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

PHYSICS

A UNIVERSITY EXEMPLARY DEPARTMENT

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"Physics Department 'Welcome Back' Barbeque/Picnic"

written by: John R. Ficenec

John R. Ficenec
Interim Head

The Department of Physics held its now annual Welcome Back Barbeque Picnic at noon on Friday, August 23rd in the courtyard between Robeson and Williams Halls. The weather cooperated nicely. About 200 faculty, staff, research associates, graduate students, undergraduates, and family members attended. About 60% of the incoming freshman class of 54 and all of the 11 incoming graduate students were able to attend. Thanks go to Diane Walker Green, coordinator of undergraduate services, who organized the festivities. Good food and conversation were followed by brief self-introductions by everyone.

Three new Research Associates joined the department this fall. Mairbek Chshiev, a Post-doctoral Associate working with Massimiliano DiVentra on spintronics and Casimir forces, Vishnu Jejjala, a Postdoctoral Associate working with Djorde Minic in the area of string theory, and Clark Snelgrove, working with Mark Pitt on the development of laboratories and lecture-demonstrations for the Chemistry/Physics building which is currently under construction. We are also delighted to have Professor Per A. Rikvold spend the fall semester here on sabbatical from Florida State University working with condensed-matter theorists Beate Schmittmann, Uwe Tauber, and Royce Zia on issues in non-equilibrium statistical mechanics.

I wish to extend a warm welcome to the new members of our physics community and a welcome back to our continuing members. We hope that your time here will prove productive and enlightening. The times ahead present new challenges with additional budget cuts for the University due to the shortfall of State revenue. Every attempt will be made by the central administration to minimize the impact of these additional cuts on the academic programs. The Department, the newly forming College of Science, and the University will need the best efforts of faculty, staff, students, alumni, and friends as we seek to become one of the top thirty institutions of higher education in the nation.

"Fiber to dye for"

article courtesy: TechNews

Psychedelic fashion may hold a secret ingredient to faster optical networks. A little-known reaction key to making tie-dye T-shirts may spur advances in fiber-optic communications.

Four researchers at Virginia Tech in Blacksburg are developing materials to make polymer films that may enable better control of laser light used in super-fast telecommunications networks. The key ingredient is Procion Red, a dye commonly used to create the colorful, swirling shirt patterns.

The Virginia Tech team — physicist Randy Heflin, biochemical engineer Kevin Van Cott, chemical engineer Richey Davis and chemist Harry Gibson — takes its cues from the age of nanostructure assembly, not the Age of Aquarius. But if the dye can be used to make better components for electro-optic modulators— devices that convert electrical signals to optical ones — then faster and cheaper signal conversion might be possible. "There seems to be a bit of excitement about it," says Van Cott. "There is still a lot of work that needs to be done."

["The research project so far] has been very successful," says Heflin

In fiber optics, data is converted to light and carried at high speeds over glass fibers. Fiber-optic gear turns lasers and other light sources on and off to direct information through a network. With a microscopically thin film able to better modulate the way light refracts, light can be made to travel faster and at lower cost to network operators.

Think of the film as a door controlling light entering a room. As applied to optical communications, researchers think a faster way to control the light would be to leave the light on and open and close the door, rather than start and stop the power source. "It's not so much a power source as it is a speed one," says Heflin. "With these [electro-optic modulators], you can actually turn the light on and off more quickly ... as opposed to actually turning the power to the laser on and off."

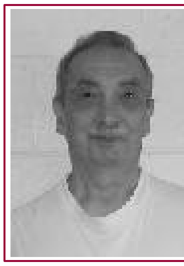
The Virginia Tech team thinks modulators made with these new materials could be up to 10 times faster than existing gear.

"If EO modulators could be made cheaply enough to be used in the home or office, that could greatly speed up access to the Internet," said chemical engineering professor Davis. Procion Red, the T-shirt dye, comes into play because its chemical properties give the film greater durability to withstand electricity shot through the film. It's the same property that reacts to the cotton in T-shirts.

Biochemical engineer Van Cott came across the idea of using the dye for the films while reading a book on pharmaceutical purification. Serendipitously we were able to stumble across it and figure out the right conditions," he said. The team presented its findings during April's American Chemical Society national meeting and will have a paper published in a German chemistry journal. They also hope to supplement their initial $250,000 in research funding with a $2 million grant from the National Science Foundation, in hopes of having a product ready in a year. "[The research project so far] has been very successful," said Heflin. "And the NSF has made a major push in the area of nanotechnology ... and combining it with other disciplines." Far out.

