Issues in Physics & Astronomy at the BPA

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Plasma Science: Advancing Knowledge in the National Interest

Caryn J. Knutsen, BPA Staff

Ed. Note: This article is largely inspired by the Executive Summary of the report.

On the cusp of a new era, plasma science is poised to make significant breakthroughs in the next decade that will transform the field. The international magnetic fusion experiment, ITER, is expected to confine burning plasma for the first time—a critical step on the road to commercial fusion. The National Ignition Facility (NIF) plans to ignite capsules of fusion fuel to acquire the knowledge necessary to improve the safety, security, and reliability of the nuclear stockpile. Low-temperature plasma applications are already ushering in new products and techniques that will change everyday lives. More and more, plasma scientists are being called on to help crack the mysteries surrounding exotic phenomena in the cosmos. These are just a few examples to illustrate the dynamic future ahead. The future will be exciting, but also challenging, for the field of plasma science.

It was within this landscape that the National Research Council convened a committee to conduct a decadal assessment of and outlook for plasma science and engineering. With support from DOE, NSF, and NASA, the Plasma 2010 Committee was co-chaired by Steven C. Cowley and John Peoples, Jr. The committee was made up of experts from high and low-temperature plasma science and engineering as well as atomic, molecular, and optical physics, accelerator and beam physics, and high-energy density (HED) astrophysics.

Contributing to at least four areas of national interest, plasma science is an important part of the web of interdependent disciplines that make up our essential core knowledge base: economic security and prosperity; energy and environmental security; national security; and scientific discovery. Advancement in any one area is highly dependent on progress in the others, making breadth a requirement for a well-organized national research enterprise. Challenges posed by the goal of advancement are being addressed by a large but diffuse U.S. community of plasma scientists and engineers, but effective stewardship of the field remains neglected.

The Plasma 2010 report, *Plasma Science: Advancing Knowledge in the National Interest*, discusses the scientific highlights of the past decade and opportunities for further advances in the next decade in an effort to help steward the national plasma science effort. The report examines the broad themes that frame plasma research and offers a bold vision for the future. The expanding scope of plasma research is creating an abundance of new scientific opportunities and challenges. These oppor-

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Condensed-Matter and Materials Physics: The Science of the World Around Us

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Ed. Note: This article is largely inspired by the Executive Summary of the report.

Condensed-matter and materials physics (CMMP) is the science of the material world around us. Long ago, curiosity about the natural world led to questions about condensed-matter systems, such as water, snow, ice, and rocks, and how they respond to light, heat, and mechanical forces. This thirst for fundamental understanding has been inextricably tied to the desire to manipulate nature by harnessing its properties or creating new materials to serve human needs. The inherent intertwining of pure and applied research defines and enriches the CMMP enterprise to this day.

Condensed-Matter and Materials Physics: The Science of the World Around Us, the latest volume in the Physics 2010 decadal survey, looks at the field of CMMP during the last decade. The 20th century was a period of remarkable fundamental and technological progress in CMMP. Continued federal and private investments led to considerable advances in basic understanding of condensed-matter phenomena. Years later, these advances led in turn to the invention of devices that now form the basis of much of our technological society. U.S. leadership in nurturing invention has contributed significantly to our nation's economic strength. In particular, the industrial development of many of these technologies has led to current U.S. leadership in computing and global communications.

What are the prospects for CMMP in the early part of the 21st century? The report identifies six Grand Challenge areas: (1) How do complex phenomena emerge from simple ingredients? (2) How will the energy demands of future generations be

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

T.I. Meyer, BPA Staff

The Board on Physics and Astronomy met for its spring meeting on April 27-28, 2007, at the Keck Center of the National Academies in Washington, D.C. Chair Anneila Sargent called the meeting to order and thanked everyone for their participation.

The meeting opened with a discussion led by Tony Chan, incoming assistant director of the NSF Mathematical and Physical Sciences (MPS) directorate. Dr. Chan described a number of focus areas for the directorate in FY08, including physical sciences at the nanoscale, the science beyond Moore's law, physics of the universe, complex systems, fundamental mathematical and statistical science, sustainability, and cyber-enabled discovery. Among the challenges facing MPS, he listed broadening participation, maintaining balance between core program activities and the operations of new facilities, and facilitating international partnerships where appropriate. Dr. Chan closed his remarks by commenting on initiatives under way in Europe and China to advance their federal research programs.

From the NSF Physics Division (PHY), Joseph Dehmer observed that "Physics is very important across the board for advancing the nation." Dr. Dehmer described the objectives of PHY: pursuit of intellectual frontiers, broadening impacts, educating the next generation of scientists and engineers as well as the general public, and stewardship. He commented on PHY's effort to broaden participation and showed some progress in several metrics. Dr. Dehmer offered a number of fitness indicators to consider when examining the relative merits and timing of large facility projects. Among these were the following: (1) exciting science goals, vetted and prioritized by the community; (2) proven technologies; (3) stable scope and funding; (4) alignment at each level of government—within agencies, between branches, with science-policy priorities, and with agency procedures; (5) stable partnerships; (6) strong managing partner; (7) socialization with the broader scientific community; (8) adequate understanding and tacit support from the general public; and (9) generally favorable budget climate.

