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There's Oil in Them Thar Rocks
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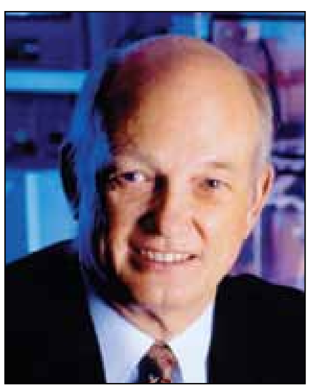
Brinkman Nominated to Head DOE Office of Science

Former APS President William F. Brinkman has been chosen by President Barack Obama to be the Director of the Office of Science in the Department of Energy. As its head, Brinkman would oversee the largest sponsor of basic physical science research in the country. He will be leaving his position as a Senior Research Physicist at Princeton University.



Brinkman served as president of the Society in 2002. Prior to that, he held the position of Vice President, Research at Bell Laboratories, which oversaw all research by Lucent Technologies. In addition he has served on numerous national committees including chairing the National Academy of Sciences Physics Survey, the 8-volume "Brinkman Report" of 1986.

As *APS News* goes to press, the date for his confirmation hearing has not yet been set; however he is expected to be confirmed by the full Senate when it does come up for a vote.

Physicists Bring Their Moxie to National Intelligence

By Calla Cofield

"How many people have heard of DARPA?" asks a woman in a fuchsia business jacket at the front of the room. Nearly everyone in the room. She smiles, "Ok—we're like DARPA for spies."

That's how Lisa Porter describes the Intelligence Advanced Research Projects Activity, IARPA, a government agency started in 2008 that invests in high-risk, high-payoff research to advance national intelligence. Ten years ago Porter worked as an applied physicist, but 9/11 prompted her to put her efforts toward national security. Now Porter is director of IARPA, where she keeps her physics roots strong. She spoke at a session at the APS April Meeting and discussed both the obvious and less-obivous ways that the physics community can contribute to national intelligence.

The obvious ways include advancing technology from basic research: quantum information science, sensor technology, and pushing the size, weight and power

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Scientists Issue Call for More Public Engagement

Negative perceptions of science in the public mind have been intensified lately by anxiety about dwindling fuel sources and spikes in energy costs, as well as by ideological attacks on the science of climate change and evolution. Recent studies have shown widespread misconceptions abound about basic but important technical essentials. At the APS April Meeting a number of scientists spoke out in order to help bridge this gap between the laboratory and the public sphere.

Speaking at the April Meeting's public town hall session on science and society, Lawrence Krauss, a professor at Arizona Sate University and one of science's most vocal proponents, called scientists to become more involved in the public debate over science.

"Fundamentally we need to convince people to believe in science because science works," Krauss said, "Scientists need to learn how to do public relations… We have to learn how people listen."

Speaking at a session entitled "Science Policy: Yesterday, Today and Tomorrow," Neal Lane, presidential science advisor under Clinton, similarly called for a new era of what he dubs "Civic Science." Such civic scientists would work on important national projects, while at the same time represent the public face of the science community to promote the importance of all fields to the general public. Emphasizing the need to work across disciplines, Lane added that, "our voice as scientists speaking common messages needs to be heard."

Much of this concern has been galvanized by an apparent growing disconnect between the importance of energy issues and the public's understanding of them. A recent public survey carried out by the organization Public Agenda, titled "The Energy Learning Curve," found that three-quarters

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Kirby Succeeds Franz as APS Executive Officer

Photo by Ken Cole

Judy Franz (left) and Kate Kirby on the terrace at APS headquarters

Kate Kirby of the Harvard-Smithsonian Center for Astrophysics will be the new Executive Officer of the APS, succeeding Judy Franz, who is retiring after serving in the position for 15 years. Kirby will assume her new position at APS headquarters in College Park, MD in late July.

The Executive Officer is one of three APS Operating Officers. Together with Treasurer/Publisher Joe Serene and Editor-in-Chief Gene Sprouse, Kirby will oversee the day-to-day operations of the Society. She will be responsible for meetings and membership, as well as programs such as education, outreach, public affairs, and international affairs.

Kirby earned her bachelor's degree in chemistry and physics from Harvard/Radcliffe College in 1967 and her PhD from the University of Chicago in 1972. After a postdoctoral fellowship at the Harvard College Observatory (1972-73), she was appointed as

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APS Launches Free News Service for its Members

APS has introduced a new benefit for its members to help them stay abreast of the latest physics news. Called the APS Weekly NewsBrief, it highlights timely physics articles featured in the mainstream press.

The service, which will be sent free of charge to APS members who choose to subscribe, culls through numerous publications each week looking for the most interesting and relevant physics articles in the popular press. Stories already featured have ranged from an article in *US News and World Report* on using pulsars to detect gravitational waves to a *New Scientist* spot about strengthening spider silk using titanium. The NewsBrief highlights more than just the latest discoveries, and include feature stories about developments important to all aspects of the physics community, both in the US and around the world.

"The articles are broader in scope than what is highlighted on the APS website," said Trish Lettieri, Director of Membership. She added, "The NewsBrief will offer more general physics stories…topics that are of general interest to our members."

The Weekly NewsBrief was able to get off the ground with help from the Forum on Physics in Society, which contributed member lists and support. APS staff also debuted the new benefit at this year's March Meeting. Already the service has picked up over 1,500 subscribers, with many more expected as members hear about it at upcoming meetings and via the website.

To sign up for this free member service, follow the link on the Membership page of the APS website.

April Meeting Prize and Award Recipients

Photo by Bill Cronin

Front row (l to r): Carlo Becchi, Luciano Ristori, Thomas I. Banks, Paul Sorensen, David Maloney, Patricia Lewis. Back row (l to r): John C. Collins, David Arnett, R. Keith Ellis, Davison E. Soper, Zheng-Tian Lu, Carlos R. Ordóñez, James B. Hartle, Saskia Mioduszewski, Gaston R. Gutierrez, Curtis Hieggelke, Steven M. Clayton, Robert D. McKeown.

Members in the Media

"It's a good way to get grant money to study something. But it's still a pipe dream. … I think it's one of those trendy things that won't lead to anywhere."

***Emanuel Derman**, Columbia University, on why he thinks that using neuroscience to model the stock market won't work*, The Wall Street Journal, *April 16, 2009.*

"I no longer own a car. Let me just say that in most of my jobs, I mostly rode my bicycle. [Now] My security detail didn't want me to be riding my bicycle or even taking the Metro. I have a security detail that drives me."

***Steven Chu**, Department of Energy,* The New York Times Magazine, *April 16, 2009.*

"In the lab, we only look at one type of molecule at a time. But when we look in space, all the molecules are there at the same time. That's the difficulty,"

***Eric Herbst**, Ohio State University, explaining the difficulty detecting complex molecules in distant galaxies using radio telescopes,* MSNBC.com, *April 21, 2009.*

"I'd like to do research that has practical applications, that is useful in everyday life,"

***Eric Eason**, University of Colorado, after winning the prestigious Hertz Fellowship at age 17,* The Denver Post, *April 22, 2009.*

"My expectation is that NASA will be given marching orders and that they won't be the same as that of the Bush administration…They are still working on the old plan, and the clock is ticking."

***Neal Lane**, Rice University, voicing concern over NASA's lack of direction without a head administrator,* The Associated Press, *April 22, 2009.*

"The Rydberg electron resembles a sheepdog that keeps its flock together by roaming speedily to the outermost periphery of the flock, and nudging back towards the center any member that might begin to drift away,"

***Chris Greene**, University of Colorado at Boulder, on the creation of the first Rydberg molecule,* BBC News, *April 23, 2009.*

"Somehow they have managed to get thousands of gigantic magnets, get them arranged so that they're within a few microns of where they're supposed to be, and then cool it down to a couple degrees above absolute zero,"

***Joseph Lykken**, Fermilab, describing some of the incredible engineering that went into building the Large Hadron Collider,* CNN International, *April 28, 2009.*

"Bright spots reflect their assigned wavelength but dark ones don't…When the 2-D rainbow reflects from the object, the image is copied onto the color spectrum of the pulse."

***Bahram Jalali**, UCLA, explaining the operation of his team's new, 6-million frames per second camera,* BBC News, *April, 29, 2009.*

"Like interacting with an expert, it will understand what you're talking about, do the computation, and then present you with the results,"

***Stephen Wolfram**, Wolfram Research Inc, promoting his newly developed web tool that can interpret simple questions and answer them directly,* BBC News, *April 30, 2009.*

"Essentially, we are transforming a straight line of light into a curved line around the cloak, so you don't perceive any change in its pathway,"

***Xiang Zhang,** Berkeley, on how new metamaterials are being used towards the creation of an "invisibility cloak,"* BBC News, *April, 30, 2009.*

"A great thing about the physics of beer is the bubbles,"

***Stephen Morris**, University of Toronto, getting ready for Toronto's "Sipping Science" day,* Globe and Mail*, May 2, 2009.*

"The fun in 'Star Trek' didn't come from copying science, but from having science copy it. My job wasn't to put real science into 'Star Trek,' but to imagine new ideas that hadn't yet been thought of."

