DEPARTMENT OF PHYSICS NEWSLETTER
FOR ALUMNI AND FRIENDS

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SANTA CLARA UNIVERSITY

Inside this issue:

LETTER FROM THE CHAIR, JOHN BIRMINGHAM

Dear Friends, Colleagues and Alumni,

It is a pleasure to bring you the first issue of the SCU Physics newsletter. It's a very exciting time in the department. Below and inside you will read about faculty research and discover what some of our recent graduates are now doing.

The last year has found each of our full-time faculty members busy with teaching, scholarship and service. Our two newest professors, Chris Weber and Guy Ramon, have each developed new courses in addition to establishing vibrant research programs. Chris experimentally studies magnetic impurities in semiconductors (p. 2) and has developed an upper-division optics lecture/lab course. Guy is a theoretical physicist working on quantum computation and has been responsible for introducing computational physics into the curriculum. Betty Young continues to collaborate on the Cold Dark Matter Search (CDMS). She primarily works on detector optimization and fabrication and has been a co-author on eight papers published since the beginning of 2009. Richard Barber continues to study low-temperature superconductivity but also started a new research effort a few years ago studying polymer photovoltaics, materials that show promise for green technologies (p. 6). Phil Kesten, who was department Chair for many years, currently serves as Associate Vice Provost for Undergraduate Studies. In the fall quarter he offered a new class, "The Physics of Star Trek," which supports the undergraduate Core Curriculum (http://www.startrek.com/article/how-star-trek-changed-my-life-dr-philip-kesten). Father Hayn, who taught several generations of students, retired a few years ago but comes in to the department daily, and we still rely on his knowledge of some of the vintage equipment!

The undergraduate program is healthy and vibrant. We currently have a total of 28 students majoring in physics or engineering physics and an active chapter of the Society for Physics Students (p. 7). Most of our upper-division students take part in research either on or off campus, and in November we held the first department student research symposium (p. 3). Our majors are well prepared for further studies – over the past 7 years, 54% of our graduates have gone on to graduate school. Indications are that the undergraduate program will continue to grow. I recently sent e-mail greetings to 22 high school seniors who were admitted early to SCU and who plan to major in physics or engineering physics. On pages 4 and 5 we catch up with some of our alumni.

We hope that you will stop by the department if you find yourself near the Santa Clara campus. If you cannot visit in person, please feel free to contact me via phone (408-551-7185) or e-mail (jbirmingham@scu.edu). Send us your news, and you will likely see yourself (or your friends) in print in the next edition of the newsletter.

With best wishes,
John Birmingham

FACULTY SPOTLIGHT: DR. CHRIS WEBER, ASSISTANT PROFESSOR

"Could a computer retain its memory without using any power?"

