BPA News

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EPP 2010: An Assessment of and Outlook for Elementary Particle Physics

The Elementary Particle Physics 2010 committee (EPP2010) of the National Research Council has been busy over the past half-year. Since its last full meeting at the end of January 2005 at the Stanford Linear Accelerator Laboratory in California, the committee met again in May at the Fermi National Accelerator Laboratory in Illinois and again in August at Cornell University in New York, sent a small team to Japan to meet with leaders of the field there, made presentations at other meetings and conferences, organized into a set of four working groups to debate different aspects of the report, and arranged for a number of small group discussions and briefings.

The January meeting was graciosuly hosted by Jonathan Dorfan, director of SLAC. It focused on the status of the current themes in elementary particle physics: physics of the TeV-scale, quark and lepton flavor physics, and particle astrophysics and cosmology--and the opportunties they each offer.

In March, the committee formulated a list of questions to share with a related activity being undertaken by the joint DOE/NSF High Energy Physics Advisory Panel (HEPAP). Committee discussions revealed a number of key questions that members felt needed to be addressed in order to fully understand the issues. Because HEPAP is currently overseeing a subpanel on physics connections between the Large Hardron Collider at CERN (the European Organization for Nuclear Research) and a potential TeV-scale linear collider, the committee chose to share some of its linear-collider-specific questions with the HEPAP subpanel; both groups felt that this articulation of key topics was very beneficial.

In April, vice chair Sally Dawson made a presentation about the committee's status and answered questions at the annual conference of the American Physical Society in Tampa, Florida.

In May, the committee met in person for a third time, graciously hosted by Michael Witherell at the Fermi National Accelerator Laboratory. The meeting focused on the international aspects of the field with presentations by Dr. Witherell on U.S. national program planning, Albrecht Wagner of the German laboratory DESY, Yoji Totsuka of the Japanese laboratory KEK, and Ian Halliday, former chief executive of the U.K. Particle Physics and Astronomy Research Council. Director-designate Piermaria Oddone presented a plan for the future of Fermilab. Steven Holmes discussed the accelerator research and development program for the International Linear Collider, and Gary Feldman of Harvard University presented on accelerator-based neutrino programs. Rocky Kolb described the

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In this issue:

Midsize Facilities: The Infrastructure of Materials Research

Robert Sinclair, Stanford University

Over the past four decades, methods for creating new materials and examining their detailed nature have become more subtle, sensitive, and precise. Scanning transmission electron microscopes can now identify the locations of individual atoms in a silicon wafer, focused-ion beams can create features with dimensions less than 10 nm, and secondary-ion mass spectrometers can simultaneously measure chemical concentrations and spatial locations, providing better than 35 nm resolution in one configuration and sub-ppm detection limits for high-resolution depth profiling of semiconductor devices in another. In no small way, the advent of these capabilities expanded the current focus on nanoscience and technology. However, these developments come at a price. Today's sophisticated tools for materials research are sufficiently expensive and complex that individual investigators are often no longer able to adequately own, operate, or maintain them.

Once dominated by tabletop instruments, materials research has blossomed into an endeavor whose cost of entry has risen substantially over the past decades. Instruments critical to materials research are becoming sufficiently expensive that resources must be pooled to manage these instruments in small to midsize multiuser facilities. By bringing together resources (in terms of equipment, staff, and expertise), midsize facilities serve as much-needed centers of instrumentation, innovation, and creativity for research, education, and training. Midsize facilities often offer access to advanced research and development environments to commercial collaborators; such partnerships can invigorate local industry and even

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

The Board on Physics and Astronomy met for its annual spring meeting in Washington, D.C., on April 29-30, 2005. Chair Burton Richter called the meeting to order with a few observations on the state of the annual budget cycle. The Board started the day of presentations and discussions by considering progress on the initiative to explore the science and policy at the intersection of the physical and life sciences. Based on the discussions at the last meeting, the Board partnered with the Board on Life Sciences (BLS), the Board on Chemical Sciences and Technology (BCST), and the Board on Mathematical Sciences and their Applications (BMSA) to convene a meeting of experts in December 2004 (see related article in Winter 2004 issue). The workshop participants recommended to the NRC that a committee be convened to assess and prioritize the opportunities at the interface of the physical and life sciences. It was reported that initial conversations with representatives of DOE, NIH, and NSF during February 2005 were positive; the Board agreed to oversee the preparation of a formal proposal for the study in collaboration with BLS and BCST.

The meeting then turned to a discussion of activities at NSF. Eileen Friel spoke with the Board about NSF's Astronomy Division. A recent major development was the incorporation of Japan into the Atacama Large Millimeter Array (ALMA) project in September 2004. Although the project had originally been structured with only two regional participants (the Americas and Europe), negotiations to allow Japan to contribute key enhancements were successful. On the successful collaboration front, Dr. Friel also commented on the formal inclusion of DOE into the Astronomy and Astrophysics Advisory Committee in March 2005. She also described progress on several existing and proposed facilities, including the Advanced Technology Solar Telescope, next-generation instrumentation for the Gemini telescopes, the National Virtual Observatory, the Giant Segmented Mirror Telecope, and the Large Synoptic Survey Telescope. NSF is feeling the impact of changes at NASA, she said, in terms of increased proposal pressure. However, NSF and NASA program staff are now working together more closely. Dr. Friel also discussed the upcoming senior review commissioned by the Astronomy Division to examine optimization of the current portfolio of facilities.

