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APS News Caption Contest
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April Meeting Features Fundamental Science and Societal Issues

The latest research results in particle, nuclear, plasma, and astrophysics will be featured at the 2008 APS April Meeting, to be held April 12-15, 2008 in St. Louis, MO. In addition, there will be a wide variety of sessions devoted to education, national security, energy research, and other social issues.

The meeting will be held in conjunction with an international conference sponsored by High Energy Density Physics (HEDP) and High Energy Density Laboratory Astrophysics (HEDLA). HEDP/HEDLA sessions begin on Friday, April 11 and cover such topics as supernovae, high-energy jets emerging from active galaxies and from stars, stellar cores, shock waves and turbulence in the universe, planetary interiors (including those of extra-large sized "super-earths"), heavy ion beams, laser-driven proton beams, wakefield accelerators, quark-gluon plasmas, and laboratory-produced high energy densities at facilities such as Livermore's National Ignition Facility (scheduled for completion in March 2009) and Sandia's Z Machine.

Detecting Dark Matter. Observational evidence to date indicates that most of the matter in the universe consists of non-baryonic particle dark matter, and the race is on to detect this mysterious matter both through direct and indirect means. Stanford University's Jodi Cooley will review the evidence for weakly interacting massive particles (WIMPs) as candidates for dark matter, as well as current cryogenic techniques being used to detect dark matter directly, including the latest results from the Cryogenic Dark Matter Search in the Soudan Mine in Minnesota. Tom Shutt of Case University will describe new detectors based on liquified noble elements and next-generation experiments, such as the proposed DUSEL laboratory in South Dakota. Elliott Bloom (SLAC/Stanford) will review new experimental methods for the indirect detection of dark matter, including space-based satellites, ground-based gamma-ray telescopes, and neutrino telescopes. Leslie Rosenberg of the University of Washington will discuss the possible role of axions as dark matter. (Sessions B5.3 and M2)

Space Junk. The space age has brought many benefits, but also new problems, including the increasing amount of space debris: defunct satellites, discarded equipment, satellite fragments, and the remains of rocket stages. Even small pieces can damage or destroy operational satellites should they collide. There are currently 860 active satellites in orbit but

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Electron Beam Lithography Creates World's Tiniest Trophy

The "world's smallest trophy" is a silicon chip etched with a design consisting of nested football fields, with a helmet in the center of each field. The largest field, about 12 mm long, is visible with the naked eye; within that lies a 120 micrometer long football field that is visible with an ordinary optical microscope; and within that is a 2 micrometer long football field that requires an electron microscope to view. In the smallest football field, the yard lines are about 60 nanometers wide, 1000 times thinner than a human hair. The chip itself is about the size of a penny.

The trophy was designed and produced by Phil Waggoner, a graduate student in Harold Craighead's research group at Cornell University. The group is known for producing the nanoguitar in 1997.

The football field design and the words "Physics Central Nano Bowl Champion 2008" were etched onto a silicon nitride film that had been deposited on a silicon wafer. The largest football field was created using standard photolithography, in which a light beam wears away a coating called photoresist in the pattern desired. The exposed areas are then etched out of the silicon chip, and the remaining photoresist is washed away. The smaller two football fields were patterned using electron beam lithography, which is similar to photolithography, but uses a beam of tightly focused electrons instead of light to create the pattern.

"The main challenge was working with the design and the electron beam lithography in order to optimize the exposure dose given to the electron-beam photoresist in defining the smallest field patterns," said Waggoner.

While the photolithography process is standard and has been

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Michigan High-Schoolers Capture Nanobowl Trophy

A group of high school students from Rochester Hills, Michigan has won the grand prize in the PhysicsCentral Nanobowl video contest.

The contest challenged participants to create short YouTube videos explaining some aspect of physics and football.

The winning video, called Nanobowl X-IX, shows teams of particles, atoms and molecules competing in a series of matches. A first round match between hydrogen and antihydrogen ends with no winner, as both teams are annihilated. A match between bosons and diatomic oxygen results in a win for the bosons when it gets cold and they become a superfluid. In the final match, when a team of protons faces a team of electrons, electron capture reactions take place, resulting in neutrinos and neutrons. Neutrons are declared the winner. "I'd like to thank the neutrinos, for conserving lepton number," a cartoon neutron says after winning the championship.

Nanobowl winners from left to right: Zachery McKinnon, Christopher Ding and Tyler Johnson

This creative video was the work of Tyler Johnson, Zachery McKinnon, and Christopher Ding, students at Rochester Adams High School in Rochester Hills, Michigan.

"We kind of wanted to do something different. We like learning about particles and stuff," said Tyler, who is taking a class in nuclear physics at nearby Oakland University. He and his partners read books and looked up information about particles to make the video. They made the video entirely on their own, and they told their physics teacher they had entered the contest only after they were selected as semifinalists.

Many of their classmates and teachers have since watched the video. "We had all these random people interested," said Tyler. Particle and nuclear

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Workshop Will Demystify Running for Public Office

A workshop to be held in Washington on May 10 is designed to help other physicists do what Mike Fortner has done: run successfully for local office. Fortner, who has a physics PhD from Brandeis, does research at Fermilab and is on the faculty at Northern Illinois University. He now represents the 95th district in the Illinois General Assembly, but he started as a Historical Preservation Commissioner, and then served on his local school board before being elected as alderman and then mayor of West Chicago, moving on from there to the Illinois state legislature.

The day-long May workshop will focus on the nuts and bolts of running a local campaign, and is designed for scientists and engineers who are motivated by a desire for public service, possibly because their discipline plays such a crucial role in many policy questions or because it is important to maintain and improve science education standards.

"Any scientist or engineer who has ever thought about running for office should come to this workshop" says Lesley Stone, Executive Director of Scientists and Engineers for America (SEA). "The workshop will demystify the political process so we can get more scientists and engineers involved in positions that make a difference–from school board to Congress." SEA is the lead organization promoting the workshop, and is joined in this endeavor by a number of science and engineering societies, including APS.

The workshop is part of SEA's Campaign Education and Training project. The participating societies have produced a video to promote both the workshop and the general idea of scientists and engineers running for office. The video features interviews with Fortner, with physicist and US Representative Vernon Ehlers (R-MI), and with David Westerling, a civil engineer who has served as Town Moderator of Harvard, Massachusetts. It can be viewed by visiting the SEA website.

The workshop will take place on the campus of Georgetown University. Further details and registration information will be found on the SEA website at www.elections.sea.org.

Money Matters

Photo by Ken Cole

On February 23, about 80 officers of APS Divisions, Topical Groups, Forums and Sections gathered at APS headquarters in College Park for the annual Unit Convocation, to discuss important issues like grassroots lobbying by APS members, and encouraging diversity in physics. They also gained information from APS staff on the services that are available to help units with their activities. Here APS Director of Finance and Controller Michael Stephens (standing) goes over the finer points of unit finances with William Heidbrink of DPP (left) and Christopher Leemann of DPB.

Members in the Media

"It's even possible that there are extra dimensions where you don't live, I'm afraid."

***Lisa Randall**, Harvard University, on extra dimensions,* Colbert Report*, February 12, 2008*

"You've got to know how to ask questions. You've got to be open minded. You've got to know things. You should teach it to others.'

***Neil deGrasse Tyson**, on what it takes to be an astrophysicist,* Colbert Report*, February 13, 2008*

"Cloaking is just the tip of the iceberg. With transformation optics you can do many other tricks."

***Vladimir Shalaev**, Purdue University,* Washington Post*, February 19, 2008*

"There are a lot of materials that are very absorbing of light so that once the light gets in, very little is reflected. That is not the big issue. The big issue is persuading the light to go in there in the first place"

***John Pendry**, Imperial College London, on the new ultra-black material,* Washington Post*, February 19, 2008*

"At first we obtained things that were like chewing gum. Not quite what we wanted."

***Ludwik Leibler**, Ecole Superieure de Physique et Chimie Industrielles, on developing a type of rubber that heals itself,* The New York Times*, February 26, 2008*

"We brought back some wines that we thought would be good, and we had a tasting."

***Dick Benjamin**, on starting a wine business after bringing home wines from a shop in Washington DC, where he was attending an APS meeting,* The Augusta Chronicle*, January 21, 2008*

"It's very noninvasive. There's nothing to be scared of. No blood test, just a breath test. If you go to the medical literature you will see tons of studies that correlate certain diseases with particular molecules found in the breath. One common example is nitrous oxide, which is associated with asthma."

***Jun Ye, JILA**, on a breathalyzer test for various diseases, ABC-NEWS.com, February 19, 2008*

"The difference between milli and nano was a Nobel prize."

***Dennis Clougherty**, University of Vermont, on the nanokelvin temperature needed to produce a Bose Einstein condensate,* Burlington Free Press*, February 16, 2008*

"One of the reasons we look for planets is to find out if we're not alone in the universe."

***Kem Cook**, Lawrence Livermore National Laboratory, on a recently discovered pair of planets,* Contra Costa Times*, February 15, 2008*

"The beauty of this work is that if you have wind, or you have sonic waves, or you have vibrations, that works for you. You do not need a very large force for that."

***Zhong Lin Wang**, Georgia Tech, on a nanotech fabric that generates power from motion, Associated Press, February 14, 2008*

"The far side of the moon is the quietest place in the inner solar system in terms of radio waves. If we could get a radio telescope working there, the results could be very dramatic."

***Jack Burns**, University of Colorado at Boulder, on plans for a radio telescope on the far side of the moon,* Washington Post*, February 24, 2008*

"It's a really interesting question, Why do animals beat their wings? One reason is, they don't have wheels. They don't have parts that rotate."

***Geoff Spedding**, University of Southern California, on how bats fly,* The New York Times*, March 4, 2008*

"It doesn't seem like girls are losing interest in science and mathematics any more than they lose interest in other subjects."

