the *American Physical Society* meeting at Caltech. He suggested that one should look into the possibility of “direct manipulation” of individual atoms as a more powerful form of the synthetic chemistry that was being developed at that time. This profound statement had a two-fold implication for the future of science and technology. Besides shrinking the physical size of electronic gadgets, there was a benefit from the standpoint of fundamental science by learning how to build structures that comprised a few hundred or thousands of atoms. Atomic and nuclear physics were sufficiently developed to describe the physics of individual atoms and molecules, and, likewise, solid state physics was also able to predict properties of materials that contained billions of atoms bonded together by inter-atomic forces (for example, as in a penny that is made of copper). However, what was lacking at that time was the framework that could explain the properties of structures formed by only a few hundred or thousands of atoms. Feynman concluded his talk by challenging the attendees to build a tiny motor and to transcribe a book page on a surface 1/25,000 smaller in linear scale. He also offered prizes of \$1000 for the winner of each competition. Amazingly his motor challenge was quickly met by a meticulous craftsman using conventional tools; the motor met the conditions, but did not advance the art. In 1985 a Stanford graduate student, Tom Newman, successfully reduced the first paragraph of *A Tale of Two Cities* by Charles Dickens by 1/25,000, and collected the second Feynman prize. Interestingly this miniaturization race continues to this day world-wide, and one such participant in this competition is **Dr. Apparao Rao** in Clemson’s Department of Physics and Astronomy. The Rao group is engaged in developing synthesis methods to prepare materials whose dimensions are in the realm of nanometers (1 nanometer = 10^{-9} m). Consequently, they unravel the physical properties of their nanostructured materials using spectroscopy and electrical measurements.

In the early 1980s IBM researchers **Gerd Binnig** and **Heinrich Rohrer** made an important breakthrough, by building an extremely powerful microscope that could image and probe the properties of individual atoms and molecules. Soon thereafter, sophisticated synthesis methods were developed to prepare cage-like molecules which contained exactly 60, or 70, or roughly a million carbon atoms. These are the types of materials that the Rao group began researching when he moved to Clemson in September of 2000.



Caged molecules of carbon spanning just 0.7 nm in diameter can be formed via covalent bonding between 60 atoms. The addition of a ring of 10 carbon atoms at the equatorial position creates the next stable molecule containing 70 atoms. An extreme case, in which several million carbon atoms are added, is called a carbon nanotube.

Nano Time-line:

- 1959: Richard Feynman gives his famous talk.
- 1981: Binnig and Rohrer build a microscope to image individual atoms.
- 1985: The discovery of C₆₀ and C₇₀.
- 1991: The discovery of carbon nanotubes, also known as C_{1,000,000}.
- 1998: A nanometer-sized field effect transistor is manufactured.
- 1999: Electrical switches based on single molecules are developed.

Prior to the discovery of these cage-like molecules, carbon was known to exist either in the form of graphite (as in lead pencils) or in diamond structures (as in jewelry). Surprisingly, the nanometer-sized cage molecules exhibit superior physical and chemical properties relative to the corresponding properties of graphite and diamond.

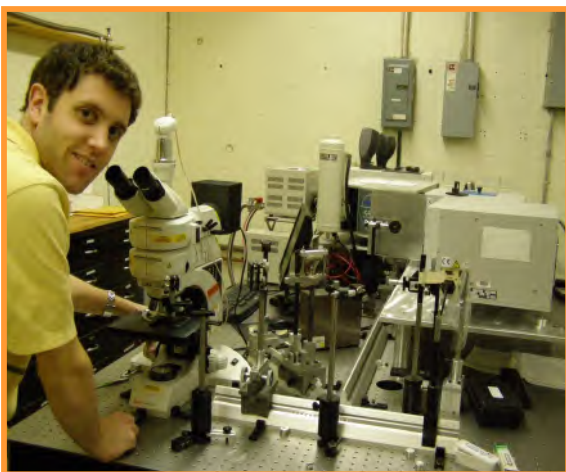
An amorphous form of graphite is used as the feedstock to prepare these caged molecules. With the help of high-energy sources like the electric arc and lasers, the strong covalent bonds present between the carbon atoms in amorphous graphite are broken to yield carbon vapor, which is then re-crystallized under appropriate conditions to form the caged molecules. One of Rao's early contributions to the synthesis of carbon nanotubes was to devise a method by which nanotubes can be prepared using a low-energy inexpensive process relative to the arc or laser methods. This technique involved decomposing a hydrocarbon source in the presence of a transition metal catalyst – a method known as the catalyst-assisted chemical vapor deposition method. The catalyst-assisted chemical vapor decomposition method proved very useful for the carbon community. By changing the hydrocarbon source to other hydrocarbons, and adding other catalysts like titanium and indium to the mixture,



Carbon nanotubes are prepared by student, Keqin Yang, using a catalyst-assisted chemical vapor deposition method.

carbon nanotubes with branched or coiled morphologies could be prepared.

Because of nanotubes' ultra-small dimensions, probing their physical properties can be extremely challenging. Attaching electrical leads and elucidating their electrical properties is not an easy matter. Therefore, the Rao group uses an alternate method in which they shine light on these nanostructured materials and infer the physical properties from reflected, transmitted or scattered light. One such optical method that has proven extremely useful is micro-Raman spectroscopy.



Graduate student, Jason Reppert, uses micro-Raman spectroscopy.

The strong covalent bonds between the carbon atoms render exceptional strength to a carbon nanotube. When compared to steel, carbon nanotubes are 100 times stronger and 10 times lighter in mass. Several researchers are interested in incorporating nanotubes in various composites to develop highly conducting composites with high strength. The Rao group has developed a method by which a single nanotube can be electrically driven into resonance, and its resonant frequency can be detected electrically. This is the harmonic detection of resonance method. Using this method, the effect of synthesis conditions on the structural integrity of nanotubes can be inferred.

Also the resonant frequency of a single nanotube is extremely sensitive to changes in the environment in the vicinity of the nanotube. Thus, the harmonic detection of resonance method enables the development of sensitive sensors for chemical and biological applications.



Students, Bevan Elliott & Gayatri Keskar, use the harmonic detection of resonance method developed at Clemson.

Besides working with carbon-based materials, the group also does extensive research on other nano-structured materials. For example, in another patented method, they have developed a method by which small pillars can be created on silicon or quartz substrates. These structures, as well as nanotubes, are routinely imaged using the atomic force microscope.

The Rao lab on the basement floor of Kinard at Clemson University is shrinking the dimensions of typical solids to tap into their potential for fundamental science and technological applications, and is engaged in research activities that promise a big future for ultra small-sized materials.

Dr. Jian He is Newest Member of Physics & Astronomy



Dr. Jian He

Dr. Jian He is the newest faculty member in the Physics and Astronomy Department. Dr. He joins us as an Assistant Professor. He received his Ph.D. from the University of Tennessee in the fall of 2004, at which time he joined Clemson University as a postdoctoral research associate, in order to work with Dr. Terry Tritt on his new Department of Energy program in thermoelectric materials. Dr. He has gained extensive expertise in thermoelectric materials and applications and has a broad background in oxide materials for a variety of applications. An initial project will be to set up a synthesis and transport laboratory. One of his first major pieces of equipment will be an optical floating zone furnace for the synthesis of oxide materials.

Jian enjoys tennis and soccer in his free time, and is likely to be found on the fields at some point on the weekend, when he is not in the lab. He and his wife, Ping Du, will make their home in the Seneca area. We all welcome Jian and Ping Du as the newest members of the Clemson Physics family.

Important Reminder!

The Department will temporarily relocate to Dillard Hall, effective April 1, 2008. This move is due to the renovations to the heating and air conditioning system in Kinard Hall that will take place over the summer. All contact phone numbers for office staff will remain the same. We will be in this location for approximately five months, while work is in progress. The first floor of Kinard will be closed and inaccessible effective April 1st, and the second and third floors will close at the end of the semester. If you have any questions regarding the move, please contact Risé Moroney at 656-3419.



Remodeling of the Science Café

Many of you responded to our last newsletter inquiring how you might best donate to the Department. One immediate project being planned by the Physics & Astronomy Department is to convert the current library and mailroom into a visitors reception area, where a variety of refreshments could be served. This would provide an area where faculty, students and visitors could meet and greet. Renovations will include expanding the current room, new flooring, repainting and the purchase of lounge furniture. The estimated cost of the renovation will be on the order of \$20,000. If you are interested in helping, please contact peterb@clemson.edu.

Drs. Manson and Larcom to Retire at End of Semester

At the conclusion of Spring Semester 2008, two members of Physics & Astronomy will be retiring after many years of invaluable service to the university. **Dr. Joseph Richard “Dick” Manson IV** and **Dr. Lyndon H. Larcom** will both officially be leaving the department. Professor Manson has been a member of the Clemson faculty since 1969. A native of Petersburg Virginia, he received his undergraduate degree at the University of Richmond in 1965 and completed his doctoral studies in physics at the University of Virginia in 1969, after which he joined Clemson’s faculty. His area of research interest has been theoretical surface physics, materials science and atomic physics. A long-standing interest and his current main research thrust is the theory of atomic and molecular scattering from surfaces.



Dr. Joseph R. Manson IV

Dick is a member of the American Physical Society, the American Association of Physics Teachers, the American Association for the Advancement of Science, and the South Carolina Academy of Science. In 1998 he received the Governor’s Award for Excellence in Science, and in 1990 was the recipient of the Alexander von Humboldt Research Award. He is married to the former Lucy Schenkman, whom he met when both were musicians in the Norfolk Virginia Symphony Orchestra. Dick and Lucy have two children, Joey and Abby, and four grandchildren. In addition to his distinguished teaching career at Clemson, Dick has forged many valuable academic collaborations in the U.S. and Europe, spending many summers in Germany and France. His presence and contributions to Physics & Astronomy will be greatly missed, however, as a member of the Clemson University Emeritus Faculty, he expects to be seen often in the department, continuing to work on his many research collaborations.



Dr. Lyndon Larcom

Dr. Lyndon H. Larcom was raised in northwestern Pennsylvania, and received his B.S. in physics from Carnegie Mellon University (known at the time as the Carnegie Institute of Technology). After graduation he attended the University of Pittsburgh where he obtained his M.S. in biophysics. Subsequent to his masters program he was awarded a National Institute of Health predoctoral fellowship to study the structure and composition of viruses under **Drs. Irwin Bendet** and **Max Lauffer**. Dr. Larcom remained on at the University of Pittsburgh on an NIH postdoctoral fellowship after receiving his Ph.D., to perform quantum mechanical calculations of molecular structure and spectra with **Dr. F. O. Ellison**.

In 1972 Lyndon came to Clemson to start an experimental biophysics program with **Dr. Burt Bronk**, who had been hired a year earlier. In those days physical and biological sciences were housed in the same college, and his appointment was split between physics and microbiology. For several years he received funding from NIH to conduct studies aimed at understanding the effects of radiation and chemical carcinogens on DNA and the biological effects of this damage in viruses and bacteria. When Clemson formed its research collaboration with the Greenville Hospital System, Dr. Larcom extended these studies to human systems. He and his colleagues soon discovered that the transformed cells in chronic lymphocytic leukemia cannot repair UVC damage and subsequently received a patent for its therapeutic use. Recently, a subset of white blood cells has been discovered that behaves abnormally when damaged by ultraviolet radiation, the cells of which are present in higher concentrations in women susceptible to breast cancer. Dr. Larcom will continue to study this phenomenon, in collaboration with the group in Clemson’s School of Nursing that is focused on clinical applications of genetics.

