Issues in Physics & Astronomy

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Challenges and Opportunities in New Materials Synthesis and Crystal Growth

James C. Lancaster, BPA Staff

For much of the past 60 years, the U.S. research community dominated the discovery of new crystalline materials and the growth of large single crystals. These efforts placed the country at the forefront of fundamental advances in condensed-matter sciences and fueled the development of many of the new technologies at the core of U.S. economic growth. The opportunities offered by future developments in this field remain as promising as the achievements of the past. However, the past 20 years have seen not only a substantial deterioration in the United States' capability to pursue those opportunities but also significant increases in investment by several European and Asian countries to develop their capacities in these areas.

The Committee for an Assessment of and Outlook for New Materials Synthesis and Crystal Growth, chaired by Paul S. Peercy (University of Wisconsin at Madison), was charged with the responsibility of assessing the health of research activities in the United States in this field, identifying future opportunities and recommending strategies for the United States to reinvigorate its efforts and thereby return to a position of leadership in this field. The committee issued its report this past spring.

The two activities in this field—discovering new crystalline materials and growing large crystals of these materials—have long been intertwined. Here, "crystalline material" refers to materials in which long-range periodicity of atomic positions is critical for the material's functionality. It is noted that such materials form a class distinct from nanomaterials, the functionality of which is defined by attributes governed by one or more nanometer-sized dimensions of the sample specimen, whether crystalline or amorphous. Once a new crystalline material is found to be either sufficiently interesting scientifically or relevant for an application—or as often happens, both—large single crystals of that material are needed for detailed study. Because of common heritage, shared resources, and strong educational bonds, it is natural to combine these related activities—the discovery and growth of crystalline materials (DGCM)—in a single study. The growth of thin, two-dimensional crystalline films also is included in this study because it shares many common scientific and technological goals with the growth of bulk, three-dimensional materials.

The research activities falling under the DGCM umbrella are broad, spreading over traditional academic disciplines such as chemistry, materials science, and physics and undertaken in institutions such as university, government, and industrial

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In this issue:

Progress on the Astronomy and Astrophysics Decadal Survey, Astro2010

Michael H. Moloney and Caryn Joy Knutsen, BPA Staff

As reported in the last newsletter the various elements of the National Research Council's Decadal Survey of Astronomy and Astrophysics (Astro2010) are well underway. Previous newsletters have given an in depth description of the survey structure and timeline.

Science Frontier Panel Update

Over the summer months the five Science Frontier Panels (SFPs) have continued their work, studying the science white papers and identifying key science questions and areas of potential discovery for the next decade. During the May 10-14, 2009 Astro2010 Meeting, known as the "jamboree," in Irvine, CA, each SFP presented internal reports to the survey committee and the Program Prioritization Panels (PPPs). This meeting brought together the SFPs and Infrastructure Study Groups (ISGs) chairs, survey committee members, and newly appointed (April 2009) PPPs. Since the jamboree, SFPs have

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

James C. Lancaster, BPA Staff

The Keck Center of the National Academies in Washington, D.C. served as the meeting site for this year's spring meeting of the Board on Physics and Astronomy. After greeting committee members and visitors, Chair Marc Kastner called the meeting to order.

Much of the first day consisted of discussions with representatives from federal agencies that support physics and astronomy research, or science research in general. The overall message about the status of science support in the current administration was quite positive. Amy Kaminski and Michael Holland, from the Office of Management and Budget (OMB), reported that they do not anticipate any changes in OMB's structure and staffing due to the recent election. OMB is working on the FY2010 budgets and intends to focus on cost realism in carrying out the Obama Administration's commitment to significantly increase spending on the physical sciences. The next speaker, Jean Cottam Allen from the Office of Science and Technology Policy (OSTP), mentioned that OSTP is still in the process of filling politically appointed positions, but is moving forward in the interim. One focus of OSTP will be improving interagency activities and two of the interdisciplinary areas that will receive priority are energy and the environment, and STEM education (science, technology, engineering and mathematics).

Joe Dehmer reported on developments in the National Science Foundation's (NSF) Division of Physics and noted they are constantly looking for ways to promote innovative efforts in physics. Among the examples cited were the Physics at the Information Frontier program focusing on issues such as quantum information computing, and the Physics of Living Systems program, which is now the fastest growing program in his division. The Division of Physics remains committed to devoting over 50 percent of its funding to increasing diversity, strengthening the funding of theory, and to core research (as opposed to the amount of funding that goes to support centers and facilities).

Zakya Kafafi, Director of the Division of Materials Research (DMR) at NSF, spoke next discussing some of the recent changes in DMR's funding outlook. The NSF budget requests are up this year seeking a 13 percent increase overall in FY2009. The Mathematical and Sciences Directorate is seeking a 20 percent increase and DMR is seeking an increase of almost 25 percent. Dr. Kafafi pointed out that while NSF provides approximately 95 percent of the National High Magnetic Field Laboratory's (NHMFL) funding, NHMFL is serving an increasingly broad user community and partnership is essential for continued operations of this facility. Dr. Kafafi also reported on the results from an advisory panel on light sources regarding future facility and instrumentation needs. Finally, she discussed a U.S.-China workshop on nanostructure materials that was held in Evanston, Illinois in September 2008, and she noted that this is just one of a number of materials networks that are developing on the global scale.

After a short break, Craig Foltz and Eileen Friel, from the Astronomical Science Division (AST) at the NSF discussed news from their division. They reported on the status of a number of the projects AST funds, including the Atacama Large Millimeter Array (ALMA), which is currently under construction. Cost performance is good, but ALMA is slightly behind construction schedule. Development of the Advanced Technology Solar Telescope (ATST)—the first large U.S. solar telescope constructed in the past 30 years—is proceeding on schedule. The ATST project is nearing completion of design and NSF hopes to have final review and completion of compliance with ancillary requirements in the summer of 2009.

The next presentations were delivered by Tom Gergely and Andrew Clegg, from NSF, and John Zuzek, from NASA, who discussed spectrum management for science. Dr. Clegg discussed a modification to Footnote 5.565 that the ITU is reviewing and that will be discussed at the upcoming World Radiocommunications Conference 2012 (WRC12). He noted that radio astronomers have a window of opportunity here to expand international spectrum regulatory considerations, which ultimately may help reduce interference to present and future ground- and space-based submillimeter instruments. Reviewing other WRC12 science issues, Dr. Gergely stated that about half of the current WRC12 agenda items have some relevance to radio astronomy. Speaking from NASA's perspective, Dr. Zuzek commented that NASA is completely reliant on continued and predictable spectrum allocation and that NASA must continue to collaborate closely with other U.S. agencies to protect vital spectrum and create opportunities for successful introduction of new technologies.

To finish up the morning's activities, Ed Weiler and Jon Morse reported the latest news from NASA. The Hubble repair is proceeding according to plan, and they expect to begin receiving new data two months after the repairs are made. Two of the top problems NASA currently faces are lack of modest launch capability and access to space. They also view the upcoming release of the NRC decadal survey report (Astro2010) as an important event for NASA; the report is considered a most effective tool in maintaining priorities and getting science programs in place. NASA hopes this survey will bring about realistic cost estimates and achieve consistency across the recommendations from the various components of the survey (the panels and the main committee). Given the increasing sophistication and rising costs of future programs, NASA also expects to see more and more joint programs—architectures and activities—with other agencies both here and abroad.