"CANDLE"

article courtesty: Dr. Alexander Abashian



Dr. Alexander Abashian
Director of CANDLE
Emeritus Professor of
Physics, Virginia Tech

***C**enter for the **A**dvancement of **N**atural **D**iscoveries using **L**ight **E**mission - a new 3 GeV Synchrotron Light Source Project in Armenia*

CANDLE operates under the auspices of a private non-profit corporation, headquartered in the United States. CANDLE is projected to be operational in the year 2006.

The CANDLE facility will be operated as an international laboratory, open to all qualified scientists in a diverse set of fields such as biology, materials science, chemistry, geology, environmental science, engineering and physics. Workshops in storage ring design and synchrotron radiation beam line instrumentation, which will bring scientists from around the world to Armenia, are anticipated for the 2002-year. They will help to optimize designs and to match the proposed facility to the needs and desires of the scientific community.

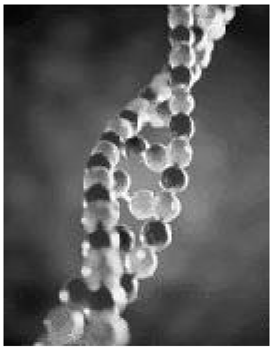
It is our vision and desire that CANDLE will provide an opportunity for the scientists in the region and beyond to have access to a user-friendly, world-class, third generation light source.

A natural byproduct of CANDLE is the renewal of the scientific standards in Armenia to its past world-class level, and the provision of employment for Armenian, as well as, neighboring mature and young scien-

see "CANDLE" p7

Research

"DNA goes spintronic"



DNA molecules could soon add 'spintronic' effects to their repertoire of surprising electronic properties. In simulations performed by Michael Zwolak and Massimiliano Di Ventra of Virginia Polytechnic Institute and State University in the US, the current flowing through DNA molecules jumped by 26% when the spins of the electrons were flipped. Previous studies have shown that DNA can act as a superconductor and a semi-conductor (M. Zwolak and M. Di Ventra 2002 *Appl. Phys. Lett*. 81 925).

Conventional electronic devices only exploit the charge of electrons. But much more powerful devices could be built if the 'spin' of electrons - which can be either +1/2 or -1/2 - could also be controlled. When the spins of electrons are aligned in one direction - or 'polarized' - by a magnetic field, the resistance they experience when they travel through a conductor is different to that experienced by electrons polarized in the opposite direction. This effect is known as magnetoresistance and can be studied by sandwiching a conductor between two ferromagnetic electrodes - a device known as a spin valve. When these electrodes are placed in a magnetic field, the spins of the electrons that they contain become polarized. If a voltage is then applied across the electrodes, the polarized electrons can flow through the conductor, from one electrode to the other. To see how polarized currents would flow through DNA molecules, Zwolak and Di Ventra considered two spin valves - one with iron electrodes and one with nickel electrodes - in which DNA was the conductor. They calculated the current that would flow through the DNA molecules when the electrodes in each spin valve were magnetized first in the same direction - or 'parallel' - and then in opposite directions - or 'anti-parallel'.

Zwolak and Di Ventra believe that it should be possible to observe these effects experimentally, and hope that their results will stimulate further studies into the electrical properties of DNA and their potential use in molecular electronics devices of the future.

The researchers found that the current flowing through the DNA in a nickel-based spin valve would increase by up to 26% when the magnetization of the electrodes was switched from anti-parallel to parallel. In an iron-based spin valve, the current would increase by up to 16% for a similar switch. This shows that electrons would be able to travel through DNA more easily when both the source and drain electrodes were magnetized in the same direction.

Zwolak and Di Ventra believe that it should be possible to observe these effects experimentally, and hope that their results will stimulate further studies into the electrical properties of DNA and their potential use in molecular electronics devices of the future.