***Jennifer Blue**, Miami University, on a study of how girls' interest in various subjects changes as they get older,* LiveScience*, March 7, 2008*

This Month in Physics History

April 1, 1948: The alpha beta gamma paper explains the origin of the elements

On April 1, 1948 a paper was published in the *Physical Review* by Alpher, Bethe, and Gamow, entitled "The Origin of Chemical Elements." The authors' names were a bit of a joke (Hans Bethe hadn't really contributed to the work), but the paper contains a significant scientific discovery. Ralph Alpher and George Gamow explained how the extreme conditions shortly after the big bang could explain the observed abundances of the most common elements in the universe.

Photo courtesy of AIP

Ralph Alpher

Physicist George Gamow was born in Odessa (now in Ukraine), in 1904. He grew dissatisfied with the Soviet Union, and after one failed attempt, he fled and immigrated to the United States in 1934. He took a position at George Washington University in Washington, DC.

In the early 1940s, Gamow was working on explaining the observed abundances of elements. It had already been shown that in the cores of stars, hydrogen nuclei fuse to form helium. But this process happens too slowly to account for the observed abundance of helium in the universe (about 1 atom of helium for every 10 atoms of hydrogen) and it didn't account for the existence of elements much heavier than helium. Gamow wondered if the conditions of the very early universe could have produced the observed helium and other elements.

The research needed knowledge of nuclear physics, but most nuclear physicists in the US at the time had been recruited to the Manhattan project, so Gamow was essentially alone in working on the problem of nucleosynthesis.

He started making calculations, beginning by looking at the density of matter in the universe and essentially running the expansion of the universe backwards to get an estimate of what the early universe might have looked like. He then began trying to figure out the probabilities of nuclear reactions in early universe. As the universe expands, conditions constantly change, so the calculations were complicated. Not particularly adept at mathematical calculations himself, Gamow recruited PhD student Ralph Alpher to help.

They started by imagining the early stage of the universe as an extremely hot dense gas of neutrons, (which they called "ylem," after a medieval word for matter). As the universe expanded, the hot compressed neutrons would decay into a mixture of protons and electrons and neutrinos. Then the protons would capture some of the remaining neutrons to form deuterium. Further neutron capture would build up heavier and heavier atomic nuclei. The process would continue as the universe expanded until it was too cool for further reactions to take place.

Alpher's calculations of nuclear processes used some of the first electronic digital computers, which had been developed during World War II. He was also able to use new data on nuclear reaction cross sections that had become available after the war ended.

The calculations agreed with the known abundance of helium. Pleased with their result, Alpher and Gamow submitted a brief communication to the *Physical Review*, titled "The Origin of Chemical Elements." They celebrated with a bottle of liqueur, which Gamow relabeled "ylem."

Gamow, who was known for his sense of humor, saw that the paper they had submitted to *Phys. Rev.* was to appear on April 1, 1948. He added the name of his friend Hans Bethe, who was known for work on nuclear reactions in stars, among other things, to the paper, so the authors would be Alpher, Bethe, and Gamow, a pun on the first three letters of the Greek alphabet.

Alpher, as a PhD student struggling to make a name for himself, objected to the addition, fearing that the name of the famous Bethe would overshadow his own, reducing the credit he received for his crucial contribution to an important piece of research. But Gamow published it with Bethe's name, despite Alpher's objections.

The paper, still known as the alpha-beta-gamma paper, not only explained the origin of the most abundant elements in the universe, but also provided the first support for the big bang model since Hubble's discovery in 1929 that distant galaxies are redshifted in proportion to their distance from us.

It later became clear that most elements actually cannot be produced by the successive neutron capture process Alpher and Gamow originally proposed because there is no stable nucleus with 5 nucleons. Another process was needed to bridge the gap to create heavier elements. The Alpher-Bethe-Gamow theory does, however, correctly explain the abundances of hydrogen and helium, which together account for more than 99 percent of the baryonic matter in the universe.

Following the publication, Alpher still had to complete his PhD. Scientists and the press heard about the Alpher-Bethe-Gamow result, and 300 people crowded in to hear Alpher's thesis defense at George Washington University in the spring of 1948. *The Washington Post*, hearing Alpher's statement that the creation of hydrogen and helium in the hot big bang took just 300 seconds, boldly reported that the "World Began in Five Minutes."

Alpher was awarded his PhD, but his 15 minutes of fame soon ended. After finishing his PhD, he and Robert Herman (who resisted Gamow's efforts to get him to change his name to Delter) continued work on the early universe. That research led them to predict the cosmic microwave background, but their prediction was ignored, and they were not given credit when the CMB was discovered in 1964. Alpher later became a researcher at General Electric. Gamow went on to study other topics as well, dabbling in the chemistry of DNA. Alpher died in 2007, shortly after receiving the National Medal of Science.

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Free E-Journal Access For Minority-Serving Institutions

In a project initiated by the National Society of Black Physicists (NSBP), the National Society of Hispanic Physicists (NSHP), and the Southeastern Universities Research Association (SURA), APS and the American Institute of Physics (AIP) have offered minority-serving academic institutions a free trial throughout 2008 to all their online publications. The two publishers have agreed to a formula that would permit these institutions to then acquire this entire collection of top physics journals at very low prices in 2009.

"Historically black colleges and universities (HBCUs) and other minority-serving institutions often lack the financial resources to obtain the research journals so important to students in physics and related fields," notes Quinton Williams, chair of the physics department at Jackson State University and past president of NSBP. "This initiative with AIP and APS is an attempt to solve that problem."

Roman Czujko, director of AIP's Statistical Research Center, points out that "HBCUs account for 60% of all physics bachelors degrees awarded to African American students, even though they comprise only 4.5% of all universities that award this degree." In addition, three of the six US universities that have awarded the largest number of PhDs to African Americans are historically black universities.

AIP, publisher of journals such as *Journal of Applied Physics* and *Journal of Chemical Physics*, and APS, publisher of the *Physical Review* series, are among the top publishers of physics journals and between them account for eight of the ten most-cited journals in the field, according to Thomson Scientific.

Cooperating with NSBP, NSHP, and SURA, the two publishers are offering free trial access in 2008 to their entire online journal collections to HBCUs and other select minority-serving institutions with a physics department. Some of these institutions subscribe to a fairly large number of AIP and APS journals (and some get none), but none of the institutions currently receives the entire collection of both publishers. Some of the institutions that currently subscribe to some AIP or APS journals will need to maintain those subscriptions, but with the trial they will gain online access to the entire collection of both publishers. These institutions can then acquire this entire collection of physics journals at very low prices in 2009.

"The journals initiative with AIP and APS has planted a seed that we hope to grow–there is certainly a need by researchers at these institutions for the journals," said David Ernst, professor of physics at Vanderbilt University, executive officer of NSHP, and SURA Fellow.

AIP and APS are accepting applications for the 2008 free trial from HBCU institutions and from a select set of Hispanic- and Native American-serving institutions. "We work with librarians throughout the developing world to provide low-cost access to our journals," states Joe Serene, APS publisher and treasurer. "We should do no less for underserved and underfinanced institutions in our own country."

Workshop Emphasizes Systems Approach to Sustainable Energy

Adopting a systems-based design strategy to eke out every last bit of energy efficiency in buildings, industrial complexes, vehicles, and municipal lighting could yield significant savings, according to speakers at a workshop on the "Physics of Sustainable Energy: Using Energy Efficiently and Producing It Renewably." Held March 1-2 in Berkeley, California, the workshop, which attracted more than 200 attendees, was sponsored by the APS Forum on Physics and Society.

Art Rosenfeld, commissioner of the California Energy Commission, described that state's recent successes in reducing electricity use compared to the US as a whole. This was accomplished in part through improved utility efficiencies, and higher building and appliance standards. In 2007, the state passed legislation to cut down on energy consumed by so-called "vampire appliances": chargers for cell phones, PDAs, and other devices that consume energy even when the devices aren't being charged. California is also beginning to phase out commercial use of incandescent lamps. "We can't just look at developing renewable energy sources," said Rosenfeld. "Those must be combined with continuing efforts to improve energy efficiencies."

Contemporary physicists rarely spend a great deal of time considering the basic physics of buildings, but David Hafemeister (Cal Poly), one of the conference organizers, has given the issue of heat transfer in his home a great deal of thought. He has made detailed calculations of his home's heating needs, taking into account such variables as square footage, ceiling height, inevitable thermal losses, local climate, double-paned windows, air ducts, furnace efficiency, and body heat given off by inhabitants. He also considered a "free temperature" effect, in which it is 3 degrees F warmer inside the house than it is outside. Based on Hafemeister's calculations, this means that no furnace heating is needed to maintain an indoor temp of 68 F until the outside temperature hits 65 F.

Photo by Richard Cohen

Alex Farrell of the Energy Resources Group at UC Berkeley gives a presentation on "The Race for 21st Century Fuels", while the audience (inset) listens attentively and waits to ask questions.

All those factors combine to determine a home's total energy usage. Because of this, small incremental improvements in energy efficiency in a building "system" can add up significantly over time, according to Daniel Harvey of the University of Toronto, who spent years developing climate change models before turning his attention to building efficiencies. In developed countries, buildings account for as much as one-third of energy-related greenhouse gas emissions.

Much progress has been made on maximizing the efficiency of individual devices commonly found in structures: pumps, motors, fans, heaters, chillers, lighting, air ducts, major appliances, and so forth. But

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The Night is Young

Photo courtesy of Art Lilley

In mid-February, APS, together with the Institute of Physics (UK), and Ghana's Kumasi Institute of Technology and Environment (KITE), hosted west African scientists, industrialists, and policy makers at a workshop in Accra, Ghana, to develop strategies for biomass energy projects in rural west Africa. Enjoying an evening break in the conference are (l to r): Art Lilley (Chairman, Community Power Corporation of Littleton, CO); APS Director of International Affairs Amy Flatten; Director of KITE Harriette Amissah-Arthur; and KITE Senior Projects Manager Ishmael Edjekumhene. More information on the workshop can be found online at/www.aps.org/programs/international/conferences/, and more information on KITE is at http://kiteonline.net.