***Leonard Mlodinow**, describing how as a writer for the Star Trek franchise he is able to both incorporate and inspire real science,* Newsweek*, May 4, 2009.*

"It's awesome–we called it, 'Black holes in a bathtub'. "

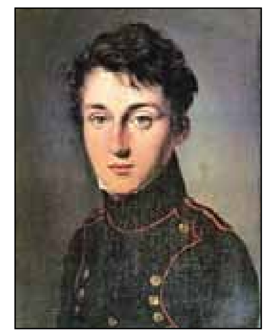
***Norman Yao**, Harvard, describing his undergrad work on how black holes behave like fluids,* The New Jersey Star-Ledger*, May 10, 2009.*

This Month in Physics History

June 12, 1824: Sadi Carnot publishes treatise on heat engines

We embrace the laws of thermodynamics as among the most fundamental foundations of modern physics. However, as recently as the early 19th century, no one had codified the laws of thermodynamics in precise, physical terms. That process began with the work of a little-known French physicist named Sadi Carnot.

Born in 1796, Carnot was the son of a French aristocrat named Lazare Carnot. His father was one of the most powerful men in France prior to Napoléon's ignominious defeat; the family fortunes rose and fell dramatically throughout the young Sadi's life in conjunction with that of the monarchy. Named for the Persian poet Sadi of Shiraz, Carnot learned mathematics, science, language, and music under his father's strict tutelage. At 16, he entered the École Polytechnique, studying under the likes of Claude-Louis Navier, Siméon Denis Poisson, and André-Marie Ampère.



Nicolas Léonard Sadi Carnot (1796-1832) in the dress uniform of a student of the École Polytechnique.

Following graduation, Carnot took a two-year course in military engineering in Metz, just before Napoléon's brief return from exile in 1815. When Napoléon was defeated in October of that year, Carnot's father was exiled to Germany. He never returned to France. Carnot the younger, dissatisfied with the poor prospects offered by his military career, eventually joined the General Staff Corps in Paris and pursued his academic interests on the side.

In 1821, he visited his exiled father and brother, Hippolyte, in Germany, where many discussions of steam engines took place. Steam power was already used for draining mines, forging iron, grinding grain, and weaving cloth, but the French-designed engines were not as efficient as those designed by the British. Convinced that England's superior technology in this area had contributed to Napoleon's downfall and the loss of his family's prestige and fortune, Sadi Carnot threw himself into developing a robust theory for steam engines.

Although the steam engine was fairly well developed by this time, the efficiency of those early engines was as low as 3%. Engineers were experimenting fervently with other mechanical means and fuels for improving that efficiency. Furthermore, there had been very little work delineating the underlying science by which it operates. The principle of energy conservation was fairly new and quite controversial among scientists at the time. It would be another 20 years before someone uncovered the mechanical equivalent of heat. When Carnot began his studies, he and his peers subscribed to the caloric theory, assuming that heat was a weightless, invisible fluid that flowed when it was not in equilibrium.

Carnot's father died in 1823. That same year, Carnot wrote a paper attempting to find a mathematical expression for the work produced by one kilogram of steam; it was never published. In fact, the manuscript was not discovered until 1966. He then tackled the two fundamental questions concerning steam engines of his day: (1) whether there was an upper limit to the power of heat, and (2) whether there was a better fuel than steam capable of producing that kind of power.

In 1824 he published *Reflections on the Motive Power of Fire,* which described a theoretical "heat engine" that produced the maximum amount of work for a given amount of heat energy put into the system. Carnot abstracted what he considered to be the critical components of the steam engine into an ideal theoretical model. The so-called Carnot cycle draws energy from temperature differences between a "hot" and "cold" reservoir. Although a theoretical construct, later in the century Carnot's ideas inspired Rudolf Diesel to design an engine with a much higher temperature in the hotter of the two reservoirs, resulting in far greater efficiency.

Carnot knew from endless experimentation that in practice, his design would always lose a small amount of energy to friction, noise and vibration, among other factors. He knew that in order to approach the maximum efficiency in a heat engine, it would be necessary to minimize the accompanying heat losses that occurred from the conduction of heat between bodies of different temperatures. He also knew no real-world engine could achieve that perfect efficiency. As such, he came tantalizingly close to discovering the second law of thermodynamics.

As for the question of which substance yielded the highest amount of work, Carnot engaged in a discussion of the relative merits of air versus steam for what he termed the "working fluid," but concluded that the maximum efficiency of an ideal heat engine did not depend on the working fluid. As he noted, "The motive power of heat is independent of the agents employed to realize it; its quantity is fixed solely by the temperatures of the bodies between which it is effected, finally, the transfer of caloric." That is, the efficiency of the "Carnot engine" depends only on the temperature difference within the engine.

Reflections on the Motive Power of Fire did not attract much attention when it first appeared, only beginning to gain notice a few years after Carnot's untimely death from cholera at the age of 36, among the myriad of casualties of the epidemic that swept through Paris in 1832. Most of his belongings and writings were buried with him, as a precautionary measure to prevent the further spread of the disease.

Described by contemporaries as "sensitive and perceptive," but also "introverted" and "aloof," Carnot was at least 20 years ahead of his time. In the short term, his work did not immediately lead to more efficient steam engines, or any other practical application. His lasting contribution was to set out the physical boundaries so precisely that Rudolf Clausius and William Thomson (Lord Kelvin) would draw on his work to build the foundations of modern thermodynamics in the 1840s and 1850s.

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The Dark Matter on Earth and the Physicists Who Find it

By Alaina G. Levine

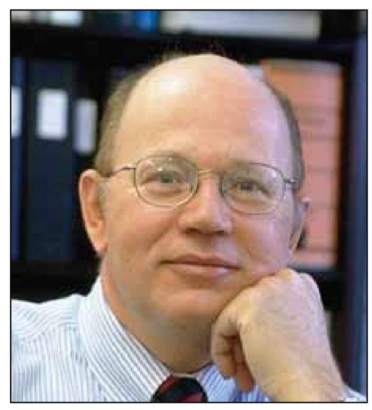
Forget high energy physics. If you really want to work on big problems in science, try a career in the oil and gas industry.

While string theorists and cosmologists struggle to understand the dark matter in outer space, there are industrial physicists who are tackling problems related to another kind of dark matter found in inner space. The oil under the Earth's crust is not easy to find, get to and extract. It doesn't sit isolated from other compounds in massive lakes, waiting for a drill to bore a hole to access it with a gigantic sucking straw. There are seemingly endless technical problems associated with locating and removing this dark matter from underground, and it presents the perfect playground for some physicists who are willing to get their hands dirty and their brains energized.

At Schlumberger, the world's leading supplier of technology, project management, and information solutions for the oil and gas (O and G) industry, physics-educated professionals have a "tremendous diversity" of career opportunities with a seemingly "infinite" number of technical problems to solve, says Schlumberger Fellow Brian Clark. The company is hired by petroleum corporations to assist with any and all aspects of oil detection, extraction, and analysis, and physicists enter the company in one of two ways: either on the Research and Development side, or as a Field Engineer.

R and D leaders work in a myriad of laboratories and engineering centers the company has scattered throughout the world. The main facility is located in Cambridge, MA, across the street from MIT. Researchers and inventors work on small teams developing potentially commercially-viable technology. The firm spends upwards of $800 million a year on research, and there are approximately 500 research projects being conducted at any given time, Clark estimates.


Allen Starkey


Brian Clark

A poster that hangs in the Sugar Land, Texas headquarters of Schlumberger describes what faces the physicist (or any other science or engineering-educated pro) who chooses the path of a field engineer: working on well sites in extreme environmental conditions–you may be 200 miles from the nearest telephone and paved road, it advertises. There is absolutely no margin for error and a sandstorm may have just knocked out your visibility. You may be assigned to work with clients in the extreme cold of the Arctic, the intense heat of the desert, or at sea. It is considered to be one of the most challenging positions in the industry, but is also one that can lead to almost any career choice within Schlumberger.

Allen Starkey started as a Field Engineer 29 years ago and now works in sales as an Account Representative in Denver. "I never get bored," he says. At Schlumberger, "you can become anything you want. You can start with physics and go into personnel, finance, sales, management,…There is unlimited career potential…(and) there is a place in Schlumberger for all types of physicists."

Clark, who has worked in R and D for the company for 20 years, agrees. He says the research that is conducted in this industry, and particularly at Schlumberger, is exciting but often misunderstood by the public. "People view it as old fashioned, (with) old technology…The images we have of the oil and gas industry are images from 100 years ago," he explains. But in fact "the industry is incredibly high tech. I think it's the most high tech industry there is because of the huge diversity of problems" in physics, math, chemistry, and geology, among other subjects. "It's just an endless number of challenging problems, and you can make tremendous progress on some of these projects …that actually have significant impacts on the way things happen in the world," Clark adds.

