BPA News

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Physics 2010: An Assessment of and Outlook for Physics

The Board on Physics and Astronomy regularly engages in a survey of all the branches of physics. Since the process occurs every 10 years or so, it is called the decadal survey of physics. Each of the major disciplines within physics is now reviewed serially. The survey process, which takes several years, encompasses atomic, molecular, and optical science, plasma physics, condensed matter and materials physics, elementary particle physics, nuclear physics, and gravitational physics. The most recent decadal survey, *Physics in a New Era*, was capped off with the release of its overview volume in 2001. It is now time to begin plans for the next survey, to be called *Physics 2010.*

After discussions that took place at several meetings, the Board has prepared a set of guidelines for each volume of the survey. The purpose of the guidelines is to provide a common framework for the volumes of the survey and to promote the most successful aspects of recent studies to enhance the effectiveness of the entire process. The key elements of the guidelines are described here.

Key Elements

The decadal survey will focus on an assessment of and outlook for each branch of physics. Each assessment will be conducted by an independent ad hoc study committee appointed by the National Research Council based on the advice and recommendations of the Board. For branches of physics where standing committees with relevant overlapping expertise are available, the standing committees will provide assistance in preparing the project proposal, forming the committee, and selecting qualified reviewers for the report review process. The decadal survey of physics serves two broad purposes: (1) it provides a periodic snapshot of the field that is useful for tracking and understanding the evolution of the science and (2) it provides a process whereby emerging opportunities can be identified and developed. Ultimately, the decadal survey is both inward- and forward-looking.

For a given discipline, committee members will be sought with expertise in the main subdisciplines. Additionally, however, several members of the committee will be from other branches of physics. This effort will help place each discipline within the broader context of physics and build connections between the different disciplines. In some cases, a committee might even include non-physicists or be chaired by someone from another discipline. The Board believes that involving a broader group of people in the consensus-building process will be beneficial for each discipline as well as for physics as a whole.

The decadal survey will focus on identifying the science drivers for the physics and the enablers of progress toward science goals. By asking each committee to focus on the compelling

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In this issue:

The Physics of the Universe

A Strategic Plan for Federal Research at the Intersection of Physics and Astronomy*

The opportunity to gather important new knowledge in cosmology, astronomy, and fundamental physics stems from recent discoveries suggesting that the basic properties of the universe as a whole may be intimately related to the science of the very smallest scale. The properties of stars and galaxies, the existence and behavior of black holes, and the way that the universe changes with time may be connected to the physics that governs elementary particles such as quarks and other constituents of atoms.

In 2002, the National Research Council released the report of the Board on Physics and Astronomy's Committee on Physics of the Universe, *Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century*. The committee, chaired by Michael S. Turner of the University of Chicago, prepared an assessment of and strategy for this area of research at the intersection of astronomy and physics. The committee identified 11 particularly direct questions that unveil and encapsulate the rich science opportunities at these crossroads. The report presented seven recommendations to facilitate the research, development, and coordination critical for realizing these scientific opportunities.

In response to the compelling science opportunities and the clear framework outlining them, the White House's National Science and Technology Council's Committee on Science chartered an Interagency Working Group (IWG) on the Physics of the Universe to examine the investments required in this new area of scientific research and to develop priorities for further action. The agencies of the Committee on Science agreed that coor-

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**This article has been adapted (with permission) from the report referenced herein.*

Highlights of the Spring Meeting of the Board on Physics and Astronomy

The Board on Physics Astronomy convened on April 16-17, 2004, at the Keck Center of the National Academies in Washington, D.C., for its annual spring meeting. Chair Burton Richter opened the meeting with some personal observations. Noting that many people are seriously concerned about the growing deficit in the budget, he suggested that the outlook for an increase in funding for physical sciences was grim and that the real goal this budget season might be to simply avoid serious cuts.

With a warm welcome from the BPA, Pat Dehmer kicked off the morning session by discussing the status and direction of DOE's Office of Basic Energy Sciences (BES). In the FY05 budget request, BES didn't fare too badly, she said, in part because of an initiative within her office to take up the basic research challenges of the President's hydrogen fuel initiative. Although there is a significant gap between the goals of the initiative and present-day projected capabilities, a workshop chaired by Mildred Dresselhaus of MIT assessed the challenges and emerged with a very positive outlook. There are three critical problems: (1) production of hydrogen; (2) storage of hydrogen as a fuel source; and (3) cost and efficiency of fuel cells to extract energy from the hydrogen fuel. Dr. Dehmer suggested that the Dresselhaus workshop and panel report helped identify a $21M component for the BES budget that focused on these issues. Turning to broader topics, she commented that faith in the "thousand flowers" method of fertilizing and nurturing a diverse portfolio of research activities has sometimes been questioned for its lack of "thematic content." Taking the comments as an inspiration, she suggested that one could organize the different research programs in BES under the generic rubric, "Can We Understand, Predict, and Control the World Around Us?"

Reviewing the national user facilities supported by BES, Dr. Dehmer called the national light sources "mammoth success stories." She pointed out that the brightness of these synchrotron sources has increased much faster than the Moore's law rate over the past few decades. The Linac Coherent Light Source is moving ahead and promises another enormous leap forward. Similarly, the Spallation Neutron Source and the five Nanoscale Science Research Centers (NSRCs) are under construction. Addressing a deeper concern, Dr. Dehmer stated that the highly constrained outyear budget scenarios are likely to present increased challenges. She outlined a call to action for the community: (1) simple and compelling expositions of the "what" and the "worth" of non-medical-related physical science research need to be perfected; (2) if the community does not provide some advice about questions of balance and proportion (between large- and small-scale science or between different research topics), then OMB and OSTP will be forced to make decisions on their own; (3) community planning must incorporate grand challenges and long-range goals, but must also be based on realistic funding scenarios. Ultimately, she said, everyone needs to experiment with paradigm shifts in the way science is communicated to decision makers.