Loretta Hopkins discussed the status and plans of NSF's Division of Materials Research (DMR) with the Board. An important observation was the tremendous proposal pressure on the grants programs; in particular, the change in cost-sharing practices has had a severe impact on the Instrumentation for Materials Research program—there were 80 new proposals this year. She also discussed how DMR is responding to several NSF-wide goals, such as increasing the average award size and duration. Dr. Hopkins also shared a rough estimate of the condensed-matter and materials physics portion of the DMR portfolio: about $100 million per year. A recent committee of visitors' report gave DMR high marks but stressed that resources was a limiting factor (both in terms of budgets and in number of staff to administer the programs).

Thomas Gergely presented some remarks about NSF's management of the electromagnetic spectrum for scientific usage, particularly with regard to radio astronomy and satellite-based observations of Earth. A key concern he identified was a shortage of experts in the science and policy of spectrum management. (For more details, see related article *A Time to File. . .Recent CORF Activities* on page 7.)

Anne Kinney discussed the status of NASA's Universe Division with the Board. She pointed out that despite all the recent perceptions of politics at the agency, three great observatories are in

space and are doing great science. Always a core theme at NASA, strategic planning was under way to adapt to the new missions, environments, and science goals of the division. She commented on the FY05 and FY06 budgets; Congressionally directed spending and Return to Flight activities are putting severe strains on the science programs, and the choices have been quite heart-wrenching.

Pat Dehmer shared her thoughts on DOE's Office of Basic Energy Sciences (BES). To set the scale of discussions, she pointed out that BES's budget is about 23 percent of DOE's Office of Science. She reviewed the progress of the various new facilities, including the Spallation Neutron Source, the Linac Coherent Light Source, and the five nanoscale science and engineering centers. Regarding the outlook for the future, she said that while there was good news (with the commissioning and turn-on of the various new world-leading facilities), BES and the community will be faced with extraordinarily tough choices. In alignment with Ray Orbach's strategy, Dr. Dehmer said that decisions would have to be made about ramping down certain current activities in order to free up resources to undertake the most compelling new opportunities.

Robin Staffin presented an overview of DOE's Office of High Energy Physics (HEP). He said the future of the domestic program was an important and significant question. He discussed the current program priorities, including the Tevatron, the B factory, the Large Hadron Collider (LHC), and the core research program at the universities and laboratories. Another challenge for the field will be the transition from the Tevatron (at Fermilab) to the LHC (overseas, at CERN). Dr. Staffin briefly described the attention and the priority that HEP and even the Office of Science at large is giving the International Linear Collider. He commented, though, that the case for the scientific payoff needs to be made clearly: "Discovering the new laws [of physics] is more important than discovering the new particles."

Dennis Kovar discussed DOE's Office of Nuclear Physics. The dominant observation in his discussion was the severity of the proposed budget cuts; the program supports nearly 90 percent of the federal funding for nuclear physics research and more than 60 percent of university-based researchers. Because of the grim outlook, the joint DOE/NSF Nuclear Science Advisory Committee was charged with examining the 2002 long-range plan in order to develop a set of priorities under a very restricted budget—that is, if new initiatives were not even possible, which activities should be phased out first in order to retain the most compelling research thrusts?

Anne Davies shared observations on DOE's Office of Fusion Energy Sciences. At the time of the meeting, the ITER site had not yet been chosen, but DOE was taking steps to make ITER a higher priority element of the program. In the tough budget climate, the program was choosing to cut back on many activities and even close several out. Dr. Davies briefly described the recent priorities report from the DOE Fusion Energy Sciences Advisory Committee; the report identified three overarching themes for the science program that incorporated pursuit of a burning plasma experiment such as ITER.

Representatives from the White House Office of Management and Budget and the Office of Science and Technology Policy then had a discussion with the Board. The theme of the administration's outlook this year is "meeting the priorities of the nation while achieving spending restraint." They pointed to a key element of the guidance, which identified the physical sciences as a priority but only with considerations of broad societal impact and well-coordinated, discovery-class research.

On the second day of the meeting, vice chair Anneila Sargent opened the meeting with a roundtable discussion among the leaders of several elements of the *Physics 2010* decadal survey of physics. Jonathan Bagger discussed Elementary Particle Physics 2010 (EPP 2010), Phil Bucksbaum discussed Atomic, Molecular, and Optical Physics 2010 (AMO 2010), and Steven Cowley talked about Plasma Science 2010 (PLS 2010). Common themes emerged from the brief work plans presented by each of the participants: (1) involvement of the community via town meetings and public message boards; (2) introduction

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Committees of the Board on Physics and Astronomy

Committee on Astronomy and Astrophysics
C. Megan Urry, Yale University, and Roger D. Blandford, Kavli Institute for Particle Astrohysics and Cosmology, *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
Karen St. Germain, Naval Research Laboratory, *Chair*

Solid State Sciences Committee
Marc A. Kastner, Massachusetts Institute of Technology, *Chair,* and Peter F. Green, University of Texas at Austin, *Vice Chair*

Atomic, Molecular, and Optical Physics 2010 (AMO 2010)*
Phillip Bucksbaum, University of Michigan, and Robert Eisenstein, *Co-Chairs*

Elementary Particle Physics 2010 (EPP 2010)*
Harold T. Shapiro, Princeton University, *Chair,* and Sally Dawson, Brookhaven National Laboratory, *Vice Chair*