Clark received his bachelors in physics and math from The Ohio State University in 1970. He went to Harvard University for graduate school, and received his PhD in 1977. His thesis research with the late Frank Pipkin focused on double quantum transitions in atomic hydrogen. He began his career at Brandeis University as an instructor, but concludes "teaching is ok, but what I really wanted to do was research." When he was recruited by a headhunter to Schlumberger in 1979, "it was like walking into a candy store," he says, "with brand new buildings, sharp smart people, really great budgets for doing research, and the time to do the research."

Starkey attended the University of New Hampshire and graduated with a bachelors of arts in physics in 1978. Because of the economic climate at the time, there was very little else one could do with a physics degree than teach, he says. He worked for two years at Plymouth State College in New Hampshire and started to pursue a Masters in Education when he saw an ad in the *Boston Globe* that intrigued him. "Do you like to work outdoors? Do you like a challenge? Do you have a physics degree?" it teased. Starkey called the number on the advertisement and within weeks he had been hired as a Junior Field Engineer and assigned to East Texas. Six months later after intense training, he was promoted to Wireline Field Engineer and was running the show at his well site. (It is typical at Schlumberger that after initial training, which now takes up to 18 months, a Field Engineer will be promoted to manager of their site, effectively directing what is often a million dollar business.)

"The thing that attracted a person to Schlumberger (at that time)…was that you weren't stuck in a cubicle and told what to do," says Starkey. "You were given a truck and told 'here's a business, go get the job done and report back when it's done.' You were your own boss." And everyday was a different environment, he says. "Some days I was in the Gulf of Mexico on a barge. Some days I was in the piney woods of East Texas. Other days I was in a swamp land full of mosquitoes." But he affirms that "every day was a fun day…They worked your (butts) off, (and) that's what made it fun. You didn't know what to expect from day to day."

Starkey's physics background immediately came in handy. "You always had to think…trouble-

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Session Explores the Future of Global Physics Projects

By Nadia Ramlagan

There are currently several physics projects at various stages of development that are truly global in scale, notably the Large Hadron Collider (LHC), and the International Thermonuclear Experimental Reactor (ITER). In addition the Synchrotron-light for Experimental Science and its Applications in the Middle East (SESAME) is a major regional project. At the APS April Meeting, a panel of speakers examined the future of these international physics projects.

The panel included Pier Oddone, Director of Fermilab; Chris Llewellyn Smith, former Director of the UK's fusion program, former Director General of CERN, and now President of the SESAME Council; Lawrence Krauss, who is the Director of the Origins Initiative at Arizona State University; and Jack Gibbons, who was Assistant to the President for Science and Technology, and Director of the White House Office of Science and Technology Policy from 1993-98. FPS Officer and Fermilab scientist Pushpa Bhat chaired the session.

International collaborations have several obvious benefits: progress is clearly fastest when you can draw on the best knowledge whatever its location; sharing project costs leverages resources; and scientists with different training and backgrounds tend to generate innovative ideas and solutions. But large projects are expensive and difficult to organize, involving years of work from thousands of dedicated scientists. Accordingly, it is important to review what has been learned from past projects, sort out and resolve issues, and look for a way forward.

In the past, projects such as the BABAR collaboration at SLAC have been successful, but not at the scale of ITER or the LHC. "When you get to the next level of scale, you really have to

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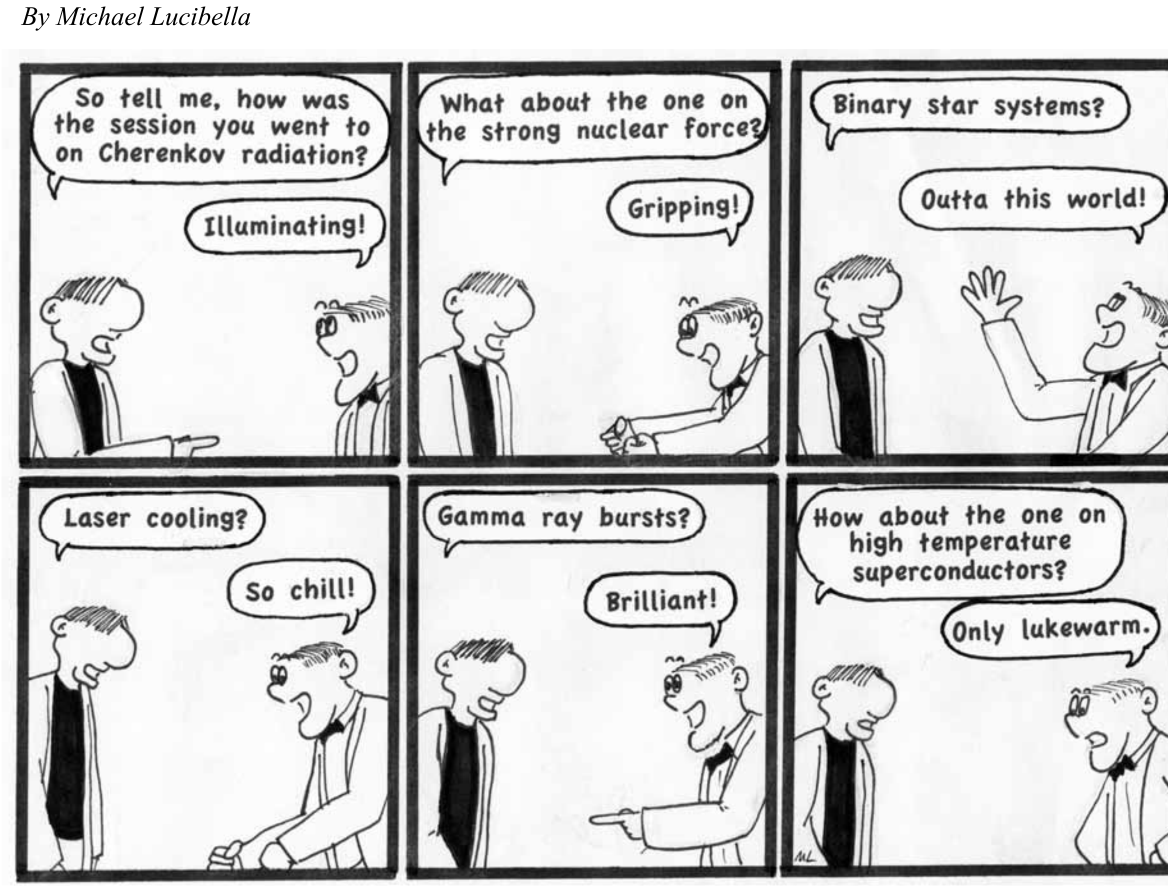
By Michael Lucibella



Letters

Back Page on Nuclear Weapons Gets it Right

I want to commend the excellent Back Page article by Raymond Jeanloz [*APS News*, April 2009] regarding the Washington home for the nuclear weapons program. Jeanloz argues persuasively against putting the program in the Department of Defense.

I spent the better part of fifty years in nuclear weapons R&D at Los Alamos and am a former leader of the program. In addition, I spent almost forty years as an advisor to the government on arms control and proliferation. In 1976 I was on the study team that recommended against putting the nuclear weapons program in the DoD for just the reasons cited in the article.

I wholeheartedly endorse professor Jeanloz's rationale and conclusions.

John C. Hopkins
Los Alamos, NM

Sunday Explosion Supports Back Page Estimate

Many (~25) years ago I participated in a series of atmospheric nuclear simulation tests that used high explosives to generate shock waves to study their effects on structures, military vehicles, etc. The most impressive test saw the assembly, at White Sands (New Mexico), of a fiberglass half sphere of 40 ft radius (80 foot diameter on the ground) which had a central ignition explosive charge and was filled with ammonium nitrate $N_2H_4O_3$ pellets (~1.7 gm/cm^3) wetted with diesel oil. This device was shot off one Sunday morning, after the Soviet spy satellites had passed. Later the test director announced that it was 20 kiloton equivalent explosion. Raymond Jeanloz's Back Page article in the April *APS News* led me to estimate the mass of $N_2H_4O_3$ to have been 5×10^6 kilograms. The Hiroshima (Little Boy, gun assembled enriched uranium, 14-18 kiloton air burst) and Nagasaki (Fat Man, internal spherical implosion of Pu, 20 KT air burst) bombs destroyed their cities. Both used about one kilogram of fissile material. Compared to the above half sphere test there is a ratio of 5 x 10^6. Ammonium nitrate has about half the energy density of TNT, while air shots see a doubling of shock wave strength due to the interaction between the reflected and incident shock waves ("Mach Y Stem"). My remembrance supports Jeanloz's 10^6 ratio between nuclear and chemical energy storages. I use my "half sphere" experience to more graphically explain the difference between the two energy densities and the dangers of even 20 kiloton nuclear bombs, which can easily be transported. All these devices are beyond considering, along with other more powerful more modern nuclear weapons.