Conference Connects Physics Teacher Educators

By Gabriel Popkin

The fourth annual Physics Teacher Education Coalition (PTEC) Conference took place Austin, Texas, on February 29th and March 1st. This conference provides a once-a-year opportunity for physics teacher educators to connect with a community of people who share a commitment to improving physics and physical science teacher education. PTEC is a project of APS, AIP, and AAPT to organize a coalition of universities, colleges, and national labs that support physics department engagement in teacher education. Over 100 institutions have joined PTEC.

For the second straight year, the conference attracted a capacity crowd of around 120 physics and education faculty, administrators, teachers, and students, who soaked up two packed days of one-and-a-half-hour workshops led by national experts on master teachers, assessment and evaluation, curriculum and teaching methods, and institutional partnerships. Among the best-attended sessions were the workshop on interactive pedagogy, "Are you really teaching if no one is learning?", conducted by Ed Prather of the University of Arizona, and the workshop on "Student Centered Activities for Large Enrollment Undergraduate Program (SCALE-UP)," led by Bob Beichner of North Carolina State. Also popular was a full-day workshop at the University of Texas at Austin on UTeach, one of the best-known and most successful science teacher preparation programs, which is now being replicated at thirteen universities around the country through grants from the National Math and Science Initiative (NMSI).

Along with workshops and plenary sessions, the conference provided an opportunity for members of the physics education community to build bridges with colleagues in other disciplines and with university administrators. Representatives from the National Association of State Universities and Land-Grant Colleges, the American Chemical Society, and Math for America attended the conference and organized several conversations and planning sessions for future multi-disciplinary initiatives in science and math teacher education.

Conference attendees were overwhelmingly positive about the program, commenting that the meeting's compact size and intense focus created a particularly rich environment for teaching, learning, and networking. Valerie Otero, a University of Colorado Education Professor, remarked on the collegial atmosphere. "There were no 'knowers', only learners. The problem of preparing qualified physics teachers is so hard that everyone is looking for someone who knows the answer," she said.

The 2009 PTEC Conference, with the theme "Institutional Change," will take place in Pittsburgh on March 13th and 14th, preceding the APS March Meeting. Another topical workshop similar to last fall's Learning Assistant workshop (reported in the February *APS News*) is also being planned, and the project will to continue to

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APS Joins Call for Science Debate in 2008

Will they or won't they? As *APS News* goes to press, the three major remaining candidates for US President are weighing an invitation to participate in a "Science Debate", slated for April 18 at the Franklin Institute in Philadelphia. The debate will take place if at least one of them accepts.

The invitation reads "Given the many urgent scientific and technological challenges facing America and the rest of the world, the increasing need for accurate scientific information in political decision making, and the vital role scientific innovation plays in spurring economic growth and competitiveness, we call for a public debate in which the US presidential candidates share their views on the issues of The Environment, Health and Medicine, and Science and Technology Policy." Hundreds of organizations have signed on to this call, as have tens of thousands of individuals, including a large number of Nobel Prize winners, university presidents, and leaders of the scientific community. APS joined the call when the Executive Board voted to endorse the debate at its February meeting.

"This debate is important for two reasons," says astrophysicist Lawrence Krauss of Case Western Reserve University, a member of the steering committee that is organizing the event. "First, issues of science and technology will be at the heart of almost every important challenge that the next president will face, from the environment, to energy, national security, health, and economic competitiveness. Second, these issues have not really been the focus of much discussion between the candidates or on the media, and the public has a right to know the candidates' thoughts on these public policy issues."

Krauss stresses that the debate will not be a science quiz, but will explore important policy issues and allow voters a better chance to make an informed decision about the candidates. "The interest in this debate has exploded in the period since I wrote about it in the *Wall Street Journal* in December," Krauss maintains. Over 100 major organizations, from the National Academy of Sciences, to the AAAS, the APS, and the Council on Competitiveness have signed on. Presidents of universities from Harvard to Stanford have joined the call, as have business people and legislators.

The debate is strategically positioned to occur only four days before the Pennsylvania primary, which has emerged as the next crucial test between Hillary Clinton and Barack Obama. Krauss is cautiously optimistic, saying "I now give the likelihood of such a debate in Philadelphia a fighting chance."

More information about the debate, and a complete list of the signers, can be found on the debate website, www.sciencedebate2008.com.

Letters

What Would a Physicist Do?

Rep. Ehlers (February *APS News*, Back Page) has shared his thoughts on having a physicist (or other scientist) as president of the country. While I certainly would not argue with his points on education, innovation and analytical thinking, I otherwise find his discussion narrow and parochial.

As a physicist who has a son in his FOURTH tour of duty in Iraq, I would want to know:

What would a physicist do about the Iraq War? We know Rep. Ehlers voted for it, that's not a good start for recommending physicists as political leaders.

What would a physicist do about the US military/industrial/university complex that costs the taxpayers $750B to $1T per year, more than the rest of the world combined spends on its military establishments?

What would a physicist do about the American Empire maintained by its military strength exerted through 11 carrier battle groups and more than 700 military installations in over 70 countries world wide, and by its economic strength exerted through the World Bank, the IMF and the WTO?

What would a physicist do about global warming? About an economic model that does not price in war, subsidies, world wide ecological damage, public health, and failed/failing states, and other externalities into the cost of fossil fuels?

What would a physicist do about the new Golden Age of income disparity that threatens our middle class, and hence our democracy? Or about universal health care? Or about our aging infrastructure?

Given that physicists have played, and continue to play, such a key role in development and maintenance of our nuclear arsenal: What would a physicist do about our stockpile of some 8000 warheads? About counter proliferation?

There is much, much more for a physicist, or anyone, to do.

Gerard Bricks
Kennett Square, PA

Not Dumb Enough to Run

I read February's Back Page with interest and agreement with the author, but Dr. Ehlers forgets one thing: no physicist is stupid enough to run for President.

Stephen C. Bennett
Boulder, CO

Physicist Not the Best Choice for President

Regarding Congressman Vernon J. Ehler's Back Page (*APS News*, February 2008): I cannot recall a more stimulating call from the Oval Office for more intense study of science and technology at American schools and colleges and advanced research and related development in schools and industry alike than the one made by President Kennedy with the challenge to place a man on the moon and bring him back safely within a decade. The overwhelming response to the call and the economic boost has lasted almost forty years. We all know that President Kennedy was not a physicist.

It is my considered belief that a Sputnik-like era has dawned on us again now calling for a similar spark from America. Global warming and all related human efforts to control the predicted devastation such as alternate sources of energy are issues and challenges that America, as before, can accept and solve. Can a candidate for election or a President in office make the call and should he or she be a physicist? My answer to the first part of the question is YES and to the latter part, NO.

A person willing to respectfully listen to divergent suggestions and capable of developing a feasible solution to the problem from the inputs should be the right choice rather than a specialist who knows more and more about less and less.

P. Mahadevan
Fullerton, CA

Needed: Young Physicist to Run for Senate

While I agree with the suggestion of Congressman Ehlers (Back Page, February *APS News*) that a physicist might make a great President, I think it is more practical and feasible that physicists try for the US Senate. I did try, perhaps for the first time in our history, in the Republican Primary in Texas in 2002, with strong endorsements of the late Prof. Milton Friedman and Congressman Ron Paul. With virtually no effort beyond creating a web site (www.lawrencecranberg.org), and at age 84, I gained only 3 percent of the voters in Texas, but I strongly encourage others younger than I to make the effort.

Lawrence Cranberg
Austin, TX

Better to Build Schools Than To Run for President

The "Physicist for President" idea discussed by Representative Vernon Ehlers in his Back Page article (*APS News*, February 2008) would not succeed politically.

As the Republican candidate for Congress in the 8th district of Massachusetts in 1962, I found that my slogan "Put a Scientist in Congress" flopped! Of course I lost for many other reasons, like running against a skilled ten-year incumbent Democrat. To help science in America and spur our economic competitiveness, Representative Ehlers could submit a bill for the Federal Government to fund and build 435 special public High Schools of Science, 63 per year, locally controlled, (like my own very successful Stuyvesant H. S.), one in each Congressional district, to which any Congressperson could point with pride. We can afford this investment in financially poor, but really bright American children.

Howard D. Greyber
San Jose, CA

Physics Major Finds Fame as Cartoonist

The Profile in Versatility in the February *APS News* on Michael Long's career in the Funny Business (and in Speechwriting) prompts me to call attention to another college physics major who has had great success in a related somewhat surprising career, albeit in the Funny Papers rather than as a standup comedian. Faithful readers of the comic strip FoxTrot have no doubt long ago deduced that its creator, Bill Amend, has more of a scientific background than do most of his colleagues. Amend was an Amherst College physics major in the class of 1983, probably our most famous physics alumnus. (This is not a secret; you can read it on his website.) Many of us on the faculty have seen our names and caricatures appear in FoxTrot. If you choose to go looking through back files of FoxTrot to find me, for instance, a clue is that when Amend was an undergraduate, I had a great deal more hair on my face than I have generally worn since that time–and about the same (small) amount on the top of my head. Some of the wording from lab notes I wrote nearly three decades ago appeared almost verbatim in one of his sequences. (No, I never received any royalties–pride of authorship was more than adequate payment.) I never would have dared to peek at Bill's notes that he took during my classes; I fear that instead of recording my equations and my words of wisdom about James Clerk Maxwell, he may have been making sketches of the professor, sketches that he saved for later use. He tells me now that whenever he puts an equation about projectile motion or a sequence of prime numbers into his strip (his editors urge him to go easy on the math and physics), he does so somewhat nervously, knowing that his former professors will be watching, ready to email him in case of an error.

