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Biggest Physics Meeting  
During the World Year of Physics

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###Embargo notice### Please do not report on the results mentioned in this press release until the day and time of the respective paper is delivered at the meeting.

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College Park, MD, January 28, 2005-----The American Physical Society (APS) March Meeting, always the biggest physics meeting of the year, will occur this year March 21-25 at the Los Angeles Convention Center. The March APS Meeting has, over the years, has been one of the most important venues for announcing the kind of discoveries--- in both fundamental and applied areas of research---that help shape modern culture.

This is the all-purpose science emporium for presenting the latest findings from the ambitious exploration of matter and space, not the space between the planets and galaxies but the space between atoms. The explorers attending this meeting don't map deep space at the megaparsec level but at the nanometer level. They probe tiny pockets of superfluid, regions where, unlike all other places on Earth, friction is banished. They nudge together ultracold atoms and can, for the first time and with the turn of a dial, control the strength of the interatomic force. They can put individual atoms in two places at the same time.

The meeting program features about 6500 talks covering a wide variety of research topics. Here are some examples of the cutting-edge work likely to lead to still more knowledge-enhancing and life-improving innovations: a session devoted to emulating nature in the design of new computers (session V22), the use of hydrogen as a storable fuel and interconvertible form of energy (D5, P14, S14, U14), superconducting diamond (A3b), condensates of ultracold fermi atoms (L3, N6), evidence for superfluid behavior in a solid (S2b), gene chips (S7), amorphous steel (H28), physics experiments conducted at extreme temperatures and pressures (X4), solid-state quantum qubits (A1), the bioengineering of artificial sight (WW7), and circuit QED (N1).

Physics research doesn't exist in a vacuum, but is linked in many ways with social issues. Pertinent sessions explore the status of women in biophysical research (B7), the human rights of scientists in China and Iran (H6), the citation of papers in Physical Review Letters (paper L19.5), journal refereeing (N44), collaborations between scientists in developed and developing nations (P3), and alternative careers for physicists, including being president of the University of California (paper P7.1).

The year 2005 marks the centenary of Albert Einstein's famous year of physics breakthroughs, when he published papers on the photoelectric effect, Brownian motion, and special relativity. Appropriately the year has been recognized as the World Year of Physics (general website: <http://www.physics2005.org/>). Nobel Laureate Douglas

Osheroff (Stanford) will deliver a special World Year of Physics public lecture Tuesday evening, March 22, at 7:30pm, in the Westin Hotel, Catalina Ballroom.

Numerous sessions at the meeting are concerned with Einstein's ideas and his fruitful collaborations with other scientists (B5 and N7). These include such well-known figures as Millikan, Lorentz, Bohr, Born, Planck, Boltzmann, and Ehrenfest, but also Emmy Noether, one of the rare women physicists of that era, who proved two deep theorems on the connection between symmetry and conservation laws, an achievement that greatly impressed Einstein. Session V4 looks at Einstein's activities in the social sphere. Scheduled talks cover such ticklish issues as racism, pacificism, Zionism, and the dropping of the atom bomb during World War II. Session T1 explores Einstein's influence on modern condensed matter physics. Alex Zettl (UC Berkeley) will discuss how Einstein's doctoral thesis work in 1905---concerned with the size, geometry and interactions of nanoparticles---anticipated many of the very issues at stake in the design and creation of next-generation nanoelectromechanical systems (NEMS).

## **WEBSITE AND PRESSROOM**

The March Meeting website (<http://meetings.aps.org/Meeting/MAR05/Content/52> (click on "epitome" to view the sessions) offers a quick way to view hotel and travel information and all the abstracts. Complimentary press registration will allow science writers to attend all scientific sessions. If you wish to come, please fill out and return the form at the end of this release. Here is information relating to the press operations at the meeting:

- The meeting pressroom will be located in the LA Convention Center, Room 508BC
- Address for the Convention Center: 1201 Figueroa St., Los Angeles, CA 90015, 213-741-1151
- Press conferences will take place in Room 508A -Pressroom hours: Mon-Wed (March 21-23 ) 7:30 AM to 5 PM and March 24 from 7:30 AM to noon.
- Pressroom phone numbers: 213-743-6200, -6201, -6203 -Pressroom fax number: 213-743-6204 -Internet lines will be available.
- Helpful tip for navigating through the program and seeking contact information about individual speakers: First click on "epitome." Then click on the session of interest, and individual papers.
- Breakfast and lunch food will be available in the pressroom from Monday-Thursday (breakfast only on Thursday).

