APS NEWS

JULY 1998 — THE AMERICAN PHYSICAL SOCIETY — VOLUME 7, NO 7

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8 Months to Go

APS Centennial
March 20-26, 1999
www.aps.org/centennial

Educator/Student Day Draws Local High Schoolers

The APS/AAPT Spring Meeting in Columbus, Ohio, featured a special Educator/Student Day on Monday, April 20th. Students and teachers from local high schools gathered at the Convention Center for a series of physics demonstrations and lectures. The event also featured a special luncheon address by Lawrence Krauss, a professor of physics at Case Western University and author of the bestselling book, *The Physics of Star Trek*, featuring selections from the Top Ten Physics Bloopers in the popular TV series (see ZERO GRAVITY, p. 4).

Participants attended a morning plenary session featuring talks by 1997 Nobel Prize winners Steven Chu and William Phillips, as well as a talk on improving physics curriculum by Edward Redish of the University of Maryland, College Park. This was followed by a demonstration of a fascinating soap film apparatus designed by Maarten Rutgers of Ohio State University, which enables him to conduct two-dimensional studies of fluid dynamics in the laboratory. The apparatus also shows great promise as an educational tool, being an easy way to demonstrate the basic concepts of fluid dynamics to students without expensive wind and water tunnels. Using this technique, Rutgers has generated giant soap film sheets, up to 40 square meters in area, which exhibit traveling waves, normal modes, diffraction colors, turbulent flows, giant undulations around air currents, and rupturing fronts.

After lunch, Beverly Taylor of Miami University demonstrated how the operation of common toys can be applied to the study of physics in the classroom. For example, cars that one can push forward, pull back, push down, and wind up can be used to describe the laws of motion. Toys that roll, spin and fly can illustrate the laws of conservation of energy, momentum, and angular momentum. And toys that light up, sound off and levitate bring in ideas from light, sound and electricity.

The event concluded with a lecture on classroom cosmology by Terry Walker of Ohio State University, covering such fundamental issues as the age, composition and eventual fate of the universe. "Everyone, from layman, to student, to teacher, to researcher is hard-wired to question where we came from and where we are going," he said. "The science of cosmology attempts to provide the answers."

A singe vortex stream behind a glass rod which punctures the film. The rod is a few mm in diameter.

Inside...

Check Out the Centennial Webpage

Up to date Centennial event and meeting information will be posted on the Centennial webpage from now through 1999. The Centennial webpage can be accessed from the APS Homepage [www.aps.org] or directly at URL [www.aps.org/centennial]. Check it often and make your reservations early as possible, as some events will have limited capacity. Information currently on the Centennial webpage includes:

EVENTS
- Nobel Laureate Exhibit and Luncheon
- International Banquet
- Physics Festival in Atlanta
- Fernbank Museum Gala (see article on page 3)
- Reunions of colleges and laboratories
- Exhibits and Displays

PROGRAMS
- Technical Program of Meeting
- Special Centennial Symposia
- Plenary and Keynote Speakers
- Roundtables and Workshops

PROJECTS
- *A Century of Physics* Timeline Wall chart & Website
- Centennial Photo Collection
- Multimedia Video
- Centennial Speakers Program and Book
- TV Documentary

Highlights from Columbus, OH Spring Meeting: "Cosmic Chords," Quark Gluon Plasmas

Approximately 1,200 physicists assembled in Columbus, Ohio, for the 1998 Joint Spring Meeting of the APS and the American Association of Physics Teachers (AAPT), 18-21 April. The Spring Meeting explored current topics in particle physics, astrophysics, fluids, particle beams, physics of beams, nuclear physics, applications, plasmas, and atomic, molecular and optical physics. Topics of technical sessions included the discovery of "cosmic chords" (see page 2), changing hadron masses in the nuclear environment (see page 3), and evidence of the first observation of the quark gluon plasma (see page 2). Nontechnical sessions included such topics as communicating physics more effectively, educating physicists for nontraditional careers, and current issues in science policy, arms control, and technology transfer.

In addition, the AAPT organized several sessions devoted to issues in education, some in conjunction with APS committees or units. The traditional ceremonial banquet for the bestowal of prizes and awards was held Saturday evening, preceded by a reception hosted by APS President Andrew Sessler (Lawrence Berkeley National Laboratory). Fourteen prizes and awards were presented, and the recipients gave lectures on their respective topics at various sessions throughout the week. Citations and brief biographies of the recipients appeared in the April 1998 issue of *APS News*.

Technical Sessions

Cosmology Today

Astrophysicists reported the latest news about events occurring at the edge of the universe at a Friday workshop. Recent observations of distant supernovas suggested that the expansion is not slowing down at all but rather speeding up, according to Robert Kirshner of Harvard, one of the leaders of this supernova effort. Wendy Freedman of the Carnegie Observatories summarized her work to measure the Hubble Constant in the relatively nearby space, using the Hubble Space Telescope. David N. Spergel of Princeton University, who is mapping tiny fluctuations in the cosmic microwave background with the Microwave Anisotropy Probe (MAP) to be launched in the year 2000, discussed how to sharpen our estimates of various cosmological parameters (such as the expansion rate and the baryon density). Edwin Turner, also of Princeton, described how he uses gravitational lensing to calculate the age of the universe.

In other astrophysics news, the most distant gamma ray burst, at a red shift of 3.4, was discovered in December and observed at several wavelengths. Optical measurements (yielding a red shift) of the object were announced by Caltech astronomer Shrinivas Kulkarni. Optical astronomers were led to the burst's spot in the sky by x-ray observations made by the BeppoSax satellite.

The Size and Shape of the Deuteron

Abdellah Ahmidouch, North Carolina A&T State University, and Betsy Beise of the University of Maryland described results from the t20 experiment at the Jefferson Laboratory in Virginia. This experiment has gained new information on the shape and size of the deuteron. This new experiment is the first to resolve details of the deuteron structure down to a fifth of the proton's size. Surprisingly, and contrary to some theoretical predictions, the experiment showed that even at this small scale the deuteron can still be described perfectly well by "classical" nuclear physics as a system of a proton and a neutron loosely held together, without considering the fundamental building blocks of the particles, namely quarks and gluons.

Electromagnetic Probes of Nuclei

Many present-day nuclear physics accelerators shoot an electromagnetic probe, such as an electron, at nuclei to uncover detailed information about their properties. A Saturday morning session featured recent results from numerous electromagnetic facilities

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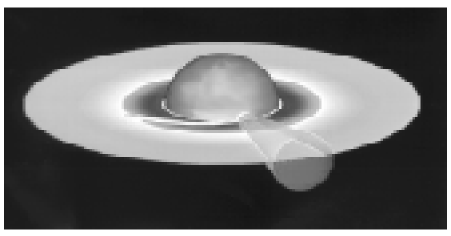
"Cosmic Chords" Support Prediction of Einstein's Theory

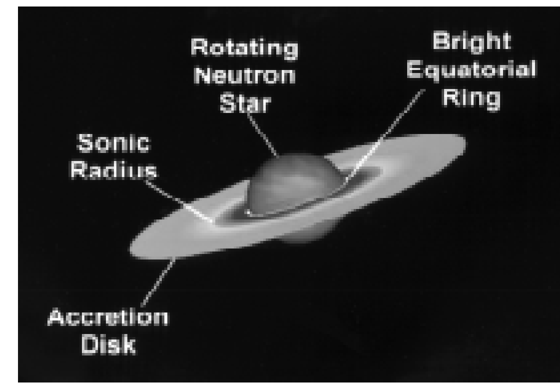
The strongest gravitational fields ever measured have been recorded by scientists using the Rossi X-Ray Timing Explorer (RXTE) satellite. At the APS/AAPT Joint Spring Meeting in Columbus, Ohio, Frederick Lamb of the University of Illinois described how observed very rapid oscillations in the brightness of xrays emanating from certain neutron stars can be used to deduce their properties, such as mass and size. The data may also represent the first evidence for a unique effect of strongly curved spacetime predicted by Einstein's theory of gravity but never before observed.

RXTE was designed to monitor (over microsecond time intervals) the x rays coming from binary star systems in which matter from a conventional star is siphoned off into an accretion disk surrounding a nearby neutron star or black hole. Neutron In about 16 binary-star systems that contain neutron stars, blobs of gas in the disk are thought to spiral in toward the neutron star, picking up speed and approaching the speed of light before they make a final plunge onto the surface. When gas from these clumps collides with the surface of the star, it reaches temperatures of 100 million degrees. The x rays produced in this process become dimmer when the hot gas is on the far side of the star and brighter when the heated gas is on the near side of the star, leading to quasi-periodic oscillations in the x-ray brightness. In fact, some of these neutron stars that produce high frequency x-ray oscillations radiate more energy in a second than the sun radiates in a week, according to Lamb.



Generation of the Sonic-Point Keplerian Frequency QPO: An illustration of how the high frequency X-ray brightness oscillations are thought to be produced.

The researchers had expected to observe a cacophony of frequencies in the x-ray emission from the stars, similar to the discord produced when one presses keys randomly on a piano. Instead, they discovered that the brightness variations only occur at certain well-defined rates, "pure tones" that have been dubbed "cosmic chords", which correspond to special orbital periods for the gas going around the star. "The clockwork of the universe is much more orderly than we had dreamed," Lamb said. "The pureness of these tones makes it possible to use them to investigate how matter moves in the strongly curved space-time near these neutron stars."



Flow Inside the Sonic Point: This shows a perspective view of accreting gas swirling around the neutron star.

The gravitational fields measured corresponded to a spacetime warping of 30%. By comparison, the proportional curvature of space is only about one part in a million near the sun's surface and one part per billion near the Earth's surface. The spacetime encountered by the gas is so highly warped because the gas is able to skim within a few km of the neutron star, which itself is only about 10 km in diameter.

Lamb and William Zhang of NASA Goddard focused particularly on the binary-star system 4U1820-30, about 20,000 light years from Earth. The neutron star has a mass of 2.3 solar masses and orbits its companion star in only 11 minutes. Close observations of this system confirmed a prediction made by Lamb and his colleagues Coleman Miller and Dimitrios Psaltis that the gas blobs would continue to spiral inward until they reached an "innermost stable orbit," where they would orbit before making the dive for the surface. This is a purely

(continued on page 5)

Evidence Suggests First Observation of Quark-Gluon Plasma in J/psi Particle Production, Changing Hadron Masses

In today's universe, quarks are never observed individually but only in groups of twos or threes held together by particles known as gluons. Aiming to recreate some of the conditions of the very early universe, physicists are smashing together nuclei at high energies and attempting to produce a quark-gluon plasma (QGP), a hot soup of many individual quarks and gluons. Physicists expect to see the QGP when Brookhaven's Relativistic Heavy Ion Collider (RHIC) begins smashing together nuclei at unprecedentedly high energies next year, but some researchers who spoke at a Saturday morning session at the APS/AAPT Joint Spring Meeting in Columbus, Ohio, have suggested that QGPs may have already been produced in lower-energy experiments at CERN's Super Proton Synchrotron.

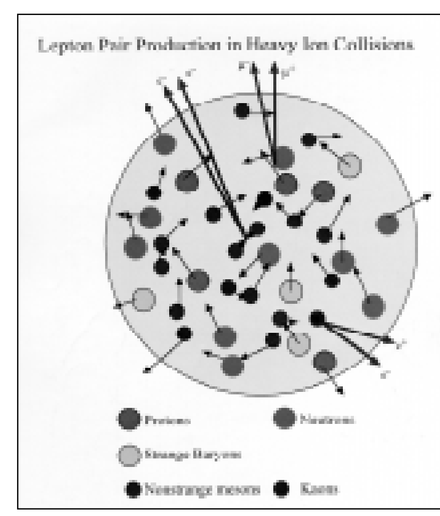
Normal nuclear matter is made up of protons and neutrons, which are themselves made up of quarks and gluons. Detailed calculations involving quantum chromodynamics, the theory describing the forces between quarks and gluons, indicate that when nuclear matter is compressed and/or heated, a transformation to a QGP should occur. According to Spencer Klein of Lawrence Berkeley National Laboratory (LBL), in a QGP, protons and neutrons lose their identity, and the nucleus turns into a soup of strongly interacting quarks and gluons with properties very different from normal nuclear matter.