After lunch, Pat Dehmer, Deputy Director for Science Programs in the Office of Science at the U.S. Department of Energy (DOE) spoke to the board. She reported that for the first time appropriations in the FY 2009 budget request were in line with the America Competes Act, which calls for the doubling of certain science budgets over an approximately 7 year span. As to department plans, she expects to see more research centers focused on specific issues and expects to see a more balance portfolio that extends beyond just energy-based studies. The ITER project is going into the design and construction phase and Dr. Dehmer is confident of continued support by the United States.

Next, Harriett Kung, Associate Director of the Office of Basic Energy Sciences at the DOE, spoke of the long-term strategic planning efforts that have been underway at DOE, developing a roadmap for energy research. Among the products of those efforts are a set of Energy Frontiers Research Centers that have been announced, and will receive initial funding later this year.

Continuing with the string of DOE representatives, Dennis Kovar, Associate Director of the DOE's Office of High Energy Physics (HEP), spoke next noting that HEP's budget and their program for FY 2009 is in much better shape than in previous years. HEP has been able to mitigate most of the serious impacts associated with the FY 2008 funding reduction and has developed a new strategic plan for high energy physics in the United States, the implementation of which is supported by the FY 2009 increase. Dr. Kovar then discussed how HEP's program will generate advances not only in accelerator physics but also in cosmic frontier studies and advanced technology development, among other areas.

Dr. Gene Henry from the DOE Office of Nuclear Physics (NP) presented next and commented that past investments have positioned the U.S. nuclear physics program as a world-leader or among the leaders in all the major scientific thrusts of nuclear physics, but sustained funding is needed to continue to operate the facilities, to remain competitive, and to maintain a leadership role in the future. Dr. Henry reported that there is an opportunity for NP to implement a world-class program that will deliver new insight into the nature and structure of matter that will have significant impact outside of nuclear physics, so long as the Office of Science's budget continues to double over the next decade.

Steve Eckstrand from DOE/OFES delivered a presentation on OFES mission, goals and program, ITER status, and strategic planning. He noted that creating and exploring a burning plasma in ITER is the crucial next step in the magnetic fusion energy science (MFES) program. Dr. Eckstrand also discussed HEDLP activities in OFES, and the new joint HEDLP program with NNSA that was started in FY 2008, and he discussed the OFES Fusion Simulation Program (FSP) in which they are collaborating with the Office of Advanced Scientific Computing Research (ASCR)

Chris Deeney, from the National Nuclear Security Administration (NNSA), reported on the status of NNSA's work on high energy density physics studies. Through 3 facilities owned and operated by NNSA, they are attempting to study what happens to materials under extreme conditions. Dr. Deeney was able to report that the newest of those facilities, the National Ignition Facility (NIF), is now operational and is preparing for a full ignition attempt in 2010.

Michael Lubell, APS Director of Public Affairs, then provided his perspective on science will be treated under the Obama Administration. In the near term, the administration has put a strong science advisory team in place and science is being well-supported, particularly with the instatement of the Recovery and Reinvestment Act. In the out years, Dr. Lubell sees two conflicting trends—the previously mentioned goal of doubling the science budgets and a counter-push to constrain federal budgets as deficits are brought under control and the economy starts to recover.

The second day of the meeting began with a presentation by Dr. Larry Nagahara, Program Director in Oncology in the National Institute of Health's (NIH) National Cancer Institute. After discussing the sobering reality associated with cancer incidence and mortality, Dr. Nagahara discussed a new program put in place in NCI's Center for Strategic Scientific Initiatives that seeks to draw upon ideas and concepts developed in physics to provide new perspectives for tackling various issues faced in cancer research.

Next, Dr. Adam Riess, Johns Hopkins University, delivered a science talk on dark energy, focusing on why the con-

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Highlights of the Spring Meeting of the Committee on Atomic, Molecular and Optical Sciences

Michael H. Moloney, BPA Staff

The Committee on Atomic, Molecular and Optical Sciences (CAMOS) is a standing activity of the Board on Physics and Astronomy (BPA). The committee membership covers the full breadth of the atomic, molecular, and optical (AMO) sciences and forms a multidisciplinary group with experts from universities, industry, and government laboratories.

After a period of dormancy during the writing of the AMO2010 volume of the Physics 2010 Decadal Survey, Controlling the Quantum World: The Science of Atoms, Molecules, and Photons, CAMOS has been reestablished with the following objectives:

- To provide active stewardship of the agenda laid out in Controlling the Quantum World;
- To provide a means for dialog with federal agencies on AMO science and related fields;
- To initiate case studies on important timely topics in AMO science and/or its multidisciplinary connections with other fields of science and technology.
- To provide a venue for discussion among AMO scientists and thereby provide a unifying force in this diverse and varied field.

Following the appointment of the committee in the spring, CAMOS held its first meeting since 2004 on May 15-16, 2009, in Washington DC. The agenda on the first day focused on two themes: updates from the agencies supporting AMO research and a “focus session” on Quantum Information Science.

Federal agency representatives from the National Science Foundation (NSF), the Department of Energy (DOE), the National Institute of Standards and Technology (NIST), and Air Force Office of Scientific Research (AFOSR) attended the meeting and provided presentations to the committee. In particular, the agencies discussed their plans to spend extra funds from the then recently-appropriated stimulus funds, and addressed their performance in recent years. They also discussed how their programs had been impacted by the AMO2010 report.

The committee heard how the AMO2010 report effectively laid out the science opportunities in the field that underpins the research support in the federal agencies. The NSF representative commended the report for aggregating AMO science into compelling intellectual streams that will help attract attention to the field. The DOE representative noted that the report had played an important role in the strategic planning of the AMO-related activities in the Basic Energy Sciences program. The report was well-aligned with growth in the DOE program and had an impact on the planning of the energy frontier research centers and the BES report Directing Matter and Energy. The NIST representative noted that over 70% of the physics laboratory activities were related to AMO science. He also mentioned how well the AMO2010 report had packaged the field and that NIST had used the report to justify new programs both internally and externally. The AFOSR representative noted that the priorities in the AMO2010 were well aligned with the agency’s programs.

The agency discussions also addressed the importance of Quantum Information Science (QIS) both in the AMO2010 report and in their respective programs. This theme lead logically into the second half of the meeting, during which the committee held a focus session on QIS.

CAMOS intends to organize “focus sessions” on various topical research issues from time to time. The intent is to highlight progress in a particular research area related to AMO science. The committee will consider which areas are ripe for attention and possibly in need of a full NRC study. The format of a focus session includes science updates from active researchers and program updates from agency representatives, followed by discussions among all the invited speakers and the committee of the area under consideration. The focus session on QIS included science updates from Brian DeMarco, University of Illinois at Urbana-Champaign, and Chris Monroe, University of Maryland. The agency representatives from the morning session also contributed comments and suggestions. Carl Williams from the Administration’s Office of Science and Technology Policy (OSTP) outlined their recent report on QIS and the outcomes from a workshop held shortly in advance of the CAMOS meeting (see http://www.eas.caltech.edu/qis2009/).

