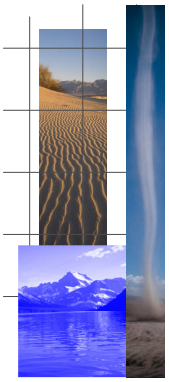

Schrödinger's Tiger

The Clemson University Physics and Astronomy Newsletter

Fall 2012

Volume 7, Issue 2

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Department News

Small "Packages" Hold Big Potential

Dr. Apparao Rao (left), and Research Assistant Professor Ramakrishna Podila examine a sample of freestanding carbon buckypaper. Dr. Rao has received NSF funding to explore the high power density storage potential of this material.

Clemson University physics professor, **Dr. Apparao Rao**, has devoted his career to exploring a world that, for most, is almost impossible to imagine. Rao has devoted his life to discovering the laws of physics that operate in a world of indescribable minuteness, and he is known as a leader in developing nanoscale materials. At one-billionth of a meter, these compounds have a much greater surface-to-volume ratio than other substances, which can lead to unusual and often, very useful properties. His work with the infinitesimal is attracting major attention.

Recently Dr. Rao received a $1.2 million National Science Foundation (NSF) grant to explore the use of carbon nanomaterials for energy storage. As the principal investigator, he will lead a team of interdisciplinary researchers from Clemson and the University of California, San Diego (UCSD). Clemson collaborators include **Dr. Mark E. Roberts** (Chemical and Biomolecular Engineering) and **Dr. Ramakrishna Podila** (Physics). The UCSD collaborator is **Dr. Prabhakar Bandaru** (Mechanical and Aerospace, and Electrical and Computer Engineering).

The global push for alternative, renewable, energy sources is creating a need for compatible materials and devices that can store energy for later use. Recent advances in nanoscience and technology show tremendous gains in energy storage performance. However, a major roadblock preventing technology transfer to industry is the absence of

A Message from the Chair

Greetings and best wishes for 2013 to all our alumni and friends. Clemson Physics & Astronomy had a very good summer and fall. As you will see in this issue, we have made exciting new science discoveries. Excellent new students joined both our graduate and undergraduate programs this semester. With the help of friends, alumni, and retired faculty, we have established new scholarships and fellowships at both levels to aid in recruiting students. **Dr. Feng Ding**, an accomplished computational biophysicist, joined our faculty in August. **Dr. Joan Marler**, an atomic physicist and trapper of ions and molecules (a field recognized with the 2012 Nobel Prize in Physics), will join the faculty very soon. We are searching for new faculty again this year.

More than two hundred people came to campus to witness the transit of Venus between the clouds in June. Over three hundred people heard the lecture in November by Dr. John Mather, Nobel Laureate in Physics from NASA's Goddard Space Flight Center. This level of interest and intellectual curiosity in our community is gratifying. Our second annual research symposium this August, organized by and with major contributions from our students, was again a great success. Students are already planning the third annual display of all our research. It will be held on the Monday before classes begin in August 2013. We would love to see you there.

We will miss our friends and colleagues, **Dr. Max Sherrill** and **Dr. Brian Donehew**, whom we recently lost.

Also, we would like to hear from you, with updates on what you are doing now, suggestions about the newsletter or department activities, or recommendations on students or faculty whom we should be recruiting.

Dr. Mark D. Leising, Chair
Department of Physics and Astronomy
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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. 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. As a non-profit organization, the Foundation is exempt from federal income tax under Section 501(c)(3) of the1986 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.

There are several ways to donate. You may use the enclosed envelope or send a check to the Clemson University Foundation, P.O. Box 1889, Clemson, SC 29633. Checks should be made payable to the Clemson University Foundation with Physics and Astronomy specified on the memo line. Alternately, you may visit the Clemson website: **http://www.clemson.edu/giving/how/** and make a secure electronic donation. Again, please specify that the donation go the Physics & Astronomy Department and indicate to which project you would like to donate. Thank you, as always, for your continued support of the Department. You may contact the Annual Giving Office at (864) 656-5896, should you have any questions regarding your donations. If you have other questions you may contact the Department directly at (864) 656-3416.

processes for continuous and scalable manufacturing. With this end in mind, Rao and his team will use the NSF award to develop novel types of electrochemical capacitors with blueprints for their scalability. The overall objective is the development of nanostructured hybrid capacitor electrodes comprised of electrically conducting polymers and carbon nanomaterials using manufacturing methodology. The project will result in widely used hybrid electrochemical capacitors with far superior performance compared to those available today.