The matter in the early universe was almost certainly QGP until the temperature fell below a few trillion degrees, a millionth of a second after the Big Bang. It is also possible that QGP exists in the core of neutron stars. Today, scientists are trying to create a QGP in the laboratory. Although calculations show that the QGP should exist, the temperature and density required to create one are less well determined. The best estimates are that the quark gluon plasma may appear at temperatures around 2 trillion degrees centigrade, which may be produced by smashing heavy nuclei like lead together at high energies.

Many techniques have been proposed to detect a quark gluon plasma once it is produced. Olivier Drapier of the Institut de Physique Nucleaire in Lyon, France, has collected data regarding one possible signature, suppression of J/psi production, a particle composed of a charmed quark and a charmed antiquark bound together. The production rates for J/psi in nuclear reactions can be estimated based on rates measured in proton-proton collisions. However, in a QGP, the J/psi is likely to be quickly destroyed, because of the higher interaction probabilities in the plasma. Thus, a deficit of J/psi may indicate the presence of a quark gluon plasma.

Drapier presented results on J/psi production in collisions of lead nuclei from the NA-50 experiment, conducted at CERN. He was followed by Dmitri Kharzaev of Brookhaven National Laboratory, who discussed recent theoretical work on J/psi production, specifically focusing on whether models which do not include the QGP can explain the recent data. His talk included the idea that a briefly created QGP cracked the J/psis into single quarks, which became too far separated to recombine when the QGP quickly cooled.

The remaining two speakers, Johann Peter Wurm from Max Planck Institut in Heidelberg and Volker Koch from LBL, focused on closely related topic: the production of low mass lepton (electron or muon) pairs. Lepton pairs are also produced in heavy ion collisions. Like the J/psi, they are a sensitive probe of the reaction dynamics. Unlike J/psi, they are produced by several different mechanisms, including the decays of mesons (bound states of a quark and an antiquark), bremsstrahlung (electromagnetic interactions of the nuclei), and annihilations of meson-antimeson pairs.



Theorists typically mix a cocktail of these mechanisms, trying to explain the observed rates and invariant mass spectra. These "cocktails" fit the data well for collisions of lighter nuclei. However, for collisions of heavier nuclei, the data and theory differ significantly. This may be because the properties of known particles change when they are immersed in nuclear matter. Wurm discussed experimental data from accelerators at LBL and CERN on dilepton production. Koch complemented this with a discussion of recent calculations of changes in particle masses and decay modes when they are immersed in nuclear matter, and their effect on the dilepton mass spectrum.

According to Koch, the strong interaction QCD vacuum has plenty of structure, indicated by the existence of several condensates, particularly the chiral quark condensate. This in turn indicates that chiral symmetry — in which the helicity of the quarks is con-

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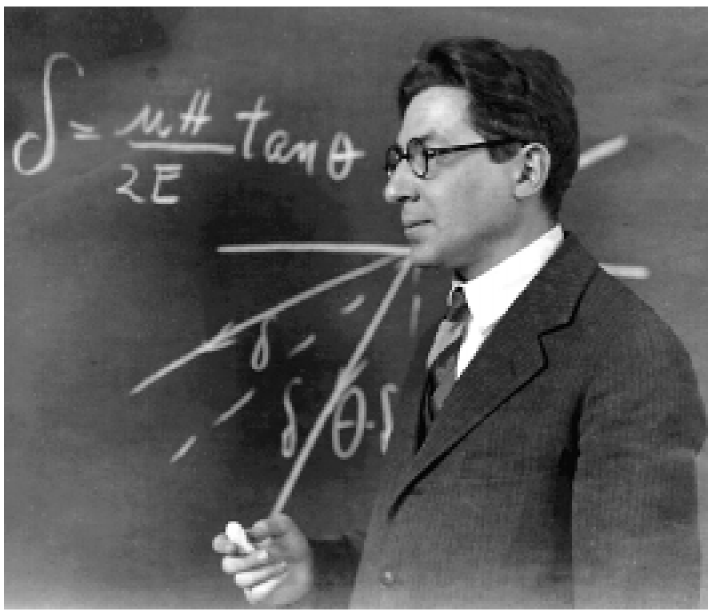


Photo courtsey of AIP Niels Bohr Library

Isidor Rabi

Isidor Rabi: Scientist and Citizen

by John S. Rigden, American Institute of Physics

Isidor Issac Rabi was born 100 years ago, nine months before the birth of the American Physical Society. He completed his dissertation and his PhD in July 1926, just days from his 28th birthday. One year later, he left for Europe to experience physics at the cutting edge.

The new quantum mechanics, created in Europe during the period 1925-1927, fascinated Rabi. While he was especially intrigued by the Stern-Gerlach experiment, it was Schrödinger's wave mechanics, published in early 1926, that provided Rabi his first opportunity to use the new theory. With Ralph Kronig, Rabi solved the Schrödinger equation for the spherical top molecule and gave a complete treatment for such a molecule. Kronig's and Rabi's paper on the spherical top molecule was rejected by the editor of *Physical Review* because it was too long. Kronig and Rabi shortened the paper and their results were published in the February, 1927 issue of *Physical Review*. In spite of this successful foray into quantum mechanics, Rabi was restive. He recognized that America was really backward in physics - really underdeveloped and Rabi felt the need to observe and work with those who had created the new theory.

Many young American physicists were in Europe studying at those centers where quantum mechanics was the daily passion. Rabi spent two years in Europe working with Bohr, Pauli, Stern, and Heisenberg. The experience had a profound effect on Rabi. In subtle and not so subtle ways, Rabi and the other American visitors were made to realize that American physics was regarded by their hosts as second rate. Rabi, Ed Condon, Robert Oppenheimer, and others promised themselves that they would change this and bring American physics to greatness. "And we did," said Rabi.

Rabi was one of the most influential leaders who brought American physics out of the shadows cast by the greatness of European physicists. Rabi did this through his roles as physicist and citizen.

During the decade of the 1930's, Rabi established his molecular beam laboratory at Columbia University where, together with his illustrious students, he measured nuclear properties with ever increasing precision. A beautiful evolution of experimental techniques culminated with the discovery of the magnetic resonance method in 1938. The magnetic resonance method revealed the quadrupole moment of the deuteron which required the introduction of new nuclear forces. Rabi won the Nobel prize in 1944 for this work and since that time, four of Rabi's students have also won this high honor.

Rabi's physics opened doors for him to serve America as a citizen. He was deeply concerned about the war in Europe and in December 1940 left his laboratory just at its peak of productivity. He went to the newly formed MIT Radiation Laboratory where he became Associate Director for Advanced Research. After the war, he continued his physics, but in addition became active in science policy at the national and international levels. He almost single-handedly transformed the Science Advisory Committee to the President's Science Advisory Committee which reported directly to the President. Through the United Nations, he and Dag Hammarskjöld organized the first International Conference on the Peaceful Uses of Atomic Energy. In 1984, Bill Moyers featured Rabi on a television program called, "Rabi: Man of the Twentieth Century. During the final years of his life, Rabi was regarded as the dean of American physics.

A century of physics

1935-1945: Physics in World War II

by Hans Christian von Baeyer

Throughout the nineteen thirties, while America struggled with the Great Depression and Adolf Hitler's Nazis rose to absolute power in Germany, physicists quietly continued to collaborate across national boundaries. Quantum mechanics proved to be a reliable framework for the study of solid matter, of molecules, and of atoms. The discovery of the neutron and the invention of the cyclotron launched the new science of nuclear physics. Although the size of the nucleus is 100,000 times smaller than that of an atom, and its internal energy higher by the same amount, quantum mechanics continued to work perfectly. The future of physics looked promising. But by the end of the decade, World War II broke out in Europe and swept the whole world, including the physics community, into its wake. Physicists and engineers helped to win the air-borne Battle of Britain by developing Radar, and their German colleagues designed the V-2 rockets that terrorized London. Of greater historical significance, though, was the construction of the atomic bomb.

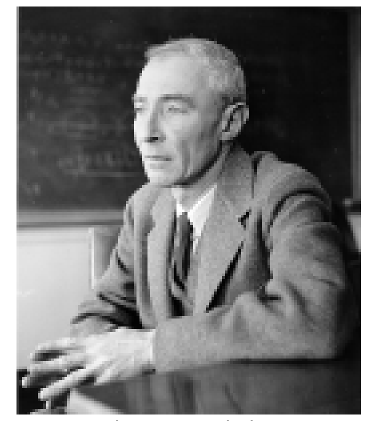


Photo courtsey of AIP Niels Bohr Library

Robert Oppenheimer

As soon as nuclear fission was discovered in Europe, it became apparent that if a way could be found to release its energy in a bomb, the course of the war would be altered. In America a number of physicists, many of European origin, worried that Hitler might acquire such a weapon and persuaded the normally pacifistic Albert Einstein to warn President Franklin D. Roosevelt. In an urgent letter dated August 2, 1939, he explained the danger by writing: "It is conceivable ... that extremely powerful bombs of a new type may thus be constructed." Einstein's letter did not have an immediate effect, but eventually helped to persuade the United States to begin the monumental task of building an atom bomb.

The man chosen to direct the project was the theoretical physicist Robert Oppenheimer. Although he had no industrial or even experimental experience, he proved to be a remarkably effective leader. His team on a remote mountaintop in New Mexico, and smaller groups in other secret laboratories, included most of the nation's best physicists. By the force of his towering intellect Oppenheimer managed to unite this fractious group in a common effort to design and build a bomb, and to test it successfully in July 1945. By then, Germany had already surrendered, but its ally Japan was still at war.

In August 1945, two atomic bombs dropped on the Japanese cities of Hiroshima and Nagasaki contributed to a quick end of World War II. Their chief legacy, however, was to be felt for a long time. For almost half a century the Cold War"s nuclear stand-off between the United States and the Soviet Union held the world in its grip.

Editor's Note: A CENTURY OF PHYSICS, a dramatic illustrated timeline wallchart of over a hundred entries on eleven large posters is intended for high schools and colleges. Each poster covers about a decade and is introduced by a thumbnail essay to provide a glimpse of the historical and scientific context of the time.

In the August/September issue, APS News will feature ***1945-1954 The Post-War Boom***.

Gala Event of the Century

Dust off your tuxedo and shine your dancing shoes for the Centennial Meeting. A black-tie optional gala event and dinner in celebration of the accomplishments of the 20th Century physics will take place Saturday evening, March 21, 1999 at the Fernbank Museum of Natural History in Atlanta. International, U.S. and Atlanta dignitaries, including Nobel laureates attending the Centennial, will be special guests as will the science teachers attending the Nobel events earlier in the day. The gala event, to be described in more detail in a future mailing to APS members, will be able to accommodate up to 2000 participants. APS members who wish to attend should plan to register early.

At the same time, we expect the gala to be the opening of a physics exhibit entitled *"Wonders of the 20th Century"* currently in development at the Fernbank museum. This exhibit will be designed to travel to other science museums after its Atlanta opening. Besides excellent food and drink included in the evening, there will be continuous showings of the IMAX movie, *Cosmic Voyages,* as well as a multi-media presentation celebrating the achievements of physics. Physics-related entertainers will be present as will various types of music.

First Observation *(continued from page 2)*

served — is spontaneously broken, implying that the quarks must be mass-less and thus travel with the speed of light. However, "We know that the constituent quark mass is rather large, about a third of the mass of the nucleon," said Koch. "This is because chiral symmetry is spontaneously broken in the vacuum of QCD."

Similarly, restoring chiral symmetry by melting the chiral quark condensate at high temperatures should cause the quark masses to become small, and since the light hadrons are made out of constituent quarks, their mass should drop as well. While this prediction is hotly debated, most researchers do agree that the mass difference between certain hdrons is exclusively due to the breakdown of chiral symmetry and thus should vanish once chiral symmetry is restored.

Because both of these techniques rely on relatively rare probes, charmed quarks and dileptons, progress has been limited by the statistical accuracy of the data. In 1999, RHIC will begin to collide gold nuclei at much higher energies than current accelerators. The data thus collected will extend these studies to considerably higher energies with improved statistics.

zero gravity

Top Ten Star Trek Science Bloopers

by Lawrence Krauss

1. In Space, No One Can Hear You Scream. The promo for "Alien" got it right, but Star Trek usually doesn't. Sound waves DO NOT travel in empty space! Yet when a space station orbiting the planet Tanuga IV blows up, from our vantage point aboard the Enterprise we hear it as well as see it. What's worse, we hear it _at the same time_ as we see it. Even if sound waves could travel in space, which they can't, the speed of a pressure wave such as sound is generally orders of magnitude smaller than the speed of light.