Some highlights of the ensuing discussion were:

- QIS was described as a new and emerging field and not merely an interdisciplinary field. AMO science has given birth to QIS but it will evolve beyond these roots to involve

Committee on Atomic, Molecular and Optical Sciences

Stephen Pratt, Chair, Argonne National Laboratory
Pierre Meystre, Vice Chair, University of Arizona
Charles Conover, Colby College
Steven Cundiff, JILA, NIST: University of Colorado
Todd Ditmire, The University of Texas
Norval Fortson, University of Washington
Timothy Gay, University of Nebraska
Marshall Jones, GE Global Research
Christopher Monroe, University of Maryland
David R. Schultz, Oak Ridge National Laboratory
Carol E. Tanner, University of Notre Dame
David Weiss, Pennsylvania State University

math, theoretical computer science, and other areas of physics and chemistry.

- There is no investment strategy yet within the Administration for QIS.
- While the AMO2010 report's chapter on QIS tended to focus on computation and nearer term research goals, QIS is "more than just implementing qubits." It includes quantum simulation, for instance.
- There are fundamental questions in QIS that are ready to be explored. QIS will unlock our understanding of quantum processes as well as opening up new technology pathways. Any future NRC report should focus on describing the intellectual foundations of this emerging field.
- The profile of research support from the federal agencies is changing and as some of the applications of QIS, such as cryptology, move from science to engineering. Support for some of the leading scientists is drying up. Meanwhile QIS funding in Europe and elsewhere in the world is increasing with science-driven approaches.

Since the focus session, CAMOS has been preparing a white paper on QIS to explore the need for and avenues to undertaking a new NRC study in this emerging field.

In the weeks that followed the May meeting the committee also held the first of what will be an annual town hall meeting at the APS Division of AMO Physics meeting in Charlottesville, VA. The committee will next meet in Irvine, CA on December 12-13, 2009, and details of that and all other CAMOS activities can be found at http://sites.nationalacademies.org/BPA/BPA_04849. ■

Highlights of the Spring Meeting of the Solid State Sciences Committee

James C. Lancaster, BPA Staff

The Solid States Sciences Committee held its spring meeting at the Keck Center of the National Academies in Washington, D.C. on April 1-2, 2009. Representatives of federal agencies that support research efforts in solid state sciences presented reports to the committee that, in contrast to previous years, quite positive.

Harriet Kung, Director of the Basic Energy Services Program for the U.S. Department of Energy, reported on Secretary Steven Chu's plans for DOE and discussed some of the strategic planning efforts underway to carry out those plans. Zakya Kafafi, Director of the National Science Foundation's Division of Materials Research, reported on NSF's plans for its centers and facilities that focus on materials research and discussed efforts to promote education in this area. Both DOE and NSF addressed the significant increases in support for research in condensed matter and materials sciences in the current budgets and the American Recovery and Reinvestment Act.

Michael Holland, the program examiner for the Energy Branch at the Office of Management and Budget, provided a slightly different perspective on issues associated with government funding of the sciences, and led a discussion with the committee on how authorizations and appropriations for science take place at the federal level. He also discussed ways that the SSSC can be most effective in participating in these processes on behalf of its constituent communities.

Solid State Sciences Committee

Barbara Jones, Chair, IBM Almaden
Monica Olvera de la Cruz, Vice-chair, Northwestern University
Daniel Arovas, University of California, San Diego
Collin L. Broholm, Johns Hopkins University
Paul Chaikin, New York University
George Crabtree, Argonne National Laboratory
Andrea J. Liu, University of Pennsylvania
Joseph Orenstein, University of California at Berkeley
Arthur P. Ramirez, University of California at Santa Cruz
Richard A. Register, Princeton University
Mark Stiles, National Institute of Standards and Technology
Dale Van Harlingen, University of Illinois, Urbana-Champaign
Fred Wudl, University of California, Santa Barbara

The committee also heard several presentations from researchers whose work focuses on biological connections to condensed matter and materials sciences. Nigel Goldenfeld, University of Illinois at Urbana-Champaign, discussed biological modeling from a condensed matter perspective and general areas where physicists and biologists can find meaningful collaboration. Robert Austin, Princeton University, discussed his recent work on spin glasses and how some of his findings might shed light on biological issues such as the dynamics of evolution and cancer therapy. Mark Bowick, Syracuse University, discussed his research with bio-inspired soft matter and efforts to synthesize studies on natural and artificial nanoscaled structures. The final speaker was Mark Pinto, Chief Technology Officer for Applied Materials, Inc, who presented some of the outstanding issues the industry is facing in nanomanufacturing technologies. ■

Highlights of the Spring Meeting of the Plasma Science Committee

David B. Lang, BPA Staff

The spring meeting of the Plasma Science Committee (PLSC) was held on March 27-28, 2009 in Washington, DC. Riccardo Betti, PLSC Chair, began the meeting by welcoming the committee's guests.

Steve Eckstrand from DOE/OFES delivered a presentation on OFES mission and program issues, funding major facilities and collaborations, ITER status, strategic planning status, and details on the planning process. He noted that there are significant program issues, including rebuilding the leadership of OFES, supporting the ITER program, addressing the programs in a flat-budget scenario, and the need for new initiatives and strategic plans. He went on to discuss OFES' role in ITER, a large international project that will demonstrate the scientific and technical feasibility of fusion power. The goal for first plasma has slipped from 2016 to 2018-19, with a staged commissioning. Dr. Eckstrand also discussed HEDLP activities in OFES, and the new joint HEDLP program with NNSA meant to extend OFES' present program to other areas of fundamental HEDLP science, including laboratory astrophysics. He also noted that OFES is preparing a 15-20 page Strategic Plan Outlook to submit to Congress, that it will conduct three Research Needs Workshops patterned after the BES activity of the same name.

The next talk was delivered by Chris Deeney, Director of the Office of Inertial Confinement Fusion in NNSA. He began by discussing HEDP science within NNSA, commenting that the three largest HEDP facilities are operated by the Administration (Z, OMEGA, and NIF). He also stated that NIF will soon be operational in 2009. He then spoke about a FESAC HEDLP report that identified numerous research opportunities that should be supported, such as High energy density hydrodynamics, Magnetized high energy density plasma physics, and Relativistic high energy density plasma physics.

Patrick Colestock, PLSC Member, presented the results of the committee that conducted the review of the plan for U.S. fusion community participation in ITER. Dr. Colestock, who chaired that committee, discussed the report's findings and recommendations. The report concluded that U.S. participation in planning for ITER had been strong relative to its level of contribution to the project of about 9%. It also found that the U.S. fusion program was threatened by the unstable commitment to the project embodied in the decision to not fund the first installment of U.S. support to ITER in FY2008. The committee's report also recommended several goals and metrics to be considered in the future development of the plan for U.S. participation in ITER.

Joe Dehmer, Director of the Division of Physics at NSF, spoke about NSF Physics' (PHY) strategic and investment goals, as well as its historical funding levels and its funding of women and underrepresented minorities. He then discussed plasma physics' role within PHY. Plasma physics received $2.372M in FY08 and is sub-program in the AMOP Program. He guessed that plasma physics might receive a substantial boost in funding in FY09.