Plasma Science 2010*
Steven Cowley, University of California at Los Angeles, and John Peoples, Fermi National Accelerator Laboratory, *Co-Chairs*

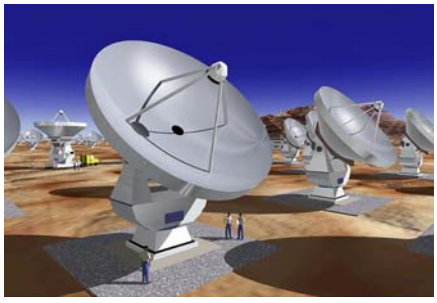
*Elements of the new survey *Physics 2010*

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

Review of ALMA Science Requirements

Roger Blandford, Kavli Institute Institute for Particle Astrophysics and Cosmology

The Committee to Review the Science Requirements for the Atacama Large Millimeter Array conducted a study to evaluate the consequences of a descoping of the Atacama Large Millimeter Array (ALMA), which is intended to be the main ground-based observational facility for millimeter and submillimeter astronomy for the next three decades. ALMA is a multinational project being carried out by a collaboration among North America (the United States and Canada), Europe (the European Southern Observatory and Spain), and Japan. Initial bidding on construction of the individual antennas in the array raised the possibility that the project might need to be descoped in order to manage its cost. Credible independent advice on the impact of such a descoping on the technical performance and scientific capabilities of



the instrument was required.

In response to a request from the National Science Foundation, the National Research Council convened a panel of experts that I chaired to address this issue. The charge to the committee was formulated as follows: The committee will evaluate the following issues related to a possible descope of the ALMA array to 40 or 50 12-m antennas. Were such a descope to be carried out,

1. What would be the impact on the attainability of the technical performance specifications?

2. What would be the loss of speed, image quality, mosaicking ability, and point-source sensitivity?

3. What would be the impact on the scientific reach of the project? Would ALMA still be sufficiently transformational in terms of its scientific potential to warrant continued support by the United States?

4. Is there a particular threshold in the number of antennas below which ALMA would suffer a degradation in its performance sufficiently serious that it would not merit the scientific priority accorded it in the 1991 survey of astronomy and astrophysics?

The committee held a two-day meeting on April 6-7, 2005, at Stanford Linear Accelerator Center in Menlo Park, California. The committee's final report was publicly released on June 20, 2005. The committee concluded that:

• A 60-element array would be greatly superior to any current or planned comparable instrument for several decades and would revolutionize millimeter and submillimeter astronomy.

• Two of the three level-1 requirements, involving sensitivity and high-contrast imaging of protostellar disks, will not be met with either a 40- or a 50-antenna array. It is not clear if the third requirement, on dynamic range, can be met with a 40-antenna array even if extremely long integrations are allowed for.

• Speed, image fidelity, mosaicking ability, and point source sensitivity will all be affected if the ALMA array is descoped. The severest degradation is in image fidelity, which will be reduced by factors of two and three with descopes to 50 and 40 antennas, respectively.

• Despite not achieving the level-1 requirements, a descoped array with 50 or 40 antennas would still be capable of producing transformational results, particularly in advancing understanding of the youngest galaxies in the universe, how the majority of galaxies evolved, and the structure of protoplanetary disks, and would warrant continued support by the United States.

• Furthermore, it is the committee's appraisal that a 40-antenna array would retain ALMA's strong support within the general astronomical community. However, the rapid decline in imaging capability that would result from a further reduction below 40 antennas would erode this support.

Following the release of the committee's report, NSF and Associated Universities, Incorporated (AUI), which operates the National Radio Astronomy Observatory for the NSF, announced that, on July 11, 2005, AUI signed a contract with Vertex Communications Corporation to purchase 25 antennas for ALMA. If the European partner, the European Souther Observatory, follows suit, the array will have 50 antennas. ■

Committee to Review the Science Requirements for the Atacama Large Millimeter Array

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Atomic, Molecular, and Optical Physics 2010

Michael H. Moloney, NRC Staff

It has been almost a decade since the publication of the last comprehensive assessment of the field of atomic, molecular, and optical (AMO) science, known as the FAMOS report. And it has been 6 years since publication of the Committee on Optical Science and Engineering report that discussed many AMO applications. Since the publication of these assessments, there have been several major advances in AMO science that are manifestations of profound changes in the field. A new study of the field, assessing progress and looking ahead to the future, is therefore timely.

As examples, the demonstration of Bose-Einstein condensation is driving many new advances, not merely in atomic and molecular physics but also in statistical mechanics and condensed matter physics; quantum optics holds great promise for the future of quantum information processing; and a collaborative effort between accelerator and atomic physics recently resulted in the production of substantial quantities of antimatter atoms (larger than the sum of all antimatter atoms previously reported), leading to exciting prospects for precision tests of CPT (charge parity time) violation and antimatter gravity.

Thanks to these and other developments, the AMO field now has a leading role in the scientific enterprise—with considerable input from and impact on fields as varied as condensed-matter physics, high-energy physics, biophysics, computer science, nanotechnology, cosmology, and medicine. As a reflection of the community-wide excitement and in recognition of the forefront research being conducted in AMO science, it is worth noting that four Nobel prizes have been awarded in this field since 1994.

