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Apker Award Finalists

Photo Credit: Jessica Clark

The Apker Award is given annually to two students for outstanding research as an undergraduate. One award is for a student at an institution granting a PhD degree; the other goes to a student at an institution that does not grant a PhD. The recipients are chosen from six finalists, three in each category, who assemble in Washington in September for a day of interviews with the selection committee. Shown here after the long day of interviews had ended are (l to r): Matt Landreman (Swarthmore); Jeffrey Moffitt (College of Wooster); Taylor Hughes (U. of Florida); Nathaniel Stern (Harvey Mudd College); Peter Onyisi (U. of Chicago); Beth Reid (Virginia Tech). The two recipients will be announced in next month's APS News.

APS Members Choose Bahcall as New Vice President in 2003 Election

APS members have chosen John Bahcall, professor of natural sciences at the Institute for Advanced Study in Princeton, as the next APS vice president in the 2003 general election. He will assume office on January 1, 2004, becoming president elect in 2005 and APS president in 2006. The APS president for 2004 will be Helen Quinn (SLAC).

In other election results, Philip Bucksbaum of the University of Michigan was chosen as chair-elect of the APS Nominating Committee. Evelyn Hu (University of California, Santa Barbara) and Arthur Ramirez (Bell Labs) were elected as general councillors, and Sukekatsu Ushioda of Tohoku University in Sendai, Japan, was elected as international councillor.

John Bahcall

Bahcall has been with the Institute of Advanced Study since 1971, having previously been on the physics faculty of the California Institute of Technology. He received his BS from the University of California, Berkeley, his MS from the University of Chicago, and his PhD from Harvard University in 1961, all in physics. In 1964 he and Raymond Davis, Jr. proposed that neutrinos from the sun could be detected with a practical chlorine detector. In the subsequent four decades, Bahcall has refined theoretical predictions and interpretations of solar neutrino experiments.

Bahcall's other areas of expertise include weak interaction theory, models of the galaxy, atomic and nuclear physics applied to astronomical systems, stellar evolution, and quasar emissions. Most recently he has worked on ultra high energy cosmic rays and the time dependence of the fine structure constant. He received the National Medal of Science in 1998 for his theoretical work on solar neutrinos and for his role in the development of the Hubble Space Telescope. He is a past recipient of the Dannie Heineman Prize and the APS Hans Bethe Prize.

In his candidate's statement, Bahcall recalled attending his very

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Physics Departments Endorse Statement on Education of Teachers

By Susan Ginsberg

Approximately 250 US physics departments have endorsed a joint APS/AIP/AAPT statement that calls for the active involvement of physics departments in improving the science education of future K-12 teachers.

The executive officers of APS, AIP and AAPT sent a letter to physics department chairs last spring and again this fall to ask for endorsement of the statement, first issued in 1999. The response has been much stronger than expected.

APS, AIP and AAPT plan to post the list of endorsing institutions on their websites and send the list to the NSF. "This has been an amazing outpouring of support," says Judy Franz, Executive Officer of APS. "It's easy to sign a statement saying that K-12 preservice education is important; it's quite another for a physics department to get behind a statement saying that the department itself accepts direct responsibility to make the change."

As *APS News* goes to press, two hundred and forty physics departments, ranging alphabetically from Albertson College of Idaho to Youngstown State University, have endorsed the 1999 statement. "This sort of activity is a natural outgrowth of what we're already doing in my department," says Jon Bagger, Chair of the Department of Physics and Astronomy at Johns Hopkins University in Baltimore. "In addition to major efforts through QuarkNet, the Sloan Digital Sky Survey and the FUSE Satellite, many of our individual faculty members make outreach a part of their work." Bagger believes that the location of his school has in large part prompted their efforts, " Johns Hopkins is located in the middle of a tremendously underserved community, and it's our responsibility to find ways to

See **ENDORSE** *on page 7*

Use of Shock Waves in Medicine Among Highlights of 2003 SCCM Conference

The APS Topical Group on Shock Compression of Condensed Matter held its biennial conference in Portland, Oregon, from July 20-25. Topics included the targeting and destruction of cancer cells, needle-free drug delivery, making solid hydrogen, progress toward fusion, and watching the instantaneous freezing of water. Among the plenary speakers was this year's recipient of the Shock Compression Science Award, Jim Asay (Washington State University), who spoke about how shock waves can be tailored for investigation of specific properties of materials under extreme compression, such as occurs in meteor impact, the interior of large planets, or in large explosions.

Shock compression studies examine the effects of shock waves on materials of scientific and engineering importance. Shocks can be produced by high-speed impacts or intense explosions. Study of shock waves began as a part of the nuclear weapons program, but the benefits from this new field of science have been far-reaching.

A New Medical Tool. Understanding shock waves in biology and medicine is a new challenge and a new opportunity for shock compression science. Biological tissues are fundamentally different and considerably more complicated than the liquids and solids normally studied by shock compression. Laser surgeries generate

See SHOCK WAVES *on page 6*

Automatic Visa Revalidation Solves Most March Meeting Visa Problems

Although it was initially thought that people with F-1 or J-1 visas might run into trouble in reentering the US after attending the APS March meeting in Montreal, it turns out that students, postdocs and visitors from all but a few countries can make use of the automatic visa revalidation program, which will eliminate potential difficulties.

Details can be found on the March meeting web page at: http://www.aps.org/meet/MAR04/visa/index.html.

Report Says:

Revolutionary Breakthroughs Needed for Hydrogen Economy

By Susan Ginsberg

A report indentifying the basic research necessary to make possible a competitive hydrogen economy was released by the Department of Energy's Office of Science in late August. "Basic Research Needs for the Hydrogen Economy" summarizes the findings of a Basic Energy Sciences "Workshop on Hydrogen Production, Storage and Use" convened in May with the express purpose of identifying the research advances necessary to enable cost-efficient use of hydrogen as a fuel. The workshop was chaired by Mildred Dresselhaus of MIT, a former Director of the Office of Science, and a former President of the American Physical Society.

The report identifies six cross-cutting areas as critical research directions, including catalysis; nanostructured materials; membranes and separations; characterization and measurement techniques; theory, modeling and simulation; and safety and environmental issues. The report also names biological and bio-inspired science as promising approaches for progress. Simple incremental advances in the present state of the art are not

See **HYDROGEN** *on page 7*

Highlights

Members in the Media

"I always advised friends to take the [Strategic Defense Initiative] money and do some useful physics with it instead of seeing it wasted."
—Peter Zimmerman, King's College London, Village Voice, September 10-16, 2003

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"What we were doing was creating a bright background template to differentiate incoming ICMs. The work was very valuable scientifically and good for the country and defense. I think there's nothing wrong with that kind of research."
—Douglas Osheroff, Stanford University, on SDI research, Village Voice, September 10-16, 2003

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"The University of Arizona's biggest strength is the involvement of every undergraduate student who wants to be in frontline research in physics."
—J.D. Garcia, University of Arizona, on UA's being chosen as a "thriving physics program", Arizona Daily Star, September 23, 2003

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"That would be the same as if all you can do with wood is burn it for energy. It's remarkably crude. Having a more sophisticated understanding of the nucleus, we'll be able to do more sophisticated things with it."
—Lawrence Weinstein, Old Dominion University, Newport News Daily Press, September 7, 2003

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APS Creates Task Force on Research Collaboration with Africa

In order to strengthen ties between US and African physicists, the APS has established a Task Force on Research Collaboration with Africa. Chaired by David Ernst (Vanderbilt University), the task force's principal goal is to explore the feasibility of creating an exchange program and secure funding for it. To that end, task force members will first research existing programs that promote interactions with Africa. They will also establish a list of interested APS members and corresponding interested physicists in Africa for possible future exchanges.

Latin America has been a major focus of APS international outreach for several years, but Ernst says the time is right to expand that scope to Africa. "There's a sense that at least some areas of Africa are moving forward at a more rapid rate than in the past," he says, citing plans to construct telescopes and laser centers as evidence of a region ripe for the development of a strong scientific enterprise. "There's also interest in Africa from US funding agencies and foundations, and more resources are becoming available."

The idea for the task force grew out of discussions APS President Myriam Sarachik had with colleagues regarding how African colleagues suffered from feelings of isolation once they returned from training, research, or schooling abroad, and had difficulty keeping current with scientific developments and maintaining contacts with US research programs. Getting equipment to centers in Africa in dire need of it is another challenge, both because of high transport costs and the need to train African colleagues in the use of new equipment.

Sarachik believes the APS can play a role in establishing better communications between the two communities and in developing and implementing exchange programs, but the Society lacks the major resources such a project would require—hence the focus on identifying existing collaborative programs to which the APS could contribute. Europe, for example, has many active programs already in place, including those supported by the Abdus Salam International Centre for Theoretical Physics (ICTP), the Swedish International Development Agency, the National Science Foundation, and the Department of Energy among others.

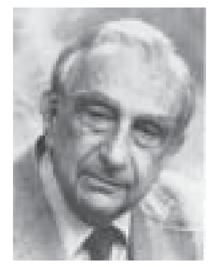
The other task force members are S. James Gates, University of Maryland, College Park; Katharine Gebbie, National Institute of Standards and Technology; Kennedy Reed, Lawrence Livermore National Laboratory; and Bruce Barrett, University of Arizona.