## **PRESS ACTIVITIES AT THE MEETING**

During the week a number of press conferences will be held. A press conference schedule will be issued in early March, along with further tips about notable papers at the meeting (see also the list below). Science writers will be able to attend any regular invited- or contributed-paper session at the meeting.

**THE FOLLOWING LONG LIST OF ITEMS IS INTENDED AS A SUMMARY OF POSSIBLE STORY IDEAS AND SELECTED HIGHLIGHTS AT THE MEETING.**

**Spin Hall Effect Likely to Deflect Many Physicists into Monday Sessions**

Physicists at the March meeting will be buzzing over a newly observed phenomenon, the spin Hall effect, whose origin is still being hotly debated and has the potential of leading to extremely low-power memory chips and computer processors. The classical Hall effect, studied by every physics undergraduate, is created by the deflection of electric current as it traverses a conductor in a magnetic field. The spin Hall effect, on the other hand, is the deflection of an electron in a semiconductor in a direction that depends on the electron's "spin" (roughly speaking, the direction in which its internal bar magnet points). At sessions B1 and D10, the spin Hall effect will be discussed by theorists and experimentalists, including two groups that recently demonstrated the effect (papers B1.5 and D10.1). Originally proposed in 1971, theoretical interest in the phenomenon revived again recently and over 60 theoretical papers have been published over the past two years. More recently, the effect was actually observed in the lab. More fresh results are expected at the March Meeting. (For more information, see *Physics Today*, February 2005; for commentary, contact David Awschalom, UC Santa Barbara, [awsch@physics.ucsb.edu](mailto:awsch@physics.ucsb.edu) and Jairo Sinova, Texas A&M, [sinova@physics.tamu.edu](mailto:sinova@physics.tamu.edu)). By the way, at this meeting, the prestigious Oliver Buckley Prize will be awarded to Gabriel Aeppli (University College, London), David Awschalom, and Myriam Sarachik (City College of New York), for their work with spin physics.

**Antifreeze Proteins**

More than 35 years ago scientists discovered special proteins in the bloodstream of certain fish that prevented them from freezing. These antifreeze proteins (AFPs) have also been found in insects, plants, fungi, bacteria, even vertebrates. They either keep the organisms from freezing in the first place or, if crystallization has occurred, help to mitigate recrystallization damage, a process in which large ice grains grow at the expense of small grains, irrevocably breaking some tissue structures. AFPs are able to work, scientists think, by binding to (and limiting further growth of) ice crystals. The first direct observations of AFP on newly formed ice crystals will be reported by a team from Ohio, Yale and Queen's Universities. (Natalya Pertaya, [pertaya@helios.phy.ohiou.edu](mailto:pertaya@helios.phy.ohiou.edu), D21.3)

**Physicists' Solutions for Faster Computer Chips**

Is Moore's Law--the doubling of the amount of transistors on a computer chip every 18 months--truly coming to an end? Recent incidents, such as the cancellation of a 4 GHz Pentium IV chip, point to significant difficulties in making more transistor-dense, and thereby faster, computer chips. The March Meeting features physicists' near-term solutions and long-term proposals for faster, more-power-efficient chips. Presenters will showcase both evolutionary solutions (such as strained silicon, described below) and revolutionary possibilities (such as spintronics; sessions include A10, B1, D10, H4, J10,

U10, V10; and molecule-scale electronic devices; sessions include A14, B14, P35, S35, V35). Also, please see Ralph Cavin's (Semiconductor Research Corporation) talk on ways to get around current chip design obstacles (L5.1).

### Strained Silicon Joins Arsenal of Integrated-Circuit Technology

The chip industry is turning to strained silicon---essentially a stretched-out form of silicon--as a means to make faster, low-power computer chips with conventional technology. Physicists have long known that strained silicon--silicon atoms stretched to larger-than-normal distances from each other in a plane--contains electrons that travel up to twice the maximum speed of electrons in ordinary silicon. While the original motivation for strained silicon was to make chips with speedier electrons, researchers now realize that using reduced-strength electric fields to turn on and off transistors could get electrons moving at conventional speeds but dissipating lower levels of power as they travel through dense networks of transistors. At session J15, speakers from industry (AMD and Soitec) and academia will present some of the latest discoveries and challenges of implementing this promising technology. Strained Si technology has begun appearing in the product lines of major chip manufacturers such as AMD, Intel, TI and IBM. (For more information, contact session chair Ya-Hong Xie, UCLA, 310-825-2971, yhx@ucla.edu)