Robin Staffin then discussed the activities of the Office of High Energy Physics at DOE. Summarizing the budget outlook, he said "There is a lot of physics left to do and yet decreasing funds with which to do it." The national user facilities would see an increase in FY05 according to the President's Budget Request, but basic research would decrease, averaging out to +0.5 per cent. Most of the increases in user facility funding are being directed toward Fermilab to help realize Run II and to start work on BTeV. Dr. Staffin then introduced the joint DOE and NSF request to the NRC for a study on the future of elementary particle physics (see the *Physics 2010* article in this issue). Commenting on Fermilab, Dr. Staffin said that a number of recent review panels have reported that "things are starting to be fun again," with good progress being made on increasing the luminosity. The energy frontier will be ceded to the Large Hadron Collider after 2007, when that project will be commissioned; Dr. Staffin noted that while the United States comprises 15-20 per cent of the researchers in the international

project, the United States is only providing 10 per cent of the cost. He finished up by describing two emerging projects, the Joint Dark Energy Mission (JDEM) and the Linear Collider (LC). JDEM is a high priority in the Office of Science's 20-year facilities plan, and offers an opportunity to collaborate with NASA on its Dark Energy Probe in the Beyond Einstein program. Unfortunately, NASA funding for the Beyond Einstein probes has been deferred beyond the 5-year budget horizon. DOE is continuing R&D activities for SNAP, its leading concept for the JDEM mission, but does not expect to be able to maintain the project indefinitely while NASA evaluates the future of the Beyond Einstein missions. On the LC, Dr. Staffin emphasized that a wide variety of professional groups have achieved consensus that an electron collider with a center of mass energy of 500 GeV, upgradeable to 1 TeV, is the next machine needed to advance the science. The LC does provide significant complementarity to the LHC, he stated. Dr. Staffin closed his presentation with several issues: (1) neither the site nor the technology, let alone the funding, for the LC have been identified; (2) the future of the domestic program, including the mix of laboratories and peoples and the balance of accelerator/nonaccelerator programs, is unclear; (3) the future of joint international and interagency programs is equally unclear; and (4) there is concern about the adequacy of accelerator research and development activities in the United States.

Dennis Kovar presented an update on activities at the Office of Nuclear Physics at DOE. He described the five major scientific thrusts of the field: quark structure of matter, phases of nuclear matter, nuclear structure and dynamics, nuclear astrophysics, and fundamental symmetries. He said that investments so far have yielded significant progress and future progress is foreseen; in the longer term, however, additional investments will be needed in order to maintain leadership. Dr. Kovar presented several of the recent related scientific accomplishments, including neutrino flavor oscillation, the new phase of matter observed at RHIC, and observation of pentaquark candidates at Jefferson Lab. Budgetwise, the office is up 2.9 per cent in the FY05 request, dominated by medium-energy and heavy-ion facility operations. Priorities in the FY05 budget request are to effectively operate the user facilities, to enhance support for university and laboratory researchers and theorists, and to support needed investments for the future. Top priorities for major new construction are the Rare Isotope Accelerator (RIA), an underground science laboratory, and an upgrade of the Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab. These priorities are reflected in the Office of Science 20-year facilities plan, Dr. Kovar said. He also indicated that these nuclear physics initiatives directly address three of the questions raised in *Connecting Quarks with the Cosmos*.

Anne Davies then discussed the status of DOE's Office of Fusion Energy Sciences (OFES). She described the budget outlook for OFES (mostly flat at +0.6 per cent) and identified some of the $31M that is moving to support ITER by refocusing science and technology efforts. Support for inertial fusion energy in her office is in decline, and fusion technology is being closed out, although some of the activities are being moved to the plasma technology program. To trim costs, facility operations are being shortened to 14 weeks instead of 18. Other activities are being stretched out over more time to reduce the yearly expense. The future direction for FIRE is unclear. Dr. Davies commended the Burning Plasma Assessment Committee of the NRC for its recent final report, saying that OFES is already embracing two of the recommendations (to enter ITER negotiations and to integrate ITER into the program by setting priorities across the board in terms of science issues). She commented on the status of ITER negotiations, described the stalemated site decision, and added that one reason for the U.S. decision to support the Japanese site was a perception that the level of commitment from Japan's science and industry programs was slightly greater. Dr. Davies also agreed that the future of fusion would depend greatly on ITER moving forward.

Ed Weiler then discussed the Office of Space Science at NASA with the Board. He described the new vision for NASA as articulated by the President on January 14, 2004. The four main elements of the vision are (1) to implement a sustained and affordable human and robotic program to explore the solar system and beyond; (2) to extend the human presence across the solar system, starting with a return of humans to the moon in preparation for human exploration on Mars and other destinations; (3) to develop the innovative technologies, knowledge, and infrastructures for exploring and supporting decisions about the destinations for human exploration; and (4) to promote international and commercial participation in exploration to further U.S. interests.

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Committees of the Board on Physics and Astronomy

Committee on Astronomy and Astrophysics
Wendy L. Freedman, Carnegie Observatories, and
Roger D. Blandford, California Institute of Technology, *Co-chairs*

Committee on Atomic, Molecular, and Optical Sciences
Pierre Meystre, University of Arizona, *Chair*

Plasma Science Committee
Cary B. Forest, University of Wisconsin at Madison, *Chair*

Committee on Radio Frequencies
Donald Backer, University of California at Berkeley, *Chair*

Solid State Sciences Committee
Lee Magid, University of Tennessee at Knoxville, *Chair*

Committee on Smaller Facilities
Robert Sinclair, Stanford University, *Chair*

Committee on Opportunities in High Magnetic Field Science
Peter B. Moore, Yale University, *Chair*

Committee on Review of the Science Requirements of the Terrestrial Planet Finder
Wendy L. Freedman, Carnegie Observatories, *Chair*

Committee on Review of USAF-Supported Astronomical Research
Steven M. Kahn, Stanford University, *Chair*

More information on BPA committees may be found on the BPA Web site at <www.national-academies.org/bpa>.

