

Biggest Physics Meeting of the year

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

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College Park, MD, January 27, 2006-----The American Physical Society (APS) March Meeting, usually the biggest physics meeting of the year anywhere, will occur this year March 13-17 at the Baltimore Convention Center by the harbor in Baltimore, Maryland. The March APS Meeting has traditionally been the showcase for the kind of cutting-edge research results that appear, sometimes not so long after, in all the kind of electronic--communication--computer--medical diagnosis equipment that have done so much to shape modern culture.

Over 6500 papers will be delivered, some of them in prestigious invited-paper sessions, some in sessions of shorter 10-minute talks, and some in the form of posters. The large disciplinary areas at the meeting will be condensed matter physics, biological physics, chemical physics, new materials, fluid dynamics, polymers, and large-scale computing. Many of the presentations concern fundamental physics discoveries, while many others will look at the progress made toward implementing scientific discoveries in practical devices.

The March Meeting is a place where the latest developments in leading physics research areas (e.g., superconductivity, nanotubes, superfluids, quantum information, ultracold atoms) are reported and where whole new subjects are represented for the first time (e.g., fast electrons in graphene, session D2). The diversity of session subjects is abundant: planetary interiors (A42), ultrafast chemistry (R13), liquid splashing (P8), biological swarming (G8), optical clocks (K1), snake vision (Y26), nanoplumbing (N26.4), Bose-Einstein transistors (B43.10), serial crystallography (A29.11), microscale synthetic swimmers (B29.2), plastic-explosive-degrading enzyme (P26.4), cooper-pair molasses (Z39.11), doubly electromagnetically induced transparency (N43.1), vortex-phase qubits (B43.13), novel skin creams, and antimicrobial coatings for medical devices (G29.5).

Not all the sessions are technical in nature. Session H4a looks at Renaissance art (did painters use optical devices to achieve “realistic” effects?) and Broadway theater (science and math related themes). Other topics with social implications include Intelligent Design (M50, Tuesday night, March

14---see below), nuclear proliferation and terrorism (B5), US technology in the age of globalization (N5), how to be a referee (N34), the foundations of evolution (R7---see below), the use of complexity theory on Wall Street (A33, B33) and in studying population dynamics (Z28), and issues relating to university physics departments including the status of women, curricula trends, foreign students, and ethics (H5).

WEBSITE AND PRESSROOM

The March Meeting website is <http://meetings.aps.org/Meeting/MAR06/Content/346>; click on "epitome" to view the session topics and times. The site offers a quick way to view hotel and travel information. Complimentary press registration will allow science writers to attend all scientific sessions. If you wish to attend, please contact Phillip Schewe (pschewe@aip.org).

Here is information relating to the press operations at the meeting:

- The meeting pressroom will be located in the Baltimore Convention Center, Room 334
- Press conferences will take place in Room 333
- Pressroom hours: Mon-Wed (March 13-15) 7:30 AM to 5 PM and March 16 from 7:30 AM to noon.
- Pressroom phone numbers: 410-649-6498, -6502, -6506, -6510
- Pressroom fax number: 410-649-6494
- Internet lines will be available.
- 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 LIST OF ITEMS IS INTENDED AS A SUMMARY OF POSSIBLE STORY IDEAS AND SELECTED HIGHLIGHTS AT THE MEETING.

FOUNDATIONS OF EVOLUTION

From gene chips to microfluidics and nanotechnology, new tools now exist to test and explore biological evolution at a much deeper level than was possible 20 years ago. An entire session will be devoted to cutting-edge physical sciences approaches for bolstering the study of evolution. According to speaker Daniel Fisher of Harvard (fisher@physics.harvard.edu), evolution can now become a quantitative experimental science, with the ability to do such things as manipulate microorganisms at the genetic level, move biomolecules with microfluidics, and make detailed measurements with state-of-the-art optics tools. The University of Chicago's Jim Shapiro (jsha@uchicago.edu), another speaker at the session, shows that an information-science approach is bound to offer many new details about evolution. As he points out, the results of 50 years of molecular biology research have shown that the genome is not a passive blueprint, but rather a complex information-processing unit, and that cells have "natural genetic engineering tools" for restructuring DNA molecules. Other speakers at the session include Michael Deem of Rice University ("Life Has Evolved to Evolve"), Juan Keymer of Princeton (evolutionary ecology of *E. coli*), and Richard Lenski, University of Michigan. (Session R7; for more information, also contact session organizer Robert Austin of Princeton, austin@Princeton.EDU, and session chair Herbert Levine of UC-San Diego, levine@herbie.ucsd.edu)

RENAISSANCE PAINTING AND OPTICAL DEVICES

Painter David Hockney and physicist Charles Falco (Univ of Arizona) began collaborating a few years ago in proposing the idea that some Renaissance painters used optical devices to aid to in the production of realistic, almost photographic, details in their works. This hypothesis has generated a great deal of controversy in art history circles. Falco (520-621-6771, falco@u.arizona.edu) will summarize evidence in favor of the theory and his work with Hockney. He will also give a public lecture on this subject at the Walters Art Museum in Baltimore on the Wednesday of the meeting (at 630 PM). (Session H4a)

NANOTUBE YARNS AND TEXTILES

New carbon nanotube yarns and sheets, stronger than steel and extremely light, could be used for a wide variety of futuristic applications, including artificial muscles, solar cells, energy storage, solar sails, electrically conducting appliqués, and several types of lamps, displays and sensors. These sheets are transparent, flexible, light, and extremely strong, and can be produced quickly. Ray Baughman of the University of Texas at Dallas (ray.baughman@utdallas.edu, 972-883-6538) will describe how he and colleagues produce these textiles by starting with a forest of nanotubes and spinning them into long, thin sheets, and will evaluate their use for some of these amazing applications. (N32.1)

CHOOSING SEX

One of the major unsolved questions in evolutionary biology is why sexual replication appears to be the preferred, indeed often the only, mode of replication for complex, multicellular organisms. Why don't organisms instead choose asexual reproduction, which is a bit riskier (no built-in mechanism for preventing the accumulation of mutations) but typically quicker (no time spent in finding a suitable mate). In a new mathematical model, possibly the first to directly address the evolutionary advantage for sexual reproduction in complex organisms, Emmanuel Tannenbaum of Ben Gurion University (etannenb@gmail.com) considers a replicating population of single-celled organisms, whose genomes consist of two chromosomes, and applies some simplifying assumptions (e.g., any mutation in a chromosome renders it defective). If the cells replicate slowly, he finds, so that the time lost in finding a mate is small compared to the time it takes to replicate, then the benefit from recombination (i.e., the contribution of genetic material from two distinct organisms) is sufficiently large to make sexual replication the preferred strategy. This conclusion differs from previous notions, which assumed that sexual replication was simply more advantageous in all small populations, while the new analysis suggests for possibly the first time that sexual reproduction is advantageous only in those small populations with low replication rates. (W29.15)

SEARCHING FOR SUPERSOLIDS

In 2004 evidence for superfluid behavior in a solid, solid helium, was reported for the first time. Then at last year's APS March meeting Tony Clark and Moses Chan of Penn State said that they have obtained evidence also for superfluidity in solid hydrogen. Because the existence of a superfluid solid would require much new thinking about macroscopic quantum behavior, the number of theoretical papers on this topic have been increasing rapidly, and several groups have commenced experimental studies. At this year's meeting, Chan's group will be reporting more solid results on these two supersolid systems. Other groups may have something to say as well (sessions B2 and G41)

INTELLIGENT DESIGN

Session M50 looks at the impact of this topic much in the news and the efforts of many to keep science education on a scientific footing. Jeremy Gunn (American Civil Liberties Union) will review some of the legal milestones concerning the teaching of evolution, such as the Scopes trial of 1925, and will suggest how scientists can contribute to the ongoing debate. Marshall Berman (Sandia National Lab and past vice president of the New Mexico State Board of Education) looks at the social and political standing of science and of religious fundamentalism. Francis Slakey (APS) will review past policy action by the American Physical Society and current efforts in this area. Finally, Cornelia Dean of the New York Times will describe how the evolution and intelligent design issue has been covered in her newspaper. (Tuesday night, March 14, Marriot Hotel, Grand Salon V)

BUILDING A BETTER VIRUS

Viruses are very simple organisms, consisting of little more than a membrane surrounding genetic material. The microorganisms propagate through hijacking other cells by inserting their DNA into their victims, which in turn begin churning out copies of the infecting virus. Rahul Sharma and You-Yeon Won (yywon@ecn.purdue.edu, 765-494-4077) of Purdue are building artificial analogues of viruses designed to deliver therapeutic genetic material, instead of causing disease. The researchers create their artificial viruses with a trio of polymers; one that binds to a DNA molecule and collapses it to a compact size, and two others that encapsulate the DNA in a coating much like a virus' membrane. Although the work is still in early stages, it could lead to an efficient gene therapy method that mimics the ancient and effective infection behavior of natural viruses. (V16.2)

SINGLES' BAR FOR SPINS

Rice and MIT researchers will report on their ongoing investigations of an unusual superfluid phenomenon in gases of ultracold fermions such as lithium-6. Because fermions are one of the fundamental building blocks of matter, the new research may bear on diverse phenomena ranging from superconductivity to the dense quark matter at the core of neutron stars. Conventional theory says that superconductivity requires an equal number of spin-up and spin-down particles (analogous to the particles having bar magnets pointing up and pointing down), similar to requiring an equal number of men and women at a dance hall. Using ultracold atomic gases consisting of spin-up and spin-down atoms, physicists can now test what happens this condition is not met. Randy Hulet and his colleagues at Rice University (randy@rice.edu) have shown that an ultracold mixture of lithium-6 atoms, which are fermions, can pair up into a superfluid even when there are unequal numbers of spin-up and spin-down atoms (i.e., couples still form peacefully even when there a lot of excess men at a dance hall). Beyond a critical mismatch, however, the unpaired loners (the single men) are no longer tolerated and are suddenly expelled from a uniformly paired core to a surrounding shell containing the excess spin-up atoms (so that a wall of singles surrounds the paired-up couples). The nature of the mismatched, yet uniform, superfluid before the separation occurs is especially enigmatic, and may involve some exotic, new form of superfluidity. By observing superfluid vortices in such systems, Nobel laureate Wolfgang Ketterle and his colleagues at MIT (ketterle@MIT.EDU) could show that superfluidity persists for the phase-separated imbalanced system. They placed a limit on the degree of mismatch that could support superfluidity by observing that vortices no longer form in extremely mismatched gases. (Papers H6.3 and D43.4)

NANO DRUG COURIERS

A novel coating provides safe passage for drugs attached to magnetic nanoparticles, potentially leading to rapid and precise treatment of diseases and injuries. Delivering drugs via magnetic particles allows

doctors to use magnetic fields to attract the particles to locations in the body where they are most needed. Doctors can also monitor the motion of the particles and their therapeutic cargo with MRI imaging systems. But there is little benefit to the technique if the drugs don't stay attached to the particles long enough to reach a trouble spot. Diandra Leslie-Pelecky (dleslie@unlnotes.unl.edu, 402-472-9178) and colleagues have attempted to solve the problem by sealing drug-coated nanoparticles with layers of surfactant molecules that keep the chemicals in place until the particles reach their destinations. The method is currently undergoing animal studies testing the effectiveness of particles that deliver drugs to reduce brain damage following a stroke. (G22.4)

ACOUSTIC CRYSTALLIZATION

Sound consists of a longitudinal pressure wave producing alternately regions of high pressure followed by low pressure in the medium through which it passes. A few years ago, physicists at the Ecole Normale Supérieure (Paris, France) focused a sound pulse which was so powerful (4 bars amplitude at 1 MHz) that the medium (liquid helium) actually crystallized for a moment. But the crystals nucleated on a glass plate which had been placed at the acoustic focus for calibration purposes. The same group has progressed; now they can for a brief time solidify a region in the bulk of superfluid helium by focusing an even more powerful pulse of sound without the need for any nearby solid wall. Sebastien Balibar (balibar@lps.ens.fr), who will report the new results obtained with R. Ishiguro and F. Caupin, says that this work should not only help understanding how far one can pressurize a liquid before it crystallizes but also how superfluidity should vanish in a Bose liquid when the interatomic interactions increase. (Paper A41.4)

ARTIFICIAL GRAVITY FOR MICROORGANISMS

The single-cell organism *Paramecium caudatum* employs a process known as gravikinesis, the act of regulating its swimming speed depending on whether it swims with or against the force of gravity. Gravikinesis fights the paramecium's natural tendency to settle to the bottom of a body of water and form sediment; as a result it swims harder upward than downward. Karine Guevorkian (guevorkian@physics.brown.edu) and James M Valles Jr. of Brown University have successfully observed and quantified gravikinesis in *Paramecium* using a magnetic-force gravity simulation technique. The simulation approach employs magnetic forces that can be directed to pull in tandem with gravity's forces to create enhanced gravity or to push in opposition to gravity to create weakened and even inverted gravity (in which the organism moves opposite to the direction of gravitational force).. These strong magnetic forces are generated by intense inhomogeneous magnetic fields such as those available at the National High Magnetic Field Laboratory acting on the "diamagnetic" materials naturally present in cells. Besides reproducing results obtained from high gravity in a centrifuge chamber, the technique allowed the researchers to investigate the swimming speed regulation in decreased and inverted simulated gravity.(Paper B29.3)

NANOPORE DNA SEQUENCING

Some proteins naturally form nanometer-scale pores through which ions travel to enable communication within and between nerve cells. Researchers are developing biotechnology applications for natural and artificial versions of such nanopores. For example, nanopores are coming closer to enabling faster and better DNA sequencing than present biochemistry-based methods. In the general concept, DNA would traverse through the pore, and in one scenario, the change in ion current as DNA passes through could yield the sequence of bases in the DNA. A Brown University group led by Sean Ling (Xinsheng_Ling@brown.edu) will present one solution to reading the individual letters

of DNA molecules through nanopores even though they are only 4 angstroms apart (N26.10), as well as making addressable nanopores on chips (N26.1). An entire session on nanopore biophysics (H7) includes a number of advances in nanopore technology from leading researchers, such as Cees Dekker of the Delft University of Technology (dekker@mb.tn.tudelft.nl) who will discuss his group's latest work with artificial nanopores (H7.2). NIST's John J. Kasianowicz (john.kasianowicz@nist.gov), the researcher who first proposed using nanopores for DNA sequencing ten years ago, will also show that the nanopore of a protein secreted by anthrax may provide the basis of new technologies for quickly detecting anthrax in blood samples, measuring the levels of toxins in the body, and studying the effectiveness of therapeutic agents that fight anthrax (H7.1).

ANTI-BROWNIAN TRAP

Nanometer-scale objects, such as proteins and DNA, constantly jiggle around in a liquid solution as they are bombarded by the heat-carrying solvent molecules that surround them. This jiggling, also known as Brownian motion, makes the task of studying nano-objects very difficult: the objects just don't hold still. Conventional laser tweezers can trap objects, but the smaller the object, the brighter the required laser beam, typically harming objects smaller than 200 nm. Adam Cohen of Stanford (aecohen@stanford.edu) will present the Anti-Brownian Electrokinetic (ABEL) trap. It eliminates the Brownian motion of one object in solution, allowing detailed examination of its properties. The ABEL trap works by using a small, nondamaging amount of laser power to track the tiny Brownian movements of the object, and then applying precisely customized electric fields to cancel those movements exactly. By optimizing their setup, the researchers trapped single fluorescently labeled protein molecules in solution. These molecules (as small as 10 nm in diameter) are the first proteins trapped in solution and the smallest objects ever trapped in solution. This achievement opens the possibility of studying individual proteins free-floating in solution. (Paper G26.1)

HYDROGEN ECONOMY

Hydrogen power has the potential to produce less pollution and reduce dependence on fossil fuels. But significant challenges remain in order to make a hydrogen economy efficient and economically feasible. Speakers in session A5 will present an overview of the challenges for the hydrogen economy, and some promising ways in which physics and materials science can enable progress. Mildred Dresselhaus of MIT (and past president of the APS and AAAS, as well as being a former official of DOE) will open the session with a big picture view of the hydrogen initiative. She will discuss the needs of a practical hydrogen economy, including production, storage, and utilization and will also highlight recent progress and opportunities (A5.1). Next, Claus Hviid Christensen of the Technical University of Denmark will discuss metal ammine salts that have been recently proposed for safe, reversible, high-density and low-cost hydrogen carriers (A5.3). Manos Mavrikakis (UW-Madison) will show how first-principles methods can be used to predict properties of materials and identify catalysts for specific applications needed for hydrogen fuel cells (A5.4). (A number of other sessions at the meeting also focus on new materials for hydrogen storage: A16, H16, N16)

OTHER ENERGY SESSIONS

In addition to the hydrogen economy, two other speakers in A5 will talk about novel materials for other energy applications: Mercuri Kanatzidis (Michigan State University) will present recent progress in nanostructured chalcogenide materials that could be used as more efficient thermoelectric materials, which convert heat to electrical energy (A5.2). Fred Schubert will discuss a

excitement. Physicists often model economic interactions as if they were collisions of atoms in gases: one agent, or atom, gains from the interaction, while the other loses. This means they can use equations drawn from thermodynamics to predict distribution patterns of wealth in various countries, for example. Victor Yakovenko (University of Maryland) will describe his work analyzing empirical data on income in the US, which he believes follows the equilibrium probability distribution of energy in a closed physical system. Specifically, money is locally conserved in interactions between economic agents. He found that the majority of the population (97-99%) belonged to a lower class that followed classical thermal distribution equations, while the upper class (1-3%) followed a “superthermal” model in which the distribution parameters change over time with the rise and fall of the stock market. Juergen Mimkes of Germany’s Paderborn University, argues that the daily struggle for survival of all economic systems follows a Carnot cycle that is driven by energy: heat pumps and economic production both depend on oil, GDP, and oil consumption, which he found run parallel for all countries. Motors and markets are based on the same laws of calculus (macro-economics) and statistics (micro-economics). One team of researchers will present a new equation of state for financial markets that connects order flow to price formation, based on a large data set gleaned from the London Stock Exchange. (A33 and B33)

Jennifer Ouellette of APS also contributed to this press release.

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