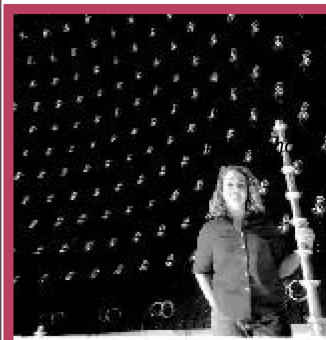
article courtesy: PhysicsWeb - first published 23 July, http://www.physicsweb.org/article/news/6/7/16

"Alumni News"

Jennifer Raaf

***Virginia Tech Physics Graduate** - Jennifer received her BS degree in 1997.*

Fermi National Accelerator Laboratory — **The MiniBooNE Experiment** — At present, Jennifer Raaf, a graduate student from the University of Cincinnati, is conducting a series of tests. She measures the transparency of each oil sample using light with the same blue color as the flashes produced by charged particles emerging from neutrino reactions. "Different companies put in bids for the 250,000-gallon oil contract," Jennifer said. "They all must submit a ten-gallon sample." Without knowing from which company they came, Jennifer tests the properties of the different samples. More than 30 tank trucks will come to Fermilab. The oil of every truck will be tested before it is pumped into the detector.



JENNIFER RAAF

photo courtesy: Fermilab photo

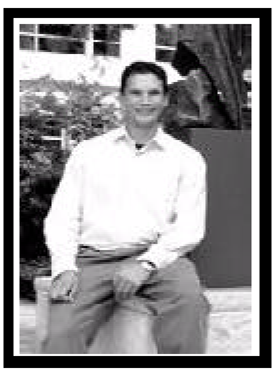
article courtesy: Ferminews

Full article on the MiniBooNE experiment can be accessed at http://www.fnal.gov/pub/ferminews/ferminews01-08-10/p1.html.

"The Science Leaders of Tomorrow"

SPS national internships are designed to create broad-based learning opportunities for undergraduate physics majors. Internships are eight weeks long (June 24 - August 16, 2002). Students are placed in organizations and agencies, which want to utilize the energy and diversity of aspiring students and contribute to their professional development through meaningful assignments, both relevant to the institution's programs and in the advancement of physics or allied sciences. Participating organizations also assign one or more mentors among its senior staff to guide the interns' work and overall experience.

Jason Tabeling, physics senior, among five interns selected for summer 2002



I am a senior at Virginia Tech pursuing degrees in Physics and Mathematics with minors in Astronomy and Spanish. I spent the first half of this summer working at VT for Dr. Randy Heflin experimenting with the electrochromic properties of polymer ISAM thin films. For the remainder of the summer, I will be creating a website to publicize the William F. and Edith R. Meggers Project Award in addition to working on the development of the new SOCK project. If time allows, I will also work to expand the awareness of the Careers Using Physics (CUP) website at the high school level.

During my time at college, I have become increasingly active in the SPS. I started as a member-at-large of the chapter's governing board in my freshman year. Then after a sophomore year full of helping with society activities, I was elected vice president in my junior year. In the upcoming year I will serve as chapter president and Associate Zone Councilor for Zone 4. Also, through the efforts of a then-graduate student at VT, I became involved in a very active physics outreach program. By teaching physics to middle and high school students, outreach efforts provided particularly rewarding experiences that complemented my own study of physics perfectly. Involvement in the SPS and the outreach program have allowed me to immerse myself in the local physics community and forge a great many friendships that have been invaluable to my development as a student of physics.

article and photo courtesy: Society of Physics Students, National Office

Innovation Award

Massimiliano Di Ventra, assistant professor of physics, was awarded the Egg Factory Innovation award for his work.

Di Ventra invented a transistor that uses single organic molecules to amplify electrical current. It has been heralded as a key component of the emerging field of molecular electronics, which could replace silicon-based microelectronics within 10 years. Di Ventra also received a CAREER Award from the National Science Foundation.

"Local professors share teaching honor"

article courtesy: The Virginian-Pilot

David Wright was among 11 professors who shared Virginia's top teaching honor —– the state Outstanding Faculty Awards. Wright is a physics professor at Tidewater Community College. Wright received his doctorate from Virginia Tech in 1984.

David Wright, Physics, TCC

David Shaw Wright is an object in perpetual motion. He's flailing around his lecture room at Tidewater Community College, playfully dodging the molecules flying around him.

He's kneeling on the floor, trying to bend over to knock down a can of spices with his face. He falls over, because his center of gravity is too high.

He's sitting on the desk, balancing a plastic winged bat on his nose to illustrate its center of gravity.

"He's like a little kid," says his boss Greg Frank, chairman of the division of natural sciences and math at TCC's Virginia Beach campus. "He's got more energy than anyone I know of." And more gizmos and demonstrations.

