A year in the APS
and
The importance of PHYSICS in the 21st Century

Cherry Murray
APS Past President
February 14, Washington, DC
2009 – a year in the APS presidency

January — Barack Obama takes office and appoints physicists to Cabinet posts

February — financial crisis, ARRA - “Shovel ready Projects” - APS Washington Office works to provide jobs for science in bill / Ridge space task force / Franz announces retirement / search for new Executive Officer/ new topical group on energy proposed/ APS copyright agreement with authors expanded to derivative works

March — 3 mo. strategic exercise at APS begins; APS budget cuts to deal with fiscal crisis; 2010 US budget maintains science funding

April — my charge to CISA: how to better serve international members; good bye party for Judy Franz, retiring after 15 years as APS Executive Officer/ Obama speech at NAS

May — petition to Council to replace 2007 APS statement on climate change; I appoint ad hoc committee to advise Council and presidential line
2009 – a year in the APS presidency

June — Executive Board retreat – APS guiding principles across society, new APS journal pricing and budget process, Ridge expansion plans

July — 1st anniversary of Physics - Kate Kirby begins as new Executive Officer; $6.5M PhysTec NSF grant awarded/ Phys Rev Letters announces more stringent review criteria

August — Physics Frontline APS Washington Office blog begins; APS and Harvard agreement on open source repository at Harvard

September — launch of NSF funded Minority Bridge pilot program

October — Nobel Prize to APS members – LaserFest plans

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2009 — a year in the APS presidency

November — Council votes not to change 2007 climate statement but to have POPA review it for “clarity and tone”

Executive Board requests Constitution and Bylaws Committee propose new procedures for future APS statements to allow due deliberation by Council including member comment period

CISA report to Executive Board with recommendation to increase number of international Councilors

December — Copenhagen talks; presidential line discussions on possible APS study on climate science; new petition to Council for APS study; member emails; OSTP request for open access comments; START II talks; POPA report on nuclear downsizing
The importance of PHYSICS in the 21st Century
The Scale of Things – from the Planck length to the cosmos

The beauty of physics

Discovering and understanding nature

New tools for scientific discovery in all fields

Planck length ~ strings

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Adapted from Astronomy lectures by J. Schombert, U. Oregon, 2005
Why should the federal government fund physics R&D?

- National security
- Economic security
- Energy and environmental security
- New knowledge – discover, understand nature and the cosmos
- New tools for other sciences and society – biology, environmental sciences, medicine, etc.
Physics Community Focus Government/Public Rationale

- National security
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Economic Challenges: Globalization & Complacency

“...the Committee is deeply concerned that the scientific and technological building blocks critical to our economic leadership are eroding when many other nations are gathering strength...We fear the abruptness with which a lead in science and technology can be lost - “

RECOMMENDATIONS

• 10,000 teachers, 10 million minds - K-12 science and mathematics education
• Sowing the Seeds through Science and Engineering Research: Strengthen the nation's commitment to long-term basic research that has the potential to be transformational to maintain the flow of ideas that fuel the economy, provide security, and enhance the quality of life.
• Best and Brightest in Science and Engineering Higher Education
• Incentives for Innovation
Economic driver: science-technology cycle

Fundamental understanding

Quantum mechanics, band structure of solids, semiconductor junction theory...

Advanced modeling of materials & phenomena, new states of matter observed in 2D electrons

Invention

Transistor

HEMT

Innovation of new technology

Microprocessor, parallel computation

Observation of cosmic bounce in cosmic background radiation, spectroscopy of single atoms,...

Mobile wireless handsets, ultra-sensitive detectors

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National Security Challenges

Irregular Challenges

- Non-state and state actors employing "unconventional" methods to counter stronger state opponents - terrorism, insurgency, etc. (e.g. terrorism, civil war, insurgency, unrestricted warfare)

Traditional Challenges

- States employing military forces in well-known forms of military competition and conflict (e.g. conventional air, sea and land forces, nuclear forces of established nuclear powers)

Catastrophic Challenges

- Terrorist or Rogue State employment of WMD or methods producing WMD-like effects against American interests. (e.g. attack on homeland, global markets, or key ally that would generate a state of shock and preclude normal behavior)

Disruptive Challenges

- Competitors employing technology or methods that might counter or cancel our current military advantages (e.g. technological - bio, cyber, or space war, ultra miniaturization, directed energy, diplomatic blackmail, cultural or economic war)

Source: Quadrennial Defense Review, 2006
Economic Challenges: U.S. Trade Balance

Aerospace, pharmaceuticals, office and computing equipment, scientific instruments

Biotechnology, life sciences, optoelectronics, information and communication equipment, electronics, flexible manufacturing, advanced materials, aerospace, weapons, nuclear technology

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Energy Security Challenges

Top ten countries with oil reserves

World energy consumption

US petroleum production and consumption

The United States was self-sufficient in energy until the late 1950s when energy consumption began to outpace domestic production. At that point, the Nation began to import more energy to fill the gap. In 2007, net imported energy accounted for 29 percent of all energy consumed.


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Global Climate Challenges and Concerns

CO₂ emissions growth vs IPCC 2001 Projections

- Actual emissions: CDIAC
- Actual emissions: EIA
- 450ppm stabilisation
- 650ppm stabilisation
- A1FI
- A1B
- A1T
- A2
- B1
- B2

50-year constant growth rates to 2050

- B1 1.1%
- A1B 1.7%
- A2 1.8%
- A1FI 2.4%

Observed 2000-2006 3.3%

IPCC 2007 Projections

- A2
- A1B
- B1
- Constant composition commitment
- 20th century

Raupach et al. 2007, PNAS

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US Funding Challenges and Concerns
Global R&D Environment

Total National R&D as % of GDP, 1991-2006

- Japan
- U.S.
- Korea
- Germany
- EU-27
- China

Source: National Science Foundation, National Patterns of R&D Resources and OECD, Main Science and Technology Indicators. Data not available for all nations for all years. AUGUST '08 © 2008 AAAS

U.S. Total R&D Spending is about 2.5 % of GDP

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Decline in U.S. Industrial basic research

New partnerships between academia, national labs, industry need to take on a leadership role in the spectrum of goal-oriented, multidisciplinary basic-long term applied R&D to meet the nation's biggest challenges.

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Economic Challenges: U.S. Discretionary Spending

Federal Spending

BY 2007 $B

Source: OMB FY200 Budget History

Aging population; complex social security and health care system – financial bailout, International trade deficit

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Defense vs non-defense federal R&D trends

Federal Spending on Defense and Nondefense R&D
Outlays for the conduct of R&D, FY 1949-2006, billions of constant FY 2008 dollars

Source: AAAS, based on CMB Historical Tables in Budget of the United States Government FY 2009. Constant dollar conversions based on GDP deflators. FY 2000 is the President’s request. Note: Some Energy programs shifted to General Science beginning in FY 1998. FEB '08 © 2008 AAAS

in billions of constant FY 2008 dollars

Source: AAAS analyses of R&D in annual R&D reports. * - FY 2009 figures are latest AAAS estimates of FY 2009 request. FY 2008 figures exclude pending supplementals. R&D includes conduct of R&D and R&D facilities. DOE S&T figures are not comparable for all years because of changing definitions. MARCH '08 REVISED © 2008 AAAS

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Federal non-defense R&D spending balance

Trends in Nondefense R&D by Function, FY 1953-2009
outlays for the conduct of R&D, billions of constant FY 2008 dollars

Source: AAAS, based on OMB Historical Tables in Budget of the United States Government FY 2009. Constant dollar conversions based on GDP deflators.
FY 2008 is the President’s request.
Note: Some Energy programs shifted to General Science beginning in FY 1995.
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“At such a difficult moment, there are those who say we cannot afford to invest in science. That support for research is somehow a luxury at a moment defined by necessities. I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been.”

President Barack Obama
April 27, 2009
National Academy of Sciences
“Physics is what physicists do” (Brian Pippard)

Physics is a way of looking at the world, parsing and solving model problems as a way of gaining understanding of the essentials of the actual problem.

This kind of thinking is necessary in order to further the frontiers of knowledge AND to address societal challenges.

The 21st century research enterprise – and addressing 21st century global challenges such as a sustainable global energy supply, food and good health for all, international security – also require teamwork and multidisciplinary thinking.

Physicists are needed as part of the team! Think about training of bachelors, grad students, and those who will not replicate you as physics profs.
A 21st century physicist - “Physics is what physicists do”

- International

- Interdisciplinary – biophysics, geophysics, laser physics, ...

- Works anywhere from fundamental to near-term applications

- Degree obtained and job content – BS, MS, PhD, ... student, teaching, research, R&D, operations, management

- Sectors – education, academic, industry, national labs/government

- Diverse – gender, ethnic, ...

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PHYSICS is as important in the 21st Century as it was in the 20th!