Associate Director Robin Staffin told the Board about the Office of High Energy Physics (HEP) at DOE. He explained the priorities of the program and reviewed the impact of the FY07 continuing resolution. After a pause over the last few years, construction for new HEP projects will ramp up. He acknowledged the considerable impact of the Board's recent report *Revealing the Hidden Nature of Space and Time: Charting the Course for Elementary Particle Physics*. Dr. Staffin noted that the last decade had converted budget for capital construction to operating budgets; that trend would now reverse, although it wouldn't be easy. He highlighted the excitement of the Large Hadron Collider finishing construction in Europe and discussed the status of the global design effort for the International Linear Collider. He described the new budget line appearing in FY08 to support superconducting radio-frequency cavity research; this technology promises to have broad impact across the physical sciences. As part of the effort to recognize and promote this R&D effort, the activity will be called out separately in the FY08 and future budget requests.

By telephone, Alan Stern spoke with the Board in his new role as NASA associate director for the Science Mission Directorate (SMD). He explained his top priorities as getting more science done for each taxpayer dollar, promoting U.S. leadership as appropriate, and implementing the President's Vision for Space Exploration. He also commented on several initiatives to restore balance to the SMD portfolio, notably the announcement of opportunity for up to three new Small Explorer missions.

Briefing the Board on issues at the NSF Division of Materials Research (DMR), acting division director Lance Haworth explained that DMR seeks to support research on the fundamental understanding of materials and con-

densed-matter systems. As a percentage of the portfolio, the larger facilities have grown over the past decade more than the smaller centers. However, the tools and facilities of the division have continued to have very broad impact. In coming years, DMR will be addressing challenges such as broadening participation, supporting mid-scale instrumentation and facilities, balancing support across modes and disciplines, and fostering the development of younger faculty.

Wayne Van Citters discussed the work of the NSF Astronomy Division with the Board. For FY07, he said that the Major Research Equipment and Facilities (MRFEC) account had been supported at the FY06 level but that by softening new starts for NEON and the Oceans Observatories Initiative, NSF expected to continue with ALMA on schedule. He outlined the plans to respond to the NSF Senior Review of Astronomy. The Astronomy Division is exploring a variety of service models with its partner and management organizations, with the goal of developing a response to and an implementation plan for the recommendations of the Senior Review. With regard to the upcoming decadal survey of astronomy and astrophysics, Dr. Van Citters emphasized interacting with the broader community and engaging them in the process.

Wrapping up the morning session, NSF's Electromagnetic Spectrum Manager Tomas Gergely reported on issues of electromagnetic spectrum management and policy on behalf of radio astronomy and remote-sensing activities. He previewed the discussions scheduled for the 2007 World Radiocommunications Conference to be held in October. Closing out his remarks, he reiterated his concern about the lack of incentives for younger scientists and engineers to get involved in spectrum management.

Patricia Dehmer addressed the Board after lunch and discussed the plans for the DOE Office of Basic Energy Sciences. She called attention to the FY07 budget implemented by Congress in its year-long continuing resolution and explained how her office is pursuing basic research needs for a secure and sustainable energy future. Technology, energy, and society are inextricably intertwined, she said, and a thoughtful strategy will be needed to move the system into the 21st century. She then laid out the process her office is using to pursue the basic research side of the continuum of research, development, and deployment.

Dennis Kovar discussed the DOE Office of Nuclear Physics. The DOE office provides more than 90 percent of the federal funding for nuclear physics in this country, a stewardship role that it takes quite seriously. He shared with the Board a roadmap for the future that was organized around six scientific thrusts identified in the 2002 long-range plan. Although the current U.S. nuclear physics program is among the world leaders in all the major thrusts of research, he emphasized that this was because of past investments. The American Competitiveness Initiative's budget-doubling path offers one route for maintaining this status.

Raymond Fonck then described the DOE Office of Fusion Energy Sciences in his role as associate director. He commented on international progress in developing the construction framework for ITER and outlined several new charges to the FACA committee that advises the office. The program has three core elements, he said: stewardship of plasma science, a joint program in HED laboratory physics, and fusion energy science and technology. Dr. Fonck then described a joint initiative with the defense programs side of DOE that was proposed in the FY07 Presidential budget request. It would focus on HED laboratory plasmas and bring together world-class facilities and scientists to make progress in this area.

From DOE's National Nuclear Security Administration, Christopher Keane discussed several programs supporting inertial confinement fusion and HED science. He discussed the larger context of the program, mentioning the transition to "Complex 2030," the administration's plan for a revitalized and more focused nuclear-weapons complex. The program is entering a golden age with the upgrade of the Z-machine at Sandia (2007), the Extended Pulse upgrade of the OMEGA laser at Rochester (2008), and the expected completion of the NIF at Livermore (2010). He also discussed the joint program in HED laboratory plasmas that will be launched in FY08. This program follows recommendations of the BPA study *Frontiers in High Energy Density Physics: The X-Games of Contemporary Science*. Workshops, joint solicitations, the establishment of a federal advisory committee, and a strategic plan will

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Committees of the Board on Physics and Astronomy

Beyond Einstein Program Assessment Committee
Charles F. Kennel, Scripps Institution of Oceanography, and Joseph H. Rothenberg, Universal Space Network, *Co-chairs*

Committee on Astronomy and Astrophysics[1]
C. Megan Urry, Yale University, and Charles L. Bennett, The Johns Hopkins University, *Co-chairs*