### How Frogs Get Perfect Pitch

Clawed frogs in South Africa depend for dinner on their ability to sense the floundering of insects on the surface of the pond they inhabit. Not just detect but discriminate: the frog can tell apart water waves at, for example, a frequency of 14 Hz from one at 14.5 Hz. J. Leo van Hemmen and coworkers of the Technical University of Munich study what happens at the synapse level in order to allow the frog to get his meal at the insect level. The frog can "hear" with its skin and detect motions in the pond as slow as 0.1 mm/sec through an underlying "lateral-line" system. And, no, humans could never learn to hear with their skin; human touch sensors aren't sensitive enough. Van Hemmen will report on how the frog develops effective "wetware" (neuronal software and hardware) for catching prey by coordinating visual and skin inputs in a kind of "supervised" learning with a millisecond time resolution. (Paper V22.3, LvH@ph.tum.de, 49-89-289-12362)

### Superatom Chemistry

Researchers have discovered that clusters of aluminum atoms can behave as "superatoms" that mimic the chemical properties of different elements depending upon the size of the cluster. Starting with iodine-based compounds called polyiodides, a team of researchers from Penn State and Virginia Commonwealth University removed a single iodine atom and replaced it with an aluminum cluster made of either 13 or 14 atoms. As a result, the clusters exhibited chemistry similar to halogen atoms such as iodine (in the case of the 13-atom cluster) and alkaline earth elements such as magnesium (14-atom cluster), but with some differences too, leading in one case to the creation of a whole new

class of polyiodide structures. These results provide further evidence of an underlying "periodic table" of cluster elements. In addition, the clusters may lead to novel materials such as aluminum-based compounds that wouldn't rust. (Paper X35.8; contact A.W. Castleman, [awc@psu.edu](mailto:awc@psu.edu); more info at <http://www.vcu.edu/uns/Releases/2005/jan/011305.html>)

### Detecting Single Spins

Session X3 features numerous breakthroughs that follow up on a major physics headline of 2004--the ability to detect single electron spins on or beneath a surface. Presenting the magnetic resonance force microscopy system that achieved this feat, Daniel Rugar of IBM-Almaden ([rugar@almaden.ibm.com](mailto:rugar@almaden.ibm.com)) will discuss long-term prospects for increasing the instrument's sensitivity to read the spins of individual nuclei--a goal that could lead to atom-scale mappings of the interiors of molecules such as HIV. While IBM's magnetic technique is presently designed solely for locating unpaired single electrons in a solid sample, independent groups at the Delft University of Technology in the Netherlands (Jeroen Elzerman, [elzerman@qt2.tn.tudelft.nl](mailto:elzerman@qt2.tn.tudelft.nl)) and UCLA-Los Alamos (Ming Xiao, UCLA, [mingx@physics.ucla.edu](mailto:mingx@physics.ucla.edu)) have developed electrical techniques for measuring the actual orientations of single electron spins that are confined in gallium-arsenide quantum dots and field-effect transistors respectively. Scott Crooker of Los Alamos ([crooker@lanl.gov](mailto:crooker@lanl.gov)) will discuss how simply listening to magnetic "noise"-- random, thermally induced spin fluctuations in a magnetic system -- can provide the same information about the properties of the spins as would the conventional approach of actively perturbing the spins with electric and magnetic fields. Joerg Wrachtrup of the University of Stuttgart ([j.wrachtrup@physik.uni-stuttgart.de](mailto:j.wrachtrup@physik.uni-stuttgart.de)) will describe an optical method for observing the evolution of the state of a single electron spin.

### Flu Vaccine's Effectiveness

Using sophisticated tools of statistical physics, Michael Deem of Rice University ([mwdeem@rice.edu](mailto:mwdeem@rice.edu)) will present a new method of predicting the annual flu vaccine's effectiveness in preventing flu-like illness. Traditional approaches include the "phylogenetic" method, in which researchers examine the mutations in the entire hemagglutinin protein (the major protein on the surface of influenza A virus). Zeroing in more precisely, the Rice team measures the fraction of amino acids that change in the hemagglutinin protein's "dominant epitope," the antibody-triggering region of the molecule that tends to mutate the most. The new measure correlates with vaccine effectiveness even better than do results from studies on ferrets, which had been thought to exhibit influenza symptoms in a manner similar to that in humans. Deem believes that this new measure will prove useful in designing the annual flu vaccine and in interpreting vaccine efficacy studies. (Paper P23.11)

