



**Mathematical and Physical Sciences  
Advisory Committee  
(MPS AC)**

**F. Fleming Crim  
Assistant Director  
National Science Foundation  
January 23, 2015**




**How Round is the Electron ?  
Measuring the Electric Dipole Moment of the Electron  
A Science Hors d'Oeuvre**




## How Round is the Electron ? Measuring the Electric Dipole Moment of the Electron

**Division of Physics (PHY)**


Advanced Cold Molecule EDM



The ACME Collaboration




**Harvard-Yale**  
David DeMille (Yale)  
John Doyle (Harvard)  
Gerald Gabrielse (Harvard)




**Order of Magnitude Smaller  
Limit on the Electric Dipole  
Moment of the Electron**

The ACME Collaboration,\* J. Baron,<sup>1</sup> W. C. Campbell,<sup>2</sup> D. DeMille,<sup>3,†</sup> J. M. Doyle,<sup>1,†</sup> G. Gabrielse,<sup>1,†</sup> Y. V. Gurevich,<sup>1,‡</sup> P. W. Hess,<sup>2,¶</sup> N.-P. Hutsejer,<sup>2</sup> E. Kirilov,<sup>2,§</sup> I. Kozyryev,<sup>3,||</sup> B. R. O'Leary,<sup>2</sup> C. D. Panda,<sup>2</sup> M. F. Parsons,<sup>2</sup> E. S. Petrik,<sup>1</sup> B. Spaun,<sup>1</sup> A. C. Vutha,<sup>2</sup> A. D. West<sup>3</sup>


**Science 343, 269 (2014)**



**Testing the Standard Model using Atomic, Molecular, and Optical Physics**




## How Round is the Electron ? Measuring the Electric Dipole Moment of the Electron




**Elizabeth Petrik, Harvard University**

ACME  
Collaboration  
presents:




Harvard University



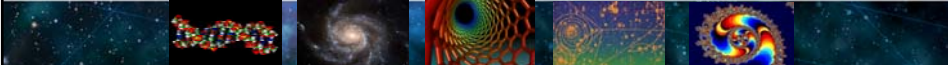
ElectronEDM.org

The  
Electric Dipole  
Moment  
of the  
Electron

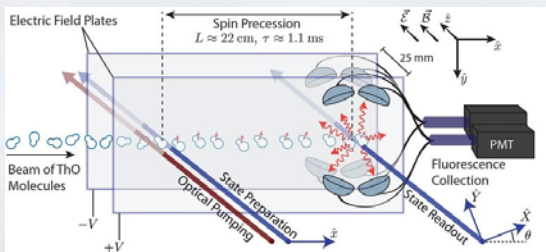


Yale University

<https://www.youtube.com/watch?v=UlfIReRmynk>



## How Round is the Electron ? Measuring the Electric Dipole Moment of the Electron

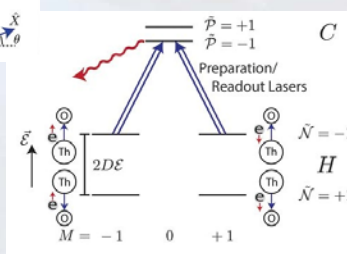


Place the electron in the internal electric field,  $E_{eff}$ , of ThO to shift the energy in proportion to its dipole moment,  $d_e$

$$U = -d_e \cdot E_{eff}$$

Prepare a coherent superposition of two-spin states, causing the spin vector to precess in the x,y-plane

The precession angle, read out by another laser, depends on the dipole moment.