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NASA has been working very hard to reposition itself to take on this vision; the Office of Space Science (OSS) has received a significant portion of the responsibility because of its experience with robotic missions. Dr. Weiler then commented on the OSS budget in the FY05 request; he said that whether or not one likes the vision, it would keep the budget profile from stagnating or even decreasing. Only three agencies were above inflationary increases in the request: DOD, DHS, and NASA. NASA would be up 5 per cent for 3 years, and then at about 2 per cent per year after that to stay abreast of inflation. He added that retiring the Space Shuttle and completing the Space Station would free up money as well.
Within OSS, the news is mixed. No themes were cut, but some rates of growth were slowed; however, the budget for the office is still up 41 per cent at the end of the next 5 years, he said. A new theme—Lunar Exploration—has been added, starting at $70M in FY05 and growing, which will be managed in the Solar System Exploration division of OSS. The Sun-Earth Connections (SEC) theme and the Structure and Evolution of the Universe (SEU) themes are not fully within the vision, Dr. Weiler said, and as such they have become lower priorities and are undergoing some refocusing. The solar physics component of SEC would be relatively untouched (several Explorer missions would be delayed), but the space physics portion would have decreased growth in the administration's plan. He then detailed some of the elements of the Mars Exploration Program, including orbiters, landers, rovers, and mobile laboratories. Dr. Weiler discussed the ramifications of the vision on the SEU theme, most of which would affect the Beyond Einstein program. The space-based gravity-wave observing mission LISA would be delayed by 1 year, and the x-ray observatory Constellation-X would be delayed by 2 years. The three smaller Einstein Probe missions in the program would be "deferred beyond the current budget horizon." There would be some extra short-term funding to finish the projects currently under way: GP-B, GLAST, and SWIFT. Within the SEC theme, the Solar Terrestrial Probes would be reduced and stretched out; except for the Living With a Star program, research and operations would be frozen at FY04 levels. Dr. Weiler finished his presentation with several comments on the Hubble Space Telescope's (HST) future. The fifth servicing mission (SM-4) was cancelled by NASA Administrator Sean O'Keefe because of overall Space Shuttle safety and risk concerns; unfortunately, this puts the HST on a path toward systems failure (estimated to occur in 3 years), when the batteries fail (the gyros will fail first, but there is a zero-gyro-safe mode). The Goddard Space Flight Center project crew has been asked to examine ways to extend HST's operational life. A request for information has been filed with industry to collect ideas for robotic rescue options. Finally, per an understanding with the Senate Appropriations Subcommittee, a National Academies panel is being convened to evaluate all HST life extension and servicing options. [The National Academies' Committee on Assessment of Options for Extending the Life of the Hubble Space Telescope was formed in late April 2004 and has already met three times. An interim report is planned for release in late July. — Ed.] The general caveat remains that shuttle missions must meet all requirements of the Columbia Accident Investigation Board and the Stafford-Covey Task Group before shuttle operations can resume. Dr. Weiler speculated that a robotic rescue-and-retrieve mission might be most tenable since it takes some of the human risk issues off the table.

In the follow-up discussion, Board members asked about the vision and about the potential for international collaboration. Dr. Weiler said that the intention is certainly to include international partnerships in the vision's implementation, but it is simply too soon to make any specific statements. Discussing how funding decisions within SEU and the Origins themes were made, he said that the search for life is embodied in a Presidential Directive and that the first thing OSS might do with extra money would be to restore the solar and Einstein probes. Of course, he observed, JDEM would need to compete with the other Einstein probes to go forward. Other Board members questioned the degree of community involvement in recent sweeping policy decisions, ranging from the Moon-to-Mars vision, the cancellation of the Hubble servicing mission, and interactions with the press corps. Dr. Weiler confessed that the orderly presentation to the community had been hijacked by an early leak (not uncommon in Washington), so NASA had to scramble to stay on top of the news cycle.

Paul Hertz remarked on the newly renamed Astronomy and Astrophysics Advisory Committee (AAAC) that was established (from the National Astronomy and Astrophysics Advisory Committee) as part of the NSF Authorization Act of 2002 with a mission to assess the coordination of astronomy and astrophysics programs at NASA and NSF and make recommendations. Charged to provide a report to Congress by March 2004, the committee worked hard to develop a series of recommendations covering NSF development of the Giant Segmented Mirror Telescope, NASA-DOE-NSF coordination on the Large-aperture Synoptic Survey Telescope and JDEM, and NSF development of the Advanced Technology Solar Telescope and the Solar Dynamics Observatory. The committee's report also called for inter-agency coordination of a plan for cosmic microwave background research and for efforts to implement recommendations in support of theory, laboratory astrophysics, and the National Virtual Observatory. Dr. Hertz finished by discussing the role of the AAAC in NASA's eyes: it provides a useful format for reviewing astronomy and astrophysics programs across the agencies to identify gaps and overlaps. There is some concern about having yet another advisory committee that is external to the existing agency FACA structures, however. The purview of the AAAC has also not been well defined, he said.

After lunch, Joe Dehmer discussed with the Board the status and direction of NSF's Division of Physics. Dr. Dehmer presented an "irreducible set of strategic goals" for the division: (1) intellectual frontiers; (2) broader impacts; (3) education; and (4) stewardship. He shared a list of physics frontiers and noted that while condensed-matter physics was not explicitly included, the list was not intended to be balanced or exhaustive. He presented three examples of new frontiers in more detail: Bose-Einstein condensates, the gravitational wave obser-

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intellectual questions, the Board hopes to achieve a more forward-looking decadal survey, one that is more directly useful for program managers in planning their strategies. The Board cautions, however, that each volume of the survey should not try to be exhaustive: a message that is clear and consistent is more important than a comprehensive list of all activities in the discipline.

A prioritization of the science within each discipline will be sought, with an emphasis on ranking the science priorities, not the facilities or instruments necessary to do the work. In an era of constrained budgets and emerging sophisticated opportunities, policymakers have found that reports that prioritize the leading science topics are the most useful for making decisions about the future. As a budget examiner once noted, "These priority decisions have to be made; the community can either be involved by contributing its best thinking, or it can go away and let overworked staff who aren't experts make own their best guesses."

Another recommendation is for each volume of the decadal survey to be accompanied by a short, well illustrated booklet highlighting the emerging science. This booklet would be targeted at a broad audience and should be pursued for fields that lack such a popular version. For instance, the 1999 report on condensed matter and materials physics resulted in the preparation and publication of the very successful ancillary booklet, *The Physics of Materials: How Science Improves Our Lives*. Community involvement and effective dissemination are also critical ingredients in any successful report. In its guidelines, the Board encourages each committee to work with the American Physical Society or other professional societies to hold at least one town meeting to facilitate public discussion and input to the committee's deliberations. Likewise, an effective plan for dissemination (follow-up after publication of the volume) is important. Face-to-face meetings between a few members of the committee and agency representatives or key decision makers continue to be a very effective strategy.

EPP 2010

The first volume of the decadal survey to be undertaken will most likely be *EPP 2010: Elementary Particle Physics in the 21st Century*. The National Science Foundation (NSF) and the Department of Energy's Office of High Energy Physics approached the BPA earlier this year about starting a project to plan for the future of elementary particle physics (EPP). The reasons for this request are several: The recent HEPAP long-range planning subpanel report was well received in 2001, but the situation has evolved since then; likewise, there is also a wider appreciation for other kinds of physics that fall within the particle physics purview. Also, a number of key reports are due soon that will inform decisions in the next few years (from the APS study on neutrinos to the Drell report *The Quantum Universe* to the International Technology Review Panel report on technology choices for the Linear Collider). The *EPP 2010* report will provide DOE and NSF with a prioritized implementation plan.

At the dawn of the 21st century, elementary particle physics is poised to address some of the most basic questions in science. There is a consensus in the field and among the agencies supporting it that a realistic plan formulated in the context of the global science enterprise is essential to guide progress. Obtaining the answers to these questions will require a global effort of great scale and complexity.