2. Faster Than a Speeding Phaser. The Voyager episode "The Phage" involves an attempt to beat a phaser beam. Phasers are, we are told, directed energy weapons. If phasers are pure energy and not particle beams, as the Star Trek technical manual states, the beams must move at the speed of light. No matter how fast one moves, one can never move out of the way of an oncoming phaser beam. Why? Because in order to know it is coming, you have to first see the gun being fired. But the light that allows you to see this travels at the same speed as the beam. It is impossible to know it is going to hit you until it hits you.

3. If the Plot Isn't Cracked, Maybe the Event Horizon Is. In the same episode, a "crack" in the event horizon of a black hole saves the day for the Voyager. The event horizon around a black hole is not a physical entity, but rather a location inside of which all trajectories remain inside the hole. It is a property of curved space that the trajectory of anything, including light, will bend back toward the hole once you are inside a certain radius. Either the event horizon exists, in which a black hole exists, or it doesn't. There is no middle ground big enough to slip a needle through, much less the Voyager.

4. How Solid a Guy is the Doctor? There is a wonderful Voyager scene in which a patient asks the holographic doctor how he can be solid if he is only a hologram. The doctor answers by turning off a "magnetic confinement beam" to show that without it he is as noncorporeal as a mirage. He then orders the beam turned back on, so that he can slap the poor patient around. Magnetic confinement works wonders for charged particles, which experience a force in a constant magnetic field that causes them to move in circular orbits. However, light is not charged. It experiences no force in a magnetic field. Since a hologram is no more than a light image, neither is the doctor.

5. To Interphase, or Not To Interphase? In the Next Generation episode "Phantasms," invisible interphase insects invade the Enterprise by clinging to the bodies of the crew. However, if they could observe the Enterprise from their "phase," they could interact with light, an electromagnetic wave. By Newton's First Law, they should in turn have been visible. In order to see or sense light, you have to absorb it. By absorbing light, you must disturb it. If you disturb light, you must be visible to someone else. Similarly, the force that allows them to rest on normal matter without going through it is nothing other than electromagnetism — the electrostatic repulsion between the charged particles making up the atoms in one body with the atoms in another body. And once you interact electromagnetically, you are part of our world.

6. Sweeping Out the Baby with the Bathwater. In the Next Generation episode "Starship Mine," the Enterprise docks at the Remmler array to have a "baryon sweep". It seems that these particles build up on starship superstructures as a result of long-term travel at warp speed, and must be removed. The only stable baryons are protons and neutrons in atomic nuclei. Since these make up everything we see, ridding the Enterprise of them wouldn't leave much of it for future episodes.

7. How Cold is Cold? Another gaffe involves an object's being frozen to a temperature of -295 degrees Celsius. This is a very exciting discovery, because on the Celsius scale, absolute zero is -273 degrees. Absolute zero is the lowest tempeature anything can potentially attain, because it is defined as the temperature at which all molecular and atomic motions, vibbrations and rotations cease. Since temperature is associated with molecular and atomic motion, you can never get less than no motion at all; hence, even 400 years from now, absolute zero will still be absolute.

8. I Have Seen the Light! Whenever the Enterprise shoots a phaser beam, we see it. But of course this is impossible unless the phaser itself emits light in all directions. Light is not visible unless it reflects off something. Thus, unless empty space is particularly dusty, we shouldn't see the laser beam except where it hits.

9. Astronomers Get Picky. A NASA scientist pointed out an error I had missed. It is generally standard starship procedure to move into geosynchronous orbit around planets. Thus, the ship should remain above the same place on the planet's surface, jusst as geosynchronous weather satellites do on Earth. Nevertheless, when the Enterprise is shown orbiting a planet it is usually moving against the background of the planet's surface.

10. Those Darned Neutrinos. In an episode of Deep Space Nine, Quark has gotten hold of a machine that alters the laws of probability in its vicinity. One can imagine how useful this would be at his gambling tables. The ruse is discovered, however, by Dax, who happens to analyze the neutrino flux through the space station. To her surprise, she finds that all the neutrinos are coming through left-handed. The neutrinos that spin in the opposite direction seem to be missing. Of all the phenomena the Star Trek writers could have chosen to uncover Quark's shenanigans, they managed to pick one that is actually true. As far as we know, neutrinos are only left-handed. They are the only known particles in nature that apparently can exist in only one spin state.

Sometimes truth is indeed stranger than fiction.

Adapted from "The Physics of Star Trek", by Lawrence M. Krauss (New York: Harper Collins/BasicBooks, 1995, pp. 162-172.

Recent Experiments on Exotic Atoms

Exotic atoms are unique traps for elementary particles like muons, pions and antiprotons and allow physicists to test fundamental laws like the CPT theorem, quantum electrodynamics, the theory of strong interactions, and the properties of elementary particles. The trapped particle may also serve as a probe for the strong and electromagnetic forces exerted by the atomic nucleus, according to F. Joachim Hartmann of the Technical University of Munich in Germany, who spoke at the APS/AAPT Spring Meeting in Columbus, Ohio.

In an exotic atom an elementary particle of negative charge and sufficiently long lifetime orbits besides the electrons around the nucleus. The most common particles to form such atoms are the muon, the pion, and the antiproton. As the masses of the elementary particles forming exotic atoms are large compared to that of the electron, the dimensions of their orbits in these atoms are much smaller and the energies required to eject them from the atom are much larger than for electrons in ordinary atoms. This makes exotic atoms suitable for studying the properties of exotic particles such as their mass, charge, spin, magnetic moment and the strength of their interaction with nuclear matter, Hartmann reported.

Exotic atoms are formed when particles are shot into and slowed down in matter. When they reach energies comparable to the binding energies of the outer atomic electrons, they are captured by an atom to form highly excited exotic-atom states. Similar to ordinary atoms the system is de-excited by emission of exotic (muonic, pionic, antiprotonic) x rays with energies up to the gamma-energy region, or by the ejection of an electron from the host atom (the Auger effect). The whole de-excitation process, called a cascade, is finished within pico- to nanoseconds. Because it achieves this lowly excited state so rapidly, the exotic particle dumps an energy of up to 1 GeV into the nucleus, several times the energy released during a nuclear fission reaction. And, said Hartmann, "the energy of the emitted gamma radiation allows one to draw conclusions on important properties of the particle."

Antiprotonic helium is a very special exotic atom. In 1991 it was demonstrated that about 3% of all antiprotonic He atoms exist in long-lived, metastable states with a microsecond lifetime, orders of magnitude longer than in the ordinary exotic atom. Irradiation of this atom with laser light of the appropriate wavelength brings the exotic atom to a short-lived level. The usual fast cascade follows and leads to states from which annihilation occurs. Because the wave length and hence the energy of the laser light may be determined with a precision of parts per million, this resonant de-excitation provides a means of determining the energy levels in the simple three-body system with unprecedented accuracy.

In another recent experiment, heavy antiprotonic atoms were used to probe the difference between neutron and proton densities at the nuclear periphery. Antiprotons are shot into samples which contain only one isotope of an element. After exotic-atom formation and cascade, they annihilate with one nucleon from the nucleus. Because this annihilation occurs at some distance from the nucleus, all of the annihilation products (mostly pions) might miss the nucleus, producing a nucleus which has either one neutron (annihilation of the antiproton on a neutron) or one proton (annihilation on a proton) less than the original nucleus. If the nuclei thus generated are radioactive, they may be detected with high sensitivity via their decay products. If there are more neutrons at the place where annihilation occurs than one would expect, this would result in the enhanced generation of nuclei with one neutron less. According to Hartmann, such an effect has been observed for a number of nuclei and used as a rigid test for existing nuclear-structure theories.

IN BRIEF

Neal Lane Becomes New OSTP Director

Neal Lane, former Director of the National Science Foundation and Fellow of the APS, was named by President Clinton to be the new Science Advisor to the President and Director of the Office of Science and Technology Policy. John Gibbons, also a Fellow of the APS, retired from this post in April.

Rita Colwell Confirmed as New NSF Director

The Senate confirmed Rita Colwell as director of the National Science Foundation. Colwell, who was most recently a Professor at the University of Maryland, has a Ph.D. in marine microbiology from the University of Washington.

Physics Today Celebrated its Golden Anniversary

Physics Today magazine celebrated its 50th anniversary in May with a special issue including winning entries from a contest which asked for a news report of an imagined research breakthrough of the future. The issue also included articles on the magazine's early beginnings, as well as selected short summaries of highlights of each decade.

Online Resource for Physical Sciences Established

The American Association of Physics Teachers (AAPT) has established an online Physical Sciences Resource Center (PSRC), an easy-to-use and innovative Web site providing resources and links for the entire spectrum of physical sciences. "We want the PSRC to be the first place physics educators look for teaching ideas," said AAPT Executive Officer Bernard Khoury. Educators can use the site for information and reviews of curriculum materials for all grade levels, ideas for demonstrations, examples of evaluation instruments, and articles and links about the latest approaches to science education. Topics range from acoustics to statistics and thermodynamics, to computers and technology. In addition to a searchable database of scientists who have volunteered to serve as resources for specific educational levels, the site also has a career center with links to career bulletin boards, job search engines, and internship and research opportunities. [www.psrc-online.org]

Physical Review Editorial Office Expanding

Ever notice how the 'Creeping Green,' aka *Physical Review* journals, demands ever increasing shelf space? Well, the same is true for the increasing number of editors and production workers who have been shoe horned into its editorial offices. The photo shows progress in the expansion and face lift of the Ridge facility on Long Island, NY. The project will be completed later this year.

Council Structure to be Reviewed by Newly Established Task Force

At its April meeting, the APS Executive Board and Council voted to establish a task force on the structure and responsibilities of the APS Council, an action deemed necessary "in light of new demands upon the Society caused by its increasing range of activities and the many additional units that have been formed," the resolution stated. Chaired by Ernest Henley (University of Washington), the task force is charged with reviewing the structure of the Council with respect to representation and overall size, and with examining the distribution of responsibilities between the Council, Executive Board, and various bylaw committees. On the basis of the review, the task force will make recommendations that might improve the value and effectiveness of Council meetings and APS governance as a whole. A final report is scheduled for presentation at the May 1999 Council meeting.

Scenes from the Fellow Reception of the APS April Meeting

Speakers at Centennial Session Pay Tribute to Leo Szilard

Leo Szilard — physicist, inventor, biologist, writer and occasional diplomat — was the subject of a special Saturday afternoon session at the APS/AAPT Spring Meeting in Columbus, Ohio, sponsored by the Forum on Physics and Society, the Forum on International Physics, and the Forum on the History of Physics. The session opened with an official greeting from Istvan Szemenyei, counselor for science and technology of the Embpassy of the Republic of Hungary.

Photo courtesy of AIP Niels Bohr Library

Leo Szilard

In the field of nuclear physics, Szilard's role as an inventor is well recognized, according to V.L. Telegdi of the University of California, San Diego, and CERN. The concept of a sustained nuclear chain reaction is credited to him, and a joint patent with Enrico Fermi covers all the essential features of the carbon-uranium reactor. "His proposals concerning accelerators, covered in applications for patents which never seem to have been issued, have not yet been publicized," Telegedi said. Szilard is also credited with inventing the cyclotron, the linear accelerator and the concept of phase stability, as well as drafting Albert Einstein's 1939 letter to President Franklin Roosevelt, which led to the Manhattan Project.

Szilard originated from a polycultural family, according to George Marx of the University of Budapest in Hungary, this year's Beller Lecturer, who discussed Szilard's roots and interdisciplinity. In the early 20th century he grew up in Hungary, at the crossroads of history, where political regimes, national borders, ideological doctrines, and "final truths" changed in a dizzying cavalcade. Instead of conservative dogmatism, this social environment required critical thinking in order to survive. "World War I was the school of John von Neumann, Eugene P. Wigner and Leo Szilard, each of whom learned to trespass political and disciplinary boundaries without inhibition," said Marx. "And their sensitivity for trends had been utilized by the U.S. when war efforts and high tech required orientation under new horizons."