While AMO science is important in its own right, it also results in key enabling technologies for other areas of science, engineering, health, business, defense, entertainment, and elsewhere. In the same way that developments in electronics enabled the breakthrough technologies of the 20th century, so too will developments in AMO science enable breakthrough technologies of the 21st century. Examples of the continued and increasing impact of AMO science surround us in our daily lives. Advances in fiber optics and the Internet have changed the way we communicate; advances in lasers and spectroscopy lead to better medical diagnostics and higher-precision surgery; and advances in optics and sensors contribute significantly to improving our national security. It is safe to assume that AMO science will be a catalyst for scientific and technological revolutions that will have a profound impact in the decades to come.

With support from DOE and NSF, the National Research Council convened the AMO 2010 committee in early 2005. The committee was charged to

1. Review the field of AMO science, emphasize recent accomplishments, and identify new opportunities and compelling scientific questions.
2. Identify the impact of AMO science on other scientific fields, emerging technologies, and national needs.
3. Identify future workforce, societal, and educational needs for AMO science.
4. Make recommendations on how the U.S. research enterprise might realize the full potential of AMO science.
5. Produce an intermediate report addressing key research issues and themes facing the research community, as well a full final report and a separate summary of its findings and recommendations.

Under the leadership of Philip Bucksbaum and Robert Eisenstein, the committee met for the first time on April 4-5, 2005, in Washington, D.C., where it heard testimony from the federal agencies and several leading scientists. The committee also hosted two town meetings in order to broadly engage the community; the first was held at the American Physical Society's Division of AMO Physics meeting on May 20, 2005, and the second at the CLEO/QELS meetings on May 25, 2005. The committee is scheduled to meet again at the end of August in Irvine, California.

The committee has attacked the task with an enthusiam and energy that will surely have a broad impact. Stay tuned for a good report to read next year! ■

Committee on Atomic, Molecular, and Optical Physics 2010

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Midsize Facilities (continued from page 1)

spawn new ventures. Thus, midsize facilities play a critical role in the materials research enterprise. Their ubiquity is one of their greatest strengths. As needs are identified and as researchers coordinate their activities, it is possible to initiate such a facility, although doing so is becoming more difficult. That is, midsize facilities represent sufficiently small levels of investment that they can be (and have been) spread widely around the country. Most importantly, this characteristic allows smaller and nonelite research institutions to participate in and contribute to research effectively.

As the role of midsize facilities has expanded, the need for a systematic and careful assessment of best principles has grown, especially in a fiscally constrained era. In response to these developments, the National Research Council formed the Committee on Smaller Facilities in 2003, with support from the National Science Foundation and the Department of Energy, to examine the broader issues of optimizing current and future investments in the facility infrastructure of materials research and to recommend strategies for effective operation and utilization in a revenue-neutral environment. The committee's final report was released in prepublication form in June 2005.

In its analysis, the committee defined a midsizie facility as a facility that maintains and operates one or more pieces of equipment at a university or national laboratory and has the following characteristics:

- Facilitates scientific and/or technological research for multiple users;
- Provides services on local, regional, or national scales;
- Is open to all qualified users subject to generally agreed-upon rules of access;
- Has a resident staff to assist, train, and/or serve users; and
- Has a replacement capitalization cost of between approximately $1 million and $50 million and an annual operating budget (including staff salaries, overhead, supplies, routine maintenance and upgrades, and so on) in the range between $100,000 and several million (2004) dollars.

Federal program managers, university administrators, and the media have blurred the distinction between a "center" and a "facility." The committee distinguishes these entities in the following manner. A center is a collection of investigators with a particular research focus. A facility is a collection of instrumentation, equipment, or physical resources that enables investigators to conduct research activities.

Midsize facilities are distinct from small facilities in being sufficiently large that they require a dedicated and explicit infrastructure for their sustained success. They are distinct from large facilities in being sufficiently small that they are flexible and responsive to the needs of a relatively local user community. And the equipment costs are not so large that the facility cannot be duplicated in numerous geographical regions.

The committee has identified real challenges facing the future viability of midsize facilities. Prominent among these challenges are providing and sustaining long-term infrastructure, networking with other facilities, balancing competing purposes while maintaining a clear mission, and cooperating with commercial interests in compliance with federal guidelines for noncompetition. These facilities are sufficiently sophisticated in structure and content that careful stewardship is necessary: A complex support network (both individually and collectively) is required to maximize their effectiveness.

The committee estimates that there are about 500 midsize facilities nationwide that provide essential instrumentation support for materials research. The aggregated annual operating budget of this collection of facilities is estimated be on the order of several hundred million dollars; the replacement cost for the equipment now in place at these facilities is estimated to be several billion dollars.

Clearly, there is a disconnect between what researchers at midsize facilities perceive is needed for their success and the level of resources currently available. Directed by its charge to consider revenue-neutral options in these fiscally constrained times, the committee identifies reallocation of existing resources in materials research as an option to address the needs of midsize facilities. Midsize facilities that are regionally based; have the attributes of good management, organization, potential for sustainability; and are large enough to offer professional staff training and career prospects should be preferentially supported.

In order to sustain and to develop a leadership role for the United States in materials, the committee made several recommendations. The responsibilities should be shared between the research agencies and the community (composed of proposers, reviewers, managers, host institutions, and users).

Collective Stewardship. To maintain national capabilities to perform world-class, forefront scientific research in materials, the Department of Energy, the National Science Foundation, and other federal agencies should foster cooperative, responsible planning among all stakeholders to provide collective stewardship of midsize facilities. That is, midsize facilities require explicit programmatic planning for their support and oversight.