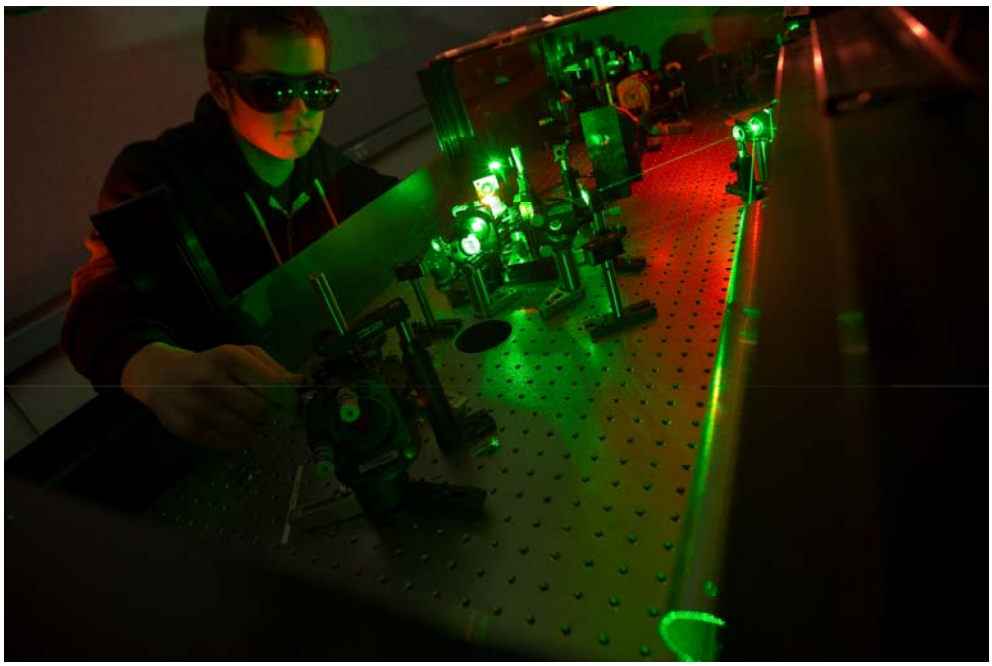
Using Lasers to Watch Electrons Move

Could a computer retain its memory without using any power? Could computer logic and storage someday be combined on the same chip? These possibilities motivate research on magnetic semiconductors such as $Ga_{1-x}Mn_xAs$. But before making practical devices of these materials, scientists need a much better understanding of how they work: what do the electrons do to make the material become magnetic?

Professor Chris Weber believes the answers can be found by looking at processes that occur in less than one-trillionth of a second. He and his undergraduates have built a state-of-the-art optical experiment using lasers to control, and then measure, the microscopic motion of electrons in $Ga_{1-x}Mn_xAs$. Their laser produces extremely short pulses of light that, as in strobe-light photography, reveal the electrons' positions in rapid succession. Information about those positions is encoded in the reflected light, in changes of just ten parts per million.

The electrons' motion is diffusive—much like the spreading out of an ink droplet in water. A theorem due to Einstein relates the diffusion to the number of quantum-mechanical energy states available to the electrons. This "density of states" plays a key role in creating magnetism in magnetic semiconductors, and it can be inferred from Weber's experiment. Prior measurements of it have been few and controversial.

In their experiments, Weber and his students cool a sample of $Ga_{1-x}Mn_xAs$ to the temperature of liquid nitrogen before measuring it. That's because, like all magnetic semiconductors, $Ga_{1-x}Mn_xAs$ is only magnetic when its cold.

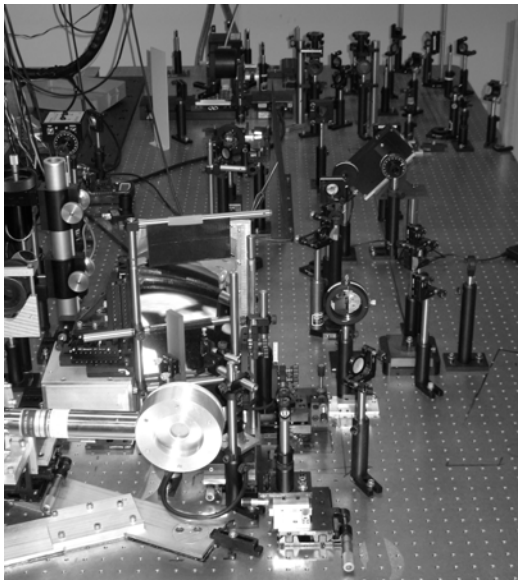


Student Craig Benko SCU '10 adjusts a Ti:Sapphire laser in Prof. Weber's lab. The laser is powered by intense green light and produces extremely short pulses of red light. Photo credit: F.J. Gaylor Photography 2010.

SPOTLIGHT CONTINUED

Any practical electronic device made of magnetic semiconductors, though, will need to operate even at room temperature. Weber hopes that someday a new material will be made that will remain magnetic up to room temperature and that his experiments will help to pave the way. “The route to designing better materials," he says, "is understanding how the ones we've got work. The uncertainty about the density of states is the main obstacle." Weber’s lasers, split-second timing, and a lot of careful experimental work may yet overcome that obstacle.

Professor Chris Weber received his A.B. and Ph.D. in physics from the University of California at Berkeley in 1999 and 2005, respectively. He joined the Santa Clara faculty in 2008.



It's done with mirrors. Dozens of mirrors and lenses coax four laser beams into just the right configuration to control and measure electrons' motion. The sample of $Ga_{1-x}Mn_xAs$ *is kept cold in a cryostat (foreground). Photo credit: C.P. Weber 2010.*

Professor Chris Weber believes the answers can be found by looking at processes that occur in less than one trillionth of a second.

STUDENT RESEARCH SYMPOSIUM

On November 5, 2010 a handful of our juniors and seniors presented some of their faculty-sponsored research. The program included these talks:

Scintillating Physics in Zurich
Stoney Strickland

Studying Capacitance of MOS Devices, à la Française!
Scotty Bemis

Collective Nuclear Spin States in a Double Quantum Dot
Sean Wells-Rutherford and Teddy Mefford

Shedding Light on Photovoltaic Device Performance
Emilee Sena

What Information is Carried in a Neural Spike Train?
Aaron Melgar

Ultrafast Laser Measurements of Spin Diffusion in Magnetic Semiconductors
Stan Hiew

Scotty Bemis’ “Sound-to-light Converter” built in Physics 151, the senior lab course (2011).

CATCHING UP WITH ALUMNI: UPDATES FROM SOME OF OUR GRADUATES

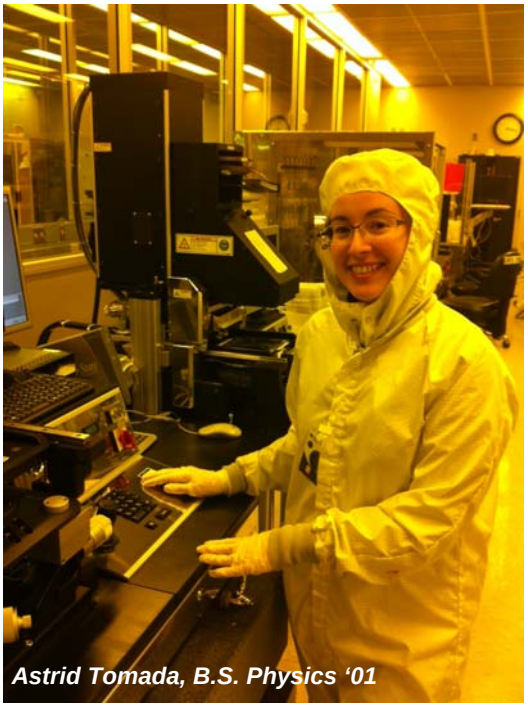
Ilya Nemenman, B.S. Physics (and Math) '95

I studied theoretical physics for three years in Belarus before coming to the States and arriving at SCU, where I earned B.S. degrees in physics and math in 1995. I then attended San Francisco State University where I earned an M.S. in physics in 1997. From there I went to graduate school at Princeton where I earned a Ph.D. in theoretical physics in 2000, focusing on studying information processing in living systems.

It was during my graduate school years that I realized that studying string theory cannot be more exciting than studying the brain that can study string theory! So I shifted my research focus from quantum field theory to theoretical biophysics and computational biology. I did my postdoc work at the Kavli Institute for Theoretical Physics in Santa Barbara and then, to obtain some training in basic biology, at the Columbia University Joint Centers of Systems Biology. This was followed by a research position at Los Alamos National Laboratory. In 2009 I moved with my family to Atlanta, Georgia, where I am currently an Associate Professor of Physics and Biology at Emory University.

It was a cold November in the late '90s when I jumped on an airplane to come to California from my little town in Italy. My plan was to spend a couple of years here and finish my physics degree, but it ended up being quite a different story. After improving my English language proficiency, I was accepted at SCU as a transfer student in Physics with a minor in Computer Science. I graduated in 2001, and with the mentoring and help of Professor Betty Young I landed a position at Stanford as a Science Research Assistant in the Physics department. While working full-time at Stanford I earned an M.S. in Management Engineering from SCU in 2006.

My work at Stanford is mostly with the Cryogenic Dark Matter Search (CDMS) a 13-institution, international research collaboration. My major contributions involve fabricating and packaging the state-of-the-art CDMS detectors we use to search for WIMPS (Weakly Interacting Massive Particles) in the Universe. These detectors have patterned superconductive sensors and are fabricated in a clean-room facility at Stanford. Once packaged, the detectors are deployed in the Soudan Underground Facility (a deep mine in Minnesota) where they are cooled to well below 0.1 Kelvin. This project is very interesting and challenging, as we are continuously optimizing our detectors for various detection schemes. My job can be very absorbing but it is also flexible enough to allow me to have a wonderful family.



Astrid Tomada, B.S. Physics '01

ALUMNI CONTINUED

I graduated from SCU in 1998 with a double major in Engineering Physics and Electrical Engineering. During my time at SCU I was most fortunate to have the opportunity to work as a research assistant for Dr. Young. Supporting her research in dark matter detectors, I learned much about fundamental physics research, building and operating a lab, and performing simulations and experiments on detector devices.

After graduation I worked for Lockheed Martin Space Systems Co. and was responsible for providing on-orbit support for critical national assets at Onizuka Air Force Station (the "Blue Cube"). I learned a great deal about spacecraft operations and troubleshooting problems with complex systems. A few years later I joined a small group performing applied physics R&D for spacecraft systems, and then eventually became a Systems Engineer in the Advanced Concepts group where I worked on novel space systems and key business pursuits.

In 2006 I moved to the beautiful state of New Hampshire to work in BAE Systems' space products division, continuing to support critical national space assets as a Systems Engineering Manager. Although I really enjoyed working in the spacecraft industry, I eventually decided to try something different. Last September I joined iRobot's 510 PackBot program where I now work to continue advancement of a robotic platform that enables our law enforcement officers and soldiers to remotely perform high threat, dangerous missions. The picture below shows me in our lab next to one of our test robots. The skills I developed during my academic tenure at SCU, and more specifically as a member of the SCU Department of Physics, have created numerous challenging and exciting career opportunities.

John Cross, B.S. Engineering Physics (and EE), SCU '98

"I was most fortunate to have the opportunity to work as a research assistant for Dr. Young."

ALUMNI—WE WANT TO HEAR FROM YOU!

Please e-mail or mail us the following information:

- Name & year of graduation
- What you did after school (advanced degrees, work, travel)
- What you are doing now
- How your SCU degree contributed to your current activities
- We love pictures!

Let us know if we can feature you in an upcoming newsletter. You can e-mail this information to Rima Nemechek (rnemechek@scu.edu) or mail to Department of Physics, Santa Clara University, 500 El Camino Real, Santa Clara, CA 95053.

Devin Wesenberg's "Bass Booster" built in Physics 151, the senior lab course (2011).

PHOTOVOLTAICS WITH PROFESSOR RICH BARBER

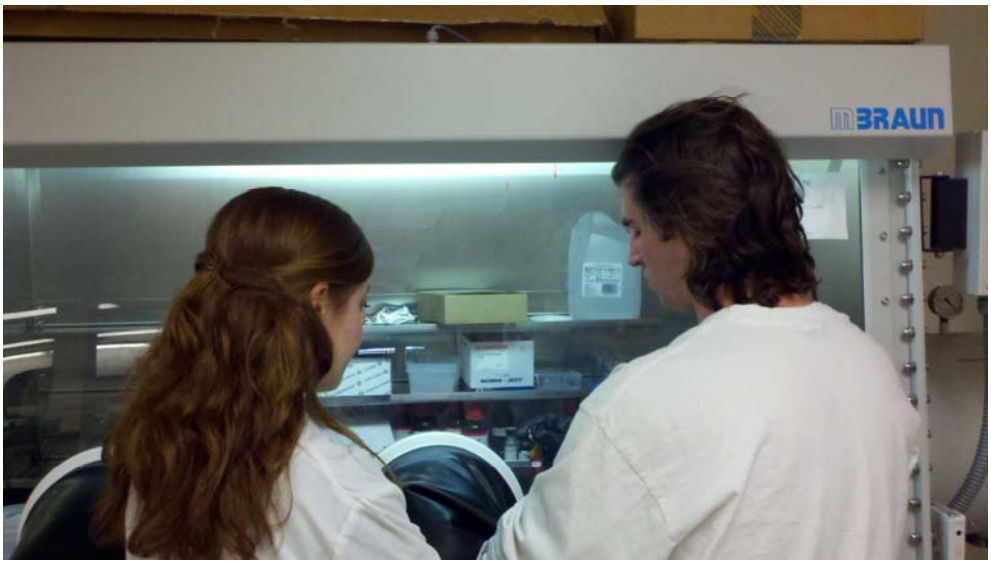
"These materials offer the promise of cheap and easily manufacturable solar cells."

My primary research is a collaborative effort with Professor Brian McNelis and Professor Thorsteinn Adalsteinsson in the Department of Chemistry and Biochemistry studying polymer photovoltaics. These materials offer the promise of cheap and easily manufacturable solar cells. Their use in technologies is currently limited due to their relatively low efficiency and poor chemical stability. In solution, the polymer in these devices is observed to be iridescent — light striking the polymer causes electronic excitations which decay by re-emitting light (hence the glow). By adding C-60 molecules to the mix as electron acceptors, we are able to separate the charges in those excitations and collect them as current.

We are studying the role of the C-60 molecules in device lifetime. We have found correlations between how long these devices last and their optical absorption.

Our first results from this work appeared in *Solar Energy Materials & Solar Cells* 94, 537 (2010). Currently there are two SCU seniors working on this project: Emilee Sena (Chemistry and Biochemistry) and Devin Wesenberg (Physics). Emilee is focused on the spectroscopic absorption measurements, and Devin is making and testing devices. Emilee will present our latest results at the 2011 March Meeting of the American Physical Society in Dallas.

These students recently wrote a successful proposal which was funded by SCU's Center for Science Technology and Society. This work will continue as we try to understand how to improve these materials.



Emilee Sena SCU '11 and Devin Wesenberg SCU '11 work in Professor Barber's lab.

SOCIETY OF PHYSICS STUDENTS

We have a very active SPS group this year. Seniors Allison Kopf (President) and Jacob Jackson (Vice President) have been busy organizing activities and events for the group. New members were welcomed with a barbeque in the fall. SPS has been offering physics tutoring on a weekly basis and getting a great turnout. Some exciting events have been planned such as a field trip to Lick Observatory, a tour of NASA, a trip to the Nightlife event at the California Academy of Sciences, a camping trip, and additional social gatherings and multiple pizza dinners. SPS is currently reaching out to the community to establish a program with local middle school children.

Scotty Bemis SCU '11 tutoring

Allison Kopf's "Message Scroller" built in Physics 151, the senior lab course (2011).

WHERE DO OUR PHYSICS ALUMNI GO?

Over 50% of our graduates pursue advanced degrees. The Physics and Applied Physics graduate programs our students have attended include Univ. of Colorado (Boulder), Naval Postgraduate School, Univ. of Arizona, UC Berkeley, UC Irvine, UCLA, UC San Diego, Univ. of Florida, Univ. of Texas Anderson Cancer Center (Medical Physics), Harvard, Yale, Stanford, and Princeton.

Some of our graduates have gone on to study in other fields at institutions including Columbia (Earth Resources), Dartmouth (M.D./Ph.D), Ithaca (Education), Stanford (Industrial Engineering), UC Berkeley (Law), UC Davis (Chemical Engineering), UCLA (M.D.), Univ. of Chicago (Law), Univ. of Oregon (Math).

Statistics for SCU Physics graduates, 2003—2009

Graduate School Physics	30%
Other Graduate/Professional School	24%
Other Career	27%
Unknown	19%

THANK YOU FOR YOUR INTEREST AND DONATIONS!

We are always interested in learning of new internship or employment opportunities for our strongest physics and engineering physics majors. If you know of such an opportunity, please get in touch with us! We also greatly appreciate donations to the Physics department. Recent donations have been from Intellivision (to support polymer photvoltaics work) and NVIDIA (to support MOS-device physics work). Please consider a tax-deductible donation that can be used to support faculty and student research and student travel to conferences. You may send a check to the Physics department payable to SCU, or visit the online giving site at http://www.scu.edu/give/. To donate online, select "Make Your Gift." To direct your gift to Physics select "Other" in the pull down menu, and after you designate an amount, select "Other" again, and type in the Physics department as the recipient.

"I'm a physicist, not a doctor!" - Prof. Cobbwell

(Paraphrasing Peter Parker's (Spiderman's) science professor, paraphrasing Dr. Leonard McCoy)

AN EXCITING NEW PHYSICS CLASS! PROFESSOR PHIL KESTEN

This fall I had one of the greatest teaching experiences of my career! It was my first time teaching "The Physics of Star Trek," a course I developed over the past year to satisfy the Science, Technology, and Society requirement in the new Core Curriculum. Unlike a course aimed at science and engineering majors, in which there are clearly defined "important" topics to cover and which students must master, the Physics of Star Trek offered me the chance to pick and choose from a wide range of interesting physics subjects.

The Physics of Star Trek might not be what you think. We didn't watch Star Trek episodes in class. We didn't talk about fanciful, made-up, science-fictiony science. We didn't dress in costumes or learn to speak Klingon. Yes, the physics we uncovered is related to Star Trek, but it is all **real physics**. We talked about conservation of momentum and energy, about relativity, and about the Heisenberg uncertainty principle.

We also discussed warp drive and transporter beams, which led us to topics like the curvature of space, general relativity, nuclear power, and the Standard Model of particle physics. (Oh, and yes, warp drive is real. Okay, we can't *do* it yet, but there is at least a theoretical underpinning. See Alcubierre, M. *"The Warp Drive: Hyper-fast Travel within General Relativity," Classical and Quantum Gravity,* 11(5), L73-77 (1994). And people have been building and testing transporters since the late 90s; see http://media.caltech.edu/press_releases/11935.) And along the way we got to answer questions like… How do we measure the distance to a planet or star? How does an Einstein's Cross form? And why do we care about finding water on Mars or Europa or a planet orbiting another star? All interesting stuff — a great way to get students interested in science they might never have thought about otherwise!

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