APS members interested in participating in an African exchange program should send their name, address, phone, FAX and e-mail to Michele Irwin, APS Office of International Affairs, mirwin@aps.org. Thoughts or suggestions for the task force itself should be sent directly to the task force members.

This Month in Physics History

November 1, 1952: Teller and the Hydrogen Bomb

Often touted as the "father of the hydrogen bomb," Edward Teller was one of the most controversial scientists who worked in the US thermonuclear weapons program. While many colleagues considered him a highly imaginative and creative physicist, others were alienated by his frequently autocratic style and single minded pursuit of a fusion program to build a "super bomb".



Edward Teller

Born in 1908 in Budapest, Hungary, to Jewish middle class parents, Teller grew up during a particularly turbulent time in the country's political history. By the time he was ready to pursue advanced studies in science, Hungary was ruled by a virulently anti-semitic fascist dictator, and the young Teller opted to leave his homeland to study in Germany under Werner Heisenberg, among others. He earned a PhD in theoretical physics in 1930 from the University of Leipzig, and while he accepted a research post at the University of Göttingen after graduation, Hitler's rise to power prompted him to emigrate first to Denmark in 1934, where he worked with Neils Bohr, and then to George Washington University in the US in 1935.

While his prior research had been in quantum mechanics, at GWU he began a very productive collaboration with Russian émigré George Gamow in nuclear physics. They formulated the so-called Gamow-Teller rules for classifying subatomic particle behavior in radioactive decay, and attempted to apply the new understanding of atomic phenomena to astrophysics.

Following the outbreak of World War II, he was one of the first scientists recruited to work on the Manhattan Project, working first at the University of Chicago before moving to Los Alamos National Laboratory.

It was Enrico Fermi who first suggested the notion of a hydrogen bomb to Teller. Even before the first atomic bomb, in September 1941, Fermi thought that an atomic bomb might heat a mass of deuterium sufficiently to ignite a thermonuclear reaction.

Although part of a group of distinguished scientists charged with designing an atomic bomb, Teller was much more interested in the feasibility of a "super bomb." He wanted both options to be pursued at Los Alamos, but building the simpler fission device was deemed daunting enough, and the fusion project was abandoned. This disappointed Teller, and also led to tensions with his fellow scientists, particularly Hans Bethe, who disapproved of Teller's stubborn refusal to perform the detailed calculation of the implosion when the theoretical division was already shorthanded.

In 1945, the atomic bomb was successfully tested at Alamogordo, New Mexico. Teller returned to the University of Chicago after trying again, unsuccessfully, to persuade Los Alamos to pursue fusion and create a thermonuclear weapon even more powerful. It wasn't until the Russians detonated their own atomic bomb that President Truman ordered the lab to develop a fusion weapon. Robert Oppenheimer, Fermi, and many other veterans of the Manhattan Project had vehemently opposed the plan, and the result was a deep and bitter rift between two factions of atomic scientists. Teller finally saw his dream materialize on November 1, 1952, when the first hydrogen bomb was successfully detonated on Eniwetok Atoll in the Pacific Ocean.

Following this success, Teller lobbied Congress vigorously for a second laboratory for thermonuclear research, and the Atomic Energy Commission eventually established Lawrence Livermore National Laboratory. Teller served first as a consultant, then as associate director, and finally as director of the new facility.

The final break with his former Manhattan Project colleagues came in 1950 during Oppenheimer's security hearings. Teller testified against Oppenheimer, saying, "I would prefer to see the vital interests of this country in hands that I understand better and therefore trust more." Many in the scientific community felt this was an unforgivable betrayal and ostracized Teller for life.

Unlike Oppenheimer, whose strong moral sense was appalled at what science had wrought in the development of thermonuclear weapons, Teller decried the perceived contradiction between the results of science and the requirements of morality, insisting that contradiction and uncertainty should be embraced.

He continued to be a staunch advocate of a strong national defense program, championing continued nuclear testing and the Strategic Defense Initiative ("Star Wars"). He was recognized in 1962 with the Enrico Fermi Award, citing him "for leadership in research on thermonuclear reactions, and for his efforts to strengthen national security and to insure the peace."

In the May 22, 1998 issue of *Science* magazine, Teller, then a senior research fellow at the Hoover Institution at Stanford University, defended the morality of his 1949 recommendation to develop the H-bomb. "I am still asked on occasion whether I am not sorry for having invented such a terrible thing as the hydrogen bomb. The answer is, I am not," he wrote. "Several decades later, the cold war ended with an American victory. It is possible, perhaps even probable, that my advice to give a positive answer to the question of the hydrogen bomb played a significant role in determining this outcome."

Teller died September 9, 2003, unrepentant and controversial to the end.

Further Reading:

"Andrei Sakharov and Edward Teller," *Oxford Companion to the History of Modern Science*, J.L. Heilbron, ed., Oxford University Press, 2003, pp. 727-728.

"Edward Teller, Father of the Hydrogen Bomb," Academy of Achievement, <http://www.achievement.org/autodoc/page/tel0pro-1>.

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Editor .... Alan Chodos
Associate Editor .... Jennifer Ouellette
Special Publications Manager .... Elizabeth Buchan-Higgins
Design and Production .... Stephanie Jankowski
Forefronts Editor .... Neville Connell
Proofreader .... Edward Lee

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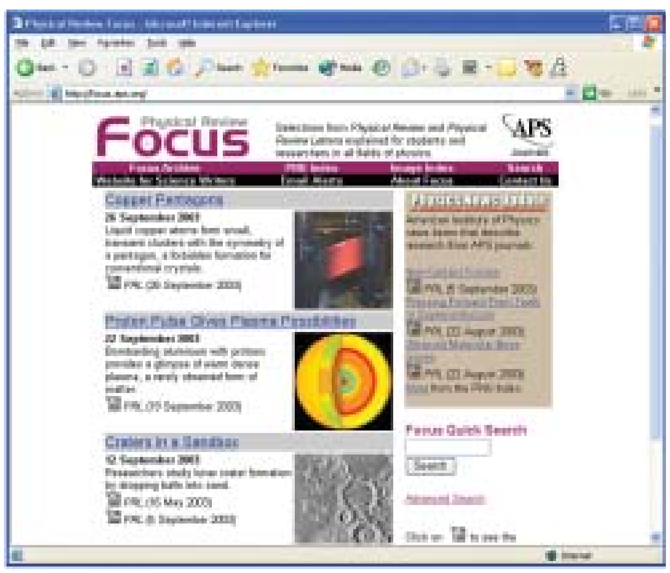
Phys Rev Focus Fans Include Teachers and Undergrads

By Pamela Zerbinos

In March of 1998, APS launched a website called *Physical Review Focus* in hopes of facilitating communication between physicists of different disciplines and increasing their awareness of research outside their specific field. Although it still serves this function as its primary goal, its scope has broadened significantly to encompass the education of undergraduates and even high-school students.



The website, which is updated once or twice a week, explains in simple language selected research articles recently published in the APS journals *Physical Review* and *Physical Review Letters*. The papers appearing on the site are usually chosen for their educational value or interest to nonspecialists, rather than simply for their scientific merit. Although recent statistics are not available, the editor, David Ehrenstein, says that in late 2002 the home page got upwards of 20,000 hits per month. The accompanying e-mail list, which informs readers of the latest Focus stories, currently has around 7,600 subscribers from over 70 countries.

Because physicists often don't follow closely what's going on outside their chosen field, Ehrenstein found that lowering the bar enough for all physicists to understand a story was not far from writing for undergraduate physics students, an audience he wanted to reach out to.

"I based it to a large extent on my own experience as an undergraduate," said Ehrenstein, who majored in physics at Oberlin College before going on to get his PhD. "These are people who are interested in current physics research, but they can't read the journals. There's not much out there for them. They can read something like *Discover* Magazine, but they often want more in-depth information."

Ehrenstein's experience is echoed by physics educators from around the globe, who have turned to *Focus* to help fill the gap.

Pete Markowitz, who teaches physics at Florida International University, uses the material in his modern physics course, where "the students are mostly physics majors and they have a curiosity about what is happening in 'their' field. Modern physics, especially the lab, is the first chance the students get to explore what physics is currently about. I find *Physical Review Focus* to be unique in that it provides current research and is in a simple format suitable for any interested reader."

Focus' emphasis on current research is quite important to many of its readers. Physics students from schools as varied as Moscow State University, Carleton College and the School of the Art Institute of Chicago (SAIC) have professors who use *Focus* articles to keep them abreast of current research. SAIC students enrolled in Elizabeth Freeland's modern physics course, for example, are required to do reports on *Focus* articles and are encouraged to check out the *Focus* archives for a final report topic.

Other physics educators use the site in slightly different ways. Like Freeland, Nelson Vanegas, at the Universidad de Antioquia in Medellin, Colombia, asks his introductory students to summarize *Focus* articles and present them to

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Simple Physics Can Be Useful in Understanding Real-World Issues

By Susan Ginsberg

David Hafemeister, author of numerous books on science policy topics and professor emeritus of physics at California Polytechnic State University, is currently in the middle of a series of seminars at physics departments showing students that one can apply physics to real-world issues.