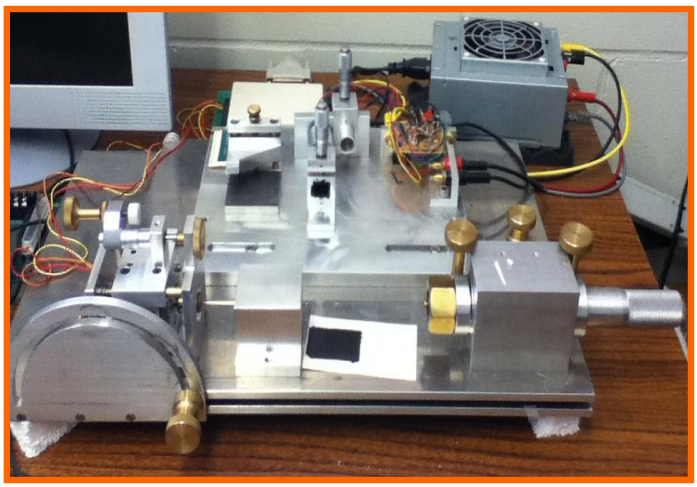
Rao and his collaborators often use Raman spectroscopy, a laser light scattering process, to explore the mysteries of nanomaterials, particularly carbon based nanostructures. Just as a gong produces sound waves that are characteristic of the metal of which it is made, nanoparticles, when struck by a focused laser beam, produce vibrations of the carbon atoms (called phonons) that can be recorded by a spectrometer and used as a fingerprint for characterizing the material being studied. This latest NSF grant will build on a recent publication of research undertaken by Rao and Podila, in collaboration with **Dr. Rahul Rao** (Wright Patterson Air Force Base, Ohio) and **Dr. Masa Ishigami** and **Mr. Ryuichi Tsuchikawa** (University of Central Florida) that deals with the special characteristics of graphene. Graphene is an ultra-thin sheet of carbon atoms arranged in a honeycomb structure. This "super-material," exhibits a kind of "chicken-wire" mesh structure at the nanoscale, where covalent bonding between the carbon atoms makes it super thin and super strong. Graphene is so thin and lightweight that 2.5 grams of a single layer can cover an entire football field.

During production, graphene sheets tend to fold and scroll due to inherent mechanical stresses. In their latest research, Rao and Podila have resolved an ongoing debate concerning these stress effects. "Although these carbon sheets have amazing properties, they do not exhibit a band gap (an energy range at the atomic level that is a major factor in determining the electrical conductivity of a solid), an essential characteristic for the electronics industry," explains Rao. "Currently, researchers are endeavoring to forcefully open a gap in graphene by folding, twisting and scrolling the sheets, and quantifying the effects of such stresses on its phonon properties. The NSF project aims to engineer the defects in graphene and nanotubes to obtain high energy storage". "In Raman scattering of graphene, the net energy difference between the incident laser energy and the scattered laser energy is determined by the material's electronic structure and the nature of atomic vibrations," says Podila. "This study could potentially guide current efforts toward strain engineering for opening a tunable band gap in graphene." Currently, researchers are striving to produce such a gap to exploit the material's high electron mobility, which would provide an improved alternative to existing silicon technology. Creating a tunable band gap is necessary for building the next generation of computer chips, transistors, solar cells, etc. "Discovering so many potential applications for nanomaterials makes every day in the lab an adventure," observes Dr. Roberts. "Our ongoing work with graphene and carbon nanotubes points to advances in the electronics and energy storage industry, and this new NSF project for energy storage could have a significant impact on applications ranging from household power tools to energy management and conservation applications, says Rao. Good things do, indeed, come in small packages. *(Adapted from Clemson University Feature Stories, Sept. 11, 2012)*

P & A RESEARCH LAB PLAYS AN IMPORTANT ROLE IN MANY DEPARTMENT PROJECTS

The Physics and Astronomy Research Lab plays a vital role in many Physics and Astronomy research projects. **Lamar Durham**, **Jonathan Simpson**, and **Barrett Barker** work on many specialized projects, including the rocket launches featured in this edition of the newsletter. For one of Dr. Rao group's research projects, there was a need to experimentally determine the torsional force constants of a *single* carbon fiber, or a thin bundle of carbon nanotubes. The Research Lab personnel helped design, fabricate, and assemble most of parts for the "twister" depicted in the picture on the following page.