A committee with membership drawn from both inside and outside the field of elementary particle physics will be formed to carry out an in-depth assessment that will provide a 15-year plan for the future of the field. Town meetings and other events will be conducted to ensure broad community involvement in formulating the plan. Scientific opportunities and objectives will be identified and priorities will be set. Prioritized implementation plans will be formulated to achieve stated scientific objectives. The assessment will build on a number of sources: recent work of subcommittees of the High Energy Physics Advisory Panel (a FACA committee to advise the Department of Energy and the National Science Foundation), reports of committees of the NRC, and the Department of Energy's 20-year facilities plan for the Office of Science. The international effort in the field and the plans and views of Europe and Asia will also be taken into consideration. The project will be completed within 2 years of its inception.

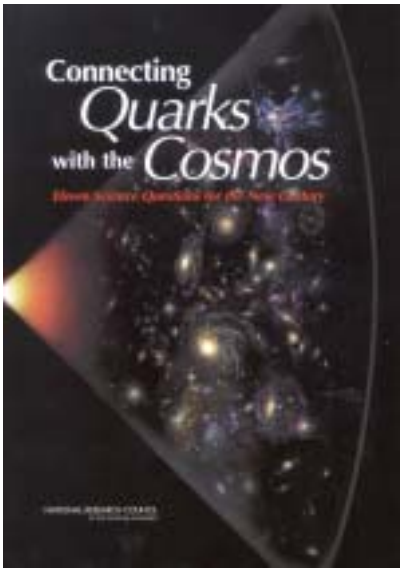
In recent years, the field has begun to confront questions that overlap those confronted by neighboring disciplines—e.g., cosmology, nuclear physics, and astrophysics. And the experimental program has become increasingly multinational. Thus, planning for the field should engage experts from allied fields to ensure that the intellectual framework for the field is broadly credible. It should also involve leaders of the European and Asian research communities in elementary particle physics with whom the United States will be partnering.

Other *Physics 2010* volumes

The BPA's Committee on Atomic, Molecular, and Optical Sciences has prepared a proposal for a decadal assessment of and outlook for AMO science, *AMO 2010*. The assessment will be framed in terms of compelling questions that express in simple terms the intellectual drivers for the field. These questions will enable a nonscientist reader to understand what it is that AMO researchers want to learn in the coming decades and why. The report will focus on four key tasks: (1) identifying new opportunities, compelling scientific questions, and themes that have arisen from recent advances and accomplishments in the field; (2) discussing connections between AMO science and other scientific fields, emerging technologies, and national needs; (3) explaining how AMO science meets workforce, educational, and other societal needs; and (4) recommending a strategy to fully realize the potential at the frontiers of AMO science. It is expected that the *AMO 2010* project will begin by early 2005 with support from NSF and DOE.

The BPA's Plasma Science Committee and Solid States Sciences Committee are preparing similar plans for their respective volumes of the physics survey. ■

Physics of the Universe (continued from page 1)



dination would enable them to provide the most beneficial results from such investments. The IWG members included representatives from the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Office of Science and Technology Policy (OSTP), and the Office of Management and Budget (OMB). In a new report released at the spring meeting of the Board on Physics and Astronomy, April 16, 2004 at the Keck Center of the National Academies, the working group presented its conclusions on the actions necessary to implement the recommendations of *Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century*. (The report may be found online at http://www.ostp.gov/html/physicsoftheuniverse2.pdf.)

Introducing the report, presidential science advisor John Marburger wrote, "[this] report provides a Federal cross-agency strategic plan for discovery at the intersection of physics and astronomy. . . The IWG activities captured in this report represent a new approach for coordinating and prioritizing research programs across the government to explore an emerging scientific frontier."

Using the R&D investment criteria consistent with the President's Management Agenda (relevance, quality, and performance), the IWG undertook a prioritization of potential investments. Projects included within the scope of the Physics of the Universe plan were required to align specifically with and be motivated primarily by at least one of the 11 questions. A larger number of important projects were examined but were not included in the scope of the Physics of the Universe program because they did not pass the alignment and motivation test.

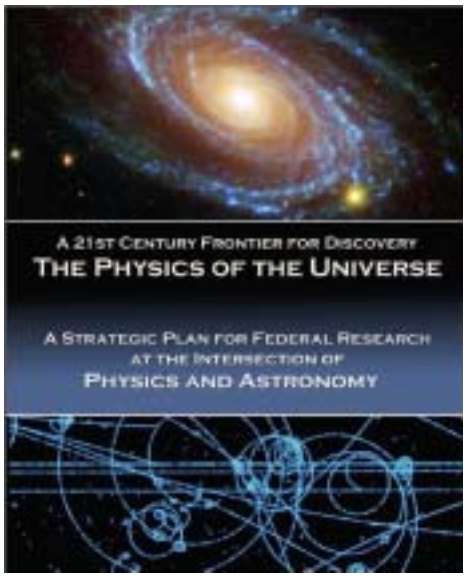
Based upon an assessment of the current suite of existing facilities and the opportunities with the greatest potential for scientific advancement, the IWG has developed prioritized findings and recommendations for programmatic investment to advance the opportunities identified in *Connecting Quarks with the Cosmos*. These priorities represent the next steps for the nation and will need to be revisited on a regular basis as changes in such factors as available funds, scientific advances, and our technological readiness to make significant progress change with time. The process used by the IWG is outlined below.

Step 1: Prioritize the questions. Varying levels of activity and investment are currently being expended to answer each of the 11 questions. Moving forward, future investments should be aimed at strategically positioning the U.S. scientific community to address those issues. To maximize the probability that the United States will be strategically positioned, the highest priority new investments need to be identified. This is never an easy task but is an especially vital one when resources are limited.

Step 2: Identify potential activities. The foundation for the development of a coherent set of recommendations from the IWG was a broad set of reports from the National Research Council, reports from the DOE-NSF advisory committees HEPAP and NSAC, and strategic plans from NASA's Office of Space Science and DOE's Office of Science. This suite of reports served as the reference source for the IWG to identify projects and activities already recommended by the scientific community that can contribute directly to answering the 11 questions. In this way, the recommendations of the IWG remain consistent with the advice and recommendations from the scientific community and align with the mission and goals of the individual agencies.

Step 3: Grouping of related elements. The next step was to sort the eleven questions based upon common programmatic needs or themes. For example, some experiments investigating dark matter, neutrinos, and proton decay will have a common need for deep underground laboratory space. Using the prioritized ranking of the scientific questions, the IWG then applied an additional criterion: programmatic readiness to proceed. The IWG examined whether the plans and proposed facilities were reasonably well developed and determined whether a path forward could be identified. Programmatic readiness was assessed on the basis of whether a project had been identified, whether the science case for such a project has been made, and whether R&D on a project is under way.

