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Quanta

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

PHYSICS
A UNIVERSITY EXEMPLARY DEPARTMENT

Dr. John Ficenec
Professor, Interim Chair
Dr. Jimmy Ritter
Professor, Assoc. Chair
Ms. Janet Sanders
Dept. Business Manager
Ms. Deborah Cruise

"Physics chairman becomes Interim Dean"

Lay Nam Chang, physics department head since 1995, surrenders his role as chairman to become College of Arts and Sciences interim dean, which became effective January 2002.

Dr. Chang joined the Virginia Tech faculty in 1978. Prior to coming to Virginia Tech, he worked with the physics faculty at the University of Pennsylvania for seven years, and conducted research at MIT and at the University of Chicago. He has been a visiting scientist or visiting instructor at institutions of higher education in Denmark, British Columbia, Singapore, and the United States.

Chang received his Ph.D. from the University of California at Berkeley in theoretical physics. He has written extensively for refereed journals and has published numerous reports of his work.

Provost Mark G. McNamee said in announcing his selection for the position that "Dr. Chang emerged as an energetic and effective scholar who combines established leadership experience at Virginia Tech with a quiet passion to move the college and the university forward in

Dr. Lay Nam Chang, Interim Dean

its quest for enhanced stature and success. He is committed to the goals of diversity and excellence, and he is prepared to face the challenges and opportunities that lie ahead." According to McNamee, the College of Arts and Sciences, Virginia Tech's largest college, is beginning "a substantive discussion of new organizational models that could enhance the ability of the college to achieve its strategic academic goals."

Dr. Chang, in accepting his position said, "Although the university and the college are facing some great challenges, these in turn spawn extraordinary opportunities. As we strive toward meeting President Steger's goal of reaching the top 30, we will be positioning ourselves better to fulfill our potential to be the key player in higher education in the state. I look forward very much to meeting this challenge, with the help and support from the faculty and staff of the college. And I look forward to working with the provost and the president and others in the university as we begin the process." Chang noted that former dean, Robert Bates, would be "a tough act to follow."

"Dr. Ficenec assumes position as Interim Chair"

Dr. John Ficenec assumed the position of Interim Chair for the Department of Physics on January 10, 2002. Dr. Ficenec has been a physics faculty member since coming to Virginia Tech in 1968. Prior to becoming Interim Chair, Ficenec served as Associate Chair. Dr. Ficenec

see "Interim Chair" p 3

"Di Ventra's molecular electronics work earns NSF award"

Courtesy acknowledgement, "Sally Harris, Virginia Tech Spectrum"

Massimiliano Di Ventra of the Department of Physics has received a Faculty Early Career Development Program (CAREER) Award from the National Science Foundation (NSF) to develop and use novel atomic-scale first-principles approaches to enhance scientists' understanding of the non-linear transport properties of molecular wires.

Massimiliano DiVentra

CAREER awards are presented annually to a select roster of young faculty members nation-wide who have the potential to make significant contributions to engineering and scientific research and instruction. Di Ventra's award is for $300,000 over five years.

At the nanoscale level (one-billionth of a meter) scientists potentially can develop revolutionary ways of making materials and products that will greatly increase the speed of electrical processes and reduce the power needed to run electronics devices. Di Ventra does computer simulations in the area of molecular electronics, which could change the practice of science. "A fundamental understanding of the electron-transport properties of molecular structures at the atomic level is vital for the development of molecular electronics," Di Ventra said.

Molecular electronics involves developing immensely fast and powerful computing circuits based on trillions of individual building blocks, each no larger than a single molecule, Di Ventra said.

These molecules have to perform functions identical or analogous to those of transistors, diodes, conductors, and other key components of today's solid-state micro-electronics.

"Chemists, physicists, and engineers have actually shown that individual molecules and molecular wires can conduct, switch electric current, and store information," Di Ventra said. "However, to further advance this new technology, we need to understand how molecular devices work both singularly and when connected together. This in turn requires understanding how electrons behave when traveling into regions as small as a few atoms."