The torsion reference tube, consisting of 0.3 mm O.D. hypodermic tubing, required a mount to secure it coaxially along the operational axis of the instrument. One component, which the team suggested and implemented, was the multi-axis bearing that allows combined rotational and axial adjustment of the reference tube. A recent upgrade was a micrometer controlled sample tensioner. Again, demonstrating their wide range of capabilities, the P&A Research Lab designed and built the necessary component, which was successfully integrated into the experimental setup. Dr. Rao is now writing an article for the *Review of Scientific Instruments* that could not have been possible without the participation of the P&A Research Lab personnel. According to **Lamar Durham**, the principal constructor of this machine, the challenges of designing and building this instrument included, but were not restricted to, the ability to manufacture a collet small enough to accurately hold a .3 mm O.D. tube, as well as mounting sample tubes in the vertical position and then going horizontal for the experiment. Moving samples to a horizontal position for testing under magnification proved to be difficult, but ultimately doable, and calibrating the rotational movement of the sample tubes required a high level of precision. To solve some of these challenges, the Research Lab Team personnel fabricated a micro-collet inside a collet block, which reduced vibration from positive concentric pressure, and they used a rigid frame multi-position platform to allow for zero to ninety degree positioning. A precision linear bearing was used to assure the fluid rotational and axial motion of the sample tubes. Micrometers were used in the x and y axis to measure precise movements during the torsional testing. This is just one of many examples in which the Lab team makes advanced Clemson Physics & Astronomy research possible.



A shop-built setup for measuring torsional (twisting) properties of individual micron-sized fibers

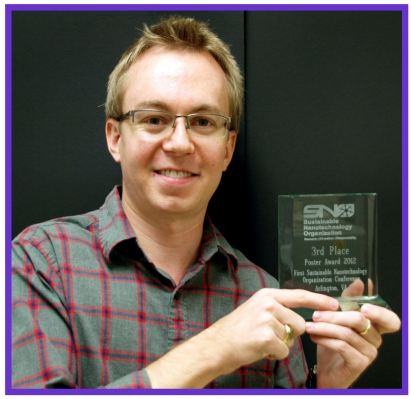
Deepak Saini Wins Sigma Xi Research Award and Travel Grant to India

Deepak Saini

Deepak Saini, graduate student of **Dr. Aparao Rao**, has won the Sigma Xi Grant-In-Aid Research (GIAR) Award. The GIAR program, supported by Sigma Xi- Scientific Research Society, funds young and enthusiastic researchers to extend their scientific expertise. The awarded grant of $1,000 will enable Deepak to study the electrical response of resonating doubly-clamped fabricated cantilevers. The research will be conducted under the guidance of **Dr. Prabhakar Bandaru** at the University of California, at San Diego.

She has also received a travel grant in the amount of 3,000 by the American Physical Society. This grant is sponsored by the Indo-U.S. Science and Technology Forum (IUSSTF), which provides travel funds to visit and temporarily work at a research laboratory in India. Deepak will utilize this money to pursue research at the S. N. Bose National Center for Basic Sciences with **Dr. Arup Kumar Raychaudhuri,** to investigate the importance of the Fe- catalyst particle in Y-Junction Multi Walled Carbon Nanotube. The program will hopefully lead to new long-term scientific collaborations that will be highly beneficial to both the participating institutions.

