International Physics Community Joins Forces for 2005 World Conference in South Africa

As part of the celebration of the World Year of Physics 2005, UNESCO, ICTP, IUPAP and the South African Institute of Physics (SAIP) will sponsor a World Conference on Physics and Sustainable Development, to be held October 31-November 2, 2005, in Durban, South Africa. The APS will be a co-sponsor and help with the organization.

The conference will review the contributions that physics has made to society in the past, and formulate a plan for the contributions that it can and should make in the future. The conference is partially a follow-up to a broader United Nations World Summit on Sustainable Development held in Johannesburg in the summer of 2002. Four themes have been chosen: physics and economic development, physics and health, energy and the environment, and physics education.

Several international conferences have been scheduled for 2005 on these topics, and will serve as preparatory meetings for the 2005 World Conference—the first time the International Physics Community will focus its collective attention on these themes, and the interplay between them.

Attendees of about 500 people will come from 40 countries. Physicists are particularly eager to attract participants from Africa, Asia, Latin America, and the Middle East, as well as from more developed countries, and the organizers hope to be able to provide travel grants for as many as half of the attendees.

"Physics has contributed greatly to the health and economic well-being of people around the world. However, the contributions have not led to equal progress in all parts of the world," said APS Director of International Affairs Amy Flatten. See SOUTH AFRICA on page 5

Integral Looks at the Cosmos Through Gamma Glasses

Scientists have opened a new window on the formation of elements in the universe with a new space-based gamma ray telescope called INTEGRAL (International Gamma Ray Astrophysics Laboratory), launched by the European Space Agency in 2002. At the APS April meeting, researchers on the collaboration reported on the scientific highlights to date of the project.

Gamma ray photons are a million times more energetic than those of visible light, and can pass through matter with hardly any interaction. Even more powerful than X-rays, they are nonetheless blocked by Earth’s atmosphere. Hence, gamma ray astronomy is largely space-based.

Positron annihilation is one source of gamma rays in the universe. Gamma rays are often created in the radioactive decays of short-lived elements inside such cosmic sources as supernovae and novae. Other sources include pulsars and microquasars. Launched in October 2002, Integral uses two specially designed gamma ray telescopes to register these elusive rays. One provides the sharpest images of the gamma ray sky ever seen and the other measures the energies of the gamma rays with unprecedented accuracy. The telescopes work in tandem with an X-ray monitor and an anti-coincidence detector. According to Roland Diehl of the Max Planck Society in Garching, Germany, this is the first time (serving on the President’s Science and Advisory Committee).

As the founding director of the Xerox Palo Alto Research Center, he assembled and led a research laboratory imbued with a vibrant spirit that has had a profound effect on industrial research and played a decisive role in the creation of the modern computer.

The American Physical Society has commemorated his manifold contributions by establishment of the George E. Pake Prize. The APS Council expresses deep sympathy to his wife, children, grand-children, and many friends.

Innovation Task Force Unveils New Advocacy Campaign

On April 20, at a press conference attended by members of industry and academia, the APS unveiled an advocacy campaign to illustrate the importance of basic research to the future of American innovation, economic growth, and job creation. Targeted at policymakers and the general public, the initiative will seek to reverse a decline in federal investment in basic research in the sciences and engineering through paid advertising and traditional lobbying and outreach to policy makers on Capitol Hill.

The new initiative is sponsored by the Task Force on the Future of American Innovation, which includes the APS and 13 other organizations associated with business and academia. Specifically, the task force is calling on the federal government to grow the budgets of key research agencies by 10-12% per year over the next five to seven years. These agencies include the National Institute for Standards and Technology, the National Science Foundation, the Department of Energy’s Department of Science, and the Department of Defense’s Defense Research Accounts.

Basic research in the US over the last few decades has led to breakthroughs in fields that have spawned entirely new industries. Notable examples include lasers, the integrated circuit, fiber optics, the Internet, and global imaging systems.