His classes ricochet from one experiment to the next. Wright makes Bill Nye look static. It's all to make physics look fun. "I want to instill in them the wonders of the world around them," says Wright, 51, who has been at TCC for 27 years. "I want them to leave the class with a positive image of physics. It applies to the world everywhere. Have you ever considered what holds a plane up in the sky?" (See Bernoulli's Principle.)

"If teachers did a lot more hands-on and made it more interesting, students would get turned on a lot quicker," Wright says.

He recalls *his* high school physics teacher: Nice man, kind of dull. "He wasn't an inspired teacher. He didn't get excited about it. I told myself: *I'd* be more fun than this."

He is, he is, say his students. "He's made it a lot more interesting than I thought it would be," says Scott House, an elementary education student in one of his morning classes. "I'm usually asleep this time of day, but he keeps us awake." House might even take another physics class, though it's not required. Wright hasn't confined his love of physics to the classroom.

Since 1988, he's been a consultant to Busch Gardens, sponsoring programs that allow kids to measure the G-forces they endure while riding coasters. He appears on "The NASA Why? Files," a national PBS show produced out of NASA Langley. Oh, and he's been on Regis' and Conan's shows, both times lying on a bed of nails while a cinderblock lying atop him is smashed to bits.

That, Wright says, illustrates at least two principles of physics. First, each nail supports a slight fraction of his weight. A lot fewer nails would mean a lot more pain. Second, because the cinderblock is at a

- see "Wright" p7 -

"SCHEV honors several scientists with 2002 outstanding faculty awards"

The Outstanding Faculty Awards are the Commonwealths's highest honor for faculty at Virginia's public and private colleges and universities. These awards recognize superior accomplishment in teaching, research, and public service. On March 1, 2002, Governor Mark Warner and members of the General assembly joined SCHEV in recognizing this year's eleven Outstanding Faculty Award recipients during special ceremonies at the State Capital.

Governor Warner presenting award to Dr. David Wright
(photo courtesy: State Council of Higher Education for Virginia)

article courtesty: Virginia Academy of Science, Virginia Scientists

Research

"Thinner More Flexible Silicon Panels"

article credits to: SpaceDaily News

Virginia Tech researchers are creating flexible photovoltaic devices, or solar cells, by building up nanometer-thick layers of materials selected for their ability to self-assemble and to convert light to electricity.

The work was presented at the 223rd national meeting of the American Chemical Society, April 7-11 in Orlando. A nanometer is about 10 atoms thick. Creating material layers a few atoms thick is not hands-on work. Researchers select materials that will self-assemble. Positively and negatively charged molecules are electrically attracted to one another. Building materials based on this attraction is called ionic self-assembled multilayers (ISAM). Virginia Tech researchers are creating flexible photovoltaic devices, or solar cells, by building up nanometer-thick layers of materials selected for their ability to self-assemble and to convert light to electricity. The researchers are using polymers and molecules called fullerenes. The advantages of these carbon-based (organic) materials over silicon are flexibility and light weight.

"You can fabricate a large area all at once, limited only by the size of your vat of solution from which you grow the films," says James R. Heflin, associate professor of physics at Virginia Tech. "Organic solar cells can be flexible, so you could have deployable sails on a space craft, or fold your solar cell into your briefcase or backpack." So far, the efficiency of organic solar cells is only about 20 percent of silicon. But the Virginia Tech researchers are using ultra-thin layers of fullerenes that act as electron acceptors, which they have demonstrated increases the efficiency of the organic solar cells. "Starting with a conducting polymer, which is a light emitter, we can apply a fullerene layer and produce electrical current from incident light," says Heflin. The problem being solved by nanotechnology is the distance between the materials that are electron donors and acceptors. The fullerene has to be within 10 nanometers of where the light is absorbed for current to be created. "We believe we can improve the efficiency by factors of five or 10 through nanoscale control of the composition and thickness," Heflin says. "We expect organic solar cells will be at least as efficient as silicon within five years." The second ISAM application, electrochromic films, is also existing technology being improved with nanotechnology. Films are presently being produced that will change from transparent to dark by applying a small voltage, and changed back by reversing the voltage.

"An electrochromic display will allow you to view the screen of your laptop computer from any angle," explains Heflin.

The electric field drives ions from one layer of the film to another layer to activate or deactivate optically-absorbing molecules. Applications already include rear view mirrors in automobiles that darken automatically and coated windows that can be darkened with the push of a button. But current materials require several seconds to change color. Researchers from Virginia Tech and Luna Innovations Inc., funded by the SBIR program, are working on the application of such materials for flat panel displays. Current LCD flat panel displays must be viewed head-on.