Nick Geitner Wins Sustainable Nanotechnology Organization Poster Prize



Nick Geitner

Graduate Student **Nick Geitner** won third prize for his poster presentation "Oil Spill Remediation Using Biocompatible Dendritic Polymers" at the First Sustainable Nanotechnology Organization (SNO) conference recently held in Washington D.C. Nick was among the three prize winners and three honorary mentions for the fifty posters presented at the conference, organized by the National Science Foundation, the National Institute of Health, and the U.S. Environmental Protection Agency. SNO is a newly launched professional society that aims at advancing fundamental knowledge in all aspects of sustainable nanotechnology. Nick joined **Dr. Pu-Chun Ke**'s lab in August, 2011 to pursue a Ph.D. in the field of soft matter with an environmental emphasis. He has published one paper for his Masters research at Miami University of Ohio and one paper here at Clemson, both as first author. Nick is in the process of submitting two manuscripts by end of this year,describing the binding of graphene with algal exudates and dendrimer physical chemistry.

Archimedes Foundation Scholar at Clemson

Aleksandr Kakinen, a Ph.D. student from **Dr. Anne Kahru**'s Molecular Genetics Lab at the National Institute of Chemical Physics and Biophysics in Estonia, has been conducting research in **Dr. Pu-Chun Ke's** lab this fall. While at Clemson, Aleksandr examines the biophysical interactions between silver nanoparticles and luciferase, an enzyme that catalyzes bioluminescence from fireflies. The purpose of this research is to understand the impact of nanomaterial exposure on enzymatic activity, which serves as a reporter on the state of cell transcription and ATP level. In addition to this topic, Aleksandr also studies the formation of biocorona by algal exudates and graphene, in collaboration with **Dr. Ramakrishna Podila** in **Dr. Apparao Rao's** lab. Aleksandr's four-month stay is funded by a Doctoral Studies and Internationalization Mobility (DoRa) grant from the Archimedes Foundation, jointly supported by the European Union and the Estonian government. In addition to Aleksandr, the Ke lab has recently hosted the research stays of **Dr. Luca Monticelli** of INSERM, France, **Dr. Emppu Salonen** of Aalto University, Finland, and **Dr. Annele Virtanen** of the Tampere University of Technology, Finland. Conversely, Dr. Ke has sent students for research training at Aalto University, Finland; Nordita, Sweden; Iowa State University; and the University of Massachusetts at Amherst.

Aleksandr Kakinen

The ATREX Experiment Launched Successfully

The Anomalous Transport Rocket Experiment (ATREX) launched successfully from the NASA/Wallops Flight Facility located on the Eastern Shore of Virginia at 4:58 a.m. on March 27, 2012. The experiment was designed to probe a region of high-speed winds located at the edge of space in a region where strong electrical activity in the Earth's ionosphere affects spacecraft and global communication systems.

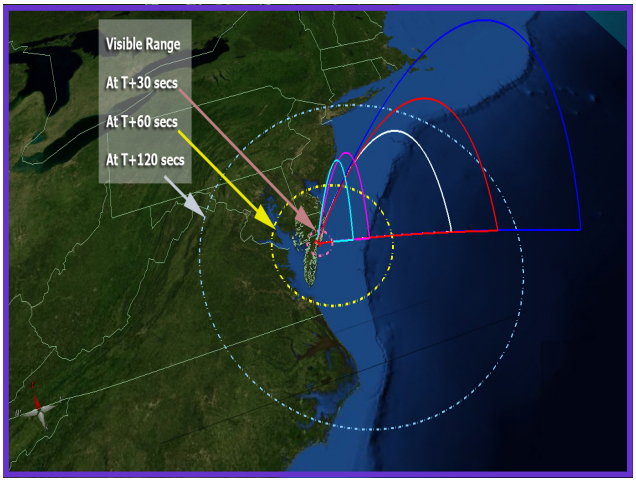
A total of five rockets were launched over a five-minute period along an east-southeast trajectory to release tracer trails that were used to track the atmospheric motions and learn more about how turbulence associated with the strong wind systems disperses material in the lower ionosphere.

The Principal Investigator for the experiment is **Dr. Miguel Larsen** and the Co-Investigator is **Dr. Gerald Lehmacher**, both from the Department of Physics & Astronomy at Clemson University. The science mission was funded by NASA, and the launch operations were carried out by personnel at the NASA facility located at Wallops Island, Virginia. The rockets provided measurements over a horizontal range that stretched over more than 500 km. and extended almost halfway to the island of Bermuda. The launches were attempted each night for more than a week while waiting for good weather conditions, so that the tracers could be seen from the ground and clear conditions in the rocket impact areas over the ocean. All the requirements for the launches were finally met in the morning on March 27.