Last year, Di Ventra and experimentalist Randy Heflin received Nanoscale Exploratory Research grants from the NSF as seed money to begin to explore the nanoscale world through computer simulations and a combination of optics, thin-film technology, and analytical biochemistry. With the CAREER award, Di Ventra will use newly developed atomic-scale first-principles approaches to study some of the most fundamental issues of transport in molecular wires that can have a major impact in developing molecular electronics. These include current-induced forces, local heating and heating dissipation, fluctuations of current, and interference effects at the molecule-leads contacts.

In addition to conducting his work in concert with experimental studies, Di Ventra will integrate his research program into undergraduate and graduate education by developing a new course on career opportunities in nanotechnology. To compare theoretical predictions and experimental results, Di Ventra will collaborate with Heflin of physics and Harry Dorn of chemistry, all in the College of Arts and Sciences, as well as with experimental groups at Yale University and IBM's J.J. Watson Research Center.

Collaborations with experimentalists will help advance the new technology and provide input for future developments in molecular electronics, Di Ventra said. By providing theoretical models, Di Ventra will help shorten the experimental time needed for selecting materials and structures with specific transport properties. "The concept of materials and devices 'by design' will be finally realized," he said.

Collaborations both within and outside the university will lead to a multidisciplinary effort in the development of molecular electronics. Di Ventra also will provide interested researchers around the world with the computational tools developed in the project, a move that will facilitate world-wide collaborations and exchange of scientific ideas and foster improved tools to develop new technologies.

Di Ventra came to Virginia Tech in the summer of 2000.

" Interim Chair "

continued from page 1

Dr. John Ficenec
Interim Chair

received his Ph.D from the University of Illinois (Urbana) in Experimental Particle Physics. He is presently a member of the CLAS collaboration at Jefferson Lab, serves on numerous committees, and remains a member of several professional organizations.

"Department Update"

submitted by Interim Chair, John Ficenec

As you have noticed in this issue, there have been several changes since the last issue of Quanta. Department Chairman Lay Nam Chang has assumed the duties of Interim Dean of Arts and Sciences for up to 18 months, and I have assumed the duties of Interim Department Chairman for the same period. The university, college, and department are faced with significant state budget cuts for at least the next two years, and a possible restructuring of units within the university is under active discussion. In short, it is a challenging and exciting time.

The goals, objectives, and initiatives

see "Department Update" p7

"SPS selected as an Outstanding Chapter"

The Virginia Tech chapter of the Society of Physics Students was selected as an Outstanding SPS Chapter for the 2000-2001 school year. Less than 5% of the SPS chapters nationwide are so honored, fewer than one per state.

The selection was based on the depth and breadth of SPS activities conducted by students in such areas as physics research, public science outreach, physics tutoring programs, hosting and representation at physics meetings, and providing social interaction for chapter members.

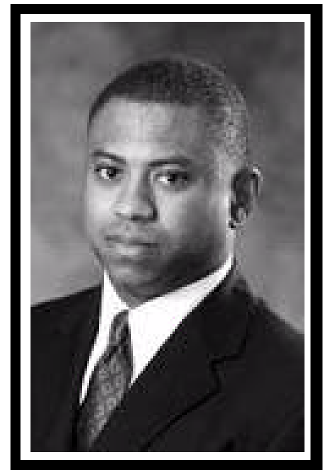
Congratulations not only goes out to our SPS students, but also to Dr. Jerome Long who has devoted his time and energy to the students and to their betterment. This award is a testament to Jerome's personal leadership skills as much as it is an acknowledgement of the chapter's superior performance. **Congratulations to Dr. Long and the Virginia Tech chapter!**

Congratulations!
Society of
Physics Students

"Alumni News"

Colin Hill, M.Sc., C.E.O., President & Founder

Mr. Hill is the founder of Gene Network Sciences and serves as President and Chief Executive Officer. Mr. Hill has extensive sci-



Colin Hill -
1996 Physics Graduate

entific experience in the areas of gene network modeling, pioneering the application of methods based in statistical physics and nonlinear dynamics to the stochastic dynamics of gene expression. He is the co-founder of a multi-disciplinary research effort at Cornell University dedicated to combining computational and experimental approaches to the study of signal transduction pathways. Mr. Hill is the co-creator of the Digital Cell TM software environment for the modeling of complex gene networks and biochemical pathways. Mr. Hill earned his B.S. degree in Physics from Virginia Polytechnic Institute and State University and his M.S. degree in Physics from McGill University and Cornell University, respectively.

