Overview of the NSF Directorate for Mathematical and Physical Sciences (MPS)

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**NSF Vision**

To enable America’s future through discovery, learning and innovation.

**NSF Mission**

- Promote the progress of science;
- Advance the national health, prosperity, and welfare;
- Secure the national defense.
NSF’s Strategic Goals

Discovery – Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the Nation as a global leader in fundamental and transformational science and engineering.

Learning – Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Research Infrastructure – Build the Nation’s research capability through critical investments in advanced instrumentation, facilities, cyber infrastructure, and experimental tools.

Stewardship – Support excellence in science and engineering research and education through a capable and responsive organization.
NSF-Wide Scientific Investments

- Cyber-enabled Discovery & Innovation
- National Nanotechnology Initiative
- NSF Centers
- Networking & Information Technology R&D
- Science and Engineering Beyond Moore’s Law
- Broadening Participation
Science and Engineering Beyond Moore’s Law (SEBML)

Research Investments for Economic Competitiveness

Goal: To position the U.S. at the forefront of communications and computation capability beyond the physical and conceptual limitations of current technologies.

Materials for ultra-fast computing: MPS-supported research on graphene materials could lead to microchips that operate at much higher speeds than is possible with today’s standard silicon chips.

Quantum Information Science is a promising area of SEBML. Quantum information is fragile and susceptible to loss. Recent progress in electron spin quantum memory improved robustness by controlling interactions with nuclear spins in diamond.

Jiang et al., Science 326, 267 (2009)
National Nanotechnology Initiative

- Nanomaterials and nanodevices
  - Computing
  - Communications
  - Energy (e.g., solar)
- Nanomanufacturing
- Environment, health, and safety
NSF FY 2011 Budget Request Highlights

[MPS request: + 4.3% (+ $58.07M)]

Budget Request highlights:
• Maintaining healthy core programs
• Investing in research to meet national needs (SEBML, SEES, CDI, Nano)
• Training a technically competent scientific workforce (CAREER, GRF, IGERT) and broadening participation
• Transformative Interdisciplinary research
## FY 2011 NSF Budget Request

<table>
<thead>
<tr>
<th>$M</th>
<th>2009 Omni</th>
<th>2009 ARRA</th>
<th>2010</th>
<th>2011</th>
<th>% over 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>5152</td>
<td>2062</td>
<td>5564</td>
<td>6018</td>
<td>8.2%</td>
</tr>
<tr>
<td>Edu &amp; HR</td>
<td>845</td>
<td>85</td>
<td>873</td>
<td>892</td>
<td>2.2%</td>
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<tr>
<td>TOTAL NSF</td>
<td>6469</td>
<td>2401</td>
<td>6873</td>
<td>7424</td>
<td>8.0%</td>
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</table>
Total NSF Funding: President's Plan for Science and Innovation
FY 2009-FY 2017 (dollars in billions)

<table>
<thead>
<tr>
<th>Year</th>
<th>Funding (in billions)</th>
<th>Percent Change Over Previous FY</th>
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<tbody>
<tr>
<td>2009</td>
<td>6.5</td>
<td>6%</td>
</tr>
<tr>
<td>2010</td>
<td>6.9</td>
<td>6%</td>
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<tr>
<td>2011</td>
<td>7.4</td>
<td>8%</td>
</tr>
<tr>
<td>2012</td>
<td>7.8</td>
<td>5%</td>
</tr>
<tr>
<td>2013</td>
<td>8.3</td>
<td>7%</td>
</tr>
<tr>
<td>2014</td>
<td>8.9</td>
<td>7%</td>
</tr>
<tr>
<td>2015</td>
<td>9.5</td>
<td>7%</td>
</tr>
<tr>
<td>2016</td>
<td>10.2</td>
<td>7%</td>
</tr>
<tr>
<td>2017</td>
<td>10.9</td>
<td>7%</td>
</tr>
</tbody>
</table>

ARRA = American Recovery and Reinvestment Act
Top 5 Things to Know About MPS

• Most extensive and diverse scientific portfolio.
• Centered around the American Competitiveness Initiative (ACI): fundamental discovery to marketable technologies.
• Largest budget: $1.35 Billion FY’10.
• Develops & supports major facilities.
• Diverse approaches: smaller individual Principal Investigator (PI) grants to larger centers/ institutes.
MPS Scientific Opportunities

• Physical sciences at the nanoscale.
• Science beyond “Moore’s Law”.
• Physics of the universe.
• Complex systems (multi-scale, emergent phenomena).
• Fundamental mathematical and statistical science.
• Sustainability (energy, environment, climate).
• Interface between the physical and life sciences.
• Computational and Cyber-enabled Discovery and Innovation (CDI).
MPS Scientific Priorities for FY 2011

- Science beyond “Moore’s Law” and Quantum Information Sciences.
- Sustainability (energy, environment, climate).
- Interface between physical & life sciences.
- Cyber-enabled Discovery and Innovation.
- Physics of the universe.
- Education and Workforce (CAREER, post-doc programs, REUs…).
Young Investigators

- Research Experiences for Teachers
- Research Experiences for Undergraduates
- Graduate Research Fellowships
- CAREER awards

RET teachers introduce girls to infrastructure renewal concepts. *Credit: Univ. of Cincinnati College of Engineering and College of Applied Science.*

Student researchers sample contaminated sediment. *Credit: Karl Rockne, Univ. of Illinois at Chicago*
CAREER
Supporting Young Investigators

- Prestigious 5 year awards for new faculty
- About half of all NSF CAREER dollars come from MPS.
- Have large impact in outreach and education. Innovative university curricula are developed, as well as outreach efforts to middle schools and minority-serving institutions.

CAREER request: + 6.5% (to $209M)
## MPS BUDGET by Divisions

(Dollars in Millions)

<table>
<thead>
<tr>
<th>Divisions</th>
<th>FY ’09 Omnibus</th>
<th>FY ’09 ARRA</th>
<th>FY ’10 Estimate</th>
<th>FY ’11 Request</th>
<th>Change over FY ’10 Estimate</th>
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<tr>
<td>Astronom. Sci.</td>
<td>$228.67</td>
<td>$85.80</td>
<td>$244.78</td>
<td>$251.77</td>
<td>$6.99 2.9</td>
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<tr>
<td>Chemistry</td>
<td>211.67</td>
<td>87.36</td>
<td>232.87</td>
<td>247.56</td>
<td>14.69 6.3</td>
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<tr>
<td>Materials Res.</td>
<td>282.52</td>
<td>108.17</td>
<td>301.55</td>
<td>319.37</td>
<td>17.82 5.9</td>
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<tr>
<td>Math. Sci.</td>
<td>224.84</td>
<td>97.34</td>
<td>240.49</td>
<td>253.46</td>
<td>12.97 5.4</td>
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<tr>
<td>Physics</td>
<td>262.47</td>
<td>96.30</td>
<td>293.98</td>
<td>298.19</td>
<td>4.21 1.4</td>
</tr>
<tr>
<td>OMA</td>
<td>33.70</td>
<td>------</td>
<td>38.17</td>
<td>39.56</td>
<td>1.39 3.6</td>
</tr>
<tr>
<td>MPS Total</td>
<td>1,243.88</td>
<td>474.97</td>
<td>1,351.84</td>
<td>1,409.91</td>
<td>58.07 4.3</td>
</tr>
</tbody>
</table>
World Class Major Facilities
Keep University Researchers at the Frontier

- CHESS
- NRAO
- LIGO
- NSO
- NOAO
- LHC
- CHRS
- CESR
- GEMINI
- NSCL
- NAIC
Bold Dreams: Horizon to 2020

- Advanced Technology Solar Telescope (ATST)
- Deep Underground Science and Engineering Laboratory (DUSEL)
- Energy Recovery LINAC (ERL)
- Giant Segmented Mirror Telescope (GSMT)
- Large Synoptic Survey Telescope (LSST)
- Extended VLA (EVLA)
- Square Kilometer Array (SKA)
Astronomical Sciences (AST)

From the Big Bang to DNA

- Origin and evolution of the Universe
- Origin and evolution of galaxies
- Origin and evolution of planetary and stellar systems

National astronomy portfolio

- Three agencies - NSF, NASA, and DoE – and internat’l partnerships
- Strong tradition of private funding
- NSF assigned federal stewardship of ground-based astronomy
- Includes open-access facilities and mission-free unrestricted grants

AST has a strong program in Education and Special Programs (including a major investment in post-docs)
• Major CAREER and REU support.
• Centers program growing.
• Collaborations with NIH and DOE.
• Critical areas of research for FY 2010: Energy, Element and Molecule Recycling, Designed Emergent Behavior, Imaging the Ultrasmall.
DMR Programs:
Metallic and Metallic Nanostructures, Ceramics; Electronic Photonic Materials; Condensed Matter Physics; Condensed Matter and Materials Theory; Solid-State Chemistry; Polymers; Biomaterials; Materials Research Sci and Eng Centers; National Facilities and Instrumentation; Office of Special Programs

Key Research Areas for FY 2011:
Environmental, energy, and economic sustainability; Matter by design; The quantum realm; Physical-chemical-biological interfaces

DMR supports a wide breadth of science – fundamental research to the development of technological applications.
Mathematical Sciences (DMS)

“Core business”: Single investigator and Group proposals through targeted solicitations and covers the entire mathematical spectrum

Institutes: 5 NSF-initiated, support for 3 others
Visitors to long term programs, workshops

Workforce: Responding to a major challenge.
EMSW21 training grants; Postdoctoral fellowships;
Research for Undergraduates

In addition to the fundamental research in mathematical sciences, DMS plays an enabling role of all other sciences; DMS has been successful in partnering with other NSF Divisions and Directorates and with other government agencies.
Physics (PHY)

Facilities:
LHC, LIGO, IceCube, NSCL, CESR, DUSEL

Programs:
Atomic, Molecular, Optical, and Plasma Physics; Biological Physics Elementary Particle Physics; Gravitational Physics; Nuclear Physics; Particle and Nuclear Astrophysics; Physics at the Information Frontier; Physics Frontiers Centers; Theoretical Physics; Education and Interdisciplinary Programs

PHY collaborates closely with DOE and international partners to support science at large facilities. NSF’s physics portfolio is more diverse than physics portfolios at any other federal agency.
Office of Multidisciplinary Activities (OMA)

- Catalyzes cross-cutting research in areas of strategic emphasis in MPS, as well as areas that may emerge as strategic
- Facilitates partnerships with other agencies, industries, state and local governments, and international organizations
- Supports innovative experiments in education and broadening participation

OMA neither receives nor reviews proposals; rather, OMA co-invests with MPS Divisions
How do I apply?

What are the processes?

How will I be reviewed?
NSF Proposal Process

1. Principal Investigator submits proposal (solicited or unsolicited)
2. NSF conducts a compliance check/review
3. NSF evaluates proposals using two review criteria:
   a) Intellectual Merit and
   b) Broader Impact
4. Review process is:
   a) By mail (ad hoc) and/or panel
   b) Confidential
   c) Anonymous
5. Program Officers weigh reviews and portfolio balance issues; recommend proposals for funding or decline
6. Management reviews those recommendations; makes decisions
7. PIs are notified
Merit Review Criteria: Intellectual Merit

- How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields?
- How well qualified is the proposer (individual or team) to conduct the project?
- To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts?
- How well conceived and organized is the proposed activity?
- Is there sufficient access to resources?
Merit Review Criteria: Broader Impacts

• How well does the activity advance discovery and understanding while promoting teaching, training, and learning?

• How well does the proposed activity broaden the participation of underrepresented groups?

• To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?

• Will the results be disseminated broadly to enhance scientific and technological understanding?

• What may be the benefits of the proposed activity to society?
How to make an NSF Proposal Competitive

• Match and justify the budget to the scope of the proposed work – ask for what you need!

• Be familiar with projects that have succeeded – search award abstracts at http://www.nsf.gov/awardsearch

• Special programs/consideration exist for Primarily Undergraduate Institutions, e.g., RUI and ROA; for colleges and universities in EPSCoR states
Reasons For Funding
A Competitive Proposal

• Scientific Impact
• PI Career Point
• Program Portfolio Balance
• Special Programmatic Considerations (CAREER/RUI/EPSCoR, for example)

New and original ideas
Sound, succinct, detailed focused plan
Preliminary data and/or feasibility calculations

Relevant experience
Clarity concerning future direction
Well-articulated broader impacts
• Volunteer to be a reviewer and panelist
• Participate in NSF-funded events, workshops, etc.
• Send your best ideas to NSF: consistent with prog focus and goals.
• Get to know your Prog Directors
• Keep us informed of your accomplishments
• Work within your institutions to support collaborative, interdisciplinary research
• Suggest transition strategies and improvements from basic research to prototyping and production
• Plan to serve as a prog officer (“rotator”) or division director