Committee on Biomolecular Materials and Processes[2]
Arup Chakraborty, Massachusetts Institute of Technology, *Chair*

Committee on Radio Frequencies
Paul A. Vanden Bout, National Radio Astronomy Observatory, *Chair*
Jeffrey Piepmeier, NASA Goddard Space Flight Center, *Vice Chair*

Condensed-Matter and Materials Physics 2010 (CMMP 2010)[3]
Mildred S. Dresselhaus, Massachusetts Institute of Technology, and William J. Spencer, SEMATECH, *Co-chairs*

NASA Astrophysics Program Assessment Committee[1]
Kenneth H. Keller, University of Minnesota, *Chair,* and Martha P. Haynes, Cornell University, *Vice Chair*

Materials Synthesis and Crystal Growth Committee
Paul S. Peercy, University of Wisconsin at Madison, *Chair*

Plasma Science Committee
Riccardo Betti, University of Rochester, *Chair*

Solid State Sciences Committee
Peter F. Green, University of Michigan, *Chair,* and Barbara Jones, IBM Almaden Research Center, *Vice Chair*

Spectrum Study Committee
Marshall H. Cohen, California Institute of Technology, and Albin J. Gasiewski, University of Colorado at Boulder, *Co-chairs*

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[1]Joint with Space Studies Board
[2]Joint with Board on Life Sciences
[3]Elements of the new survey *Physics 2010*

NSF's MRSECs: Looking Back, Moving Forward

Sharon Foretia, NRC Anderson-Commonweal Intern

Ed. Note: This article is largely inspired by the Executive Summary of the report.

The National Science Foundation's (NSF's) Materials Research Science and Engineering Centers (MRSECs) trace their origin to the Interdisciplinary Laboratories (IDLs) created by the Advanced Research Projects Agency in the 1960s. Initiated in 1994, MRSECs represent the latest in a series of centers designed to foster organized group research on materials in the academic community. After a little more than a decade, the MRSEC Impact Assessment Committee was convened by the National Research Council in response to an informal request from the National Science Foundation. Charged to examine the impact of the MRSEC program and to provide guidance for the future, the committee included experts from across materials research as well as several from outside the field. The purpose of this study was to (1) assess the performance and impact of the National Science Foundation's Materials Research Science and Engineering Centers (MRSEC) program and (2) on the basis of current trends and needs in materials and condensed-matter research, recommend future directions and roles for the program.

To address this task, the committee, comprising representatives of universities, industry, and national laboratories, held four in-person meetings, four whole-committee teleconferences, extensive questionnaires to and telephone interviews with NSF and university personnel, and visits to current, former, and would-be MRSEC sites. Four working subcommittees addressed issues associated with research, education and outreach, industrial outreach, and facilities and management. The nature of materials research demands mechanisms to support interdisciplinary collaboration for the conceiving and execution of ideas and for developing capabilities to sustain our nation's competitiveness in the production of new technology and products based on advances in materials science and engineering. This work often is conducted over a very long timescale, and new materials tend to have far-reaching implications for many other fields, from medicine to high-energy physics to the economy. The task at hand was to assess the relative performance and impact of MRSEC-supported activities in comparison to other mechanisms of support and to recommend a robust strategy for the future of the program.

The committee examined the performance and impact of MRSEC activities over the past decade in the areas of research, facilities, education and outreach, and industrial collaboration and technology transfer. It concluded that the MRSEC program has had important impacts with the same high standard of quality as other multi-investigator or individual-investigator programs. Although the committee was largely unable to attribute observed impacts uniquely to the MRSEC program, MRSECs generally mobilize efforts that would not have occurred otherwise.

Research

In assessing the impact of the research enabled by the MRSEC program, the committee sought first to identify any unique, distinguishing features. However, it found no simple, quantitative, objective measure to clearly differentiate the MRSEC research product from that of other mechanisms supporting materials science and engineering research.

The committee studied a set of major breakthroughs in materials research over the past four decades. U.S. universities, and in particular MRSECs and their predecessors, the MRLs, played a limited but pivotal role in several of these discoveries. Overall, it determined that the MRSEC program produces excellent frontier science of the same high standard as that supported by NSF through other mechanisms. The quality of MRSEC research is at least on a par with that of other multiple principal-investigator programs and with individual grants in the United States and internationally and is an important element of the overall mix for support of materials research, including support for big centers and single-investigator grants.

Experimental Facilities

The MRSEC program offers one of the principal opportunities in materials research to support shared experimental facilities that include not only equipment but also the personnel to provide training for students and maintenance. Growing constraints on the per capita MRSEC budget have greatly diminished this ability, which is a concern for the infrastructure of materials research in general.

Education and Outreach

Education and outreach (EO) covers a broad range of activities that serve audiences including K-12 students and teachers; undergraduate, graduate, and postdoctoral researchers; policy makers; and the general public. The MRSEC EO program has impacts on the NSF mission to educate and prepare the nation's future workforce:

- MRSECs provide unique opportunities for interdisciplinary research experiences that are different from those an individual student would experience in a single-investigator laboratory.
- MRSECs foster environments that support interactions with other programs to leverage funds and coordinate activities across campuses and disciplines. This culture leaves a vital imprint on students who work in MRSECs.
- MRSECs foster a mentality of outreach and a sense of responsibility for current and future researchers.