Ralph F. Wuerker
Westlake Village, CA

Science Overlaps with Most Religions

In your February issue, you did well in presenting some comments about Faith and Physics. And yes, we might all disagree about everything when it comes to such a subject. For that very reason, it is fine to include such comments from time to time. It would be wrong to never mention their "various relationships."

Most religions are based upon an acceptance of a God, who exists within our reality, and who was involved with the creation of the earth, and placed man here upon the earth. So with some religions, there really are going to be some assumptions about certain events that are able to be addressed by science. Therefore, science really could place some religions into rankings as to how close or to how far apart each might be in terms of their "scientific acceptableness." And science should do such things!

And in turn, religions can use science to tell how well they are doing as a religion, and how well science is doing. Thus, there really are some overlaps, and we should be willing to point out those areas that support both, or do not support both.

Gerald L. O'Barr
San Diego, CA

Anything Supernatural Must be Fiction

In the April 2008 issue of *APS News*, Joseph R. Tatarczuk at Poestenkill, NY wrote "What caused the Big Bang? The standard answer is that a physicist cannot answer that question." First of all, that's not true since there are theories in physics such as eternal inflation and quantum cosmology that do answer that question. Second, even if we don't know what caused it, we know what definitely did not cause it. We know it was definitely not caused by magic. If you watch a magician perform a trick, and you have absolutely no idea how he did it, you know for certain how he did not do it. You know for certain he didn't do it using magic powers. If you read a book that does not contain magic, you might wonder whether it's fiction or nonfiction. On the other hand, if you read a book that contains magic, you would know for certain that it's fiction. It would be possible for someone to read "War and Peace" and mistake it for nonfiction. It would not be possible for someone to read "Lord of the Rings" and mistake it for nonfiction. The word "magic" is a synonym for "impossible," and the "impossible" is defined as something that can exist only within fiction. Christians say an omnipotent supernatural being with infinite magic powers deliberately made the entire infinite universe using only its most inifinite magic powers. That's the most magic thing, meaning the most impossible thing, that anyone ever made up.

The Christians say its magic, so they say it's impossible, so they admit they're talking about a work of fiction.

Jeffery Winkler
Hanford, CA

Article Makes Blinking Mistake

"This Month in Physics History" [*APS News*, March, 2009] is about Clyde Tombaugh and his discovery of Pluto. It seems that his "blink comparator"–a classical astrometric device, has grown a suffix to become a "blinking comparator," leaving some of us, indeed, blinking!

Peter D. Noerdlinger
Boulder, CO

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of the public agree that the US should move towards increased usage of alternative energy. However the same poll found that 51 percent could not identify a renewable energy source and 39 percent couldn't even identify a fossil fuel.

This is of particular concern because many predict that in the upcoming century, the greatest scientific and technical challenge will be to develop vast quantities of inexpensive and renewable energy for the world's growing population. Methods using today's cutting edge technology will need to be developed on a massive industrial scale, likely with a great deal of government support.

"If the voters are ignorant of technical matters, how can they evaluate the performance of government officials, and thus establish the legitimacy of their governance? Science must therefore, not only give wise advice to government, but must also find a way to share their understanding of the factual basis for policy choices with the public," said Lewis Branscomb, Professor of Public Policy and Corporate Management (emeritus) in Harvard's Kennedy School of Government, presenting at the Science Policy session.

Already current energy sources are beginning to feel the strain of excessive use. Recent spikes in fuel costs, and concerns over global climate change have highlighted the coming need for large quantities of alternative fuels.

Recent fuel cost spikes however may only be the tip of the iceberg in upcoming decades. Though extrapolations are always inexact at best, projections based on known global petroleum reserves and fuel consumption, predict some sort of future global energy crisis. Many analysts conclude that within the next century, global oil and natural gas reserves will be tapped out and new alternate fuels will be needed.

Working through these looming energy problems while simultaneously promoting science to the public might seem daunting, but there is also optimism about the future. Many at the meeting have seen the election of Barack Obama as a boon for the science community. In his April 27 speech to the National Academy of Sciences, President Obama said he wanted the United States to recommit itself to the pursuit of basic science. He also pledged a target of 3 percent of the country's gross domestic product be devoted to research and development.

"I'm going to participate in a public awareness and outreach campaign to encourage students to consider careers in science, mathematics, and engineering because our future depends on it," President Obama said, adding that, "We are restoring science to its rightful place…Our progress as a nation, and our values as a nation, are rooted in free and open inquiry. To undermine scientific integrity is to undermine our democracy."

Some scientists even see the potential energy crisis as an opportunity in itself. John Gibbons, who preceded Neal Lane as science advisor to President Clinton, said he saw it as the perfect platform to promote physics for the public good.

"If you're in the right place at the right time, namely an emergency, you can get a lot done," Gibbons said.

SESSION continued from page 3

ask questions. Because along with the benefits of getting a critical mass of people and money come a whole host of other issues that are actually very difficult to handle. There are few examples of successfully completed projects of the grand scale of ITER–that remains to be seen," said Oddone.

How do different nations come together to manage, fund, and generate successful projects? Do we want to have a defined model for global projects? Who are the drivers for the decision making? And provocatively, do we need an international science agency? These are pressing questions for the next decade.

There are disadvantages to international collaboration to consider: it can reduce competition, and the added complexity of decision making often proceeds sporadically, rendering the process very time consuming. Additionally, there may be tension between commercial competition and collaboration, as seen in ITER.

"We've learned a lot of lessons. The lesson of the SSC [*Superconducting Super Collider*] was if you want a collaboration to be international, it's best to start at the beginning. Don't set something up and ask others to come in later, because that's difficult. And it takes time to built up confidence between the administrators," said Llewellyn Smith.

Referring to ITER, he continued, "Another problem is that everyone wants to contribute in-kind. But if you disperse the contributions too much you risk making all sorts of problems in integration and management and it drives the cost up. People didn't understand that would happen."

All of the speakers brought up the US and its declining role as a major player in global science. Because each new Congress acts independently, long-term commitment to projects is vulnerable to the annual funding cycle, creating an impression of unreliability in the eyes of other countries.

Even in tough economic times, the US needs to work on resuming its position as the ballast of funding and involvement. "Any major international project is going to span some period of economic recession. And during that time it will be very easy to kill an international project, the SSC is one example. Science, especially esoteric science, seems an easy target," said Krauss.

In order to ensure funding for these projects, showing the public that fundamental research has an economic payoff is imperative. Without communicating the implications of international collaborations and esoteric science, support is likely to be scarce. "We haven't done our homework in going farther in pointing out the efficacy of this work to the investors, namely the taxpayers," said Gibbons.

Despite the encumbering problems that loom ahead, global projects continue to be an inspiration. "Scientific projects are a model for society, they have been remarkable in allowing countries that will not otherwise interact, to interact, and not just at a peripheral level, but at a fundamental level. The fact that the LHC can be built by thousands of physicists in hundreds of countries speaking dozens of languages, and it actually works–is remarkable," said Krauss.

Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: Science Research Budgets

The Obama Administration released its Fiscal Year (FY) 2010 Budget in early May. The numbers for the key physical science research accounts are consistent with the President's pledge to double research funding over a ten-year period beginning with FY 2006. The Administration's plans for the Department of Energy Office of Science (DOE Sci), the National Science Foundation (NSF), and the National Institutes of Standards & Technology (NIST) dovetail with the America COMPETES Act, which authorizes these agencies' budgets to be doubled in that timeframe. The President's budget request for FY 2010 contains the following:

- **NSF:** Up 8.5%, or $555M, from $6.50B in FY09 to $7.05B in FY10.
- **DOE Sci**: Up 3.9%, or $184.1M, from $4.76B in FY09 to $4.94B in FY10. The budget includes $100M for the Energy Frontier Research Centers that would support a projected 1,800 researchers and students, primarily at universities, but also at national labs, industry, and non-profits at 46 centers. The focus of the centers would be fundamental, basic science, emphasizing transformational energy research. In addition, the request includes $10 million to "stand up" ARPA-E (which received $400M in the Stimulus Package earlier in the year).
- **NIST Core:** Up 1.2%, or 7.5M, from $644M in FY09 to $651.5M in the FY10 request. The Scientific and Technical Research and Services (STRS) would rise from $472M in FY09 to $535M in FY10, an increase of 13%, while the Construction of Research Facilities (CRF) would decline from $172M in FY09 to $117M in FY10, a decrease of 32%. In fact, excluding congressionally directed projects and a construction grant during FY09, NIST Core would receive a 15% increase in FY10.
- **NASA Science:** Down 0.6% from $4.5B in FY09 to $4.48B in FY10. The devil is in the details: Earth Science would rise 1.6% to $1.35B; Planetary Science would rise 1.6% to $1.35B; Astrophysics would decline 7.1% to $1.12B; and Heliophysics would rise 2.3% to $0.61B. The Administration's out year budget plans will likely change following the review of the human spaceflight program under the chairmanship of Norman Augustine.