Such innovations in turn created new industries: the semiconductor industry alone has created 226,000 jobs with worldwide sales of $166 billion. Basic research at American universities has created 4,000 spin-off companies with an estimated 11.1 million employees and annual worldwide sales of $323 billion. According to Robert Shaw, a Nobel laureate in economics, at least 50% of the nation’s economic growth over the last 50 years has come from technological innovation.

Yet US federal investment in basic research continues to decline. While the GDP nearly doubled from $6 trillion in 1980 to $12 trillion today, federal investment in R&D in the physical and mathematical sciences and engineering plummeted from $6 billion to $2 billion. And according to President Bush’s FY05 budget request continues the trend of previous administrations.

See TASK FORCE on page 4

Photo Credit: ESA, F. Lebrun (CEA-Saclay)
Sometimes it can take awhile for experiment to catch up with theory in physics. Predicted in the 1920s, it took about 20 years before actual creation of the first Bose Einstein condensate (BEC) in the laboratory. That achievement established an entirely new branch of atomic physics that continues to provide a treasure trove of new scientific discoveries, since it enables scientists to study the strange and extremely small world of quantum mechanics if they were looking through a giant magnifying glass. The BEC phenomenon was first predicted by Satyendra Bose and Albert Einstein: when a given number of identical Bose particles approach each other sufficiently closely and move slowly sufficiently, they will combine to form a Bose-Einstein condensate (BEC) at a low enough (mere billionths of a degree above absolute zero) temperature. The atoms will behave like the photons in a laser: they will be in a coherent state and constitute a single “superatom.”

JILA’s Carl Wieman (University of Colorado, Boulder) and Eric Cornell (NIST) first started searching for a BEC around 1990 with a combination laser and magnetic cooling apparatus. Wieman proposed the use of 200 diode lasers (the same type used in CD players) instead of the $150,000 lasers other groups were using. His approach was initially met with skepticism by his colleagues, but Wieman began to report regular progress, several other groups joined the race to achieve the first BEC. Between January and July 1995 atoms at room temperature, the JILA team first slowed the rubidium atoms and captured them in a laser trap. This cooled the atoms to about 10 millionths of a degree above absolute zero—still far too hot to produce a BEC. Once trapped, the lasers are turned off and the atoms are held in place by a magnetic field. The atoms are further cooled in the magnetic trap by selecting the hottest atoms and kicking them out of the trap. Then came the tricky part: trapping sufficiently high density of atoms at temperatures that were cold enough to produce a BEC. This, Wieman and his colleagues had to devise a time-averaged orbiting potential trap (an improvement to the standard magnetic trap). The world’s first BEC was achieved at 10:54 AM on June 5, 1995 in a laboratory at JILA, a joint Institute of Universities of Colorado, Boulder, and NIST. The BEC was formed inside a carrot-sized glass cell, and made visible by a computer camera that monitored about 20 microns in diameter, or about one fifth the thickness of a sheet of paper. The result was a BEC of about 2,000 rubidium atoms that lasted for 15–20 seconds. Shortly thereafter, Wolfgang Ketterle also achieved a BEC in his laboratory at MIT.

Today, scientists can produce condensates of much greater numbers of atoms that can last as long as three full minutes, and they continue to glean intriguing new insights into this unusual form of matter. Between September 2001, over three dozen other laboratories had replicated the discovery. In 1997, he and his colleagues developed an atom laser based on BECs that was able to dip single atoms downward, and captured them in place by a laser trap. On February 2, 1999, a team at Harvard University used a BEC to slow down light to just 58 MHz by shining a laser beam through the condensate. Two years later the team announced that it had briefly brought light to a complete stop.

In March 1999, scientists at the NIST facility in Boulder demonstrated that they could entrain two super cold atoms into a beam to create a device that shoots out clusters of atoms in any direction. The breakthrough could lead to a new technique for making atom chips, or to construct nanodevices one atom at a time.

