Nanoscale | Quantum Phenomena Institute
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OHIO UNIVERSITY

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NanoForums foster student collaboration

Graduate student Kendal Clark presented his STM research last month for a group of students across disciplines as part of the NanoForum program.

"There is a big difference between giving a talk to your research group and giving it to a group of other students who are not so familiar with your work," he said. He added that answering student questions helped him better understand his research.

In its second year, the NanoForum program encourages student collaboration through informal, student-led research talks.

"The NanoForum is intended to be a meeting for students."
-Dr. Sergio Ulloa

"The NanoForum is intended to be a meeting for students," said Sergio Ulloa, professor of physics and program director. "We want students to communicate across fields as often as possible."

NanoForums are 4 p.m. every second Tuesday in Clippinger 259. For a schedule, visit www.ounqpi.org.

Team's models help discover method for controlling spin with electric field

Modeling by Anh Tuan Ngo and Sergio Ulloa revealed key factors to controlling spin electrically. Photo by Erica McKeehen | University Photographer

For decades, the transistors inside radios, televisions and other everyday items have transmitted data by controlling the movement of the electron's charge. Scientists have now discovered that transistors could use less energy, generate less heat and operate at higher speeds if they exploited another property of the electron: its spin.

Until now, scientists in spintronics have controlled spin by attaching an external magnet directly to transistors. But with the demand for smaller devices on the rise, a bulky magnet is not an efficient or practical method of controlling spin, said Sergio Ulloa, professor of physics.

"The holy grail in spintronics is to address spin with something other than magnets," he said. "An electrical field is portable and easy to switch on and off."

Ulloa and graduate student Anh Tuan Ngo helped solve this issue by providing theoretical modeling for the first experiment to successfully control an electron's spin using purely electrical fields.

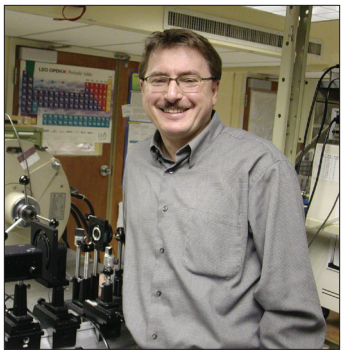
See SPIN, pg 3

DURIP grant funds new MOKE spectrograph

When Wojciech Jadwisienczak pulled an old magnetic characterization system out from the corner of his lab two years ago, he knew the equipment was outdated. For starters, the heart of the system—its electromagnet—was more than 40 years old.

"New equipment for magnetic characterization is badly needed at OU," said Jadwisienczak, assistant professor of electrical engineering. "We have limited capability to characterize magnetic materials at the micro or nano scale after they are taken out of the growth chamber."

See MOKE, pg 3



OHIO UNIVERSITY 1804
NANOSCALE | QUANTUM PHENOMENA INSTITUTE
OHIO UNIVERSITY
CLIPPINGER LABS, ROOM 163, ATHENS, OH 45701
TEL: (740) 593-1757 FAX: (740) 593-0433
WWW.OUNQPI.ORG MALA@HELIOS.PHY.OHIOU.EDU

Director's Corner

Institute grows with new student programs, grants

Dear Colleague,

There have been many exciting developments in the Institute over the past six months. Each of our 26 faculty members is actively engaged in research, involving both graduate and undergraduate students. We have a high level of grant activity totaling $1,009,685 since April, with 5 new grants received. Members are also publishing papers in top journals, such as those highlighted here.

The new overhead return policy beginning July 1, 2009 strongly favors even greater benefits for institute members, including the newly rolled-out TIP (travel incentive program).

The NanoForum program was launched in spring quarter 2009 to promote and strengthen the research of our students. Attendance has been excellent, and we expect this trend to continue.

Major initiatives over the summer included writing two ARRA "stimulus" proposals—one for the "Atomistic Construction Facility (ACF)" (sent to NIST, $15M request) and another for a new 15 Tesla/300 mK cryogenic STM with MBE growth facility (sent to NSF, $1.99M request).