He does this by simplifying the math, making assumptions, and doing quick and dirty calculations. His talks, as Hafemeister freely admits, "are full of 'spherical cows' to deal with issues like climate change." As part of this series, the Physics Department and the Security Policy Studies Program at The George Washington University teamed up to host a colloquium by Hafemeister in early September on the APS Boost Phase Intercept Study.

At the September 4 colloquium at GWU, Hafemeister gave the historical context of defensive missile systems beginning with Lyndon Johnson's negotiated defensive systems, through Ronald Reagan's Star Wars program, to the current situation which prompted the APS study on Boost Phase Intercept Systems.

Hafemeister took the colloquium audience through the calculations to determine the effectiveness of three systems discussed in the APS study: airborne lasers and ground- and space-based interceptors.

In discussing the airborne laser, Hafemeister pointed out the issue of overcoming turbulence as well as the uncertainty in the effects of shock and ablation on the target. "It's a hard physics problem," said Hafemeister after calculating to first order what the energy on the target would be coming from an airborne laser carried by a Boeing 747. "My guess is even the Pentagon doesn't know all the answers. I hope the DOD's Defense Science Board is asking hard questions."

With space-based interceptors some of the policy decisions are a simple matter of understanding basic physics, says Hafemeister. To intercept missiles from anywhere on the globe, you need either a lot of lighter interceptors, or fewer heavy ones.

Hafemeister easily illustrated the trade-off between weight and number of interceptors using a chart from the APS study and some simple physics equations.

The last system Hafemeister described was the ground-based interceptor. Although judgment calls are needed as to whether a particular interceptor was feasible, Hafemeister insists that GBIs can be understood using "Newton's laws and reasonable parameters." Hafemeister 's goal is to show the "system of decision" that is used by politicians, and how much of this system is basic physics in science policy questions.

Hafemeister ended his talk with an appeal to cooperative diplomacy: "You and I sitting in a bar over a napkin can get around any weapons system. What we really need to do is get people to talk to each other and be friends." Asked by an audience member whether this was a reference to getting physicists and engineers to work together, Hafemeister answered, "No, I meant getting nations to talk to each other, diplomatically. It's a political science concept."

Hafemeister's most recent book, "Physics of Societal Issues: Calculations on National Security, Environment and Energy" will be released in December of this year. The book is being published by Springer-Verlag and The American Institute of Physics Press.

Ask the Ethicist

Editor's Note: *Ethical issues have been much in the news recently, and the APS has revised and extended its guidelines for professional conduct, with regard to both research and publications. There is an APS Task Force on Ethics, which is expected to report to Council this fall. This month,* APS News *is inaugurating what we hope will be a continuing series of columns addressing ethical issues that are submitted by our readers.*

Anything is fair game, and we encourage questions relating to research practices, to authorship and other publication-related issues, and also to the propriety of research in certain ethically sensitive areas. Readers should submit questions to ethics@aps.org *or by mail to Jordan Moiers, c/o* APS News, *One Physics Ellipse, College Park, MD 20740. They should identify themselves and provide contact information, but their identities will be jealously protected.*

In order to be ethically aboveboard ourselves, we make two confessions: in this first column, we faced a chicken and egg problem, with the result that the letter below was not actually submitted by a reader, but was constructed by our staff based on an actual incident within our experience. We hope that reader response will help us avoid this expedient in the future. The second confession is that Jordan Moiers is a nom de plume, *which we hope will insulate the author of this column from undue influence and unwarranted reprisals.*

The opinions expressed in this column are not necessarily those of either the APS or APS News.

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My former collaborators recently included me as coauthor on a paper that I never laid eyes on prior to its publication. I wholeheartedly respect the authors and have absolute faith in their work. I am also grateful that they feel my earlier contributions warranted coauthorship. However, is it ethical for them to add my name to a paper if I didn't have a chance to review it? What should I do to correct the record now?

Sincerely,
O.H.

Dear O.H.,

In years past, your former collaborators' generosity technically did not reach the level of an ethics breach. After all, you are probably intimately familiar with the subject of the paper if you were an important member of the collaboration a short time ago. Recent, highly publicized ethics violations, however, have raised the bar with regards to assigning physics paper authorship.

The original APS Guidelines for Professional Conduct, which were adopted in 1991, state "Authorship should be limited to those who have made a significant contribution to the concept, design, execution or interpretation of the research study. All those who have made significant contributions should be offered the opportunity to be listed as authors." It is entirely conceivable that you made significant contributions that warrant coauthorship. New language in 2002, however, complicates things a bit.

According to the updated guidelines, "Every coauthor should have the opportunity to review the manuscript before its submission. All coauthors have an obligation to provide prompt retractions or correction of errors in published works. Any individual unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor."

Clearly, you didn't have the opportunity to review the manuscript prior to submission, although multiple use of the word "should" in the guidelines still leaves a bit of wiggle room. You could approach the level of a legitimate coauthor now if you review the paper with an eye toward providing "retractions or correction of errors," but I doubt your friends would appreciate it if you exercised your responsibilities (assuming that any corrections are called for), considering the fact that you are a *former* collaborator. In fact, the level of comfort you and the other authors feel with you taking responsibility for retractions or corrections seems as good a test as any for coauthor status.

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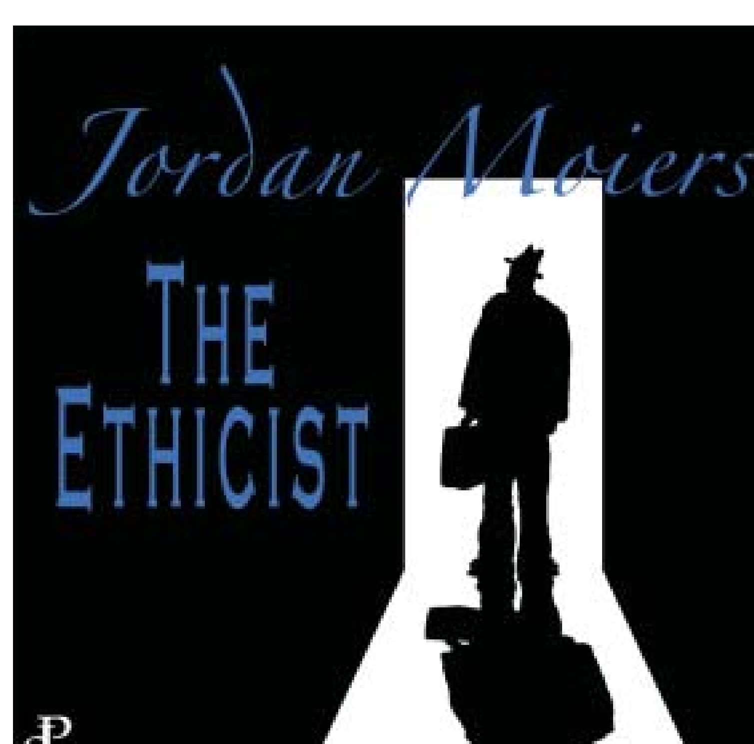


Viewpoint...

A Mind Can Be Open Without Being Empty: Skepticism and Scientists

By James Trefil

When you get involved in explaining science to the public, sooner or later someone will come up to you to complain about the close mindedness of the scientific community.

Often, they will spin a story that goes like this: there was once an isolated, ignored genius who had worked out the truth about a particular scientific problem. Ignored by the scientific establishment, this individual nevertheless persevered, and long after his death his true genius was finally recognized. The usual people cited are Galileo Galilei or Alfred Wegener (the author of the theory of continental drift), and the usual purpose of the story is to invite a comparison between the way these figures were treated and the trouble the storyteller is having getting scientists to listen to his revolutionary theories about ESP, UFO's, or the origin of the universe.

Is the scientific community really closed to ideas from the lonely genius? Do the historical stories of Galileo and Wegener really show that we are willing to listen only to our own?

Starting with Galileo, we can point out that it wasn't the scientific community that persecuted him, but the established Church.

In fact, the Copernican theory of the heliocentric universe had been debated in the European scientific community for a century before Galileo brought it to the attention of the public with his popular books.

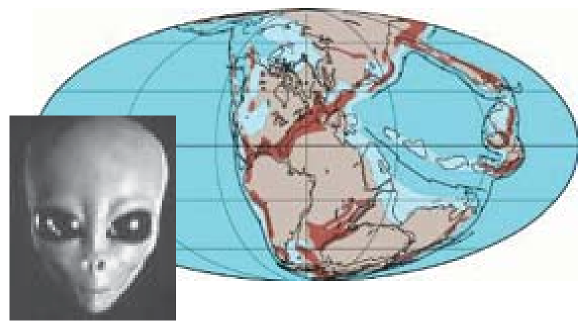
Even ignoring the issue of heresy, there would have been good reasons for scientists in the 17th century to reject Galileo's arguments. Most of his book *Dialogue Concerning Two World Systems* was taken up by an argument for heliocentrism based on a completely incorrect theory of the tides.

The story of Alfred Wegener is less familiar to most people, although the "sound bite" folklore about him is that he discovered the motion of continents early in the 20th century and was ignored, even though he ultimately turned out to be right.

In fact, Alfred Wegener was not only a respected member of the German scientific establishment, he was one of its leaders.

Wegener was the director of one of his country's major research institutions.

The only reason Wegener enters the mythology of science is the fact that in 1915 he published a book called *The Origin of Continents*, in which he suggested that at some time in the past all the land on Earth had been clumped together into one giant supercontinent, which he called Pangaea ("All Land"), and that the continents had moved ("drifted") to their present positions since then. This is the celebrated theory of Continental Drift.