Far from being limited to atomic physics, Szilard's interests ranged from statistical physics through information theory to biological evolution, from life phenomena through hot atoms to nuclear strategy and deterrance. "His intellectual adventures might look like crazy jumps for specialists," said Marx. "But now, looking back to the political and technological history of the 20th century one can see than it was a consequent progress of a future-sensitive mind."

In addition to being a creative physicist and biologist, Szilard's concern about how scientific discoveries might affect humanity led him to seek political solutions to enlarge the benefits and limit the damage caused by his work, many of which were summarized by William Lanouette, a writer and public policy analyst who is the author of Genius in the Shadows: A Biography of Leo Szilard, The Man Behind the Bomb. This disposition to save the world came to Szilard by the age of 10, when he read *The Tragedy of Man*, a Hungarian epic poem in which humanity faces extinction yet continues to survive by maintaining a narrow margin of hope. With this hope Szilard brought about improbable scientific and political feats, such as the nuclear chain reaction and the Moscow-Washington Hotline, as well as many attempts in 1945 to prevent the atomic bombing of Japan. In addition, Szilard published a novel, *The Voice of the Dolphins*, a parable of the technical prowess and moral limitations of our times.

Edward Gerjuoy of the University Pittsburgh closed the session with a description of how, for essentially his entire adult life, Szilard sought to increase the likelihood that the results of basic scientific research — which have so greatly increased humanity's ability to manipulate the natural world, especially since World War II — would be used for humanity's benefit. He reviewed and assessed Szilard's endeavors in this quest, reflecting on its significance for those who assembled to honor him 34 years after his death.

A short biography of Szilard appeared on page 6 of the February 1998 issue of *APS News*.

Cosmic Chords *(continued from page 2)*

general relativistic (GR) effect; in Newton's mechanics, by contrast, the blob could have gotten arbitrarily close to the surface, providing it were going fast enough.

Lamb and Miller's calculations showed how the x-ray brightness oscillations could be used to determine the masses and dimensions of neutron stars and to look for evidence of the innermost stable orbit. They predicted that the frequency of the x-ray brightness variations should increase as the gas flows onto the neutron star and hence its x-ray power rises, until the clumps of gas producing the oscillations reach the innermost stable orbit, at which point they should become constant as the x-ray power continues to rise. The observations by Zhang and his collaborators confirmed Lamb's prediction of this effect. They found that as its x-ray power rises, the frequency of the brightness oscillations increases until it reaches approximately 1,050 times per second. As the x-ray power increases further, the frequency remains constant, indicating that the innermost stable orbit has been reached.

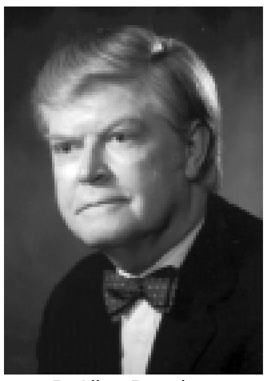
According to Zhang, this correlation between theory and experiment opens up a new "strong-gravitational field" era in GR studies. "There is a good possibility that the Rossi Explorer has provided the first evidence supporting the predictions of Einstein's theory of gravity about how matter moves in strongly curved space-time," said Lamb. "All previous tests of general relativity have been made in regions where space-time is curved only very, very weakly." The measurements of the gas motion even provide hints as to the nature of the strong nuclear force sustaining the neutron star against further gravitational collapse. The new evidence indicates that the nuclear force is stiffer and more repulsive than has generally been thought.

OPINION

APS VIEWS

A Year of Opportunities: APS Retiring Presidential Address

by D. Allan Bromley, APS Past President


D. Allan Bromley

In my formal statement as a candidate for the APS vice-presidency some four years ago, I included the following goals, should I be elected: (1) work with our sister scientific societies to make a more coherent and persuasive case for continued investment in science and technology to both the Administration and Congress; (2) work with other physical societies worldwide to strengthen our interactions and mutually benefit from shared discussion of problems and solutions that may evolve from them; and (3) work to provide better communication with the members of our own society. To these I should have added working to prepare for an APS Centennial celebration worthy of the achievements of physics and, especially, of American physics over the past century, as well as our aspirations for the coming century.

Cooperation with Sister Societies. From my years as science advisor to President Bush, I knew firsthand that both the White House and the Congress considered the scientific and technological communities to be by far the least effective in making their cases for federal investment in their fields. In part, this lack of effectiveness reflected a peculiar characteristic of the science and technology community: when there is trouble on the horizon, we pull the wagons into a circle, but unlike other communities, we shoot in! I spent a remakrable amount of my time in Washington defending physics programs and projects from other physicists.

How then do we become a more effective constituency? The American*Historical Factal* Association for the Advancement of Science's June 1996 projections of the anticipated federal spending on non-defense research and development for FY1995 through FY2000 showed, in real terms, a decline of some 30%. This made abundantly clear the need for coherent action. In early 1997, we in the APS got together with the American Chemical Society, the American Mathematical Society, and the American Astronomical Society to discuss how we could most effectively work together in making a persuasive case for science and technology. These four societies formed the nucleus of all the activity throughout the tear.

We recognized that one of the most striking changes taking place in science and technology in recent years has been the rapidly increasing interdependence within and between the sciences and technologies. Breakthroughs in a given field frequently have their greatest impact in other fields that are quite remote and where they have been totally unexpected. In parallel, some of the nation's leading economists have published studies that showed more than one-half of the growth in the U.S. Gross Domestic Product since World War II can be traced directly to implementation of new science-based technologies. Technology is the engine of economic growth and competitiveness. The clear message is that if we are to look forward to a strong economic future tomorrow, we must invest in science and technology today.

Our discussions resulted in a joint statement calling for an increase in federal R&D investment in the range of 7% for FY1998. "The Seven Percent Solution," as it became known, received a great deal of media and Congressional attention, resulting later in the year in the introduction of a bipartisan Senate bill (S.1305) calling for a doubling in the budget amount authorized for basic science and medical research over the next decade. When the smoke of the Congressional budget process cleared away and the final FY1998 R&D appropriations became available, the NSF, DOE's Basic Energy Sciences, and NIH received the requested 7% or more increase while, overall, an increase of roughly 4% had been appropriated. By late 1997, 100 societies had become involved in support of a "unified statement" calling for a "doubling of the nation's research budget during a 10-year period."

In early February, President Clinton's FY1999 budget request to Congress included 11% increases for the NSF and DOE, 9% for NIH, 8% for basic research overall, 6% for university research overall, and 7% overall for peer reviewed R&D programs. This is gratifying, although there is a long way to go before these increases are actually appropriated by the Congress. There is no agreement, as yet, on how the projected surplus in the FY1999 federal budget will be distributed, and there are many competing claims on the discretionary component of that budget. For the first time in history, however, the professional socieites have played a coherent and effective role in presenting the case for continued federal investment in science and technology.

Cooperation with Foreign Physical Societies. Early in 1997 we scheduled a planning meeting on international collaboration, to be held in October in Washington, DC. Topics discussed included electronic publishing, science policy and funding, physics education and public education, and physics and capacity building. All participants left the meeting feeling that the free and open discussions had been extremely valuable.

In the case of electronic publishing, we are in the middle of a very rapid and important transition, not only for what it portends in terms of publishing research results, but also for the fact that some 85% of the Society's total budget comes from its publishing activities. It is far from obvious how this will change as we become ever more electronic, although under the leadership of our new editor-in-chief, Marty Blume, we have made dramatic progress toward electronic publishing in the past year. It was encouraging to find from the discussion that all of the major national physical societies involved in significant publication activities faced roughly the same problems.

With regard to science policy and funding, the end of the Cold War removed much of the rationale for continuing investment in science and technology, and physicists, in particular, hadbeen monumentally ineffective in making the case for continuing federal investment in their field. The question that was emphasized throughout our discussions was how best to make changes in public policy, and to encourage better investment in physics. As noted above, our experience in the U.S. is that collaboration among the professional societies has the potential for major impact.

In the area of education, the recent release of the Third International Mathematics and Science Study underscores the scandalous situation in American pre-college education. While our students were roughly competitive with those of other nations at the end of grade 4, by the end of grade 8 they had fallen well below the average and by the end of grade 12, in physics they were at the absolute bottom of the list of 21 nations studied. All of the nations involved in our meeting faced the same problem of having too few students interested in physics as an undergraduate major, but we in the U.S. are in a class by ourselves when it comes to inferior quality of the education we are providing to our children and grandchildren.

There are no easy solutions, but it is clear from our discussions that objective standards, trained teachers, more work on the part of students, and greater parental involvement are all critically important. Information technology can be hekpful, but is certainly not the answer. Nor is more money. Last year we spent on the order of $550 billion on pre-college education, which is more per student than any place else in the world. We certainly cannot claim we've been getting our money's worth.

Convocations of Fellows. In conjunction with the fundraising aspects of the APS Campaign for Phyiscs, a number of meetings specifically for Fellows of the Society have been held. Last year, however, we decided it was of particular importance to keep our Fellows more fully informed as to APS programs and activities. To this end, we planned regional meetings across the nation where such discussion and input could occur. The first was held in September in New York City, in which more than 130 Fellows from the New York and New England regions participated in a cocktail reception followed by an extended discussion on APS activities. The second such meeting was held in Washington last November, and the third was held in March during the APS March Meeting in Los Angeles. A fourth meeting was held in April during the Joint APS/AAPT Spring Meeting in Columbus, Ohio. We have had nothing but positive input concnering these meetings and I am sure they will continue as a regular feature of APS activities.

Capacity building — in the sens that it implies the development of indigenous career opportunies in all nations — and a more rapid industrialization and development process repies critically upon access to modern information technology. Too often we in the development world have attempted what we call "technology transfer" to other parts of the world without recognizing that there are absolutely critical requirements before such transfer can be effective. These include a stable agricultural economy, a stable political structure, and a stable and high quality educational enterprise. As Arthur Clarke once pointed out, for some 98% of the world's inhabitants, high technology remains totally indistinguishable from magic.

In this connection it is clearly the case that exchanges of scholars and students at every level are critical to capacity building. Technology transfer occurs only in the mind of humans. If we are to be effectve in applying physics or any science or technology to capacity building, it is essential that basic science andtechnology are recognized as fundamental components of national foreign policy and development. It hardly needs emphasis that this is important both for the developing and developed countries. As a specific example, we in the U.S. have never succeeded in making science or technology an integral part of the activities of our State Department.

Centennial Celebration Planning. The 100th anniversary of the founding of the APS occurs in 1999, and will be celebrated at a mjor meeting during the week of March 20th in Atlanta, Georgia. Substantial planning has already begun in earnest with the hiring of a centennial director, Franmarie Kennedy, and the engagement of the Edelman Public Relations Firm to assist in improving our access to the media, and in developing clearly focused messages. We are making every effort to involve as many of the citizens of Atlanta and the surrounding regions during the celebration. For example, we are arranging for children to interact one-on-one with the more than 40 Nobel Laureates in physics who have confirmed their participation.

Among the projects essentially completed is a Physics Wall Chart, which we plan to make available to every U.S. secondary school and, if funding permits, to every elementary school. Much of that material, which covers the last century of physics, will also appear in a coffee table book for general audiences. A Centennial Speaker's Bureau has been assembled with more than 200 registrants — persons who have agreed to respond to requests for colloquia and seminars focusing in part on the history of physics over the past century. A complete photographic gallery of Nobel Laureates in physics will be on display, along with a comprehensive collection of photographs of leading physicists of the past century. In addition, many APS divisions are developing displays for the centenntial. Substantial planning has also been deovted to outdoor exhibits of physics experiments in local parks, as well as to theatrical and cultural events.

In conclusion, 1997 was a year of opportunities. We have made an important start in working with our sister societies to develop a more persuasive constituency for U.S. science and technology. Our collaboration with the international community of physicists already promises significant mutual benefits. Both personally and on behalf of my colleagues in the Presidential line, I would be remiss were I not to express again our profound thanks to the Senior Officers and the entire APS staff. They are a dedicated, creative and deeply motivated group, and it has been a great pleasure working with them.

Adapted from a talk given by D. Allan Bromley, Sterling Professor of the Sciences at Yale University, at the Joint APS/AAPT Spring meeting in Columbus, Ohio. For the complete text of Dr. Bromley's Retiring Presidential Address, contact Amy Halsted, APS, One Physics Ellipse, College Park, MD 20740; FAX: 301-209-0865; email: halsted@aps.org.