In 2000, Amherst College presented Amend with an honorary degree for his creation of FoxTrot.

Robert H. Romer,
Amherst, MA

Rowland Spinning in his Grave

On the Back Page of the January *APS News* the editor reprints the presidential address of Henry A. Rowland, the first president of the American Physical Society. In the closing paragraphs of his address Rowland laments "the sins of the past" "because our ancestors dissipated their wealth on armies and navies" "designated to kill" instead of spending only "one percent of this sum to save our children and descendents from misery and death." Today, one hundred and eight years later, it is apparent that nothing has changed. It is particularly ironic that the institution that Rowland was addressing, the American Physical Society, now has a large, and growing, number of its members employed directly or indirectly in the military establishment. Perhaps this is an ominous sign that the human species is firmly on the road to its own self-annihilation. Henry Rowland is surely not resting in peace. Have we, as physicists, failed APS's first president and humanity in the bigger picture?

Karo Michaelian
Mexico City, Mexico

Heisenberg Article Found Appalling

I was appalled by the portion of the article about Heisenberg (*APS News*, February 2008) that read: "...he was a patriotic German citizen, and he became a leader in the German fission program, which failed in its effort to build an atomic bomb." The comprehensive and well-known book "Heisenberg's War" by Thomas Powers, published in 1993, is not that forgiving.

Louis Costrell
Rockville, MD

Viewpoint...

Physicists Lead the Establishment of a Novel Research Institution in Cyprus for the Middle East

by Constantia Alexandrou

Cyprus appears on most global maps, if at all, as a small dot off the cost of Lebanon. Can Cyprus nevertheless offer a fertile environment for the development of a word-class educational and research institution serving the entire Eastern Mediterranean region, one that would educate future regional leaders to more eagerly use science, technology and management instead of the threat of war to respond to scarcity, tap diversity, and resolve conflict? This aspiration is being put to test, largely through the involvement of the international scientific community, via the recent establishment of the Cyprus Institute (www.cyi.ac.cy).

The initial spark came in 1992 with the establishment in of the University of Cyprus (www.ucy.ac.cy). The academics that came to work there had pursued careers mostly in the US or Western Europe, with the Physics Department, established in 1999, being no exception. Difficulties were associated with the lack of academic and research tradition, and with the inhomogeneity of the faculty coming from different backgrounds. Nevertheless, fifteen years after the admittance of its first students, the University of Cyprus has established itself as the highest center for learning serving local educational needs. Whether it can become a regional, or even a world-class, institution is problematic for a number of reasons, ranging from governance structures that do not reward excellence to the lack of innovation culture in the surrounding society. These are features common in this geographical area of the world that hinder the emergence of world-class institutions. According to the *Times* magazine list (November 5, 2004 issue) of the top 200 universities worldwide none are from this area, with two from Israel being the only exceptions.

When Cyprus entered the European Union (EU) in 2004, it held the embarrassingly last position in funds spent on research per capita. The government reacted with increasing spending on research thereby becoming the fastest growing in the EU for the last four years. The impact is becoming visible: two additional public universities and three private ones have been established and funding for research is rising steadily. Cyprus is doing very well in claiming competitive research funds from EU and, in the recent highly competitive European Research Council call, Cyprus emerged as a champion. Education, research, and innovation have become top priorities for all political parties. This is fortunate since political and social unity on such issues can drive R&D, as was seen in the case of Finland and Ireland, a decade ago.

The proposal that articulated the vision for the Cyprus Institute was developed by a five-member committee that included three physicists: E. J. Moniz of MIT, C. N. Papanicolas of the University of Athens and H. Schopper of CERN. The other two were F. Rhodes and G. Ourisson former Presidents of Cornell and Louis Pasteur Universities respectively. The proposal was debated and enthusiastically endorsed in 2002 by a convocation of international scholars that included many prominent academics, among them scientists of the stature of the late H. Curien, H. Varmus, P. Crutzen and J. Sachs. These scholars came with the belief that Cyprus, at the cross-roads of Western and Eastern civilizations, in an area of long political strife, and with good relations with both Israel and the Arab world, holds the promise to become Europe's gateway to the East, playing a catalytic role for new understanding and reconciliation among the nations of the region. They endorsed the creation of a novel, technologically oriented world-class Institute based in Cyprus but serving the entire region. The Cyprus Institute, a private non-profit organization, is to be structured ab initio to facili-

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Number of Physicists in Congress Jumps by Fifty Percent

Former Fermilab physicist Bill Foster has been elected Representative for the Illinois 14th Congressional District. Foster is now the third physicist, and third APS Fellow, in Congress, joining Vernon Ehlers (R-MI 3rd) and Rush Holt (D-NJ 12th).

Foster defeated Republican dairy magnate Jim Oberweis in the special election held March 8 to replace retired Representative and former Republican House Speaker, Dennis Hastert. Foster will now serve the rest of Hastert's term, and will then face Oberweis again in the regular election in November.

The Illinois 14th congressional district includes the western suburbs of Chicago, including the area where Fermilab is located. Foster, a Democrat, captured 52 percent of the vote in the usually Republican-leaning district.

Dozens of scientists, including 28 Nobel laureates, endorsed Foster. "The scientific community was very excited by the prospect of having another scientist in Congress, because there's been a lack of understanding of and respect for science in the public policy realm," said Foster's press secretary Andrew Dupuy.

Voters also saw value in Foster's background as a physicist, according to Dupuy. "People want change, and sending a scientist to Congress certainly represents a change."

"Most of the challenges facing this country are economic or technological, and as a businessman and a scientist, Congressman Foster has the background and experience to address those issues. Energy policy would be an obvious example–Foster's understanding of science is vital to finding solutions for energy independence," said Dupuy.

Foster received a bachelor's degree in physics from the University of Wisconsin-Madison in 1975 and a PhD in physics from Harvard University in 1984. During his 22 years at Fermilab, Foster played a leading role in the design and building of several particle physics experiments. As a member of the CDF collaboration he designed much of the original electronics and participated in the discovery of the top quark. He was also was a co-inventor of Fermilab's Antiproton Recycler Ring.

In addition to being a physicist, Foster is a successful businessman. When he was 19, Foster and his brother started a theater lighting company, Electronic Theatre Controls, which now provides over 70% of the theater lighting in the US.

Make Your Voice Heard

Photo by Ken Cole

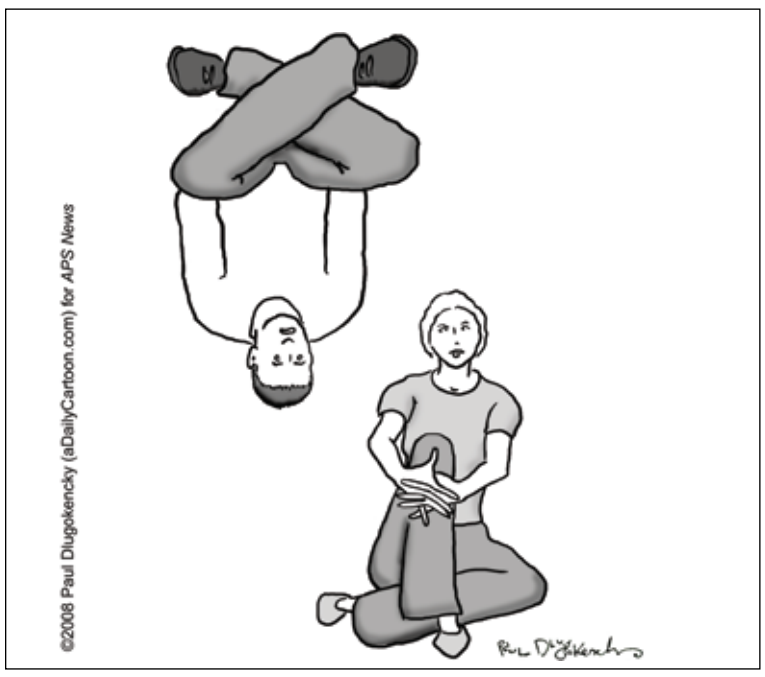
APS Press Secretary Tawanda Johnson (standing) explains to a March Meeting attendee the importance of letting Congress hear from the scientific community. The APS Contact Congress effort allowed physicists at the meeting to use specially designed software to send letters to their Senators and Representatives. During the meeting, a new record of 1745 attendees used the system to weigh in on the importance of science funding.

zero gravity

The Lighter Side of Science

APS News Physics Caption Contest

On its back page, the *New Yorker* magazine runs a weekly caption contest. Ever on the lookout for good ideas, and not ashamed to copy them slavishly, *APS News* proudly announces its own caption contest, the major difference being that we want the cartoon + caption not only to be funny, but also to have something to do with physics. *APS News* cartoonist Paul Dlugokencky has drawn the cartoon at right, and has deliberately omitted the caption. For all we know, he may have no idea what the caption should be. But it looks like there's a physics joke in there somewhere.



Readers of *APS News* are invited to submit suggested captions by email to caption@aps.org. The deadline for submission is May 31. The three best captions, as decided by *APS News* editors, will appear in the July issue of *APS News*, and APS members will be able to vote for their favorite online at the *APS News* web site, www.aps.org/publications/apsnews. The winner will be announced in the October issue, and will receive a print of the cartoon signed by the artist, as well as a copy of the book "Physics in the 20th Century" and an APS tee shirt. The full contest rules appear online on the APS News web site.