The SPIRE program is also growing rapidly, with the first student going to Argentina this summer (Greg Petersen) and four others going to Hamburg (Kendal Clark, Andrew Dillulo, Tianjiao Chen, and Jennifer Drerup).

Finally, installation of the new Helium Recovery and Liquefaction facility is in progress. Once operational, it will provide a ready and low-cost source of LHe to NQPI members.

-Art Smith, Director

NANOBYTES

Dr. Alexander Govorov received a $195,798 grant from the National Science Foundation.

Dr. Nancy Sandler received a $188,000 grant from the National Science Foundation.

Dr. Gang Chen received a $357,373 grant from the National Science Foundation.

Dr. Savas Kaya received a $5,887 grant from the National Institute of Standards and Technology.

Briefs: News from around the Institute

Physics alumnus **Venkatraman "Venki" Ramakrishnan** was recently awarded the Nobel Prize in Chemistry for his work on the function of ribosomes.

Saw Wai-Hla and **Greg VanPatten** have returned from their sabbaticals. Each spent time researching in Germany.

Alexander Govorov is currently on sabbatical.

Savas Kaya sponsored the Friday science talks on OU's local WOUB radio station on behalf of the Institute.

Physics graduate student **Yeliz Celik** will defend her doctoral thesis in late November.

Physics alumnus H. **Lee Mosbacker** is teaching a class in the OU College of Business this quarter, called Technology and Entrepreneurship (MGT 491).

This fall NQPI will host **Dr. Lena Ivanova,** a postdoctoral student at the Technical University in Berlin. During her visit, she will present her doctoral research on gallium nitride and quantum dot systems.

Planning is currently underway for the **5th Annual NQPI Retreat**, to be held this spring.

Nancy Sandler and **Sergio Ulloa** were selected to deliver invited talks at a recent research workshop in Israel, titled "50 Years of the Aharonov-Bohm Effect: Concepts and Applications."

Physics graduate student **Swati Ramanathan** received a $1,000 Sigma Xi Grant for her research in optical properties of nanoparticles.

Annual weekend retreat encourages member collaboration, brainstorming

(L to R): Ralph Whaley, Gang Chen and Savas Kaya take a nature walk during the NQPI Retreat at the Carpenter Inn in nearby Pomeroy, Ohio.

NQPI members gathered to discuss the institute and their research at the 4th Annual NQPI Retreat in April.

During the two-day retreat, members brainstormed ideas for future conferences, shared instrumentation facilities and the future of NQPI.

Between these business discussions, the members participated in group activities such as a nature walk on the Carpenter Inn's property.

Foster poses with one of the physics department's microscopes during her visit to OU. Her specializations are light microscopy and spectroscopy.

Master microscopist, entrepreneur presents colloquium at alma mater

Barbara Foster returned to Ohio University last spring for the first time in twenty years to present a colloquium titled, "I Didn't Know You Could Do That (IDKYCDT)!!: Nanoscale Probing, Imaging and Spectroscopy."

Master microscopist and founder of a successful company, The Microscopy & Imaging Place, Foster has developed her interest in microscopes ever since she graduated from OU with a degree in science education.

The Microscopy & Imaging Place uses early stage market research to help launch new products and new companies.

In addition to running her company, Foster is a contributing editor for *American Laboratory* magazine and still teaches occasional training classes on microscopy.

MOKE, from pg 1

He was recently awarded a DURIP grant from the Army Research Office to develop the magneto-optical Kerr effect (MOKE) spectrograph, a modular magnetic characterization system.

In the system, the researchers place a material into a magnetic field and probe it with polarized light, typically a laser beam, and then determine what characteristics in the material caused the observed changes in polarization.

Using this noninvasive probe means that scientists can perform measurements in three geometries—polar, longitudinal and transversal—and in a spectral range from ultraviolet to near infrared.

The equipment can also operate at low temperatures. In the future, Jadwisienczak plans to adapt the MOKE system for use with low dimensional magnetic materials such as quantum dots.