LETTERS

Nuclear Test Dark Matter

I wonder if the APS home page could include a geographic "DARK" area, located on this planet, where nuclear tests are occuring this very moment?

Steven Mandell
Lantana, Florida

Editor's note: *Reaction letters to May's Back Page by Priscilla Auchincloss appear on page 12.*

Physics and Toys: Fun for Everyone

by Raymond C. Turner

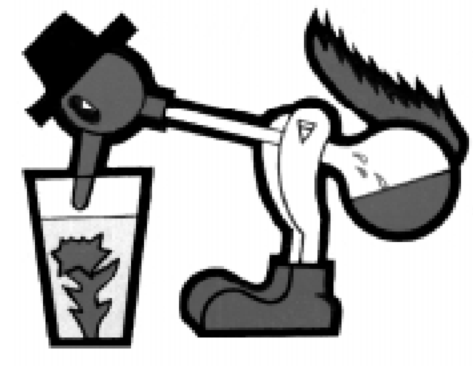
All too often when the word physics is mentioned, people have a very negative reaction. Fortunately, the basic principles of physics can often be demonstrated, as well as made fun, by using ordinary children's toys. By understanding how these toys work the observers can better understand the world around them. Toys can also be used with students of all ages. I have successfully used toys in physics presentations to pre-kindergarten classes, and elder hostel groups, as well as all ages in between. The detailed analysis of the toys differs depending on the background of the observers, but in every case the physics is the same, and the toys allow for a nonthreatening and fun presentation.

There are any number of toys which can be used to illustrate various physics principles of mechanics. A Hot Wheels race car and track can be used to demonstrate velocity and acceleration, or be analyzed using energy concepts, while a water rocket can be used to demonstrate the principle of momentum. For now, let us discuss several toys that deal with magnetism and light.

For example, a toy periscope can be used to demonstrate reflection of light and image formation with flat mirrors. A particularly interesting version is the rotating periscope. While a periscope is usually used to look at an object in front of you, the top of this periscope can be rotated about the vertical axis so that you can look behind you. When you rotate the top mirror in this way, the image is inverted, such that the image is in the normal upright position when looking straight ahead, but inverted when you look behind you. (Now you know why submarine commanders in the movies always turned with their periscopes.) Examination of the toy periscope shows that it contains two mirrors, one in the top and one in the bottom, each of which is at an angle of 45 degrees to the vertical. You should be able to quickly sketch two light rays from the object to your eye in order to analyze the upright and inverted images. This is exactly what I have my students do in order to have them begin to understand image formation using light rays.

A more complex toy that became popular several years ago is called laser tag, consisting of a "laser" gun and a target. The gun emits an invisible beam of radiation, and the target is a sensor which emits an audible signal when the wearer is "tagged." What are the properties of this radiation? There are any number of specific questions that can be asked and then answered by investigation. Does the beam travel in straight lines, or does it bend around corners? Can the beam be reflected, and if so, does it behave like light when it is reflected? Can the beam be refracted? Can it be diffracted with a diffraction grating? Is the beam transmitted through a sheet of paper?

If you perform some of these experiments, you find, for example, that the beam can be reflected from a mirror or sheet of metal, and that it obeys the law of reflection. The beam is also found to refract when it is sent through plexiglass and is found to obey Snell's law of refraction. Perhaps surprisingly, it is found that the beam will transmit through a sheet of paper. The particular version of this toy I prefer to use is called the infrared blaster, emitting a beam with an infrared wavelength of about 930 nm. This can be used to illustrate how a physicist goes about investigating the properties of an unknown, obtaining good experimental results in the process.



Another toy — perhaps better termed a novelty — is a flicker light, commonly found in toy stores and gift shops. This is an electric light bulb in which the filament vibrates in an erratic fashion that is supposed to simulate a flickering candle. What makes its filament vibrate? Examination of the bulb shows that the wire filament is free to move somewhat, and there is a magnet near the filament. When a current flows in the filament, there is a magnetic force on it, due to the field of the permanent magnet. This magnetic force is in a direction perpendicular to both the field and the current. Since the light is operating on the usual 60 Hz ac line, the direction of the current reverses 60 times per second. Thus, the direction of the force on the filament changes at the same rate, causing the filament to vibrate back and forth, at a rate too rapid to be followed by our eyes. So why does the light appear to flicker?

While the magnet for most of these lights is mounted inside the bulb, I was fortunate enough to obtain a magnetic wild flicker bulb which had the magnet mounted on the outside. This allowed me to move the magnet away from the bulb, so that I could see the effect of reducing the magnetic field at the filament. As you would expect, the further the magnet was moved away, the smaller the amplitude of the vibration. But this permits another aspect of the vibration to be observed.

When the magnetic field is small, the vibration of the filament is regular (60 Hz) and is observed only as an apparent broadening of the filament. As the magnet is moved closer to the bulb, the amplitude of this smooth vibration increases until suddenly, the filament begins to wildly flicker. This flicker is at a much lower frequency than 60 Hz and its rate is presumably determined by the mechanical resonant frequencies of the filament. The onset of this flicker is most likely a demonstration of chaotic motion that occurs when the amplitude of the motion is large enough to cause significant nonlinear effects. This simple toy thus demonstrates the magnetic force on a current carrying wire, as well as serving as a means for introducing the concept of chaos.

These are just a few of the many toys that can be used to illustrate basic physics principles. Only your imagination and ingenuity limit you in your application of the fundamental laws of physics to ordinary objects, even toys. Physics can be fun not only for students, but also for the teacher. By using toys, physics can be fun for everyone.

Raymond Turner is an Alumni Distinguished Professor of Physics at Clemson University in South Carolina, and is the recipient of the first AAPT Award for Excellence in Undergraduate Teaching. This article first appeared in the Fall 1997 issue of the APS Forum on Education Newsletter and was the basis of an invited paper presented at the APS/AAPT April Meeting in Columbus, Ohio. Other physics toys in action may be observed at the following Web site: [www.clemson.edu/phys- car].

Springtime Demos Illustrate Basic Physics Concepts

On Sunday afternoon, physicists from Ohio State University entertained attendees of the APS/AAPT Spring Meeting with demonstrations illustrating physics principles in everyday objects. Sponsored by the Physics Instructional Resource Association (PIRA) and the AAPT Apparatus Committee, the session was very well attended. PIRA is an organization intended to serve the needs of physics educators around the country by providing means for sharing ideas about demonstrations, laboratory activities, and instructional resources in general to advance the quality of physics education at all levels.

Maarten Rutgers displayed his talents for building some of the world's largest soap films, which can approach heights of 20 feet. He has constructed an apparatus to study two-dimensional fluid flows, which are typical in planetary atmospheres, for example. The device consists of two vertical nylon wires hanging down from a single point, held taut by a weight to form the sides of the flow channel. A simple soap solution — typically one or two parts of Dawn dish soap detergent to 100 parts tap water — drips onto the wires at the top. As it dribbles down, the wires adhere together with the soap solution. They are then pulled apart, forming a soap film in between them. Gravity pulls the film down at a rate of approximately 10 miles per hour, and a bucket beneath the weight collects the solution.

Rutgers' laboratory films are typically about 8 to 10 feet tall and 2-6 inches wide, but "nothing stops you from making these films as large as you like," he said. He has constructed soap films 4 stories high and 14 feet wide in the atrium of the Carnegie Science Center in Pittsburgh, PA. A giant soap film reaching 7 stories (80 feet) and 4 feet wide was produced at the University of Chicago's James Franck Institute. Such tall films, says Rutgers, are 10,000,000 times taller than they are thick. The Xperiment Museum in Stockholm, Switzerland now has a permanent installation with a two-story flowing film.

Roderick Grant (a.k.a. "Chef Boy R.G."), a professor emeritus at Denison University and amateur chef, used simple cooking examples to demonstrate basic physics concepts. For example, he added a tablespoon of hot cocoa to a cup, filled it with hot water, and then tapped the cup's bottom with a spoon until the pitch stabilized. He then poured water into one tall glass, and club soda into a second, tapping the bottoms of each to compare the pitch. The pitch of the class of soda water changed after it was stirred gently. "Dissolved air released from mixing cocoa, or from the release of CO_2 in soda, modifies the velocity of sound and consequently the perceived pitch," Grant explained. He also demonstrated conduction and convection cooling, using containers of water and soup, respectively, and supplied attendees with a reference list for a wide variety of articles discussing the culinary aspects of physics and chemistry.

Leonard Jossem and Richard Noll displayed unexpected electrical behavior in ordinary light bulbs, showing how to confine an electron in a Penning trap, as well as how to trap fluorescent particles. Edward Adelson demonstrated a spectrum of pastel colors obtained without the usually required prism or slit. Alas, a scheduled appearance by unicyclist Harris Kagan, intended to demonstrate that a ball thrown straight up in the air while on a moving unicycle will always land right in front of him, was canceled due to injury during practice.

Additional information and photos of giant soap films, as well as directions on how to make your own, links to other Web sites, and references to books and articles on the subject, can be found at http://www.physics.ohio-state.edu/~maarten and http://www.exploratorium.edu/ronh/bubbles/bubbles.html. More information about unicycling may be found at http://www.unicycling.org.

A study of a different kind of isolated object, perhaps to be used in future turbulence generating grids. A utility knife tip punctures the film. The sharp edges produce small vortices in a shear layer roll-up. This fine structure is convected into a much larger von Karman vortex wake.

April Meeting

(continued from page 2)

and detectors around the world. For example, Edward R. Kinney of the University of Colorado and DESY presented new results from the HERMES experiment at DESY in Germany which provide detailed experimental information on nuclear spin, a quantum property which describes how a nucleus interacts with magnetic fields. Finally, Pete Markowitz of Florida International University discussed the results of Jefferson Lab experiments that probe the formation of omega mesons, short-lived and highly unstable nuclei consisting of two quarks.

Measuring Planck's Constant

In efforts to come up with the most precise value of Planck's constant to date, a NIST group led by Edwin Williams has performed experiments that relate Planck's constant to mechanical measurements of a kilogram mass attached to a coil in a magnetic field. With these measurements, they were able to determine Planck's constant to an accuracy of 0.15 parts per million. The group is working to increase the accuracy of their measurement tenfold, and their experiments overall aim to lead to a definition of the kilogram based on quantum units, rather than one based on the stalwart physical artifact currently stored in France.

Looking for Cracks in the Standard Model

The current theory of particle physics, the standard model, has been successful in accounting for most of the violent phenomena observed at accelerators. Still, researchers must always be on the lookout for anomalies that point to new physics. Bruce Strau (Columbia University) from the HERA collaboration in Hamburg, Germany, reported electron-proton collisions evidence for bizarre particles called leptoquarks. Sarah Eno (University of Maryland) reported on recent experiments at Fermilab, where the Tevatron's 1.8 TeV of collision energy can hypothetically reincarnate quarks into various exotica, such as Higgs bosons and supersymmetric particles. Ian Scott (University of Wisconsin) summarized new results from the LEP electron-positron collider.

Light-Front Field Theory

Physicists believe that a proton is made up of three quarks held together by particles known as gluons. Each proton is constantly bathed in a sea of virtual particles, making it difficult for the modern theory of particle physics, known as quantum chromodynamics (QCD), to describe the properties of a proton's constituents in isolation from its surroundings. In the early 1970s, Richard Feynman suggested that it would be easier to separate the proton from virtual particles if the proton was moving near the speed of light, relative to a fixed point-of-view. In such a reference frame, one would know that the proton's constituent particles were also moving at near-light speeds, while it would be much less likely for the virtual particles to be traveling at such velocities.

This "light-front" approach has explained some key results in particle physics experiments, but it has not been possible yet to compute the properties of high-energy (excited) states of the proton from first principles in this (or any other) framework. The primary barrier to computation has been the belief that quarks in a proton are strongly bound to gluons, which makes computation difficult. In a new version of the light-field approach, Nobel Laureate Kenneth Wilson and Robert Perry of Ohio State University, Stan Glazek (Warsaw University), and others propose that quark binding is considerably weaker than expected; the only strong binding is of gluons to each other, and that this is enough to prevent the appearance of free quarks. Such an assumption may lead to greater success in analyzing the excited states of the proton and of other objects containing quarks.

Rare Processes in Spontaneous Fission

An international collaboration of researchers from thirteen institutions in the U.S., Romania, Germany, Russia, China, and Brazil has discovered that along with normal fission, neutronless fission in some elements like Californium is also possible. According to Vanderbilt University's A.V. Ramayya, there are several processes, such as californium splitting into molybdenum and barium, which is called cold (neutronless) binary fission. Usually 1-10 events of this type occur per 10,000 total fission events of 252Cf. This rare process could not be detected until recently because of the lack of sensitivity in detector systems. At a cost of $20 million provided by the U.S. Department of Energy, a 110-gamma-detector array called Gammasphere was constructed in the U.S. These data provide significant new insight into the fission processes and particularly the theoretically predicted cold fragmentations of nuclei.

Sensing with Luminescent Materials

Fluorescence characteristics of the rare earth elements are particularly favorable for use in optical thermometry. The first commercial fiberoptic temperature sensor become available in the early 1980s, with significant improvements in product design and performance since then. In addition, the development of rare earth doped fibers for communications purposes has opened up the possibilities of new all-fiber systems capable of making measurements with compact probes. At a Tuesday morning, John Sullivan of Purdue University discussed the use of luminescent molecular probes to obtain surface pressure distribution measurements on wind tunnel models, flight vehicles and other fluid flow rigs. His technique imbeds luminescent molecular probes in a binder to form a pressure sensitive paint (PSP). On excitation by light of the proper wavelength, the luminescence, is detected by a camera or photodetector.

Accelerator-Driven Transmutation of Waste

Nuclear waste from commercial power plants contains large quantities of plutonium, other fissionable actinides, and long-lived fission products that are potential proliferation concerns and create challenges for long-term storage. The current U.S. policy is to store unprocessed spent reactor fuel in a geologic repository. However, long-term uncertainties are hampering the acceptability of this approach.

Accelerator-driven Transmutation of Waste (ATW) concept offers the U.S. and other countries the possibility to greatly reduce plutoinium, higher actinides and environmentally hazardous fission products destined for permanent storage. Spent fuel would be shipped to the ATW site where the hazardous waste products would be destroyed by fission or transmutation in their first and only pass through the facility, using an accelerator-driven sub-critical burner cooled by liquid lead/bismuth and limited pyrochemical treatment of the spent fuel and residual waste. "ATW does not eliminate the need for, but instead enhances the viability of permanent waste repositories," said Venneri, adding that ATW also brings to the table new technologies that could be relevant for next-generation power producing reactors.

Physics Laureates

Nobel Prize winners seldom rest on their laurels. All three of last year's recipients of the Nobel Prize in Physics described their current research in Monday sessions. Steven Chu of Stanford University reported on the physics of DNA molecules which, because of their mechanical, self- assembling and molecular-recognitions properties, are potentially useful building materials for nanotechnology. William Phillips of NIST described tenuous crystals in which the atoms are held in place not by chemical forces, but by laser beams, forming so-called "optical lattices," a periodic pattern of potential wells that confine the atoms in a regular lattice. Claude Cohen-Tannoudji of the College de France et Laboratoire Rastler Brassel described prize winning research on manipulating stars with light.

Nontechnical Sessions

Voodoo Science

Robert Park of the University of Maryland, author of APS's weekly report "What's New," received the Joseph Burton Award of the Forum on Physics and Society for his colorful commentary on public issues relating to science at a Saturday morning. He is notable for his crusade against pseudo-science or, as he likes to call it (in those cases where the notoriety of the results far exceeds the experimental support), "voodoo science." Also honored at the same session were the 1998 recipients of the Leo Szilard Award: David B. Goldstein of the National Resources Defense Council and Howard Geller of the American Council for an Energy-Efficient Economy, who spoke in favor of enacting new national efficiency standards for equipment for meeting future climate goals at a profit.

Science Wars

In 1996 NYU physicist Alan Sokal sent a hoax article to the journal *Social Text*, a journal devoted to "Science Studies," the sociological study of science. The article subtly lampooned many of the arguments used by other authors in the journal. The ensuing acrimony over the hoax, and the numerous letters to the editors of various publications has added a new sharpness to the debate over the objectivity and cultural role of science. At a Saturday morning session, three observers of this ongoing "science war" offered their perspectives on the controversy: George Levine, an English professor at Rutgers University; Ullica Segerstrale, sociologist with the Illinois Institute of Technology; and physicist Kurt Gottfried of Cornell University.

Current Policy Issues

In November, the White House issued a report from the President's Committee of Advisors on Science and Technology (PCAST), entitled *Federal Energy Research and Development for the Challenges of the Twenty-First Century*. The report addresses why U.S. funding for this program is important, and recommends many changes in the current federal portfolio. During a Monday morning session, John Ahearne (Duke University and Sigma Xi), a member of the PCAST panel that issued the report, summarized the recommendations within the context of the recent Kyoto meeting on climate change. At the same session, Jo L. Husbands of the NAS' Committee on International Security and Arms Control outlined the basic conclusions and recommendations of the Committee's report entitled, *The Future of U.S. Nuclear Weapons Policy*. That recommends deeper reductions in nuclear arms and fundamental changes in the policies that govern nuclear operations.

Communicating Physics Effectively

Several scientists with considerable expertise in writing or lecturing about physics were featured at a Monday morning session on how to communicate physics more effectively. Barbara Levi, a long-time editor of *Physics Today*, shared some of the lessons she has learned over the years about how best to translate research results from various physics subfields. Hans Christian von Baeyer of the College of William and Mary, who has written widely about physics for general audiences, expressed his belief that no less than 5% of the total effort of every physics department should be devoted to the popularization of physics, to combat the threats of anti-science, pseudo-science and general indifference to science. "Popularization of physics is changing from a genteel art to a necessity for survival," said von Baeyer, offering several hints and suggestions for effective science writing.

Special thanks to Philip F. Schewe and Benjamin Stein of the American Institute of Physics' Public Information Office for contributing to the coverage of technical sessions in this issue.

1998 SPRING MEETING PROGRAM COMMITTEE:

Chair: Paul Grannis, State University of New York, Stony Brook
Vice-Chair: Bunny Clark, Ohio State University
AAPT Program Chair: Larry Kirkpatrick, Montana State University

APS Program Committee: Virgina Brown, National Science Foundation (Past Program Chair); Stuart Freedman, University of California, Berkeley (DNP); Ben Gibson, Los Alamos National Laboratory (DNP); Cynthia Keppel, Hampton University (COM); Peggy Cebe, Tufts University (CSWP); Kate Kirby, Harvard-Smithsonian Center for Astrophysics (DAMOP); Josh Grindley, Harvard-Smithsonian Center for Astrophysics (DAP); Frank Moss, University of Missouri (DBP); David Landau, University of Georgia (DCOMP); Robin Hochstrasser, University of Pennsylvania (DCP); Naomi Halas, Rice University (DLS); Bill Hermannsfeldt, Stanford University (DPB); Howard Gordon, Brookhaven National Laboratory (DPF); Miklos Porkolab, MIT (DPP); Colston Chandler, University of New Mexico (FBSTG); Paul Zitzewitz, University of Michigan (FED); Allan Franklin, University of Colorado (FHP); Galen Fisher, General Motors (FIAP); David Pines, University of Illinois (FIP); William Colglazier, National Academy of Sciences (FPS); Abhay Ashtekar, Penn State University (GTG); Bruce Brandt, NHMFL (IMSTG); Steve Lundeen, Colorado State University (PMFCTG).

1998 General Election Preview

Members To Choose New Leadership for 1999

The membership of The American Physical Society will elect a Vice-President, a Chair-Elect of the Nominating Committee, and four General Councillors in the 1998 General Election. Ballots must be received by the 10 August 1998 deadline in order to be valid. A slate of candidates has been prepared by the Nominating Committee, and biographical summaries for each are provided below. Full biographical information and candidates' statements are printed in the ballot.

FOR VICE PRESIDENT

HERMANN A. GRUNDER
Thomas Jefferson National Accelerator Facility

Grunder was born and raised in Basel, Switzerland, and received his Ph.D. in Physics from the University of Basel in 1967. He joined the staff at Lawrence Berkeley National Laboratory in 1959, serving as Group Leader of the 88-Inch Cyclotron. After receiving his Ph.D., he returned to LBNL as a staff scientist, later becoming deputy director. He also served as a special assistant for advanced facilities in the Division of High Energy Physics at the Department of Energy in Washington during the construction of the SLC, ISABEL, and the Tevatron II. In 1985, Dr. Grunder left LBNL to assume directorship of the Continuous Electron Beam Accelerator Facility, now the Thomas Jefferson National Accelerator Facility (Jefferson Lab), which was being built in Newport News, Virginia. Grunder has been very involved in the APS, serving on the Division of Nuclear Physics Executive Committee, chairing the Division of Physics of Beams and Executive and serving as DPB Councillor in 1996-1997.

GEORGE H. TRILLING
University of California, Berkeley Lawrence Berkeley National Laboratory

Born in Poland, Trilling received his Ph.D. in 1955 from the California Institute of Technology. After postdoctoral appointments at Caltech and the Ecole Polytechnique in Paris, he joined the University of Michigan in 1957 as assistant professor of physics. Three years later he moved to the University of California at Berkeley, serving as Department Chair in 1968-72, and as Director of the Physics Division of the Lawrence Berkeley National Laboratory in 1984-87. He is presently a professor emeritus of physics at UCB and a senior faculty physicist at LBL. His research is in experimental particle physics, and has included studies of hadron interactions and resonances, electron-positron annihilation at high energy, and colliding beam experiments and detectors. Trilling has served on numerous advisory committees including the High Energy Physics Advisory Panel. Within the APS, he served on the Physics Planning Commitee and as Chair of the Division of Particles and Fields. He is presently a DPF Divisional Councillor.

FOR CHAIR ELECT OF THE NOMINATING COMMITTEE

CHARLES B. DUKE
Xerox Corporation

Duke's career has encompassed research, teaching, editing, and industrial management in institutions spanning academia, government and industry. He received his Ph.D. in physics from Princeton in 1963. Currently, he serves as Vice President and Senior Research Fellow in the Corporate Research and Technology Group at Xerox Corporation. Other industrial service includes technical and management positions at the Xerox Research Laboratories, and six years as a staff member of the General Electric Corporate R&D Center. His academic career began in 1969 when he was appointed a Professor of Physics at the University of Illinois in Urbana, Illinois, posts which he held until 1972. He served as Adjunct Professor of Physics at the University of Rochester during 1972-88 and Affiliate Professor of Physics at the University of Washington during 1988-89. His government service consisted of his appointment as Deputy Director and Chief Scientist of the Pacific Northwest Laboratory during 1988-89, during which time he founded the Environmental and Molecular Sciences Laboratory. Duke currently serves on the Council and Executive Board of the APS, and was a co-founder of the Forum on Industrial and Applied Physics in 1995.

MICHAEL S. TURNER
The University of Chicago/Fermilab

Turner is the Bruce V. and Diana M. Rauner Distinguished Service Professor and Chair of the Department of Astronomy & Astrophysics at The University of Chicago. He also holds appointments in the Department of Physics and Enrico Fermi Institute at Chicago and is a member of the scientific staff at the Fermi National Accelerator Laboratory. Turner received his Ph.D. in Physics from Stanford University in 1978. His association with The University of Chicago began in 1978. Turner has been honored with the APS Julius Edgar Lilienfeld Prize. He is a theorist whose research focuses on the application of elementary-particle theory to the origin and evolution of the Universe. His current interests include inflationary cosmology, big-bang nucleosynthesis, dark matter and structure formation, and the cosmic microwave background radiation. Within the APS, Turner has served as on the APS Council and Executive Board, the Publications Oversight Committee, the Committee on the Status of Women in Physics, and the Committee on Committees.