2002 - 2003 Award Winners

Alice Estes Martin Scholarship
H. Burke Green

Col. Nelson Carey Brown Memorial Scholarship
Jennifer Beard

Daniel C. & Delia F. Grant Endowed Scholarship
Jennifer Beard, Justin Krometis, Rafael Hipolito, Brian Donovan, Jerome Mettetal, II, Carol Thornton

Frank Leigh Robeson Scholarship
Beth Reid

H.Y. Loh Award
Anubav Vasudevan

Hugh D. Ussery Scholarship
Aaron Wallo, Sara Yancey, Christopher Purcell

Lubna Ijaz Scholarship
Alma Robinson

Ray F. Tipsword Scholarship
Martin Drees

Robert C. Richardson Scholarship
Beth Reid, Christopher Graziul, Larry Cook

Robert P. Hamilton Prize
Jerome Mettetal, II

Webster & Sara Schoene Richardson Memorial Scholarship
Andrew Fenley, Zachary Lewis, Edouard Bernard, Jeremy Saria, Jason Tabeling

C.H. Wan Scholarship
Ed Lyman, Jerome Mettetal, II

Jamie Dunn Memorial Scholarship
Mark Makela

"Physics Faculty receive promotions"

It is a pleasure to announce and offer congratulations to Dr. Leo Piilonen (left) and Dr. Mark Pitt (right) on their recent promotions. Dr. Pillonen was granted promotion to Professor. Dr. Pitt was granted tenure and promotion to Associate Professor.

"Borexino Solar Neutrino Detector Nears Completion"

written by Bruce Vogelaar, Associate Professor

Understanding symmetries in nature has led to some very powerful analytical tools used in every freshman physics class. The continuous symmetries are perhaps the most familiar: that the outcome of an experiment does not depend on its absolute location in space (called translation invariance) gives rise to momentum conservation, rotational invariance gives rise to angular momentum conservation, and time invariance to energy conservation.

Other symmetries are less familiar but no less powerful: the inability to tell someone in another universe their right hand from their left is called parity invariance. While once thought to hold for all physical processes, we now know parity is violated in the weak interaction.

It turns out the weak interaction is very odd – nature seems to only provide left-handed neutrinos, one of the fundamental particles in the Standard Model. This means that if you face the direction the neutrino is traveling, its spin is 'counter-clockwise'. Of course, this is only *always* true if you could never move to a frame traveling faster than the neutrino, because in that frame, the neutrino would be going the other way, and its spin would appear to be 'clockwise'.

Since no one has ever seen signs of a right-handed neutrino, our theories assume that nothing can go faster than a neutrino. That means that neutrinos must travel at the speed of light and be massless, making neutrinos and photons the only massless fundamental particles of the Standard Model. Since we're still not sure why *any* of the fundamental particles have the masses they do, it's an important assertion.

Recently, however, it turns out that neutrinos do have mass. It's too small to see directly, but you can get at it indirectly. The sun is a great source of neutrinos to study since two are produced every time four hydrogen atoms are converted into helium. About 60 billion neutrinos from this source pass through your body each second. (Note: no need to worry, however, since the typical distance a neutrino will travel through solid lead before interacting once is about a light-year!)