The new system, called Nano-MOKE, will open up a new avenue for the post-growth magneto-optical characterization of these materials at OU, he said.

SPIRE student researches in Argentina

Graduate student Greg Petersen continued his PhD research at the National Atomic Energy Commission in Buenos Aires this summer as part of the Spin-Polarized Partnership for International Research and Education (SPIRE).

During his stay in Buenos Aires, Petersen learned a new research technique that he will incorporate into his work with Dr. Sandler—parameterized tight binding.

Petersen says explaining his research to the directors at the National Atomic Energy Commission was challenging but rewarding.

"When I went there, I had to defend how I saw the research problem," he said. "The directors would ask me questions that would help me find holes in my understanding."

When not researching, Petersen explored Buenos Aires and other parts of Argentina.

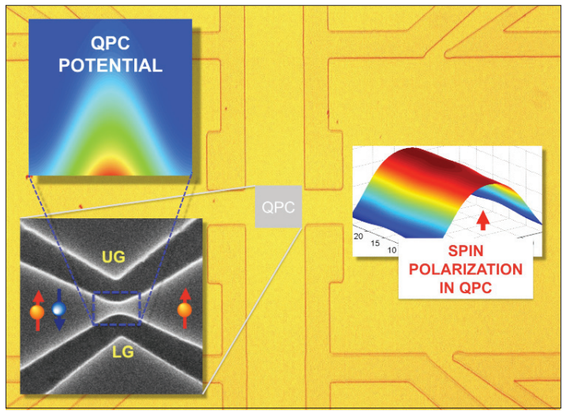
SPIN, from pg 1

This finding appears in the article, "All-Electric Quantum Point Contact Spin-Polarizer." *Nature Nanotechnology,* published online Sept. 6, 2009.

The team collaborated with a research group at the University of Cincinnati, led by Philippe Debray and Marc Cahay. Debray conceived and designed the experiments. The OU team's calculations explained the behavior of the electrons and predicted how strong the electric field's control over the spin would be.

The models revealed a key to the experiment—that the tiny connection along which the electrons travel in the device must be asymmetrical.

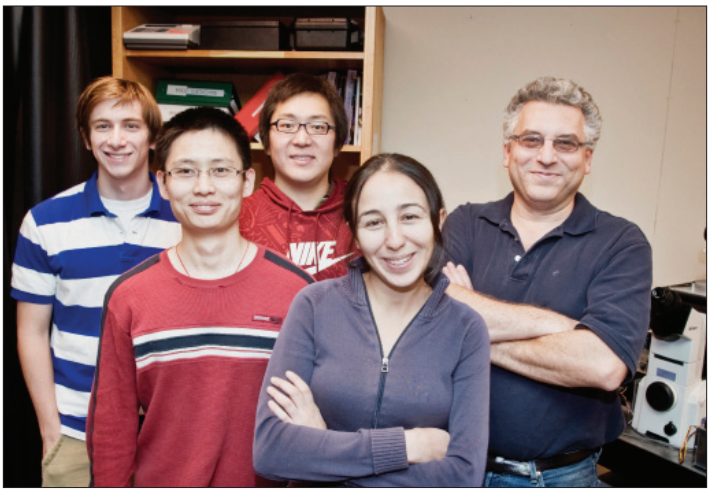
Asymmetry lets the electrons recognize in which direction they are traveling. This helps their spin determine which way is up, thus allowing the electrons to engage in spin-orbit coupling and polarization. The coupling triggers the spin and the electron-electron interaction enhances it. This lets the scientists control the spin current electrically.



Micrographs of experimental device. Lower left image is a 3.7 x 4 square micron blowup of the quantum point contact (QPC) region in the center. The applied voltages on lower (LG) and upper (UG) gates result in a strongly asymmetric QPC potential depicted in the upper left inset. The combination of lateral spin-orbit coupling in the system and strong electron interactions result in the 100% spin polarization in the QPC shown in the right inset.

This work is supported by the Materials World Network and a National Science Foundation PIRE grant. Ulloa says the next step is to adapt the experiment for higher temperatures.