Dr. Larcom feels that during his thirty-six years at Clemson, he has been extremely fortunate to have worked with such pleasant and helpful colleagues in both departments and has thoroughly enjoyed collaborating with them. He is proud of having had the honor of serving as thesis advisor to more than fifty excellent graduate students. Most importantly his greatest personal blessing was meeting his wife, Diane, who also worked in the Department of Physics and Astronomy. They have two children, Kim and Brian, and two grandchildren Briana, age 6, and Crate, age 5. After retirement Lyndon plans to dedicate his time to his family.

Dr. Meredith Newby Forges Italian Collaboration

In the summer of 2007 Assistant Professor Meredith Newby visited Elettra, a synchrotron facility in Basovizza, Italy, to present a seminar on her research entitled, "Expanding the Structural Role of Non-Coding RNA: the Multifaceted Role of Pseudouridine".

The Newby Laboratory uses physical tools, primarily fluorescence and nuclear magnetic resonance (NMR) spectroscopies, to address important questions in biology and medicine. Of particular interest to her research group is the study of the physical properties of certain RNA molecules in the cell that do not code for proteins. How these RNAs, (composed of a limited repertoire of only four chemically similar nucleotides), adapted throughout evolution to so many diverse roles, still remains a mystery.

While in Italy, Meredith met with local researchers and established contacts for further collaboration. Her laboratory is working toward expanding its current projects to include a collaborative effort with Elettra beam line scientist Dr. Heinz Amenitsch. Heinz is an expert in small angle X-ray scattering (SAXS) studies, a method ideal for collection of low-resolution structural data from biological molecules. Physics undergraduate student, Robert Clarke, and Masters student, Chris Mart, are currently synthesizing and purifying RNA samples in the Newby Lab to ship to Italy for preliminary off-line SAXS studies.

If successful, a proposal will be written with the data to obtain synchrotron beam line time. Meredith enjoyed her time at Elettra, and would like to have a reason to bring students back with her to Italy. This particular project is related to the study of cancer, so she hopes that these upcoming SAXS experiments are fruitful.



Dr. Terry Tritt

Dr. Terry Tritt Wins Governor's Award

Dr. Terry Tritt of the Physics and Astronomy Department has been selected as the 2008 recipient of the South Carolina Academy of Science's Governor's Award. This award was established in 1985 by the Drug Science Foundation to honor an individual or team within the state whose achievements and contributions to science in South Carolina merit special recognition and to promote wider awareness of the quality and extent of scientific activity in the state. Since 1989, the award, named the "Governor's Award for Excellence in Science", has been under the joint sponsorship of the Governor's Office and the South Carolina Academy of Science. In 1993 the Dewees Development Corporation and Harbor Watch of Charleston joined these groups. Subsequently, Roche Carolina Inc., Mead Westvaco, and Michelin North America joined the award, in 2000, 2004, and 2005, respectively.

This honor was bestowed on Dr. Tritt for his overall contributions to his field. In addition to receiving this award, Terry was recently elected to the International Academy of Thermoelectrics as an Academy Fellow and also as its Vice President.

He will also serve as the Materials Research Society Chair for its spring 2009 meeting, which will host over 5000 attendees in San Francisco.

Clemson Astronomy Students View Lunar Eclipse

On February 20, 2008, Clemson Physics and Astronomy students gathered at the South Carolina Botanical Garden to observe the lunar eclipse. Students from the astronomy labs, their friends, and members of the community -- about 60 people in all -- watched the eclipse, drank hot chocolate, and observed Saturn, Mars, various star clusters, galaxies, and nebulae. It was coordinated by graduate student, **Ginger Bryngelson**, with help from other students.