The immediate priority is heavily weighted toward the investigation of dark energy, a recently discovered phenomenon that is causing the universe to expand at a faster and faster rate, contrary to the general belief of cosmologists and astronomers as recently as 1998. Dark energy, when it is adequately explored and explained, is expected to have strong implications for fundamental physics and perhaps the nature of gravity, as well as for the nature, history, and potential fate of the universe. The IWG recommends three top priority investigations of dark energy by means of space and ground-based astronomy, which should be enabled by coordinated activities of the



agencies. These priorities are (1) the NASA-DOE Joint Dark Energy Mission (JDEM), (2) weak lensing observations such as those proposed to be carried out by the Large-aperture Synoptic Survey Telescope (LSST) ,with coordination between NSF and DOE and with expertise from NASA as appropriate, and (3) an approach to be developed by NASA and DOE using ground-based observations of cosmic microwave background radiation and space-based x-ray observations.

Also ready for immediate investment are certain new approaches to the study of dark matter, neutrinos, and proton decay, which involve physics experiments in underground and other ground-based laboratories. This work, joining the efforts of two agencies, can illuminate the mysterious dark matter, which comprises the vast majority of all matter in existence but whose detailed nature is completely unknown to science. New and upgraded work on the nature of gravity through massive, high-speed computations, as well as ground and space-based observatories, is also ready for immediate investment. New studies of gravity even bear on the possible existence of higher dimensions, once thought to be in the realm of science fiction but now considered seriously by physicists.

Further in the future, to be spelled out in jointly formulated roadmaps by the agencies, are new departures in the study of the heavy elements and nuclear astrophysics, the birth of the universe, high-density and high-temperature physics, and high-energy cosmic ray physics. In each area, coordinated planning at the roadmap stage is essential to maximize the return on the nation's investment.

The IWG focused its work on the large-scale projects needed to support research activities aimed at understanding the physics of the universe. Such projects are essential elements of a research program, have the most significant budget and policy implications, and require joint planning to ensure that the nation develops the facilities and programs required to answer the most pressing questions without duplication or gaps. The IWG recognizes that concomitant investments in theory, simulation, data archiving, and user groups are essential to reaching an understanding the physics of the universe, and it expects the participating agencies to respond to these requirements in an appropriate way.

Each revolution in physics, such as the discoveries and subsequent explanations of electromagnetism, radioactivity, and nuclear forces, has produced far-reaching social and industrial consequences that were largely unanticipated. The new physics in *Connecting Quarks with the Cosmos*, when explored and comprehended, may well more than repay our initial investments in exploratory research. ■

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vatory LIGO, and the Physics of the Universe as identified in the NRC report *Connecting Quarks with the Cosmos*. Dr. Dehmer introduced a new program at the division focused on particle and nuclear astrophysics, likely to be the home for most of the NSF Physics of the Universe activities. He also discussed the Physics Frontier Centers programs, commenting that these centers are unique because they pit the different fields of physics against one another. The center grants also do not have a sunset clause and are indefinitely extendable (through recompetition). The centers already awarded have galvanized students and faculty alike at their respective institutions. A host of facilities are supported by the Physics Division, and the growth in demand and opportunity is straining the ability to support these facilities. Budgetwise, the FY05 request included a 30.6 per cent increase in funding for the Mathematical and Physics Science (MPS) directorate since FY 2001, with a +25.7 per cent component for the Physics Division. Half of the new money for MPS is directed at Physics of the Universe activities. In discussion with the Board, Dr. Dehmer added that the physics division has had to squeeze its base programs by about 7 per cent to accommodate the two new Physics Frontier Centers and the contributions to LHC and the Rare Symmetry Violating Processes project.

Wayne Van Citters presented an update on activities at NSF's Division of Astronomical Sciences (AST). He commented on the FY05 budget request, noting that AST would receive a 4.0 per cent increase, more than its fair share of the MPS directorate's budget. He presented brief updates on the main facilities; there are now three University Radio Observatories, with the next competition scheduled to begin in 2005. The Gemini Observatory has both telescopes running science more than 70 per cent of the time and facility instruments are being delivered. The Atacama Large Millimeter Array in Chile is on track to begin construction this year with ground breaking scheduled for November 2004. Dr. Van Citters discussed the AAAC from the NSF point of view: Because NSF no longer has divisional advisory committees, it considers the AAAC to be a valuable resource. The NRC's Committee on Astronomy and Astrophysics cannot deliver timely tactical advice on some matters—the overhead to convene a letter-writing committee is sometimes just too great. Dr. Van Citters then commented on the planning and development of the National Virtual Observatory (NVO) and the Large Synoptic Survey Telescope (LSST). The NVO is in its third year and has been successful in developing a framework of standards, protocols, and prototypes; NASA data centers are moving toward compliance while discussions continue about implementation. Planning groups for LSST have been convened and a consortium was formed; funding for technology development studies is included in the FY05 request. Several DOE labs have expressed interest in participating through the design and construction of a camera that will cost in excess of $100M. Likewise, the Giant Segmented Mirror Telescope project is moving forward with the articulation of a detailed science case and the formation of a consortium to undertake the technology development. It is expected that proposals will come to NSF requesting support for about half of the total cost. Balancing all of the tall orders in the decadal survey is a big challenge, Dr. Van Citters said.

Tom Weber presented an update on NSF's Division of Materials Research (DMR) in the MPS Directorate. Based on

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some recent discussions in the community about the role of the condensed-matter physics program within NSF, Dr. Weber joked that DMR is "the other physics division." NSF funds both applications-based research and so-called curiosity-driven research, contrary to certain complaints, he asserted. A unique aspect of DMR is its breadth. Many different disciplines, types of research problems, and types of people are supported: roughly 30 per cent chemistry, 30 per cent physics, and 30 per cent engineering. An example of a crosscutting program is materials theory; centers are another. The main sourced of increases in DMR's budget (now $250M in total) have been the "nano" and "info" initiatives; the good news is that a lot of the science is shifting in this direction, too, he said. Of the $77M nano money going into DMR, $50M is in the core programs. The success rate of proposals is about 35 per cent, which seems to remain constant over time, Dr. Weber reported. Since science is increasingly international, DMR is leading the way by fostering international activities such as the International Materials Institutes. DMR is launching a new mid-scale instrumentation program to bridge the gap between $2M and $20M, to support significant instruments such as beamlines or high-field magnets. Under pressure from the Director to increase the size of individual grants, the trade-off has been to fund fewer people, which then affects the renewal rate, he said.