The problem to be overcome is to increase the speed for the color of the film to change. The refresh rate on a computer screen is 60 to 80 times per second. Electrochromic films presently being produced consist of two materials, each 100 nanometers thick. The Virginia Tech researchers are using self-assembly to create alternating one-nanometer thick layers of the ion conductor and an electrochromic polymer — reducing the distance the ions must travel by a significant amount and increasing the response time. "We have now shown switching times faster than 20 times per second, which is getting close to what is needed for a computer screen," says Heflin.

"David Wright"

continued from page 5

state of "huge inertia," hammering it apart won't create a burst of life-threatening energy. Still he admits, "It takes a lot of faith in physics to do that."

His faith isn't concentrated solely in physics. A devout Mormon, Wright says there needn't be a conflict between religion and science. And his faith has magnified his teaching. "My religous viewpoint helps me to understand how important it is to care about people. I try my hardest to help them achieve."

Wright received his bachelor's degree in physics from Brigham Young University in Utah in 1974 and his master's in 1975. That year, he sent 543 resumes. He got only one interview and one offer, both from TCC, and he hasn't left. In the interim, he received his doctorate from Virginia Tech in 1984.

Lately, Wright has been teaching the tricky subject of torque. It governs how a force affects the rotation of an object. The bottom-line applications include where to hold a wrench (at the very end) and where to put a nut in a nutcracker (in the middle, at the point where the arms connect).

The fancy equation is that the torque equals the force applied to an object multiplied by the length of the lever arm. The lever arm is the distance between the object and the point of rotation. If you want to balance two things, the torques on each side must be equal. That's hard to explain, but easy to demonstrate.

He puts a long board on the floor and places a wooden wedge under it to form a makeshift seesaw. He calls for the heaviest guy in the room. A 190-pounder gets up, and the rail-thin professor proclaims: "I can lift him with one thumb."

He puts the wedge very close to one end of the board and asks the student to stand on that end. Wright goes to the other side of the board. He pushes down, elevating the student an inch. The reason: Wright's force was small, but his torque is greater because his distance from the base is much farther than the student's.

"He-Man, right? No, Torque-Man."

"CANDLE"

continued from page 2

tists, thus reversing the brain drain from the region. These scientists will conduct research and development to bring about advances in health, environmental protection, physics, chemistry, biology, geology, electronics, crystallography and other useful and peaceful causes for the benefit of all humanity.

Scientific collaborations between Armenia and neighboring and far countries for the design, construction and operation of CANDLE are strongly encouraged.

> ***"CANDLE will open opportunity for the scientists to perform world-class research on the benefit of Armenia, region and worldwide."***

"Outreach News"

article written by: Alma Robinson

Alma Robinson
Outreach Coordinator

Have you ever seen students walking around Robeson carrying Tupperware containers filled with physics equipment and wondered, "**What in the world are they doing?"**

The Physics Outreach program is an independent study course dedicated to bringing the excitement of physics to area schools. It is geared towards graduate and undergraduate students who have an enthusiasm for helping young students learn about the fundamental aspects of physics. We visit schools and hold campus visits to conduct demonstrations and activities on such topics as gravity, light, electricity, magnetism, momentum, energy, heat, and pressure. Outreach is always well received by the schools, as each semester we get over 100 thank you letters from students and teachers. While many of the kids write enthusiastically about taking (or majoring) in physics when they get to high school or college, our aim is not to make everyone a physicist. Instead we hope to show every student we visit that physics is all around him/her and it's fun to explore.

This semester, we have 23 participants and we plan on taking about 40 trips throughout the year, serving over 20 elementary, middle and high schools including: Harding Avenue, Willis, Dublin, and Belle Heth Elementary Schools, Madison, Auburn, Christiansburg, and Blacksburg Middle Schools, Floyd County and George Wythe High Schools. We will also be participating in the Technology Studies Leadership rally, Kipps Elementary PTA Science Night, and the Montgomery County Public Schools staff development program.

"Contribute to the future of physics "

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

?? 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.

If you would like your contribution to support the initiatives in Physics, please designate your gift to the "Department of Physics." Thank you so very much for your thoughtful consideration and your generous support of Virginia Tech.

Your contributions are greatly appreciated.

Please fill out the form below and mail to: Virginia Tech, Department of Physics, Robeson Hall 0435, Blacksburg, Virginia 24061-0435. If you need more space, please attach additional information.

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