It was learned that the most significant and well-documented contribution of MRSEC EO programs is the preparation of future researchers at all levels. However, the future impact of MRSEC EO activities is threatened. The continued lack of specificity in EO expectations at the agency level has led to an emphasis on quantity over quality and on innovation over impact. The committee recommends that MRSECs should focus resources on programs with proven high impact that leverage the MRSECs unique research strengths and that can be meaningfully evaluated. They recommended that the

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met? (3) What is the physics of life? (4) What happens far from equilibrium and why? (5) What new discoveries await us in the nanoworld? (6) How will the information technology revolution be extended? Each challenge is described in detail in the report.

U.S. CMMP researchers will not be alone in tackling these challenges. The United States remains a leader in CMMP worldwide, but its premier position is in jeopardy. There are several contributing factors: (1) Other parts of the world are investing heavily in research and development; (2) in the United States, industrial laboratories are now focused on much-shorter-term research and development goals, with little emphasis on basic research; and (3) federal research funding for CMMP has been approximately flat in the United States in inflation-adjusted dollars over the last decade.

The consequences of the decline of industrial involvement and nearly flat federal funding for CMMP are serious indeed: (1) Many of the key technological innovations responsible for U.S. leadership in communications and computing were developed at the once-great industrial laboratories; (2) many of today's leaders at universities, national laboratories, and other institutions come from industrial laboratories where they conducted high-risk fundamental research with relatively little funding pressure. Currently very few such research environments are available to young researchers to nurture their professional growth; (3) at the National Science Foundation, CMMP proposal funding rates have dropped dramatically in the last 5 years, from 38 percent to 22 percent. These low proposal success rates greatly amplify the hidden overhead of writing and reviewing proposals and disrupt the continuity of scientific research; (4) strong support for principal investigators is particularly important for CMMP research. Strong, healthy individual investigator research programs are needed for effective, evolving collaborative efforts and for transitioning in and out of larger collective research activities; (5) during the last 5 years, the size of grants increased only 15 percent, while the cost of supporting students increased by 25 percent in as-spent dollars; and (6) over the last decade, the number of publications contributed by U.S. authors remained essentially flat in two major journals reporting CMMP research results worldwide, whereas foreign contributions nearly doubled in the same time frame.

The report offers seven recommendations to realize the potential of CMMP research in the coming decade. They are based on an assessment of the most efficient use of resources and projected growth in funding for the field—7 percent per year over the next 10 years. This rate of growth reflects the levels recommended in the President's American Competitiveness Initiative, which seeks a doubling of the physical science research budget of NSF, DOE, and NIST in 10 years. Recommended actions follow:

(1) Basic research in CMMP contributes to the economic strength and leadership of the United States. The committee recommended that DOE and NSF undertake the following actions: (a) Strong support should be maintained for individual and small groups of investigators. The ratio of support for individuals and small groups of investigators relative to support for centers and facilities should not decline in the next decade**.** (b) The average success rates for funding of proposals should be increased more than 30 percent over the next 5 years to give junior scientists the opportunity to obtain research results before the tenure decision and to enable currently funded researchers to maintain continuity in their research. (c) Grants to individuals and small groups of investigators should be increased to maintain the buying power of the average grant.

(2) Funding agencies should develop more effective approaches to nurturing emerging interdisciplinary areas for which no established reviewer base now exists. The CMMP community should organize sessions at national meetings to engage funding agencies and the community in a dialogue on best practices for proposal review and for the support of nontraditional, rapidly evolving areas.

(3) Outreach, K-12, and undergraduate science education initiatives should be supported via supplemental or stand-alone grants administered by separate NSF and Department of Education programs, instead of through individual research grant awards. In the present system, the quality of outreach programs is a criterion in the evaluation of NSF grants. The present approach

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characterize the new program.

Joel Parriott and Amy Kaminski, from the Office of Management and Budget (OMB) and Kate Beers, from the Office of Science and Technology Policy (OSTP), presented views from the Executive Office of the President about the FY08 budget request. They discussed the importance of clear priorities, decision rules, and explicit "science per dollar" judgments in making policy choices for the federal science portfolio. Dr. Beers said that the FY07 budget passed by Congress was less than the White House request and could therefore affect the starting points for FY08 negotiations. She highlighted several efforts at OSTP including renewed efforts to coordinate "physics of the universe" research across the agencies, implementing the soon-to-be-public recommendations of the interagency task force on high energy density physics and the collection of lessons learned from past multiagency efforts to collaborate on large-facility research projects.

On a lighter note, the Board heard a presentation from BPA staff member Timothy Meyer about his experience teaching (and learning from) high-school students about the federal process for formulating and implementing science policy. He developed and taught a 5-day intensive course that role-played the Executive Branch's development of the federal science budget. He joked that at the end of the class, any of the students could have taken a senior position in science policy or program management and would discharge those duties with all the success, pathologies, and personality that could be expected of the most qualified candidates.