Both chambers of Congress are expected to consider the budget request in their respective Appropriation Committees sometime in June or early July. Barring unforeseen developments, Congress should complete the budget process on time this year, with final passage of agreed-upon bills sometime in September.

Be sure to check the APS Washington Office's webpage (http://www.aps.org/public_affairs/index.cfm) for the latest news on the FY10 Budget.

ISSUE: POPA Activities

The National Security Subcommittee has been working on their Nuclear Verification Study, which will examine verification technology for the reduction of nuclear arsenals. The Study Committee convened for their first workshop on April 21-22 in Washington, DC. A second workshop is being planned for June 30–July 1.

The Energy & Environment Subcommittee has been working on their Carbon Capture Study, which will examine non-biological CO_2 capture. The Study Committee held their first workshop on March 23-24 in Princeton, NJ and work has begun on producing a final report.

If you have suggestions for a POPA study, please visit http://www.aps.org/policy/reports/popa-reports/suggestions/index.cfm and send in your ideas.

ISSUE: Washington Office Media Update

Science magazine published a story on April 3 about a meeting sponsored by the Task Force on the Future of American Innovation that involved a discussion with House Speaker Nancy Pelosi, university presidents and association leaders. The meeting addressed the importance of science in developing solutions to US challenges, such as energy security. APS is a founding member of the Innovation Task Force.

Log on to the APS Public Affairs website (http://www.aps.org/public_affairs) for more information.

Historic Meeting

Photo courtesy of George Zimmerman

The Executive Committees of several APS units meet in conjunction with the APS April Meeting. Among them is the Forum on the History of Physics, whose Executive Committee convened in Denver on May 4. In attendance was APS Treasurer Emeritus Harry Lustig, a former member of the committee. Shown, l to r, are: Roger Stuewer, George Zimmerman, Bob Arns, Harry Lustig, Gloria Lubkin (committee Chair), David Cassidy, Dan Kleppner, and Tom Miller.

Speakers Reflect on Telescopes Old and New

By Calla Cofield

Richard Ellis rang in the 2009 APS April Meeting with his keynote address "The Quest for Giant Telescopes: Four Centuries of Challenge & Scientific Discovery." Ellis, a professor at Caltech, took more than 300 audience members down a winding historical path, from the continuing challenge to mold larger and larger mirrors, through the development of CCDs and the push to stretch telescopes beyond the optical range. Other speakers at the meeting filled out Ellis's talk with their own reports on current and future telescopic endeavors.

Peter Michelson of Stanford University announced new results from the Fermi Gamma Ray Telescope, which hit online news sources shortly after his plenary talk on Saturday. Fermi has successfully collected counts of electrons and positrons with energies above 100 GeV, similar to data collected by the PAMELA satellite observatory. The particles could be emanating from nearby pulsars, or they might be signatures of dark matter. The telescope awaits data to analyze photons in this energy range, information they hope will clarify the source of the particles.

April Meeting attendees were invited to comment on and ask questions about the upcoming Joint Dark Energy Mission, JDEM, at a town hall meeting Sunday night. The JDEM satellite mission planned by NASA and the U.S Department of Energy hopes to study the nature of the accelerating universe.

"Dark energy is the mystery of our time," said Neil Gehrels of NASA Goddard who spoke on the current state of JDEM. "I think the time is right for JDEM for a number of reasons…New technology, large format detectors are now available. There really should be a mission to fly these and do a wide-field spectroscopic survey of the sky."

Mike Salamon of NASA and Kathy Turner of DOE spoke about their agencies' dedication to a cooperative, cost-effective mission, with Salamon noting that cost constraints are "a very serious issue," for JDEM.

Alexandre Refregier from the French institute CEA Saclay spoke about EUCLID, an equivalent dark energy mission that the European Space Agency is planning. When asked if the US and European projects had any intention of joining forces, representatives said they certainly intended to have the projects work cooperatively, and they couldn't rule out the possibility of a combined mission.

The future of JDEM may partially depend on Astro2010, the decadal survey by the National Research Council (NRC) of the National Academy of Sciences. With input from members of the scientific community, Astro2010 will survey the fields of space- and ground-based astronomy and astrophysics, and prioritize the most important scientific and technical activities for 2010-2020. The survey's target audiences are funding agencies and policy makers.

Ellis concluded the keynote talk by noting a curious pattern in telescope history: "[Astronomers] always do better than they say they're going to do," he said, stirring up laughter from the audience. He noted, for example, that few of the largest discoveries made by the Keck telescope were projected in the planning stages in 1985. He added, "Research changes so rapidly, it's inevitable that we do things differently than we predict."

With that in mind, it may be impossible to imagine what new results will appear at next year's meeting!.

KIRBY continued from page 1

Research Physicist at the Smithsonian Astrophysical Observatory and Lecturer in the Harvard University Department of Astronomy (1973-1986 and 2003-present). She also is a Senior Research Fellow of the Harvard College Observatory. From 1988 to 2001, she served as an Associate Director at the Harvard-Smithsonian Center for Astrophysics, heading the Atomic and Molecular Physics Division. In 2001, she was appointed Director of the National Science Foundation-funded Harvard-Smithsonian Institute for Theoretical Atomic, Molecular and Optical Physics (ITAMP).

Her research interests lie in theoretical atomic and molecular physics, particularly the calculation of atomic and molecular processes important in astrophysics and atmospheric physics. In 1990, she was elected to Fellowship in the APS.

"Kate Kirby will bring visionary leadership and commitment to the APS," said APS president Cherry Murray. "We are thrilled at her appointment. She is a distinguished physicist who deeply understands the missions and operations of APS. With the scientific taste, eloquence, and diplomatic skill she has demonstrated in her career, she will be an exceptional advocate for all of physics. We are also extremely grateful for the extraordinary leadership that Judy Franz has provided over the last 15 years."

Kirby has both chaired and served on numerous APS committees, including the Fellowship Committee (1993-95), the Nominating Committee (1994-96), the APS Ethics Task Force (2002-2003), the Committee on Prizes and Awards (2005-2006), and the Search Committee for APS Leadership Positions (2005-06). She was elected APS Councilor-at-Large (1991-93) and Divisional Councilor for the Division of Atomic, Molecular and Optical Physics (DAMOP) (2003-07) and elected to the APS Executive Board (2005-06). In addition, she has served as Vice-Chair, Chair-Elect, and Chair of DAMOP (1995-98).

Among her other activities are service on the Department of Energy Basic Energy Sciences Advisory Committee (2003-2008) and being co-chair of the BESAC Subcommittee on Theory and Computation. She has been a member of the National Academy of Sciences/National Research Council Decadal Assessment Committee for Atomic, Molecular and Optical (AMO) Science (AMO2010), and Chair of the International Conference on Photonic, Electronic, and Atomic Collisions (2001-2003).

Kirby said she is elated about beginning her tenure at APS.

"Having served the Society for well over two decades as a volunteer on a number of committees, the Council and Executive Board, I am excited to be joining the APS leadership team," she said. "I look forward to working with APS staff and the membership to advocate for physics in the public arena and to serve the community of physicists throughout the US and the world."

Bad Astronomer, Good Public Lecture

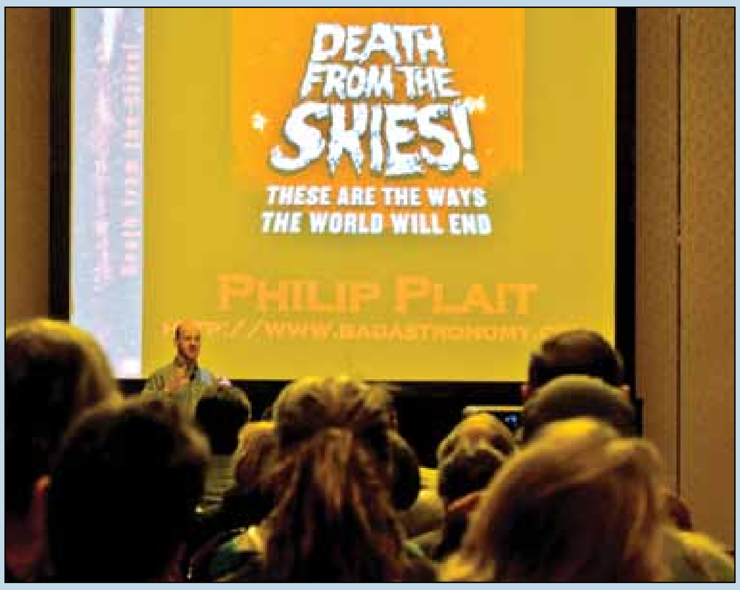

Photo by Brian Mosley

On the evening of May 4 at the APS April Meeting in Denver, noted blogger and author Philip Plait (aka the Bad Astronomer) gave a public lecture about asteroids, what would happen if one hit Earth, and how to prevent it. The talk, based on his latest book "Death from the Skies", was attended by an audience of several hundred and was followed by a book signing.

