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NEWS

Awards & Honors

The following UMD experts were included on the American Physical Society's (APS) 2008-2009 Outstanding Referee List:

- S. M. Bhagat
- Dieter Brill
- Sankar Das Sarma
- J. Robert Dorfman
- Andrew Elby
- Theodore Einstein
- Michael Fisher
- O.W. Greenberg
- Hans Griem
- Ted Jacobson
- Christopher Jarzynski
- T.R. Kirkpatrick
- Edward Ott
- Steve Rolston
- Stephen Wallace
- John Weeks

The Outstanding Referee program was instituted in 2008 to recognize scientists who have been exceptionally helpful in assessing manuscripts for publication in the APS journals.

Chris Long, Graduate Student, was one of ten students nationwide selected for a 2009 Ludo Frevel Crystallography Scholarship Award. The award, granted by the International Centre for Diffraction Data (ICDD), is designed to support graduate students conducting research in crystallography-related fields. Long won for his proposal titled "Rapid Identification of Structural Phases in Combinatorial Thin-Film Libraries Using X-Ray Diffraction and Non-Negative Matrix Factorization."

In the News

Jordan Goodman, Professor, was quoted in Science News, February 28. The article, on the surplus of particles from space invading Earth's atmosphere, can be found here.

James Gates, Professor, published an article that appeared in the January 20th Baltimore Sun. The article, on the election of President Obama, can be found here.

Bei Lok Hu, Professor, was quoted in Discover News, January 29. The article, on entangled particles that can suddenly and irrevocabl lose their connection, can be found here.

Edward Redish, Professor, was quoted in The Columbus Dispatch, January 29, regarding an article that was recently published in Science Education, by Physics Alumnus **Lei Bao**.

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RESEARCH SPOTLIGHT

Research Spotlight
By: Ian Appelbaum

In 1922, Stern and Gerlach performed an experiment to test the then-prevailing semiclassical “pre-quantum mechanics” theory of the atom by Bohr and Sommerfeld. By measuring the birefringence of a beam of neutral silver atoms through an inhomogeneous magnetic field, the existence of an internal atomic magnetic moment was deduced. Although this result was taken at the time to provide confirmation of the old Bohr-Sommerfeld atomic theory, a successful interpretation attributing it instead to the intrinsic magnetic moment of the valence electron was provided several years later by Uhlenbeck and Goudsmit in 1925. In the original version of this theory, the charged electron was thought to rotate about its axis to create this magnetic moment; the related internal angular momentum was thus called “spin”. (Wolfgang Pauli famously ridiculed this idea, and the modern interpretation is that spin is a quantum mechanical degree of freedom that does not have a classical analogue.)

Physicists have therefore known that the electron has a magnetic moment for over 80 years. Why, then, have electrical engineers not exploited electron spin in semiconductor devices, where, up to now, only electron charge and effective mass affect transport? Spin orientation (“up” and “down”) can encode information and potentially lead to the design of fundamentally different logic-processing devices with improved performance or alternative functionality, but electron spins in today’s integrated circuits are effectively randomly oriented and so play no role. Preferentially orienting the spins (or injecting “spin polarized” electron currents) is a challenge, in part because, unlike charge and mass (which are conserved), aligned spins will randomize again over time in nonmagnetic semiconductors and spin polarization will decay.

Magnetism of conventional materials like iron is related to the spin polarization of the conduction electrons, so when spin-polarized electron transport was first proposed as the basis for a semiconductor device operation in 19901, it was assumed that we could orient the spins in semiconductors simply by drawing them from a ferromagnetic metal contact. However, as several authors showed in 2000,2,3 the task is made difficult by the unavoidable mismatch in electrical resistivity and the timescales for spin relaxation (spin “lifetime”) between metals and semiconductors. Recently, it was demonstrated that spin-polarized electron injection into semiconductors from magnetic metals could be successfully achieved using quantum mechanical tunneling through thin insulating barriers instead, or by injection of electrons far out of thermal equilibrium (so-called “hot” electron injection).4

Over the past several years, my group has explored spin-polarized electron injection, detection, and spin control during transport in the semiconductor silicon, Si (which is, of course, the materials basis for the microelectronics industry). Because of several fortuitous intrinsic properties, electrons in Si have an extraordinarily long spin lifetime, preserving their spin orientation information for long durations.5 Furthermore, by controlling their transport in allelectronic devices, we have shown that this information can be moved over several millimeters,6 perhaps long enough to inspire design of spin-controlled integrated circuits that can leverage the already existing large technology infrastructure investment in Si.

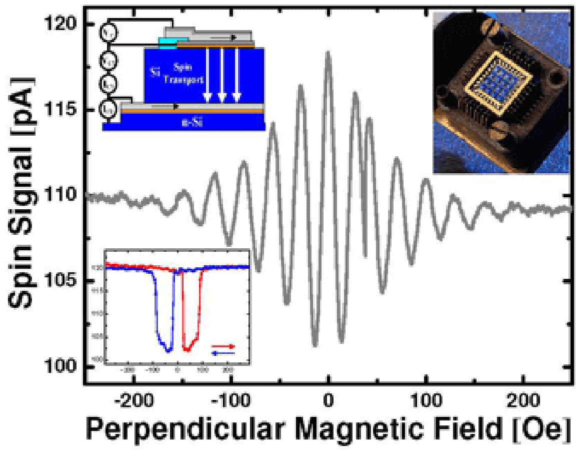

Fig. 1: Signal oscillations due to spin precession in our devices is caused by magnetic torque, and provides unambiguous evidence for spin-polarized electron transport in Silicon; (top right) Silicon spin transport devices; (top left) Side-view device schematic; (bottom left) Device measurements in a magnetic field parallel to the device plane, which can be used to determine the degree of spin polarization of injected electrons.

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2 G. Schmidt, D. Ferrand, L. W. Molenkamp, A. T. Filip, and B. J. van Wees, Phys. Rev. B 62, R4790 (2000).
3 E.I. Rashba, Phys. Rev. B 62, R16267 (2000).
4 Ian Appelbaum, Biqin Huang, and Douwe J. Monsma, Nature 447, 295 (2007).
5 Biqin Huang, Douwe J. Monsma, and Ian Appelbaum, Phys. Rev. Lett. 99, 177209 (2007).
6 Biqin Huang, Hyuk-Jae Jang, and Ian Appelbaum, Appl. Phys. Lett. 93, 162508 (2008).

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ALUMNI SPOTLIGHT

Alumni Spotlight: Ben Thorp

1. General background information/education. What schools did you attend and what degrees

did you obtain?

B.S. Physics, U of Maryland 1964. Graduate work at U of Bridgeport, Rensselaer Polytechnic Institute and U of Tennessee. Work caused me to move too much to accumulate enough credits for a graduate degree against the then rules. That was OK because it was the knowledge and skills that were important.

2. What led you to the University of Maryland?

Reputation and the possibility of a cyclotron which was diverted to a College in Texas when LBJ became President in 1963.

How would you describe your experience here?

I started as a full time employee at the Glenn L Martin Facility (wind tunnel) and went to the University part time. Both were a great experience. I then entered as a full time student in Physics with a minor in Philosophy. At that time I did not realize what a powerful experience that would be. It helped to understand "first principles" in science, technology, business and life. With that understanding my contributions were far greater than they would have been otherwise.

3. Where do you currently work?

I am currently doing consulting work in biorefineries. That is the conversion of biomass materials into renewable fuels. Using the skills developed in understanding first principle I have become a recognized expert in that field.

4. Describe your research.

Fundamentally it is the conversion of biomass into fuels and chemicals. There are 3 major pathways. The first pathway is to hydrolyze the cellulose in woody materials or energy crops or spent agricultural crops through the application of enzymes or acids. This hydrolysis converts the cellulose to sugars which can then be fermented to ethanol or other chemicals. The second pathway is to gasify or heat these materials with limited oxygen until they decompose to a synthesis gas which is largely composed of hydrogen, carbon monoxide and carbon dioxide. This synthesis gas is then catalytically converted to liquids by a number of processes. The country of South Africa used the Fischer-Tropsch process to make a variety of transportation fuels for coal syngas after the oil embargo was placed on them 50+ years ago. The third pathway is to use a sequence of chemical and catalytical processes to make a direct conversion. This is the most complex method and the one least developed.

5. Do you enjoy what you are doing?

Yes. Within the last 2 years I was invited to two European Conferences to give a summary of biorefinery activities in North America. As a result of this I was engaged by the Ministry of Energy, European Commission (their equivalent of the Department of Energy) to be part of an independent team to review and grade submissions for potential awards.

6. Have you held other positions since graduating from UMD?

Previously I was an executive with Huyck Corporation, BE&K Engineering, James River Corporation and Georgia Pacific Corporation, all of whom were acquired by other companies. Surviving and profiting from acquisitions required the development of additional skills. This skill was developed from the principle to "always trade up".

7. What advice would you give current students?

First select courses that will develop skills in understanding first principles. Science and math will focus on deductive reasoning. Others must be selected to develop inductive reasoning. Use and develop these skills when employed even in lower level jobs... It takes a long time to get really good at this. However, it can be personally rewarding. Also this does not just apply to science and business. It can apply to quite different experiences like raising children. Just watch babies when they are months old and try to figure out why they do whatever they do. When you can understand a little of this your ability to interact and be a parent can increase significantly.

Do you remember any problems that you faced while here?

One of the biggest problems I had was developing an understanding that completing the course work was not really providing an education. I had to complete the course work to stay at the university. Then I had to understand the subject which meant understanding first principles. There were some professors who were quite good at helping me do this. There were others that were bothered by this approach and I let it cause minor conflicts. Due to lack of finances, and no student loan programs at that time, I had to work almost the entire time. This left very little time for sleep. I managed to develop some skills at getting rest with little actual sleep. These skills proved to be to great advantage later in life.