FOR GENERAL COUNCILLOR

PHILIP H. BUCKSBAUM
University of Michigan

Bucksbaum is Professor of Physics at the University of Michigan, and Associate Director of the NSF Center for Ultrafast Optical Science. His research is in experimental atomic physics with particular emphasis on the behavior of atoms and molecules in intense laser fields, and on measurements of fundamental forces and symmetries in atoms. He received his Bachelor's degree in Physics from Harvard College in 1975, and his Ph.D. degree in Physics from the University of California at Berkeley in 1980. Following postdoctoral positions at Lawrence Berkeley Laboratory and Bell Telephone Laboratories, he joined the Technical Staff at Bell Labs in Murray Hill, NJ in 1982, where he remained until joining the faculty of the University of Michigan in 1990. Within the APS, Dr. Bucksbaum is a member of the Division of Atomic, Molecular, and Optical Physics (DAMOP), the Division of Laser Science (DLS), and the Precision Measurements Topical Group. He has served the Society on numerous committees. He is also a Distinguished Traveling Lecturer for the DLS. He will assume the Otto Laporte Professorship in Physics at the University of Michigan beginning September 1998.

L. CRAIG DAVIS
Ford Research Laboratory

Davis is the Manager of the Physics Department, Ford Research Laboratory. The mission of this department is to conduct long range research in areas of physics that have potential impact upon the Ford Motor Company's business. His personal research has been in electro/magnetorheological fluids, composite materials, applications of superconductivity, magnetic levitation of high-speed ground transportation, electron tunneling, atomic spectra, electron spectroscopy, resonant photoemission, and the theory of alloy semiconductors. He received his degrees in Physics from Iowa State University (Ph.D. 1966) and the Califor-

Continued on page 10.

Nomination Ballot—1999 Bylaw Committees

To be Completed Only by Members of The American Physical Society
(please complete both sides)

The Committee on Committees has the responsibility for nominating elected members of the Publications Oversight Committee and the Lilienfeld Prize Committee, and for advising on suitable candidates for service on other Bylaw Committees appointed by the President.

The Committee needs input from the membership. Current personnel and last year's annual reports for many of the committees are on the APS Homepage under the Governance button. **Please provide the name and affiliation of nominees and attach information on career highlights and suitability of the nominee for the committee indicated. Self-nominations are encouraged. Please duplicate this form as necessary, and complete both sides. Please verify that your nominees are APS members.**

The deadline for receipt of nominations is 10 August 1998.

COMMITTEE ON CAREERS AND PROFESSIONAL DEVELOPMENT
Name & Affiliation:

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Name & Affiliation:

COMMITTEE ON EDUCATION
Name & Affiliation:

COMMITTEE ON FELLOWSHIP
Name & Affiliation:

COMMITTEE ON INTERNATIONAL FREEDOM OF SCIENTISTS
Name & Affiliation:

COMMITTEE ON INTERNATIONAL SCIENTIFIC AFFAIRS
Name & Affiliation:

INVESTMENT COMMITTEE
Name & Affiliation:

LILIENFELD PRIZE COMMITTEE
Name & Affiliation:

Continued on Reverse

Continued from page 9

nia Institute of Technology. He was a postdoctoral fellow and an instructor at the University of Illinois, before joining the Ford Motor Company in 1969. He has been a Guest Scientist at DESY (Hamburg, Germany), the Institute for Theoretical Physics (Santa Barbara) and the Jet Propulsion Laboratory, as well as an Academic Affiliate of the Center for Fundamental Materials Research at Michigan State University. Davis served APS as Chair of the Forum on Industrial and Applied Physics in 1997-8.

LARRY GLADNEY
University of Pennsylvania

Gladney is an Associate Professor in the Department of Physics and Astronomy at the University of Pennsylvania. His research career has been focussed on the study of weak interactions of heavy quarks. At present, he is part of the Babar collaboration working at the SLAC B factory. This facility seeks to understand the nature of CP-violation through intensive study of neutral B meson decays and thereby provide crucial tests of Standard Model predictions as well as search for physics beyond the Standard Model. He obtained his Ph.D. in Physics at Stanford University in 1985 where he made the first measurements of the lifetimes of the neutral and charged D mesons in the electron-positron collider environment. He came to Penn as a postdoctoral student in 1985 and became Assistant Professor in 1988 while working on the CDF experiment. He was one of the main contributors to the first direct observation of B mesons in the hadron collider environment, the start of a rich era of B meson studies at such machines. Since 1994, he has been associate director and a lead teacher for the Lincoln-Penn Pre-College LASER program, an outreach program that provides 4 hours of hands-on instruction in physics, chemistry, biology, mathematics, and computer engineering to 120 students, in grades 7 through 12, enrolled in public and parochial schools throughout the Philadelphia area. His awards include the 1997 APS Edward A. Bouchet award.

LEON LEDERMAN
Illinois Institute of Technology/Fermilab

Lederman served as Fermilab Director from 1979-1989. Before that he taught and did research in particle physics at Columbia University, where he also did his graduate work.

While at Columbia, he did research at the 400 MeV Synchrocyclotron (NEVIS), at Brookhaven National Laboratory, at CERN's Intersecting Storage Rings, at the Berkeley Bevatron and the Rutherford Lab in the UK. He is the recipient of the National Medal of Science (1965) given by President Johnson and the Fermi Prize (1993) given by President Clinton. He received the Nobel Prize in Physics in 1988 for his work with Mel Schwartz and Jack Steinberger on neutrinos. Lederman made Fermilab a strong center for Latin American physicists and engineers, helping to create user groups in Brazil, Mexico, Colombia and Bolivia. During his Fermilab tour, Lederman led an aggressive outreach program in science education. He helped to start the Illinois Math and Science Academy (1986), a 3-year public residential school for gifted students, and then the Teachers Academy for Math and Science (1990), to upgrade the math and science skills of primary school teachers in the Chicago public schools. He is a founding member of the DOE Advisory Group, HEPAP, and has served on NSF Advisory Groups for Physics and Science Education. He served as President and as Chairman of AAAS (1990-1992). He has co-authored Quarks to the Cosmos with David Schramm, and The God Particle with Dick Teresi.

W. CARL LINEBERGER
University of Colorado/JILA

Lineberger received his Ph.D. in 1965 from the Georgia Institute of Technology, working with Earl W. McDaniel. After a postdoctoral with Lewis Branscomb at JILA, he joined the faculty of the University of Colorado in 1970. He is presently the E. U. Condon Professor of Chemistry and Fellow of JILA at the University of Colorado at Boulder. Lineberger has received the APS H. P. Broida Prize and the Earle K. Plyler Prize, and the Irvin B. Langmuir Prize of the American Chemical Society.

Lineberger's research interests are in experimental chemical physics, laser spectroscopy, and the ultrafast dynamics of molecular reactions. His current research activities include studies of molecular rearrangements following photoexcitation, photodetachment threshold phenomena, and dynamics of molecular cluster ions. In the APS, Lineberger has served as Chair of the Division of Chemical Physics (1982/83) and the Division of Atomic, Molecular and Optical Physics(1986/87). He has also served as Chair of the Topical Group on Laser Science (1994/95), and is currently a member of the Physics Policy Committee.

JIM MCGUIRE
Tulane University

McGuire has been Murchison Mallory Professor at Tulane University in New Orleans since 1991. He belongs to divisions of atomic, condensed matter, chemical, laser, nuclear, plasma and elementary particle physics of APS, and is currently active in atomic, optical, chemical and condensed matter physics. McGuire received his Ph.D. in high energy nuclear physics from Northeastern University in 1969 and went to Texas A&M as an Assistant Professor. During 1972-1991 he was at Kansas State University. In 1997-98 he was a Alexander von Humboldt senior awardee at the University of Frankfurt, Germany. McGuire's research has been in understanding the dynamics of electron correlation. In 1997, McGuire published "Electron Correlation Dynamics in Atomic Collisions" and was an Editor of the "Encyclopedia of Physics". He was a site leader for the Introductory University Physics Project in 1992-1993. He is active in science outreach and public education in New Orleans. He has served on APS various committees, including Secretary-Treasurer of DAMOP, Executive Committees of DAMOP and FBSMD. He was one of the organizers of the first APS Congressional Day.

THOMAS O'NEIL
University of California, San Diego

O'Neil is a professor of physics at the University of California at San Diego. He is a plasma theorist whose early research included the extension of Landau damping to the nonlinear regime and the theory of plasma wave echoes. Currently, he studies the physics of magnetically confined nonneutral plasmas, liquids, and crystals. He is a fellow of the APS, co-recipient of the 1991 APS Award for Excellence in Plasma Physics, and the recipient of the 1996 APS James Clerk Maxwell Prize for Plasma Physics. He received his B.S. degree from California State University at Long Beach in 1962 and his Ph.D. from UCSD in 1965. After a brief period on the research staff of the Plasma Physics Group at General Atomics Corporation, he returned to UCSD as a faculty member in the Physics Department, where he will be chair starting this summer. He has served the APS Division of Plasma Physics on many committees including the Executive Committee. This year he serves as a Distinguished Lecturer for Plasma Physics. He has been a Divisional Associate Editor for Physical Review Letters, and served on the Advisory Board for the Institute for Fusion Studies and the Institute for Theoretical Physics.

JAMES TREFIL
George Mason University

Trefil received his Ph.D. in Theoretical Physics from Stanford University. After postdocs at CERN and MIT and a junior faculty appointment at Illinois, he joined the faculty at the University of Virginia, where he eventually became University Professor of Physics. He assumed his current position at George Mason in 1985. His current research, carried on in collaboration with the paleontology group at the University of Chicago, involves constructing mathematical models to interpret the fossil record.

His main interest is in promoting scientific literacy both inside the university and among the general public. He is the author or co-author of 25 books and numerous magazine articles on science for the general reader. With Robert Hazen, he has developed a university level scientific literacy course and textbook now being used by over 150 universities and colleges. He is on the Science Boards of National Public Radio and Astronomy Magazine, Science Consultant to Smithsonian magazine, and Contributing Editor for Science to USA Today Weekend Magazine. His writing has won numerous awards, including the AAAS Science Journalism Award. He is a Fellow of the World Economic Forum and a member of the AAAS Committee on Public Understanding of Science.

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Name & Affiliation:

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COMMITTEE ON MEMBERSHIP
Name & Affiliation:

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COMMITTEE ON MINORITIES
Name & Affiliation:

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COMMITTEE ON THE STATUS OF WOMEN IN PHYSICS
Name & Affiliation:

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PUBLICATIONS OVERSIGHT COMMITTEE
Name & Affiliation:

____

PHYSICS POLICY COMMITTEE
Name & Affiliation:

____

Concise biographical information on your nominees is *essential*.

Nominator's Information

Name:______________________________

Affiliation, Address:______________________________

____

Signature: ______________________________

Please Address Your Envelope to:

The American Physical Society
ATTN: AMY HALSTED
One Physics Ellipse
College Park, MD 20740-3844
Fax: (301) 209-0865
Email: halsted@aps.org

The deadline for receipt of nominations is 10 August 1998. Thank you.

Announcements

Physical Review Focus

PR Focus, the fully electronic journal featuring physics highlights, is available FREE through the APS Home Page [www.aps.org] or directly at [publish.aps.org/FOCUS]. To receive one-paragraph introductions to *Focus* stories each week by e-mail send the following message to majordomo@aps.org: subscribe focus [Leave the subject line blank].

NOMINATIONS FOR PRIZES AND AWARDS

The following prizes and awards will be bestowed at the Fluid Dynamics Division Meeting in 1999. A brief description of each prize and award is given below, along with the addresses of the selection committee chairs to whom nominations should be sent. Please refer to the new 1998-1999 Centennial APS Membership Directory, pages A19-A37, for complete information regarding rules and eligibility requirements for individual prizes and awards.

1999 FLUID DYNAMICS PRIZE

Sponsored by friends of the Division of Fluid Dynamics and the American Institute of Physics journal Physics of Fluids.

Purpose: To recognize and encouragAnnouncementse outstanding achievement in fluid dynamics research.

Nature: The prize consists of $5,000, a certificate citing the contributions made by the recipient, and a travel allowance to the meeting at which the prize is bestowed.

Send name of proposed candidate and supporting information before 1 September 1998 to:. Elaine S Oran (Chair), 3516Duff Dr., Falls Church, VA 22041; Phone (202) 767-2960; Fax 202 767 4798; Email ORAN@LCP.NRL.NAVY.MIL

1999 OTTO LAPORTE AWARD

Sponsored by the friends of Otto LaPorte and the APS Division of Fluid Dynamics.

Purpose: To recognize outstanding research accomplishments pertaining to the physics of fluids.

Nature: The award consists of $2,000, and a certificate citing the contributions made by the recipient.