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tate learning across disciplinary boundaries, to transcend national borders, applying the best of science, technology, and management to deal with some of the world's most refractory problems. The first indications regarding the development of the Institute seem excellent: The first Research Center of the Institute, on Energy, Environment and Water Resources, developed with public funding in partnership with MIT, was inaugurated on the 10th of December 2007 by the President of the Republic. The second Research Center on Technology in Archeology is being developed in partnership with the Louvre and the third on Computation-based Science and Technology with the University of Illinois. The involvement of the international community in the realization of the Institute remains strong, as exemplified by the Chair of its Board of Trustees, physicist E. Brézin of École Normale Supérieure and ex-President of the French Academy of Sciences. The project also finds strong support from local academics, including the majority of the physics community because of a convergence of mutual aspirations: to transform Cyprus into a research-oriented society and help establish world-class research in this part of the world.

There are positive developments in neighboring countries. Perhaps the most notable example is SESAME (www.sesame.org.jo), an international synchrotron light source facility being built in Jordan under the auspices of UNESCO. Cyprus, like many other countries in the region, regards SESAME as a great opportunity to accomplish in the Middle East what CERN did in postwar Europe. The last Council meeting of SESAME, held in Cyprus in December 2007, explored and endorsed close cooperation between the Cyprus Institute and SESAME, noting the common aspirations that drive the development of both institutions.

This is just the beginning of a long and difficult path. Continuous support from the international community is crucial. Working together with countries in the region to build research infrastructure of the highest caliber, establishing international norms and openness will be a key element. It is indeed a challenge for Cyprus and the other countries in the region to establish a research environment that resembles that of countries where world-class institutions can flourish with all the positive aspects that this will bring to their people.

Constantia Alexandrou is Professor of Physics at the University of Cyprus, and Ex-Vice Chair of the Interim Governing Board of the Cyprus Institute.

INSIDE THE BELTWAY: WASHINGTON ANALYSIS AND OPINION

Physicists Feel the Pain, Too

by Michael S. Lubell, APS Director of Public Affairs

Get me some Ambien or Lunesta! I'm exhausted, but the racket won't stop. No, I don't mean my upstairs neighbor, who is a considerate, hard-working member of Congress–definitely not the partying type. It's the endless presidential campaign, which on the Democratic side promises to continue in primary mode until the September convention, as I suggested almost a year ago.

For the 24-7 cable channels, the endless campaign provides them with a *raison d'être*. For weary me, it's becoming a mind-numbing din.

True, Barack Obama has inspired tens of thousands of young people to take voting seriously. And the idea of having a new occupant of the White House who is a woman, a black–at least on his father's side–or a septuagenarian is certainly going to represent a substantial change from the *status quo*.

But what have we really learned about the potential new occupant over the last year, other than their individual claims to be agents of change? Hillary Clinton wants to provide healthcare for the 45 or so million Americans who currently go without, and she wants to give our veterans their just due when they come home. John McCain wants to clean up the swamp of corruption, eliminate torture and keep American troops in Iraq for a century. And Barack Obama wants to do away with partisanship, bring our troops home, and fill us with hope.

If you go to the campaign websites, you find a lot more, but since the candidates rarely talk about the issues, we're pretty much left with the roar of emotion generators. And for good reason: political campaigns are all about arousing feelings, as I noted a few months ago.

Still, I'm getting tired of having my passions juiced. I'm tired of watching Obama play cheerleader to the chant of "Yes, we can!" I'm tired of watching Clinton clap her hands in time to "Yes, we will!" And when John McCain starts every sentence with "My friends," I'm wondering why he doesn't think some people out there might be his enemies.

There are plenty of problems facing our country that demand attention: the crumbling infrastructure, the sinking dollar, the liquidity crisis, the mortgage implosion, climate change, energy security, the national debt, sagging innovation, lagging competitiveness, Medicare shortfalls, a Social Security Trust Fund that has no balance, soaring health care costs, and an education system that doesn't deliver.

Won't somebody please address them beyond serving up the usual banalities? I don't expect the candidates to have foolproof solutions, but wouldn't it be nice if they treated us like adults once in a while and provided some thoughtful ideas?

The paucity of policy content in the presidential campaigns was the subject of discussion at a dinner at a friend's Capitol Hill house the other night. There were twenty members of the House of Representatives present along with Emory University neuro-psychologist Drew Westen, author of *The Political Brain*. One member asked Westen whether this year's presidential campaign engines were simply running on emotional gas–my turn of phrase, not hers.

Every successful campaign in recent memory has, Westen replied. In fact, he said, one of Hillary Clinton's problems is that she doesn't have the extraordinary ability to appeal to people's hearts and guts the way Bill Clinton, Ronald Reagan and John Kennedy did in their successful runs for the White House. Duds who didn't have the emotional mojo? Think John Kerry, Michael Dukakis, or Al Gore before his Hollywood makeover.

As I've written before, I think Westen and his Republican counterpart, Frank Luntz, pretty much have the political magic correct. And apparently the current crop of candidates thinks so, too.

So when the science community clamors for a "Science Debate," don't hold your breath waiting. If there's anything further away from emotion than science, I haven't run into it.

Nonetheless, with significant parts of the research enterprise reeling from the effects of the Fiscal Year 2008 budget, it would be comforting to the science community–especially to the recently unemployed or furloughed–to hear at least one of the candidates say, "I feel your pain." Science may be devoid of emotional substance, but scientists aren't.

PHYSICS AND TECHNOLOGY FOREFRONTS

New Ultrasonic Medical Applications Based on Acoustically-Induced Microbubbles

Researchers continue to develop innovative new medical techniques and applications for sound waves: specifically, those in the ultrasonic region. First introduced in 1942 by the Austrian scientist Karl Theo Dussik, ultrasonic imaging remains one of the most reliable, safe, and simple imaging techniques in medicine. Yet today, ultrasound is being used for so much more than basic medical imaging.

At greater intensities, focused ultrasonic pulses are now used to break up and liquefy body tissue: disintegrating gall bladder stones, or breaking down tumors in the brain and pancreas, for example. And in the last 20 years, therapeutic ultrasound has been explored for targeted drug delivery, to cauterize wounds, and even disrupting bacterial biofilms.

One of the key mechanisms for many of these useful effects appears to be microbubbles, induced by acoustic cavitation. "Recent studies are showing that microbubbles can help us address a variety of current clinical needs," Vesna Zderic (George Washington University) reported at last fall's meeting of the Acoustical Society of America (ASA).

Microbubbles can be introduced either by injecting ultrasound contrast agents–bubbles for this purpose can be purchased for $700 per fluid ounce–or by using high-intensity ultrasonic ultrasound fields that produce bubbles in the tissue. According to Zderic, microbubbles can become active by resonating to the tone of the ultrasound (stable cavitation), or by violent implosion (inertial cavitation). In the former, they serve to enhance imaging; in the latter they deliver mechanical energy punching holes in cell membranes to improve transport of drugs to specific sites, destroying tumors, and promoting clotting in cases of internal bleeding.

Miniscalpels and Biofilms. It may one day be possible to exploit acoustic cavitation to make surgical incisions inside the body with no need to open or puncture the skin in any way, according to Zhen Xu of the University of Michigan. He and his colleagues are investigating the effects of applying high-intensity ultrasound pulses focused into tiny acoustic "scalpels," to test whether they can deliver acoustic power without heating to tissues deep within the body.

The high-intensity ultrasound causes microbubbles to form at the focal point. These bubbles expand and collapse with great force–cavitation–and this activity can mechanically fragment tissues. Xu believes this may occur because cell membranes cannot withstand the pressure caused by the bubbles.

Xu's team has succeeded in focusing acoustical beams into a cluster of "miniscalpels" roughly the size of a single cell. They can control the beams electronically using a computer mouse or a joystick. Also, the surgery can be precisely targeted and monitored in real time because the microbubbles are easily tracked with conventional ultrasound or MRI technologies.

Photo by George Lewis Jr.

A therapeutic ultrasound transducer exerting a force on the surface of water.

Microbubbles can also help break up biofilms, the protective slicks formed by single-celled organisms when they clump together on a solid surface, communicate with each other, and secrete a mucus-like substance. Such films can form inside pipes and pollute water supplies, or create a slippery slime on creek rocks. Bacterial films like *Staph aureus* can form on medical devices in the human body, causing severe infection, and even death. These mucus secretions protect the bacteria in biofilms from being easily killed.

E. Carr Everbach and his colleagues at Swarthmore College recently demonstrated that acoustical waves can disrupt biofilms and destroy bacteria. They grew biofilms of a strain of fluorescing *E. coli* on microscope slides sandwiched between two piezoelectric bars. They placed ultrasound transducers directly onto the microscope slide to avoid shifting the placement of the samples during the laser zapping process.

All these things enabled them to view the biofilm under a confocal microscope before, during, and after charging the piezoelectric bars, thereby setting up standing acoustical waves on the biofilms. They observed changes in the biofilm structure that showed a mechanical destruction of the film and bacteria. Specifically, the dead bacteria didn't fluoresce. Once a chunk of biofilm has broken off, it is easier to kill the bacteria with antibiotics.

Microbubbles, they found, were key. "If you do this without the presence of any bubbles, not much happens," said Everbach. "What causes the disruption of the bacteria isn't the ultrasound directly, but microscopic bubbles that we introduce into the system, which are directed by the ultrasound into acoustic cavitation." Bubbles can also form naturally as part of the biological metabolism of bacteria. "We're trying to understand how much we even need external bubbles," he said. "We can look at the interaction of bubbles, ultrasound, and cells under a microscope in real time to get a better idea of what's going on."

The research is still in the early stages, but Everbach believes the technique could be applied in personalized water sterilization systems, and to fight hospital-acquired infections more effectively, particularly by curtailing the buildup of biofilms on implanted medical devices. "We're interested in understanding the fundamental mechanisms of interaction, not jumping right to some industrial scrubbing process."

"Rubbing the Brain." Neurosurgeons can usually successfully remove as much as 99.5% of a brain tumor when they operate, but they can't be as aggressive about removal as they might be in other, less sensitive areas of the body. A few scattered cancer cells are usually left over, which are treated with powerful anticancer drugs.