Pulsars Proposed as Direct Gravity Wave Detectors

The direct detection of gravitational waves is the holy grail of modern day experimental relativity. Massive detectors both on the ground and in orbit are currently being built for this purpose. Projects such as LIGO and LISA are tremendous undertakings, costing hundreds of millions of dollars apiece. Now however, members of a small international team of physicists with no central facility and operating on a budget of only $8 million over the next decade have thrown their hats into the ring as serious contenders to be the first to directly observe gravitational waves.

When a massive object like a black hole accelerates, distortions in space-time can propagate out like a wave traveling at the speed of light. This warping of space-time manifests itself as the brief expansion and contraction of distances. On a terrestrial scale, these expansions and contractions are so tiny, they are nearly impossible to observe. However the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) expects that the tremendous distances that separate interstellar

objects will amplify these otherwise tiny distortions.

The minute distortions of spacetime first predicted by Einstein in 1916 have so far eluded observation from even the most sensitive detectors. In 1993, Russell Hulse and Joe Taylor were awarded the Nobel Prize in physics after detailed observations of the binary star system PSR 1913+16 showed a loss of orbital energy at exactly the rate predicted by Einstein's equations. However the direct observations of the associated waves have remained elusive.

NANOGrav's novel method won't require any costly new facilities, only the careful observation of known phenomena. They'll scan the skies using radio telescopes to look for any slight irregularity in the uniform beat of pulsars. The radio waves emitted from a pulsar's poles can be easily detected on Earth as they sweep by as an even rhythm of pulses, making them some of the most accurate clocks in the universe.

It's this near perfect regularity that makes them the ideal beacon to hunt for gravitational waves. Some of the most efficient pulsars are as accurate as atomic clocks, losing only a fraction of a second over thousands of years.

Gravitational waves emitted from a source will cause a momentary expansion and contraction of the space between the observed pulsar and the Earth, This will produce a brief change in the apparent frequency of the pulsar, the signal that the NANOGrav team will be looking for.

Andrea Lommen, chair of the NANOGrav group, said that they've been testing their method on simulated data, "In the near future we'll run our code on real pulsar data to see what limits we can place on existing sources," she said.

The NANOGrav team has already been collecting information on known pulsars since August of 2007. They have identified about 30 suitable pulsars out of a total 1,500 known throughout the universe. These tend to be "recycled pulsars," which have absorbed their stellar binary partners. They spin extremely fast and are old enough to have settled down to a smooth rotation with few glitches and little extraneous noise.

After writing the programs for collecting and analyzing the data is completed, the team hopes to move on to observations with existing powerful telescopes such as the Arecibo Telescope in Puerto Rico. As larger and more powerful radio telescopes are built, such as Allen Telescope Array and the proposed Square Kilometer Array, the NANOGrav

PULSARS continued on page 7

INTERNATIONAL News

...from the APS Office of International Affairs

Physics in India – complex problems and a story of great strides

By Surajit Sen

Indian scholars have been contributors in mathematics, astronomy, and in certain areas of the physical and biological sciences from ancient times. For complex historical reasons, as J.V. Narlikar mentions in *The Scientific Edge*, Indian science suffered significantly in the period beyond 12th century A.D. Nevertheless, the nation has seen physicists such as Bhabha, Bose, Chandrasekhar, Raman, Saha, Sarabhai, and many distinguished others. Their academic journey is tied to India's deep and time-tested commitment to physics education and research during the difficult years of struggle for independence from Britain. Now, nearly 52 years after independence, India is the world's largest democracy with 28 percent of its 1.1 billion people living in the densely populated urban areas of Mumbai, Kolkata, Delhi, Chennai, Bengaluru (formerly Bangalore), Hyderabad and some 30 other cities with over a million population. India's per capita income is low, about $1,000 per year with 25 percent of the population below the poverty line, but it boasts a fast-growing economy with steady and near double digit growth rate of the GDP. The country has enormous challenges and incredible opportunities in science education and research. The physics scene mirrors the national mood.

School level science education in the urban slums and in the rural areas of the 28 states, 6 union territories and Delhi involves some 200 million children of ages between 6 and 14. Only about 20% of them achieve acceptable 5th grade level competence. There is an acute paucity of schools and teachers. Education beyond the middle school is often not economically viable. Numerous non-governmental organizations have been involved in addressing these problems. Though the challenges of making such a large population scientifically literate are very formidable, the last 30 years have seen tremendous achievements in science education in rural India due to the pioneering efforts of theoretical physicist Vinod Raina, former Bell Labs scientist Sujit Sinha, and many others.

The 10 million students in India's colleges and universities constitute a mere 12 percent of the student generation. About 42 percent of this student body comprises of women. With some 18,000 institutions that include colleges, universities, and institutes, India has the largest number of academic institutions in the world. However, India does not have the largest student enrollment. The established university system is stretched thin and often unable to provide incentives to support faculty research. Thanks to the attraction of high-paying start-up jobs in the IT and other sectors, there has also been a steady decline in the number of young entrants into the basic sciences. While India struggles with issues of equity, access and quality at all levels of science education, the investment in school, college and university levels in teaching and research seems to be on an upswing. The openly available *National Knowledge Commission* report released on May 28, 2008 acknowledges India's problems and challenges and suggests that appropriate investments, bodies, policies and processes be sequentially introduced to attract and retain talented students in basic sciences. As we shall see below, these investments are already being made.

There are world-class programs for advanced graduate work in physics in research institutes such as the Tata Institute of Fundamental Research (TIFR) in Mumbai, Indian Institute of Science (IISc) and Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) both in Bengaluru, S.N. Bose National Centre for Basic Sciences and the Indian Association for the Cultivation of Science, both in Kolkata, and the Institute of Physics at Bhubaneshwar. The Indian Institutes of Technology at Delhi, Kanpur, Kharagpur, Roorkee, Guwahati and Mumbai are highly competitive institutions for undergraduate, graduate and doctoral studies. There are substantial funds for carrying out research. In some cases these funds can be of a magnitude comparable to that in many of the wealthy nations. Faculty and students at these elite institutions have the intellectual capability and the institutional commitment needed to carry out research that is cutting edge by any standards. Physics is a beneficiary of the government's aggressive investment initiatives in basic research.

Another realization of the new initiative to re-energize India's academic enterprise has been the recent establishment of the Indian Institute of Science Education and Research (IISER) with planned campuses in Pune, Kolkata, Chandigarh, Trivandrum, and Bhopal and the founding of the National Institute of Science Education and Research (NISER) in Bhubaneshwar. These institutions, some already operational, are following an American model of a university but the focus is on undergraduate and graduate teaching and research in the sciences. The budget per institution exceeds some $80 million per institution per year. The existing university systems are being reformed and the low faculty salaries are being scaled up to make academic life rewarding. University Grants Commission (UGC) affiliated universities such as the Jawaharlal Nehru University in Delhi, Banaras Hindu University in Banaras, University of Hyderabad in Hyderabad are among some of those to become the early beneficiaries of these dramatic changes. The state universities are expected to follow the lead. In short, the opportunities to pursue cutting edge research in physics in India have never been better.

A view of the TIFR campus in Mumbai, located near the Arabian Sea.

Compared to many wealthy nations, women are reasonably well represented in academia, though it has been difficult for women to garner recognition that is commensurate with their accomplishments. Steps are being taken to address these disparities. The infrastructure is improving rapidly and there is a significant need for faculty to take up positions in Indian institutions. In addition, India has premier national laboratories in Delhi, Pune, Jamshedpur, New Delhi, Pilani and Hyderabad. These laboratories are overseen by the Council of Scientific and Industrial Research (CSIR) and complement the Bhabha Atomic Research Centre in Mumbai and the Raja Ramanna Centre for Advanced Technology in Pune, both run by the Department of Atomic Energy (DAE).

The National Knowledge Commission recommends that instead of the current 350 universities, India needs some 1500 universities. But such an enormous expansion can only happen over an extended time. There is also a suggestion that sufficiently distinguished foreign universities may be allowed to have some level of operation in India.

US physics has had long standing and significant ties with India:

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the National Science Foundation (US), the Department of Science and Technology (India), and an independent non-government body called the Indo-US Science and Technology Forum support the institutional links. The Forum is jointly nurtured by the Department of Science and Technology and the U.S. Department of State. The Indo-US strategic partnership includes areas such as energy issues, information and communication technologies, disaster response initiatives, space cooperation, agriculture alliance, and HIV/AIDS issues. The Forum strives to grow catalytic activities, foster collaborations with industry, academia and government in the two nations by funding symposia, workshops and conferences in the frontier areas of sciences and engineering, by supporting visiting researchers, organizing training programs, and providing travel-based support. In collaboration with the Forum, APS has launched a new Travel Grant program to enable both faculty researchers and students from India to perform collaborative research and teaching in the US and vice versa. This new program is expected to help initiate long lasting collaborations between the physics communities in the two nations at a time when both nations can benefit from such partnership in basic research, technology development, and in the global effort to meet the challenges associated with preserving the environment, combating global warming, and in energy research.