The trick to studying neutrino mass using neutrinos from the sun is that there are actually three 'flavors' of neutrinos in nature. The 'electron' flavor is generated in the

see "Borexino" p6

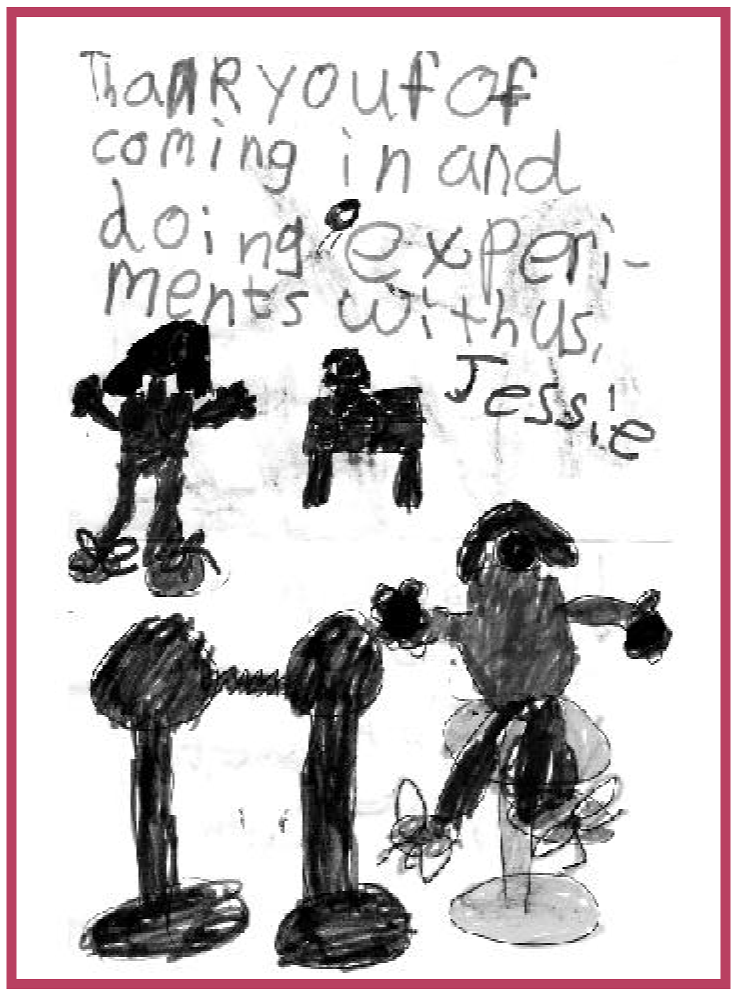
Physics Department Outreach Program

submitted by Amy Emerson, Instructor and Outreach Coordinator

The Virginia Tech Physics Outreach Program helps school children in rural Southwest Virginia experience first hand the joy of discovery. Each year, the program makes about forty trips to elementary, middle and high schools, and hosts a number of campus visits for high school students.

The program has two main goals. The first, and perhaps the most obvious, is to bring physics to young children in a way that is meaningful and fun. Around 1,000 children come into contact with the physics outreach program through yearly classroom visits and school assemblies. The outreach program has received hundreds of thank-you notes and pictures from the students and teachers. Middle school students enjoy assembly programs with 10-12 demonstrations and discussion. In programs for elementary school students, visits take the form of about six different "learning stations," covering topics like motion, pressure, light or electrostatics. The students tour the stations in small groups, and are free to do most of the activities themselves, with supervision and guidance from the college students.

The second goal of the Physics Outreach program is to expose college students to the challenges of science education in K-12 schools, and encourage them to take an active role in their community. On average, 25 college students per semester take part in the Physics Outreach program. Over half of these students are physics majors, with the other students from a variety of majors — international studies, philosophy, chemistry, and engineering, to name a few. All academic levels are represented — first-semester freshmen and graduating seniors, alike. Many students in the program have been doing physics outreach for a number of years! Students report that physics outreach gives them confidence in public speaking and dealing with children, and especially teaches them to explain difficult concepts to a wide variety of people (a skill which is important in most any field).