Norbert Schroeder discussed recent developments in electromagnetic spectrum management and policy with the Board. In spring of 2003, the administration issued an Executive Memorandum to convene a task force to review, revise, and reform the United States program of spectrum management. The objectives of the spectrum reform task force are (1) to overhaul and rebuild the radio spectrum management processes to be more responsive, effective, and efficient; (2) to foster economic growth; (3) to maintain U.S. global leadership; and (4) to satisfy vital U.S. needs in areas such as public safety and scientific research. There is no mechanism to identify what the federal government is investing in its uses of the spectrum, he said. Similarly, the Federal Communications Commission and the National Telecommunications and Information Administration are completely reactive bodies, making policy when needs are brought before them rather than managing proactively. Dr. Schroeder described the BPA's involvement in the process through presentations by the chair of the its Committee on Radio Frequencies (CORF) at a special workshop held this past February; CORF also filed formal comments in response to a Notice of Inquiry. The spectrum task force plans to release a preliminary report in early summer 2004. Longer term, planning exercises will be needed, however, and Dr. Schroeder suggested that the Board should consider contributing a study on the scientific uses of the spectrum to clearly identify the parties involved and their needs, and to help design procedures to more effectively incorporate these needs. In the ensuing discussion, Board members asked how domestic radio spectrum policy issues might be handled internationally, such as with regard to the radio astronomy telescopes in Argentina and Chile. Dr. Schroeder responded by agreeing that those questions were important and that a general framework for defining the type of "protection" desired would need to be established.

Next up were budget examiners Joel Parriott and David Trinkle from the White House Office of Management and Budget (OMB). They were joined by J. Patrick Looney of the White House Office of Science and Technology Policy (OSTP). Board members asked how the BPA could help OMB and OSTP in their work. Dr. Parriott said that community-based exercises to determine overarching science priorities were quite helpful. Another question was whether the science community should consider reprioritizing its science goals based on new assumptions such as those brought about by new budgetary models. The White House staff agreed that this might become important, but added that implementing priorities takes time and patience—for instance, short-circuiting a set of priorities by continuing to directly lobby appropriators damages the entire process. Dr. Parriott added that some science communities have shown that they can successfully prioritize "new money," but the real challenges in this era of declining budgets will be to successfully reprioritize all projects, including ongoing work.

After more discussion, Dr. Looney took the floor to formally introduce the final report of the OSTP Interagency Working Group on the Physics of the Universe (see related article in this issue). He described the procedure the interagency committee used to develop the findings and recommendations and then briefly described the conclusions. The goal was to examine ongoing projects (setting aside projects not yet under development) that were ready for immediate investment and to think about cooperation between agencies at more than just the program level. In the follow-up discussion, Dr. Looney agreed that *Connecting Quarks to the Cosmos* did not explicitly set priorities; as federal program managers, the interagency working group needed to do that. He also commented that while *Connecting Quarks to the Cosmos* was the original inspiration for this activity, the astronomy decadal survey and other documents had also been consulted. Board members asked about a long-term strategy to consider both the astronomy and astrophysics decadal survey and intermediate reports like *Connecting Quarks*; Dr. Looney said that this matter is important and needs considerable discussion at the community level. He also explained that the interagency group did not try to consider all activities that were important; the group did recognize that other activities outside of this domain are still very important and must be undertaken. Dr. Richter wrapped up the discussion by commending Dr. Looney and his team for a tremendous amount of work and cited this interagency effort as a model for how to move from the initial inspiration to the final strategic plan for implementation.

The meeting wrapped up its first day with a general discussion. Board members expressed concern over the apparent change in focus at OSS in response to the President's vision—in particular, away from the Beyond Einstein missions. Others asked if there was a perception that the recent community priority-setting exercises might have turned out differently had the current budget situation been more predictable.

After thanking everyone for attending, Dr. Richter adjourned the meeting for the

day.

The second day of the meeting was devoted to discussions with the standing committees. Vice chair Anneila Sargent convened the meeting promptly at 8:30 am. Robert Richardson of Cornell University presented a summary of the recent division-level review of the Board. The Division on Engineering and Physical Sciences (DEPS) oversees the operation of the BPA and periodically reviews each of its member boards to ensure quality and integrity and to offer advice on how to improve effectiveness. The overall conclusion of the review was that the Board has been very effective and that it has a reputation for credible and responsible activities. The only suggestions for improvement were (1) to enhance the value effectiveness of the decadal surveys of physics (especially the overview volume) and (2) to build more connections with the integrative levels of government (especially in Congress). For instance, the panel suggested that the Board chair tour Washington in advance of the spring meeting (as was done this year) to remain sensitive and responsive to the issues and needs of government. The review panel also recommended that the BPA continue to be cognizant of the general perception that the Academies are "too slow and too expensive." Finally, the panel advised the BPA not to rest on its laurels; in the fast-moving policy world, there is always a danger of becoming a fixture.

Wendy Freedman reported on the status and plans of the Committee on Astronomy and Astrophysics (CAA). She reviewed the most recent decadal survey's prioritized lists of initiatives of which CAA is the steward. The committee has been active in getting the adaptive optics initiative funded for GSMT. It has also worked well with the AAAC to maintain alignment with the priorities outlined in the decadal survey. CAA has undertaken the preparation of several research briefings to supplement some of the material in the survey text and to make it more accessible to the public. The agencies have agreed to support the first such briefing on the astronomical origins of life. NASA has also asked the CAA to evaluate the science accessible by the Terrestrial Planet Finder; this mission was recommended by the decadal survey, and the technology has advanced sufficiently that choices must be made about the scope and schedule of the eventual instruments. The CAA is actively pursuing ways to enhance support for theory; the decadal survey proposed an experiment to tie new theory money to each project, but the results so far have been mixed. Dr. Freedman finished her remarks by observing that there is some concern that the CAA is too constrained to give useful, informal advice to NSF and NASA.

Cary Forest next reported on the Plasma Science Committee (PLSC). He noted that the committee is charged to be representative of the entire field, ranging from accelerator physics to low-temperature plasmas and high-temperatures plasmas used in fusion. While ITER is being constructed, domestic plasma science budgets are likely to be squeezed even more. The plasma science volume of the physics decadal survey, *Plasma 2010*, will have to deal with this issue to some degree. *Plasma 2010* has been informally approved by the funding agencies, but the start date to begin work is likely early autumn 2004 because of other activities in progress. For instance, the future shape and direction of the domestic fusion program may hinge upon the outcomes of the ITER negotiations. Also, based on a recommendation of the Burning Plasma Assessment Committee, DOE has charged the Fusion Energy Sciences Advisory Committee with identifying and prioritizing the OFES science portfolio. Dr. Forest then presented some strategies for organizing the work of *Plasma 2010*, such as identifying the scientific highlights, connecting them with national priorities, and then outlining strategies to make them happen. Board members asked about composition of the eventual *Plasma 2010* ad hoc committee. Dr. Forest responded that the PLSC had thought about trying to represent each of the main areas of plasma science. After some discussion, the Board urged the PLSC to consider including a member or two from outside plasma science and to draw heavily on the recent Burning Plasma and High Energy Density Physics reports.

Pierre Meystre discussed the status and direction of the Committee on Atomic, Molecular, and Optical Sciences (CAMOS). He described some of the advances in atomic, molecular, and optical (AMO) science that were not predicted in the most recent report, such as ultracold atoms and molecules and matter-wave optics. Likewise, the connections to other fields of science have grown significantly. Dr. Meystre then discussed the proposal for the AMO science volume of the physics decadal survey, *AMO 2010*. Although there is a dearth of large facilities to prioritize, he said, there is still significant intellectual value in identifying and prioritizing the compelling science questions. He suggested a framework for the report that centered on the connections between big questions, grand challenges, and life-transforming technologies. Board members discussed how to understand the value and effectiveness of a decadal study in a field as fast-changing as AMO science. It was also agreed that one of the toughest challenges in preparing an overview of any field is responding to the pressure to include everything. Others suggested that smaller, intermediate studies could be more selective (and perhaps more accurate), but their effectiveness might be diminished because of the narrow scope. The question of evaluating the need for the standing committees and the ad hoc decadal survey committees was also broached, in particular because of the severe funding limitations for AMO science. Dr. Meystre pointed out that both NASA and DOD make relatively large investments in AMO; in the future, CAMOS would like to build a better relationship with both of these agencies.

Lee Magid reported on the activities of the Solid State Sciences Committee (SSSC). She noted that the SSSC was started in 1971 and has been a standing committee under the BPA since 1983. The SSSC is actively listening to the condensed matter physics community's discussion of self-identity, particularly in light of the upcoming condensed matter and materials physics volume of the physics decadal survey, *CMMP 2010*. Also at the spring SSSC meeting, Myriam Sarachik discussed the potential role that the American Physical Society could play in the decadal assessment. The two active study committees, the Committee on Smaller Facilities and the Committee on Opportunities in High Magnetic Field Science, have both recently released interim letter reports and hope to dis-

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charge their duties before the end of 2004 with the preparation of their final reports. Dr. Magid also commented on new projects in preparation. After informal conversations with NSF's Division of Materials Research, the SSSC is preparing a proposal to convene an ad hoc committee to review the past and future performance and impact of NSF's materials research laboratory program. Another two studies are still in development, one focusing on biomolecular materials and processes, the other assessing the state of advanced materials synthesis. Recent meetings of the SSSC also featured discussions about exploring the connections between amorphous and disordered materials from a theoretical perspective. Concluding her presentation, Dr. Magid formally announced to the Board her decision to step down this July as she is assuming a 2-year appointment with NSF's Division of Chemistry. In the follow-up discussion, Board members asked how *CMMP 2010* would cover the theory part of the physics portfolio. Dr. Magid responded that with a broad and well composed committee, the issue of theory should arise naturally in the assessment and outlook discussion.

Finally, Don Backer presented comments on the Committee on Radio Frequencies (CORF). He summarized several recent filings by CORF with the FCC and NTIA on behalf of scientific, passive uses of the radio spectrum. He also commented on the activities at the Department of Commerce that Dr. Schroeder had outlined the day before, namely, the Presidential Spectrum Policy Task Force. Dr. Backer reiterated the need for clear thinking about the future. In discussion, Board members asked if CORF worked across agencies. Dr. Backer explained that the CORF meeting itself serves as common reference for the different players, "We are the meeting ground" for these parties, he said. He also explained that CORF was working on a pair of technical and policy information documents to be used in education and outreach efforts. The biggest problem, he said, is "convincing people that passive use does not mean nonuse."

In the closing session, the Board returned to its discussion from the last meeting about expanding the collaborative connections between physics and biology. Jeremy Berg of NIH's National Institute of General Medical Sciences discussed opportunities and challenges in biological physics with the Board. He discussed the state of biomedical research and some of the research problems where physics and biology were both in use, such as genome sequencing and biological complexity. Dr. Berg then discussed the recent NIH roadmap, describing it as an effort by current NIH director Elias Zerhouni to cut across the issues and the 27 different institutes to best address what may be falling between the cracks. The roadmap was developed with an exhaustive and broad-based process; the outcome was a framework of priorities for the NIH as a whole organization, a vision for a more efficient, innovative, and productive system of research, and a set of initiatives that are central to improving the quality of healthy life. Amongst these initiatives are centers for biomedical computing, research teams for the future, and molecular libraries and imaging. Dr. Berg compared multi- and interdisciplinary research as equivalent to elastic and inelastic collisions between disciplines on research topics, and explained that the NIH is taking these challenges seriously. In the ensuing discussion, Board members asked about the challenges of computational biology. Dr. Berg explained that many biological systems lie somewhere between crystalline solids, where everything is fixed, and relatively dilute systems, where statistical averages are good predictors of behavior; the interactions quickly take complexity to a new level. The way for physicists to get involved in these areas of research was also discussed; Dr. Berg recommended that interested parties "find a smart colleague (in biology) and get involved," as only people who become masters of both disciplines are able to identify the truly hard and relevant problems on which to work. Programs fostering such interactions are springing up around the country, starting with simply locating these two types of researchers next to each other in the same building. The idea of including biological physics as an element of the *Physics 2010* decadal survey was also discussed After more consideration, the Board agreed that the next step might be to convene a meeting of key players to discuss the opportunities and to determine a route for progress.

Daniel Rokhsar then presented a science talk about genomics, concentrating on the techniques and challenges of tracing back ancestral hierarchies of physiology using genetic comparisons. He presented phylogenetic trees of gene diversification and explained how evolutionary forces selectively encourage functional parts of the genome over millions of years. For instance, since the evolutionary divergence between mice and humans occurred sufficiently long ago, a large proportion of still shared genome components might serve similar functional purposes in each species. That is, a good number of the irrelevant areas of the genome have probably been washed out by the process of random mutation since the evolutionary divergence. The common ancestry of humans and chimpanzees is too recent to support such an analysis. That is, portions of the chimp genome that still exist in humans may no longer serve a purpose, but have not had time to "decay away" under the forces of evolution. Dr. Rokhsar closed by telling the Board that as a former physicist, he thinks the barrier to entering biology is lower than some people might think, but it is nontrivial and requires hard work and a long attention span.

The meeting then turned general discussion. Board members discussed the guidelines for the disciplinary volumes of the *Physics 2010* decadal survey and reviewed the statement on BPA mission and strategy. It was agreed that special considerations would apply to the overview volume of *Physics 2010* and that a greater effort at synthesis should be attempted. As chair of the Board, Dr. Richter extended a special thank you to Wendy Freedman, Lee Magid, and Tom O'Neil as retiring members of the BPA for their tremendous contributions. "Lee is being stolen by the feds; thanks for kicking the SSSC into high gear—please do the same for NSF!" he joked. With the consent of the Board, Dr. Richter adjourned the meeting around 3 pm, in time for a sunny afternoon in Washington, D.C.

The next meeting of the Board is scheduled for November 6-7, 2004, in Irvine, California. ■

BPA Mission

The Board on Physics and Astronomy (BPA) was created in 1983 as the successor to the National Academy of Sciences Office of Physical Sciences. Several standing committees were assigned at that time to the BPA, including the Committee on Atomic, Molecular, and Optical Sciences, the Solid State Sciences Committee, and the Committee on Radio Frequencies. Later, the Committee on Astronomy and Astrophysics and the Plasma Science Committee were created in response to requests from the scientific community. Since its inception, the BPA has published more than 40 reports, workshops, and collaborative activities, including two surveys of physics and two surveys of astronomy.

The important questions in physics and astronomy change as we learn more about nature, and that rate of change has been increasing. The BPA seeks to inform the government and the public regarding important scientific opportunities and issues as well as the changing nature of science. It builds bridges between the evolving subdisciplines of physics and astronomy and with other areas of science. The BPA is successful if it helps the science community and society understand what is needed to advance physics and astronomy and why doing so is important.

Every activity of the BPA is aimed at accomplishing one or more of the following goals:

- Monitor the health of physics and astronomy.
- Identify trends in research and new developments at the scientific forefronts.
- Foster interactions with other fields and cooperation among academic disciplines.
- Strengthen connections to technology.
- Facilitate effective service to the nation.
- Improve public understanding of science.
- Encourage cooperation among federal agencies, government laboratories, and universities involved in research in physics and astronomy.

Approaches for achieving these objectives include the following:

- Periodic assessments of major fields. By setting priorities, these surveys provide programmatic guidance to agencies.
- Response to particular needs and requests from federal agencies, both those that have programs of research and those that play an administrative role.
- Continuing surveillance of scientific progress and identification of issues and problems in various fields. Several standing committees are focused on this task.
- Cross-disciplinary studies of special areas that lie in the intersection of several disciplines.
- Many scientific assessments address the benefits that accrue to society through technology development that follows from the pursuit of science.

BPA Update: Emerging Projects

- *Committee on Review of USAF-Supported Astronomical Research.* The goal of this committee is to review the scientific research being conducted at the United States Air Force's (USAF) 3.6-meter telescope in Maui, Hawaii, under the sponsorship of the Air Force Office of Scientific Research (AFOSR). The committee will evaluate the science being conducted in terms of scientific value, productivity, and whether it takes advantage of the unique properties of the telescope facility, and will its conclusions and recommendations to the director of AFOSR in a letter report. This study is on a fast track, with completion expected this summer.

- *Review of the Science Requirements of the Terrestrial Planet Finder.* This study will review NASA's current scientific objectives for the Terrestrial Planet Finder (TPF) mission and prepare a brief letter report containing an independent scientific assessment of whether these objectives remain consistent with the priority given to the mission by the Astronomy and Astrophysics Survey Committee. In carrying out this charge, it will consider (1) the scientific goals of the mission as developed by the NASA TPF-Science Working Group, (2) plans for acquiring the necessary precursor scientific knowledge, (3) the rationale for the mission that formed the basis of the priority assigned by the 2000 NRC report *Astronomy and Astrophysics in the New Millennium*.

- *The Role of Laboratory Instrumentation in Advancing Science and Engineering Research: A Symposium to Honor Arnold O. Beckman.* A symposium will be held in autumn 2004 and will feature lectures and discussions by about 15 leading scientists and engineers active in current research, development, and design of laboratory instrumentation and technology. Current issues, trends, and questions will be identified. In addition, science and technology historians, journalists, and policy experts will chronicle key developments in the history of laboratory instrumentation and describe how these developments helped shape science and engineering research. Finally, participants will address the outlook for laboratory instrumentation and its implications for the future. The presentations will be collected and published along with a summary of the discussions.

- *EPP 2010: Elementary Particle Physics in the 21st Century.** This project is likely the first element of *Physics 2010*. Elementary particle physics is poised to address some of the most basic questions in science. Obtaining the answers to these questions will require a global effort of great scale and complexity. A committee of 15 persons is charged to construct a plan for U.S. participation in this effort. In particular, the committee will (1) Identify, articulate, and prioritize the scientific questions and opportunities that define elementary-particle physics. (2) Recommend a 15-year implementation plan with realistic, ordered priorities to realize these opportunities. The committee will not make specific organizational or budgetary recommendations.

- *AMO 2010: An Assessment of and Outlook for Atomic, Molecular, and Optical Science.** As the next element of the coming decadal assessment and outlook, *Physics 2010*, this study will be report on the status and direction of AMO science. The report shall review the field of AMO science, emphasizing recent accomplishments, and identifying new opportunities and compelling scientific questions; identify the impact of AMO science on other scientific fields, emerging technologies, and national needs; identify future workforce, societal, and educational issues for AMO science; and make recommendations on how the U.S. research enterprise might realize the full potential of AMO science.

*Elements of *Physics 2010*

BPA Update: Upcoming Meetings in 2004-2005

October 2004

10/2-3	PLSC meeting, Irvine, Calif.
10/21-22	SSSC meeting, Irvine, Calif.

November 2004

11/6-7	BPA meeting, Irvine, Calif.
11/30-12/1	CAA meeting, Irvine, Calif.

April 2005

4/1-2	PLSC meeting, Washington, DC
4/7-8	SSSC meeting, Washington, DC
4/29-30	BPA meeting, Washington, DC

THE BPA Web site at **www.national-academies.org/bpa** provides news on recently released reports and other developments as well as a link to this newsletter in PDF format. Reports may be ordered at **www.nap.edu**.

Recent Reports:

Interim Report of the Committee on Smaller Facilities

Coming Soon:

Final Report of the Committee on Opportunities in High Magnetic Field Science

Final Report of the Committee on Smaller Facilities

Letter Report of the Committee on Review of USAF-Supported Astronomical Research

Letter Report of the Committee on Review of the Science Requirements of the Terrestrial Planet Finder

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