### Terahertz Medicine and Homeland Security

The terahertz portion of the electromagnetic spectrum (300 GHz-10 THz) spans the region between radio waves and light. THz radiation is non-ionizing and can penetrate

many materials well. These and other unique capabilities of terahertz radiation are leading to new inventions in areas ranging from medicine to homeland security. Michael Kemp of TeraView Ltd will discuss the use of THz radiation in medical imaging to detect cancer. David Zimdars of Picometrix, Inc. (dzimdars@picometrix.com) will present a THz scanning system that has been deployed to scan space shuttle fuel tanks for defects. Erich Grossman of NIST (erich.grossman@nist.gov) will describe the design of an imager for concealed weapons detection. (Session N5)

### Deep 3D Images of Biomolecules

Ordinary x-ray crystallography shines x rays yields the structure of a biomolecule (such as a protein) by providing averaged information from scattering from a large number of identical unit cells. UCLA physicist John Miao, by contrast, forms high-resolution images of non-crystalline samples. He and his colleagues use the SPring-8 synchrotron in Japan, the most powerful x-ray continuous x-ray source in the world, to reveal layered images with spatial resolution as good as 7 nm. These layers are then stacked up to provide the best 3D images yet for targets such as E. coli and yeast. Microscopic methods with as good or better spatial resolution, such as scanned probe microscopes or electron microscopes, can't form 3D images ([www.physics.ucla.edu/research/imaging](http://www.physics.ucla.edu/research/imaging), miao@physics.ucla.edu, paper P2.4)

### Plenary Talks

A plenary session is the occasion for great scientists speaking about great topics. The common theme of the four talks at Session G1 will be the way in which changing attitudes begin to recrystallize an entire field (an overarching modification sometimes referred to as a "paradigm shift"). These shifts will be traced for the following subjects: Carlos Bustamante (UC Berkeley) on the advent of single-molecule biology, Andrea Ghez (UCLA) on the center of our galaxy, Barry Barish (Caltech) on particle physics, and Nobel laureate Robert Laughlin (Stanford) on strongly-correlated electron systems (meaning phenomena such as the quantum Hall effect). Also, although not given a plenary designation, session L6 features a series of popular talks on such fascinating subjects as complexity, sonoluminescence, and optical tweezers.

### Fast Cancer Detection in Single Cells

Many cancer-detection devices still use venerable staining and fluorescence techniques. A newer approach, developed at Sandia National Lab, use single cells as waveguides within special optical cavities. The way in which the laser light in the cavity is scattered or absorbed depends on the internal state of the cell, especially the structure of the cell's mitochondria, which in turn change under malignant conditions. Sandia scientist Paul Gourley (plgourl@sandia.gov) will report that his laser method is fast (clean spectra are produced with picosecond sampling times) and are less prone to misinterpretation than fluorescent methods. The Sandia technique is particularly suited to cell types (brain, muscle, liver) with lots of mitochondria. (Paper D21.13)

## What Happens When You Scratch Your Skin?

Scratching the skin with a needle triggers a physiological response, sending substances that create vasodilation (dilation of the blood vessels) in order to repair the scratch. In efforts to find out about crucial--but poorly understood--mechanical processes behind this response, researchers have devised a method that obtains the contraction state of smooth and very small muscles situated around blood vessels. As the smooth muscle decontracts (relaxes), the blood vessel diameter increases, facilitating the delivery of substances within the bloodstream to repair the skin. But since smooth muscles are very small, their contraction state cannot be directly measured with existing techniques. However, using a combination of numerical models and laser measurements, the researchers have shown that smooth muscles relax in the entire surrounding tissue after the scratch. Then, the muscles contract in the surrounding tissue, while they keep relaxing on the line of the scratch. In this way, a higher blood volume is transported from the surrounding tissue to the blood vessels closest to the scratch. Based on their technique, the researchers have described the entire mechanical response to skin irritation. (Paper A23.10; Contact Daniela Bauer, Ecole Nationale des Ponts et Chaussées, France, [bauer@lami.enpc.fr](mailto:bauer@lami.enpc.fr))

## Microfluidics

The design and use of clever hydraulic equipment that fits onto a microchip is one of the hottest topics in soft condensed matter physics. Work in this area might lead, for example, to more efficient fuel-cell power supplies for wireless communications, faster electrophoresis for DNA sequencing, the crystallization of protein types that can't be performed any other way, faster separation of white and red blood cells, and what could be called high-resolution filters. (Sessions L37, N37, P37, V37)

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### **SCIENCE WRITER REGISTRATION FORM APS 2005 March Meeting**

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\_\_\_\_\_ I shall attend the meeting.

\_\_\_\_\_ I cannot attend but please send me later press releases

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