Recent progress in this area includes the development of "gliodel wafers": disc-shaped implants infused with cancer-fighting drugs that are placed at the site where a tumor used to be just before the neurosurgeon closes everything up after removing a brain tumor. This means the drugs can dissolve and diffuse slowly into the surrounding brain tissue to kill any lingering cancer cells. However, pharmaceutical agents don't appear to penetrate brain tissue uniformly–something that puzzles researchers.

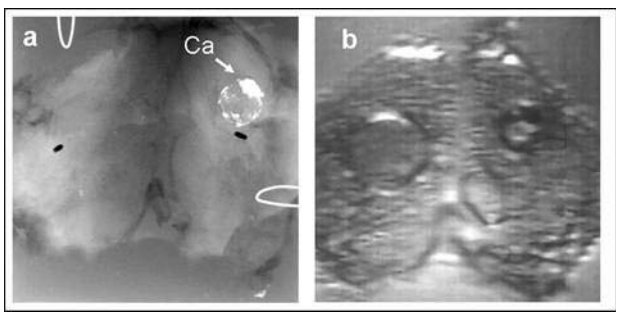

Photo by Azra Alizad

a) X-ray and (b) vibro-acoustography (VA) images of an excised human thyroid. The VA image shows a calcified lesion on the right side and a cyst on the left side of the thyroid.

Brain cancers are especially challenging, according to George Lewis Jr., a researcher at Cornell's department of biomedical engineering. Some of the newer drugs can easily kill any straggling cancer cells–provided the drug can reach them. Cancer cells migrate to other areas of the brain rather quickly after surgery. Sure, it's only a few millimeters to a centimeter, but it's just enough to elude the drugs. "In two weeks you have tumors reappearing, and in two months, the patient is dead," Lewis says. That's why brain cancers like neuroblastomas and neurofibromatosis are still the leading cause of cancer-related death in people under the age of 35.

Lewis is investigating the use of acoustic pulses to help brain tissue absorb chemotherapy drugs faster–before the cancer cells have a chance to migrate very far–and also increase the range of diffusion. He and his collaborators at Yale and Princeton use focused ultrasound to agitate the tissue matrices, enhancing permeability and making it easier for the drug to get into the brain tissue. Basically, they're massaging the brain tissue to open up the pores, since the brain is kind of similar to a sponge.

Initial results from experiments with a horse brain indicate that with such a technique, the drugs do indeed spread further and faster into the tissue than they would by natural diffusion alone–a hundredfold further, in fact, which makes it very promising for future treatment of brain cancers. They're now carrying out a full study using live animals to see if they still get enhanced diffusion effects, and also to make sure a living creature can withstand the treatment.

It is still not entirely clear what mechanism is actually at work in the technique. Some of Lewis's collaborators suspect that acoustic cavitation from microbubbles works to bloat the pores and open them up sufficiently so the drugs can diffuse through the tissue more effectively. Lewis thinks it might be primarily a mechanical effect related to the acoustic waves: "They go through the tissue as a compression wave, which oscillates the tissue and massages it to allow the drug more readily to diffuse through it." He likens it to how dentists will often massage a patient's gum when injecting Novacaine. "We're trying to rub the brain" using ultrasonic waves.

Better Thyroid Imaging. Thyroid cancer is becoming an increasingly common diagnosis, because doctors are much better at using ultrasonic imaging to detect small thyroid nodules, an indication of possible thyroid cancer. Yet according to Azra Alizad of the Mayo Clinic College of Medicine, 95% of such nodules turn out to be benign, which can only be determined by fine needle aspiration or biopsy. This happens in part because thyroid tumors are often much harder than normal tissue, and thus it is more difficult to distinguish between benign and cancerous nodules.

Alizad and his colleagues have developed a novel non-invasive imaging technique called vibro-acoustography (VA) that is especially sensitive to tissue stiffness, and also produces high resolution and high contrast images. The technique employs ultrasound to vibrate thyroid tissue at low frequencies, and the resulting vibrations are detected by a highly sensitive microphone. According to Alizad, harder tissue produces a significantly different acoustic field than softer tissue, so it is easier to detect the difference between them.

Most recently, Alizad has tested the technique on excised human thyroids from autopsy, and found that VA images showed calcifications, anatomic details, tissue structures, and nodules when present. He has yet to test the technique in clinical trials, but VA is currently being clinically evaluated for the detection of breast cancer lesions in human trials.

Medical acoustics has come a long way since doctors first used stethoscopes to listen to the human heart at the dawn of the 19th century. No doubt scientists will develop even more advanced applications of focused acoustical energy for the medical field in the future.

George Lewis, Jr. got the idea of using ultrasound for targeted anticancer drug delivery from an Indian study on using sono-poration for transdermal drug delivery. This is an older technique in which the drug is applied to the skin, and then ultrasound is applied which breaks down the skin surface so the drug can better permeate through. The Indian leather industry uses a similar technique to help dyes diffuse into the leather, resulting in a more uniform color.

TROPHY continued on page 6

physics aren't part of the high school curriculum, Chris pointed out, so he thinks their video might have gotten some people interested in these topics, he said.

The three students each received a copy of "the World's Smallest Trophy."

The Nanobowl X^{-IX} producers also received $1000 dollars cash.

In addition to the grand prize, several other prizes were awarded:

The award for "Most heartwarming" went to "Physics: An Underdog Story" by UCLA Society of Physics Students.

The award for "Most inspirational" went to "Angelo State Physics and Football" by the Angelo State SPS and the Rams Football Team.

The award for "Most Creative" went to "The Fysics of Phootball" by a group of advanced placement physics students at Greendale High School in Greendale, WI.

A People's Choice Award went to "Theoretical Football" by The College of Wooster Society of Physics Students.

These winners each received a nanotrophy and a certificate of recognition. The videos can be viewed at http://www.physicscentral.com/nanobowl/index.html

Angelo State physics professor Toni Sauncy said in an email that the video contest inspired physics students and got the football team involved. "I thought the biggest and most significant part was getting my physics students working with my football players, but it grew well beyond my initial expectations. So, I consider the project an overwhelming success. It brought together the community of learners on many levels."

BEAM continued from page 1

in use for some time, "Electron beam lithography is a newer technique and can produce extremely small feature sizes, much smaller than the wavelength of light used in standard photolithography," said Waggoner. Electron beam lithography can be used for other things besides nanobowl trophies. "Common applications include NEMS, nanofluidics, and many other applications in nanotechnology," he said.

APRIL MEETING continued from page 1

more than half a million pieces of orbiting debris larger than one centimeter in size. David Wright of the Union of Concerned Scientists will discuss what we can do to stem the growth of space debris and reduce the threat to orbiting satellites. Caroline Reilly of RAND Corporation will demonstrate why space-based warfare is a bad idea within this context. And MIT's Geoffrey Forden will focus on China's January 2007 test of an anti-satellite weapon (ASAT) and the impact it and similar weapons could have on the amount of orbiting space debris. (Session X6)

Physicists Going Underground. Three sessions at this year's meeting focus on the advantages of setting up experiments in the depths of Earth. John Wilkerson (Center for Experimental Nuclear Physics and Astrophysics, University of Washington) begins the first session by describing some of the things we can learn from underground experiments, including discovering the nature of neutrinos; detecting dark matter; determining the origins of the elements; explaining why the universe is mostly made of matter rather than antimatter; and much more. Other talks in the session identify the challenges of going underground, the technologies necessary to make the experiments work, and the sorts of data that experiments placed far underground might provide. (Sessions B13, D13, and E13)

Return of the Bubble Chamber. A venerable, but nearly forgotten, particle detector known as the bubble chamber is making a comeback as it breaks new ground in the search for dark matter. A small bubble chamber was at the heart of the Chicagoland Observatory for Underground Particle Physics (COUPP) that recently contradicted claims that dark matter had been detected in an Italian experiment. Andrew Sonnenschein (Fermilab) will describe the goals and capabilities of a new version of the COUPP experiment, which will be scaled up from the initial 2 kilogram chamber to a 60 kilogram version. By expanding the size of the experiment, the researchers increase their chances of finding a dark matter particle or, if they fail to find one, narrow down the range of the forms dark matter might take on. In either case, COUPP will offer insight into the elusive material that makes up the bulk of the matter in our universe. (E13.9)

APS Energy Efficiency Study. Nobel laureate Burton Richter (Stanford Linear Accelerator Center) will preview the APS Energy Efficiency Study that is currently underway. The study focuses on energy efficiency in buildings and transportation, which together consume 70% of the energy in the US. The study will identify immediate actions that could reduce energy use, the possibility of new energy-conserving devices emerging in the next five years, and revolutionary advances that could lead to long-term reductions in energy waste. The full report is due out in the early summer of this year. (G1.1)

Pioneer Anomaly Update. NASA recently revealed that the unexplained deviations in the paths of the Pioneer 10 and 11 spacecraft may occur with several other space probes as well. The cause, and even the existence, of the trajectory anomalies has long been the source of heated scientific debate. Slava Turyshev (Jet Propulsion Laboratory and California Institute of Technology) will update the status of the Pioneer Anomaly investigation now that more trajectory data is available. Turyshev will also address research into one possible cause of the anomalies–the tiny forces arising from the uneven emission of heat from the spacecraft (aka thermal recoil). (H7.1)

Exoplanets. More than 200 extrasolar planets have been discovered to date, mostly gas giants composed primarily of dense fluid hydrogen and helium at pressures millions of times greater than our atmosphere and at very high temperatures. Burkhard Militzer of UC Berkeley will discuss the challenges of characterizing such extreme systems, and some recent success with shock wave experiments. Diana Valencia of Harvard University will discuss ongoing investigations into the composition and structure of Super-Earths. LLNL's Jon Eggert will talk about reproducing planetary cores in the laboratory. (11HE)

The Most Extreme Environments in the Universe. The universe looks very different when viewed in gamma rays, with remarkable features and large variations on all timescales. Generally, gamma rays are emitted from the most extreme environments, such as supermassive black hole systems and neutron stars. In the next few months, the Gamma-ray Large Area Space Telescope (GLAST) will be launched into orbit, where it will survey the sky from outside Earth's atmosphere, which absorbs gamma rays. With its large leap in all key capabilities, the novel telescope will allow astrophysicists to observe this almost completely unexplored part of the electromagnetic spectrum over the entire sky every few hours. At the April Meeting, Steven Ritz (NASA GSFC and U. Maryland) will discuss the GLAST mission and its scheduled May 16 launch. (M5.2)

Highest Energy Gamma Rays Ever Detected. In the mountains just above Los Alamos, NM lies the Milagro Gamma-Ray Observatory, a large manmade pond filled with water and lined with photodetectors. Whenever gamma rays hit Earth's atmosphere, they create showers of cosmic rays that hit the pool and produce a detectable blue light. As Earth rotates on its axis, the observatory continually turns and maps out high-energy sources in northern sky. Jordan Goodman (University of Maryland) will describe how the observatory recently identified a source of the highest-energy gamma rays ever seen. At the April Meeting, he will describe the Milagro results along with observations from the HESS telescope, a powerful gamma ray detector in the southern African country of Namibia. Together these observatories mapped and measured this significant source, which as yet has not been identified. (M5.3)

High Energy Physics. Dozens of sessions report on the latest news from accelerator labs for experiments happening right now. Prominent coverage is also being given to the testing of the Large Hadron Collider (LHC) and planning of the International Linear Collider (ILC)(sessions WS2, S2, R2, and others).

Gender Equity in Physics. In session R4, Nora Berrah of Western Michigan University will report on the Committee on the Status of Women in Physics (CSWP) May 2007 workshop titled "Gender Equity: Strengthening the Physics Enterprise in Universities and National Laboratories." Other speakers in the session will discuss recommendations on how to make physics more attractive to women, and how to retain female physicists. In session D6, a panel discussion on international gender issues in physics focuses on policies of the European Union, and why there are so few female physicists in Latin America. Session W16 focuses on data from a survey of high school students in New Mexico.

Putting Gravity to the Test. Gravity is perhaps the most familiar force, but it's also one of the weakest, which makes it difficult to test. Session T10 features a number of talks focusing on new ways to test the limits of gravity. Quentin Bailey (Embry-Riddle Aeronautical University) looks at the ways that measurements of the Earth-moon distance could be used to check gravity at long ranges, in view of recent proposals of modifications of the Standard Model of physics. Josh Long (Indiana University) describes tests at the other end of the size scale with flat, vibrating surfaces that check on gravity at a range of 50 millionths of a meter. Nicolas Yunes (Penn State) discusses the possibility that gravitational probes could be used to check string theory and quantum gravity, which is important because researchers have yet to find another feasible way to test the theories. (Session T10)

Mergers and Acquisitions. Physicists believe that mergers between two black holes could be a key source of gravitational waves strong enough to be detected by both ground-based (LIGO) and space-based (LISA) detectors, depending on their masses. Michael Coleman Miller of the University of Maryland and Scott Hughes of MIT will discuss how detection and characterization of such systems can yield unique information about stellar evolution, dynamics at many scales, and even help map the large structure of the universe. (Session T6)

Movies of the Universe in Three Billion Pixels. High atop Cerro Pachon, a remote mountain in Chile, in the next decade the large synoptic survey telescope (LSST) should come online and begin continuously imaging more of the universe than all the telescopes in history combined. The LSST will image the entire visible sky, taking fast, high-resolution snapshots of large patches in 15-second exposures and mapping out the entire sky every three days. LSST will do this continuously for ten years and will generate the largest astronomical data set ever assembled–about 30 terabytes a day, the equivalent of 100 million CDs over ten years. Ian Shipsey (Purdue) will discuss aspects of the telescope design and mission, including how it will examine the visible universe and address fundamental questions about the nature of dark matter, dark energy and the expansion of the universe. (W7.3)

International Year of Astronomy 2009 2009. marks 400 years since Galileo turned his telescopes skyward, and the United Nations is celebrating with the World Year of Astronomy. Kala Perkins will share some of the new ideas for how to communicate astrophysics concepts to students and the public, and how to engage them in a cross-cultural event. (Session J16)

ANNOUNCEMENTS

M. Hildred Blewett Scholarship for Women Physicists

This scholarship has been established to enable women to return to physics research careers after having had to interrupt those careers for family reasons. The scholarship consists of an award of up to $45,000. The applicant must currently be a legal resident of the US or Canada. She must be currently in Canada or the US and must have an affiliation with a research-active educational institution or national lab. She must have completed work toward a PhD.

Applications are due June 2, 2008. Announcement of the award is expected to be made by August 1, 2008.

Details and on-line application can be found at http://www.aps.org/programs/women/scholarships/blewett/index.cfm

Contact: Sue Otwell in the APS office at blewett@aps.org

Now Appearing in RMP: Recently Posted Reviews and Colloquia
You will find the following in the online edition of
Reviews of Modern Physics at
http://rmp.aps.org

Colloquium: Chaotic quantum dots with strongly correlated electrons
R. Shankar
Collections of large quantum dots–basically large artificial atomsfixed on a substrate–have aggregate properties that are besttreated with statistical approaches. This Colloquium describes important theoretical tools for this purpose, particularly the renormalization group and random matrix theory.

ERRATUM

In the March *APS News* Prizes and Awards Insert, the institutional affiliation of one of the recipients of the Dissertation Award in Nuclear Physics was incorrectly given. The correct affiliation of Deepshikha Choudhury is Ohio University.

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reach out to the physics community through booths at future APS and AAPT meetings, as well as a scholarly book on teacher preparation, to be published in 2009. Project leader and APS Director of Education Ted Hodapp says, "At a time when policy makers are requiring more students to take physics in our nation's already understaffed classrooms, it is critical that we turn the excitement and momentum from the PTEC Conference into action, and results."

For full proceedings of the conference, please go to www.ptec.org/conferences/2008.

Photo by Ted Hodapp

Former APS President Helen Quinn (Stanford Linear Accelerator Center), Stamatis Vokos (Seattle Pacific University), and Valerie Otero (University of Colorado at Boulder) have an animated discussion between PTEC conference sessions.

WORKSHOP continued from page 3

Harvey maintains that putting them all together in the most optimal way could result in systems-level savings many times higher than what can be achieved if we simply continue to address just the individual components.

For example, standard heat pump technology is designed to transfer warm air to cooler air. There are some fundamental physical limits to how efficient the heat pump can be, as French physicist Sadi Carnot proved in the 18th century. But Harvey found that by cutting the flow rate through ducts or pipes in half, he could significantly reduce the electricity needed. Harvey advocates an integrated design process for future urban planning, complete with computational fluid dynamics modeling.

Lighting also consumes a significant amount of energy. As solid state lighting continues to improve, we can expect to see this technology employed more broadly than in the niche applications it currently occupies, according to Steve DenBaars of the University of California, Santa Barbara. Years of research have improved efficiencies and made it possible to build white LEDs with the same broad spectrum as conventional incandescent bulbs. Currently, researchers are achieving 152 lumens per watt with efficiencies between 65% and 85%; by 2012, they should reach 280 lumens per watt with 90% efficiencies.

The Back Page

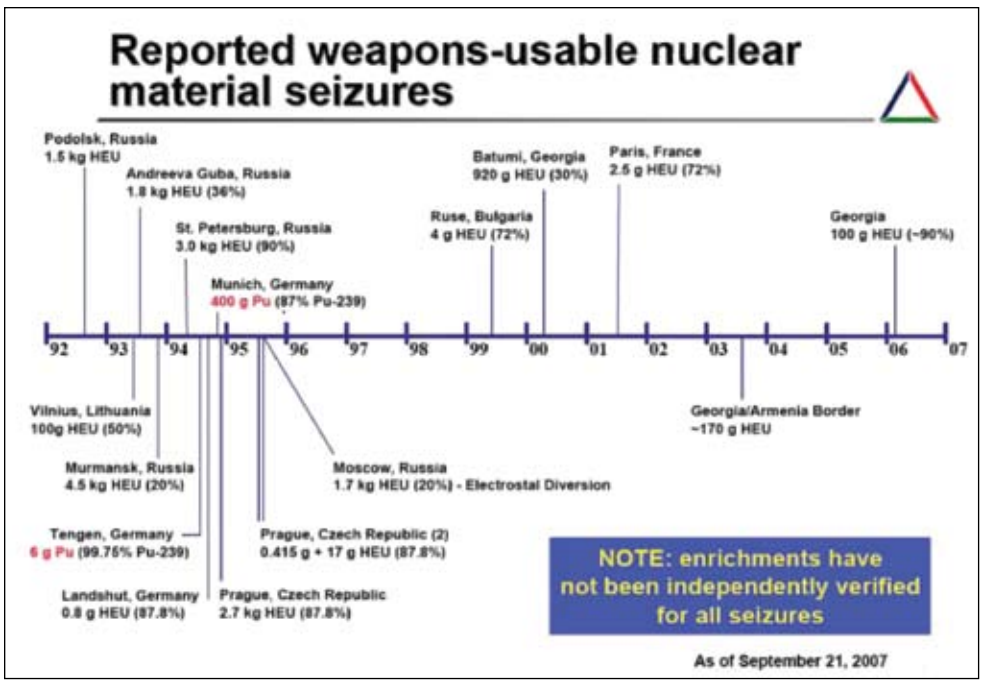
Nuclear Forensics

By Michael May

Nuclear forensics is the technical means by which nuclear materials, whether intercepted intact or retrieved from post-explosion debris, are characterized (as to composition, physical condition, age, and other characteristics) and interpreted (as to provenance, industrial history and implications for nuclear device design).

Nuclear forensics has a long history. During the first fifty years of the nuclear era, nuclear forensics techniques were developed and used to determine the characteristics (such as yield, materials used, design details) of nuclear explosions carried out by the US and by other countries. That application can still come into play if a nuclear explosion is detonated and debris are recovered. But the principal emphasis today is on the application of nuclear forensics techniques to help attribute either intercepted materials or an actual explosion to its originators. This different emphasis places different and new requirements on the technical analysis. In particular, it makes the availability of databases and sample archives from various countries much more important than was the case when the principal application was diagnosing an explosion from a known source.

According to International Atomic Energy Agency (IAEA) data, there have been 1340 reported incidents of lost or stolen radioactive material intercepted between 1993 and 2007. Most of those have not been recovered. Among the material intercepted, a significant number involved highly enriched uranium (HEU) or plutonium, in amounts ranging from grams to hundreds of grams as shown in the picture above, also from IAEA data.



If intact material is recovered, the shape, surface finish, impurities, chemical and isotopic compositions, and other features can lead to identification of some of the industrial history of the material and identify its age since it was last chemically separated. While most plutonium-producing reactors and uranium enrichment facilities fall into a few generic types, individual facilities and processes used for uranium-rich materials differ in a number of potentially telltale details. Whole fuel elements have been recovered and identified and a number of other such identifications have been made.[1]

If a nuclear detonation of unknown origin takes place, analysis of the radioactive debris can again establish the age and point to the processes used to make the plutonium or HEU. In time, possible nuclear device designs can be inferred by using reverse engineering computer codes. The procedure used, obstacles and time pressure will of course be entirely different from the cases of interceptions of small quantities of material. The overall situation after a detonation and the location of the detonation, whether in the US or abroad, will determine a great deal of what can be done and on what time scale. Ash Carter, Bill Perry and the present author have delved into what would happen and what should happen the "Day After" a nuclear explosion in a city, in a report available on the web and in print.[2]

The two relatively most accessible places to collect debris from a nuclear explosion are from the fallout downwind from the detonation point and the radioactive cloud drifting with the prevailing winds. Sample collection from the crater will be very difficult for some period of time because high radioactivity will inhibit access to the crater. But even collection from the fallout area (which will need to take place at a number of sites since the materials of interest will not condense and fall uniformly) will require special precautions both for safety of personnel involved and to preserve evidence. Time in the high fallout area must be tracked and limited. Rapid transport suitable for transporting radioactive evidence must be available. All this will require coordination with the FBI, which would be in charge overall in the US, and with the federal and local agencies in charge of response and recovery. Collection of airborne debris requires specially equipped aircraft. Much of what would need to be done can be speeded up and improved.

Nuclear forensics is part and parcel of the overall attribution process; it may be more or less helpful, depending on circumstances. One of the main features of attribution, including forensics, is that results are only available over time. This is not of great importance in cases of material intercepts, unless an entire weapon or material in amount sufficient for a weapon is intercepted, which has not happened. In the case of a nuclear detonation, this time delay and the uncertainties of the initial interpretations assume major political importance and there would be great pressure to obtain firm results to guide policy decisions as soon as possible. It is essential that mechanisms be in place to avoid wrong decisions. The only way to assure partially that those mechanisms will be in place is for the organizations and policy makers that would be involved to carry out realistic exercises that test coordination, operational readiness and that involve participation from the leaders that will have to make relevant attribution decisions.

Last year, a Working Group of the American Physical Society's (APS) Panel on Public Affairs (POPA), in conjunction with the American Association for the Advancement of Science (AAAS) Center for Science, Technology and Security Policy, was charged to produce an unclassified report describing the state of the art of nuclear forensics, assessing its potential for preventing and identifying unattributed nuclear material intercepts and nuclear attacks, and identifying the policies, resources and human talent to fulfill this potential. The APS/AAAS Working Group report was released on February 16 of this year at the annual meeting of the AAAS in Boston. It is available at http://cstsp.aaas.org/content.html?contentid=1546 and includes the charter of the working group and the biographies of its members.

On the basis of the facts summarized above, the Working Group came to five recommendations.

R&D to Develop Advanced Lab and Field Equipment and Numerical Modeling: There is considerable room for improving the equipment that would have to be used following a nuclear detonation. Much of it dates to the Cold War. More up-to-date equipment would allow for more substantial early field measurements and more rapid and accurate laboratory analysis. A program should be undertaken to develop and manufacture advanced, automated, field-deployable equipment that would allow the necessary measurements to be made rapidly and accurately at a number of sites. Such field equipment is not now readily available. Advances in numerical simulations that provide design information are also needed.

Workforce Development: There are approximately 35-50 scientists working on nuclear forensics at the national labs, not enough to deal with an emergency. A number of them would be double-booked in case of a nuclear emergency. In addition, as things stand, the present numbers will not be maintained: some will move to other responsibilities and many will reach retirement age. Unless a new program is funded, some will not be replaced: the pipeline is nearly empty. A program to develop trained personnel should be undertaken that should include funding research at universities, graduate scholarships and fellowships, internships at the labs, and incentives that stimulate industrial support of faculty positions. The program should be sized to produce at least 3-4 new PhDs per year in the relevant disciplines for the first ten years, and to maintain skilled personnel level thereafter. Scientists with such training could also go into (and be drawn from) the related fields of geochemistry, nuclear physics, nuclear engineering, materials science, and analytical chemistry.

International Cooperation and Sample-Matching Database Development: Doing nuclear forensics on either intercepted or detonated material is inherently an international enterprise: the material (so far) has all come from abroad, key facilities, databases and sample archives are located abroad, the cooperation of other governments and government institutions is essential, and, in the event of a nuclear explosion, the radioactive cloud and fallout will go all over the world, so that many institutions abroad will analyze and interpret it. The US government should extend its ongoing initiatives to counter WMD terrorism to include provisions for prompt technical and operational cooperation in the event of a nuclear detonation anywhere in the world. Such cooperation should most importantly include enlarging and providing for prompt access to international and other databases and linking them electronically under suitable precautions to protect state and commercially sensitive information in normal times. The wider the participation in this effort, the more confident the processes of nuclear forensics will be. The present Global Initiative, co-chaired by the United States and Russia, could be a vehicle for undertaking this effort. The effort will involve the IAEA, which has much relevant data and capabilities. However desirable, the effort nonetheless will encounter a number of obstacles stemming from differing classification rules in different countries, commercial concerns over competitive advantage, and reluctance of some countries to release potentially compromising information. None of those obstacles in the view of most working group members constitute showstoppers, but the program must of necessity be considered a long-term one.

Exercises: Two types of exercises can be carried out: technical exercises, which test operational capabilities, coordination, communication and policies that would be needed at all levels of the organizations concerned in the event of a nuclear detonation anywhere in the world, and war-game types of exercises, structured to involve senior decision-makers in some approximation of what the real situation would be. To date, mainly technical exercises have been carried out. While no exercise can fully simulate the possibly chaotic situation that could prevail in the wake of a nuclear detonation in a city, nevertheless much can be done to make sure top-level leadership is prepared to promulgate realistic decisions in the areas of public health, foreign policy, and military action. Exercises should be structured so as to illustrate the strengths and limitations of nuclear forensics as well as to test capability and coordination in light of both the time-urgent needs of the situation and also the ability to communicate to the public and manage expectations.

Review and Evaluation Groups: Neither the ongoing program to deal with nuclear material intercepts, nor the ongoing exercises are made full use of from the standpoint of incorporating their lessons into the culture of the relevant organizations. In addition, to the working group's knowledge, there is no expert panel to advise top level leadership of the meaning of developing events in case of an emergency. The US government should establish two groups: one to systematically review, evaluate and keep records of both the results of intercepts and the exercises recommended above; the other to advise the US government in real time on the results of nuclear forensics and what they mean in the event of an emergency. The second group would provide independent assessment of developing forensic and other technical information in case of a nuclear emergency. Its function would be somewhat similar to that of the Cold War Bethe Panel, which advised the US government as to the physical results of foreign nuclear tests and the implication of those results. Both groups should have international participation, as appropriate.

No one knows if a terrorist group is likely to set off a nuclear explosion. We know that there is a black market in nuclear weapons materials. We know that there are huge quantities of these materials stored in the United States, Russia, Pakistan and other countries, and we know that the security in many cases is not as good as it could be. We know that a small crew that includes some specialists and has some time in a protected location could assemble a primitive nuclear weapon from stolen or otherwise acquired materials, and we know that the weapon could be transported in a small truck. A terrorist group would encounter many obstacles–guards, border crossings, intelligence operations from several countries, technical countermeasures, but a nuclear detonation is possible. We believe the recommendations made above would improve US ability to deal with it. A strong international program aimed at strengthening forensics capabilities may also help dissuade a state from cooperation with terrorist groups and encourage it to improve the security of the nuclear material it owns.

Michael May was the Chair of the APS/AAAS working group on nuclear forensics. He is Professor Emeritus (Research) in the School of Engineering, and a Senior Fellow with the Center for International Security and Cooperation of the Freeman-Spogli Institute for International Studies at Stanford University. He is Director Emeritus of the Lawrence Livermore National Laboratory.

[1] In a historically curious incident, a 5x5x5 cm cube of pure natural uranium was recovered in 2007 from a forested area in Germany and traced with near certainty to the 1940s, perhaps falling from Werner Heisenberg's pocket as he bicycled away from an allied detachment nearing his laboratory. I am indebted to Dr. Klaus Luetzenkirchen of the Institute for Transuranium Elements in Karlsruhe, Germany, for this example.

[2] For a more detailed overview of "The Day After," see links at http://cisac.stanford.edu/publications/day_after_the_action_in_the_24_hours_following_a_nuclear_blast/ or http://belfercenter.ksg.harvard.edu/publication/2140/day_after.html?breadcrumb=%2Ftopic%2F7%2Fdirty_bombs