This montage of images (right), showing the progression of the February 20th eclipse, was taken with a Canon 20Da camera, using a 300mm sigma lens. All images were obtained at 800iso, but varied from 1/25 to 4 seconds in exposure. The processing and merging was performed in Photoshop. The astrophotographer of these images is **Jason Puls** from Greenville, a Junior in Physics.



Time-elased image of the lunar eclipse



Clemson students assemble in the SC Botanical Garden to view the lunar eclipse on February 20, 2008.

As mentioned in our fall newsletter, one of the Department's goals is to provide students with regular astronomical observing opportunities a few hours per week in the South Carolina Botanical Garden, beyond those usually offered to laboratory students. This would require the purchase of another reflecting telescope in the 11--15 inch class and to permanently mount two telescopes in a protective structure (probably a roll-off shed). An alternative is a more expensive modular or larger structure to accommodate a larger telescope in the future. If you would like to contribute to this project please contact lmark@clemson.edu.

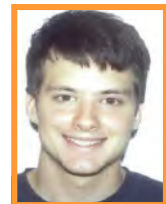
NSF Fellowships Go to Russell Hedden & Robert Clarke



Russell Hedden

Russell Hedden and **Robert Clarke** have been selected as recipients of National Science Foundation (NSF) fellowships. Russell is a student of **Dr. John Meriwether** and has been featured in previous newsletters for his atmospheric research work in both Alaska and the Cape Verde islands. Russell's efforts on these projects were crucial to their success. With the support of the NSF Graduate Fellowship he plans to attend Cornell University to work with **Dr. Michael Kelley**, who was one of the space physics community leaders that advocated for the construction of the Alaskan radar project on which Russell worked.

Robert Clarke will be graduating this May with two bachelor's degrees --- one in Physics and the other Electrical Engineering, along with a minor in Mathematical Sciences. He gained research experience in our department under the supervision of **Drs. Meredith Newby** and **Murray Daw**. Robert was chosen as a 2007 Barry M. Goldwater Scholar and will use his NSF Fellowship to attend the University of California at Berkeley in the fall, where he plans to pursue a Ph.D. program in Physics. Congratulations go out to both Russell and Robert on this outstanding achievement!



Robert Clarke

Students in the News....

Liyu Guo, a Ph.D. candidate in the Department of Physics and Astronomy, participated in a ten-week trip to the 2007 Summer School at the Jicamarca Radio Observatory in Perú, sponsored by the National Science Foundation. The experience was extremely rewarding, as it enhanced Liyu's knowledge of middle and upper atmospheric observations with various powerful radars. The rich culture and the fascinating archaeological heritage of Perú also made this a trip she won't soon forget. Liyu works for **Dr. Gerald Lehmacher** in the Atmospheric Physics program of the department.



Liyu Guo takes in the sights at Machu Picchu.



Bo Zhang

Dr. Terry Tritt's graduate student, **Bo Zhang**, was selected for the Outstanding Graduate Student Award at the fall 2007 meeting of the Materials Research Society. Bo was the first Clemson student to be selected for this award.

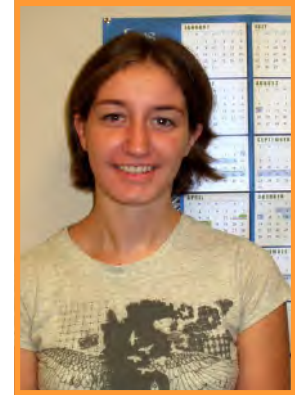
MRS Graduate Student Awards are intended to honor and encourage graduate students whose academic achievements and current materials research display a high level of excellence and distinction. The society seeks to recognize students of exceptional ability who show promise for significant future achievement in materials research.