The five-rocket payload instrument packages were designed and built by Department of Physics Research Lab technicians **Lamar Durham** and **Jonathan Simpson**. The process of preparing the payload instruments for launch involved more than a year of manufacturing and extensive testing, both at Clemson and at Wallops, to ensure that the payloads would function properly during the flights. All systems functioned well during the launches.

Clemson graduate and undergraduate students were also involved with the experiment and are now participating in the data analysis. Both **Andrew Kiene**, a graduate student in the Physics Department, and **Brenden Roberts**, a Junior undergraduate, had extensive involvement with the testing of equipment prior to the launches and the operation of support equipment during the launches. Camera sites were operated by Clemson personnel at locations in New Jersey and North Carolina, as well as at the launch site in Virginia.

The collage shows the launchers for the five sounding rockets in the lower right-hand corner, as well as the five near-simultaneous launches in the center. Six of the tracer releases are also visible, stretching from the upper left-hand part of the photograph toward the horizon over the ocean. The rapid spreading of the trails due to the high-speed winds and the strong turbulence in that part of the atmosphere are evident.



A depiction of the trajectories for the five rockets launched within a five-minute period from Wallops Island, Virginia. The apogee (maximum altitude) was different for each rocket, but the trails were all released in the same altitude range.

The experiment was highlighted on the main NASA web site, as well as on the Wallops Flight Facility web page, Facebook page, and Twitter page. The launch operations were streamed to the Internet each night of the launch window.

The fact that the launches and the tracer releases were visible over a large part of the east coast of the U.S. increased public interest in the project. There were a total of 25,000 views of the live stream, 21,000 Twitter followers, and 7,600 Facebook followers for the mission. The launches were reported on 380 local TV stations and in a large number of national and international news stories. Analysis of the experiment data started soon after the launches were completed and is expected to be completed sometime in the spring of 2013.

Preliminary results show that the high-speed winds are part of a large-scale circulation system. The initial analysis also shows that there is strong turbulence in the region due to the strong winds and large wind shears that enhances the horizontal transport at those altitudes. The results of the experiment are important for our understanding of the Earth's upper atmosphere and the processes by which material and energy are transported globally in the geospace region. In addition, the same processes responsible for the high-level wind system on Earth are likely to exist in other planetary atmospheres as well.

You can check out projects such as ATREX and other Wallop's Island research initiatives on Facebook on their page, NASA's Wallop's Flight Facility at http://www.facebook.com/#!/NASAWFF?fref=ts

The Department Welcomes New Faculty Member Dr. Feng Ding

Dr. Feng Ding

Please join us in welcoming **Dr. Feng Ding** as our newest faculty hire. Ding received his B.S. degree in Physics from Nanjing University (NJU) in 1997. After two years as a graduate student at NJU, in 1999, he joined the Center for Polymer Studies at Boston University and obtained his Ph.D. in Physics in 2004. From 2004 to 2012, Dr. Ding has been working at the University of North Carolina at Chapel Hill as a Postdoctoral Fellow (2004-2006), a Research Associate (2006-2008), and later as a Research Assistant Professor (2008-2012). Dr. Ding has made many original contributions to the fields of protein folding, protein aggregation, protein design, RNA folding, RNA 3D structure predictions, and, recently, molecular recognitions. He joined us in August 2012 and has already published papers in collaboration with our faculty and students. We extend a heartfelt welcome to Dr. Ding, as he joins the faculty.

International Symposium on Continuum Solvation Modeling in Biological Systems: Developments and Applications

The annual meeting of the American Chemical Society is the largest scientific meeting, and it typically involves more than 20,000 attendees. It covers a broad spectrum of topics, including Computational Biophysics and serves as an excellent platform for getting together researchers from all around the world. Bearing this in mind, Clemson Biophysics professor **Dr. Emil Alexov,** together with **Dr. Ray Luo** from the University of California at Irvine, organized an international symposium within the 244th American Chemical Society (ACS) National Meeting.

Dr. Emil Alexov and Dr. Ray Luo, symposium organizers

The title of the symposium was "Continuum Solvation Modeling in Biological Systems: Developments and Applications." The ACS meeting was held in Philadelphia from August 19 to 24 of this year. The symposium had nine full sessions, each with six speakers spanning over five days, both during morning and afternoon sessions. Each talk was thirty minutes long, including time for questions. It was the longest among the other symposia at the 244th ACS meeting and, according to the participants, it appeared to be the most attended.

The meeting aimed at elaborating on state-of-the-art techniques in continuum solvation modeling in biological systems. It is well known that continuum solvation methods (being faster and, by definition, equilibrium methods) are frequently preferred over explicit methods, which are computationally demanding and may have issues with convergence. The popularity and the community interest in such methods were demonstrated at the meeting by the talks given by prominent researchers in the field and by the involvement of the participants in discussions either during the sessions or after the business hours. The talks and speakers were all equally important, but one, in particular, highlighted the work done by Clemson researchers.

Of special note was the session on the Poisson-Boltzmann equation and its applications for biological systems. It featured Clemson researcher **Dr. Brian Domini**, from the Chemistry Department, who reported on a new development of a method for modeling salt dependence of the non-polar component of solvation energy. **Dr. Chuan Li**, from the Laboratory of Computational Biophysics and Bioinformatics at the Department of Physics and Astronomy, outlined an exact and highly efficient approach for parallelizing the calculations of the Poisson-Boltzmann equation, achieving a speedup (with respect to the sequential code) on the order of tens or hundreds of times. **Dr. Lin Li**, also from the Laboratory of Computational Biophysics and Bioinformatics, presented a talk on modeling the dielectric properties of biological macromolecules within the framework of Poisson-Boltzmann formalism. The symposium was a great success. It brought together prominent researchers with students and postdoctoral fellows and initiated many interesting discussions. The organizers are committed to keeping it running, and the next symposium will be in 2014 at the annual meeting of ACS.

Physics: Elegant, Elementary, and Enlightening

Dr. Daw's Introductory Physics with Calculus class explores new approaches to the study of physics.

By: Rachel Andorfer, Kristyn Brandenburg, and Connor Murray

What's the coolest thing about physics? Is it the theories and principles in quantum mechanics that allow us to take the first steps in quantum teleportation? Or is it Einstein's Theory of Relativity? **Dr. Murray Daw** argues that the answer is much more fundamental, and, surprisingly, simple. Dr. Daw teaches "Introductory Physics with Calculus," which employs the idea that physics is based on a common experience with the world. It should be grounded in common sense, made rigorous. In these classes, physics is explained in terms of observations that we make about the world.

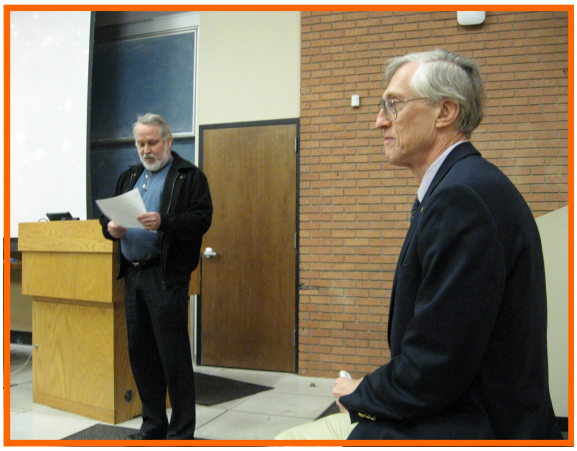
The class proposes that the mathematics of vectors and calculus originates with our common experiences of the world and fits naturally within the subject of physics.

Dr. Daw often asks physicists who have not taken the class, "What is momentum?" The most common answer is the mathematical relation $p=mv$. He then asks, but what IS it? Most of the time, they can't explain it, although they intuitively know what it is. His classes help students to understand a phenomenon, before they learn to describe it with mathematics. When he tells people that momentum is simply the cause of locomotion, they say that they knew that, but never knew how to describe it. Dr. Daw maintains that if one really understands something deeply, then one should be able to explain it in simple terms, and he focuses on making sure his students have this full understanding. He teaches the two-semester introductory class for only physics majors. This results in a much smaller class size, enabling more one-on-one time with the professor, so he can more easily ensure their full understanding of the material. **Kristyn Brandenburg**, who has taken both semesters, comments, "I enjoyed taking the class with other physics majors. It allowed me to get to know the students in my major and that helped me tremendously when it was time to study for a test." Separating the physics majors from non-majors who may take introductory physics creates a sort of community, perhaps even a family. This is highly beneficial to the students, and this may not have occurred without that separation. It is beneficial to create this community early, as these students go on to take the same classes throughout their undergraduate experience and will be relying on each other for friendship and support in terms of homework and studying.

The majors-only course uses **Dr. Anthony Rizzi's** textbook, *Physics for Realists*. Rizzi's text serves to remind students that physics is the study of physical being — not a class devoted to memorizing equations. **Rachel Andorfer**, a physics major taking introductory physics, says "This class takes you beyond the numbers, to where the numbers came from and what they really mean." Dr. Daw firmly believes that Rizzi's approach will "revolutionize our understanding of physics and the way it is taught." Another physics major taking introductory physics, **Taylor Kimmel**, opines that "We actually learn what happens in the physical world, then learn the math behind it by deriving the equations." These classes give physics majors not only a deeper, more intuitive understanding of physics, but give them a community that will benefit them long after their undergraduate studies are finished.

Nobel Laureate Gives Public Lecture on History of the Universe

Dr. John C. Mather, a senior astrophysicist at NASA's Goddard Space Flight Center and the 2006 Nobel Laureate in Physics, visited Clemson in November. He gave a public lecture to some three hundred people in the Strom Thurmond Auditorium, and presented a Physics and Astronomy colloquium. He also met with several groups of students and faculty during his visit. In his public lecture, "The History of the Universe from Beginning to End," he explained what we know, and how we know it, about the origin and fate of the Universe, the Solar System, and the Earth. The Clemson students and community turned out in force and asked dozens of questions afterward. Dr. Mather is now the Senior Project Scientist on the James Webb Space Telescope at NASA.



Dr. Dieter H. Hartmann introduces public lecture by Dr. John C. Mather

His work was the subject of his colloquium, in which he elaborated on its mission status and progress, and outlined future opportunities for scientific investigations. Dr. Mather and all here at Clemson enjoyed his visit greatly.

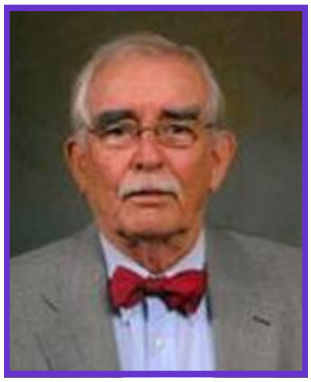
SECOND ANNUAL SIRPA MEETING — A BIG SUCCESS

Graduate students taking a break from SIRPA meeting

August 20, 2012 marked the second annual Symposium for the Introduction to Research in Physics and Astronomy (SIRPA), hosted by the graduate student body of Clemson's Department of Physics and Astronomy. The full-day event consisted of multiple graduate student and faculty research presentation sessions, interlaced by two poster sessions at the Clyde V. Madren Conference Center on the banks of Lake Hartwell. The purpose of the student-led conference is to introduce the incoming graduate students to the various research groups within the Department and their ongoing projects. This year's conference included the addition of a keynote speaker, **Ian Durham**, who discussed non-traditional job options in the world of physics. Clemson Physics and Astronomy research was showcased in twenty-two talks, with over twenty posters on astrophysics, Earth's atmosphere, fundamentals of physics and quantum mechanics, quantum computing, computational modeling of biophysical molecules, nanoscale materials, and ion beam physics. The event concluded with a dinner served in the Grand Ballroom. The conference was well-attended by faculty, students, and the Department staff.

In Memoriam

Dr. Max D. Sherrill (1930-2012)



Dr. Max D. Sherrill

Dr. Max D. Sherrill, 82, husband of **Emily Semmes Sherrill**, died Monday, Novenber 12, 2012 at the CARC Skilled Nursing Center in Anderson, after an extended illness. Max was born in Hickory, North Carolina, attended Lenoir-Rhyne College and was a 1953 graduate of the University of North Carolina at Chapel Hill, where he also earned his Ph.D. in physics in 1961.