## How Round is the Electron ? Measuring the Electric Dipole Moment of the Electron

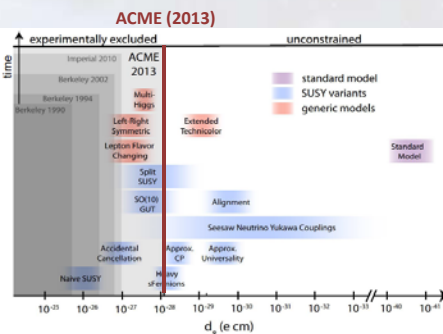
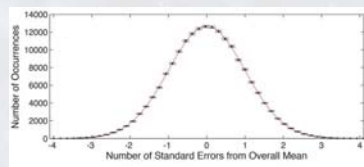
Assessing statistical and systematic errors is central to determining the limit

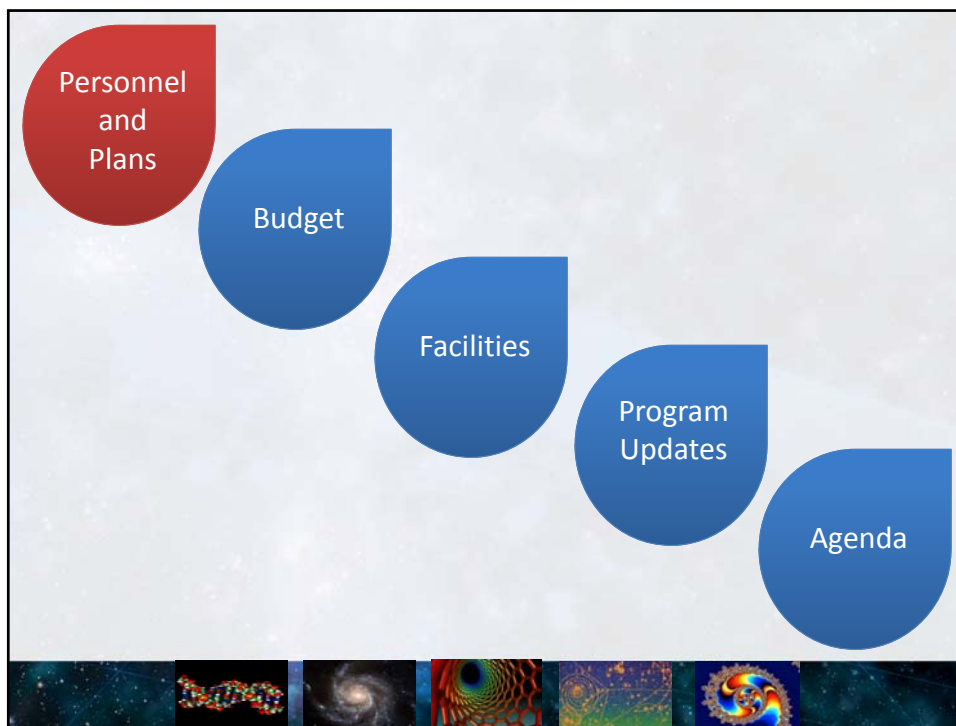
$$d_e = (-2.1 \pm 3.7_{stat} \pm 2.5_{syst}) \times 10^{-29} e \text{ cm}$$

$$|d_e| < 8.7 \times 10^{-29} e \text{ cm}$$


Testing Variants of the Standard Model

Special Thanks to John Gillaspay






**Office of the Assistant Director (OAD)**  
Donna O'Malley, Budget Officer  
(Detailee AST)



**Chemistry Division (CHE)**  
Steve Bernasek, Division Director  
Sept 2014 – Feb 2015



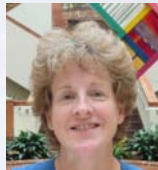
**Farewell and Thanks !**

## Division Leadership

### Chemistry



**David Berkowitz**  
University of Nebraska  
Division Director  
Feb 2015 – Aug 2015



**Carol Bessel**  
Acting Deputy  
Division Director

### Materials



**Linda Sapochak**  
Deputy  
Division Director

Selection of  
Division Director and Deputy Division Director  
Nearing Completion