Regional Networking. To improve the effectiveness of the current national investment in midsize facilities, agencies should realize the economies of networking. That is, midsize facilities participating in a regional network should be given priority for expansion of capability and capacity. Teaming among and consolidation of neighboring facilities to form regional resources should be strongly encouraged by the agencies. Midsize facilities that are successful in this regard should be provided with adequate long-term infrastructure support. Proposals for new midsize facilities—or for significant changes to existing midsize facilities—should be viewed within the context of the region; they should develop a strong business case based on measured need within the region and should outline expected relationships with existing resources in the region. To facilitate networking, midsize facilities should develop an online inventory of resources to enable

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A Time to File. . .Recent CORF Activities

David B. Lang, NRC Staff

In late June, astronomers at the Harvard-Smithsonian Center for Astrophysics announced the discovery of a nascent planetary system at a stage of planet building never before observed. Orbiting within star TW Hydrae's protoplanetary disk were seen vast swaths of innumerable rocky pebbles, extending out to over a billion miles. As the pebbles continue to orbit the young star they will collide with one another and agglomerate, forming larger and larger pieces and eventually, say the researchers, form planets. Because astronomers know that the pebbles emit radio waves proportional to their size, the scientists were able to discern their approximate size and determine in which stage of formation the system is. Combined with other data, this observation advances astronomers' understanding of the complex processes that govern the formation of planetary systems.

These observations were made at the Very Large Array (VLA), a system of 27 25-m radio telescopes in the New Mexico desert that can observe in numerous bands between 73 MHz and 50 GHz. By combining data from each telescope, the array performs with the resolution of an antenna 36 km across and the sensitivity of a dish 130 m in diameter.

Clearly, telescopes such as the VLA operate near the current limits of technological sensitivity, and future projects must push the boundary back even further. If researchers are to understand exotic objects and complex processes such as quasars and cosmic evolution, radio astronomy is going to play a large part.

There are, of course, challenges beyond technical capability. Just as ground-based optical and infrared astronomical observations suffer from data contamination and signal loss because of poor atmospheric stability and temperature, so also do radio observations. However, radio frequency interference (RFI) differs from that faced by optical and infrared astronomers, because the dominant RFI is produced by humans. Radio astronomers have always shared the spectrum with the public, but as wireless communications technology has become cheaper, RFI-emitting devices have become nearly ubiquitous. Spurious and out-of-band emissions threaten the quality of radio astronomy data collection and can even damage instruments.

The Committee on Radio Frequencies (CORF) represents scientific interests and provides input to governmental rulemaking bodies. CORF, whose purview includes Earth remote sensing, radio astronomy, and other related sciences, has been convened under the auspices of the National Research Council since its inception in 1961. CORF has been able to affect rulemaking at the Federal Communications Commission (FCC) to consider impacts on important areas of research.

Earlier this year, the FCC released two Notices of Proposed Rulemaking (NPRMs) requesting input from both the science and industry communities in order to guide decision-makers.

In February, the FCC asked for input on an NPRM to replace or relax its ban on airborne usage of 800-MHz cellular handsets. The FCC has proposed using picocells inside the aircraft. Of particular concern to CORF is protection of radio astronomy observations of the hydroxyl radical (OH) at 1660-1670 MHz, an important spectral line for investigating the formation of protostars and the network of chemical reactions involved in the formation of atoms and molecules. Also, the characterization of OH is vital to understanding violent galactic collisions. For these reasons, astronomers were given primary allocations at 1660-1670 MHz.

CORF told the FCC that spurious emissions of second harmonics from cell phone transmissions at 830-835 MHz could create RFI damaging to radio astronomy observations in the 1660-1670 MHz band. Normally, operation of cell phones does not affect radio observatories since the transmissions lie on the horizon rather than in the line of sight. However, a passing aircraft full of cell phone users could easily find its way into an observatory's line of sight.

While CORF took no position on whether the FCC should authorize the airborne use of cell phones, CORF did support the FCC's proposal to permit their use only if the handsets are controlled by an airborne picocell fixed within the aircraft. A picocell would manage transmissions between the users on the aircraft and the cellular tower on the ground, obviating direct communication between cell phone and ground and limiting the power at which the cell phones transmit their signal, thus minimizing RFI to ground-based radio astronomy observatories.

No decision has yet been made by the FCC on this issue. But since FAA regulations prohibit the use of all types of mobile telephones on aircraft, any steps taken by the FCC will still leave the ultimate decision on allowing or disallowing cell phone use on aircraft to the FAA.

Also in February, the FCC issued another NPRM looking for comments on potentially licensing the operation of aeronautical mobile satellite service (AMSS) to communicate with fixed-satellite service in the 14.0-14.5 GHz range to facilitate aircraft telecommunications and enabling broadband technology while airborne.

Within this band, at 14.47-14.50 GHz, lies the formaldehyde line, included in an International Telecommunications Union recommendation as a line of great importance to radio astronomy. Formaldehyde is a primary molecule for studying comets, star formation, protoplanetary disks, and the inner regions of distant galaxies. Also, the molecule is of great interest to researchers striving to understand the origin of living organisms.