Max's research concerned superconductivity, tunneling, and the properties of thin films of metals. The paper that earned him acclaim as a graduate student showed that the superconducting transition temperature of a metal could be changed by adding or subtracting electrons using the "field effect," in which what is now called a gate voltage changes the properties of a substance.

This idea has been used ever since to form field effect transistors and to study other systems. Max also worked on superconductivity, for example tunneling in niobium and the properties of superconducting thin films, while at the General Electric Research Center. When he came to Clemson in 1967, Max inherited a lab, which became less ordered, but more active. He continued to study the properties of thin films, including the properties of fluxons, and the interaction of fluxons in paired films and tunneling in more complicated geometries, such as cylinders.

He retired from the faculty in 1996 and volunteered often with the Clemson Child Development Center. Retired professor **Dr. Will Graben** offered this reminiscence of Max: "Max was my good friend for over forty years. We shared a close professional relationship until my retirement in 1993. Afterwards, as founding members of the notorious Old Friendly Fellows At Lunch, otherwise know as the OFFAL group, we met each Thursday in local, frugal eateries. Max had one trait which set him apart from other colleagues; he was a wonderful story teller. Put another way, Max was a compulsive talker…I was called upon many times to entertain a visitor to our department. I capitalized upon Max's verbosity by asking him to join us. This worked well, because there was never an awkward lull in the conversation. I admired Max because he was a good scientist, a good family man and a good friend. The OFFAL group will miss him." Dr. Graben echoes the sentiments of many of Max's good friends and colleagues here at Clemson.

Dr. Brian Donehew (1969-2012)

Dr. Brian Donehew

Brian Donehew (Ph.D. 2011) passed away on November 17, 2012 at the age of 43. Brian graduated from high school in San Antonio, Texas, eventually earning bachelors degrees in Business Administration and Math and Physics from Texas A&M and U.T. San Antonio, respectively. He completed a Masters Degree in Solid State Physics from Southwest Texas State University, before coming to Clemson to study astrophysics. While at Clemson, Brian worked with **Dr. Sean Brittain**, studying methods for measuring mass accretion from gaseous disks around young stars onto those stars, and he earned his Ph.D. in May 2011. He was an excellent and dedicated teacher in physics and astronomy labs, for which he was nominated for the college graduate student teaching award. Brian frequently volunteered for our outreach efforts, presenting shows in our planetarium and conducting observing nights for school children and the public. After leaving Clemson, he was a Visiting Assistant Professor at the University of Tulsa and was continuing his dedicated service to the profession as an Assistant Professor of Physics & Astronomy at Ball State University, when he died unexpectedly. He is survived by his mother **Edith Donehew**, his father and step-mother **Jerry** and **Clary Donehew**, his sisters **Andrea** and **Julie**, and his nephews **Tony** and **Tyler**.

The Clemson University Physics and Astronomy Newsletter

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Department News

Dr. Bradley S. Meyer will be spending the spring semester on sabbatical at the University of Hawaii at Manoa on the island of Oahu. During this time, he will be collaborating with colleagues on research on the early Solar System.

Dr. Priyanka Bhattacharya (Ph.D., 2012) has become the Linus Pauling Distinguished Postdoctoral Fellow at Pacific Northwest National Laboratories in Richland, Washington.

Dr. Ginger Bryngelson (Ph.D., 2012) has accepted a position as Assistant Professor of Physics and Astronomy at Francis Marion University in Florence, South Carolina. Ginger worked under the direction of **Dr. Mark Leising**, while at Clemson.

Dr. Tatsiana Ratnikova (Ph.D., 2011) has been accepted to the Postgraduate Certificate Program in Medical Physics at the University of Chicago. At Clemson she worked with **Dr. Pu-Chun Ke**.

Dr. Daniel Thompson (Ph.D., 2012) has accepted a position with General Motors Research and Development in Detroit, Michigan.

If you have any suggestions for the newsletter, please email your thoughts to: rvogt@clemson.edu. To subscribe or unsubscribe to *Schrödinger's Tiger*, please go to our mail list at: **https://mail.clemson.edu/mailman/listinfo/panda-newsletter**