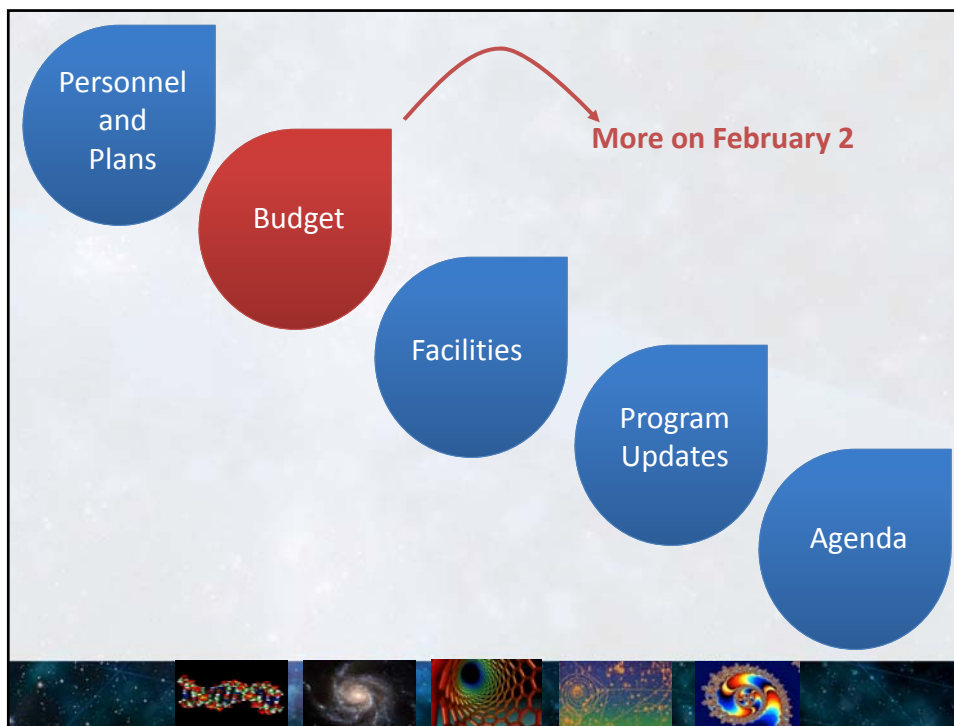


## MPS Advisory Committee

Quarterly Meetings  
(3 virtual, 1 at NSF)

Next Meeting  
(Virtual)  
April 3, 2015





UNITED STATES National Science Foundation			
	FY 2014	FY 2015 (request)	
NSF	\$ 7172 M	\$ 7255 M	1.2%
R&RA	\$ 5808 M	\$ 5807 M	--

**FY 2015  
BUDGET REQUEST TO CONGRESS**

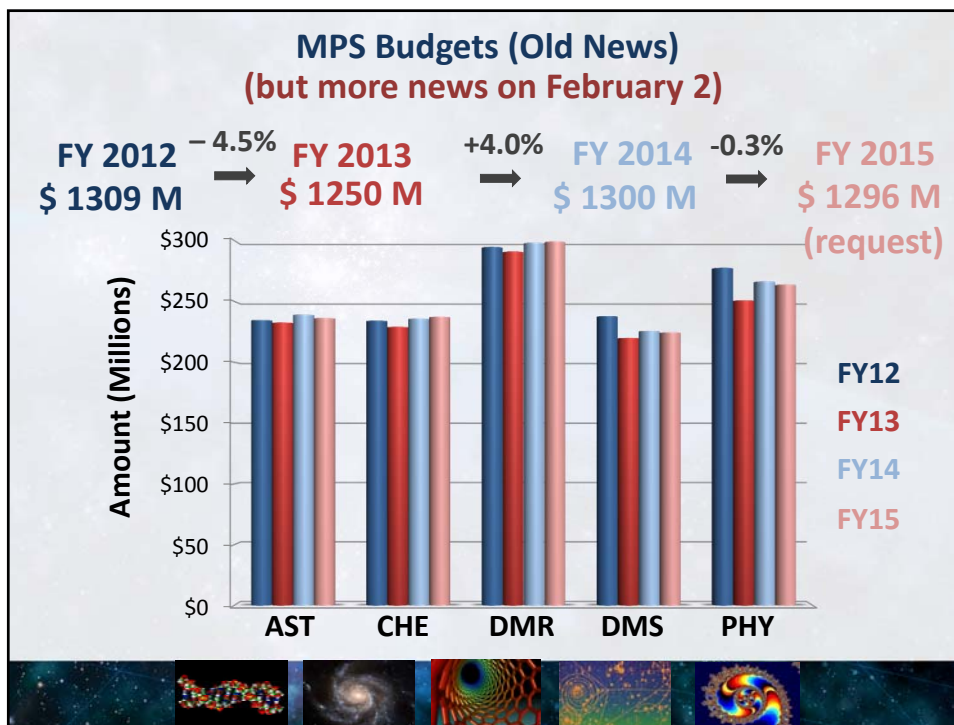
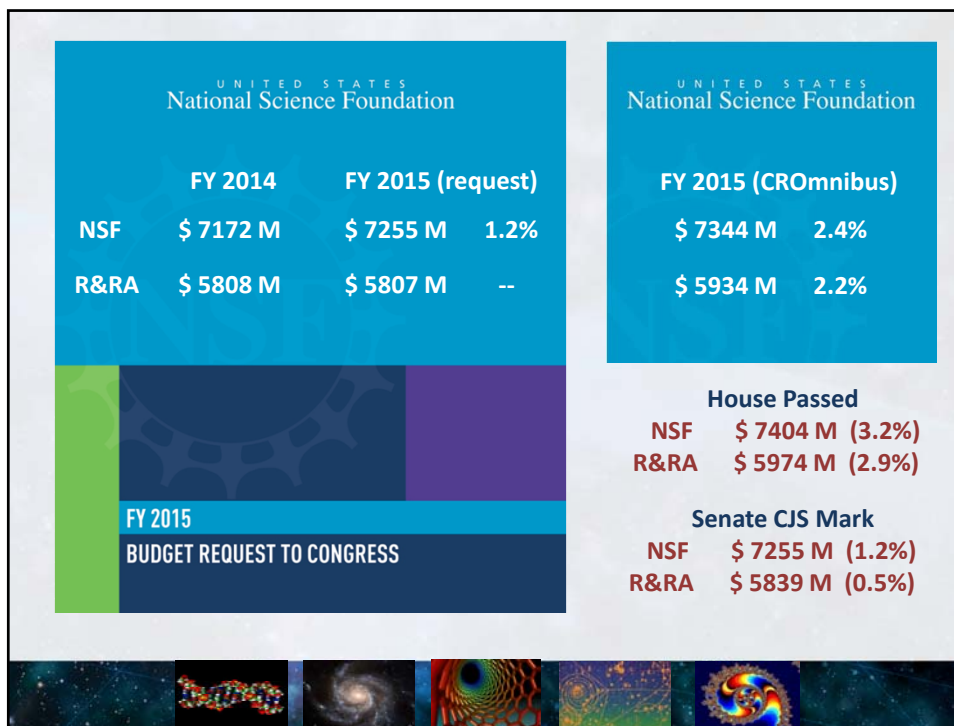
UNITED STATES  
National Science Foundation

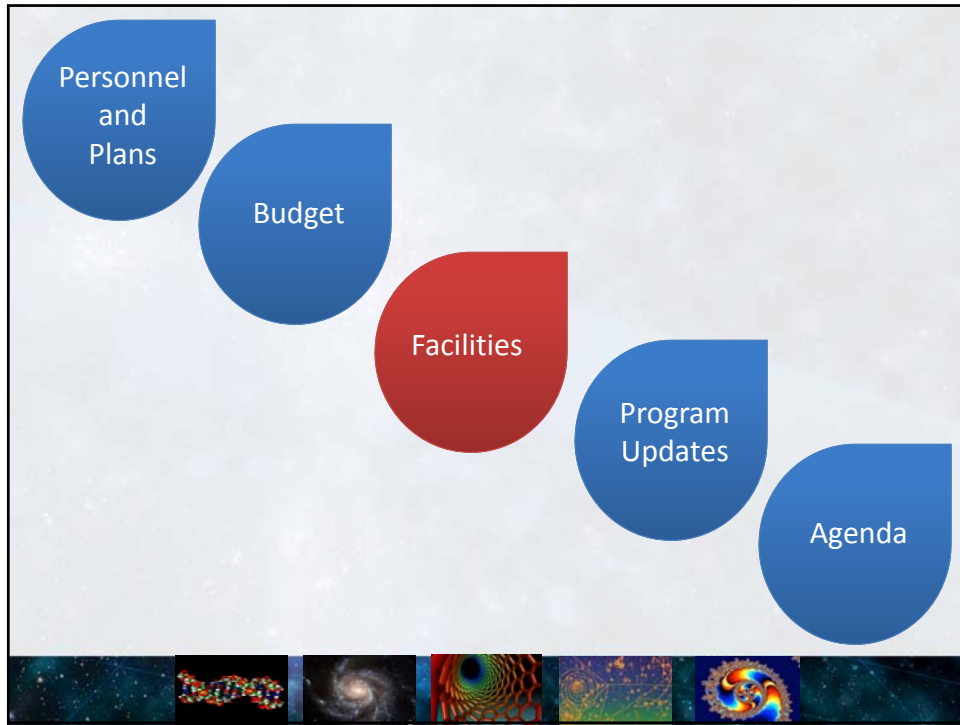
**NSF**

**FY 2015  
BUDGET REQUEST TO CONGRESS**

**MISSION:** To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.  
—From the National Science Foundation (NSF) Act of 1950

**VISION:** A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education.  
—From Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018





### A Few Events

  
Wikipedia Commons Jordanagoodman

**High Altitude Water Cherenkov Observatory (HAWC)**  
Dedication - March 20, 2015

**Large Synoptic Survey Telescope (LSST)**  
Laying the First Stone - April 13, 2015



**Laser Interferometer Gravitational-Wave Observatory (LIGO)**  
Advanced LIGO Completion - May 18, 2015





### Three Facility Re-competitions Underway

**National Optical Astronomy Observatory (NOAO)**



NOAO/AURA/NSF

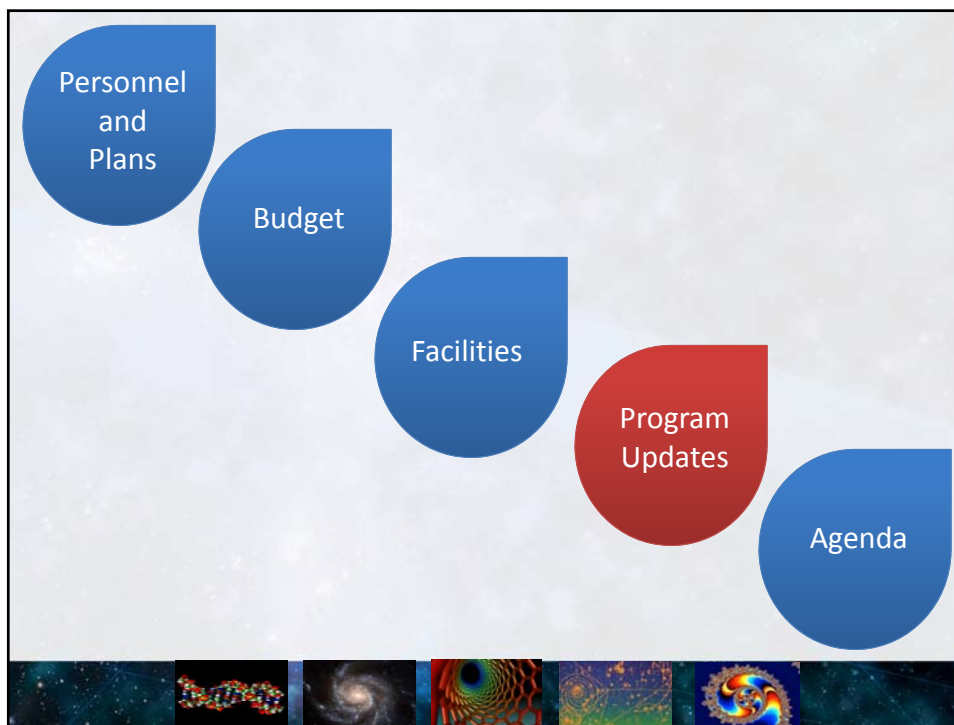


NOAO/AURA/NSF

**Gemini Observatory**



**National Radio Astronomy Observatory (NRAO)**



## A Few Updates on Activities and Issues

### Visits to MPS-Funded Institutions

Visiting to learn about breadth of individual research



Stanford and Berkeley  
(February)



Two more visits during FY 2015

### “Reproducibility of research results”

Continuing discussions in NSF and with OSTP

### Public-Private Partnerships in Science Funding

On our agenda today



## A Few Updates on Activities and Issues

### Public Access to Data

NSF plan for publications is still at OSTP

### Committees of Visitors

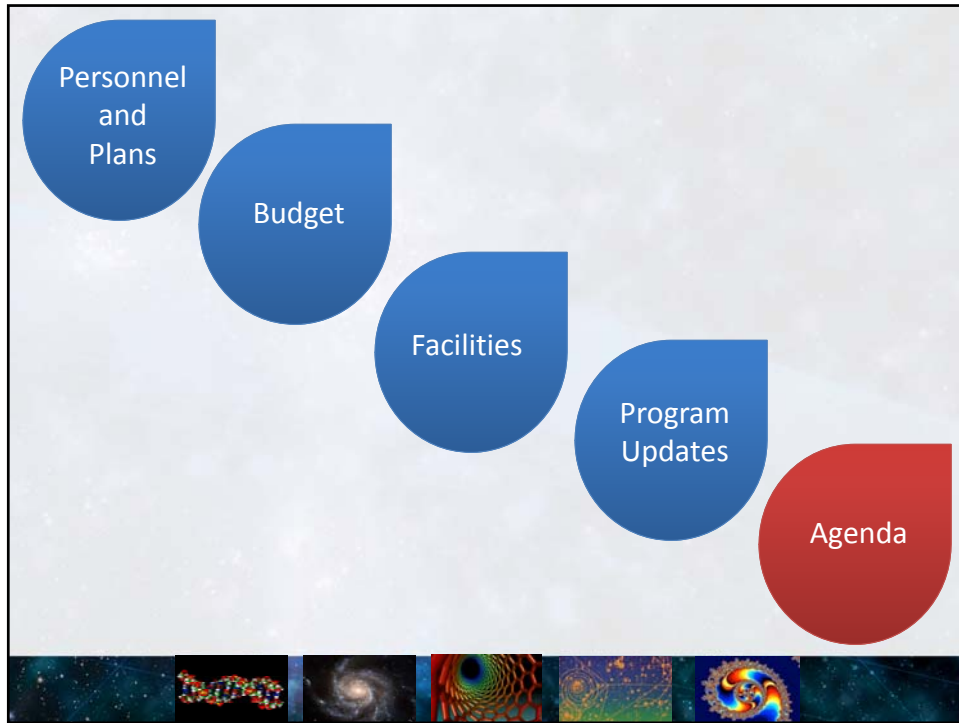
Three this year: AST, DMR, PHY

You will hear the reports in due course

### Portfolio Analyses and Reviews in MPS

Continuing to describe and discuss our collection of  
programs and awards





### Agenda



**State of the Directorate** ✓

**Receive the “P5” Subcommittee Report** 60  
Young-Kee Kim

**Public – Private Partnerships** 30  
Jennifer Pearl

**MPS Liaison: Advisory Committee for Cyberinfrastructure** 20  
Juan Meza



## Agenda



**MPS Liaison: Advisory Committee for  
Environmental Research and Education** 20  
Michelle Buchanan

**MPS Liaison: Advisory Committee for  
International Science and Engineering** 20  
Graham Harrison

**Closing Discussions and Plans** 15  
Juan de Pablo