Three students from Clemson Physics & Astronomy Department have been selected as members of the ten-student delegation to the 2008 ACC Undergraduate Research Conference at Florida State University from April 18-20, 2008. They include **Dr. Pu-Chun Ke's** student, **Michelle Reid**, **Dr. John Meriwether's** student, **Russell Hedden**, and **Kemper Talley**, who works for **Dr. Emil Alexov**. This is a conference on ACC undergraduate research and will be attended by students and faculty from twelve different ACC institutions. Dr. Meriwether will also attend this conference. He and Russell Hedden were featured in the Spring 2007 department newsletter for their work with faculty from the University of Illinois, in providing new instrumentation for two atmospheric observation stations located in the Cape Verde islands off the western coast of Africa.

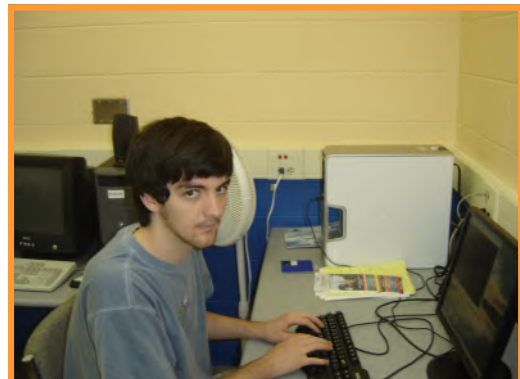
On another note, **Michelle Reid** and Dr. Ke's other student, **Marcus Allegood**, will be conducting research at Helsinki University of Technology, Finland this summer for three months. This research is supported by an International Research and Education in Engineering (IREE) program of the National Science Foundation.



Russell Hedden and Dr. John Meriwether



Michelle Reid



Kemper Talley hard at work

Physics Students Travel to Washington, D.C. for National Competition



From left to right: Dr. Chad Sosolik, U.S. Senator Jim DeMint, students Adam Dean and Niru Maheswranathan during their visit to Washington D.C.

In the spring of 2007 the work of a physics undergraduate student, **Adam Dean**, who participated in Clemson's Research Experience for Undergraduates (REU) program, along with **Niru Maheswranathan**, a high school student from the Governor's School in Greenville, and graduate student, **Russell Lake**, was submitted and accepted for a national competition called "Posters on the Hill". Adam, Niru, and Russell worked on the creation of the "Nanopaw" image, pictured below. They collaborated with **Dr. Chad Sosolik** on the initial stage of this project, by testing methods for pattern creation using microscope tip-surface crash events.

"Posters on the Hill" is a competition sponsored by the Council on Undergraduate Research, wherein sixty projects are chosen and presented to Congress in April of each year. The mission of the Council is to support and promote high-quality undergraduate student-faculty collaborative research and scholarship.

Dr. Sosolik and the students traveled to Washington D.C. for this competition and had the opportunity to meet with congressional representatives from South Carolina, most notably with **U.S. Senator Jim DeMint** (pictured above) and **Third District Congressman Gresham Barrett**. Russell Lake and Dr. Sosolik later submitted the "nanopaw" image as a "Science as Art" entry in Clemson University's 2007 "Science as Art" competition where it received Honorable Mention. This work eventually ended up as a publication that appeared in print in January of 2008 in the *Review of Scientific Instruments*.



Nanopaw

This is the image taken and created with the scanning tunneling microscope in Dr. Chad Sosolik's laboratory. It shows a surface imprint that was created on a silver crystal by the students on this project.

As you can see, the main pad on the paw is roughly 50 nanometers across, and the shapes have all internally assumed a roughly hexagonal pattern -- an effect that is driven by the inherent sixfold symmetry of the silver surface the lab utilized.

Clemson Students See the Stars

On March 22, 2007 Dr. Sean Brittain took four undergraduate students, **Crystal Fordyce**, **Matthew Henderson**, **Nicole Jackson**, and **Laura Laughlin**, to Kitt Peak near Tucson, Arizona, to observe at the Mayall 4m telescope. The students were traveling to the observatory as part of a project initiated in the "Introduction to Modern Astrophysics" course (ASTR 302/303). The students enrolled in this class were charged with the task of writing a research proposal. Dr. Brittain noted that the process of developing a tractable hypothesis, designing a practical experiment to test the hypothesis, and convincing one's peers to support the proposed project - in short, writing a research proposal - is the cornerstone of a successful scientific career.