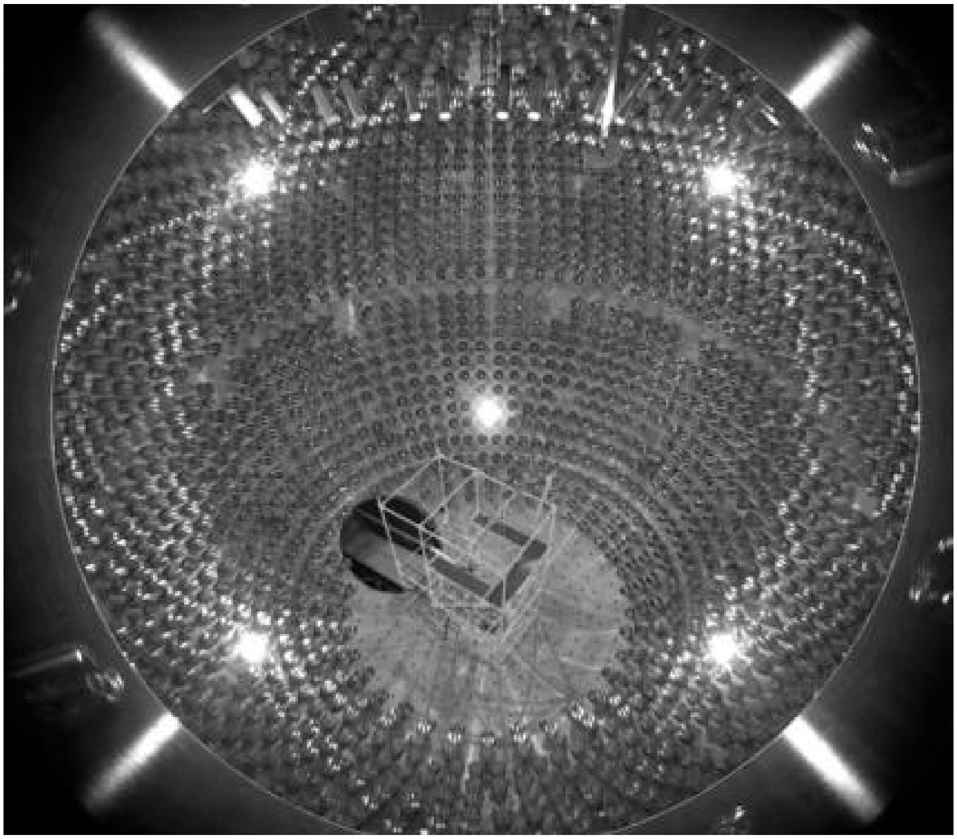


Whether a student ends up as a physicist, writer, teacher, or engineer, they will be a better person for having shared their love of science with someone else.

Thanks to all of the faculty members who have supported the Physics Outreach program!

“Borexino”

continued from page 4



The Borexino detector, seen from one of the VT calibration cameras. The access-port at the bottom is 3 meters in diameter. Along the sides are mounted 2200 photomultiplier tubes, used to detect the light given off when a neutrino interacts. An inner 8.5 meter diameter thin plastic vessel used to separate the active scintillator from a buffer region is not installed yet.

sun, but on its way to earth (about 8 minutes) this flavor can convert into another flavor – ‘muon’ or ‘tau’. The way this happens is similar to how two swings on a playground swing set can couple to each other through torsion of the support beam. Start one swing in motion (electron neutrino), and, if the dampening is minimal and the support beam not too rigid, eventually the first swing will be stationary, and the neighboring swing (muon neutrino) in motion. This phenomenon is described as a ‘coupled oscillator’ and shows the interference between eigen-modes of the system. For this to happen with neutrinos, the neutrinos must have mass and the different flavors must couple to each other.

Detectors here on Earth can tell the difference in the neutrino flavor which arrives, and have shown that these oscillations are indeed happening. Virginia Tech is involved in one such detector called Borexino, located in a national lab deep under the Gran Sasso mountain in Italy. It is the only detector that can identify what is known as the ‘Beryllium-7 neutrino flux’ from the sun. By measuring this flux, we can obtain a better understanding of neutrino mass and mixing parameters.