Surajit Sen is a professor of physics at the State University of New York at Buffalo and the current president of the American Chapter of the Indian Physics Association.

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team expects to greatly expand their catalogue of suitable pulsars for their research.

"If we increase our sensitivity, which is what we'll be doing in the next five to ten years, we will begin to detect super massive black hole binaries," Lommen said, adding that this time frame puts the NANOGrav team "in the running" to be the first to directly detect gravitational waves.

"I guess you could call it competition, but it's definitely very healthy," Lommen said, "Our time scale is similar to that of LIGO, we both expect detection within a decade. I expect we will detect sources before LISA does."

The ground-based Laser Interferometer Gravitational-Wave Observatory (LIGO), which will measure the expansion and contraction along the lengths of two sets of four-kilometer long tunnels in Washington and Louisiana, should come fully online sometime in 2014. The Laser Interferometer Space Antenna (LISA), three satellites which will measure similar spatial distortions while trailing Earth's orbit, won't launch until 2018 at the earliest.

Right now the NANOGrav team is continuing to refine their computer program using simulated data. As algorithms are improved, finer and finer variations in pulsar timing will become apparent. The more random background noise they can filter out, the clearer signal they should be able to pick up.

"Gravitational waves will be detected within the next decade. The discovery will absolutely revolutionize astronomy and physics and I'm tremendously excited that I get to be a part of that," Lommen said.

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limit on increasingly discrete devices. At a press conference at the meeting, scientists from Los Alamos National Laboratory and the National Institute for Standards and Technology, NIST, discussed the microcalorimeter: a new device about the size of a quarter, intended for astronomical applications but with potential uses in radioactive materials detection. Cooled to just above absolute zero, the lack of thermal noise gives the microcalorimeters the highest resolution of alpha particles of any detector available.

Current detector technologies cannot discern between radon and uranium, for example, two elements with very similar alpha particle signatures. This causes a significant number of false alarms at border checkpoints since radioactive radon is usually legal to transport, but uranium sends up a red flag for its weapons applications. But the microcalorimeter can determine the difference between these two elements with no ambiguity, and even distinguish between isotopes of the same element, like plutonium.

It could still be three to five years before the devices are available for such applications, and because they are superconducting and need to be cooled with liquid helium, hand-held versions are unlikely. Ullom says lower-resolution detectors could be used to scan samples, and if they read radioactive, then the sample would be subject to search by a microcalorimeter.

Besides technology, physicists have information that can benefit national security. Physicist Richard Muller had information he felt was pertinent to national security, and wanted to make sure it got to the right people. So, he titled his book *Physics for Future Presidents*. (He hears that Michelle Obama did receive a copy to give to the President.)

Muller has taught a class at Berkeley by the same name for ten years and delivered an excerpt from it at the April Meeting titled, "A Physicists Evaluates the Terrorist Threat." Muller shares with students the energy content of an atomic bomb, a stick of dynamite, a tank of airplane fuel, and a batch of chocolate chip cookies. The point is to illustrate the most efficient and inefficient ways to cause destruction, and why heat, not an explosion, brought down the twin towers on 9/11.

Muller's non-partisan course is intended for non-physics majors (although he challenges undergraduate physics students to pass his exams), and prepares students to discuss physics in a public forum. Muller is now publishing a course guide so teachers can adopt his class format.

Besides technology and information, what else can physics provide to national intelligence? Porter argues it's their way of thinking: their methodologies and their moxie.

Porter and IARPA are currently focused on cyber security as the field that needs their attention both because of our increasing dependence on the cyber world, and a lack of structure in the study of cyber security.

"As physicists we like to model things and predict behavior," says Porter. "You don't get that a lot in the [cyber security] community."

Cyber security experts currently have no way to quantitatively evaluate how secure any one system is, or even determine which of two systems is more secure. Porter hopes that physicists' ways of thinking, of modeling, of asking questions, of organizing and testing will be the key to building a systematic approach to predicting and overcoming cyber vulnerabilities that loom on the horizon.

"Is there a science of cyber security that we could try to develop?" asks Porter. "It certainly seems worth asking the question. If it turns out we can't do it, then along the way we probably will have learned quite a bit." She ended her talk to a roar of applause, and pointed her audience to the IARPA website, where they accept open solicitations.

ANNOUNCEMENT

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Random matrices and chaos in nuclear physics: Nuclear structure

H.A. Weidenmüller and G.E. Mitchell

Predicting the long-term behavior of any chaotic system is impossible, simply because it is impossible to know the initial conditions with sufficient precision. Manifestations of classical chaos in quantum systems are dealt within a subfield known as quantum chaos. Its origins are rooted in nuclear physics theory–specifically in the random-matrix theory that was developed in the 1950s and 1960s, initially by Nobel Prize winner Eugene Wigner, to explain statistical properties of the compound nucleus in the regime of neutron resonances. Today, random matrix theory is the basic tool of the interdisciplinary field of quantum chaos, and the atomic nucleus is still a prime laboratory of chaotic phenomena. This article reviews the applicability of random-matrix theory to nuclear spectra. It is concluded that chaos is a generic property of nuclear spectra, except for the low-energy region.

MATTER continued from page 3

shoot, use your intuition," he recalls. "Something broke everyday and you had to figure it out, and having a science background really helped." The specific value he derived from studying physics was related to problem solving and logical analysis. "The way that physics helped was (with) the ability to think through a problem," he says. "That type of scientific method was very applicable to Schlumberger."

Clark says his PhD work aided him greatly in his career. "When I was a graduate student, I had a lot of leeway to do my thesis," he explains. "I spent two years in the machine shop by myself designing and building equipment, so I got a feeling for designing things, how to integrate microwaves and atomic beams and vacuum systems and electronics...I got to do all aspects of experimental design." That was a really good experience, he says, because he was responsible for everything, so he got to learn everything.

"What we do at Schlumberger is basically build stuff that we stick down a hole and it makes a lot of scientific measurements," Clark continues. "You have to deal with the electronic and mechanical design, physics of the measurement, software, and data interpretation. It's actually surprisingly closely related to…small scale atomic physics experiments" like those he did in graduate school, he says.

Although Clark has done stints in management and engineering during his tenure, today he serves as one of only 10 Fellows in the company. "I had pretty heavy management responsibilities for a time," he concedes. "Going back to being a full time scientist and inventor is much more fun than spending your day dealing with personnel, legal, (and) financial" issues. He has the freedom to investigate all sorts of novel technologies, and he meets with the CEO and the other Fellows regularly to discuss company-wide initiatives and issues, as well as larger concerns such as global energy.

In 1996, Clark was recognized with an award from the Society of Petroleum Engineers for an oil formation evaluation tool he invented that ushered in a new type of well exploration. His device used electromagnetic spectroscopy to measure the resistivity of petroleum formations while a hole was being drilled. The tool "could make the measurement in minutes (instead of days) after the bit had penetrated into the formation," says Clark, and do so in undisturbed zones of the formation without causing much damage to the formation or the drill bit. This innovation enabled the exploration of horizontal wells which allowed for improved and increased extraction of oil from underground sources.

Oil tends to be in tiny layers and because of pressure changes, when you drill vertically you eventually start sucking water out rather than oil, explains Clark. "But when you drill horizontally and stay within the oil zone and go for a mile, you can draw a mile's worth of oil out. It's a much more efficient process. It's one of the two things that has revolutionized the whole oil…and natural gas business," he says.

Starkey's career has also enabled him to innovate. In addition to sales, he has worked in operations, marketing, and internal auditing. While conducting operational audits, Starkey traveled to many corners of the globe to analyze Schlumberger's actions. He designed an automated computer inventory system and helped sell one of Schlumberger's subsidiaries. He was the first Field Engineer to do any of these things–prior to this, only MBAs and CPAs served in these capacities.

He has moved 15 times and has lived in Australia, Saudi Arabia, California, Louisiana, and Texas. A recent assignment in Dubai involved sales and support to national oil companies throughout the Middle East. Today, Starkey assists clients with the directional drilling technologies offered by Schlumberger, including the horizontal drilling enabled by Clark's research. He is consistently the top-producing revenue generator in his division and is recognized in the Denver area as being the "go-to guy to solve problems…not just a peddler of services," he says. Starkey's physics education helps him to better explain the technology, such as tools that use gamma rays to take measurements, to curious clients.

The career forecast for physicists in O and G is positive. Even with the world's energy needs changing rapidly, there will always be a need for petroleum companies and scientists whose expertise lies in this industry, says Clark. "Oil moves everything in the world," he continues. "If we stopped producing oil and gas today, half the people in the world would die."

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The Back Page

Evaluating Science or Evaluating Gender?