On the second day of the meeting, the Board heard from Martha Haynes about the recently released NRC report *Assessment of the Performance of NASA's Astrophysics Program.* She described the charge to the review committee and the committee's analysis of the relative balance of the NASA program as it sought to realize the priorities of the decadal vision. The committee concluded, in part, that NASA's Astrophysics Division does have the resources to pursue the priorities, goals, and opportunities outlined in the previous decadal survey and the 2002 NRC report *Connecting Quarks with the Cosmos.*

Changing hats, Professor Haynes summarized the review of the BPA carried out by the NRC's Division on Engineering and Physical Sciences (DEPS) at the November BPA meeting. On the basis of wide consultation with sponsoring agencies and the scientific community, the DEPS review committee gave the Board excellent marks on the quality, importance, and impact of its studies. The committee also praised the performance of the BPA staff. The DEPS review noted that the timeliness of NRC reports in general could be improved and that engaging the broader community in the study process would be increasingly important in the future. The DEPS review also praised the Board for its innovations in the committee process, such as as including outsiders in the membership.

This discussion brought the meeting to a close. With a warm thank you to everyone, vice-chair Marc Kastner adjourned the meeting. ■

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confuses two conceptually distinct goals to the point that neither is optimally served. The funding agencies and the research community both want outreach programs to succeed, and they should confer to determine how best to implement an effort to achieve that goal.

(4) The CMMP community should work to improve the representation of women and underrepresented minorities in CMMP through mentoring; providing flexible working conditions, daycare opportunities, and viable career paths; and developing outreach programs targeted to students and the public and aimed at increasing the numbers of prospective researchers.

(5) OSTP should convene a study with participation from DOE, DOD, NSF, NIST, the physics community, and U.S. corporations to evaluate the performance of R&D activities that might replace the basic science previously done by the large industrial laboratories, and the contributions that those laboratories made to the training of future scientific leaders and educators.

(6) DOE and NSF should develop distributed national facilities in support of the design, discovery, and growth of new materials for CMMP research.

(7) State-of-the-art instrumentation and facilities are critical to CMMP research. The committee's top-priority recommendations for instrumentation and facilities follow; please see the report for more. (a) DOE and NSF, partnering with NIH and NIST, should create a consortium focused on research and development needs required for next generation light sources. The consortium, with an independent chair, should include stakeholders from universities, industry, and government (both laboratories and agencies). The consortium should formulate a light source technology roadmap and make recommendations on the R&D needed to reach milestones on the roadmap for a new generation of light sources, such as seeded x-ray free electron lasers, energy-recovery linac driven devices, and other promising concepts. The consortium should also take into account cost containment and internationalization of research facilities. (b) DOE should complete the instrument suite for the Spallation Neutron Source (SNS), and provide of state-of-the-art ancillary equipment for these instruments. (c) DOE and NSF should support CMMP community needs for electron microscopy instrumentation at universities on a competitive basis. Cutting-edge electron microscopy technique development should be continued to fully reestablish U.S. competitiveness in developing the next generation of electron microscopes. (d) NSF should continue the support of the National High Magnetic Field Laboratory and high magnetic field instrumentation development.

Without strong support for basic research, U.S. leadership in CMMP is unlikely to survive. Such a loss could cause the United States to miss critical opportunities in growing new markets and could significantly hamper U.S. economic innovation. The recommendations of the CMMP 2010 Committee focus on ensuring U.S. leadership in this intellectually exciting field that is technologically and economically vital to the nation. ■

Survey of Scientific Uses of the Spectrum

David B. Lang, BPA Staff

Under the auspices of the BPA's Committee on Radio Frequencies (CORF), a new committee, the Spectrum Study Committe, has been formed to survey the scientific uses of the radio spectrum. The committee, co-chaired by Marshall H. Cohen of Caltech and Albin J. Gasiewski of the University of Colorado, will prepare a report exploring the scientific uses of the radio spectrum. The report will: (1) Portray the science that is currently being conducted using the radio spectrum; (2) Identify the spectrum requirements necessary to conduct research; (3) Identify the anticipated spectrum requirements for at least the next 10 years; and (4) Advise spectrum policy makers on the value to the nation of accommodating scientific uses of the spectrum, recognizing the need to balance multiple communities.

The committee will comment on spectrum use by the relevant scientific communities but will not make recommendations on the allocation of specific frequencies. Support for this work from the National Science Foundation, the Department of Commerce, and the National Aeronautics and Space Administration is gratefully acknowledged.

In the United States, the Federal Communications Commission (FCC) has the authority to regulate telecommunications frequencies and their use for frequency bands used by the private sector. The National Telecommunications and Information Agency (NTIA) has the authority to regulate telecommunications frequencies and their use by federal government agencies. In reality, most frequency bands are shared between the private sector and the public sector and therefore are dealt with by both the FCC and NTIA on a cooperative basis.

In recent years, the explosion of new wireless technologies has significantly increased demand for access to the radio spectrum. The proliferation of wireless electronics and communications applications has placed pressure on spectrum managers in the FCC and NTIA to open new areas of the spectrum for commercial use. While these offer consumers exciting new products, technologies such as ultra wideband (UWB) devices for use in vehicular radars threaten access to the bands that are needed to conduct scientific research.

Since the current system of allocating bands in the radio spectrum was developed, over 50 years ago, this increased demand has led to discussions in both government and industry about new ways to thinking of spectrum allocation and use. Initiatives such as the FCC's Spectrum Policy Task Force have aggressively approached this issue and will likely play an important role in how spectrum policy is shaped in the future. As the paradigm of spectrum management changes, spectrum users will have a unique opportunity to influence the process for the better.

Scientific users of the radio spectrum, such as radio astronomers and earth scientists using remotely sensed data, have an important stake in the policies that will result from the spectrum survey. This survey will identify the needs of today's scientific activities to assist spectrum managers in balancing the requirements of the scientific users of the spectrum with those of other users.