The book was hardly ignored; it was debated widely in Germany.

In general, hard rock geologists opposed it and theoretical geophysicists supported it. There were two main arguments against his thesis: one centered on the fact that no one could think of a mechanism that could move the continents, while the other concerned the question of whether the data supported Wegener.

Wegener advanced five pieces of evidence that supported his thesis of continental motion.

These were **(1)** the fact that the coastlines of Europe, Africa, and the Americas fit together like a jigsaw puzzle, **(2)** the fact that some geological formation (mainly in Africa) seemed to continue across into the Americas, **(3)** the fact that some fossil species seemed to be found in corresponding places on both sides of the Atlantic, **(4)** the fact that the location of glacial moraines seemed to indicate that continents once had a different relation to the poles than they do now, and **(5)** the fact that two different geodetic determinations of the distance between Greenland and Europe indicated that the distance was increasing.

Hard rock geologists argued that in many cases Wegener had simply gotten the rock identification wrong—that what he called glacial moraines were nothing of the kind, for example. They also pointed out that the facts that two minerals are identical doesn't mean they were made in the same place and that, given the enormous number of geological formations in Europe and North America, it was not surprising that a few would match up.

Other aspects of Wegener's argument could be incorporated easily into the Fixed Earth theories of the time. These theories incorporated land bridges that could sink beneath the ocean, so the fossil evidence could be easily explained. They also allowed the possibility that during an earlier stage, continents could indeed have moved on a molten planet. Thus, the jigsaw puzzle fit evident on the map didn't have to imply that the continents were still moving.

Finally, the geodetic evidence was such that the error in the two measurements was larger than the claimed difference, a fact which weakened the Greenland argument considerably.

In the end, then, scientists of the 1930's and 40's were quite right to reject continental drift. So what has happened since then to change our view of the Earth?

In a word, data. Starting in the mid 1960's, data supporting the notion of continental motion started to come in. Starting with the measurements of paleomagnetic patterns on the ocean floor and extending to studies of magnetic records in sediments and rocks, a picture of a dynamic, active Earth emerged. Confronted with overwhelming data, the scientific community gave up its fixed Earth paradigm and adopted the new one in less than five years.

The theory that emerged was not Wegener's continental drift, even though it incorporated the notion that continents move. Wegener's theory contained features, such as the notion that the average elevation of the continents would increase over time, that simply aren't true. And plate tectonics supplies a mechanics for moving the continents (involving convection in the Earth's mantle), something that was conspicuously missing from continental drift.

The main lesson to be learned from Wegener's story, then, is exactly the opposite of the one the spinners of mythology want to advance. The scientific community is fully capable of abandoning a lifetime's worth of belief and adopting a new outlook provided there is enough data to justify the change. The fact that we don't accept ESP, UFOs, harmonic convergences, and the like arises from the fact that there isn't enough data to support them, and has nothing to do with the close mindedness of the scientific establishment.

It's a nice thing to remember next time you are confronted by a New Ager at a party.

James Trefil is Clarence J. Robinson Professor of Physics at George Mason University in Fairfax, Virginia. This and other commentaries by scientists can be found on the Physics Central website: www.physicscentral.com.

Nanoneurosurgery, Bio Scans and Home Holograms Featured at 2003 OSA/DLS Conference

The first demonstration of cellular microsurgery in living cells, a digital camera that can make home holograms, and improvements in face recognition technology were among the technical highlights at the 2003 Frontiers in Optics conference. Co-sponsored by the Optical Society of America and the APS Division of Laser Science, the annual event provides up-to-the-minute advancements in optics and photonics research, and features a breadth of significant topics from medicine to astronomy and computing.

The meeting was held October 5-9, 2003, in Tucson, AZ, and also featured a joint plenary session with three world-renowned keynote speakers: Presidential Science Advisor John Marburger, Roger Angel (University of Arizona) on the observation of extra-solar planets, and Harvard University's Gerald Gabrielse on cold anti-hydrogen.

Entangled Photons for Long-Distance Calibration

Testing optical devices such as telescopes and spectrometers often requires a carefully calibrated source of photons, which are then sent to an optical device to see how it responds.

But when the optical device is located in hard-to-reach places such as aboard the International Space Station, it's not always easy or cost-effective to carry a calibrated source to the optical instrument. Researchers at the University of Maryland, Baltimore County, have developed a scheme to accurately test optical equipment at remote locations.

Giuliano Scarcelli and coworkers have built a prototype of a system that allows them to precisely characterize optical devices at a distance by taking advantage of the fact that entangled photons have very special relationships.

If the state of one of a pair of entangled photons is measured, the state of the other photon can be unequivocally calculated from quantum mechanical rules.

The researchers first create a pair of entangled photons. One photon is sent to a monochromator, where its characteristics are precisely recorded. The second photon is sent to the device to be tested, and the device's response to the single photon signal is recorded and sent back to the lab.

Because the researchers know the state of the second photon by looking at the first, they can determine the response of the remote optical device to a well-known signal, and can interpret the remote device's measurements.

So far, the researchers have experimentally confirmed their results on instruments located at two meters from the entangled photon source, but longer distance tests are feasible in principle.

Nano-neurosurgery

Eric Mazur of Harvard University discussed the use of very short laser pulses to alter single biological structures. Using this technique, the researchers have demonstrated "cellular microsurgery" in living cells, by eliminating a single mitochondrion or cutting the strands of a cytoskeleton. Furthermore, the researchers have performed "nano-neurosurgery" in living nematodes, by cutting individual axons in the organism without killing the nerve cell or disrupting the surrounding tissue. Compared to traditional biochemical or mechanical methods of manipulating tissue, femtosecond micromanipulation is more selective and precise and less invasive, opening the door to many new studies, which the researchers are currently pursuing with colleagues at Harvard Medical School and its biology department. Such studies could identify new clinical uses of femtosecond lasers in surgery at the cellular level and also unlock mysteries of the brain.

Optical Telescopes Could Detect Life Beyond Solar System

Wesley Traub of the Harvard-Smithsonian Center for Astrophysics discussed telescope designs that could potentially detect signs of life on planets beyond our solar system. Examining up to 150 nearby stars, these new telescopes would obtain highly detailed images in the visible part of the light spectrum. Besides having the ability to detect new planets, such high-resolution visible images could indicate planetary oxygen, water, ozone, air, and possibly even land plants (by recording the distinctive light that would be reflected by chlorophyll). To capture these features, scientists on NASA's Terrestrial Finder Program propose the design of a state-of-the-art "coronagraph," a telescope that blocks out the central light from a star to detect much fainter surrounding objects. "This will be far, far better a telescope than has ever been built," Traub says, "and today there are teams of people working to make such a telescope and to send it to space sometime in the coming decade."

Improvements in Face Recognition Technology

Secure access to physical and virtual spaces is becoming increasingly important for security. Passwords

See OSA CONFERENCE *on page 6*

Six Physicists Honored at October, November Unit Meetings

Six physicists are being honored with APS prizes and awards at unit meetings this fall. The 2003 James Clerk Maxwell Prize, Excellence in Plasma Physics Award, and Outstanding Doctoral Thesis Award in Plasma Physics were bestowed during the 2003 APS Division of Plasma Physics meeting, held October 27-31 in Albuquerque, New Mexico.

And the 2003 Fluid Dynamics Prize, Otto LaPorte Award, and Andreas Acrivos Dissertation Award will be presented during the upcoming meeting of the APS Division of Fluid Dynamics, November 23-25, in Meadowlands, New Jersey.

2003 James Clerk Maxwell Prize

Eugene N. Parker
University of Chicago
Citation: *"For seminal contributions in plasma astrophysics, including predicting the solar wind, explaining the solar dynamo, formulating the theory of magnetic reconnection, and the instability which predicts the escape of the magnetic fields from the galaxy."*

Parker received a BS in physics from Michigan State University in 1948 and a PhD in physics from the California Institute of Technology in 1951. He was an instructor in the Department of Mathematics at the University of Utah 1951-1953 and then a research associate with Walter M. Elsasser in the Department of Physics.

Parker moved to the University of Chicago in June 1955. He retired from the University of Chicago in 1995.

Parker was elected to the National Academy of Sciences in 1967. Parker has received various scientific awards over the years, including the National Medal of Science in 1989, and the 2003 Kyoto Prize in Basic Science.

2003 Excellence in Plasma Physics Research Award

Siegfried Glenzer
Lawrence Livermore National Laboratory
Citation: *"For elegant diagnostics using collective Thomson scattering together with x-ray spectrocopy which greatly advanced the understanding of the complex plasma environment in laser driven hohlraums used in inertial confinement fusion."*

Glenzer earned his undergraduate degree in 1990 and his PhD in 1994 in plasma physics from the Ruhr-Universitat Bochum in Germany.

He came to the US in 1995 as a postdoctoral fellow at Lawrence Livermore National Laboratory, where he is currently head of the Plasma Physics Group in the National Ignition Facility program, performing the first experiments on the NIF laser.

His research interests are in the areas of inertial confinement fusion, plasma spectroscopy, and laser plasma interactions. He also first introduced Thompson scattering to characterize hohlraum plasma conditions, and has since used the technique to study atomic kinetics and plasma waves in high temperature and high density plasmas.

2003 Outstanding Doctoral Thesis in Plasma Physics

Alex Arefiev
University of Texas at Austin
Citation: *"For first principles theoretical analysis of a plasma thruster that models the helicon plasma source, single-pass radio frequency heating, and particle and momentum balance."*

Arefiev received his BS in physics from Novosibirsk State University (Russia) in 1998.

As an undergraduate student, he worked at the Budker Institute of Nuclear Physics (Novosibirsk, Russia). His undergraduate research was focused on the physics of single species plasma. In 1999, he enrolled in the graduate program in plasma physics at the University of Texas at Austin.

His graduate work was supported by the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) project (NASA Johnson Space Center), Institute for Fusion Studies, and Fusion Research Center.

Arefiev received his PhD in physics in 2002. He is currently employed by the Institute for Fusion Studies as a postdoctoral fellow. He has also joined the High Intensity Laser Science Group at the University of Texas at Austin, to collaborate on theory involving laser-irradiated micro-clusters. His areas of interest include helicon plasma sources, ion cyclotron heating, and laser-target interaction.

2003 Fluid Dynamics Prize

Jerry Gollub
Haverford College and University of Pennsylvania
Citation: *"For his elucidation of chaos, instabilities, mixing and pattern formation in various contexts including fluid convection, and his contributions to our understanding of surface waves, film and granular flows, through his clever experiments, lucid papers and lively lectures."*

Gollub received his AB from Oberlin College in 1966, and his PhD in experimental condensed matter physics at Harvard University in 1971. He has been on the faculty of Haverford College since 1970, and is also affiliated with the University of Pennsylvania.

He has undertaken a wide range of experiments on nonlinear and fluid dynamics, including studies of instabilities and pattern formation in fluids, chaotic dynamics and turbulence, nonlinear waves, mixing in fluids, and the dynamics of granular materials. He has coauthored an undergraduate textbook on nonlinear dynamics, and teaches physics courses for a broad audience.

Gollub received the first APS Award for Research in an Undergraduate Institution. He co-chaired a study of advanced high school mathematics and science for the National Research Council, and has served on the APS Executive Board.

2003 Otto LaPorte Award

Norman J. Zabusky
Rutgers University
Citation: *"For pioneering and enduring contributions in nonlinear and vortex physics and computational fluid dynamics, including: the soliton; contour dynamics and V-states for 2D flows; vortex projectiles for accelerated inhomogeneous flows; and visiometrics for reduced modeling."*

Zabusky received his PhD in physics from the California Institute of Technology in 1959. A former Guggenheim Fellow, he spent five years at Bell Laboratories, eventually heading the Computational Physics Research Department, before joining the faculty of the University of Pittsburgh as a professor of mathematics.

In 1988 he moved to Rutgers University as State of New Jersey Professor of Computational Fluid Dynamics.

Zabusky is an advocate of the "visiometric" process which can enhance productivity for scientists and engineers who visualize, diagnose and quantify databases from large-scale simulations. He also gives talks on science and the art of fluid motion for artistic innovation and collaboration, and for science and engineering outreach.

2003 Andreas Acrivos Dissertation Award

Projsenjit Bagchi
University of Illinois, Urbana-Champaign
Citation: *"For his careful and extensive numerical experiments elucidating the fundamental mechanisms governing the motion of a spherical particle subject to complex unsteady and inhomogenous flows at moderate to high Reynolds number"*

Biographical information unavailable at press time.

zero gravity
The Lighter Side of Science

Strung Out

By Woody Allen

I am greatly relieved that the universe is finally explainable. I was beginning to think it was me. As it turns out, physics, like a grating relative, has all the answers. The big bang, black holes, and the primordial soup turn up every Tuesday in the Science section of the *Times*, and as a result my grasp of general relativity and quantum mechanics now equals Einstein's—Einstein Moomjy, that is, the rug seller.

How could I not have known that there are little things the size of a "Planck length" in the universe, which are a millionth of a billionth of a billionth of a billionth of a centimetre? Imagine if you dropped one in a dark theatre how hard it would be to find. And how does gravity work? And if it were to cease suddenly, would certain restaurants still require a jacket? What I do know about physics is that to a man standing on the shore time passes quicker than to a man on a boat — especially if the man on the boat is with his wife.

The latest miracle of physics is string theory, which has been heralded as a T.O.E., or "Theory of Everything." This may even include the incident of last week herewith described.

I awoke on Friday and because the universe is expanding, it took me longer than usual to find my robe. This made me late leaving for work, and because the concept of up and down is relative the elevator I got into went to the roof, where it was very difficult to hail a taxi. Please keep in mind that a man on a rocket ship approaching the speed of light would have seemed on time for work—or perhaps even a little early and certainly better dressed.

When I finally got to the office and approached my employer Mr. Muchnick to explain the delay, my mass increased the closer I came to him, which he took as a sign of insubordination. There was some rather bitter talk of docking my pay, which, when measured against the speed of light, is very small anyhow. The truth is that compared to the amount of atoms in the Andromeda Galaxy I actually earn quite little. I tried to tell this to Mr. Muchnick, who said I was not taking into account that time and space were the same thing. He swore that if the situation should change he would give me a raise. I pointed out that since time and space are the same thing, and it takes three hours to do something that turns out to be less than six inches long, it can't sell for more than five dollars. The one good thing about space being the same as time is that if you travel to the outer reaches of the universe and the voyage takes three thousand earth years, your friends will be dead when you come back, but you will not need Botox.

Back in my office, with the sunlight streaming through the window, I thought to myself that if our great golden star suddenly exploded this planet would fly out of orbit and hurtle through infinity forever—another good reason to always carry a cell phone. On the other hand, if I could someday go faster than a hundred and eighty-six thousand miles per second and recapture the light born centuries ago, could I then go back in time to ancient Egypt or Imperial Rome? But what would I do there: I hardly knew anybody.

It was at this moment that our new secretary, Miss Lola Kelly, walked in. Now, in the debate over whether everything is made up of particles or waves Miss Kelly is definitely waves. You can tell she's waves every time she walks to the water cooler. Not that she doesn't have good particles but it's the waves that get her the trinkets from Tiffany's. My wife is more waves than particles too, it's just that her waves have begun to sag a little. Or maybe the problem is that my wife has too many quarks. The truth is, lately she looks as if she had passed too close to the event horizon of a black hole and some of her—not all of her by any means—was sucked in. It gives her a kind of funny shape, which I'm hoping will be correctable by cold fusion. My advice to anyone has always been to avoid black holes because, once inside, it's extremely hard to climb out and still retain one's ear for music. If, by chance, you do fall all the way through a black hole and emerge from the other side, you'll probably live your entire life over and over but will be too compressed to go out and meet girls.

And so I approached Miss Kelly's gravitational field and could feel my strings vibrating. All I knew was that I wanted to wrap my weak-gauge bosons around her gluons, slip through a wormhole, and do some quantum tunneling. It was at this point that I was rendered impotent by Heisenberg's uncertainty principle. How could I act if I couldn't determine her exact position and velocity? And what if I should suddenly cause a singularity; that is, a devastating rupture in space-time? They're so noisy. Everyone would look up and I'd be embarrassed in front of Miss Kelly.

Ah, but the woman has such good dark energy. Dark energy, though hypothetical, has always been a turn-on for me, especially in a female who has an overbite. I

See **ZERO GRAVITY** *on page 7*

NRC committee requests input from High Magnetic Field Science community

A new National Academies committee is requesting input on the current state of high magnetic field science. The Committee on Opportunities in High Magnetic Field Science (COHMAG) will produce a report on the facilities for experiments at high magnetic fields (above 12T), the current state and scientific opportunities of the disciplines that use high field magnets, and the prospects for advances in related technologies. COHMAG invites comments on the following: how have high magnetic fields had an impact on research directions? How have the facilities at NHMFL or other high-field magnet centers been of use? What new facilities or new capabilities would be most valuable? In what new areas of research are high magnetic fields likely to have a large impact? Comments should be sent to: cohmag@nas.edu.

ELECTION *from page 1*

first APS meeting in the winter of 1960, which stimulated the concept for one of his first research experiments. He decided to run for APS president because "throughout my career as a physicist, I have benefitted from APS [activities]... and I would enjoy giving something back to the Society." Along with continued outreach activities in education, Bahcall's priorities for the APS include communicating the importance of maintaining the scientific enterprise to Congress and the White House. "The future of our nation depends upon a strong technological base that can only be maintained by increased federal support for the physical sciences," he wrote.

No stranger to Washington, DC, Bahcall lobbied in the 1970s to persuade Congress to reverse then-President Nixon's decision to remove the Hubble Space Telescope from the federal budget. He continues to be involved as a Washington advocate for other scientific projects, and believes that APS members need to work together to promote science funding at national and state levels, with those in academia joining those in industry "to reverse the tragic and dangerous decline of physics research in the private sector."

Bucksbaum is an experimental atomic physicist who earned his BS from Harvard University in 1975 and his MS and PhD from the University of California, Berkeley. After a year at Lawrence Berkeley National Lab, he joined the research staff at Bell Labs as a postdoc in 1981, then became a member of the technical staff. He remained there until moving to the University of Michigan as a professor of physics in 1990, where he is currently the Otto LaPorte Collegiate Professor of Physics and director of the NSF Center for Frontiers in Optical Coherent and Ultrafast Science.

His principal research interest is quantum control of atomic and molecular processes using ultrafast and strong optical fields. He is particularly interested in the control of wave packets in atoms and molecules using far infrared, visible, or x-ray pulses. He has served on both the APS Council and Executive Boards and is current editor of the *Physical Review's* Virtual Journal of Ultrafast Science, as well as divisional associate editor for laser science for *Physical Review Letters*.

In his candidate's statement, Bucksbaum cited changes in the US technological, educational and research infrastructure, driven by challenges in health, security and the national economy, as evidence of the need for strong scientific advocacy in Washington. As Congress continues to debate immigration and international contacts, security at the national labs, federal funding for basic physics research, and national testing in public schools, among other issues, the APS officers "must be eager and able to articulate the vision and promote the diverse opportunities that physics offers," he wrote.

Hu received a BS in physics from Barnard College in 1969 and her MS and PhD from Columbia University in 1971 and 1975, respectively. She worked at AT&T Bell Laboratories until 1984, when she joined the University of California, Santa Barbara, as professor of electrical and computer engineering. Since 1987 she has held a joint appointment in the materials department. She is currently the scientific co-director of a newly formed California NanoSystems Institute (CNSI), a collaboration between UCSB and UCLA, established by the State of California as one of four California Institutes for Science and Innovation. Her research has focused on the fabrication and characterization of semiconductor heterostructures with critical dimensions at scale lengths of tens and hundreds of nanometers. Most recently these studies have included interaction of quantum dot emission within specially designed semiconductor cavities, such as photonic crystal resonators.

In her candidate's statement, Hu said she decided to run for APS councillor in order to take a more active role in formulating and representing the directions of the APS, since the Council "serves as an important catalyst in developing new opportunities for the cross-fertilization of ideas and research directions that will build on our existing strengths." Her priorities include establishing integrative programs of education and communication, and building "a vital, participatory membership that draws from the broad strengths and enthusiasms of those working in physics."

Ramirez earned his BS in physics from Yale University in 1978 and his PhD in physics, also from Yale, in 1984. He worked at Bell Labs until 2000, moving in 2001 to Los Alamos National Laboratory. He is both leader of the Materials Integration Science Laboratory and co-director of the Institute for Complex Adaptive Matter. He is also a member of the APS Division of Condensed Matter Physics Executive Committee. His research interests in experimental condensed matter include low dimensional magnetism, heavy fermion systems, thermoelectric materials, colossal magnetoresistive materials, molecular electronics, and superconductivity in various systems.

"Physics is a discipline that continually seeks to affect change," Ramirez wrote in his candidate's statement. "As a professional society, we must continue to embrace new subject matter while not losing sight of what constitutes physics: quantitative rigor, predictive capacity, and simplicity of models." As general councillor, he hopes to preserve the Society's traditional culture while encouraging new avenues of research, such as molecular science, information science and homeland defense. "The problems before us are as exciting and important as ever," he said. "Physics will thrive in times of upheaval in the scientific landscape, even when such change is not caused by our past successes."

Born in Tokyo, Ushioda earned a BS in physics from Dartmouth College in 1964, and a PhD in 1969 from the University of Pennsylvania. He served on the faculty of the University of California, Irvine until 1985, when he returned to Japan as professor of the Research Institute of Electrical Communication at Tohoku University. He is currently president of the Physical Society of Japan, has worked with IUPAP, and is a member of several national committees concerned with research funding of the Japanese Society for the Promotion of Science and the Ministry of Education, Culture, Sports, Science and Technology. He has worked in several areas of experimental solid state physics, most recently focusing on the spectroscopy of light emission from the scanning tunneling microscope.

In his candidate's statement, Ushioda expressed his sense of honor at being asked to run for international councillor, which he feels will "give me an opportunity to make some contributions to APS as a physicist with two homelands." Through his work with international scientific organizations, "I have learned that different national societies face many common issues," including science education, funding of major research facilities, and underrepresentation of women. "I believe that solutions to these and other issues will be most effectively achieved by close international coordination and collaboration," he wrote.

LETTERS

Saw Flash Two Time Zones Away

In your description of the Trinity test ["This Month in Physics History", *APS News* July 2003] you wrote "... the blast created a flash of light that was seen over the entire state of New Mexico, as well as parts of Arizona, Texas and Mexico… ".

I believe I saw that flash in Georgia, 2,200 kilometers away. Here's my account taken from an unpublished manuscript prepared with the help of Arnold Kramish.

"In the summer of 1945, I was stationed at the Warner Robins Army Air Base, south of Macon GA. The base was crowded and for the summer, at least, I was sharing a tent with other junior officers. Early one morning, I stepped out of the tent, turned my back to the already hot sun and stretched; and I saw on the horizon a white flash against the dark western sky. I put that observation in the back of my mind and kept it there for many years; I can't really say why or how or even when (at least ten years ago) I came to think of it again.

"Taking into account the direction, the time of year, the time of day, the bluish white color and the short duration, I have become persuaded that the flash of light originated in the Trinity test. Warner Robins GA is about 2,200 kilometers very nearly due east of the Trinity test site and two time zones away."

Berol Robinson
Meudon, France

OSA CONFERENCE *from page 4*

and PINs can be lost or forgotten. However, using biometrics (for instance a face, fingerprint or iris) for matching a live subject to a stored template, security can be improved.

At Carnegie Mellon University, Vijayakumar Bhagavatula and his team have been developing methods to achieve improved biometric verification using a tool called "correlation filters." This approach provides several advantages such as graceful degradation (part of the face can be occluded and it is still recognized), shift-invariance (images do not have to be centered) and smaller error rates. The same methods were also applied for fingerprint and iris recognition.

Making Holograms with Digital Cameras

Combining digital photography with computer number-crunching, a research group headed by Joseph Rosen from Ben-Gurion University in Israel has developed a promising new method of recording holograms of any three-dimensional scene. In addition to making it easier for industry to produce holograms, the new method can potentially give consumers the ability to make 3-D movies of events, by using digital cameras and special computer software. Conventional holographic recording requires lasers and complicated optical systems. In contrast, Rosen and his students, David Abookasis and Youzhi Li, use a standard digital camera to take a set of many pictures of the 3-D object from different points of view. The set of pictures is sent to a computer, and mathematically processed with a new algorithm developed by the researchers. The computer output is a hologram, which can be printed out on a hardcopy transparency or on a screen such as an LCD. When this hologram is properly illuminated, a real 3-D image of the original object is reconstructed in front of the viewer's eyes. According to Rosen, their hologram is the only non-laser technique that recovers all the 3-D effects of the original.

—Compiled by Philip Schewe, AIP

SHOCK WAVES *from page 1*

shock waves in living tissues, causing both mechanical and chemical changes. The shock waves can compress biological molecules and change the pH and ionic strength of the aqueous media, and can result in wanted and unwanted chemical and biological effects including irreversible damage via denaturing proteins, tearing tissues and killing living cells.

In a special symposium on medical applications for shockwaves, Charles Lin of Massachusetts General Hospital and Harvard University, discussed how shock waves generated by short laser pulses can kill living cells containing absorbing nanoparticles. Nanoparticles can be tailored for a variety of uses including selective uptake by cancer cells, allowing targeted cell killing without the use of poisonous chemotherapy agents.

In the same session, Hyojin Kim of Chungnam University described a new approach to understanding the molecular basis for shock compression of biological systems, the "energy landscape" approach. He presented data in which shock waves are used to study large amplitude motions of proteins and discussed the first observation of viscoelasticity in shocked proteins. And Apostolos Doukas of the Wellman Laboratories of Photomedicine, Massachusetts General Hospital, Harvard Medical School, discussed using shock waves to deliver drugs through the skin without needles and to deliver genetic materials into living cells.

Hydrogen Compressed to a Solid. Understanding highly compressed hydrogen is vital in efforts to achieve laser-driven fusion, processes in stars and the role of hydrogen in more everyday settings. Discovery of the properties of highly compressed hydrogen has been a major goal and source of competition in the international shock wave community. Another highlight of the SCCM conference was a symposium on the properties of fluid hydrogen at very high pressures and temperatures.

The symposium featured lectures by leading experimentalists and theoreticians from the US and Russia on progress and challenges in understanding the surprisingly complex behavior of hydrogen at extreme conditions.

—Compiled by David Harris

ETHICIST *from page 3*

Apparently your former colleagues included you as coauthor out of respect and admiration for your previous, crucial contributions. An acknowledgment would not only have been more appropriate, but would have also given them the opportunity to express a heartfelt sentiment such as "Without the dedication, insight, and pigheaded determination of O.H., none of this work would have been possible."

Attempting to correct the record at this point by publishing a modification of the paper's author list seems extreme, and could even offend the other authors. You might consider brushing off your old notebooks and taking a close look at the paper in order to fulfill the letter of your ethical obligation. And when you have a chance, whip off an email to your friends to let them know that a simple "thanks" will be enough next time around.

Best wishes,
Jordan Moiers

ANNOUNCEMENTS

AIP STATE DEPARTMENT FELLOWSHIP

This fellowship program represents an opportunity for scientists to make a unique contribution to the nation's foreign policy.

The American Institute of Physics will sponsor one fellow annually to spend a year working in a bureau or office of the State Department, providing scientific and technical expertise to the Department while becoming actively and directly involved in the foreign policy process.

Fellows are required to be US citizens and members of at least one of the 10 AIP Member Societies at the time of application.

Qualifications include a PhD in physics or closely related field, or equivalent research experience.

Applicants should possess interest or experience in scientific or technical aspects of foreign policy.

Applications should consist of a letter of intent, a two-page resume, and three letters of reference. Please visit http://www.aip.org/mgr/sdf.html for more details.

All application materials must be postmarked by November 1, 2003 and sent to: AIP State Dept Science Fellowship. American Institute of Physics, ATTN: Audrey Leath, One Physics Ellipse, College Park, MD 20740-3843. For additional information or questions, please contact Audrey Leath at aleath@aip.org or (301) 209-3094.

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: Saturation of electrical resistivity
—O. Gunnarsson, M. Calandra, and J. E. Han
Is there a resistivity maximum for metals at high temperature? A classical argument predicts a saturation of the resistance when the electrons' mean free path is comparable to atomic distances. The resulting bound is satisfied for most metals, but violations have been found recently in high-T_c cuprates and other materials. This Colloquium presents a general analysis of the limiting behavior based on the *f*-sum rule, showing conditions when the saturation bound is applicable or not.

FOCUS *from page 3*

the class.

"The idea," Vanegas said, "is to make them aware of where the frontier in physics is and to let them know the names of universities, centers and scientists active today so they can take it as a goal to get there."

Marjorie Olmstead, who teaches at the University of Washington, also uses the site in her intro course. "I look through the last six to eight months of *Focus* articles and link to those relevant to the quarter," she said. "I use it to emphasize that even though most of what they are learning has been known for over a century, there is still modern research based upon it and pushing it forward."

College professors are not the only educators using *Focus* in their classrooms; the site is also used by high school teachers for similar reasons. Daniel Kutsko, who teaches physics at Jersey Village High School in Houston, Texas, says he uses *Focus* articles "to highlight the reality that what we study in class is going on right now, and physics is changing as we speak. Additionally, I have used these articles to engender in high school students the confidence that—on their own, with no help from me—they can actually read and understand what's happening in the physics community."

Mary Brake, who teaches at Mercy High School in Farmington, Michigan, says she uses *Focus* to keep ahead of her students, who can bring in physics articles for extra credit and explain to the class what the article is about.

"They often bring in articles about the latest findings in physics," Brake said, "and the reason I know this is because I have usually just read *PRF*. I have found that they do not usually understand the articles and I end up trying to explain the new discoveries. I am glad they're interested, but I wish they would bring in articles they could explain without my help. But *PRF* keeps me up-to-date and one step ahead of my students."

Physical Review Focus is at focus.aps.org. *To be added to the e-mail list, send a blank e-mail message to* join-focus@lists.apsmsgs.org

HYDROGEN *from page 1*

enough to bridge the gap between what is now known about hydrogen production, storage and use, and what is required by a hydrogen economy; therefore, says the report, "the objective of [a research program] must not be evolutionary advances but revolutionary breakthroughs."

"There's a huge gap between where we are now and where we need to be in terms of the knowledge base for the hydrogen economy," says Dresselhaus. "Some very radical ideas are needed to advance the field, and that points to basic research."

These breakthroughs can only come with cross-pollination between research fields, believes George Crabtree of Argonne National Laboratory, Associate Chair of the BES Workshop. "A lot of people are doing work that might be relevant to hydrogen research but is not labeled that way. We're trying to bring all these people together, and we want to make the basic energy research community aware of the opportunities in hydrogen research."

Progress can't be made just by established professionals in established fields, either, continues Crabtree. "The research tools are there and those tools weren't there ten years ago, but there is a critical need to bring more students into the fields related to hydrogen research, such as chemistry, physics, electrochemistry, nanoscience, and other cross-cutting research areas. These are real growth-potential fields."

The BES Workshop included 120 participants from academia, industry and the national laboratories, as well as from the Offices of Energy Efficiency and Renewable Energy, Fossil Energy and Nuclear Energy (DOE). The full 175-page report, including 65 pages outlining high-priority research directions, can be found at http://www.aps.org/public_affairs/popa/reports/nmd03.html.

April Program Committee Meets

Photo credit: Alan Chodos

Members of the program committee gathered at APS headquarters in September to begin planning for the 2004 April meeting in Denver. Seated (l to r): Jill Dahlburg, Luis Orozco, Gay Stewart, Steve Holt, Amitava Bhattacharjee. Standing (l to r): Bill Carithers, Don Geesaman, Stan Wojcicki, Ben Gibson, Charlie Glashausser, Nan Phinney, Rocco Schiavilla, Jim Isenberg.

ENDORSE *from page 1*

empower the next generation of scientists."

Stanford University also endorsed the joint statement. Doug Osheroff, Chair of the Physics Department, says that his department did so because "the statement suggests a mechanism for improving the science education of K-12 teachers so that they will feel more comfortable with questions from students, and appreciate the motivation of the students asking them."

The Stanford Physics Department is in the process of creating a BA program in physics to provide a broad science education for students destined to be either K-12 teachers, science writers, or go into some other profession requiring a strong background in the physical sciences.

"It is essential that these students leave Stanford with an understanding of a body of knowledge of science and an understanding of what physical research is all about and how it is carried out," says Osheroff.

But despite their commitment to K-12 education, some schools are wary of increasing faculty responsibilities. At the University of Pennsylvania, the Department of Physics and Astronomy is acutely aware of the time-crunch placed on their young faculty. "We ask them to do top-notch research and to teach top-notch undergraduate and graduate courses. It's tough to make pre-service teaching a requirement as well," says Tom Lubensky, Chair of the University of Pennsylvania Physics Department.

Lubensky further points out that good K-12 training requires a large investment in time and money from the local school districts, "and we just don't have that here currently." He says that it will not be easy to implement programs that go beyond current ones, which include participation in QuarkNet and a very successful Penn Summer Science Academy for high school students, which for the past two summers has employed local high school teachers.

Lubensky's department endorsed the statement, although he cautions, "It's going to take more than signing documents to fix the K-12 system."

The text of the joint statement follows:

AIP-MEMBER SOCIETY STATEMENT ON THE EDUCATION OF FUTURE TEACHERS (Adopted by the APS Council, 21 May 1999)

The scientific societies listed below urge the physics community, specifically physical science and engineering departments and their faculty members, to take an active role in improving the pre-service training of K-12 physics/science teachers.

Improving teacher training involves building cooperative working relationships between physicists in universities and colleges and the individuals and groups involved in teaching physics to K-12 students.

Strengthening the science education of future teachers addresses the pressing national need for improving K-12 physics education and recognizes that these teachers play a critical education role as the first and often-times last physics teacher for most students.

While this responsibility can be manifested in many ways, research indicates that effective pre-service teacher education involves hands-on, laboratory-based learning. Good science and mathematics education will help create a scientifically literate public, capable of making informed decisions on public policy involving scientific matters.

A strong K-12 physics education is also the first step in producing the next generation of researchers, innovators, and technical workers.

American Physical Society
American Association for Physics Teachers
American Astronomical Society
American Institute of Physics
Acoustical Society of America
American Association of Physicists in Medicine
American Vacuum Society

ZERO GRAVITY *from page 5*

fantasized that if I could only get her into a particle accelerator for five minutes with a bottle of Château Lafite I'd be standing next to her, with our quanta approximating the speed of light and her nucleus colliding with mine. Of course, exactly at this moment I got a piece of antimatter in my eye and had to find a Q-tip to remove it. I had all but lost hope when she turned toward me and spoke.

"I'm sorry," she said. "I was about to order some coffee and Danish but now I can't seem to remember the Schroedinger equation. Isn't that silly? It's just slipped my mind."

"Evolution of probability waves," I said. "And if you're ordering I'd love an English muffin with muons and tea."

"My pleasure," she said, smiling coquettishly and curling up into a Calabi-Yau shape. I could feel my coupling constant invade her weak field as I pressed my lips to her wet neutrinos. Apparently I achieved some kind of fission, because the next thing I knew I was picking myself up off the floor with a mouse on my eye the size of a supernova.

I guess physics can explain everything except the softer sex, although I told my wife I got the shiner because the universe was contracting, not expanding, and I just wasn't paying attention.

The Back Page

Oversupply, Undersupply: Can We Ever Get Workforce Issues Right?

By Merrilea J. Mayo

There are two strident voices in the workforce debate. The first claims we don't have nearly enough scientists and engineers. The second (usually articulated by jobless scientists and engineers) claims we already have too many. Last year a *Wall Street Journal* article espoused the first view, quoting the President of the National Academy of Engineering in support of its arguments. Boy, did the NAE President hear from the holders of the second view—in spades.

How can both sides be right?

In my opinion, the answer is relatively simple. We have a vibrant, well-tested system for producing scientists and engineers in this country. It is called federal R&D funding.

As *Figure 1* shows, there is an extremely strong correlation between the R&D funding that the government issues every year, and the number of bachelors students produced—at least in the physical science, math, and engineering disciplines.

A more eloquent economic framework by Goldman and Massy makes the same case for S&E students at the PhD level. The problem, as it were, stems from the fact that federal R&D funding—which sets up domestic student supply—operates completely independently of any indicator or driver of "demand. "It is difficult to find any *economic* indicator—and we tried several—that correlates at all with student output to any degree of fidelity.

Consequently, it appears students are churned out whether or not they are needed by the market. Sometimes we get oversupply. Sometimes we get undersupply. But we rarely get it right.

Given this situation, it seems the rational thing to do would be to design an S&E workforce system where supply meets demand, where all workers get jobs and all jobs have workers. What would such a system look like? One appealing thought is that we could predict worker demand and then adjust congressional R&D appropriations accordingly.

Unfortunately, this solution makes two unfounded assumptions: 1) that scientists can control Congress and 2) that scientists have a model that accurately predicts worker shortages and surpluses.

The better approach is to simply "go with the flow." Forget about prediction and preemptive measures: just design a responsive system where the student production continuously and automatically readjusts to workforce demand, whatever that demand is at the moment.

In other words, reestablish the lost feedback loop between student supply and worker demand, so that federal R&D funding does not become the only input to student production.

First, there needs to be a mechanism by which students continuously receive input from the job market—not just at the career services interview table, after four years of education have already gone by. The blandishments of well-funded professors, though much more constant in a student's life, also do not qualify as "information about the job market." A "hot" field in the research market does not easily translate to a "hot" field in the non-academic job market, since basic research is usually five-25 years out from production.

One way to accomplish a job market reality-check for undergraduate students is to establish a tradition of student summer jobs in industry as part of the curriculum. There's nothing like trying to find a summer job and realizing no one wants your intended specialty to think about changing your direction to match the market.

In addition, a summer job experience lets you know quite viscerally that the courses you really needed to have had were design of experiments and statistics, not dislocation theory. As a professor, I discovered that India's IIT system was a mother lode of truly excellent graduate students. That system requires integrated academic plus industrial training of its undergraduates. So, integrated training is not only useful for those undergraduates who enter the workforce immediately upon graduation, it is also useful for undergraduates who wish to pursue advanced degrees.

At the undergraduate level, one also needs to recognize that the economy, and hence the job market, has a time constant much shorter than the average four year degree. Even if a student has a way of knowing that a particular field has a strong vacancy rate, and begins studies in that field, the vacancy rate can change dramatically by the time he/she graduates. Thus, there is a strong need to reduce the time constant associated with the degree to match the time constant of the job market. This can be done by delaying the choice of a major until the senior year—one year out from the job market, rather than four. This should cut down on hysteresis effects and the concomitant four year transients in undersupply/oversupply swings relative to the market, as observed by labor economists in many fields.

It will also give the undergraduate three years in which to develop a deep but flexible skill set that can be used for *any* technical job. In the engineering disciplines, such a curricular overhaul becomes much more possible under the Accreditation Board for Engineering and Technology (ABET) 2000 accreditation guidelines. Earlier ABET regulations prescribed exact sets and sequences of courses for a department's degree program to be accredited. Under ABET 2000, the rigid course requirements for engineering majors are gone. Instead, the department must establish its own educational outcomes metrics and prove continuing improvement in its students' accomplishments as measured by those metrics. Though some complain that these standards are in fact no standards at all, they do provide the flexibility for an enterprising department to completely abandon old "course quota" paradigms and strike out on a path that leads to greater employability of its graduates. Conveniently, the greater student employment rates would qualify as an ABET 2000 outcomes metric.

At the graduate level, the lack of feedback between supply and demand stems not only from the amount of R&D funding in each field, but the mechanism of that funding. A large fraction of graduate students receive federal funding in the form of research assistantships on federal grants. They take and the projects they work on are all tightly directed towards their advisor's end goal of getting the next grant, since it is the advisor who is paying the way. Separating the student's funding from the professor's funding—in the form of portable fellowships—gives the student the economic independence to pursue those training paths most likely to result in a job.

While the replacement of assistantships by fellowships is an often-voiced cure for undue academic self-replication (and jobless students), it has never been implemented by the federal agencies on a grand scale. A fear of unintended consequences keeps a wholesale transformation of the system from occurring, and budget arithmetic prevents the simple addition of large numbers of fellowships to the existing assistantships.

However, a median path might be to take existing grants and separate them into two parts: the first part, containing the stipend and tuition, would be sent to the receiving department to be used as a portable fellowship for a worthy student.

The second part, containing all the supplies, professorial salary, and research equipment support, would be sent to the research account of the grant-winning professor.

This scheme allows students to gain enough economic independence that they can chart a learning experience best suited to maximize their *own* chances of economic success, rather than their professors'.

If done well, the economic separation of student and professor may even benefit the department: the scheme could be arranged so the department obtains a federal agency commitment for student slots well ahead of the admission decision deadline. That would be a true luxury.

Beyond graduate school, one must look towards periodic retraining as a method of keeping people in registry with the ups and downs of the job market. Multiple education treatments per career are the logical next step in an educational progression that has progressively shortened itself to match technology cycles. The earliest technical trades—*e.g.*, goldsmithing, fletching, masonry—had time constants measured in multiple generations. Fathers would teach sons, because the underlying technology changed little from generation to generation.

When the industrial revolution arrived, the time constant of technology shifted to about one generation in length. Suddenly it made sense to send one's offspring to a university, because the technology changed completely about every thirty-fifty years.

Come the information revolution, and we find that the time constant of technical knowledge has again shifted. A once-per-lifetime degree no longer makes sense, when a complete turnover in technology occurs in a fraction of a lifetime. It is not surprising that the EE's and the IT workers have felt the pangs of forced obsolescence first and most strongly.

Eventually all disciplines will find that a single degree earned in one's youth no longer suffices for a lifetime of employment. The university system will have to adapt, perhaps offering accredited degrees in the form of "specialization modules." These would be one year, accredited "capsule" degrees, equivalent to the final year of specialization in an undergraduate curriculum—but without requiring the prior three years of effort demanded of first degree earners.

The prescriptions so far attempt to link the domestically educated workforce to domestically available demand—yet we live in a global world, where both people and jobs cross borders with increasing ease. How do we deal with the addition of the foreign-born, foreign educated into the workforce equation? We can take the same theme—trying to establish a feedback loop between supply and demand—and extend it to visa policy. At present, our visa ceilings are set by political factors. If enough interest groups complain, the visa ceilings go up (or down). If no one complains, the visa ceilings stay where they are.

However, the sensitivity of visa policy to political factors results in large waves of immigrants at times when there may or may not be jobs for them (or for the folks already in the US).

A more logical approach might be to establish an advisory board of labor economists that can watch domestic labor market indicators for shortages or gluts (usually reflected in rising or falling salaries, unemployment rates, etc.), and continually adjust visa allotments to keep the labor market on an even keel.

The US has long prided itself on the quality of its people—both home grown and adopted from afar —and the quality of its innovation. Maybe it's time to apply some of that innovation to the future of its people, and retool our workforce system.

Merrilea J. Mayo is president of the Materials Research Society. She would like to recognize the contributions of Bill Joyce to several of the ideas in this column, most notably the reduction of effective time to degree, the value of summer jobs as feedback loops, and the concept of packaging continuing education into one year modular degrees.

Figure 1

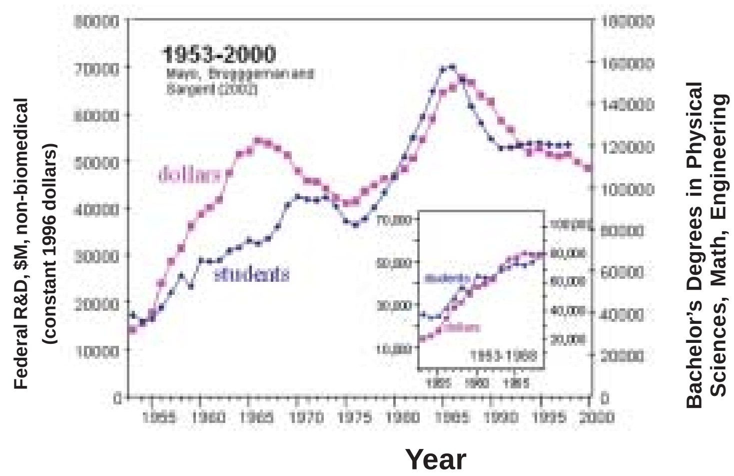


Figure 1. *Correlation between Federal R&D expenditures and bachelors' student production in the physical sciences, math, and engineering disciplines from 1953 to 2000. The apparent separation between the two curves in the early years results from a different dollar-to-student ratio in those years and can be eliminated by appropriate axis scaling (insert). A regression of students vs dollars gives 1.03 students/million 1996 dollars from 1953-1968 (R2=0.95) and 2.46 students/million 1996 dollars from 1970-2000 (R2 = 0.84).*

Sources:

1) *Budget Data: Table D in National Patterns of Research and Development Resources: 2000 Data Update (NSF Pub 01-309), National Science Foundation, Arlington, VA. Also, the NIH Almanac (NIH Pub. 01-5), National Institutes of Health, Bethesda, MD, 2001.*

2) *Student Data: Science and Engineering Degrees 1966-1998 (NSF Pub 01-325), National Science Foundation, Arlington, VA, 2001. Pre-1966 data: Science and Engineering Degrees: 1950-80. A Source Book. Special Edition. National Science Foundation, Arlington, VA, 1982.*

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