Next, William Tang from Princeton's Plasma Physics Laboratory (PPPL) discussed advanced computing for plasma science research. He noted that whereas the critical physics issues for fusion come from "gaps analysis" of the most needed predictive capabilities from advanced scientific codes that traditional theory or experiment, by themselves, cannot readily deliver, the critical computational issues come from "gaps analysis" of capabilities missing from current state-of-art tools to effectively utilize advanced computing facilities for dealing with critical scientific issues. There are some major challenges associated with computational plasma physics, including hardware complexities such as heterogenous multicore, power management, error control, communications, storage, and software challenges such as operating systems, I/O and file systems, and coding/algorithmic needs in the face of increased computer architecture complexity. He concluded his talk by stating that, in general, progress in delivering reliable predictive capabilities in FES and plasma physics will benefit significantly from access to supercomputing resources—from terascale to petascale and beyond—together with a vigorous verification and validation program

Ed Moses, Principal Associate Director of NIF and Photon Science at LLNL, delivered a presentation titled "from ignition on NIF to an ICF-based fusion-fission power plant." Dr. Moses' talk focused on using NIF to develop a hybrid fusion-fission reactor capable of burning spent nuclear fuel and weapons waste. The concept, called the Laser Inertial Fusion Engine (LIFE), would use an ICF laser system similar to the one now under development at NIF to ignite fusion targets surrounded by a spherical blanket of subcritical fission fuel. The fuel could be

Plasma Science Committee

Paul Bellan, California Institute of Technology
Michael R. Brown, Swarthmore College
Patrick L. Colestock, Los Alamos National Laboratory
Jeffrey Freidberg, Massachusetts Institute of Technology
S. Gail Glendinning, Lawrence Livermore National Laboratory
Jeffrey Hopwood, Tufts University
Chandrashekhar Joshi, University of California at Los Angeles
Michael Mauel, Columbia University
George Morales, University of California at Los Angeles
Margaret Murnane, University of Colorado at Boulder
Amy Wendt, University of Wisconsin at Madison

one of many fertile or fissile materials, including thorium, light-water reactor spent nuclear fuel, weapons-grade plutonium, highly enriched uranium, and natural and depleted uranium.

Daniel Cohn from MIT gave a talk on Plasma applications for clean fuels and vehicles. He spoke specifically on two topics: the conversion of waste to clean fuels, and onboard conversion of fuel for clean, high efficiency vehicles. He discussed the MIT Plasma Waste Treatment Technology that uses a plasma furnace to convert waste into H2-rhc gas and glass. He then discussed the "garbage to alcohol fuel system," that uses a combination of existing technologies (conventional gasifer, plasma enhanced melter, catalyst system) to produce liquid fuels from municipal waste using plasma-melter gasification. He also presented on Plasmatron Reformer Technology, an onboard plasma fuel conversion for vehicular applications that produced H2-rich gas.

Next, Riccardo Betti, Chair of the PLSC, presented the outcomes from the FESAC HEDLP subpanel charged with "identifying the compelling scientific opportunities for research in the field, identifying the scientific issues of implosion and target design that need to be addressed to make the case for inertial fusion energy, " providing background for a specific plan for energy related HEDLP studies," and identifying. the gaps in knowledge and opportunities for energy related HEDLP. The panel identified 6 areas of fundamental HEDLP science that offer interesting research opportunities. The report made a general recommendation that the joint OFES-NNSA program should support fundamental and energy-related HEDLP science by leveraging access to NNSA facilities., and then made several recommendations regarding the stewardship and technical aspects of that program. The report then laid out a three-phase scientific plan for energy-related HEDLP research. The report is available at URL http://www.science.doe.gov/ofes/FESAC-HEDLP-REPORT.pdf.

The last discussion of the day was led by Michael Holland, OMB DOE Budget Examiner. Dr. Holland discussed the role of OMB is the budget process, and specifically how it relates to the DOE Office of Science. He reported that the agency will continue to work on FY10 budgets and focus on cost realism while executing the Administration's commitment to significantly increase spending on the physical sciences. ■

Highlights of the Spring Meeting of the Committee on Radio Frequencies

David B. Lang, BPA Staff

The Committee on Radio held its spring 2009 meeting at the Keck Center of the National Academies on May 27-28, 2009 in Washington, DC. The meeting was opened with a welcome to the members and guests present by CORF Chair, Jeff Piepmeier, NASA-Goddard Space Flight Center.

Tasso Tzioumis, Chair of the Radio Astronomy Frequency Committee in the Asia-Pacific region (RAFCAP) discussed by teleconference RAFCAP's charge and composition, radio astronomy (RAS) facilities in the region, and relevant regional spectrum issues. RAFCAP is the ITU Region 3 committee that acts as the scientific expert on frequency issues for RAS and related sciences in the region. He discussed the extensive RAS facilities in the region, totaling 50 in all. Dr. Tzioumis noted special issues that low-frequency RAS facilities face now and in the future. In particular, these bands are heavily used for communications and so it will be difficult to find quiet spectrum. He further noted as potential future issues ultrawideband vehicle collision avoidance radars, broadband over power lines, and space solar power satellites.

Next, Ron Repasi from the FCC discussed several items of interest at the FCC that are of interest to CORF. He spoke about satellite communications such as Earth stations on vessels, vehicle-mounted Earth stations, and aeronautical mobile-satellite service. He also hit on terrestrial communications for public safety use at 4940-4990 MHz. Mr. Repasi went on to discuss unlicensed operations and FCC preparations for the WRC-12. He concluded by suggesting how CORF might be able to help the FCC by continuing to monitor FCC rulemakings, participating in WRC-07 implementation, reviewing the registration process for radio observatories, and briefing FCC staff on RAS and Earth Exploration Remote Sensing (EESS).

Darlene Drazenovich from the National Telecommunications and Information Administration's Office of Spectrum Management provided a helpful briefing on the World Radiocommunication Conference (WRC) process, both domestic and international. She walked the committee through the process from technical preparations to the WRC itself.

Andrew Clegg from the NSF's Spectrum Management Office delivered a presentation on the complex process surrounding spectrum allocations. In particular, he noted that radio spectrum allocations in the U.S. are the result of rules and regulations promulgated by the NTIA (for Federal government users) and the FCC (for all others), that the ITU develops spectrum allocations on a worldwide basis, which may or may not be adopted by an individual country, that every frequency between 9 kHz and 275 GHz is allocated to one or more of the 26 defined radio services, and that footnotes to the allocation table add important information to what's presented in the table itself.

Tom Gergely from the NSF's Spectrum Management Office then discussed NSF

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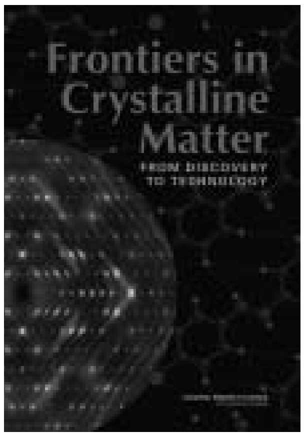
BPA Recent Reports

Caryn Joy Knutsen, Editor

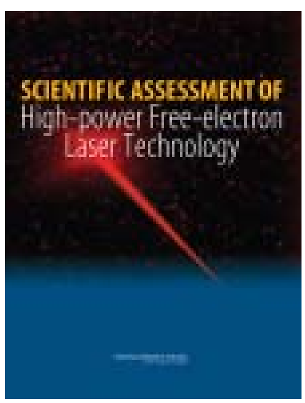
The Board on Physics and Astronomy releases several reports each year. Below are short descriptions of reports released in 2008 and 2009.