Team studies inner workings of anti-freeze proteins



The research team includes Vincent Roberts, Yangzhong Quin, Di Xu, Yeliz Celik and Ido Braslavsky. Photo by Kevin Riddell | University Photographer

Forty years ago, researchers found that some insects, fish, bacteria and other organisms have anti-freeze proteins (AFPs) in their bodies to help them survive extremely cold temperatures.

What scientists don't know is exactly how these AFPs work. Braslavsky has received a three-year grant from the National Science Foundation to find an answer to this question.

Scientists already know that AFPs attach to particular surfaces on an ice crystal, inhibiting growth of the crystal in those spots until the temperature reaches a certain point, he said.

"There are a set of proteins in insects which are hyperactive proteins. In much smaller concentrations, they can do a much better job at stopping ice," he said. "Why are certain proteins more effective?"

The team uses two techniques to understand how AFPs function—fluorescence microscopy and a microfluidic cell.

The potential for future applications is promising because AFPs could guard against freezer burn in foods or could ward off frost on crops, Braslavsky said.

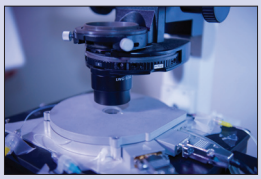
Companies are beginning to find commercial uses for AFPs. Unilever produces an ice cream with the proteins to prevent freezer burn, and some cosmetic companies incorporate the AFPs into their makeup, claiming the proteins protect skin membranes from the cold.

Braslavsky collaborates on this research with many experts, including Peter Davies from Queens University in Canada; John Wetlauffer from Yale University; Alex Groisman from the University of California, San Diego; Debbie Fass from the Weizmann Institute of Science, Israel; and Joel Stavans from Weizmann Institute.

HOW IT WORKS

Fluorescence Microscopy

The team attaches an AFP to a protein with fluorescent capabilities—the Green Flourescent Protein (GFP). Once the AFP is attached to the GFP, the team can track its position on an ice crystal.



This microfluidic cell allows the team to control temperature in their sample. Photo by Rick Fatica | University Photographer

Microfluidic Cell

Using this cell, the team flows a temperature-controlled solution around the ice crystal. This lets them observe if and how quickly the ice forms when AFPs are not present in a solution.

Former engineering student researches as NIST fellow, pursues PhD at Berkeley

Michael Lorek spent his summer researching as part of the NIST Summer Undergraduate Research Fellowship and is now pursuing a PhD at University of California Berkeley. His PhD research involves integrated circuit designs.

As an undergraduate in Dr. Savas Kaya's group, Lorek designed ring oscillator and mixer integrated circuits using Double Gate MOSFET transistors.

These novel DG-MOSFETs provide more tunable electronic characteristics and could possibly extend Moore's Law scaling due to their short channel lengths, he said.

"My research work under Dr. Kaya at OU gave me good intuition about the operation of common circuits, the operation of transistors of different types and the fabrication processes involved in making integral circuits," he said. This research gave him a strong foundation for his work with CMOS circuitry at his NIST fellowship.

Design and writing by Emily Hubbell. Editing by Dr. Eric Stinaff. Please contact Mala Braslavsky at mala@helios.phy.ohiou.edu with comments.

Chemistry grad takes teaching job

Alyssa Thomas recently graduated with a doctorate in physical chemistry and is now an assistant professor of chemistry at Utica College in New York.

During her five years at OU, Thomas researched with Dr. Hugh Richardson's group, taught undergraduate courses and defended her dissertation, "Growth of Thin Film Water on a-Al_2O_3 (0001) and its Implications for Ice Nucleation."

As one of Utica's four full-time chemistry faculty members, Thomas is in charge of physical chemistry. She also teaches general chemistry with the department chair.

Thomas will establish a lab group with undergraduate student researchers. She plans to expand on her OU work in her lab.

"I want to continue with thin film water research and also introduce basic research on the fundamentals of gold and silver nano particles," she said. "I want to expose undergraduates to nanotechnology."