In response to the FCC's proposal, CORF strongly supports AMSS coordination activities with the National Telecommunications and Information Administration as a prerequisite to licensing operation in the 14.0-14.5 GHz band, in the same manner that Boeing and ARINC

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CAA: Looking Ahead to the Next Decadal Survey

Brian D. Dewhurst, NRC Staff

The year 2005 marks the halfway point in the decade covered by *Astronomy and Astrophysics in the New Millennium*, the 2000 astronomy and astrophysics decadal survey. While still focused on the implementation of the recommendations made by that study, the Committee on Astronomy and Astrophysics (CAA) has begun to look ahead and lay the groundwork for the next survey.

The year began with the release on February 1, 2005, of a letter report presenting the conclusions and recommendations of the Committee to Assess Progress Toward the Decadal Vision in Astronomy and Astrophysics (also known as the mid-course review committee), chaired by CAA co-chair and BPA member C. Megan Urry. This study was prompted by the substantial programmatic changes at NASA and issues raised by *Connecting Quarks with the Cosmos*, and then grew to include the scientific and technological breakthroughs made since the decadal survey was released in 2000. The committee concluded as follows:

"The remarkable advances in understanding in astronomy and astrophysics achieved over the past 5 years do not require that the NRC reexamine the AANM report or undertake an in-depth mid-course review of the scientific goals or recommended priorities. On the contrary, progress in the field validates the broad scientific program envisioned by the survey and implemented thus far by the agencies."

While the report did not recommend beginning a new survey in the short term, it prompted a number of discussions about the decadal survey process and how it could be improved to respond to new pressures in the coming years. These issues were summarized in a letter from Michael Turner to the CAA, and the CAA spent much of its May meeting discussing the issues Dr. Turner raised and seeking comment from agency officials and others with an interest in the surveys as policy documents. Some of the issues are these:

1. When should the next survey begin?
2. How should the panel structure be arranged?
3. How should carryover priorities be handled?
4. How should cost growth in priority missions be handled?
5. How broad should the survey be scientifically?

A number of these issues demand careful deliberation and thought, and it is likely that addressing them will be a primary activity for the committee in the coming months and years. That said, there are a number of nearer term issues that the committee is also monitoring.

At the CAA's May meeting, the committee heard from NASA about the successes and challenges in meeting the recommendations laid out in the decadal survey. Anne Kinney provided the committee with a brief rundown of the current status of the astronomy program at NASA, including a number of scientific discoveries that had been announced in the preceding months and a detailed look at how NASA's theory money was allocated among various programs. Dr. Kinney then provided a decadal survey scorecard that summarized progress thus far.

Another major discussion was the upcoming senior review activity being conducted by the Astronomy Division at NSF. Wayne Van Citters, director of that division, presented the rationale for conducting the review at this time. Dr. Van Citters showed the committee the breakdown of the division's budget and the major expenses on the horizon, such as operations for ALMA and development funding for the Giant Segmented Mirror Telescope (GSMT) and Large Survey Telescope (LST) projects. The Astronomy Division's conclusion was that without freeing up roughly $30 million per year in time for the FY2011 budget, the division would not be able to operate its entire portfolio of facilities. Dr. Van Citters chose to use the senior review method endorsed by the decadal survey to decide if or how the necessary funds should be identified. Dr. Van Citters also explained the ground rules under which the senior review will be operating:

- The AST budget will grow no faster than inflation for the remainder of the decade.
- The unrestricted grants program (AAG) will be protected.
- Adjustments in balance must be realistic and realizable.
- Recommendations must be based on well-understood criteria.
- There will be ample opportunity for community input.

The first community input efforts were the long-range plans that were developed for ground-based optical/infrared and radio/millimeter/submillimeter observatories at NSF's request. Caty Pilachowski and John Carlstrom presented the optical/infrared and radio/millimeter/submillimeter plans and their conclusions to the committee, which also sought the perspective of a number of other people involved with various projects in these areas. The open forum provided an opportunity for those in attendance to understand the role that the Senior Review will play, and illuminated some of the challenges that that activity will face.

Later, John Mather and Eric Smith presented the status of the James Webb Space Telescope program and explained where costs had grown, leading to the need for an additional $1 billion for construction phase of the project. At the time of the meeting, NASA was preparing studies to determine how much of the projected cost growth could be mitigated and what potential options the agency could pursue in case of further cost increases. The CAA plans to hear further about the options for containing the cost of the mission at its next meeting, in November.

The CAA's May meeting provided a picture of an enterprise that was facing some significant challenges. However, these challenges are being confronted, both in the agencies and by the community. In moving forward it seems useful to examine the way decadal surveys have traditionally been done, in order to take some of these challenges into account. The CAA plans to initiate this examination in the coming months. ■

Midsize Facilities (continued from page 6)

users to optimally identify facilities for their use and to allow managers to make referrals.

Midsize facilities in materials research differ from the large national facilities because the former have no programmatic home. That is, the large national user facilities have explicit program agency stewards that oversee their long-term viability. In many cases, the capital costs and operating expenses at a midsize facility are covered by different programs, different agencies, or even different organizations altogether. The steward of a midsize facility should be identified as the party most responsible for the continuing operations and maintenance of the facility. In many cases, this party will be a federal research program; in some instances, it may be a state program or an institutional entity such as a university provost's office or the office of a national laboratory director.

Stewardship should also take into account the regional context. These facilities should be actively engaged in networking with other facilities that have similar capabilities or complementary instrumentation. These relationships will encourage rapid sharing of new methods for use of instrumentation and will facilitate user access to related technologies, an increasingly important feature of interdisciplinary research. Before facilities are approved or significant enhancements to capabilities are awarded, proposals should be evaluated in a regional context by the federal agencies. A more regional or national approach to planning for and purchasing instruments, rather than many individual negotiations, should be considered.