Frontiers in Crystalline Matter: From Discovery to Technology

(April 2009)

For much of the past 60 years, the U.S. research community dominated the discovery of new crystalline materials and the growth of large single crystals, placing the country at the forefront of fundamental advances in condensed-matter sciences and fueling the development of many of the new technologies at the core of U.S. economic growth. The opportunities offered by future developments in this field remain as promising as the achievements of the past. However, the past 20 years have seen a substantial deterioration in the United States' capability to pursue those opportunities at a time when several European and Asian countries have significantly increased investments in developing their own capacities in these areas. This book seeks both to set out the challenges and opportunities facing those who discover new crystalline materials and grow large crystals and to chart a way for the United States to reinvigorate its efforts and thereby return to a position of leadership in this field.



Scientific Assessment of High-Power Free-Electron Laser Technology

(December 2008)

This book presents a scientific assessment of free-electron-laser technology for naval applications. The charge from the Office of Naval Research was to assess whether the desired performance capabilities are achievable or whether fundamental limitations will prevent them from being realized.

The present study identifies the highest-priority scientific and technical issues that must be resolved along the development path to achieve a megawatt-class free-electron laser. In accordance with the charge, the committee considered (and briefly describes) trade-offs between free-electron lasers and other types of lasers and weapon systems to show the advantages free-electron lasers offer over other types of systems for naval applications as well as their drawbacks.

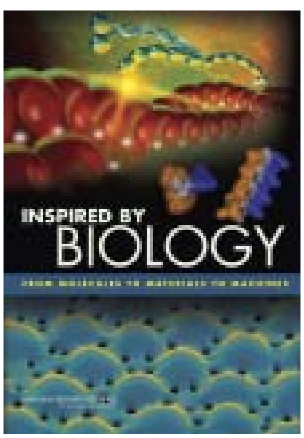
The primary advantages of free-electron lasers are associated with their energy delivery at the speed of light, selectable wavelength, and all-electric nature, while the trade-offs for free-electron lasers are their size, complexity, and relative robustness. Also, Despite the significant technical progress made in the development of high-average-power free-electron lasers, difficult technical challenges remain to be addressed in order to advance from present capability to megawatt-class power levels.

A Review of the DOE Plan for U.S. Fusion Community Participation in the ITER Program

(July 2008)

ITER presents the United States and its international partners with the opportunity to explore new and exciting frontiers of plasma science while bringing the promise of fusion energy closer to reality. The ITER project has garnered the commitment and will draw on the scientific potential of seven international partners, China, the European Union, India, Japan, the Republic of Korea, Russia, and the United States, countries that represent more than half of the world's population. The success of ITER will depend on each partner's ability to fully engage itself in the scientific and technological challenges posed by advancing our understanding of fusion.

In this book, the National Research Council assesses the current U.S. Department of Energy (DOE) plan for U.S. fusion community participation in ITER, evaluates the plan's elements, and recommends appropriate goals, procedures, and metrics for consideration in the future development of the plan.



Inspired by Biology: From Molecules to Materials to Machines

(June 2008)

Scientists have long desired to create synthetic systems that function with the precision and efficiency of biological systems. Using new techniques, researchers are now uncovering principles that could allow the creation of synthetic materials that can perform tasks as precise as biological systems. To assess the current work and future promise of the biology-materials science intersection, the Department of Energy and the National Science Foundation asked the NRC to identify the most compelling questions and opportunities at this interface, suggest strategies to address them, and consider connections with national priorities such as healthcare and economic growth. This book presents a discussion of principles governing biomaterial design, a description of advanced materials for selected functions such as energy and national security, an assessment of biomolecular materials research tools, and an examination of infrastructure and resources for bridging biological and materials science.

preparations for the upcoming WRC-12 and Agenda Items (AI) relevant to RAS. He noted that AI 1.6 was particularly important for the science services, as it would play a significant role in determining future allocations between 275-3,000 GHz.

John Zuzek, NASA's Remote Sensing Spectrum Manager discussed WRC-11 issues and objectives, and domestic concerns. He noted of primary concern to NASA AI 1.6 (passive uses of the spectrum from 275-3000 GHz), AI 1.11 (new primary allocation to the space research service (EàS) at 22.55-23.15 GHz), AI 1.12 (protection of primary services in 37-38 GHz from AMSS, AI 8.1.1(c) (improving the recognition of the essential role and global importance of Earth observation applications), and AI 8.2 (future WRC Agenda Items for the 2015 WRC and beyond). Dr. Zuzek further noted that an important domestic issue for NASA is that three upcoming NASA remote sensing missions will use the 1215-1300 MHz band for active sensing applications, and the FAA and Air Force operate important air surveillance radars in this band and these active sensing instruments could potentially cause harmful interference to these radars.

Carrie Stokes from USAID delivered a presentation on her office's efforts to promulgate remote sensing information to developing countries through its service, SERVIR.net. SERVIR provides a variety of geospatial information such as can be used for monitoring fires, algal blooms, nowcasting, land cover changes, air quality, cloud forest, climate change, and for international boundary disputes. SERVIR is very active in Central America and seeks to expand into Africa.

Paul Feldman, CORF Consultant, next discussed several FCC activities of interest to CORF. He spoke on unlicensed operations in television bands broadband over power lines, Ku-band developments concerning VMES, 4.9 GHz microwave fixed links, a modification to the GlobalStar/Iridium L-band licenses, the MedRadio service at 401-406 MHz, and the Spectrum Inventory Act bill introduced in the Senate.

David McGinnes, the NOAA/NESDIS Frequency Manager, discussed spectrum activity and WRC-11 Agenda Items of interest to NOAA. He focused on AI 1.2, AI 1.3 (spectrum for safe operation of unmanned aircraft systems), AI 1.5 (harmonization of spectrum for electronic news gathering), AI 1.6, AI 1.8 (technical and regulatory issues for fixed service between 71 and 238 GHz), AI 1.15 (possible allocations in 3-50 MHz to radiolocation service for oceanographic radar applications), AI 1.16 (passive lightning detection), AI 1.19 (regulatory measures for software-defined radio and cognitive radio systems), AI 1.20 (spectrum for High Altitude Platform Stations (HAPS) in 5850-7075 MHz), AI 1.22 (effect of emissions from short-range devices on radiocommunication services), and AI 1.24 (extension of current NGSO space-to-Earth Metsat allocation in 7750-7850 MHz).

Alan Rogers, a CORF member, delivered a presentation on instruments for studying the Epoch of Reionization (EOR), the period of time in the early universe during which matter was slowly reionized. Most instruments being built are looking for spatial structure of the redshifted 21 cm emission/absorption hydrogen line at z~8.5. Dr. Rogers noted that the powerful Orbcomm satellite downlink signal at 137-138 MHz is near the redshifted 21cm H-line. He then spoke about four current EOR experiments: the Murchison Widefield Array, the Precision Array to Probe Epoch of Reionization, the Cosmological Re-Ionization Experiment, and the Experiment to Detect Global EOR Step.