By Anne E. Lincoln, Stephanie Pincus, and Vanessa Schick

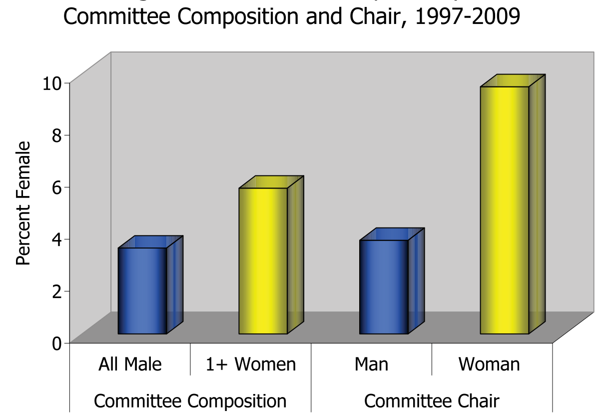
Impartiality is the cornerstone of scientific inquiry. As scientists, we base our entire system of knowledge collection and evaluation on the standard of universalism, the expectation that scientific claims and contributions are evaluated independently from the personal attributes of scientists. Yet it has also long been recognized that science is stratified, with research facilities and rewards unequally distributed among scientists. What sociologist Robert Merton termed the "Matthew effect" in science, the notion that prominent scientists often receive more credit than less well known scientists doing similar work, finds that advantages among scientists accumulate to bring resources necessary for future achievement to those persons who have already achieved.

Awards and prizes are critical in shaping the trajectories of scientific careers. Yet, men win more science awards than their representation in science careers would otherwise predict (see The RAISE Project, raiseproject.org). Recognizing the importance of the acknowledgment of one's peers to scientists' careers, in 2006 the National Academies called for more women scientists to be nominated for awards and leadership positions. While it is plausible that part of the explanation for the gender disparity in award receipt lies in the nomination process, can it be said that men do research that is inherently more important than women's research? Or might some sort of Matthew effect for gender intervene with the dispassionate evaluation of scientific achievement?

In fact, a large body of evidence suggests that social factors do influence the review and valuation of women's efforts differently from those of men. Indeed, social scientists find that when men and women of the same abilities and characteristics are compared, evaluators of both sexes tend to evaluate men more favorably than women or hold women to a higher standard.

The notion that gender influences the evaluation of scholarly work was highlighted in a recent study of manuscript acceptance rates at the journal *Behavioral Ecology.* In 2001, this journal switched from a single-blind manuscript review process, in which reviewers knew the names of manuscript authors, to a double-blind process, providing a natural experiment to test the veracity of the universalism standard. Researchers Budden and colleagues found that the manuscript acceptance rates of articles first-authored by women increased by 7.9 percent after the editorial procedural changes, which they attributed to the change in review policies. What explains these findings? Social psychologists put forward the similarity-attraction thesis–that people are most comfortable with others who are similar to them, particularly in terms of race and gender. Birds of a feather may indeed flock together.

Figure 1: APS Award Recipients by Committee Composition and Chair, 1997-2009



The American Physical Society provides an ideal circumstance to examine the evaluation of scientific work because APS keeps a record of the selection committee members for each prize. APS first began recording the selection committee members consistently for its awards in 1997. Between 1997 and 2009, APS reported selection committees for 42 different prizes given to 464 individuals, excluding student awards and awards that only women can receive (e.g. the Maria Goeppert Mayer Award). Selection committees averaged 5 members and 88 percent male. Exactly half of the committees (232) were comprised solely of men; the next most common arrangement was for one woman to be part of a five-person committee, which occurred about 36 percent of the time. All but 12 of the selection committees listed a chairperson; men chaired 86 percent of the committees.

During this period, men won 96 percent of the APS awards given to practicing physicists. That is, women won 20 of the 464 prizes bestowed during this period. On its face, this is not a particularly surprising finding, given that physics is a male-dominated discipline, but the figure still seems a bit low. (For comparison, the 2000 Census reported that men comprised 86 percent of astronomers and physicists; as of 2006, women comprised 13 percent of physics faculty in the United States and 6 percent of full professors). Given what we know about the relevance of gender in groups, does the gender composition of the committee have any relationship to the gender of the winner?

In short, yes. Logistic regression analysis, which calculates the probability of an event occurring, finds that the likelihood of a woman winning a physics award nearly doubles with the presence of each woman on the committee. So, should committees simply add women to ensure that women receive consideration for their achievements? Surprisingly, the answer is no.

Taking the analysis a step further, it turns out that committee chairs are highly important to the evaluation process. Women are 65 percent less likely than men to win an award if the selection committee chair is a man, regardless of the number of women on the committee. Indeed, women won an award 3.6% of the time from a male-chaired committee, but nearly three times as frequently under a female-chaired committee (9.5% of the time), a statistically significant difference (Figure 1).

Put another way, men are nearly three times more likely to win a prize from a male-chaired committee than from a committee with a female chair. The opposite is also true–a woman's chance of winning nearly triples under a woman chair. We should note that women winners and committee chairs are not concentrated in a few awards, so the disparity is not a matter of women and men specializing in different types of physics.

When we consider these findings, we must note that of the 63 committees they chaired, women chairs conferred awards to 57 men. Thus, while women chairs are more likely to reward women with a physics prize than are men chairs, men still dominate 9 to 1 as prizewinners from women-headed committees. In other words, although committees chaired by women tend to be "more impartial," all committees tend to disproportionately confer awards to men.

With all research, there are limitations. While members of the selection committee are prohibited from making nominations, we do not know whether more women are nominated for awards when committees are headed by a woman (and vice versa for men). Since we do not know the relative proportion of men and women who were actually nominated, how certain can we be of the finding that committee chair gender predicts the gender of the prizewinner? One strength of this conclusion is that nominations remain active for three consecutive award cycles (typically annual or bi-annual) and selection committees regularly change members, so nominees who do not win one year will continue to be considered for the same award by a different committee in two subsequent award cycles. By implication, this suggests that gender of the committee chair does indeed influence the award review process.

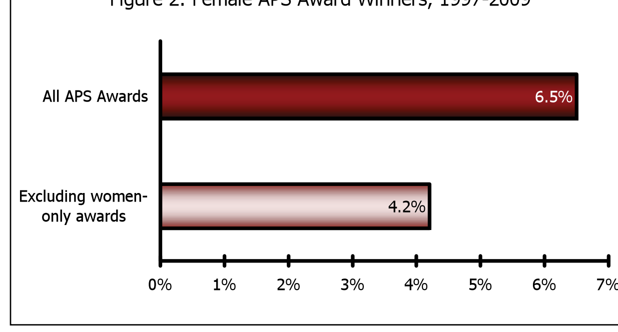
APS is one of the few societies with such a transparent award process, so we are precluded from making firm comparisons with the award committee process of similar organizations. However, data collected through the RAISE Project permits comparison of the gender distribution of award recipients across societies. Comparing the percentage of female award recipients to the current National Science Foundation data on the percentage of women employed in physics, we found that the percentage of women receiving awards is half of the percentage of women within the field, a figure that is consistent with similar societies, such as the American Physiological Society, the American Association for Cancer Research, and the American Association for the Advancement of Science. This suggests that their award process may function similarly to APS. Thus, it is possible that the same phenomena may be present across various organizations.

We do not have a decisive answer for why the gender of a committee chair is so strongly predictive of the gender of the winners. Given that physics is a male-dominated discipline, we could conjecture that when a woman is a committee chair, her gender is made more salient to the other committee members, who become more amenable to voting for a woman. But if this were the case, why then does the gender of the committee chair–male or female–nullify the positive effect of the presence of other women on the committee? If committee chairs make the final decision, it may be that committee chairs simply do prefer persons of their own gender, but if the vote is based on consensus, committee chairs serve as a symbolic stand-in for the appropriate type of winner.

How can professional societies increase impartiality? There is no "one size fits all" answer. While some research finds that increasing the size of review committees leads to a more diverse slate of winners, our study finds this not to be true for APS awards. Ultimately, blind review remains the gold standard for reducing biases.

Far from being gender-blind, the present nomination process for APS prizes has 20/20 vision. Selection committees rely upon at least two nominating letters describing the nominee's qualifications relevant to the award, the specific scientific work to be evaluated, and a list of the most important publications. In a tight-knit community like physics, knowledge of this body of work may not make it possible to completely blind the review process. However, a first step that selection committees might take would be to require a separate statement summarizing the specific research to be evaluated, devoid of reference to the author. This statement could be read first and then ranked by the committee before any supportive materials were considered. Both nomination and committee evaluation processes could benefit from scrutiny for ways to increase impartiality.

Figure 2: Female APS Award Winners, 1997-2009



A closing thought: The proliferation of women-only awards in many disciplines, like the well-intentioned Maria Goeppert Mayer award in physics, may have the unintended effect of camouflaging women's otherwise low receipt of awards (Figure 2). By only recognizing women, such awards may not only contribute to the impression that nomination and review processes are unbiased, but also create a sort of "ghetto" for female scientists, whose work is not seen as equivalent to men's achievements. Gender-blind (and indeed, race-blind) review will ensure that birds of any feather truly have the opportunity to flock together. Science will be the better for it.

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APS News welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org