The active region of the detector is a central clear plastic sphere containing 300 tons of a scintillating liquid (pseudocumene) which gives off light when energy is deposited in it. To avoid background it is located about one mile under a mountain, and a 19 meter diameter water tank surrounds the whole thing. The liquid itself must also be very pure: even 30 micrograms of dust would create serious background. We expect to see about 15 events per day due to neutrinos, a high rate for these types of detectors, despite its huge size.

Virginia Tech is responsible for calibrating the detector by inserting very weak radioactive sources into the active region through a 4-meter long 4” pipe and then locating them to within 2 cm anywhere within the 8.5 meter diameter inner vessel. To do this we have built a long 1.5” diameter sectioned ‘boom and arm’ at the end of which we mount the source and a small light-emitting diode. By imaging the diode using six cameras permanently mounted in the detector we can locate the source through triangulation. The sources themselves are in sealed quartz spheres and only have activities of a few counts per second.

The detector is nearing completion and we hope to be taking data by the end of this year. Many faculty, graduate students, and undergraduates at VT have been involved with this work, both here on campus and also in Italy. The research experience it provides is a great opportunity for undergraduates to round out their physics education and get them involved in the excitement and challenges of a large team effort. At the same time, they play a critical role in making the experiment become a reality. For more information on this and other experiments in our group, check out our webpage at http://www.phys.vt.edu/~wip.

"Department Update"

continued from page 3

of the department continue to be pursued within this new environment. The department has every expectation that with wise decisions, recruitment of superb young faculty, and your input and help we will emerge from these somewhat uncertain times with added strength and focus. We believe that physics will have a significant role in the university's drive to be one of the top 30 research institutions by the end of this decade. We also will continue to provide a nurturing and intellectually stimulating environment for our undergraduate majors.

I thank all of you for your continued interest in Physics at Virginia Tech. If you would like to contribute to the department's mission by recruiting undergraduates or graduate students into our program, or by making a financial contribution, please complete the form at the end of this newsletter.

With very best wishes, John Ficenec

"Daniel C. Kilper - featured speaker for the 2002 Physics Awards Ceremony"

Dr. Daniel C. Kilper is a 1990 graduate of Virginia Tech with B.S. degrees in both physics and electrical engineering, with honors. He was a co-recipient of the H. Y. Loh award presented each year to the outstanding graduating physics student. He received his M.S. and Ph.D. degrees in physics from the University of Michigan. Following a research appointment at the Optical Technology Center of Montana State University, he became an assistant professor at the University of North Carolina at Charlotte. Since 2000, he has been a member of the technical staff at Bell Laboratories, Lucent Technologies in the Advanced Photonics Research Department.

2001 Summer Research Program

by Diane Walker-Green

The physics department hosted a summer research program in 2001. This was a pilot program for future research opportunities. The students who participated were physics majors from small colleges. Each student was paired with professors to expand upon their knowledge and to provide hands on experience in a lab setting. Drs. Heflin, Piilonen and Spillman, along with their graduate students, guided the researchers through a positive learning experience. Below, are the comments from two participants on the summer program.

"I have decided to redirect my graduate plans to study Particle/ High Energy Physics or Quantum Optics... This change is actually due to my summer at Virginia Tech... I did learn enough about particle physics to want to study it further. So, Virginia Tech is still on my list of options."

- Samaiyah Farid

I used my research from over the summer for a class project and I got an A."

- Raven Charles

"Your contributions do make a difference"

The future of Physics is literally determined by loyal supporters who, year after year, provide financial basis for quality education.

Listed below are a few ways in which interested donors can contribute.

?? Through gift planning - charitable gifts that provide an income.
?? Through gifts of securities - stocks, bonds, or mutual funds.
?? Through matching gifts - if your employer has a matching gift program, you could double or even triple your contributions.

To learn more on the different ways you can give, visit the Virginia Tech, Office of University Development - "Ways to Give" website at http://www.givingto.vt.edu/waysgive.html.

However you choose to give, private giving contributes immeasurably to making Virginia Tech a world-class institution. Contributions are tax deductible as provided by law.

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