On the second day CORF spent the majority of its time discussing its response to NASA and NSF's request for the committee to produce a "Views" document that identifies and discussed WRC-12 AIs relevant to RAS and EESS. ■

Committee on Radio Frequencies

Jeffrey Piepmeier, Chair, NASA Goddard Space Flight Center
Douglas C.-J. Bock, Vice Chair, University of California at Berkeley / Combined Array for Research in Millimeter-wave Astronomy
Ana P. Barros, Duke University
Steven W. Ellingson, Virginia Tech
David G. Long, Brigham Young University
Darren McKague, University of Michigan
James M. Moran, Harvard-Smithsonian Center for Astrophysics
Melinda Piket-May, University of Colorado at Boulder
Alan E.E. Rogers, Massachusetts Institute of Technology/Haystack Observatory
Steven C. Reising, Colorado State University
Lucy Ziurys, University of Arizona

SSB Releases America's Future in Space Report

David B. Lang, BPA Staff

The Space Studies Board recently convened the Committee on the Rationale and Goals of the U.S. Civil Space Program to advise the nation on key goals and critical issues in 21st century U.S. civil space policy. The committee's report, *America's Future in Space: Aligning the Civil Space Program with National Need*, was released on July 7, 2009. The introductory text from the Summary of this report is reproduced below.

From its inception in 1958, much of the U.S. space program was driven by opportunities to serve national interests in a geopolitical environment heavily colored by Cold War threats and fears. Originally, the true potential of space activities was largely speculative. In the ensuing decades, however, early expectations for discovery and technological accomplishment have been richly exceeded. Without a doubt, the first 50 years of the space age have been transformative. Astronauts have stood on Earth's moon while millions watched.

Commercial communications and remote sensing satellites have become part of the basic infrastructure of the world. Satellites support worldwide communications, providing a critical backbone for daily commerce—carrying billions of global financial transactions daily, for example. Direct broadcasting beams television signals into homes globally, delivering images that bring unprecedented awareness of events occurring throughout the world. Military global positioning satellites provide ubiquitous signals that support a stunning variety of services, from assisting in the navigation of civilian airplanes, shipping, and automobiles to transmitting timing signals that enable cell phone and power grid switching. Remote sensing satellites obtain high-resolution images of Earth's surface, available now on the Internet for people worldwide to view and use, and provide critical information to monitor changes in our climate and their effects.

Our understanding of every aspect of the cosmos has been profoundly altered, and in the view of many, we stand once again at the brink of a new era. Space observations have mapped the remnant radiation from the Big Bang that began our universe. We have discovered that the expansion of the universe continues to accelerate, driven by a force that we do not yet understand, and that there are large amounts of matter in the universe that we cannot yet observe. We have seen galaxies forming at the beginning of the universe and stars forming in our own galaxy. We have explored the wonders that abound in our solar system and have found locations where life might have occurred or might even now be present. We have discovered planets around other stars, so many that it is ever more likely that there are other Earths comparable to our own.

What will the next 50 years bring? Today we live in a globalized world of societies and nations characterized by intertwined economies, trade commitments, and international security agreements. Mutual dependencies are much more pervasive and important than ever before. Many of the pressing problems that now require our best efforts to understand and resolve—from terrorism to climate change to demand for energy—are also global in nature and must be addressed through mutual worldwide action. In the judgment of the Committee on the Rationale and Goals of the U.S. Civil Space Program, the ability to operate from, through, and in space will be a key component of potential solutions to 21st century challenges. As it has before, with the necessary alignment to achieve clearly articulated national priorities, the U.S. civil space program can serve the nation effectively in this new and demanding environment.

In its initial discussions, the committee concluded that debates about the direction of the civil space program have too often focused on addressing near-term problems and issues without first putting those issues in the context of how a disciplined space program can serve larger national imperatives. In the committee's view, characterizing the top-level goals of the civil space program and the connection between those goals and broad national priorities is necessary as a foundation on which the nation (both now and in the future) can devise sustainable solutions to nearer-term issues. Therefore, the committee focused on the long-term, strategic value of the U.S. civil space program, and its report does not address nearer-term issues that affect the conduct of U.S. space activities other than to provide a context in which more tactical decisions might be made.

The national priorities that informed the committee's thinking include ensuring national security, providing clean and affordable energy, protecting the environment now and for future generations, educating an engaged citizenry and a capable workforce for the 21st century, sustaining global economic competitiveness, and working internationally to build a safer, more sustainable world. A common element across all these urgent priorities is the significant part that research and development can play in solving problems and advancing the national enterprise in each area. Instruments in space have documented an accelerating decline in arctic sea ice, mapped the circulation of the world's oceans, enabled the creation of quantitative three-dimensional data sets to improve the quality of hurricane forecasting, and created new tools to address a host of agricultural, coastal, and urban resource management problems, to cite only a few examples. Such capabilities demonstrate what can be achieved when technologically challenging space problems stimulate innovation that leads to long-term advances with applications beyond the space sector. Civil space activities are central to the R&D enterprise of the nation, often in a transformational way, and thus present powerful opportunities to help address major national objectives.

Observations from space offering unique capabilities for global environmental and land-use monitoring are essential to informed decision making about energy production and climate change policies, and they help provide the understanding required for wise management. The high visibility of space activities attracts students' attention to science, technology, and mathematics, and space activities are an exciting focus for teaching those subjects. Commercial space-related ventures now figure significantly in global economic competitiveness, and, while government investments to stimulate the nation's fragile economy will have short-term impacts, R&D investments can be counted on to make longer-term sustainable contributions to the nation's economic strength. As has countless times proved the case, research in and from space will continue to lead to important future, and not always currently predictable, benefits that hold the promise of progress toward realizing U.S. as well as shared international goals.

The committee's overall conclusion is that a preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges—environmental, economic, and strategic—will continue to make major contributions to the nation's welfare.

See "Space Future Report" on page 15

Crystal Growth
(continued from page 1)

research laboratories. Research in DGCM covers subject matter such as electronic, magnetic, optical, and structural phenomena. This diversity notwithstanding, there is a clear identity associated with researchers involved in DGCM. As can be seen from the attendance at scientific conferences in this area, it is a fairly small community, with exacting and specific technical needs and educational requirements.

While academia, the national laboratories, and private industry all have important roles in this field, industrial research laboratories historically have provided a particularly critical environment for the flourishing of DGCM activities. There, technological advancement in sectors such as the semiconductor industry, optical communications, and displays has required not only applied research to improve the performance of materials such as silicon, glass, and liquid crystals, but also basic research into their fundamental properties. Advances made in DGCM in these laboratories were the consequence of a continual interplay between device development and basic research in physics and chemistry as well as close contact among the relevant technical communities—the material scientists, the crystal growers, and the developers of technical devices. This environment also served as a critical training ground, where the specialized techniques needed for success were passed on to new generations of crystal growers.

Almost a century after the discovery of Bragg's law, by which x-rays scattered from crystalline matter were used to establish its periodic structure, DGCM research not only has a strong legacy of foundational discovery but also retains great intellectual vitality, high technological relevance, and seemingly unending promise for discovery. The demand for crystals and new materials remains strong. The past 20 years have witnessed great advances in measurement capabilities in the United States across the whole range of facilities. At small and medium-size facilities, factors such as computer-assisted automation, new spectroscopies such as scanning probes, and the commercialization of diagnostic techniques have played a large role in driving demand for new materials. At the large national laboratories, several new U.S. synchrotron x-ray sources have been built, and new capabilities in neutron scattering have been installed at the National Institute of Standards and Technology (NIST) and at the Oak Ridge National Laboratory. In addition, the National High Magnetic Field Laboratory, which opened in 1994, represents new capabilities in high magnetic field research, including a unique capability for studying the energy states of electrons in crystalline metals. These facilities represent some of the best characterization facilities in the world, creating opportunities to study, in great detail, novel magnetic, electrical, and structural properties of materials for which large single crystals are available. However, balance is needed between supporting the development of world-class characterization facilities and supporting the best materials growth; simply put, using the best neutron scattering facility in the world with suboptimal samples will engender suboptimal results.

The excitement and the promise of DGCM-based research already have been reflected in major initiatives abroad. For example, through projects such as Exploratory Research for Advanced Technology (ERATO), Japan now leads in the growth of strongly correlated oxides and organics both in bulk and thin-film form. China has significantly increased its commitment to develop expertise in crystal growth and basic materials research. And in certain areas such as ferroelectric crystals for information storage and actuator applications, China has developed the capability to produce large single crystals not currently available in the United States. The importance of international competition extends beyond national pride, however. Historically, those institutions that develop new materials are the ones with the best chance to exploit the resulting science and technology opportunities, the latter through intellectual ownership.

Despite the promises offered in this field, DGCM research in the United States today is substantially weaker than it was 20 years ago. The large industrial laboratories that historically led the nation in discovering new materials and in developing techniques for growing pure crystals no longer engage in these activities to a significant degree. DGCM research also has not found a "natural" home in the academic world in the United States. The nature of the work is inherently multidisciplinary and does not readily fit into the traditional, departmental structure of U.S. universities. Further, the start-up and operating costs of a DGCM researcher can be significantly higher than those of the typical university single investigator. Consequently, despite fundamental discoveries by DGCM researchers that have led to the establishment of entirely new subfields in condensed-matter physics, materials

MSAC Committee

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science, and chemistry, the presence of these researchers in U.S. universities is low. The net result of industrial laboratories' no longer engaging in DGCM research and the low level of research in the academic sector is that scientists and engineers in the United States face significant constraints because of inadequate access to crystals for scientific research and technology development, which frequently puts them, and the United States in general, at a competitive disadvantage.

Recommendations

In response to its charge to assess this research area, identify future opportunities, and recommend strategies to enhance opportunities in the United States, the committee concludes that DGCM remains a critically important area in condensed-matter research, and because of a change in the landscape in the United States, the continued competitiveness of the United States in this field requires that concrete and substantive steps be taken. The steps recommended by this committee are as follows.

Recommendation 1:

Develop a focused, multiagency initiative to strengthen U.S. efforts to discover and grow new crystalline materials.

Crystalline materials research impacts a broad set of technologies encompassing energy, defense, information, communications, and industrial standards, and it straddles a number of traditional academic disciplines such as chemistry, materials science, and physics. Thus, an initiative for establishing and sustaining programs specifically directed toward driving the discovery and synthesis of new crystalline materials should be coordinated among agencies that fund research in these areas, including the National Science Foundation, the Department of Energy, the Department of Defense, and the Department of Commerce (NIST). The broad goals of such an initiative should be to establish crosscutting synthesis capabilities, educational thrusts, and openly available cyber resources that will enable broad research efforts. Programs funded through such an initiative would range from small-scale equipment run by single investigators to large-scale, centralized facilities for the discovery, growth, and characterization of crystalline materials, a range necessary to address the spectrum of research needs of this field.

Recommendation 2:

Develop discovery and growth of crystalline materials "centers of expertise."

Funding should be provided for one or more "centers of expertise" that are capable of addressing the broadscale issues arising in the DGCM area. Centers have a role that cannot be filled by small programs. In contrast to small programs, centers can provide the infrastructure needed to house specialized facilities and the robust multidisciplinary environment needed for cutting-edge materials development. The purpose of these centers would be to address a range of problems, including those requiring large-scale facilities, facilities for using toxic chemicals, and facilities requiring significant technical support. In addition, the mission of one or more centers should be to address problems of crystal growth of immediate interest to U.S. industry. Working on a cost-recovery basis, these industry-oriented centers would be responsible for forming strong industrial partnerships, engaging in technology development with their industrial partners, and maintaining the expertise and infrastructure needed for industrial crystal growth. These centers also should support a small number of education and training programs that explicitly address the discovery and growth of crystalline materials and should complement the university-based education in DGCM addressed below in Recommendation 3.

Recommendation 3:

Develop and sustain programs specifically designed to strengthen and sustain education and training in the field of the discovery and growth of crystalline materials.

In order for the United States to have a strong and sustainable effort in the discovery and growth of crystalline materials, federal agencies should develop programs and policies that focus on providing the specific and often unique education and training needed for those engaged in discovering new crystalline materials and synthesizing large crystals. Special attention should be given to developing federally funded programs that encourage academic organizations to prepare cross-disciplinary curricula and opportunities for educating the United States' next generation of DGCM scientists.

Recommendation 4:

Promote cultural changes to develop and solidify academic programs in the field of the discovery and growth of crystalline materials.

The culture of U.S. science, as currently promulgated in the departmental or discipline-centric environment of universities, frequently does not reward DGCM synthesis research as much as it rewards measurement science. In order for the United States to have a strong and sustainable effort in the discovery and growth of crystalline materials, federal agencies should develop programs and policies that make it attractive for universities in the United States to hire crystal growers and promote robust research programs in this area by providing ample funding specifically for such work. The committee specifically urges that more crystal growers be hired into tenure-track positions at universities.

Recommendation 5:

Develop a network approach for research-enhancing collaborative efforts in the discovery and growth of crystalline materials while preserving intellectual ownership.

New approaches to communication are needed to advance the field of discovery

See "Crystal Growth" on page 12

and growth of crystalline materials. The internal collaboration common in industrial laboratories formerly engaged in DGCM activities greatly aided the development of materials by providing rapid responses to synthesis needs as well as rapid feedback from measurement to synthesis. A similar approach to communication among researchers should be promoted through programmatic means by the federal agencies. The committee envisions a "DGCM network" as a novel approach to scientific collaboration that would both fulfill conventional needs for greater communication and enable the new modes of collaboration afforded by cyber infrastructure. The envisioned DGCM network would provide a virtual forum for organizing synthesis efforts, crystal growers would be able to announce the availability of new compounds, and a measurer would be able to request collaboration with a crystal grower to meet the measurer's need for a specific sample. The envisioned DGCM network would also provide access to information in the physical archive of already-synthesized samples stored in individual laboratories throughout the country, further enabling collaborations. At the same time, policies and procedures for participating in the network would be designed to enhance collaborative work while protecting the intellectual contributions of researchers who discover or develop novel crystalline materials. ■

Upcoming Board and Committee Meetings

Board on Physics and Astronomy
November 7-8, 2009

Committee on Atomic, Molecular, and Optical Sciences
December 12-13, 2009

Astro2010 Survey Committee Meeting
January 25-27, 2010

Astro2010 Survey Committee Meeting
February 28-March 2, 2010

Astro2010 Progress (continued from page 1)

concluded their third and final meeting and are preparing reports for NRC review.

Program Prioritization Panels Update

In April 2009 approximately 60 panel members were appointed to the four Astro2010 PPPs. These four panels moved forward quickly in their task, holding their first meetings at the at the "jamboree." There, the panels received draft interim reports from the five SFP chairs, as well as hearing interim reports from the ISG chairs. The lively science discussions at the jamboree were a useful first step for the PPPs to begin their analysis of the programmatic aspects of the survey.

Having considered the responses from research activity proponents to the survey's first Request for Information—as well as drawing on community-written white papers on computation, laboratory astrophysics, technology development and theory—the PPPs issued invitations to various activities to present at the panels' second meetings. The PPPs also requested further written input from several other activity teams. The responses to the Requests for Information were used by the Program Prioritization Panels to make an evaluation of each proposed activity's state of maturity and scale, and at the open sessions of their June 2009 Meetings in Pasadena, CA each panel heard invited talks from some of the activities for which additional information was requested. The June Meetings were co-located with the June meeting of the American Astronomical Society which facilitated the participation of the broader research community in the Astro2010 process.

The PPPs continue to solicit further information and data from research activities as they consider their charge to recommend a prioritized program of federal investment in research activities while drawing on several sources of information: (1) the science forefronts identified by the Astro2010 science frontiers panels, (2) input from the proponents of research activities, and (3) independent cost and technical readiness assessments.

Infrastructure Study Groups Update

The six ISGs have read the position papers and amassed a very large quantity of information and data for the survey panels and committee to consider. Following the ISG chairs' presentation of interim findings at the jamboree meeting, the ISGs

Astro2010 Survey Committee

Roger D. Blandford, Chair, Stanford University
Martha Haynes, Vice Chair – Science Frontiers, Cornell University
John P. Huchra, Vice Chair – State of the Profession, Harvard University
Marcia Rieke, Vice Chair – Program Prioritization, University of Arizona
Lynne Hillenbrand, Executive Officer, California Institute of Technology
Steven Battel, Battel Engineering
Lars Bildsten, University of California, Santa Barbara
John E. Carlstrom, The University of Chicago
Debra Elmegreen, Vassar College
Joshua Frieman, Fermi National Accelerator Laboratory
Fiona Harrison, California Institute of Technology
Timothy Heckman, Johns Hopkins University
Robert Kennicutt, University of Cambridge
Jonathan Lunine, University of Arizona
Claire Max, University of California, Santa Cruz
Daniel McCammon, University of Wisconsin
Steven Ritz, SCIPP, University of California, Santa Cruz
Juri Toomre, University of Colorado
Scott Tremaine, Institute for Advanced Study
Michael S. Turner, The University of Chicago
Neil deGrasse Tyson, Hayden Planetarium, American Museum of Natural History
Paul Vanden Bout, National Radio Astronomy Observatory
Thomas Young, Lockheed Martin Corporation (Retired)

will complete their reports this summer. The confidential summary reports will be distributed to the panels and the survey committee as input into their deliberations and final reports.

Community Input Update

Astro2010 received over 600 hundred papers in response to the various calls for input: over 90 Activity Notices of Interest, over 300 Science White Papers, 69 State of the Profession Position Papers, 62 Technology Development White Papers, 8 Theory, Computation, and Laboratory Astrophysics White Papers, and over 100 Requests for Information from Activities. The survey committee greatly appreciates all those who have put so much thought and effort into the Astro2010 solicitations!

Numerous highly successful community-led Town Halls were conducted at universities and institutions all across the county. Reports from these meetings can be downloaded in PDF form as available from the Astro2010 web site (www.nationalacademies.org/astro2010). The results of the town halls have raised new and more clearly articulated questions for the Committee, Panels, and Study Groups to address. The survey committee appreciates all who took time out of their busy schedules to organize and report on these meetings!

Survey Committee Update

While the panels have been hard at work, the survey committee and its subcommittees continue to meet in weekly plenary sessions by telephone. The survey committee will meet for its fourth meeting on October 4-6, 2009 in Washington, DC, followed by its fifth meeting on January 25-27, 2009 in Irvine, CA. The main recommendations of the survey committee's report will be under consideration at these meetings. The PPP chairs will provide confidential interim reports of their panels' conclusions and recommendations to the survey committee at the October meeting. An open session is expected to be held on October 5th and an agenda will be posted online. The final survey report is still on track to be released in the summer of 2010.

Survey and committee membership rosters are available on the Astro2010 web site, www.nationalacademies.org/astro2010. ■

Astro2010 Fall/Winter Events

*September 2009**

- September 4-7, 2009, PPP: Radio, Millimeter and Submillimeter Astronomy from the Ground: Third Meeting (Woods Hole, MA)
- September 17-19, 2009, PPP: Particle Astrophysics and Gravitation: Third Meeting (Woods Hole, MA)
- September 23-25, 2009, PPP: Electromagnetic Observations from Space: Third Meeting (Washington, DC)

*October 2009**

- October 4-6, 2009, Fourth meeting of the Survey Committee (Washington, DC)

January 2010

- January 25-27, 2009, Fifth meeting of the Survey Committee (Irvine, CA)

February 2010

- February 28-March 2, 2010, Sixth meeting of the Survey Committee (Irvine, CA)

*The Astro2010 survey committee and the PPPs held meetings in September and October and these will be covered in a future issue of "Issues in Physics & Astronomy."

BPA Spring Meeting
(continued from page 3)

cept of dark energy arose and how its existence and amount affects studies of the universe. He discussed how cosmic acceleration was discovered, how it led to the dark energy theory, how the model has been tested using supernovae at redshifts less than z=1.0, how the Hubble constant can be used as a complementary probe of dark energy, and finally what the next generation of scientific probes of the model might look like.

Lastly, Astro2010 Survey Chair Roger Blandford (Stanford) gave an overview of the survey's progress, including the formation of three subcommittees, nine NRC-appointed panels, and six independent study groups. He also highlighted the efforts to engage the larger community through various requests for white papers. Then, Dr. Blandford reviewed the timeline and preparations for several [then] upcoming meetings involving the four program prioritization panels, including one held concurrently with the 214th AAS meeting in Pasadena, CA in June 2009.

The next board meeting is to take place at the Beckman Center of the National Academies in Irvine, CA on November 7-8, 2009. ■

Space Future Report
(continued from page 11)

The report identifies six strategic goals that it regards as basic for guiding program choices and resources planning for U.S. civil space activities, four foundational elements critical to a purposeful, effective, strategic U.S. space program, and seven overarching recommendations to align the components of the civil space program in order to fully capitalize on opportunities to serve the larger national interest. The full text of the report is available at the National Academies Press website at URL http://www.nap.edu/catalog.php?record_id=12701. ■

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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:

Scientific Assessment of High-power Free-electron Laser Technology

Inspired by Biology: From Molecules to Materials to Machines

A Review of the DOE Plan for U.S. Fusion Community Participation in the ITER Program

Frontiers in Crystalline Matter: From Discovery to Technology

Coming Soon:

Final Report of the Research at the Intersection of the Physical and Life Sciences Committee

Final Report of the Spectrum Study Committee

Final Report of the Understanding the Impact of Selling the Helium Reserve Committee