Long-Term Infrastructure. Host institutions and supporting agencies should give high priority to maintaining the long-term viability of midsize facilities, including provision for long-term infrastructure such as resident staff; normal operating costs, including maintenance contracts; user training and support; education and outreach; and in-house development of instrumentation and techniques.

Professional Staffing. Midsize facilities require extraordinarily talented and experienced staff; their career paths should be respected and cultivated. A midsize facility should include technical and Ph.D.-level professional staff members who are offered opportunities for career development and/or participation in ongoing facility research. Operating plans for midsize facilities should explicitly address this issue. At the heart of fulfilling their mission is midsize facilities' reliance on their experienced staff to engage users, operate and maintain instruments, and enhance instrumentation. Accordingly, the committee recommends that the educational efforts of midsize facilities should also emphasize programs that explicitly provide ongoing training and career development for facility support staff.

Periodic Review. Successful performance should be identified and rewarded. Midsize facilities should be reviewed periodically by their sponsors, consistent with their long-term responsibilities, to ensure that their primary objectives continue to be met, potential improvements to operations and instrumentation are identified, and continued funding is justified. The depth of the reviews should be commensurate with the funding levels.

Operation of a regional facility that effectively meets the researchers'—and the nation's—needs requires commitment, thoughtfulness, and effort considerably beyond what is required to maintain instruments for a single investigator or a small number of researchers. Periodic reviews provide opportunities to identify potential improvements to the facility's operations and instrumentation, as well as to assess the adequacy of funding. Finally, situations in which facility operation is no longer appropriate can be identified. Review panels should be comprised of experts from both the scientific and midsize project management domains. Our report lays out several examples of appropriate review criteria.

The Committee on Smaller Facilities emphasized the pivotal and invigorating role that midsize facilities have played in materials research. By providing access to shared tools, training, and resources, these facilities have been a cornerstone of research for a broad cross section of the community. Since the days of the first explicit interdisciplinary research laboratories in the 1960s, materials research has blazed a trail in recognizing and responding to the needs of its investigators. It is now time to acknowledge the need for the next phase of transition from a system of loosely connected independent facilities to a network of coordinated facilities. By leveraging such opportunities, the materials research enterprise will continue to offer a transformative and effective path to the future. ■

CORF (continued from page 7)

currently operate. However, it only asked that the FCC require AMSS coordination within the crucial 14.47-14.50 GHz band, leaving AMSS some freedom within 14.0-14.47 GHz.

CORF agrees with the NPRM that AMSS operations must cease entirely within line of sight of any protected radio astronomy observatory. CORF supported the FCC's proposal that AMSS operators be required to keep aircraft tracking data for 1 year and to make that data available to some parties to identify sources of interference. The data from radio astronomy observations are typically reduced and analyzed long after an observation is performed, so allowing astronomers to review this information would facilitate the removal of interference.

By communicating effectively with the FCC and NTIA, the radio astronomy and remote-sensing communities are able to preserve their place in the ever more crowded spectrum and can attempt to limit the amount of data corruption from artificial RFI. Only by keeping the radio observers' voices heard will observations such as TW Hydrae's protoplanetary apron of pebbles and still more exciting discoveries remain possible. ■

BPA Meeting (continued from page 3)

of fresh ideas and new perspectives with the inclusion of so-called "outsiders;" and (3) a careful balance in the final report of priority-setting, substantive analysis, and clear presentation of the leading science opportunities. In discussion, it was agreed that it might be useful to form an informal working group of the chairs of the elements of the decadal survey.

The Board then discussed the other standing and ad hoc committees convened under its auspices. Meg Urry, board member and co-chair of the Committee on Astronomy and Astrophysics discussed the recent activities of the committee, including the recent midcourse review letter report and the current activity assessing the dependency of ALMA's science capabilities on the number of elements in the radio telescope array. Paul Chaikin made a short presentation to the Board about the recently completed *Opportunities in High Magnetic Field Science* report, authored by a committee on which he served. (At this time, the report has been downloaded more than 12,000 times from the BPA website. —Ed.) Wrapping up the subsidiary committee reports, Marc Kastner briefly described the activities of the Solid State Sciences Committee, highlighting the formation of a committee to examine the Materials Research Science and Engineering Center program at NSF, progress in planning the decadal survey of condensed-matter and materials physics (CMMP 2010), and the relationship among several projects with connections to biology. Karen St. Germain reported on the activities of the Committee on Radio Frequencies. (For more details, see related article *A Time to File. . .Recent CORF Activities* on page 9.)

Garth Illingworth discussed the Astronomy and Astrophysics Advisory Committee with the Board, recapping the committee's recent letter report. The Board also had a discussion Michael Turner about NSF's Mathematical and Physical Sciences directorate.

Kevin Marvel, executive director of the American Astronomical Society, gave a closing keynote address about astronomy and astrophysics and the reinvention of NASA. He emphasized the heavily constrained budget outlook, comparing the size of the national deficit the size of the national tax cut. Dr. Marvel pointed out that the real challenge NASA faces is multiple competing directions. He closed by reviewing the process of congressionally directed spending and urged the community to consider these "narrow interest" activities carefully when discussing priorities and needs with congressional staff.