On June 28, 1999, JILA researchers achieved the first fermion degenerate gas of atoms. A group of German researchers demonstrated in 2001 that BECs can be created and manipulated using so-called atom chips, an achievement that could form the basis of integrated “atom circuits” based on the motion of atoms and their interaction.

And in December 2002, physicists in Innsbruck created the first BEC out of cesium atoms, the same type of atoms that constitute atomic clocks and also play a key role in certain metrological applications, including measurements of the earth’s dipole moment of the electron.

The Colorado group is now experimenting with this new form of matter in new and different ways. In July 2001, he and his colleagues were able to make a BEC shrink, which was followed by a tiny explosion similar in some ways to a microscopic supernova. So they dubbed it a “Bosenova.”

About half of the original atoms appear to vanish in the process. The condensate is reduced to 3 billionths of a degree above absolute zero—the lowest temperature ever achieved to date. Condensate physicists shared the 2001 Nobel Prize in physics for their accomplishment. Their joint discovery of the BEC continues to provide impetus for theoretical applications in such fields as precision measurement and nanotechnology, as well as the citation from the Royal Swedish Academy of Sciences said. The apparatus used by the JILA team is now part of the permanent collection of the Smithsonian Institution in Washington, DC.
QuarkNet Brings Research Experience to the High School Classroom
By Ernie Tretkoff

High school teachers around the country are participating in particle physics research, changing their teaching styles, and integrating high-energy physics into their lessons, thanks to the QuarkNet program at Fermilab, which has been running since 1999.

“We think it’s really one of the most valuable physics education programs that we have,” said Judy Juday, Fermilab’s physics education officer. “It brings so many different players into the mix. It’s a great way of bringing in people from a wide variety of backgrounds.”

Here’s how the QuarkNet program works: First, after a weeklong orientation at Fermilab, selected high school teachers spend a summer doing research with a physicist-mentor from a local university or laboratory. The teachers might work on experiments at CERN or Fermilab, or at their own university.

After their research summer, the teachers try to integrate some of what they learned into their classroom science. That might mean doing a separate unit on particle physics, many teachers find they can integrate particle physics into lessons on basic concepts such as the conservation of momentum and energy. Also during the school year follow-up, CERN and Fermilab will continue their QuarkNet teachers, along with their mentors, develop a three-week research-based program for up to ten “associate” teachers. The following summer, the lead teachers and their mentors present their three-week program at their QuarkNet center, the university or lab where the mentor teachers work.

One goal of the program is to help teachers learn how scientists work, and look at the way they bring those work skills into their classroom science. “It’s really about the teaching model to research in the classroom,” said Margaret Bardeen, managing Fermilab’s education office and spokesperson for QuarkNet. QuarkNet also aims to get teachers a more “inquiry-based” approach that involves hands-on projects rather than the traditional lecture format. Several teachers have indeed changed the way they teach.

For example, Jeff Dilks, a teacher in Iowa, conducted an experiment with his high school class from last year, and he said he realized that scientists wouldn’t do that. So

The next day he had the students think about how they could change the experiment to improve the data. The class ran the experiment and got better results. Dilks also found that the QuarkNet program has earned him, and his subject, new respect at his school. “There’s a new interest in what goes on in physics. Administrators ask what I’m doing. Secretaries provide me with newsclippings. Physics has a much higher profile around my school,” he said.

Another QuarkNet teacher, Deborah Roudeshell of northern Virginia, designed her entire physics class around the theme of the search for the Higgs boson. She taught the standard high school physics topics, but always introduced the concepts in the context of how they would apply in the search for the Higgs.

The physics researchers also benefit from the QuarkNet program. Randy Ruchti, a Project Principal Investigator and Fermilab QuarkNet mentor, appreciated the chance to expand his research group to include the teachers, and he said he learned a lot from them. “First of all, I’ve learned that among the difficulties teachers face, many are teaching to a test. So there is a lot I can learn from them. Ruchti participates in the program because he believes that “practicing scientists have an obligation to reach down to attract young people into science.”

Ruchti also said QuarkNet is something that has more traditionally under-represented groups, especially by attracting teachers who work in inner city schools. Since QuarkNet began in 1999, nearly 500 high school teachers have participated in the program, either as lead teachers or associate teachers. About 50 centers are now operating across the country. The program plans to expand to include about 60 centers, and will reach over 700 teachers. Some of the centers that have been operating for several years are now expanding to include several high school students in a summer of research at the center. One of the reasons the program has been so successful, said Bardeen, is that “it is run by a staff of teachers. "I always feel it’s important to put teachers in leadership positions," she said. “They have the understanding of what teachers face in the classroom, but they also have credibility.”

Laser Science, Quantum Optics Featured at 2004 CLEO/IQEC Conference

Breakthroughs in NASA technology, medical imaging, and homeland security technology were among the highlights at the 2004 Conference on Lasers and Electro- Optics (CLEO)/Quantum Electronics Conference (CLEO/ IQEC) — an 11-day conference showcasing the latest results in laser science, quantum optics, and related fields— which took place May 16-21 in San Francisco, California. The meeting was jointly sponsored by the APS, the Optical Society of America, and the Institute of Electrical and Electronic Engineers, Lasers and Electro- Optics Society.

The featured plenary session explored the history of the laser and future applications for technology, presentations on optics and photonics in bioscience; and optical metrology. There was also a joint symposium celebrating the 30th anniversary of the invention of the laser.

Catching Defects in Space

ッシは発表した。彼が検出できる読解ユニットの一部を含むビームカムは、燃料タンクの表面にかかる、表面の放射のランダムな部分を検出する。この技術は、スペースシャトルの燃料タンクの安定性を確認するのに役立つ可能性がある。

"Do not attempt backstepping." In fact, none are labeled, except a small left-hand dial that marks power settings. At a small gummed paper sticker sternly declaring, "These are logon/timeout. The possible settings are C, E, D, and A."

The dial is set at A, which seems to be as good a logarithm as any. The switch near the rectangular screen is held firmly down by a piece of adhesive tape with faint blue lettering, admonishing the would-be user with an incomprehensible warning: "Do not attempt (sic) to rotate reticulator slit unless you have been checked out by JCIM.

With fading hopes and dangling participles, further enlightenment is sought from the primary instruction sheet, where an earlier observer has penciled the remark, "Reckitorial can be backstepping at anytime."

Novice observer backsteps on tipout of the control room all the way to the parkin lot and heads for home.

On the homefront, high priority is given to the task of revising curriculum vitae to describe research interest as theoretical astrophysics rather than observational astronomy.

—Virginia Trimble

Gamma from page 1

The young woman in the photo is Erin McCamish, and she is holding an optical decoder unit for the CMS hadron calorimeter that she assembled. The summer this picture was taken, she was a student at Lake Shore High School in Stevensville, Ml. Now she is at the University of Michigan studying physics.

For example, Jeff Dilks, a teacher in Iowa, conducted an experiment with his high school class from last year, and he said he realized that scientists wouldn’t do that. So
Suppression of Thought is Alarming

Evolution is clearly evident everywhere in our environment, but I believe that true understanding demands that one start at the beginning. The Big Bang marked the beginning of the universe, and deductive reasoning is the only way to comprehend the mind-boggling consequences for scientific discovery, technological innovation and economic growth. Universities have led the way in the past and can play a leading role again in the future.

Stronger Stand Needed on Evolution

I have just read the APS News for April, 2004 and was interested in the article “APS Helps Local Organizers in State Battles on Evolution” beginning on page 5. I was particularly interested in the sentence on page 6 caught my eye: “These conclusions are epitomized at the place of the evolution is a topic in biology, not physics. But it is a topic that all scientists can get involved in.”

The debate involves more than just biologists and geologists. Creationists argue that a literal interpretation of scripture, estimates the age of the earth at little more than 6,000 years. This does violence to the evidence from physics and astronomy of a much older earth, namely 4.5 billion years, and an even older universe.

Moreover, anyone who has had the misfortune of being drawn into a debate with creationists will recognize the lengths they will go to distort information about the physical world in an attempt to mislead the public and competing for a “tipping point” at this many scientific journals and the National Science Foundation can get involved in.

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In an unprecedented move, 55 senators signed a bipartisan letter to Energy and Water Development Appropriations Subcommittee Chairman Pete Domenici (R-NM) and Ranking Member Harry Reid (D-NV), urging them to increase the budget for the Department of Energy’s Office of Science by 10% over that requested by the Bush Administration.

With this letter, more than half of the Senate is now on record for substantially higher funding for the Office of Science.

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When did APS News become a megaphone for the Republican Party and other assorted Bush bashers? Michael Lubell turned the April issue into a howling propagandistic diatribe against the “Beltway” column. A thoughtful analysis of Washington trends would indeed serve the interests of APS members, but the “Beltway” column is neither. There’s no need to “analyze” anything in this way, or to state that “the Beltway” column is a thinly veiled partisan attack, filled with jabs at the Bush administration, as though the APS News was the only news source, elsewhere in the way of facts or opinions of anyone other than himself. You can find much of the same at www.washingtonpost.com or www.latimes.com.

This banal “analysis” isn’t worth the paper and ink spent on it. If APS News can’t tell the difference between sober analysis and partisan Bush bashing, then maybe it shouldn’t publish political articles at all. -

Michael Lubell

Helping has been exorcised last month for dissing the Democrats. I am much amused by this reaction to my most recent column. Much of what the letter writers criticize is in their own eyes. For the record, I am not a heavy-handed partisan Democrat. My political views are about as far from the center as the majority of APS members, but I do my best not to reveal them. Apparently I succeeded all too well this time.

My point in the column was that the GOP—which had remarkable achievements last year and had the Democrats off balance—was suffering a change in fortunes. With control of both houses in Congress and the White House, they were managing with political agitpatriotes, Republicans are still in control, but only as a veritable fortress as it was in 2004. That has not proved to be the case. And it has enormous potential consequences for R&D funding, which now accounts for 15% of the total discretionary budget, including defense and non-defense.

With the Republicans put on the defense ropes by Democratic criticism, the outlook for science is not good. Anyone who doubts me should personally ask members of the Republican leadership, or any person of the budget appropriators. I have spoken to quite a few of them, and that’s what they are saying. I haven’t yet spoken to the Senate, but perhaps I should, and report that information in my next column. That way, I can maintain a certain degree of political neutrality.

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Editor’s Note: As a registered lobbying organization, the APS advocates for increased support for science, and for other public policy positions expressed in statements of the APS Council. These activities are distinct from the one-time “Beltway” lobby for particular candidates or parties. Likewise, “Inside the Beltway,” appearing bi-monthly in APS News, provides an inside analysis and commentary on the Washington scene by the APS Director of Public Affairs, Michael S. Lubell. Sometimes, however, reader takes issue with not only Lubell’s but also his impartiality. The April column generated a particularly voluminous and vociferous batch of letters. We reprint excerpts from four of them, here along with a reply from Lubell.

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Closing In on the Mysterious Dark Matter?

Initial data from the Cryogenic Dark Matter Search (CDMS II) was reported at the APS April meeting in Denver. This underground observatory in Northern Minnesota has provided a window into the search for the so-called Weakly Interacting Massive Particles (WIMPs). Should such particles be observed, it could answer the mystery of both the dark matter problem and super symmetry. The CDMS II collaboration observed “underground astration” with particle detectors located nearly half a mile below Earth’s surface in a former gold mine in Soudan, Minnesota. With cosmic rays and the background particles they produce, made of germanium and silicon crystals, the detectors have a resolution of one-tenth of a degree of absolute zero. They are capable of measuring both the charge and vibration produced by particle interactions within the crystals. The detectors are now able to look for signals just one-fourth as intense as any seen before, and the team expects to improve sensitivity by a factor of 10 to 20 over the next few years. WIMPs will signal their presence by releasing less charge than most background particles produce for the same amount of vibration.

A WIMP, which carries no charge, is expected to have roughly one-hundred times the mass of a proton. Yet WIMPs are able to slip through ordinary matter while barely leaving a trace. The presence of dark matter in the universe is detected through its gravitational effects, from the growth of structure in the early universe to the stability of galaxies today. Dark matter cannot be made of the ordinary matter forming objects in the visible universe, and constitutes as much as seven times more total mass than ordinary matter. WIMPs are a strong contender for dark matter.

The nature of dark matter is fundamental to our understanding of the formation of the universe. With the CDMS II collaboration, either the dominant mass of the universe will be discovered, or a large number of supersymmetric models will be excluded as possibilities. WIMPs might be the as-yet unknown states of some of the “exotic” atomic particles, called neutrinos. That would provide strong evidence for supersymmetry, which predicts that every known particle has a supersymmetric partner with complementary properties, although no such partners have been observed to date. Many supersymmetry models predict that the lightest such particle, called the neutralino, has a mass of about 100 times that of the proton.
Together with the American Association for Physics Teachers (AAPT), the APS has appointed a new Joint Task Force on Graduate Education in Physics. Chaired by Boston University’s David Campbell, the task force will examine current trends in physics research and education that may be contributing to the fragmentation of the physics community.

The task force is charged with examining and summarizing di-rec- tions in graduate education in physics, with special emphasis on physics 

It will identify special chal- lenges and problems facing 

graduate education in physics, and recommend appropriate actions for APS, AAPT, and/or PhD-granting universities to take in response to these themes.

"The physics community has not reviewed its graduate educa-

tion programs for ten years," said APS Executive Officer Judy 

Franz about the rationale for creating the task force. "We hope that the task force will be able to suggest positive steps to help graduate students learn physics that will enhance their un-

derstanding of the interconnections between different fields; prepare them to apply physics in a vari-

ety of fields or disciplines; and foster their appreciation of the breadth of physics.

The other task force members are: Renee DiBlie, Penn State University; J.D. Garcia, University of Arizona; James Gates, University of Maryland, College Park; Michael Pasierb, North Car-

olina State University; Peter Jung, Ohio University; Joel Fajans, University of California, Berkeley; Allen Goldman, University of Minnesota; and Tom Appelquist, Yale University.

Two-Day Los Alamos Event to Honor Oppenheimer

In honor of the cen-

tennial of the birth of J. Robert Oppenheimer, and to recognize 

the preservation of the Manhattan Project his-

tory at Los Alamos, a two-day public event will be held June 25 and 

26 in Los Alamos. 

Born on April 22, 1904, Oppenheimer was the first 

director of the Los Alamos labo-

ratory, and the technical director of 

the Manhattan Project that 

developed the atomic bomb during 

World War II. 

The event, organized by the 

Atomic Heritage Foundation, the 

preservation project dedicated to preserving 

the history of the Manhattan 

Project and the Atomic Age.

will be held June 25 and 

26 in Los Alamos. 

One of the speakers will be 

Professor Jon Kalb, who will deliver a dedication, a reception 

and dinner, on June 25.

Robert Oppenheimer (photograph courtesy of the National Archives)
The American Physical Society (APS) is seeking applications and nominations for the position of Director of Education and Outreach Programs to replace Fred Stein, who plans to retire in September. The person selected will play the leadership role in all APS education programs, including a major program to improve the physics education of K-12 teachers (PhysTEC), and will work closely with the Committee on Education and the Forum on Education. In addition, he or she will work with the Committee on the Status of Women in Physics and the Committee on Minorities in Physics in efforts to increase the number of women and minorities with careers in physics. An excellent staff is available to help with these programs.

Qualifications for the position include a PhD in physics or a related field, familiarity with the physics research and education communities, experience in managing large projects, some experience in working with teacher education programs, and excellent interpersonal and communication skills. For consideration, send a letter, resume, and professional references to Judy Franz, APS Executive Officer, franz@aps.org, by June 15.

Some recent Focus stories:

- Ghost of SuperConductivity on a Fall Day
- Magnetic measurements hint at vestiges of superconductivity near room temperature—far too warm for the full superconducting phenomenon to exist.
- Cactus Patterns Buckle Up
- Computers can simulate the forces in a growing plant, leading to spiral patterns with special mathematical relationships.
- Landmarks: The First Million-Volt Accelerator
- In 1932, the invention of the cyclotron marked the start of modern particle physics.

Statement on Referencing Guidelines

Authors have an obligation to their colleagues and the physics community to provide a set of references that communicates the precedents, sources, and context of the reported work. Proper referencing gives credit to those whose research has informed or led to the work in question, helps to avoid duplication of effort, and increases the value of a paper by guiding the reader to related materials. It is the responsibility of authors to have surveyed prior work in the area and to include relevant references.

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BACK PAGE from page 8 disciplines to intersect in unexpected ways, and public interest in science continues to grow. Still, we have great deal to worry about. Enlarging budget deficits threaten to constrict future budgets for science, immigration policies and practices may deflect new talent from the United States, and inappropriate attacks on peer review and a failure to separate science from politics can undermine the delicate balance between scientific independence and governmental oversight. And we may not be moving fast enough to promote science and its uses in the developing world, and to provide access to scientific findings through the Internet. Effective collaboration between science and government seems to me one of the few rational ways to find our path in a largely irrational and increasingly dangerous world. I hope that an accounting of these concerns can ultimately help to strengthen our traditional relationship.

COUNCIL from page 1 edged in publications, presentations, and performance appraisals. In particular, subordinates who have made significant contributions to the concept, design, execution, or interpretation of a research study should be afforded the opportunity of authorship of resulting publications, consistent with APS Guidelines for Professional Conduct.

Supervisors and/or other senior scientists should not be listed on papers of subordinates unless they have also contributed significantly to the concept, design, execution or interpretation of the research study. Mentoring of students, postdoctoral researchers, and employees with respect to intellectual development, professional and ethical standards, and career guidance, is a core responsibility for supervisors. Periodic communication of constructive performance appraisals is essential. These guidelines apply equally for subordinates in permanent positions and for those in temporary or visiting positions.

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Statement on Referencing Guidelines

Authors have an obligation to their colleagues and the physics community to provide a set of references that communicates the precedents, sources, and context of the reported work. Proper referencing gives credit to those whose research has informed or led to the work in question, helps to avoid duplication of effort, and increases the value of a paper by guiding the reader to related materials. It is the responsibility of authors to have surveyed prior work in the area and to include relevant references.

Proper and complete referencing is an essential part of any physics research publication. Deliberate omission of a pertinent author or reference is unethical and unacceptable.

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The relationship between science and government has not always been harmonious. Historically, science, like philosophy and the arts, was generally either privately funded by the wealthy or financed by wealthy patrons, who might or might not have political power. More recently, the growth of science has been aided by the new philanthropic foundations. Following the industrial revolution, as commerce learned to use the fruits of science in the 19th and 20th centuries, increasing levels of support also came from the industrial sector, often with the intention of producing something of value to the investor, not necessarily knowledge for the general public.

One of the key characteristics of governmental involvement in science is its most prominent purpose: to advance the public welfare. To achieve this goal, science and government need to be mutually supportive. In its simplest form, we can say that this means making discoveries that lead among other things to practical inventions, economic prosperity, and better health—of which are the public interest.

This relationship depends on trust between the two parties and the willingness of the public to support—a product of expanding costs that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insulting, and humiliating. One possible treatment that is annoying, insult