While the commercial uses of the spectrum have changed drastically in the past half-century, so have its scientific uses. Fifty years ago, radio astronomers sought access mainly to specific narrow bands in order to conduct their research. Today, observations of quasars, galaxies at high redshifts, and other exotic objects that have been discovered over the past 50 years do not necessarily fall into the bands allocated for studying the hydrogen line, the ammonia line, or other interesting molecules in nearby galaxies. Radio astronomers require much broader access to the spectrum than they once did to investigate new objects and phenomena.

As the space age has progressed, a number of fields have come to rely on the ability to remotely sense terrestrial phenomena such as ocean currents and surface temperatures from aircraft and orbiting satellites. These observations have led to a far better understanding of

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Astronomy and Astrophysics 2010 Decadal Survey

Brian D. Dewhurst, BPA Staff

The time has come to begin preparations for the next Decadal Survey of Astronomy and Astrophysics. This statement is the primary outcome of a meeting jointly sponsored by BPA and the Space Studies Board (SSB), held on April 28th, 2007. The meeting was led by BPA Chair Anneila Sargent and SSB chair Lennard Fisk (NAS) and included astronomers Charles Bennett (NAS), Alan Dressler (NAS), Suzan Edwards, Andrea Ghez (NAS), Martha Haynes (NAS), Jacqueline Hewitt, Christopher McKee (NAS), Jeremiah Ostriker (NAS), and C. Megan Urry. In addition, a number of individuals from related fields attended, including Jonathan Bagger, Homer Neal, Joe Rothenberg, Clifford Will (NAS), and A. Thomas Young (NAE).

In addition to directing the NRC staff to begin preparing for the next decadal survey, the group provided the staff with guidance in a number of areas pertaining to the structure of the survey and the issues it will face. Building on the work of the Committee on Astronomy and Astrophysics, which had used the previous 2 years to solicit input on the survey process from a broad range of astronomers and policy officials, the meeting discussed a number of survey-related issues.

One significant topic was how to gather effective input from the entire community. The group agreed that gathering substantial input from a broad cross section of the community was vital to the success of the decadal survey process. To achieve this goal, the group directed the staff to plan for panels with a larger membership, a large number of consultants per panel, in addition to the panel members, and the ability to hold several town hall meetings across the United States during the survey process.

A second topic was how to structure the panels that feed into the survey report. Rather than try to devise a panel structure in advance, the group decided to instruct the survey committee to organize the panels as they saw fit. It did encourage the NRC staff to include outsiders on the panels and the survey committee. The term "outsider" broadly refers to members from disciplines related to astronomy and astrophysics, from space engineering to science policy to elementary particle physics.

The credibility of the cost estimates for projects provided in decadal surveys has come into question, with the most recent projects going over their budgets. The NRC's Beyond Einstein Program Assessment Committee (BEPAC), tasked to consider the reality of current cost estimates as part of its study, developed a cost-estimating process that included hiring an outside contractor to provide the committee with independent cost estimates. BEPAC's report is due in September and, assuming the report is successful, NRC staff were directed to follow a similar procedure for their decadal survey.

Heading into the next decadal survey, a number of projects recommended in previous surveys have not yet been completed or even begun in any meaningful way. In previous surveys such projects were recommened for contruction and included in a single statement confirming the importance of the projects and encouraging their completion. At this time, however, the participants believed that the magnitude of unfinished projects is so large that were this survey to adopt a similar strategy there would be no room for new initiatives. Therefore, staff were instructed to explore ways in which projects could be considered afresh in a fair and consistent manner.

Based on the directions received at the meeting, the BPA and SSB assembled a prospectus for the study and in mid-June, received approval from the NRC's Governing Board to propose the study. Since then staff have been working to convert the prospectus in to proposals for agency support, which are expected to be submitted to the agencies in the late summer or fall. ■

NASA's Astronomy Science Centers

In June 2007, the NRC released a report entitled *Portals to the Universe: NASA's Astronomy Science Centers*. That report, conducted under the auspices of the Space Studies Board, identified a series of best practices for the operation of astronomy science centers (such as the Spitzer Science Center of the Space Telescope Science Institute). The astronomy science centers were created to serve as a link between astronomy missions and the scientists who use the data. They have been successful in enabling space-based astronomy missions to achieve their scientific potential. The authoring committee's central conclusion was that NASA had invested considerable resources in the current suite of science centers and that the centers were sufficient to operate all the current ly planned or ongoing missions. ■

NASA's Astrophysics Program Reviewed by NRC

In February 2007, the NRC released the report of the NASA Astrophysics Performance Assessment Committee. The report, *A Performance Assessment of NASA's Astrophysics Program*, concludes that NASA's astrophysics program has achieved the agency's highest priority goals by focusing on large missions such as the Hubble and James Webb space telescopes but in doing so, has squeezed out smaller missions that could be laying the foundation for future scientific discovery. The study determined that although NASA's astrophysics budget is close to a historic high, priority missions experienced cost overruns that left fewer resources for small missions. The report recommends that NASA find a way to do small-scale, low-cost missions that can be quickly conceived, built, and launched. For starters, the agency should restore funding for the Science Mission Directorate's Explorer Program to its level of 5 years ago. ■

MRSEC (continued from page 4)

NSF develop and support the MRSEC EO community in sharing and facilitating ideas and resources, including best practices, for all activities. This would be especially helpful in the area of increasing the participation of underrepresented minorities.

Industrial Interactions

An important goal throughout the history of the MRSEC program has been to promote "active cooperation with industry to stimulate and facilitate knowledge transfer among the participants and strengthen the links between university-based research and its application," according to the NSF program solicitation. Industrial outreach includes relevant sectors involved with the application of materials research beyond just commercial industries. Consequently, industrial outreach includes national laboratories and other federal entities that apply the results of basic materials research to address important national needs. MRSECs are required to develop and execute a program for knowledge transfer to industry. The program goals for MRSEC industrial collaborations are appropriate. The MRSEC program requirement for industrial collaboration leads to important activities that likely would not occur otherwise (e.g., workshops, short courses, external advisory boards with industrial advisers). The NSF should establish metrics for evaluating the effectiveness of industrial collaboration and technology transfer. Together with the team of MRSEC directors, NSF should provide a mechanism to enable industry to understand the resources and expertise available through the network of MRSECs.

Analysis

MRSECs have enormous perceived impact. MRSEC center awards continue to be in great demand. The intense competition within the community for them indicates a strong perceived value. These motivations include: (a) The ability to pursue interdisciplinary, collaborative research; (b) The resources to provide an interdisciplinary training experience for the future scientific and technical workforce, from undergraduate to postdoctoral researchers; (c) Block funding at levels that enable more rapid response to new ideas and that support higher-risk projects than is possible with single-investigator grants; (d) The leverage and motivation MRSECs provide in producing increased institutional, local, and/or state support for materials research; (e) The perceived distinction that the presence of a MRSEC gives to the materials research enterprise of an institution, thus attracting more quality students and junior faculty; and (f) the infrastructure that MRSECs can provide to organize and manage facilities and educational and industrial outreach.

The effectiveness of MRSECs has been reduced in recent years by increasing requirements without increasing resources. Increasing the mean grant size is necessary to allow the program to fulfill its important mission goals. The committee concluded that the MRSEC program needs to evolve in order to successfully meet its objectives in the coming decade. To do so, NSF must restructure the program to reduce requirements, reduce the number of MRSEC awards, and/or increase the total funding of the MRSEC program while preserving its positive elements. It recommended that to respond to changes in the budgetary landscape and changes in the nature of materials research in the coming decade, the NSF should restructure the MRSEC program to allow more efficient use and leveraging of resources. The new program should fully invest in centers of excellence as well as in stand-alone teams of researchers. The opportunity to leverage the combined resources of the MRSEC program is significant. The centers could expedite the pace of the overall research effort by taking advantage of tools and talents distributed throughout the program. Such initiatives, however, are best launched from the centers and the researchers themselves.

Building the integrated capabilities of materials research centers into a cooperating network would strengthen materials science and engineering in the United States as a discipline and as a factor in U.S. competitiveness.

The committee's final report will be formally published in October 2007. ■

MRSEC Impact Assessment Committee

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Plasma 2010 (continued from page 1)

tunities promise to further expand the role of plasma science in enhancing economic security and prosperity, energy and environmental security, national security, and scientific knowledge.

Because plasma science has a coherent intellectual framework unified by physical processes that are common to many subfields, it is much more than a basket of applications. The Plasma 2010 Committee believes that it is important to nurture growth in fundamental knowledge of plasma science across all of its subfields in order to advance the field and to create opportunities for a broader range of science-based applications. These advances and opportunities are, in turn, central to the high achievement of priority national goals such as fusion energy, economic competitiveness, and stockpile stewardship.

The vitality of plasma science in the past decade testifies to the success of some of the individual federally supported plasma-science programs. However, the emergence of new research directions necessitates a concomitant evolution in the structure and portfolio of programs at the federal agencies that support plasma science. Further, the lack of coherence across the federal government ignores the unity of the science and is an obstacle to overcoming many research challenges, realizing scientific opportunities, and exploiting promising applications. The committee observes that effective stewardship of plasma science as a discipline will likely expedite the applications of plasma science. The need for stewardship has been identified in many reports over the past two decades and now the evolution of the field has exacerbated the stewardship problem and driven the Plasma 2010 committee to conclude that a new, integrated way of managing federal support for the science is necessary.

Recommendation: To fully realize the opportunities in plasma research, a unified approach is required. Therefore, the Department of Energy's Office of Science should reorient its research programs to incorporate magnetic and inertial fusion energy sciences, basic plasma science, non-mission-driven high energy density plasma science, and low-temperature plasma science and engineering, the last two of which are new thrusts.

The new stewardship role for the Office of Science would expand well beyond the present mission and purview of the Office of Fusion Energy Sciences (OFES). It would include a broader portfolio of plasma science than the research OFES currently supports. The stewardship framework would not replace or duplicate the plasma science programs in other agencies; rather, it would enable a science-based focal point for federal efforts in plasma-based research. These changes would be more evolutionary than revolutionary, starting modestly and growing with the expanding science opportunities. The Plasma 2010 Committee recognized that these new thrusts would require new resources and perhaps a new organizational structure within the Office of Science.