After some lively discussion, and with a round of thanks and appreciation to the members for traveling to Washington, Professor Sargent adjourned the spring meeting of the Board. ■

EPP 2010 (continued from page 1)

intersection with astrophysics and cosmology. Marcela Carena, Joseph Lykken, and Young-Kee Kim organized a one-hour public comment session.

In June, committee member Charles Shank gave an invited address about EPP2010 and his personal views at the annual Fermilab Users' Meeting. He described how the current budget outlook for the physical sciences is very different from historical experience; that is, large uncertainties complicate the future outlook. Furthermore, the outlook for traditional international partners in particle physics is also constrained. These pressures make strategic decision making even more important, he said. He then shared some of the difficult issues that the committee is debating in terms of the future role of the United States in the field.

In July, six committee members, including chair Harold Shapiro and vice chair Sally Dawson, traveled to Japan to better understand the global scope of elementary particle physics. The itinerary included visits to the laboratory KEK, the Japan Proton Accelerator Research Complex (J-PARC) under construction, and the funding agency MEXT. A second trip has been planned for September to Europe, where a subset of the committee will meet with researchers from DESY in Germany, CERN in Switzerland, and represenatives from the European Committee on Future Accelerators and the Italian Istituto Nazionale di Fisica Nucleare. Also in July, committee member David Gross made a presentation about EPP2010 at a special session of the International Europhysics Conference on High Energy Physics in Lisbon, Portugal.

The committee recently met as a full group at Cornell University in Ithaca, New York, on August 2-3, 2005. Robert Aymar of CERN was one of the featured speakers at this meeting as was Barry Barish, director of the Global Design Effort for the International Linear Collider activity. Other speakers included Nima Arkani-Hamed who discussed possibilities for scientific discoveries at the LHC and connections to parallel, smaller-scale efforts. Joe Lykken presented a report from the HEPAP subpanel about scientific synergy between the LHC and ILC. The committee also heard from Maury Tigner about the university program of research in particle physics. At the end of the first day, Ian Shipsey and Ron Poling chaired a one-hour public comment session. On the morning of the second day, the committee toured the synchrotron, accelerator, and detector facilities at Cornell. The remainder of the day was held in executive session (closed to the public) to debate the findings arising from the pattern of evidence. The committee discussed a general framework for its final report, one that would describe the scientific, institutional, and budgetary contexts of the domestic program, articulate its goals, and then recommend a set of strategies to address those goals.

The committee expects to complete its final report near the end of the year; a fifth meeting has been scheduled for December 6, 2005, in Washington, D.C., at the Keck Center of the National Academies. ■

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 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

• *Rare Isotope Science Assessment.* A committee would be formed to carry out a thorough independent assessment of the importance to the nation of the science agenda for a Rare Isotope Accelerator (RIA). In preparing its report, the committee would address the role that RIA would play in the future of nuclear physics, considering the field broadly but placing emphasis on its potential scientific impact on nuclear structure, nuclear astrophysics, fundamental symmetries, stockpile stewardship and other national security areas, and on the future availability of scientific and technical personnel. The need for such an accelerator would be addressed in the context of international efforts in this area.

• *CMMP 2010.** A committee would prepare a report that articulates an outlook for the field of condensed-matter and materials physics (CMMP), concentrating on compelling scientific themes. The study would review the field of CMMP, emphasize recent accomplishments, and identify new opportunities and compelling scientific questions; make recommendations on how the U.S. research enterprise might realize the full potential of condensed matter and materials physics research; and examine the structure and level of the current research effort in condensed-matter and materials physics.

• *Assessment of and Outlook for New Materials Synthesis and Crystal Growth.* This assessment would explore the role of materials synthesis and crystal growth in condensed-matter science and technology and would identify areas of opportunity for future research. Recommendations will be made for capitalizing on these opportunities, and U.S. capabilities will be benchmarked against foreign competition.

• *Forefronts of Science at the Intersection of the Physical and Life Sciences.* This study would examine the intersection of the physical and life sciences. A committee would be formed to assess the forefronts of fundamental science at the interface of the physical and life sciences. The committee would 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.

*Elements of *Physics 2010*

New Staff Member. In response to an increased amount of work flowing through the BPA office, a new program officer position was created in late spring. Ms. Natalia Melcer will be joining the BPA as a program officer in late August. With a background in chemistry and experience working on the Hill, she will broaden the capabilities of the BPA staff. We look forward to working with her.

BPA Update: Upcoming Meetings in 2005

August 2005	
8/2-3	EPP 2010 meeting, Ithaca, New York
8/29-30	AMO 2010 meeting, Irvine, California
September 2005	
9/24-25	PLSC meeting, Irvine, California
9/30-10/1	Plasma 2010 meeting, Washington, D.C.
October 2005	
10/17-18	CORF meeting, Irvine, California
10/20-21	SSSC meeting, Irvine, California
November 2005	
11/6-7	BPA meeting, Irvine, California
11/18-19	MRSEC review committee, Washington, D.C.
11/29-30	CAA meeting, Irvine, California
December 2005	
12/06	EPP 2010 meeting, Washington, D.C.

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:

Midsize Facilities: The Infrastructure of Materials Research

The Atacama Large Millimeter Array: Implications of a Potential Descope

Coming Soon:

Proceedings of "Instrumentation for a Better Tomorrow: A Symposium in Honor of Arnold O. Beckman"

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BPA Newsletter for: