Directorate for Mathematical and Physical Sciences
Advisory Committee Meeting Minutes
November 6-7, 2008

Thursday, November 6, 2008
Morning Session

Welcome and Introductions

Dr. Tony Chan, Assistant Director of the Directorate for Mathematical and Physical Sciences (MPS) opened the meeting at 8:30 AM and introduced the new Chair of the Mathematical and Physical Sciences Advisory Committee (MPSAC), Dr. Iain Johnstone of Stanford University. He noted that Johnstone had agreed to become Chair of the MPSAC after Dr. Robert Williams of the Space Telescope Science Institute stepped down as the MPSAC Chair for personal reasons.

Johnstone pointed out that this was a period of great challenge and potential change for MPS. MPS is the largest and most scientifically diverse of the Directorates of the National Science Foundation (NSF). The job of the MPSAC is to provide advice and counsel to MPS and to its Divisions. He thanked Dr. Morris Aizenman for the preparations associated with setting up the meeting, noted that there was a full agenda, with the first day dedicated primarily to listening to information from the Directorate and the second day providing feedback. He indicated that he wanted to allot a lot of time for discussion by the MPSAC, and added that the MPSAC had a subcommittee structure available for interaction between meetings. The members of the MPSAC were introduced and it was noted there were ten new members this year.

Remarks by MPS Assistant Director

Chan introduced his remarks by noting that with respect to the FY 2009 budget NSF was operating under a Continuing Resolution and so he could not say anything definite about what the final NSF budget for FY 2009 would be. He described the NSF FY 2009 budget request, which averaged a 13% increase over the FY 2008 budget. Within this budget, Research and Related Activities were 16% above the FY 2008 Request. The request for MPS was 20% above that of FY 2008, and was the largest increase requested for any Directorate within NSF. Within this increase, the Division of Materials Research (DMR) had an increase of 25% while the Division of Chemistry (CHE) had an increase of 26%. Impact of the Continuing Resolution on MPS, if it lasted the entire year and funding was held at FY 2008 levels, included a reduction in support of Individual Investigator Awards (IIA), new solicitations would be put on hold, MPS facilities would experience shortfalls that might mean reduced run times, layoffs, and there would be delays in the development of future projects. There would be a reduction in planned instrumentation competitions and awards.

Chan provided updates on senior personnel within NSF and MPS, including the ongoing search for a Division Director for the Division of Astronomical Sciences (AST). He then described the MPS Solar Energy Initiative, which involves CHE, DMR and the Division of Mathematical Sciences (DMS). Proposals will have to have at least three co-principal investigators, with expertise in chemistry, materials research, and the mathematical sciences. There will be a two-stage proposal preparation and review process, with three-page pre-proposals to be reviewed internally. Emphasis would be placed on transformational potential and interdisciplinary synergy. Full proposals would be reviewed by interdisciplinary panels.

He then described the status of several large facility projects within MPS, including the startup of the Large Hadronic Collider (LHC), the S4 solicitation for the proposed Deep Underground Science and Engineering Laboratory (DUSEL), the Atacama Large Millimeter Array (ALMA) project (the construction cost performance is good but slightly behind schedule, and there are now 11 antennas at the site in Chile).

The AST Decadal Survey Process had begun and is being jointly funded by NASA, the Department of Energy, and NSF. Dr. Roger Blandford of Stanford University is the Chair of the Decadal Survey. A new solicitation "Proactive Recruitment in Introductory Science and Mathematics (PRISM) was released in August 2008 and will support partnerships between the mathematical sciences and other science or engineering disciplines to recruit freshmen and

sophomore students into mathematics, sciences, and engineering.

Chan described new MPS investments in NSF-wide and MPS-wide activities such as "Science and Engineering Beyond Moore's Law (SEBML)," "Cyber-enabled Discovery and Innovation (CDI)," and "Adaptive Systems Technology (AST)." He also described the MPS strategic areas that are currently being undertaken in partnership with other disciplines. Facilities that are in the planning and development states include the Large Synoptic Survey Telescope (LSST), the Deep Underground Science and Engineering Laboratory (DUSEL), and the Giant Segmented Mirror Telescope (GSMT). Major facilities challenges that MPS must face are that the cost of some facilities is now approaching one billion dollars, the need for accurate cost estimates and controls, and the need for balance between core programs and facilities management and operations.

In concluding his remarks, he noted that for FY 2010 one would need to follow through on proposed FY 2009 activities, expand partnerships with other NSF Directorates, and look at new frontiers.

In the discussion that followed Dr. David Keyes (Columbia University) asked what would happen if NSF received the FY 2009 request. Chan responded that MPS had been examining a number of scenarios, adding that there had been no real increase in funding for the last three years.

Dr. Hector Abruna (Cornell University) asked what the effect of DUSEL would be on facilities. Chan responded that DUSEL is funded through the Physics Division, with some input from the MPS Office of Multidisciplinary Activities (OMA), for the S3 and S4 solicitations. He stressed that only initial research and development is being provided for DUSEL at the present time.

Dr. Suzanne Hawley (University of Washington) asked about the status of the AST Division Director search. Chan responded that it is in the final stages, that all deliberations are still highly confidential, but that he hoped to be able to make an announcement within the next few weeks.

Dr. Dennis Matthews (University of California, Davis) asked what pressing issues Chan would bring to the attention of the Obama transition team. Chan responded that this was a question that was more appropriate for the NSF Director. The role of MPS is to support basic science and education in the mathematical and physical sciences. It is important for MPS to continue to argue that projects that MPS supports have a much longer timeframe than is common among the mission agencies. One must balance long-term research activities with the shorter-term payoffs.

Report from the Division of Astronomical Sciences

Dr. Craig Foltz, Acting Director of the Division of Astronomical Sciences (AST) stated that the National Academy of Sciences Decadal Survey Process has begun. The Survey is jointly funded by NSF, NASA, and the Department of Energy (DOE) and Roger Blandford of Stanford University will chair the Survey. Blandford had chaired the AST Senior Review. There would be an open competition of operation of the National Astronomy and Ionosphere Center (NAIC) in Puerto Rico, with a Dear Colleague Letter about to be issued. The Advanced Technology Solar Telescope (ATST) would have its final design review in March 2009, and the final Environmental Impact Statement was nearing completion. A joint preliminary design review for the Large Synoptic Survey Telescope (LSST) was planned for spring 2009.

Foltz noted that AST provides ground-based tools for astronomers and the National Observatories constitute approximately 55% of the AST portfolio. These National Observatories are the Gemini Observatory, the National Astronomy and Ionosphere Center (NAIC), the National Optical Astronomy Observatory (NOAO), the National Radio Astronomy Observatory (NRAO), and the National Solar Observatory (NSO). They serve more than 2000 scientists and students annually, result in ~1000 publications annually, provide data used in more than 50% of the US Ph.D. dissertations, and host more than 200,000 visitors annually.

Foltz then turned to what he referred to as a crisis with respect to operations of the National Observatories. The AST Senior Review (2006) made specific recommendations with respect to facilities' futures including reductions of support at NAIC, endorsement of the ATST and the Atacama Large Millimeter Array (ALMA), a recommendation of infrastructure investment at NOAO, and selective divestments at NRAO and NSO. However, early operations costs for ALMA began in FY 2006 and are growing. These costs will be partially offset by reductions in NRAO

base, but total is increasing. The problem was that the National Observatory management and operations budget had been flat-funded since FY 2006. If there is a full-year Continuing Resolution in FY 2009, this will represent the fourth year of flat funding of operations.

The design and development costs (D&D) for ATST have increased as the project approaches construction – environmental and cultural compliance costs now exceed $2,500,000, and AST is anticipating an additional cost of $1,500,000 for compliance with the National Environmental Policy Act (NEPA). There is also the need to ramp up staff to prepare for construction of the telescope. Other issues described by Foltz included concerns with respect to inflation as well as fuel and utility costs.

Foltz noted there has already been a reduction in the staff at NAIC by 25%, and that planning for even the possibility of a year-long Continuing Resolution will result in significant reduction-in-force (RIF) at all of the National Observatories. Additional cuts applied mid-year cannot be accommodated by RIFs due to severance packages, nor can they be substantially offset by facility closure. As a result, the National Observatories have begun planning for RIFs to be carried out early in FY 2009. In addition, much-needed improvements at the Kitt Peak National Observatory (KPNO) and the Cerro Tololo Inter-American Observatory (CTIO) are now being deferred for a third year.

In the discussion that followed Dr. Daniela Bortoletto (Purdue University) asked about the morale at the National Observatories. Foltz responded that morale is very low. A number of critical engineers and other personnel have been lost, although no one considered super-critical has been let go. There are plans to descope some programs at some of the observatories. The Division has indicated that they did not want the observatories to reduce observing time.

Dr. Ramesh Narayan (Harvard University) asked what role the AST and NSF would play in the Decadal Survey. Dr. Eileen Friel (Executive Officer, AST) responded that NSF staff would naturally be available for discussion and for provision of requested budget data and the like. But, beyond that, NSF would not try to guide the Survey in any way.

Dr. John Peoples (Fermilab) pointed out that the prior AST Decadal Survey had been unrealistic.

Report from the Division of Physics

Dr. Joseph Dehmer, Director of the Division of Physics (PHY) began his presentation with a description of the structure of the Division. He then described what were current physics frontier research areas, including Bose-Einstein Condensates, atom "lasers"; dark matter, dark energy, cosmology; gravitational waves (GW), GW astronomy; new fundamental particles and laws > TeV; neutrino (ν) physics and ν astrophysics; string theory, branes, duality, quantum gravity; quark-gluon plasma, supernova dynamics; ultra-fast, ultra-intense laser fields; cyberscience, quantum information science; biophysics of single molecules, cells, networks; and complexity and emergent behavior.

PHY investment priorities include quantum information systems as well as Science and Engineering Beyond Moore's Law (SEBML), the physics of living systems, Cyber Discovery and Innovation (CDI), and the Physics of the Universe (POU). In particular the focus on POU addresses deep intellectual mysteries. He noted that we were poised at the beginning of decades of multiple, transformational discoveries that will rewrite textbooks in physics and astronomy. This was an opportunity for a prominent world-leading role for NSF, and there is a need for a proactive, sustained investment plan in order for this to succeed. POU addresses the eleven questions raised in the National Research Council publication *Connecting Quarks with the Cosmos.*

Dehmer then noted that interagency and international partnerships for studies in this area are in an advanced state of preparation, and the emergence of POU has led to the repositioning of particle physics to the triad of the energy frontier, the sensitivity frontier, and the cosmic frontier. PHY is the only program within the United States that addresses all of the POU questions, and PHY and AST constitute the most powerful basis for POU discovery. In general, he noted that the last decades have witnessed a profound change in the area of experimental elementary particle physics – from world-wide competition to world-wide collaboration. A key element in this has been the role of CERN and of the Large Hadronic Collider (LHC), where teams are coming from all countries and are joining in

conditions of total equality.

Dehmer stated that the proposed Deep Underground Science and Engineering Laboratory (DUSEL) or its equivalent is needed to achieve some of the science goals for POU. The current proposed infrastructure for DUSEL will be the minimum needed for the science goals and would be expanded as needed. NSF and DOE will be in meeting to plan joint physics programs for DUSEL. Finally, he noted that support for all of MPS (co-investment) was essential. Without a co-investment strategy from MPS, PHY needed to "pull the plug" on DUSEL and focus on other aspects of POU.

In the discussion following Dehmer's presentation, Dr. Monica Olvera de la Cruz (Northwestern University) asked how much of the PHY portfolio was invested in facilities as opposed to individual investigators. Dehmer responded that PHY had a rule for portfolio balance that mandated that the support for individual investigator awards would never fall below 50% of the PHY portfolio. He also noted that PHY was phasing out support of the Cornell Electron Storage Ring (CESR) to pay for the NSF share of the LHC. PHY was also phasing out some of the Physics Frontier Centers (PFC). However, support of new facilities would not lessen support for individual principal investigator support.

Report from the Division of Mathematical Sciences

Dr. Peter March, Director of the Division of Mathematical Sciences (DMS) began his presentation by describing the areas of mathematics that DMS supports. There are the disciplinary programs such as Algebra, Number Theory & Combinatorics, Statistics; the Interdisciplinary programs such as the MPS CHE-DMR-DMS Solar Energy Initiative (SOLAR).; Workforce activities such as the Proactive Recruitment in Introductory Science and Mathematics (PRISM) program; Foundation-wide activities such as the Cyber-enabled Discovery and Innovation (CDI) program; and support of mathematical institutes. Information on these institutes can be found at the common web portal www.mathinstitutes.org.

The budget of DMS has remained relatively constant for the last several years and has actually dropped in terms of FY 1996 dollars. The FY 2008 budget is approximately $212,000,000, with 71% allocated to individual investigator awards (IIA), 14% to workforce activities, 12% to the support of the mathematics institutes, and 3% for other activities. DMS co-funded 13 of 36 awards involvement in NSF's CDI activities, and provided $6,100,000 of the $40,600,000 total spent on the solicitation.

March then described the SOLAR CHE-DMR-DMS energy initiative. This initiative responds to the NSF investment priority of fostering research that improves our ability to live sustainably on Earth. The initiative is aimed at supporting an interdisciplinary approach to the efficient harvesting, conversion, and storage of solar energy. The principal investigator teams that respond to this solicitation must include a chemist, a mathematical scientist, and a materials researcher. MPS anticipates making 3-10 awards of up to $500,000 per year.

The PRISM (Proactive Recruitment in Introductory Science and Mathematics) activity responds to the NSF investment priority of integrating research with education and building capacity in science and engineering. PRISM involves partnerships between the mathematical sciences and other science or engineering disciplines and it widens the cross section of the mathematical sciences to which freshman and sophomore students are exposed. MPS anticipates making 3-8 awards of $100,000 - $600,000 per year.

March concluded his presentation by describing some future activities involving DMS. There is a National Academy of Sciences (NAS) study of the Vertical Integration of Research and Education (VIGRE) program due in spring 2009. It is a forward-looking study by NAS of the current state and emerging trends in mathematical sciences as well as an assessment of the impact of the mathematical sciences on innovation, economic competitiveness, and national security. DMS is currently developing a research partnership with Defense Threat Reduction Agency (DTRA) and is beginning to articulate the role of mathematical sciences in sustainable development

In the question period following March's presentation, Dr. Barbara Finlayson-Pitts (University of California, Irvine) commented that while she could understand the role of CHE and DMR in SOLAR initiative, she did not see the rationale for the DMS involvement. March responded that while it is clear that there is much research that CHE and DMR can do, the addition of mathematics could help expand the opportunities for a real transformational

breakthrough. There is an important role for mathematics in modeling basic phenomena that would expand the space in which chemists and materials scientists were working.

Report from the Division of Materials Research

Dr. Zakya Kafafi, Director of the Division of Materials Research began her presentation by noting that there was a 24.7% increase from FY 2008 for DMR in the FY 2009 NSF Budget Request. The FY 2008 budget for DMR was $260,220,000. DMR was able to support 21% of its unsolicited proposals, compared with a support rate of 27% for all of MPS. The increased funds in FY 2009 (if provided) would increase the number and size of principal investigator grants and would start new centers and institutes to enable focus on transformative, interdisciplinary, global materials research and education efforts. DMR would expand investments in workforce development, especially at the junior rank while broadening participation for women, minorities and scientists with disabilities. DMR would also develop new educational and outreach activities. Within the FY 2008 budget approximately 45% of the funds were for individual investigator and group awards, 19% for facilities, and 23% for the Materials Research Science and Engineering Centers (MRSEC).

Kafafi then turned to areas in which DMR had particular interest. These included Matter by Design, the physical-chemical-biological interfaces, and the quantum realm.

With respect to the MRSECs, there were 31 centers nationwide. Within the MRSEC, the Partnerships for Research and Education in Materials (PREM) program expected to hold a new competition anticipated in FY2009, and the PREM program will be expanded to women colleges and academic institutions including those serving people with disabilities. In the MRSEC competition held in FY 2008 there were 14 awards with the largest turnover in the history of the program: five awards were to institutions that have *not* had a MRSEC, 9 existing MRSECs successfully re-competed for future support, and 4 existing MRSECs were being phased-out.

Based on the recommendations of the NAS study on MRSECs, in the next competition for MRSECs DMR will launch a new type of cyber-enabled centers (one IRG) focused on Materials Innovation in Research and Creative Learning Experience (MIRACLE) and will expand activities to the international arena.

Kafafi described the DMR national facilities [the Synchrotron Radiation Center (SRC), the Cornell High Energy Synchrotron Source (CHESS), the Center for High Resolution Neutron Scattering (CHRNS), the National High Magnetic Field Laboratory (NHMFL), and the National Nano-infrastructure Network (NNIN)] and mentioned several challenges that they face. She dealt in detail with the NHMFL. Ninety-five percent of its support is provided by DMR yet is serving an increasingly broad user community, and the development of new partnerships within NSF is essential. A second issue is the question of the stewardship of future light source facilities and the future of university-based synchrotron facilities. This was the subject of a report that would be presented to the MPSAC later in the meeting.

Kafafi then described the Global Materials Network. In Europe agencies in 20 countries are members, including Russia, the Ukraine, and Turkey. In 2008 the Agence National de la Recherche (France) and Romania joined. There are annual coordination meetings in Strasbourg and support for USA-Europe Networks of materials researchers jointly with the European Science Foundation (ESF). There are 10 Asian organizations who are members and 8 members in the Americas. DMR will continue to work with countries in developing regions in Africa, Southeast Asia, and the Middle East.

Kafafi then described several DMR workshops that had been held during FY 2008. These included the Materials Science and Engineering (MSE) Gender Equity Workshop held May 18-20, 2008 at the University of Maryland (http://www.mse.uiuc.edu/gender/index.htm). Its purpose was to understand key issues of gender equity in MSE departments and to develop strategies to foster an inclusive workplace environment. Approximately 100 participants from academia, National labs and funding agencies were present.

Report from the Division of Chemistry

Dr. Luis Echegoyen, Director of the Division of Chemistry (CHE) introduced his talk with a statement of the Division's Mission: "To support innovative research in chemical sciences, integrated with education, through

strategic investment in a globally engaged workforce reflecting the diversity of America." He described the structure and organization of CHE, and noted that Dr. Wilfredo (Freddy) Colón joined CHE and the Division of Molecular and Cellular Biosciences (MCB) in the Directorate for Biological Sciences (BIO) as a shared program officer in January 2008. This would serve as a model for future positions between CHE and other divisions in NSF.

Echegoyen described the CHE core programs for individual investigator awards and then discussed the strategic directions CHE had developed. These were: Advancing American competitiveness; communicating the value of chemistry and chemical research to the public; increasing global engagement; increasing grand challenge research through centers; broadening participation; addressing funding needs of investigators across career stages; assessing the broader impacts review criterion; and updating the division of chemistry structure.

He pointed out the impact of Federal investment in basic chemistry research, where a $1,000,000,000 Federal investment and a $5,000,000,000 chemical industry investment in research and development has lead to the creation of 600,000 jobs, a $40,000,000,000 dollar contribution to the US gross national product, and a return of $8,000,000 in taxes. With respect to advancing American competitiveness, CHE is providing leadership to the community in identifying and promulgating industry/university collaboration mechanisms that work. In April, 2008 a CHE-sponsored "Intellectual Property Issues Affecting Industry-University Partnerships" was held as a follow-up to the December 2006 Innovation Workshop. CHE intends to partner with educators to spur curricular innovation that better prepares students to become innovators, entrepreneurs, and/or industrial chemists. CHE is supporting a pilot Research Experiences for Undergraduate (REU) site that interacts with industry, has met with the Maryland Industrial Partnership about courses in entrepreneurship and is holding exploratory discussions with the National Collegiate Inventors and Innovators Alliance (www.nciia.org) about innovation workshops for graduate students and postdocs.

CHE is committed to communicating the value of chemistry and chemical research to the public as a means of attracting the best and brightest students and to garner public support for the discipline. They are sponsoring a YouTube competition for undergraduate research projects and are exploring pathways to engage major media to promote the value of chemistry. In this regard they have held discussions with Paula Apsell, the producer of NOVA and Stephen Lyons, the producer of *Forgotten Genius*. CHE is showcasing and publicizing the results of NSF-funded work through various venues such as the NSF website and press releases.

Chemistry is increasing its global engagement and encouraging U.S. students to go abroad for part of their study and ensure that the U.S. is the most attractive destination for chemists. Some 65 REU students were sent abroad to Asia, Europe and South America in summer 2008. It is supporting transformative basic chemical research on the "grand challenges" through the Centers for Chemical Innovation Program (CCI). He then described some of these challenges.

Echegoyen described CHE activities associated with broadening participation. CHE had implemented a requirement of a department plan for broadening participation in the CRIF-MU solicitation. The pilot was successful and will be repeated in FY 2009. At CHE review panels there is a presentation on implicit bias in evaluation that has been adopted by many NSF divisions. CHE is looking at addressing funding needs of investigators across career stages, and is considering community concerns about possible under-representation of Mid-Career Faculty (MCF, 10-25 years post-PhD). It wishes to encourage high risk/high reward (transformative) research, especially for MCF and to provide opportunities for principal investigators who are unfunded to re-establish chemical research.

In concluding his presentation, Echegoyen noted that CHE will be assessing broader impacts activities in their awards, including broadening participation and has initiated a pilot study with SRI to develop an assessment plan for the broader impacts of CHE-supported activities, focusing first on a limited set of questions. In addition, he will be considering how to structure CHE to best anticipate and respond to scientific needs and to achieve transformative research in chemistry. CHE has funded a Small Grants for Exploratory Research (SGER) to study the modern structure of chemistry through scientometrics. The results will inform CHE in the study of its own structure for a possible reorganization of the subdisciplinary programs.

Report from MPSAC Light Source Subcommittee

Dr. Venkatesh Narayanamurti (Harvard University) began his presentation with a description of the process the Subcommittee had taken in producing its report. There had been an initial meeting and workshop in August 2007 followed by multiple panel conference calls. A two-day workshop with key stakeholder participation took place in January 2008 and in March 2008 there were site visits to Berkeley, Stanford, Cornell, and Wisconsin. A full panel meeting was held in June 2008 and the final report was produced in September 2008.

The Charge to the Panel was the following: "The Panel is charged to provide guidance to the Directorate for Mathematical and Physical Sciences regarding future NSF stewardship and/or partnership in support of coherent light source facilities and instrumentation. Specifically:

- What is the current view of opportunities for future research using major advanced light source facilities, and what facilities are envisioned to carry out such research in the U.S.?
- What does the Panel see as the most effective role for NSF in helping to develop, construct, instrument and operate such facilities?
- Do university-based light sources now under discussion in the community (for example, a soft X-ray Free Electron Laser and/or an Energy Recovery Linac) have a critical role to play in realizing the opportunities?"

The context in which the Panel was to carry out its study was the following:

1. Science drivers in research fields likely to use major light source facilities;
2. Potential for interagency, private sector, and international partnership;
3. DOE and other federal agency plans;
4. Education and future workforce needs;
5. Multidisciplinary nature of the anticipated user communities;
6. Budget outlook and balance for NSF, MPS and DMR; and
7. NSF's responsibility to maintain appropriate balance at all levels among funding modes, including individual investigators, groups, centers and instrumentation as well as major facilities

Narayanamurti then described the fourth-generation revolution in X-ray light sources. He then presented an example from the science case of the XFEL, showing how various properties of the photon beam can have impact in different scientific areas.

The Findings of the Report are the following:

- Coherent, ultra-short pulse, exceptionally high brightness X-ray sources have properties that far surpass those of the current generation of X-ray sources.
- Exciting new scientific frontiers in areas such as lensless imaging, and ultrafast dynamics and spectroscopy are enabled by these properties.
- The scientific areas impacted are increasingly multidisciplinary and include biology, chemistry, physics, medicine, earth and environmental sciences, archeology, materials, physics and engineering. Interdisciplinary interactions will be greatly enhanced.
- Development and utilization of these sources requires advances in many areas such as accelerator physics, detectors and X-ray optics, instrumentation, data management, and cyberinfrastructure.
- Exploiting this scientific frontier in the US is essential for our competitiveness in strategic areas of science, engineering, workforce development and could have significant commercial impact.
- NSF has a culture that particularly values high risk, innovative, leading edge research.
- NSF emphasizes the education and training of the next generation of scientists and engineers.
- Historically, support by the high energy physics community for the development of accelerator scientists and engineers has benefited the light source community. However, responsibility for the development of the next generation of light source accelerator scientists and engineers is presently uncertain.
- NSF and universities together have demonstrated competence to design, construct and operate major instrumentation and large-scale facilities.
- Historically, university research has been a major source of new designs for light sources, and experimental

techniques that utilize such sources.
- While 4th generation light sources will be large-scale facilities, almost all of the science done there will be small scale and driven by individual investigators.
- There are examples of both effective and ineffective partnerships within NSF and between NSF and others that can inform future partnerships.
- New concepts for light sources beyond or supplemental to 4th generation (e.g. table top, laser wakefield) are exciting and may create revolutionary or "disruptive" technology.
- Industrial support for beamline use/research has waned, but the potential is there for resurgence.
- There is no current coordinated - interagency plan (DOE, NSF, NIH, …) for next generation light source facilities that can set US national and international science policy.

The Panel's conclusions and recommendations were the following:

- NSF and universities together have demonstrated competence to design, construct and operate major instrumentation and large-scale facilities.
- Historically, university research has been a major source of new designs for light sources, and experimental techniques that utilize such sources.
- While 4th generation light sources will be large-scale facilities, almost all of the science done there will be small scale and driven by individual investigators.
- There are examples of both effective and ineffective partnerships within NSF and between NSF and others that can inform future partnerships.
- New concepts for light sources beyond or supplemental to 4th generation (e.g. table top, laser wakefield, *etc*.) are exciting and may create revolutionary or "disruptive" technology.
- Industrial support for beamline use/research has waned, but the potential is there for resurgence.
- There is no current coordinated - interagency plan (DOE, NSF, NIH, …) for next generation light source facilities that can set US national and international science policy.
- NSF should concurrently support university-based research on concepts for light sources beyond or supplemental to the 4th generation.
- NSF must support training of a new generation of accelerator scientists and engineers for the US to remain world class.
- The issue of education and training must be addressed promptly, as the potential shutdown of currently operating NSF/university light source facilities could produce a significant gap in the pipeline for education and training of the next generation of accelerator researchers and scientists.
- MPS should work with other directorates to explore possibilities for an NSF-wide science case and the requirements for the US 4th generation facilities.
- NSF should partner with other agencies to produce a specific science case and the requirements for proposed US 4th generation facilities.

In his presentation Narayanamurti noted that originally accelerators were built for particle research. The "parasitic" synchrotron radiation (SR) was used for materials science. Gradually, sources were built solely to produce SR. Fourth generation sources present a revolution in the x-ray range analogous to how optical spectroscopies were revolutionized by the advent of the laser. The science case is very broad. It is, in fact, broader than MPS. Because of the breadth of the science, future light source support by NSF must be multi-directorate. Light sources should have dual stewardship--NSF and DOE.

The NSF role and university role are critical because of the breadth of the science that is supported at the light sources and the importance of the light sources impacts every Directorate at NSF. The panel found, from the site visits, that universities have the management structures to build and operate large light source facilities.

In the discussion that followed the presentation, Dr. Denis Matthews (UC Davis) commented that the XFEL may be somewhat ahead of its time. NSF must support building a research community, including instrumentation and the individual investigator programs to support research that will utilize the coherent sources. Narayanamurti commented that rough cost estimates were done, but the subcommittee had not gone into details because a full proposal would be competed through normal NSF processes.

Eric Cornell (University of Colorado) expressed some unease about projects like this. He was worried about how

funding of a light source facility would change NSF priorities from individual investigator awards to awards that are made to justify the facility by encouraging its use.

Daniela Bortoletto (Purdue University) noted that other countries are building light sources. This was a great opportunity for NSF at a time when there is decline in support for accelerators via the high energy community. There were, of course, funding issues, because these projects were quite expensive.

The MPSAC formally accepted the light source panel report.

Lunch Adjournment Followed by Divisional Breakout Sessions

MPSAC members had lunch with the MPS Divisions in the divisional breakout sessions. Topics discussed during these sessions included key long-range planning issues and FY 2010 budget ideas.

Thursday, November 8, 2007
Afternoon Session

The MPSAC reconvened in plenary session at 4:00 PM.

Reports from Divisional Breakout Groups

The first part of the meeting was devoted to reports on the breakout sessions. The second part was a wide-ranging discussion following a presentation by Tony Chan on a new investment model. Issues that emerged from the reports could be discussed further in Friday's session. Each division was asked to submit a brief summary of their report within the next few days.

Division of Chemistry (CHE)

Dr. William Jorgensen (Yale University) reported on the CHE breakout session.

Programs and proposals were discussed including SOLAR, EAGER, and RAPID. CHE had reported on the types of programs and proposals being supported and commented that the review of certain proposals was done internally when there were some urgency and concern for timeliness. The group expressed support for more energy-related initiatives (Energy Chemistry) and programs addressing sustainability and environmental issues. Apparently energy-related efforts can meet resistance from DOE. The question of the focus on energy was discussed with the sense that there was plenty of room for more than one source of funding (vis-à-vis interaction of DOE and NSF). For SOLAR, the requirement for three or more co-PIs with at least one in chemistry, materials, and mathematical sciences makes sense for encouraging interdisciplinary efforts; however, it was felt that the math component might tend to be more of an add-on than a central element. The International Collaborations in Chemistry (ICC) and American Competitiveness in Chemistry Fellowships (ACC-F) are timely. For ACC-F, the collaborative requirement (industrial-national lab-CHE center) coupled with the required broadening-participation plan may be viewed as overly restrictive.

The Centers for Chemical Innovation Program (CCI) has been initiated to address grand challenges, while the Collaborative Research in Chemistry Program (CRC) has been phased out. The Research Experiences for Undergraduates Program (REU), which provides support for 650 undergraduates in the summer, is viewed as highly effective with 30% involvement of under-represented minorities.

Increased funding for FY 2009 is a possibility, perhaps as much as 26%. Since it is too late for new solicitations, the consensus was that the funds should be allocated to increase success rates for proposals and the size of the awards. The small size of CHE awards may discourage more established researchers from applying to NSF. The current average size of $135K/year is viewed as totally inconsistent with the expectations of transformative science. This amount barely covers the costs for two graduate-student co-workers at a university, leaving nothing for equipment, supplies or PI summer support. How does NSF make sure that all of the pressing needs of basic research are met? Historically there is a long lead time between the granting of an award and its fruition.

Possible reorganization of CHE received considerable discussion. There are similar discussions in chemistry departments nationwide. The traditional subject areas (organic, physical, inorganic, etc.) seem less relevant in view of increased emphasis on interdisciplinary research. Some concern was expressed that the current system may be too conservative to handle more transformative proposals. The topic needs further consideration. CHE's decisions in this area can have far-ranging impact on academic chemistry departments, which are burdened by the same historical subdivision structure.

Increased advocacy for basic research in chemistry is needed. General awareness of the central role that chemical research must play in any solutions to energy and climate challenges along with its contributions to enhanced quality of life require improvement. Though many CHE programs do contribute importantly in this regard, new opportunities should be sought.

Division of Mathematical Sciences (DMS)

Dr. David Keyes (Columbia University) reported on the DMS breakout session. The session was a free ranging discussion. Included in this discussion was what DMS could bring to the SOLAR solicitation. It is expected that programs such as SOLAR and PRISM will entice number theorists into theoretical computer science studies, but it should be noted that this is not the same as computational science. An NRC report is being developed that will discuss the impact of mathematics on economic competitiveness. The group was very pleased with the DMS leadership.

He noted that the mathematical sciences (mathematics, statistics, and computation) are important in their own right. Their value is often measured, however, by the quality of their interactions with the other disciplines to which they function as "enablers." But without the healthy developmental core, the interactions grow stale and without the interactions, the developmental core becomes introspective. He noted that the group recognizes that there are many areas of mathematics and statistics that are essentially exclusively supported by DMS, probably to a more severe degree than other Divisions, which can look to DOE, NASA, NIH, *etc*. DMS has joint programs with other Divisions and Directorates, as well as through DMS' own institute programs and workforce development is also emphasized in Divisional and Institute programs

Keyes described the CDI initiative outcomes. There were 1300 preproposals received and 200 full proposals were invited. Thirty-six awards were made of which 13 involved mathematics in ways beyond routine use of existing tools (not just computation, but harmonic analysis, number theory, topology, statistics, etc.) Approximately half of the awards are multi-institutional. Although DMS had initially allocated $2,600,000 for the program, it spent $6,100,000 due to the quality of the proposals received.

Keyes provided examples of mathematical science inputs into other fields. These included high-dimensional dynamical systems (required nonlinear ordinary and partial differential equations), modeling (requiring analysis of stochastic processes and stochastic partial differential equations, and discovery in large-scale data sets (requiring data mining, learning theory). With respect to sustainability initiatives, NSF is well-suited for such interdisciplinary areas, and partnerships with mathematical sciences offer fresh thinking and institutionalize proposer conversations that stimulate both sides.

He described a diversity initiative that was organized by Mathematical Sciences Research Institute (MSRI) in Berkeley. This led to his discussion of networks. In this context networks are a concept consisting of nodes and edges. Nodes represent a particular entity whereas edges represent an interaction or association between these entities. Under this particular mechanism, DMS would fund the edges, not the nodes, and this would fill a gap between individual principal investigator awards and math institutes. It would also broaden participation beyond traditional grant holders, *e.g.* four-year colleges. Networks would support junior people and travel between nodes that have opportunistic reasons to interact, but lack a sufficient interdisciplinary or inter-institutional mechanism (*e.g.*, university-private lab).

Division of Physics (PHY)

Dr. Theresa Moldanado (Texas A&M University) reported on the PHY breakout session. The breakout session spent some time discussing the Committee of Visitors (COV) review of PHY that would take place in February

2009. The external committee is made up of 38 persons from various fields of physics. There are approximately 10 subareas within PHY that will be reviewed. It was noted that in the COV report of three years ago items that were highlighted included understaffing within PHY diversity issues, and issues involving facilities. Some of these concerns have been addressed. Support of the Physics Frontier Centers was also discussed, with support for a center averaging approximately $2,500,000 per year. There was also discussion about the nature of large facilities--does science drive facilities or do facilities drive science?

The importance of NSF research to society had to be communicated to the general public, and there was discussion of how this could be done. It was noted that PHY funds 50 Research Experiences for Undergraduate sites, and the group felt that these are a diamond in the program portfolio.

Division of Materials Research (DMR)

Dr. Monica Olvera de la Cruz (Northwestern University) reported on the AST breakout session. The current balance between support for facilities, instrumentation, centers and individual PIs was discussed. In particular, they reviewed the recommendations of the report by the NSF Advisory Panel on Light Source Facilities. The subgroup noted the scientific and educational opportunities in developing 4th generation light source facilities (coherent, ultra-short pulse, exceptionally high brightness X-ray sources) in university settings. It was concluded that though it is important for DMR to be involved in the training of students and postdoctoral associates with the expertise required to develop the science that can emerge from the 4th generation sources, DMR alone cannot support the operational cost of the pending light source proposals such as the soft X-Ray Free Electron Laser and/or an Energy Recovery Linac. Since the percentage of time used at the advanced light sources by DMR funded proposals is a small fraction of use by scientists funded by other divisions and even other agencies, a new business model is needed to cover the operational costs. This could be sharing between divisions and or agencies or funding at a level higher than the division level. This agrees with the recommendations of the Light Source Facilities Panel report, which, in line with the1999 National Research Council report on "Cooperative Stewardship: Managing the Nation's Multidisciplinary User Facilities for Research with Synchrotron Radiation, Neutrons, and High Magnetic Fields", encourage the development of a cooperative stewardship model for managing such facilities. If such model develops, DMR should have a key role in the evaluation of proposals given that its supports presently most of the related research areas, and that it has extensive experience in interdisciplinary science programs.

DMR has provided the resources and infrastructure, including the required instrumentation, for developing new science keeping a healthy balance of support for its different components. In this regard, the possibility of supporting in-house light source facilities (the so called "tabletop synchrotron X-ray sources"), which have relatively low operational cost and are useful to train the next generation of experts in optics and x-ray physics, was encouraged. Over the past years the facilities and instrumentation support has been slightly below 20%, which is appropriate. In the decision of funding new light source facilities, it is important to note that DMR has significantly impacted research involving light sources via funding the instruments that go into the end stations; for example, at the Advanced Photon Source in Argonne, where about 10% of the about 35 sectors, which have typically 2 Bean lines each, have had significant NSF funding for its construction, and many NSF funded research proposals do require such specialized equipment. For the operational cost of the National High Magnetic Field Laboratory (NHMFL), and for possible "tabletops", DMR should probably look into ways to increase support from other divisions that benefit from these facilities.

Support for new PIs and PIs from underrepresented groups was reviewed. DMR is doing a good job supporting competitive proposals from these groups and finding ways to increase the number of funded PIs in these groups. DMR is recognizing also the need to develop solid international programs that foster collaborations and provide research experiences abroad for graduate students and PIs.

Division of Astronomical Sciences (AST)

Dr. Joel Tohline (Louisiana State University) reported on the AST breakout session. He said that the group appreciated the interaction with the staff. The individual investigator programs were very strong as were the training and implementation programs.

The breakout group discussed the situation the AST facilities are facing as they are particularly stressed because

NSF is in a continuing resolution funding situation. This was already described by the AST Acting Division Director in his presentation that morning. Support for astronomy in other countries is very significant and NSF is on the verge of being outpaced in terms of dollar amounts provided and in terms of the pace at which decisions are made. NSF is at risk of losing its leadership role in frontier science. The budget process in terms of how NSF selects major items to go to Congress is slowing things down. The group was pleased with the collaboration with the Division of Physics on the Physics of the Universe activities. The group also discussed the MPS Strategic Co-investment Model (SCI).

General Comments

In the general discussion that followed the presentation it was noted that the science agencies in the international community are better funded than NSF and move far more quickly to define the direction of science; This can also be said of the private donors that support science. This results in there being a significant miss-match with respect to NSF actions in terms of timing of support. An example was that of the astronomical sciences. In Europe agencies have a five-year budget as opposed to the U.S. where one is not even certain of the status of the current year budget.

With respect to the MPS SCI plan, it will be discussed again at the April 2009 meeting.

Strategic Coinvestment Initiative (Funding New Activities in MPS)

Chan described how MPS and NSF could plan for incremental funding of future activities. The concept would provide long-term budgetary stability for new activities.

MPS is developing a funding mechanism, based on MPS scientific priorities, internally competed, and incorporates proactive planning for long-term budgetary stability of new activities.

Chan noted that in order to not just "survive" as a Directorate, but to "thrive," MPS must take advantage of new opportunities and needs to establish new research activities and construct new facilities. This is easier when we have a positive-growth budget forecast, but difficult with uncertain or flat budgets. He noted that the MPS budget has grown on average 6% annually over the last decade and one might ask why not allocate budgets for new activities directly to Divisions? The response to this is that MPS wants to support the best ideas through an open process

Historically, funding mechanisms within MPS have been through the Divisions, through budget re-direction. However, this is not *a budget builder and many initiatives require long-term budget-building. What is being proposed s*eeds cross-cutting areas of strategic emphasis to MPS as well as emerging areas. At present the Office of Multidisciplinary Activities (OMA) within MPS supports innovative experiments in education, workforce, and broadening participation. It initiates, but does not sustain indefinitely such activities and does not receive or evaluate proposals (not a "program"). OMA co-invests directly with Divisions on activities or specific awards.

The SOLAR initiative was begun in FY 2009 and is planned to continue for six years and is an example of a new strategic co-investment (SCI) model: between the Office of the MPS Assistant Director (OAD), OMA and the CHE, DMR, and DMS. SOLAR will support interdisciplinary efforts by groups of researchers to address the scientific challenges of highly efficient harvesting, conversion, and storage of solar energy. It makes use of a new interdisciplinary modality: at least three co-PIs, providing expertise in chemistry, materials research, and mathematical sciences. It will aim for transformative breakthroughs and new fundamental understanding.

Chan enumerated the principles under which the SCI model would operate. It would have joint investment among OAD, OMA, and Divisions through sustained budget allocations, with OAD commitment transferred to Divisions' base. Co-investments from Divisions would be required as part of life-cycle plan, and there would be a competition of ideas driven by scientific priorities. Total funds taken "off the top" at the OAD level would be capped at a fraction of the annual MPS budget increase to protect core programs.

Chan summarized the SCI model as formalizing and adding transparency to the MPS Assistant Director's budget

allocation process to Divisions for strategic research initiatives. It relieves immediate pressure on Divisions as OMA and OAD contribute upfront, allowing Divisions to build a stable base for the activity and limiting impact on their core. It uses competition to yield best ideas and to capitalize on unanticipated opportunities, prior to developing, or without waiting for, NSF initiatives. In addition, it formalizes planning on timescales longer than an Assistant Director's and Division Director's tenure to signify long-term commitment on a specific initiative and can be applied to partnerships with other Directorates.

There was considerable discussion of the concept and how it works. In response to a question as to whether the total amount invested in the SCI model would grow, Chan responded that it could be expected to increase by only 1%, but the amount would depend on the Directorate budget increase. The concern was expressed that some Divisions do not have very large projects would not benefit from this concept. In response to a question as to what happened to funds that would be added to the base budget in support of a project, Chan responded that the funds would remain with that Division. There was further discussion concerning how budgets are allocated and the general congressional budget process.

MPS Long Range Plan

Dr. Morris Aizenman, the MPS Senior Science Associate, presented the current concepts being developed for an MPS Long Range Plan. The MPS Vision is that MPS support enables new areas of scientific discovery, energizes the Nation's existing scientific and educational base, and develops the scientific talents, skills, and knowledge of its citizenry. Furthermore, MPS investments are essential to the Nation's economic growth, security and quality of life. MPS sees its mission as supporting excellence in science and engineering research and education by being a capable and responsive organization. MPS enables the community it supports to make discoveries about the universe and the laws that govern it; create new knowledge and understand the fundamental nature of matter, energy, space, and time; understand how processes enable and shape the complex behavior of the living world; design and develop novel materials, discover new phenomena and mathematical structures, and promote new connections between the mathematical and physical sciences; develop tools for discovery and innovation and enable future technologies; prepare the next generation of mathematical and physical scientists through research and education; and share the excitement of exploring the unknown with our nation and the world.

The MPS Long Range Plan identifies three overarching goals and seven basic strategies to realize these goals.

Goal 1: Advancing the Frontier:

Strategy 1: Strengthen Individual Investigator Research. With respect to this strategy research by individuals and small groups has the highest priority in MPS and will continue to be so. Individual divisions will continue to determine appropriate balance for each discipline, with MPS Advisory Committee and Committees of Visitors input critical to ensure appropriate balance between small and big science.

Strategy 2: Take Advantage of Unique Scientific Opportunities. MPS notes that there are timely and unique scientific opportunities that transcend single disciplines and require special, and at times immediate, attention. Also, there are Grand Challenges in the mathematical and physical sciences that may require a broadly inter- and multi-disciplinary approach that reaches not only across MPS, but also engages broad cross-sections of NSF.

Strategy 3: Address Scientific Infrastructure Needs and Impact. MPS will employ a coherent, life-cycle approach to planning for, constructing and subsequently operating major facilities and develop a Facilities Plan, with a target date of 2009 for its first issuance.

Goal II: Service to the Nation

Strategy 1: Strengthen Support for Early Career Investigators, for New Interdisciplinary Efforts, and for High-risk Areas of Research. MPS would expand efforts to support early career investigators with substantial, long-term awards (through CAREER or other mechanisms) and aggressively pursue the implementation of NSF-wide mechanisms for support of exploratory research.

Strategy 2: Strive Toward a Diverse and Capable Scientific Workforce. This would involve undergraduates in

research experiences in the freshman and/or sophomore year and engage two-year colleges in MPS research in a meaningful way. MPS would establish a postdoctoral fellowship program for interdisciplinary training and encourage the development and use of cyberinfrastructure to provide a more flexible learning environment

Strategy 3: Communicate the Societal Importance of the Mathematical and Physical Sciences to the Public by: participating in professional meetings and workshops often attended by the public media; working with the Office of Legislative and Public Affairs to develop effective collaboration activities; and highlighting advances in the MPS-supported sciences through high-visibility Web interfaces.

Goal III: Global Engagement

Strategy: Increase international connections by developing and enhancing global partnerships in support of sustainable research collaborations; developing and enhancing partnerships in the U.S. and abroad in support of development, construction and operation of international research facilities and laboratories; and continue and expand MPS support of undergraduate study abroad programs and international research experiences.

In the discussion that followed it was noted that NASA does a great job on publicity but there is a role for NSF to participate in outreach emphasizing the beauty of nature rather than practical applications. Dr. Sharon Neal (University of Delaware) pointed out that one should not just publicize the "cool stuff" but focus on impacts on people. Also, MPS should show scientists as real people whose life stories are compelling. This may provide a more meaningful approach for young people as to why a science career is desirable. Dr. Ian Robertson (University of Illinois, Urbana-Champaign) pointed out that studies exist which show what messages are most effective to take to the general public. Scientists do not necessarily know what will appeal to the public, and professional studies can help. It is very important to get the human element into science stories. Dr. Hector Abruna (Cornell University) stated that we must find new ways to communicate visually that will appeal to the video game generation.

MPS Facilities Plan

Dr. G. Wayne van Citters, Jr., the MPS Senior Advisor for Facilities Planning and Management described the MPS Facilities Plan. He noted that the impact of a $1,000,000,000 project is huge and that p*rojects of this magnitude can no longer just happen to MPS. If MPS does not do careful planning they will not happen at all.*

Objectives of the plan were that it would serve as one aspect of a joint venture of stewardship among OAD and all Divisions. It would convey the status of projects in meaningful, timely, and appropriate level of detail to OAD, OD, NSB, OMB, OSTP, Congress, the scientific community and would provide a vehicle for communication with prospective partners as well as providing useful management tools within NSF.

Major sections of the plan would include a current inventory of facilities and a description of facilities in planning, development, and construction. The plan would provide an MPS "roadmap" from development through operations. Priorities would be established with precision points detailed and budget assumptions and priorities explained.

Van Citters discussed priority setting and the elements of priority decisions. These decisions would include the science case, the role of facility in discipline, the role of the division in the discipline, the priority as established by discipline, and the project's technological and management readiness. He also discussed the role financial aspects of the project, the strength and nature of partnerships would play in the plan.

In the discussion that followed Dr. Suzanne Hawley (University of Washington) asked if other Directorates within NSF were making a similar plan, and van Citters responded that MPS was a leader in this area within NSF. Dr. Daniela Bortoletto (Purdue University) asked how this plan integrates with plans of other agencies, and Chan responded that there is a mismatch between agencies which is recognized by OSTP. Dr. John Henry Scott of OSTP commented that OSTP is working on best practices for all agencies and has set up a committee for this purpose. Tohline noted that new facilities are currently treated one at a time within the Major Research Equipment and Facilities Construction (MREFC) Projects area of the NSF budget. Is there a move to set up a steady state for funding the MREFC line item? Chan responded that there was not, but that NSF was looking at the whole portfolio. Mathews noted that delays in projects are very expensive and asked how can one reduce delays and start projects sooner. Van Citters responded that there is considerable pressure to adopt not-to-exceed costs for project

construction.

Adjournment
The meeting was adjourned at 6:00 P.M.

Friday, November 7, 2008
Morning Session

The MPSAC convened at 8:30 A.M.

Report from CEOSE

Dr. Theresa Maldonado reported on the recent Committee on Equal Opportunities in Science and Engineering (CEOSE). She is the MPS liaison to CEOSE, is currently its Vice Chair, and will assume the role of the CEOSE Chair in 2009.next year. CEOSE is congressionally mandated and is one of two NSF advisory committees that is congressionally mandated. Membership of CEOSE includes chairs of academic departments, deans, member of non-profits entities, with the goal of having a committee that is broadly representative. CEOSE has a web site at http://www.nsf.gov/od/oia/activities/ceose/index.jsp.

CEOSE meets three times per year and has *ad hoc* committees and working groups. Some of the *ad hoc* committees have focused on widening creative pathways to STEM, institutional transformation, persons with disabilities, and broadening the participation of Native Americans in science and engineering.

CEOSE is required to submit ten-year and biennial reports to Congress, with the 2005-2006 biennial report now available. With respect to the 2008-2014 Strategic Plan for CEOSE, one had to ask what the goals were and how one would know when success had been achieved. Maldonado commented that broadening participation had to be taken seriously, and how was this to be achieved. There was no national plan for broadening participation, but NSF was a leader in this area.

There was considerable discussion following Moldanado's presentation. It was noted that MPS and CHE are broadening participation leaders in NSF. CHE has taken the lead in organizing broadening participation workshops and other MPS divisions have been following Chemistry's lead. For example, CHE's Chemistry Research Instrumentation and Facilities: Departmental Multi-User Instrumentation (CRIF:MU) program proposal solicitation requires a departmental plan for broadening participation as part of a program-specific review criterion.

There was discussion of broadening participation in the context of community colleges. As CEOSE Chair, Maldondao will work to involve community colleges (faculty and students) in broadening participation efforts. It was noted that the NSF Directorate for Education and Human Resources (EHR) has some programs to support community colleges. Should NSF encourage funding of community college faculty and students through something like proposal supplements? It was noted that there was a successful DMR MRSEC program that prepared science community college faculty. However, the program no longer exists. There were differences between disciplines' broadening participation plans. More often than not, broadening participation plans have not been as successful in the disciplines of physics, mathematics, and electrical engineering. However, broadening participation plans have been successful in the discipline of biology.

It was felt that the MPSAC could organize and share broadening participation best practices instead of everyone working in isolation and that the broadening participation examples presented at the meeting should be collected and disseminated. An example was the Division of Chemistry's CRIF:MU program. In commenting on this program the suggestion was made that institution should show a track record of broadening participation and not just show a plan to start broadening participation. It was noted that CHE is determining whether the chemistry community did not push back too much with this new requirement. The concept is precedent setting and should be discussed by CEOSE. The question was raised as to whether a broadening participation plan like chemistry's would be relevant for NSF's Major Research Instrumentation (MRI) Program? However, these grants are awarded to individuals and not departments.

It was noted that DMR was a pioneer in broadening participation; all of their facilities and research centers require broadening participation plans. The division also has a broadening participation working group. DMR developed the Partnerships for Research and Education in Materials (PREM) program originally for minority students. The program now includes women and disabled students and four-year schools. The program is led by minority institutions and not Materials Research Science and Engineering Centers (MRSECs) or facilities.

Other activities carried out in this area by MPS were also described. NSF, DOE and the National Institutes of Health (NIH) sponsored a workshop for chemistry chairs on broadening participation. Based upon their broadening participation goals formed at the workshop, the chairs report every six months on their broadening participation updates and activities via a web site maintained by the Committee On the Advancement of Women Chemists (COACH). In math, they do not have facilities but they do have large grants that incorporate outreach to colleges across the country to reach women and underrepresented students, who then attend a six-week math research summer program at Carnegie Mellon University. The program is so successful that it is now over capacity.

The question was raised whether non-U.S. citizens should be eligible to apply for NSF graduate fellowships. Congress has mandated that only U.S. citizens and permanent residents can apply for NSF graduate fellowships and the comment was made that the U.S. was losing people by not allowing them to apply for these fellowships.

Hawley commented that the University of Washington Astronomy Department activity in this area has been very successful with broadening participation. Each semester the department starts with a cohort of 10 or so new freshman or transferred community college students and they are immediately involved in research. The department also creates a mentor-ladder system, in which senior undergraduates, graduate students and postdoc students all mentor students that are less experienced than them. As a result diversity within the department has increased due to the program.

It was noted that with all of the broadening participation success stories that had been described, why had the demographics not changed? Is it because the data is out of date, or is it because these efforts are only at the faculty level and not supported at the university level? The suggestion was made that perhaps an MPSAC sub-committee should be established to work with the current MPS broadening participation committee.

Report on the Advisory Committee for GPRA Performance Assessment (AC/GPA) Meeting by Joel Tohline.

Tohline gave a report on the June 2008 meeting of the Advisory Committee on the Government Performance Assessment (AC/GPA). In 1993, Congress passed the Government Performance and Result Act (GPRA) as an attempt to put all government agencies on the same page for outcome assessment. The AC/GPA was established in June 2002 to provide advice and recommendations to the NSF Director regarding NSF's performance under this Act. Each year the AC/GPA reviews the Foundation's investments in Discovery, Learning, and Research Infrastructure to determine if NSF demonstrated significant achievement under these strategic goals. The AC/GPA submits a report to the NSF Director, along with recommendations, which are incorporated into the Foundation's annual performance report. It focuses on highlights (scientific, engineering, and education accomplishments) submitted by NSF divisions. The AC/GPA also looks at Committee of Visitor (COV) reports for sense of outcome assessments. COVs look at the NSF goals of Discovery, Learning, and Research Infrastructure and Stewardship and also review highlights for outcome assessment.

A subcommittee of the AC/GPA found that conducting a close review of the COV reports led to significantly more information that could be used for assessing outcomes. The full AC/GPA felt that more information needs to be provided on people, training, long term goals of NSF. If annual highlights are not providing the proper information for COV assessment, than the highlights should be asked to answer different questions and not just report results from the last year. The AC/GPA web site is http://www.nsf.gov/about/performance/acgpa/index.jsp.

During the discussion the questions arose as to whether NSF keeps records on graduate students paid by NSF grants and what they do over the years. The response was that information is not kept on individual investigator grant graduate students over the years because to accomplish this task would require staffing to be increased by a large percentage and while this information is valuable it would be very time consuming to track and collect. Centers request and collect this kind of information. It was noted that individual COVs are the only ones capable of assessing a division as a 20-member AC/GPA cannot assess the whole foundation.

The View from the Office of Science and Technology Policy (OSTP)

Dr. John Henry Scott, a Senior Policy Analyst atthe Office of Science and Technology Policy (OSTP) began his presentation by noting that OSTP is part of the Executive Office of the President and that it consists of 30 individuals and has three political appointees. The three OSTP political appointees are: John H. Marburger, III,

Director; Sharon Hays, Deputy Director for Science; and Richard Russell, Deputy Director for Technology. Its web site is http://www.ostp.gov/. OSTP interacts with the Office of Management and Budget (OMB) and interacts with agency divisions to see what is new and upcoming in science. It is an interface between policy and science and encourages cooperation between agencies. He serves on a subcommittee on large-scale science planning and various stages of large facilities ($1 billion or above). From his perspective, it is very important for scientists to become involved in societal issues. He noted that most scientists are not interested in Washington issues but they should be.

He was asked to comment on the Light Source report and felt that what was missing from the report was the relationship of DOE and NSF in building these facilities and how NSF contribute to the activity. NSF's contributions were mentioned in the report but they were not supported by data, charts, *etc*. The societal impact of such a facility could have been discussed as well as its impact on the training of the next generation users.

He noted that OSTP can be an important facilitator for large facilities by making sure that in-kind contributions (hardware, software and policy) fit together. Since OSTP is part of the Executive Office of the President, it does not control funding. But in putting together budget requests, OSTP and OMB work very closely and OSTP provides the science justifications. It was essential for agencies to continue planning for items their communities needed in the future, and should not wait and see what the next budget would be. He felt that scientists talking to the public was very effective, as the public does have the capability of influencing congressional members.

Continuation of Previous Discussions

Dr. Johnstone noted that a number of topics had been discussed (the Light Source Report, the FY 2009 Budget, the MPS Roadmap/Strategic Plan, Societal Impact/Communication with Public, Stewardship of Disciplines, and Diversity Best Practices)

Light Source Report
Johnstone noted that topics that came up in the report presentation were: (i) that such a large project might distort the portfolio away from curiosity driven research; (ii) that there was a worry about the need for a larger workforce involved with the light source; and (iii) that the agencies would need to work together.

Dr. Ramesh Narayan of Harvard University felt that while the report makes the science case one needs to prioritize and address such things as cost, impact, who pays, etc. He thought that the report looked very incomplete, leaving out critical factors for any assessment. Chan responded that the report was just the first step. MPS would come back for further advice. The main question was whether NSF has a role to play in providing light sources.

There was further discussion on this topic, including a comment from de la Cruz stating that DMR and MPS need to begin discussions with other divisions and directorates, not just on costs, but also concerning partnerships and multiple user communities.

Energy/Sustainability
Barbara Finlayson-Pitts felt that NSF was the only agency with the mission to take the molecular view of Energy and Environment (E&E) and with all scales coupled. This topic involves a great deal of chemistry and aerosols are also involved. One has to look at the particulate physics and chemistry. If emphasized in the next administration, NSF needs to push for the coupling of energy and environment.

Chan suggested that the AC take this topic with the Director and point out that, in addition to E&E, there are two other "E"s – exoscale and education. The Social and Behavioral Science Directorate (SBE) should also be involved. March noted that DMS will be holding workshops in the next few months on these topics, but other disciplines have to be involved, since it is highly interdisciplinary.

The question was asked as to how the leadership of the integration and leadership for E&E was handled within NSF. Chan said that not all initiatives had a clear leader. The CDI activity is throughout NSF. The energy initiative could have 3 lead directorates – CISE, MPS, and ENG. Furthermore there is an environmental group involving Energy, Research, and Education (ERE) that has no budget, but for which there is an advisory committee, and it has led the biocomplexity and environment initiative. March pointed out that this ERE group issued three reports. Chan noted that the National Science Board (NSB) has a subcommittee on sustainable energy that will soon issue a report asking

for investment from across NSF, with MPS and ENG as the leading directorates. These directorates already have substantial level of activity in these areas.

FY 2009 Budget
Johnstone pointed out that MPS could end up with an FY 2009 budget anywhere in the range -5% to +20% compared to its FY 2008 budget. Tohline asked how the MPSAC could help, since a realistic analysis must consider multiple cuts across the MPS portfolio. If the MPSAC were to do this, it would require detailed information. Chan commented that MPS was going through that process now, at different levels and that there is no real time for a systematic process. The MPSAC could comment while here, *e.g.*, on the relative importance of principal investigator support or facility support. Hawling said that MPSAC members could comment on the various divisions, but wanted to know how MPS would apply a 2% reduction. In response Chan. said such a cut would not be applied uniformly to each division but, rather be based on information from each division. Dr. Dusa McDuff (SUNY – Stony Brook) pointed out that even with a cut, MPS needs to move on national priorities like sustainability and would have to make choices on others. Matthews noted that NSF does have commitments and asked if commitments could be limited in future arrangements. Dr. Jack Lightbody, Deputy Assistant Director for MPS responded that NSF has to respect contracts. Bortolleto added that NSF needed to be a good partner. Defaulting on agreements could ruin NSF's reputation.

There were further comments on this issue, including the impact on students and postdocs and the impact on the technical workforce and the sustainability of activities. Foltz and Friel were asked what the impact of a cut on short notice would have. Foltz replied that AST had a few programs such as instrumentation, where they could delay solicitation to handle the transient effect of a sudden cut. Facilities could consider furloughs, depending on the state and the percent cut, but that would not save much. Salaried staff is the biggest cost driver. Friel added that if the cut is applied line by line, there is little flexibility.

Preparation for meeting with Dr. Arden Bemen Jr., Director NSF

The MPSAC discussed topics they would raise when they met with the Director of NSF. Topics that would be addressed could be the light source panel and report, strategic investments, the budget and the FY 2009 continuing resolution, its implication of large facilities with respect to management and cost, sustainability, environment and overlap with other agencies, communication and outreach in the context of the long-range planning (focusing on people--not highlights and follow-up with post-doctoral fellows, follow up on today's CEOSE discussion, broadening participation, cuts and rescission effect on workforce and diversity, information collection, the role of the MPSAC at this time of budget uncertainty, and education.

Discussion with NSF Dr. Arden Bement, Jr.

Johnstone welcomed Dr. Arden Bement, Jr., Director of NSF, to the meeting. He was introduced to members of the MPSAC. Bement began his remarks by noting that NSF was a bottoms up organization so input from community, *e.g.* from the MPSAC, was very welcome. The atmosphere is very uncertain at this point due to the recession and there is no clear indication from President-elect as to what will take place with respect to science. The FY 2009 budget was still locked up in Congress and NSF is under a continuing resolution which means a decrease since some of our operational costs have increased. A year-long continuing resolution is a possibility. A transition team would be visiting NSF soon.

McDuff commented that President-elect Obama appeared supportive of science, so was there something NSF could capitalize on? Broadening participation and education are important. Bement responded that there was strong support from present administration and advocacy from community but these have not been reflected in the budget.

Johnstone informed the Director that the Light Source Report had been accepted by the MPSAC. The MPSAC was looking forward to further interaction with Dr. Narayanamurti concerning interagency support for this project. Matthews added that NSF has a great role to play here and should be ready to do and lead the science effort that a new facility would provide. Bement responded by noting that the report was an eye-opener and shows that the U.S. is behind. The report highlights the importance of light sources at universities for leadership and education of workforce. The country should have both types of machines, but NSF cannot afford to build and operate both. The operational and maintenance cost is too high to maintain a balance with respect to other NSF activities – so

partnerships are needed and NSF is open to such partnerships and has signaled its interest in doing so. NSF is also interested in more advanced desktop concepts. The report is timely; in fact, it would have been good to have had it 5-10 years ago. Now is a difficult time to garner resources. The possibility of funding both concepts would depend on DoE and one would also have to look for international support.

Johnstone commented on the strategic co-investment concept MPS has develop and noted that the MPSAC applauds Chan's transparent approach. The concept has generated considerable discussion. Tohline asked if it were possible for this model to move to a higher level at NSF. Jorgensen noted that some divisions would benefit more than others within MPS and asked how divisions can best deal with this situation in difficult budget times. Bement commented that the BIO and ENG Directorates were already operating with this model. It provides flexibility in supporting interdisciplinary and transformative research and helps in reaching outside the directorate. He wants to foster horizontal links across NSF but needs to take care in taking money off the top. There has been a tradition within NSF of the host covering the operational costs--doing otherwise is not fully understood and would be complicated. There also has to be concrete evidence from the community (*e.g.* through a workshop) that new undertakings are necessary, important, supported by a business plan, and desired.

Finlayson-Pitts commented that energy and environment are closely linked and NSF has an important role in this area in dealing with the fundamental science involved and providing a broad perspective on these areas. Other agencies are focused on measurements and modeling, not on basic level of the science. Is there pushback from other agencies? Bement responded that NSF was apolitical so it can support research proposed by academia broadly. NSF can work closer to the frontier and explore transformative concepts that might be disruptive--this works well for NSF but this is not the case for many other agencies. NSF works at higher levels of complexity in order to deal with the inter-relationships of environment, economy and energy. Sustainability of food, water and nutrition is critical as well. NSF is obliged to participate since it has a lot to offer, but others may feel these topics are fully covered elsewhere – he does not agree with this. He commended Chan on the SOLAR solicitation.

Neal commented on communication and outreach and stated that she was surprised by NSF's focus on highlights rather than on people. She was interested in communicating with young people about how rewarding science is, and in communication with government and the public about the benefits to society. Bement commented that NSF has an overwhelming challenge in terms of communication. One is the education of the public on important topics and pressing problems. He agreed that it was important to sell the relevance of a STEM career to young people and added that it would help broadening participation. STEM fits well with children's interest. Early exposure to research makes children more motivated and successful; retention is higher. Effort needs to be made on the learning environment for children. NSF is addressing these issues, but positive feedback is needed to accelerate the progress. In response to Matthew's question as to whether scientists should make more of an effort to explain the societal impact to the public and in particular children, Bement agreed. He thinks there should be a greater participation by university personnel in community efforts and public education – but this is not an NSF issue.

Johnstone thanked Bement for taking the time to meet with the MPSAC.

Follow-up on Director's Comments, Strategic Issues, Action Items

Aizenman asked for feedback on the MPSAC meeting format. Should it be more structured or more open? McDuff commented that it was difficult to move forward with the current budget uncertainty. She would welcome a call from Chan to get input as needed. Chan responded that there were two categories of items to discuss: rapid response and longer-term issues. There is a standing committee on emerging opportunities that could take up some topics. The proceedings of the sub-committees are not public, unlike the full committee. Johnstone suggested that a subcommittee might be created to compile proven practices. Olvera de la Cruz noted that Bement had said, in commenting on the Light Panel Report, that the U.S. is behind in terms of the science today; we need to move forward. As a member of the light source panel, she was very pleased with how Arden Bement responded to the questions.

Adjournment

The meeting was adjourned at 2:00 PM.

APPENDIX I

ATTENDEES

MPSAC Members Present at NSF
Hector D. Abruna, Cornell University
James Berger, Duke University
Daniela Bortoletto, Purdue University
Eric Cornell, JILA and the University of Colorado
Barbara J. Finlayson-Pitts, University of California, Irvine
Irene Fonseca, Carnegie Mellon University
Suzanne Hawley, University of Washington
Iain M. Johnstone, Stanford University
William L. Jorgensen, Yale University
David E. Keyes, Columbia University
Theresa A. Maldonado, Texas A&M University
Dennis L. Matthews, University of California, Davis
Dusa M. McDuff, SUNY-Stony Brook
Ramesh Narayan, Harvard-Smithsonian Center for Astrophysics and Harvard University
Sharon L. Neal, University of Delaware
Monica Olvera de la Cruz, Northwestern University
Jose N. Onuchic, University of California, San Diego
John Peoples, Jr. Fermilab
Ian M. Robertson, University of Illinois at Urbana-Champaign
Winston Soboyejo, Princeton University
Joel E. Tohline, Louisiana State University
Robert Williams, Space Telescope Science Institute (by telephone)

MPSAC Members Absent
Geoffrey West, Santa Fe Institute

MPS Staff
Morris Aizenman, Senior Science Associate, MPS
Tony Chan, Assistant Director, MPS
Denise Caldwell, Deputy Division Director, Division of Physics
Joseph Dehmer, Director, Division of Physics
Luis Echegoyen, Director, Division of Chemistry
Craig Foltz, Acting Director, Division of Astronomical Sciences
Eileen Friel, Executive Officer, Division of Astronomical Sciences
Susan Hamm, Staff Associate for Budget, MPS
Janice Hicks, Executive Officer, Division of Chemistry
Carmen Huber, Acting Executive Officer, Division of Materials Research
Zakia Kafafi, Director, Division of Materials Research
John (Jack) Lightbody, Deputy Assistant Director, MPS
Deborah Lockhart, Executive Officer, Division of Mathematical Sciences
Peter March, Director, Division of Mathematical Sciences
Celeste Rohlfing, Head, Office of Integrative Activities
G. Wayne van Citters, Jr., Senior Advisor, Facilities, MPS (present via phone)

Visitors
John Henry Scott, Office of Science and Technology Planning (OSTP)
Elizabeth Grossman, April-Burke Associates
Lance Haworth, Director, Office of Integrative Activities
Arden Bement, Jr., Director, NSF
Venkatesh Narayanamurti, Harvard University

APPENDIX II
BREAKOUT SESSION ROOMS
MPS Advisory Committee Meeting
November 6, 2008

		DIVISIONAL ASSIGNMENTS FOR MPSAC MEMBERS					
		AST	**PHY**	**CHE**	**DMR**	**DMS**	
		Room	**Room**	**Room**	**Room**	**Room**	
		I - 546	**II - 595**	**II - 525**	**II - 535**	**II - 545**	
Term Ends 09/30/09							
	JOHNSTONE					X	
	JORGENSEN			**R**			
	KEYES					**R**	
	MALDONADO		**R**				
	MCDUFF					X	
	OLVERA				**R**		
	ROBERTSON				X		
	SOBOYEJO				X		
	WILLIAMS	TC					
Term Ends 09/30/10							
	ABRUNA			X			
	CORNELL		X				
	MATTHEWS		X				
	TOHLINE	**R**					
Term Ends 09/30/11							
	BERGER					X	
	BORTOLETTO		X				
	FINLAYSON-PITTS			X			
	FONSECA					X	
	HAWLEY	X					
	NARAYAN	X					
	NEAL			X			
	PEOPLES	X					
	REICHMANIS				X		
A	WEST						

Except for AST all breakout sessions will be held in Stafford II building

TC	Teleconference
A	Absent
R	Breakout CHAIR, MPSAC member who will summarize Divisional meetings activities to MPSAC

APPENDIX III

REPORT OF THE LIGHT SOURCE PANEL

The report is available at

http://www.nsf.gov/attachments/112329/public/LightSourcePanelFinaWithFinalCorrectionslReport9-15-08.pdf

STANFORD UNIVERSITY
DEPARTMENT OF STATISTICS
390 SERRA MALL
STANFORD, CALIFORNIA 94305–4065

Iain M. Johnstone
Phone: (650) 723-9114
Fax: (650) 725-8977
Email: imj@Stanford.EDU
Web: http://www-stat.Stanford.EDU/~imj

March 11, 2009

Dr. Tony F. Chan,
Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Chan :

I have reviewed the final version of the minutes of the Directorate for Mathematical and Physical Sciences Advisory Committee meeting that was held November 6-7, 2008 (attached), and am pleased to certify the accuracy of these minutes. Morris Aizenman has done an excellent job in recording the most significant parts of the discussion.

Sincerely,

I. M. Johnstone

Iain M. Johnstone
Chair, Mathematical and Physical
Sciences Advisory Committee