SMD Science Education Status

2016 Lunar and Planetary Science Conference

“Education is not the filling of a pail, but the lighting of a fire...and NASA is the spark”

Kristen Erickson
Director, Science Engagement & Partnerships
Science Mission Directorate
March 21, 2016
SMD Science Education Restructuring

- Background – FY16 Appropriation provides $37M for NASA Science Education
- Why Restructure? To further enable NASA science experts and content into the learning environment more effectively and efficiently with learners of all ages. SMD will no longer have minimum of 1 percent set-asides through our missions, or issue disparate 3-year grants. But we are taking a strategic approach, building on our science-disciplined based legacy, and looking for new approaches given Stakeholder priorities
- Objectives?
  - Enable STEM Education
  - Improve US Scientific Literacy
  - Advance National Educational Goals
  - Leverage Through Partnerships
- How? Through the competitive selection of organizations that utilize NASA data, products, or processes to meet education objectives; and by enabling our scientists and engineers with education professionals, tools, and processes to better meet user needs. SME’s continue to be funded within the Divisions, where appropriate
Map of NASA Science Mission Directorate Science Education Selections, including Co-Is
Arizona State University—Tempe, AZ. Linda Elkins-Tanton, Principal Investigator for “NASA SMD Exploration Connection”

Challenger Center for Space Science Education--Washington, DC Robert Piercey, Principal Investigator for “CodeRed: My STEM Mission”

Jet Propulsion Laboratory—Pasadena, CA. Michelle Viotti, Principal Investigator for “NASA Active and Blended Learning Ecosystem (N-ABLE)”

Northern Arizona University—Flagstaff, AZ. Joelle Clark, Principal Investigator for “PLANETS (Planetary Learning that Advances the Nexus of Engineering, Technology, and Science)”
Opportunities

• **NSF INCLUDES** - Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science Solicitation for 40 five-year grants at ~ $300K each Deadline: *April 15, 2016*

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505289
Planetary Science Division Status Report

Jim Green
NASA, Planetary Science Division
March 21, 2016

Presentation at LPSC
Outline

• Mission Overview and upcoming Events
• FY 2016 Appropriation
• FY 2017 President’s Budget
• Discovery, New Frontiers, and Mars Exploration Program
• Europa mission
• Cubesat Selections
• Planetary Defense Coordination Office
Planetary Science Missions Events

2014
July – *Mars 2020* Rover instrument selection announcement  
August 6 – 2nd Year Anniversary of *Curiosity* Landing on Mars  
September 21 – *MAVEN* inserted in Mars orbit  
October 19 – Comet Siding Spring encountered Mars  
September – *Curiosity* arrives at Mt. Sharp  
November 12 – ESA’s *Rosetta* mission lands on Comet Churyumov–Gerasimenko  
December 2/3 – Launch of *Hayabusa-2* to asteroid 1999 JU3

2015
March 6 – *Dawn* inserted into orbit around dwarf planet Ceres  
April 30 – *MESSENGER* spacecraft impacted Mercury  
May 26 – Europa instrument Step 1 selection  
July 14 – *New Horizons* flies through the Pluto system  
September – Discovery 2014 Step 1 selection  
December 6 – *Akatsuki* inserted into orbit around Venus

2016
March – Launch of ESA’s *ExoMars Trace Gas Orbiter*  
July 4 – *Juno* inserted in Jupiter orbit  
July 20 – 40th Anniversary of the Viking missions  
September 8 – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu  
*Cassini* begins plane change maneuver for the “Grand Finale”  
Late 2016 – Discovery 2014 Step 2 selection

* Completed
FY16 Appropriation supports a robust Planetary Science program

Planetary Science $270M above the request, at $1.63B

- $277M for Planetary Science Research
- $189M for Discovery (+$33M), including full funding for LRO
- $259M for New Frontiers
- $448M for Mars (+$36M), including full funding for Opportunity
- $197M for Technology (+$55M)
  - Includes $25M for icy satellites surface technology
- $261M for Outer Planets (+$145M) with direction
  - Directs that the Europa mission be launched on an SLS in 2022 and that a lander be included ($175M)
- Direction to continue to fund AIDA/DART joint study with ESA
- Direction to establish a new Ocean Worlds program with a primary goal to discover extant life on another world using a mix of Discovery, New Frontiers, and flagship class missions
Planetary Science: President’s FY17 Budget

- Continues development of the Mars 2020 mission.
- Funds continued formulation of a mission to Jupiter’s moon, Europa.
- Continues work on the JUICE instrument in collaboration with the European Space Agency mission to Jupiter.

- Initiates studies for the next New Frontiers Mission and continues operations of Juno and New Horizons.
- Operates 13 Planetary missions including MAVEN, Mars Curiosity, Opportunity, Odyssey, Mars Express, and Cassini (Saturn).
- Increases support for technology development to accelerate future power systems.
- Increases support for Research and Analysis.
Discovery Program
### Discovery Program

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<td><img src="image7" alt="Deep Impact" /></td>
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<td><img src="image11" alt="LRO" /></td>
<td><img src="image12" alt="Strofio" /></td>
<td><img src="image13" alt="InSight" /></td>
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Psyche: Journey to a Metal World  
PI: Linda Elkins-Tanton, ASU  
Deep-Space Optical Comm (DSOC)

NEOCam:  
Near-Earth Object Camera  
PI: Amy Mainzer, JPL  
Deep-Space Optical Comm (DSOC)

VERITAS: Venus Emissivity, Radio Science, InSAR, Topography, And Spectroscopy  
PI: Suzanne Smrekar, JPL  
Deep-Space Optical Comm (DSOC)

Lucy: Surveying the Diversity of Trojan Asteroids  
PI: Harold Levison, Southwest Research Institute (SwRI)  
Advanced Solar Arrays

DAVINCI: Deep Atmosphere Venus Investigations of Noble gases, Chemistry, and Imaging  
PI: Lori Glaze, GSFC
New Frontiers Program
New Frontiers Program

1\textsuperscript{st} NF mission
New Horizons:
Pluto-Kuiper Belt

Launched January 2006
Flyby July 14, 2015
PI: Alan Stern (SwRI-CO)

2\textsuperscript{nd} NF mission
Juno:
Jupiter Polar Orbiter

Launched August 2011
Arrives July 4, 2016
PI: Scott Bolton (SwRI-TX)

3\textsuperscript{rd} NF mission
OSIRIS-REx:
Asteroid Sample Return

Launch window: Sept. 8, 2016
PI: Dante Lauretta (UA)
Next New Frontiers Program AO

• Community Announcement Regarding New Frontiers Program issued in January 2016

• Investigations are limited to the following mission themes (listed without priority):
  – Comet Surface Sample Return
  – Lunar South Pole-Aitken Basin Sample Return
  – Ocean Worlds (Titan, Enceladus)
  – Saturn Probe
  – Trojan Tour and Rendezvous
  – Venus In Situ Explorer

• Draft to be released by end of September 2016

• Final AO to be released January 2017 (target)
PSS Findings Excerpts: March 9-10, 2016

Ocean Worlds

We applaud the public and legislative interest in Ocean Worlds spurred by recent discoveries related to the possibility of extant life in the oceans of Europa, Enceladus, and Titan. The increased resources made available to PSD significantly enhance future efforts to explore these intriguing environments.

PSS encourages PSD to put in place as soon as possible a process to integrate the community input on science objectives and obtain subsequent confirmation that implementation concepts exist that can achieve those objectives within the New Frontiers cost cap.

The PSS encourages PSD to ask CAPS to consider whether inclusion of Ocean Worlds in NF-4 can be done via the processes and practices available, and to identify a path for taking advantage of similar exciting opportunities of this nature going forward.

Next CAPS Meeting: March 29-30, 2016
Mars Exploration Program
Overview

• Our operational assets remain healthy and productive:
  – MAVEN has successfully completed its prime science mission and is now continuing investigations in an extended mission
  – Odyssey continues to be healthy and contribute thermal imagery and data relay services
  – MRO continues to provide invaluable reconnaissance imaging and mineralogical mapping, supporting science investigations, rover operations, and exploring potential human landing sites
  – Opportunity continues to provide important ground truth data, recently scaling 30° slopes of Knudsen Ridge atop the southern flank of Marathon Valley
    – Curiosity at Gale Crater, generating important insights into Martian chemistry
    – Mars Express continues operating our deep radar sounder (MARSIS)
• M2020 development on-track and proceeding well:
  – PDR successfully completed Feb 2016
  – Sampling system development labs up and running
• Our foreign commitments are on track
  – Our two Electra payloads on the TGO are ready for flight
  – MOMA is proceeding in development for the ExoMars Lander
• InSight delayed to May 2018 due to late delivery of the SEIS instrument
Operational 2001–2016

Follow the Water

Explore Habitability

Seek Signs of Life

Prepare for Future Human Explorers

Mars Express (ESA)
Mars Reconnaissance Orbiter
MAVEN
Mars Orbiter Mission (ISRO)
Trace Gas Orbiter (ESA)

InSight
ExoMars Rover (ESA)
Science Rover

Opportunity Rover
Curiosity Rover

2018

2020
Europa Mission
Europa Multi-Flyby Mission Concept Overview

**Science**

<table>
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<tr>
<th>Objective</th>
<th>Description</th>
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<tr>
<td>Ice Shell &amp; Ocean</td>
<td>Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange</td>
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<tr>
<td>Composition</td>
<td>Understand the habitability of Europa’s ocean through composition and chemistry.</td>
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<tr>
<td>Geology</td>
<td>Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.</td>
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<tr>
<td>Recon</td>
<td>Characterize scientifically compelling sites, and hazards for a potential future landed mission to Europa</td>
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- Conduct 45 low altitude flybys with lowest 25 km (less than the ice crust) and a vast majority below 100 km to obtain global regional coverage
- Traded enormous amounts of fuel used to get into Europa orbit for shielding (lower total dose)
- Simpler operations strategy
- No need for real time down link

Lander Concept Studies Are Continuing
SIMPLEEx Cubesats Selections
Full missions (2)
and
Approved for 1 year Tech Development (3)
Lunar Polar Hydrogen Mapper (LunaH-Map)
PI: Craig Hardgrove
ASU School of Earth and Space Exploration

CubeSat Particle Aggregation and Collision Experiment (Q-PACE)
PI: Josh Colwel
University of Central Florida
Simplex Cubesats

Approved for Tech Development (1 year) Study ONLY

Mars Micro Orbiter
PI: Michael Malin
Malin Space Science Systems

Diminutive Asteroid Visitor using Ion Drive (DAVID)
PI: Geoffrey Landis
NASA Glenn Research Center

Hydrogen Albedo Lunar Orbiter (HALO)
PI: Michael Collier,
NASA GSFC
Planetary Defense Program
Planetary Defense Coordination Office (PDCO)

Hosted by the Planetary Science Division PDCO is responsible for:

- Oversight of potentially hazardous objects (PHOs):
  - Ensure early detection
  - Characterize PHOs of size large enough to affect Earth’s surface
  - Provide warning of potential impact effects if not deflected or mitigated
  - Provide timely and accurate communications about PHOs and any potential impact

- Lead research into potential asteroid deflection and impact mitigation technologies and techniques

- Provide lead coordination role in U.S. Gov’t planning for response to an actual impact threat (e.g., planetary science and deep space mission expertise for Federal Emergency Response Team)
International Activities
2015 NASA – JAXA MOU

- Three Hayabusa2 scientists are now Co-Investigators on OSIRIS-REx
  - Dr. Makoto Yoshikawa, JAXA
  - Dr. Sei-ichiro Watanabe, Nogoya Univ.
  - Dr. Shogo Tachibana, Hokkaido Univ.

- Three OSIRIS-REx scientists are now Co-Investigators on Hayabusa2
  - Dr. Dante Lauretta, Univ. Arizona
  - Dr. Olivier Barnouin, APL
  - Dr. Harold Connolly, CUNY

- NASA’s *Hayabusa2 Participating Scientist Program* has selected 9 investigators to join the Hayabusa2 Science Team
  - Dr. Mary Crombie, Indigo Inf. Svc.
  - Dr. Deborah Domingue Lorin, PSI
  - Dr. Carolyn Ernst, APL
  - Dr. Lucille Le Corre, PSI
  - Dr. Scott Messenger, NASA/JSC
  - Dr. Larry Nittler, Carnegie Inst.
  - Dr. Driss Takir, USGS
  - Dr. Michael Zolensky, NASA/JSC
  - Dr. Nicolas Moskovitz, LowellObs.
ExoMars 2016 IDS, GIs

- ESA released an Announcement of Opportunity on 8 February for Interdisciplinary Scientists or Guest Investigators on the ExoMars 2016 mission.
  - Mandatory Letters of Intent were due 29 February.
  - Proposals due 30 March

- A ROSES addendum will be released for proposals for US investigators to participate in ExoMars 2016 as either a Interdisciplinary Scientists or Guest Investigators on the mission
  - Because the Proposer must submit a proposal to the ESA AO, the due date for US proposals to NASA will be shortly after the addendum release date.

Note the ESA AO “is open to scientists based in ESA Member States, Canada, and Russia. However, specific expertise not present in ESA Member States, Canada and Russia could be covered by scientists from other countries. Team members participating in a team supporting an IDS can be from any country.”
Questions?