Send name of proposed candidate and supporting information before1 September 1998 to: Israel J Wygnanski (Chair), School of Engineering, University of Tel Aviv, Tel Aviv 69978, ISRAEL; Fax 972-36429540; Email wygy@genius.tau.ac.il

Now Appearing in RMP...

Reviews of Modern Physics **is a quarterly journal featuring review articles and colloquia on a wide range of topics in physics. Titles and brief descriptions of the articles in the July 1998 issue are provided below.**

1997 Nobel Prize Lectures
Steven Chu, Claude Cohen-Tannoudji and William Phillips, recipients of the 1997 Nobel Prize in Physics, describe their achievements in the cooling, trapping, and manipulation of neutral atoms.

Structure and dynamics of few-nucleon systems
J. Carlson and R. Schiaavilla review the theoretical understanding of light nuclei and their reactions. Many properties can now be accurately calculated, limited more by the multinucleon interaction than by computational technique.

Nuclear structure in odd-odd nuclei, $144 \le A \le 194$
A. K. Jain and collaborators review the complex spectroscopy of odd-odd deformed nuclei, inferring the properties of the interaction between the odd proton and neutron.

Magnetic, transport, and optical properties of monolayer copper oxides
The copper oxides are important components of high-temperature superconductors. This article by M. A. Kastner and collaborators discusses the behavior of these materials under doping, in order to understand their fundamental charge and magnetic excitations.

Quantum diffusion of muons and muonium atoms in solids
Muons have a mass and mobility intermediate between electrons and atoms in solids. V. Storchak and N. Prokof'ev review the tunneling of muons in solids, covering both the experimental observations and theory.

The uses of quantum field theory in diffusion-limited reactions
The techniques of quantum field theory are useful for classical stochastic systems. Daniel Mattis and M. Glasser discuss these applications with a number of instructive examples.

Coherent population transfer among quantum states of atoms and molecules
K. Bergmann, H. Theuer, and B. W. Shore describe a new technique for transfer between quantum states with nearly 100% efficiency, using stimulated Raman scattering.

Single-photon detection by rod cells of the retina
Rieke and Baylor describe experiments that reveal the exquisite sensitivity of biological photoreceptors, able to distinguish one photon from two.

Metal-insulator transitions
M. Imada and collaborators review the theory and experimental phenomena of the metal-insulator transition, in which huge resistivity changes take place under the control of external parameters. The article describes the many outstanding examples among transition-metal materials.

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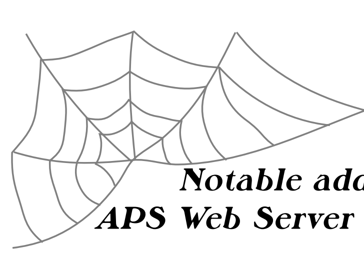

CAUGHT IN THE WEB

Notable additions to the APS Web Server. The APS Web Server can be found at http://www.aps.org

APS News Online latest edition
APS Centennial Homepage Established
APS Committees and Governance
- International Affairs Pages Updated
- Education & Outreach Committee Member Lists

Meetings
- Division of Nuclear Physics Meeting Announcement
- Division of Plasma Physics Meeting Announcement

THE BACK PAGE

Reader Responses to *Physics and Feminism,* May 1998 The Back Page by Priscilla Auchincloss

Must We Atone for Sins of the Past?

Priscilla Auchincloss' statement that "...the idea of getting physics to become more feminist strikes most physicists as a kind of heresy" is over-wrought. Much more likely they would be puzzled. What does becoming "more feminist" mean?

Auchincloss maintains that we have to increase progress for women in physics through intervention programs and recruitment. Granted. Equity in pay and opportunity is a laudable goal. Yet to the extent that equity was ever an exclusively feminist objective, society has co-opted it completely, leaving feminists with very little to actually do. Thus, she also proposes that physics departments embrace feminism, sending the faculty to workshops to cultivate gender equity awareness, and making regular assessments of the climate for women in science. This is familiar multicultural territory.

But what will embrace of feminism accomplish? According to Auchincloss, it will attract and retain women, create gender equitable environments, and reform physics education. However, nowhere does she make a cogent argument for how feminism will achieve these goals, or what the second goal even means. Instead, she spends the bulk of her article dissecting objectivity. Apparently, physics and science in general punishes women by lacking real objectivity. The solution for this is twofold. First, atone for past sins. Second, make future science practice a more balanced mix of subjectivity.

For what sins must we atone? Simply put, science colludes against women entering science. She mentions few examples. To draw upon long discredited science to discredit science in general is to miss the self-correcting mechanisms which are sciences essential features. Although the scientific revolution failed to draw women into science in the past, it and its sibling the technological revolution, are still on going. Between them they have freed untold billions of people from oppressive social constructs and miserable lives.

Apparently our sins are original. We are born into them, which makes our escape from them impossible. Moreover, the word "colludes" suggests conspiracy, yet the only co-conspirator mentioned is the church. It is bizarre that science and religion, which engaged in open antagonism for at least 150 years, and have entirely different goals and processes, are colluding.

Does science lack objectivity? Auchincloss quotes several post modern scholars on this point, for example: Evelyn Fox Keller believes that natural sciences are subject to political, psychological and social forces; Helen Longino maintains that a feminine context would produce science and more correct results; Donna Haraway is a postmodern writer of extreme murkiness whose positions are not at all clear; Finally, Thomas Kuhn's work concerns how social constructs relate to major upheavals in scientific theories. This is not strong evidence.

Even presuming that Auchincloss has proved science's results lack objectivity, she is left with the inconvenient fact that QED, or the eigenfunctions of a particle in a potential, or the laws of thermodynamics, or theories of seismology, or stellar structure, or a million other pieces of the fabric of physical science have nothing whatsoever to do with gender.

Kevin T. Kilty
La Center, Washington

Physics and Feminism — Perhaps a Bigger Issue Looms?

Priscilla Auchincloss presented some valuable points regarding the "leaky pipeline" existing for women in physics, especially in academia. Although I agree very much with the historical and philosophical contexts she identified relevant to gender and scientific thought, I think we can take this discussion one step further and deeper.

Yes, the academic climate needs foremost examination. British sociologist Kim Thomas argued all equity issues inevitably come back to the classroom. Yet not everyone in academia understands what equity means. Equity is not necessarily equal numbers of men and women in physics classrooms; equity means equal access to knowledge, opportunity, and empowerment. By the learning activities we provide, and pedagogical practices we use, we can either nurture students' interest in physics or deny them the very learning and success we expect of them.

Scientists are notoriously labeled as "intellectually arrogant," an unpleasant yet very real perception. By institutionalizing a paradigm formulated by men several centuries ago, women and other under-represented people are denied ultimate access to physics knowledge and the profession. They participate at the fringe of the culture, but are ultimately shunned from the core. How else can we explain the numerical equity of women students at the introductory level, yet numerical disparity beyond that level? Is it any wonder some women feel unwelcome or unworthy of a physics career?

Yes, academia provides tremendous validation for physics possibly having an anti-feminist nature. The slow progress of women, as well as certain ethnic minorities, in physics is perhaps a symptom of a broader level of dysfunction, be it philosophical or cultural.

I agree with Auchincloss that "Bringing together physics and feminism... has the potential to bring about positive change in the culture of physics." However, if we are to "realize a truly diverse physics community," a cultural and philosophical revolution needs to first take place within the sciences. Until we come to terms with how science is viewed and shared within our civilization, we will continue to struggle bringing about the total equity and diversity physics and other sciences lack. Change cannot come about easily if we have not completely identified the necessity for change.

David Pushkin
Montclair State University

A New Feminist Approach

Although I applaud Priscilla Auchincloss's willingness to tackle the difficult relationship between physics and feminism, I want to take them in a new direction. My purpose is twofold: first, to raise awareness that feminism is no longer centered around academic Women's Studies research, and second, to bring some additional practical suggestions to the table.

Auchincloss asserts that one problem with our efforts so far to recruit and retain women in physics lies with the fact that these efforts require extra work on the part of physicists that is "at best irrelevant to the practice of science." But biology has had phenomenal success attracting and retaining bright women scientists, as has the practice of medicine, so it's unclear why physics has performed so poorly in comparison.

However, if academic physicists have no time for volunteering at elementary schools or talking with panels who are assessing the climate for women in physics, how can they possibly have time to engage in a "discourse" about the ideological foundations of their discipline? I therefore disagree that a good solution to the problem of women in physics is to create stronger ties to feminist studies of physics. To the young women of today, who grew up in a world where equity with men is not hoped for but *expected*, these departments seem to serve the purpose of isolating feminism from the real world. A new feminism is emerging, which just as rightly calls itself "feminism," but which breaks from the older style in profound ways.

Let's look at the problem of women in physics in a fresh way. The most important question to ask is, "How is physics as a whole hurt by the extremely low percentage of women physicists?"

Physics used to be a good option for those with mathematical ability and a desire for a fast-paced intellectual life. But today, physics competes for these top people with a whole host of other options including computer engineering, technical consulting, and multimedia/Web design. In fact, the proportion of people in these fields who were originally trained in physics is stunning.

How does this relate to women? Women cast the same skeptical eye on the career market as men do, asking the question, "Is this field one where I can advance on my own merits and generally feel like I'm a valuable (and valued) member of an energetic, forward-thinking team?" Considering that physics *still* has only single-digit percentages of women, the answer appears from the outside to be "no."

Anyone who has paid attention to grad school class sizes recently knows that physics is suffering from these women's nonparticipation. We are losing not only warm bodies and intellectual talent (which would translate into more funding), but also respect because we don't compare favorably to other career options for smart, scientifically-minded women. And it's not going to get better if we ignore it.

The situation is not hopeless; there *could* be more women in physics, and physics *could* compete effectively against other career choices. We must accept that the new career options luring away potential physicists (and women physicists in particular) are valid rivals, worthy of a serious marketing effort to outmatch.

I suggest that attracting more women to physics is a matter of improving the conditions in physics in general. That will require acknowledging that physics must *sell itself* to smart people by highlighting its positive I also suggest some restructuring of physics department funds such that collegiality rather than competition among professors is encouraged, and instituting rewards (say, teaching or tenure credit) for those professors who are good mentors. And I'm sure a much longer list than mine could be drawn up!

Kim Allen
UCSD physics grad student and feminist

Physics Doesn't Need to Become More "Feminist"

I am privy to these kind of discussions at my university. There is reason for concern, I suppose. I wouldn't say that women and other minorities are "under-represented"' in physics or engineering, but I would admit that there are few women in these fields. I do not think the answer is as easy as what Auchincloss espouses.

Physics, more feminist? Physics does not need to be more anything — except appreciated. It certainly does not need to be more feminist. Yes, I have encountered bias from males in physics, as well as the occasional derogatory remark or tasteless comment. But one should be careful not to confuse the science with the scientist. Auchinclass tells us that the group provides "criticism or approval, and the paradigm to allow integration of the various parts of the puzzle." So now objectivity is a paradigm, and not a primary assumption? Is she trying to explicate the scientific method and concomitant practice of peer-review?

If so, she's done a poor job. Couching it in the language of feminist rhetoric lessens the impact of the power of reproducibility. Reproducibility means that when I make an observation, you can make the same observation independently, whether you like me or not, agree with my lifestyle, philosophy, or gender. This is where science derives its power and beauty. There is nothing exclusionary or oppressive here.

I think Auchincloss' energies would be better spent improving the overall quality of physics education. This way, when an argument is lost due to lack of knowledge, no one need cry "sex discrimination" or worse, "old boy network."

Crystal Barker
University of Arizona, Tucson

Women are Not "Other"

Years ago I read my seven-year-old daughter the story "Ronia the Robber Girl," by Astrid Lindgren. She laughed when she heard the title. "What's so funny?" I asked. "Silly," she giggled, "robber means boy!"

In her Back Page article, Priscilla Auchincloss reminds us that we have made the very same mistake. By systematically classifying women as "other than us," we have unconsciously guaranteed that females will always feel slightly uncomfortable, in spite of the profession's best efforts to "include" them.

The feminist scholars have outlined a program to reverse this trend. As Auchincloss points out, it starts by recovering lost history. Publications such as *Physics News* and *Physics Today* have made admirable efforts in this area. But even the relatively minor task of debunking invalid stereotypes is a difficult one. Making physics hospitable to all will be monumental. Cultures change very slowly, and our best hope for gender equality is through education.

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