Kitt Peak Observatory

In ASTR 302/303 the students were introduced to this process by writing a proposal to measure the growth rate of forming stars by observing the luminosity released by hydrogen as it crashes onto the surface of the star. Each group of two students was responsible for researching the scientific basis for their measurement, designing the experiment and determining the technical requirements of the observation. The two groups that submitted the best proposal were invited to travel to Tucson to perform their proposed observations on the Kitt Peak 4m telescope.

Through this creative inquiry, the students got a flavor of how open-ended scientific research proceeds, while developing their writing skills. Furthermore, this project will act as a gateway to further creative inquiry by the participants.



Dr. Brittain's students proudly display the tiger paw flag.

The measurements the students make are an important part of Brittain's research program, and form a key element of an actual ongoing research project.

Following the analysis of their data the students had the opportunity to present their work at the South Carolina Astronomy Meeting.

This project took advantage of Clemson University's new collaboration with the National Optical Astronomy Observatory and provided talented undergraduate students with hands-on experience in a world-class research facility. It is exceedingly rare for undergraduate students (and even graduate students) to visit such facilities, as only a handful of universities in the entire country have such access.

The commitment by the administration at Clemson to achieving top-twenty status is reflected by the university's investment in basic research. A notable example of this commitment has been the partnership formed with the National Optical Astronomy Observatory, which provides roughly thirty nights each year on telescopes around the world.

Such investments do not occur without the generous support of alumni and other friends of the university. We in the Physics and Astronomy Department are exceedingly grateful for the kind support of **Mr. Charles Curry** whose Foundation provided the seed funding that made the Clemson-NOAO partnership possible.

Department News



The department would like to congratulate **Amanda Crumpton** and her husband, **Ben**, on the birth of their daughter, **Ava Scarlett Crumpton**, who was born on November 20, 2007. Amanda and Ben have a son **Peyton**, age 7.



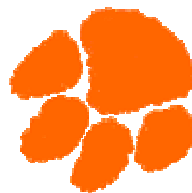
Congratulations also go out to **Dr. Meredith Newby** and her fiancé, **John Spano**, on their recent engagement and upcoming wedding. John is originally from Aiken, S.C. and works as a software developer in Greenville. They plan to have a small wedding ceremony and reception this summer at the Liberty Hall Inn in Pendleton and will reside in Easley with their four dogs, **Cali, Scrappy, Trixie, and Teddy**.



The department extends a warm welcome to **Dr. Holger Kleinke**, professor of Chemistry from the University of Waterloo in Canada, and to **Dr. James Wanliss** from Embry-Riddle University in Daytona Beach, Florida. Dr. Kleinke is an academic guest of **Dr. Terry Tritt** this spring. Drs. Kleinke and Tritt have been collaborating for over two years now and have published several papers together. Dr. Wanliss is visiting **Dr. Miguel Larsen** and will be working with Dr. Larsen on the analysis of rocket data gathered during atmospheric research trips.

If you have any suggestions for the newsletter, or any other constructive input on its format, please email your thoughts to: rvogt@clermson.edu. To subscribe or unsubscribe to *Schrödinger's Tiger*, please go to our mail list at: <http://www.ces.clemson.edu/mailman/listinfo/panda-newsletter>.

Nonprofit Organization
U.S. POSTAGE
PAID
Clemson, S.C.
Permit No. 10



We're on the Web!
physics.clemson.edu

The Clemson University Physics and
Astronomy Newsletter
118 Kinnard Laboratory
Box 340978
Clemson, SC 29634-0978
Tel: (864) 636-3416
Fax: (864) 656-0805
E-mail: hdebra@clemson.edu