The Plasma 2010 Committee commented on some of the challenges and risks associated with its chief recommendation. Among the issues to be addressed in planning such a strategy are these:

• Develop a structure that integrates the scientific elements;

• Develop and initiate a strategic planning process that not only spans the field but also provides guidance to each of the subfields;

• Identify the major risks and develop/initiate strategies to avoid them.

There is a spectacular future awaiting the United States in plasma science and engineering. But the national framework for plasma science must grow and adapt to new opportunities. Only then will the tremendous potential be realized.

The committee's final report, *Plasma Science: Advancing Knowledge in the National Interest,* was publicly released on Tuesday, May 29, 2007 in unedited, prepublication form. The co-chairs have given several public and private briefings on the report, most recently during a session at the IEEE Pulsed Power and Plasma Science Conference in Albuquerque, N.M. Follow-on briefings with the Under Secretary for Science and the Director of the Officie of Science and Technology Policy have been scheduled. For information on other dissemination activities, please see the BPA Web site. ■

Spectrum Study (continued from page 7)

the biosphere than would ever be possible using optical observations. For example, oceanographers and climatologists used the broad field of view offered by satellites in Earth orbit to analyze the ocean's temperature, salinity, and other key characteristics, leading to the discovery of the El Niño effect.

Since both radio astronomy and Earth remote sensing heavily utilize extremely sensitive, passive sensing techniques—that is, listening rather than transmitting-interference in the bands allocated for these activities can have a very negative impact on them. Out-of-band emissions can yield spurious data and even damage sensitive receivers.

The report of the Spectrum Study Committee will take on the difficult task of not only assessing the potential threat of interference to the scientific fields of radio astronomy and Earth remote sensing, but also of circumscribing the future scientific capabilities of the field based on current trends and technology development. To do so, the committee has a broad selection of scientists and engineers from both fields, as well as policy and economics experts.

The committee held its first meeting on June 12-13, 2007, in Washington, D.C., at which is heard from the three main agencies involved in these issues. Going forward, the committee is planning town hall sessions for broad community input at the International Geoscience and Remote Sensing Symposium in July 2007 and the American Astronomical Society meeting in January 2008. Involving the broad community is critical to the report's outcome and impact; not only do these efforts help the committee tap into the broad expertise of the community, but it also actively engages the stakeholders in the consensus-building process.

The committee will be conducting additional data-gathering activities throughout its deliberations and looks forward to producing a unique document to represent and protect the scientific uses of the spectrum far into the future. It is scheduled to meet again at the end of September 2007 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, 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 about 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 at 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

• *Review of a plan for U.S. fusion community participation in ITER.* Following up on activities called for in the Energy Policy Act of 2005, a small committee of about 10 members will be convened to review and evaluate the document "Planning for U.S. Fusion Community Participation in the ITER Program." The committee will determine whether the plan provides a good initial outline for the effective participation of U.S. plasma scientists in research at ITER and will recommend next steps for further development of the plan. The committee will prepare a concise report.

• *Scientific assessment of free-electron laser technology for naval applications.* Arising from discussions with the Office of Naval Research, a committee will be formed to ssess the current capabilities of free-electron lasers to deliver large amounts of energy to a target. The commtitee will assess the prospects for developing such devices with megawatt average power capabilities and identify the key technical problems that must be solved to achieve such performance. The committee will evaluate the feasibility of achieving power, energy, and other technical parameters specified by the Office of Naval Research and will not be charged to make its own determination of the requirements for effective directed-energy weapons.

• *Research forefronts at the intersection of the physical and life sciences.* An NRC study will begin shortly to examine the intersection of the physical and life sciences. A committee of about 18 members will develop a conceptual framework for this work, identify and prioritize the most compelling research opportunities and their potential benefits to society, and explore ways to enable and enhance effective interdisciplinary collaboration.

• *The impact of selling the U.S. Federal Helium Reserve.* In a follow-up to a report published in 2000, this study would assess the impact of having sold the Federal Helium Reserve on U.S. scientific, technical, biomedical, and national security users of helium over the past 5 years. To provide a meaningful context for this effort, the study will examine the helium market and the helium supply chain. Measures that would enable the Federal Helium Program to respond to future changes in the dynamics of the helium market will be identified.

New Faces at the BPA. Sharon Foretia, a graduating senior of Albert Einstein Senior High School, in Kensington, Maryland, has joined the BPA for the summer 2007 season as an Anderson-Commonweal intern. She is headed to Cornell University this autumn with a strong interest in biological science.

BPA Update: Meetings in 2007

September 2007	
9/14-15	Forefronts/PhysBio Meeting, Washington, D.C.
9/29-30	PLSC Meeting, Irvine, California.
9/29-30	Spectrum Study Meeting, Irvine, California.
October 2007	
10/18-19	SSSC Meeting, Irvine, California.
November 2007	
11/3-4	BPA Meeting, Irvine, California.
11/15-18	MSAC Meeting, Washington, D.C.
December 2007	
12/15-16	CORF Meeting, Irvine, California
12/17-18	Spectrum Study Meeting, Irvine, California
12/19-20	Forefronts/PhysBio Meeting (location to be determined)

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:

NSF's MRSEC Program: Looking Back, Moving Forward
CMMP 2010: The Science of the World Around Us
Plasma 2010: Advancing Knowledge in the National Interest

Coming Soon:

Final report of the Biomolecular Materials and Processes Committee
Final report of the Beyond Einstein Program Assessment Committee

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BPA Newsletter for: