NASA Planetary Science Program

Jim Green
Director, Planetary Science
May 23, 2012

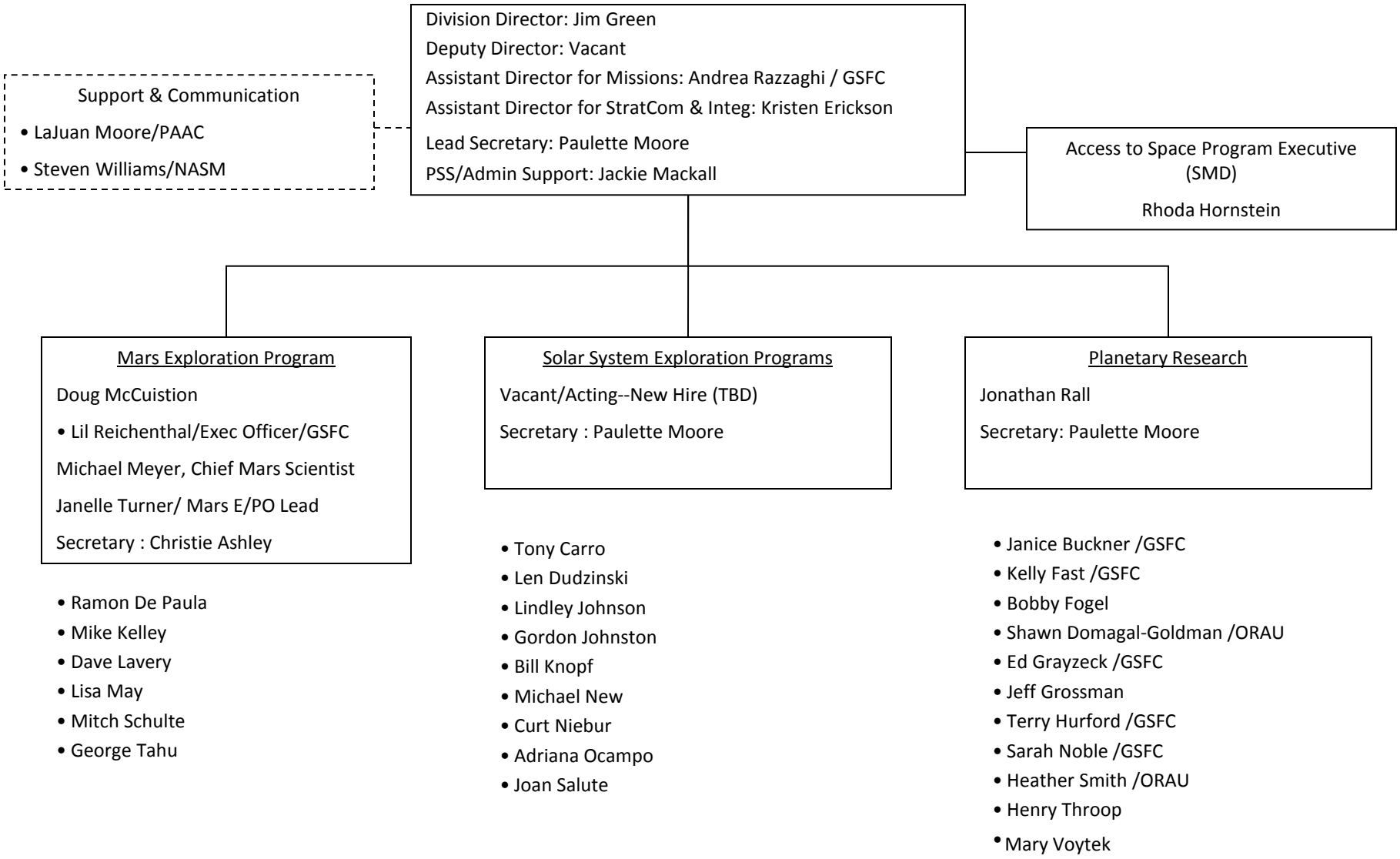
Planetary Science Objectives

NASA's goal in Planetary Science is to "*Ascertain the content, origin, and evolution of the solar system, and the potential for life elsewhere*."

- **Planetary Program** seeks to answer fundamental science questions:
  1. What is the inventory of solar system objects and what processes are active in and among them?
  2. How did the Sun's family of planets, satellites, and minor bodies originate and evolve?
  3. What are the characteristics of the solar system that lead to habitable environments?
  4. How and where could life begin and evolve in the solar system?
  5. What are characteristics of small bodies and planetary environments that pose hazards and/or provide resources?

Planetary Science accomplishes these goals through a series of strategic-large, medium, small mission and supporting research

Planetary Science Division



Year of the Solar System
Planetary Science Mission Events

• Completed

2010

- September 16 – Lunar Reconnaissance Orbiter in PSD
- November 4 - EPOXI encounters Comet Hartley 2
- November 19 - Launch of O/OREOS

2011

- February 14 - Stardust NExT encounters comet Tempel 1
- March 7 – Planetary Science Decadal Survey released
- March 17 - MESSENGER orbit insertion at Mercury
- May 5 - Selection of 3 Discovery-class missions for study
- May - Selection of the next New Frontier mission for flight, OSIRIS-REx
- July 16 - Dawn orbit insertion at asteroid Vesta
- August 5 - Juno launched to Jupiter
- August 9 - Mars Opportunity Rover gets to Endeavour Crater
- September 10 - GRAIL launch to the Moon
- November 26 - Mars Science Laboratory launch to Mars
- December 31 - GRAIL-A (Ebb) orbit insertion at Moon

2012

- January 1 - GRAIL-B (Flow) orbit insertion at Moon

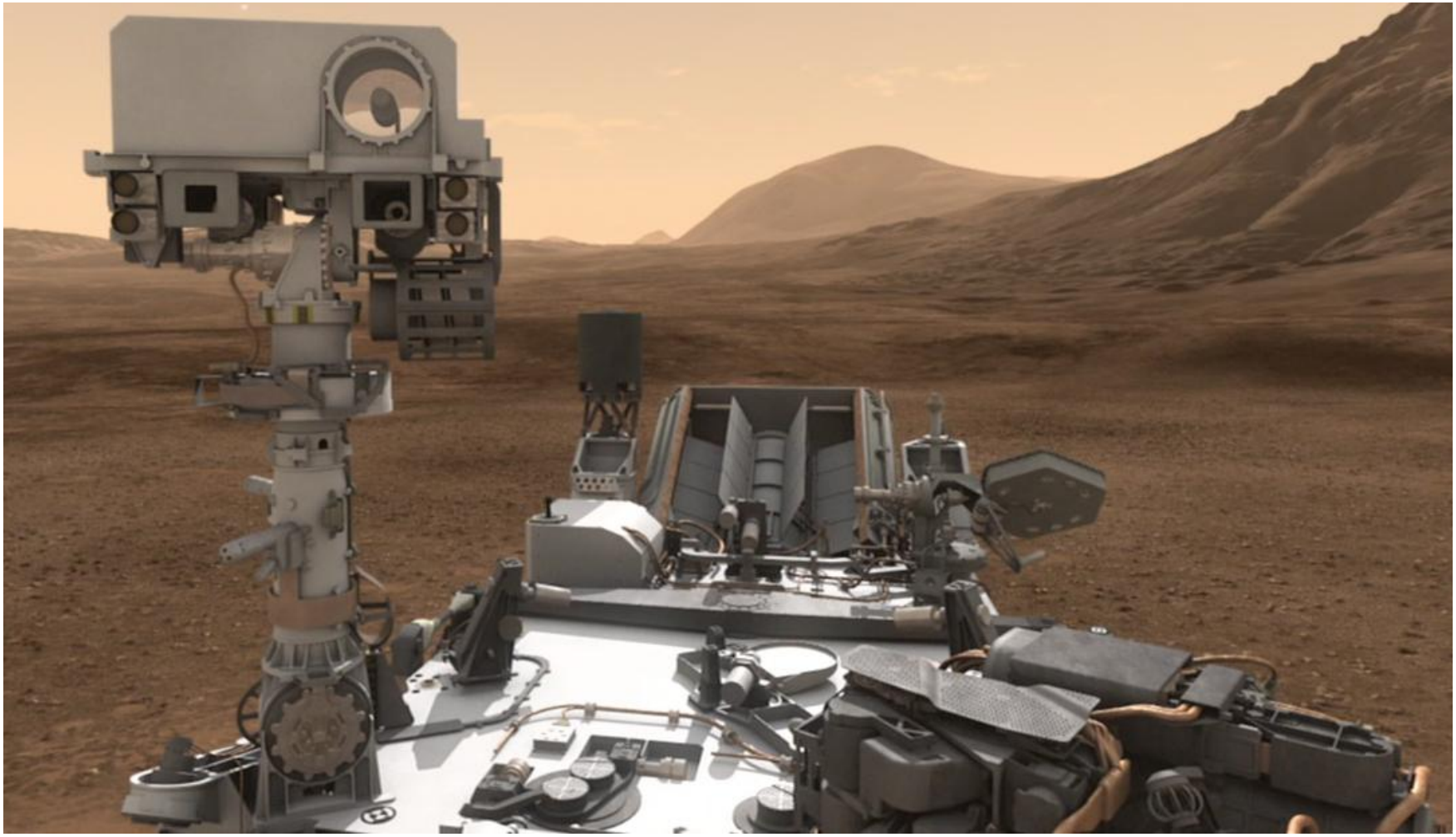
June 5 – Venus Transit – Last One in Our Lifetime

August 6 – MSL's Curiosity Rover Lands on Mars

Mid-Aug - Dawn leaves Vesta starts on its journey to Ceres

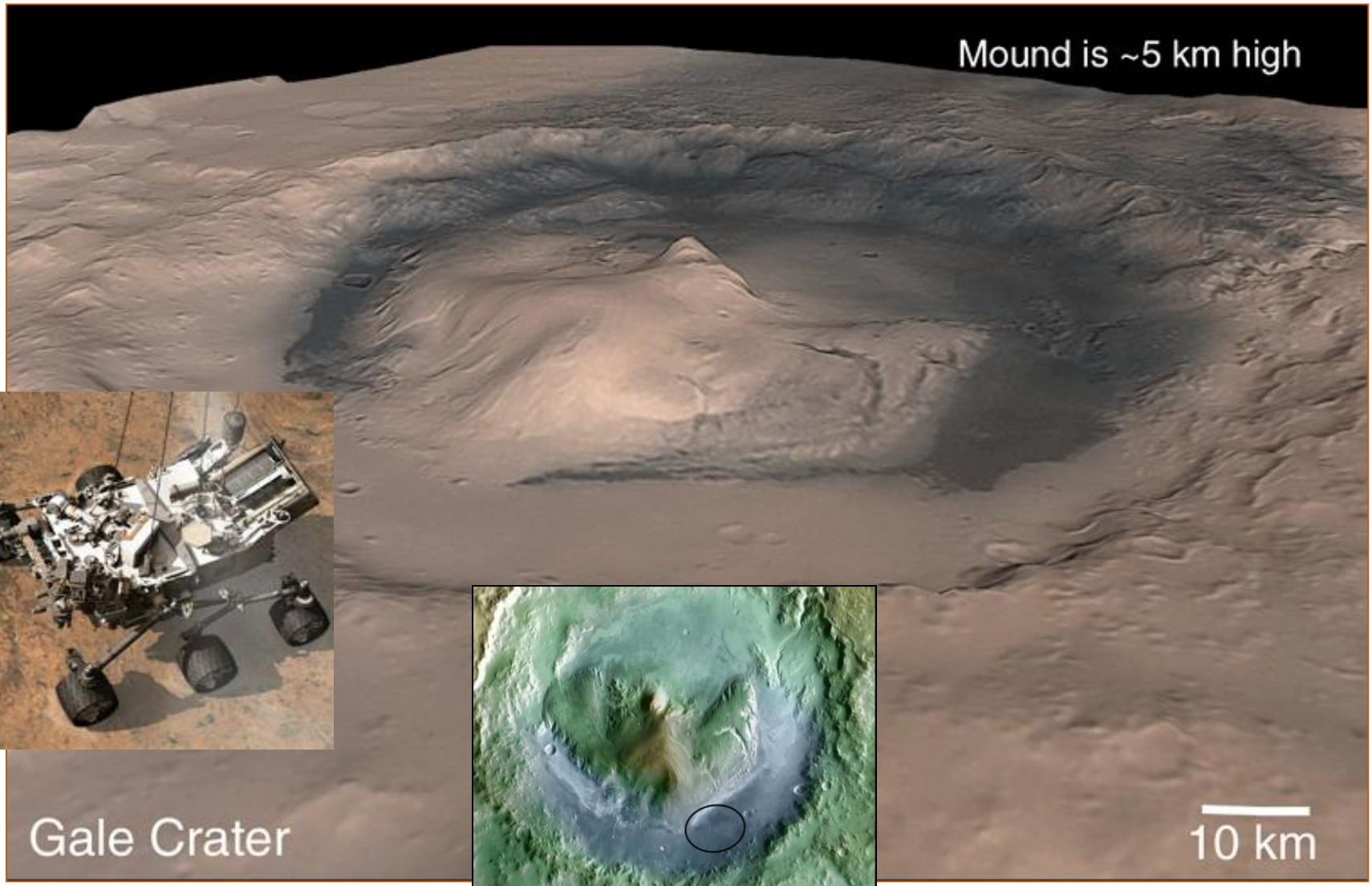
http://solarsystem.nasa.gov

Top Priority for PSD in FY12

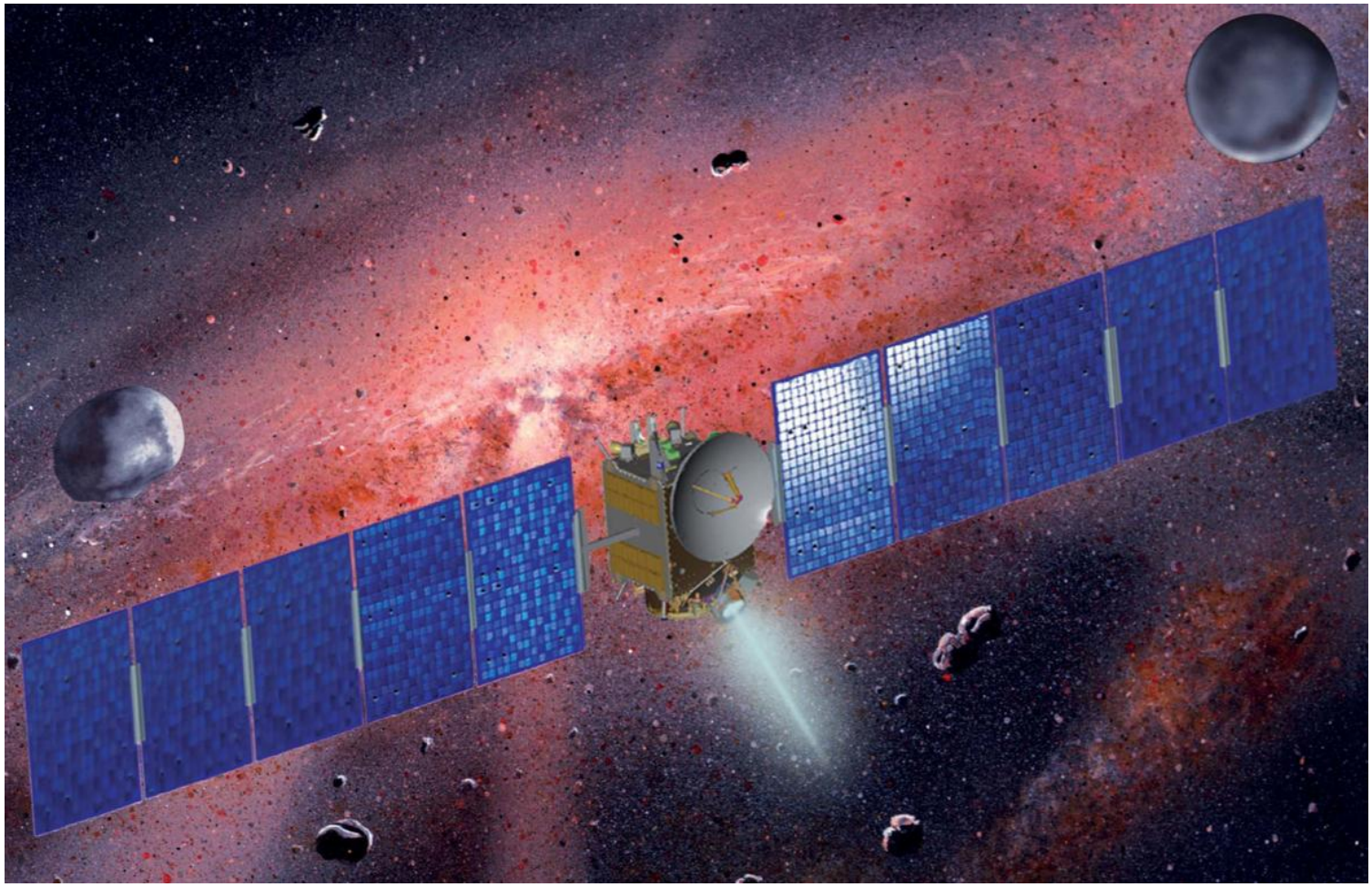


- Safely land MSL on Mars! Aug 6 (~1AM Eastern)

Curiosity's Landing Site: Gale Crater



Dawn From Vesta To Ceres



- Leaves LAMO (~220 km) and begins journey to HAMO (~680 km) over the next few weeks

2012 TRANSIT OF VENUS

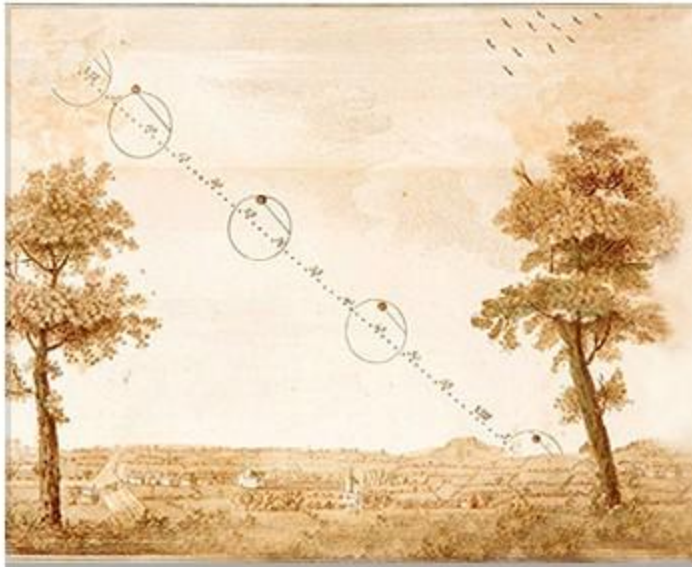
SUN-EARTH DAY: SHADOWS OF THE SUN

Live Web Cast on June 5th, 2012

Event Locations!

Find a Transit of Venus event near you on our Google Map

Submit Event



Technology Through Time, Issue #73

A Brief History of the Transit of Venus

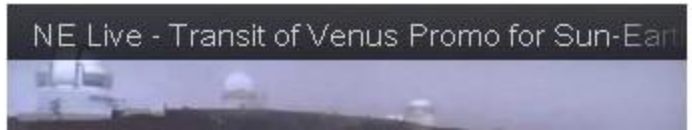
There have been 53 transits of Venus across the Sun between 2000 B.C and 2004 A.D. History says that Jeremiah Horrocks was the first human to ever witness a transit by Venus in 1639, but could other more ancient people have also seen it too?

Continue reading...

Pause | Previous | Next

1 | 2 | 3 | 4

This year's grand celebration is on June 5, 2012, the Transit of Venus! We have teamed up with NASA Edge to bring you an exciting

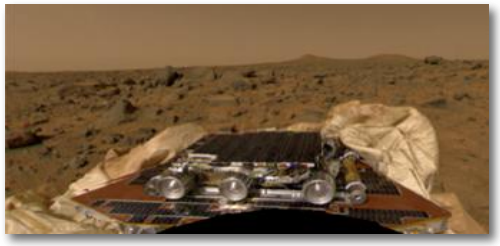


Mission Status

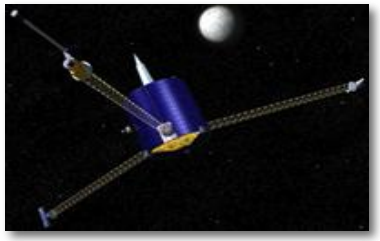
Discovery Program

Completed

Mars evolution:
Mars Pathfinder (1996-1997)



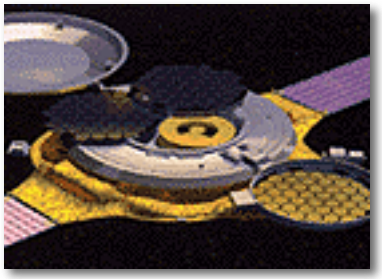
Lunar formation:
Lunar Prospector (1998-1999)



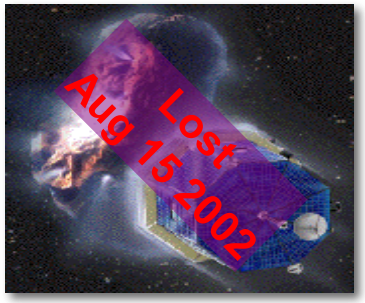
NEO characteristics:
NEAR (1996-1999)

Completed / In Flight

Solar wind sampling:
Genesis (2001-2004)



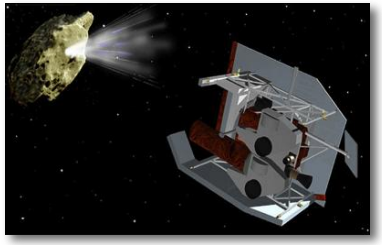
Comet diversity:
CONTOUR



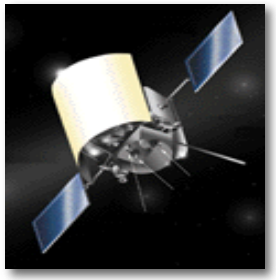
Nature of dust/coma:
Stardust (1999-2011)

In Flight / In Development

Comet internal structure:
Deep Impact (2005-2012)

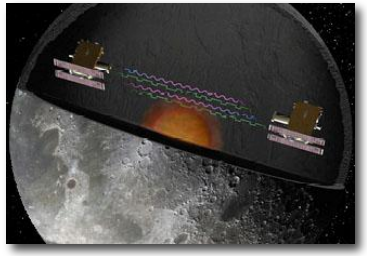


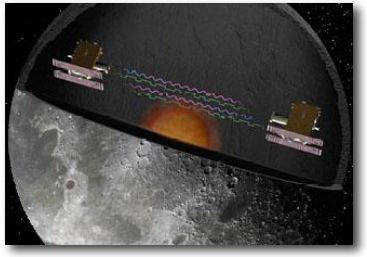
Mercury environment:
MESSENGER (2004-*2013*)



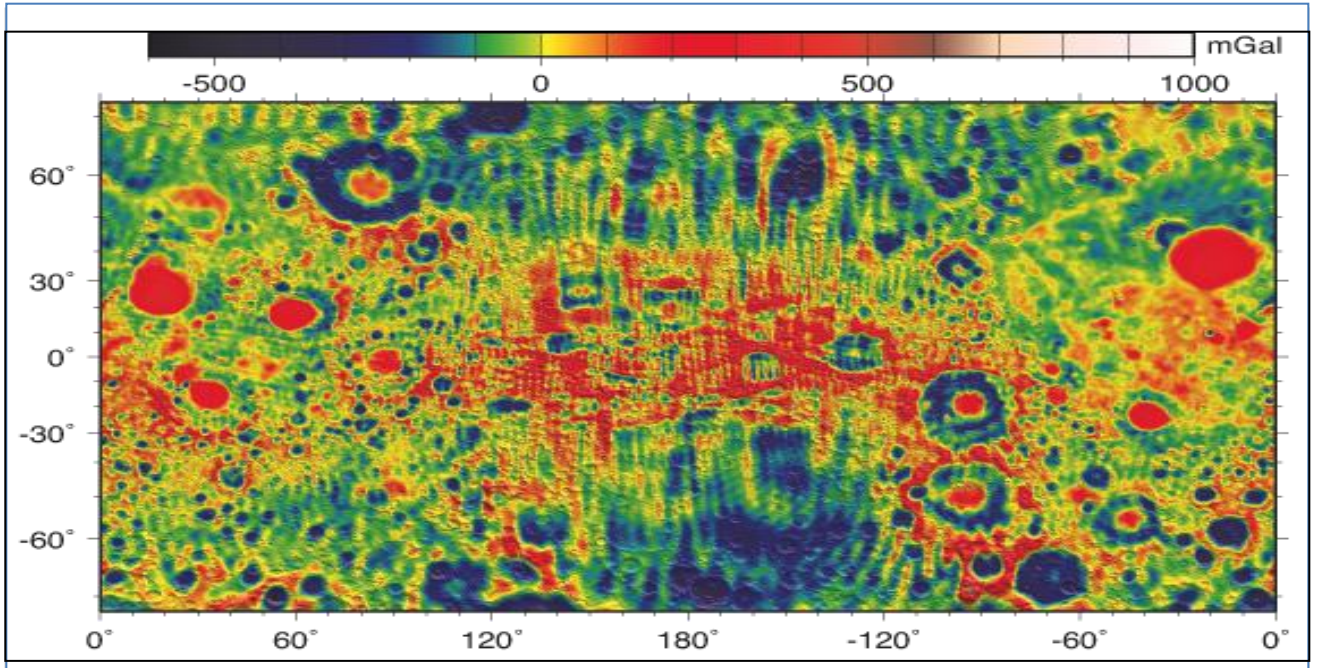
Main-belt asteroids:
Dawn (*2007-2015*)

Lunar Internal Structure
GRAIL (*2011-2012*)

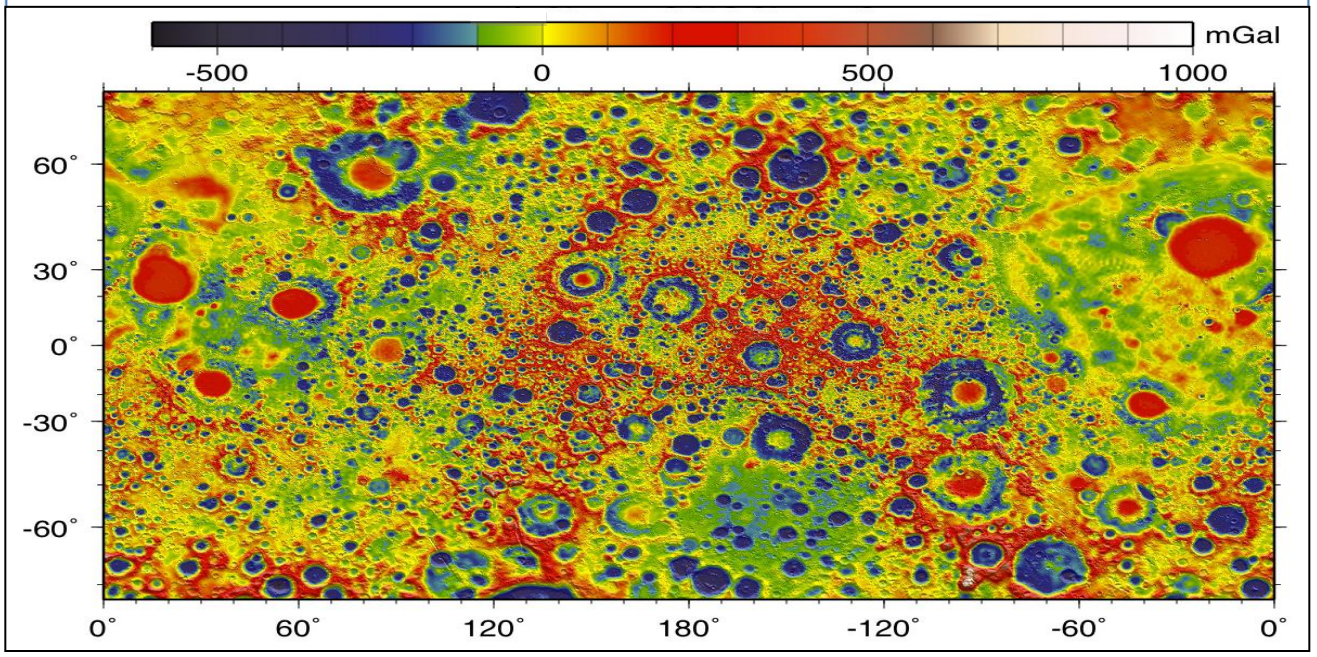




Lunar Gravity

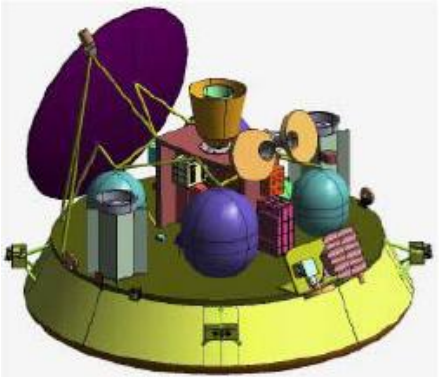


GRAIL after 1 month

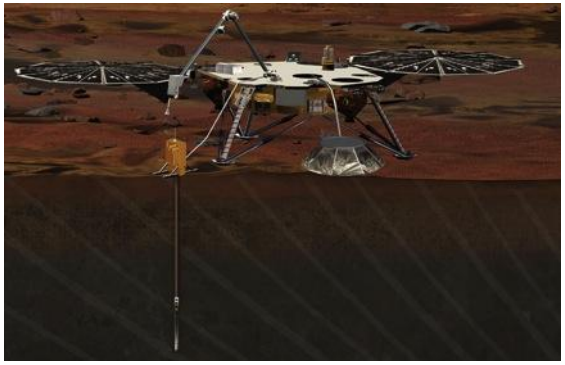


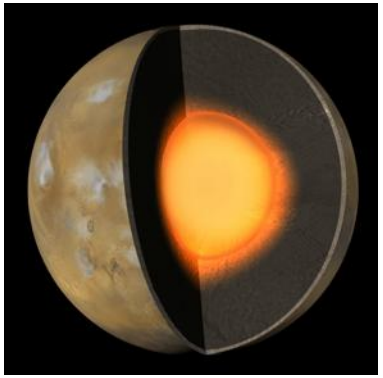
Next Discovery Mission – Candidate Studies

CHopper: Comet Hopper
PI: Jessica M. Sunshine, UMD

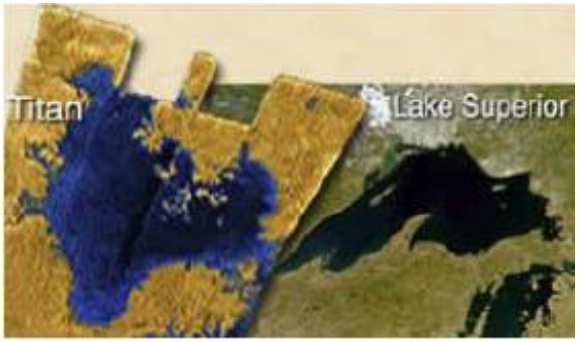


InSight
PI: Bruce Banerdt, JPL





TiME: Titan Mare Explorer
PI: Ellen Stofan, Proxemy Research



- Step-2 Proposals due March 19 (all arrived!)
- Selection announcement on track for mid-July
- Discovery-13 AO in FY15

New Frontiers Program

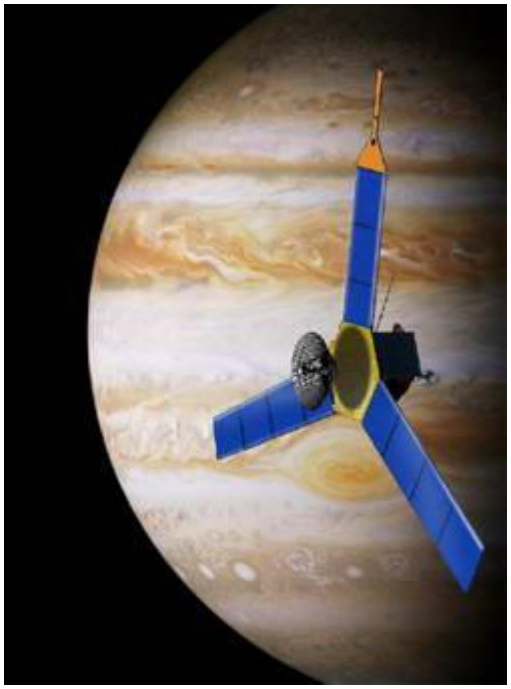
1st NF mission
New Horizons:

Pluto-Kuiper Belt

Launched January 2006
Arrives July 2015
PI: Alan Stern (SwRI-CO)

2nd NF mission
JUNO:

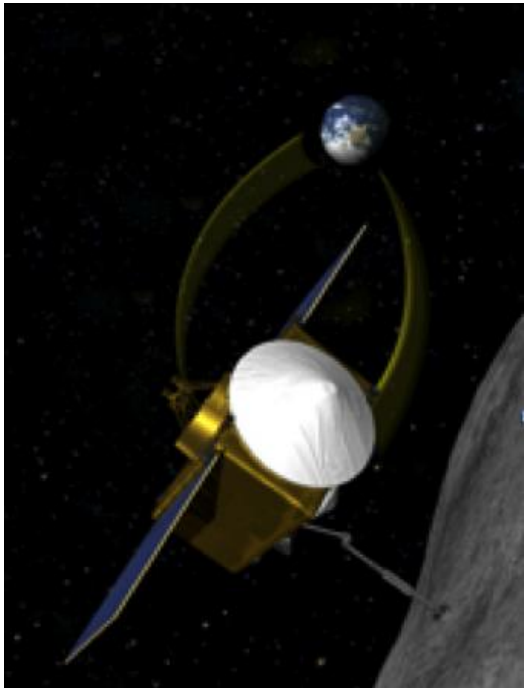
Jupiter Polar Orbiter



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

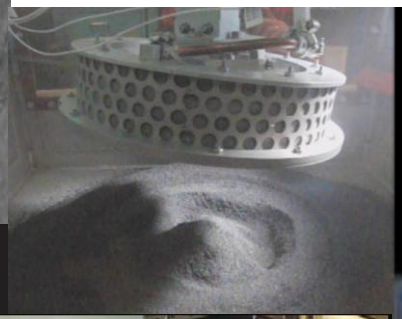
3rd NF mission
OSIRIS-REx

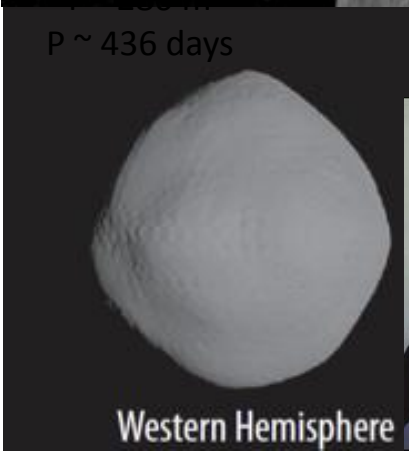
Asteroid Sample Return



Sept. 2016 LRD
PI: Dante Lauretta (UA)

Origins-**S**pectral **I**nterpretation-**R**esource **I**dentification-**S**ecurity-**R**egolith **Ex**plorer (OSIRIS-REx)





Science Objectives:

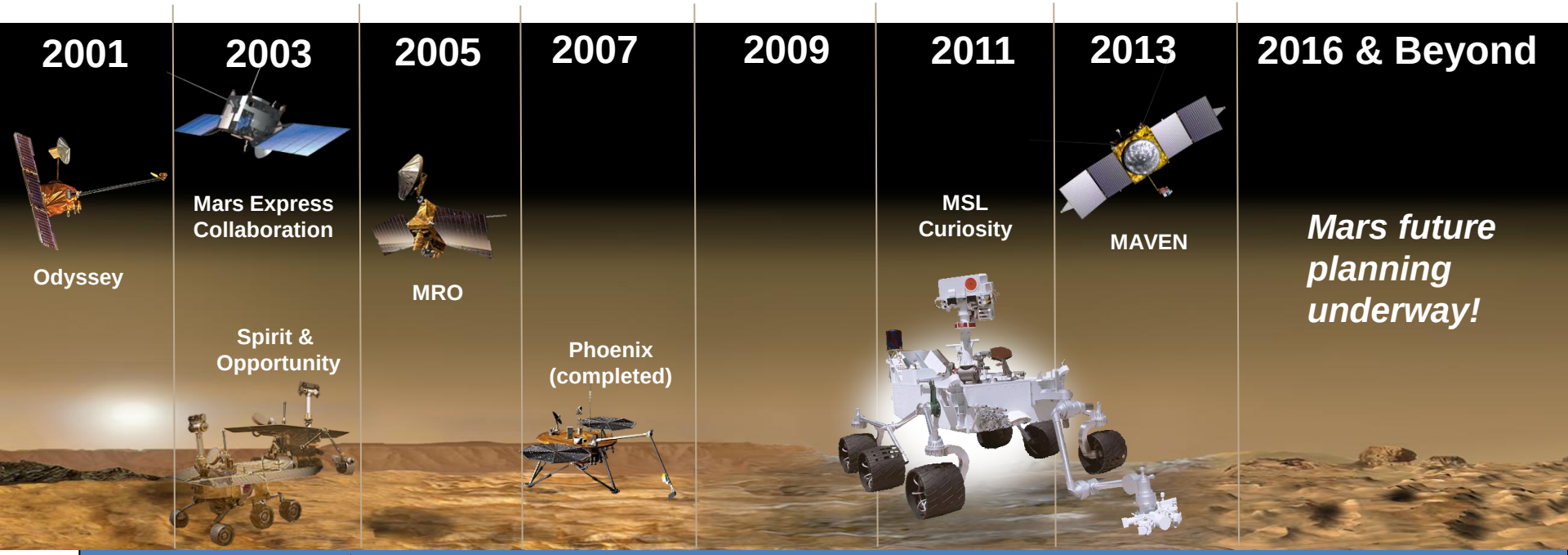
- Return and analyze a sample of pristine carbonaceous asteroid
- Map the global properties, chemistry, and mineralogy
- Document in situ the properties of the regolith at the sampling site
- Characterize the integrated global properties to allow comparison with ground-based telescopic data of entire asteroid population
- Measure the Yarkovsky effect

Mission Overview:

- Launch in September 2016
- Encounter asteroid (101955) 1999 RQ36 in October 2019
- Study RQ36 for up to 505 days, globally mapping the surface
- Obtain at least 60 g of pristine regolith/surface material
- Return sample to Earth in September 2023 in a Stardust-heritage capsule
- Deliver samples to JSC curation facility for world-wide distribution

Mars Exploration Program

An Integrated, Strategic Program



Strategic, Core Missions

Competitive PI-Led Missions

Advanced Planning with Community Input

E/PO Programs

MEP Base Technology Program

MRO Focused Technology

MSL Focused Technology

Future missions Focused Technologies

Upcoming Launches

- MAVEN and LADEE in final phases of development for 2013 launch dates

Planetary R&A Program

Supporting Research & Analysis (R&A) Program Elements

Planetary Science Research

PGG, Cosmochem, PAST, PATM, PME, PIDDP, Origins, PP, LPI, NAI, Exobiology, ASTEP, ASTID
Near Earth Objects Observation (NEOO)
Planetary Data Systems (PDS)
Astromaterial Curation

Mars Research & Analysis

Mars Data Analysis Program (MDAP)
Mars Fundamental Research Program (MFRP)

Discovery Research

SRLI DAP/LARS (Lab Analysis of Returned Samples)
PMDAP (Planetary Missions DAP)
MESSENGER/Dawn PSP
GRAIL PSP

Outer Planets Research

OPRP, Cassini DAP/PSP

Lunar Science Research

NLSI, LASER, MMAMA, PGG/Cosmo Lunar, LRO PSP

Call for Proposal to these PSD Program Elements comes out in ROSES

NASA PLANETARY RESEARCH AND DATA ANALYSIS PROGRAMS			
PROGRAM	**FY10**	**FY 11**	**FY 12**
AstroCuration	4.473	5.509	6.000
Near-Earth Objects	5.800	7.848	20.425
Hayabusa Participating Scientist Program	0.259	0.304	0.000
Planetary Data System	10.120	11.504	14.000
New Horizons at Jupiter Data Analysis Program	1.234	1.188	0.000
Cassini Data Analysis (CDAP)	4.035	5.527	5.610
Outer Planets Research (OPR)	7.922	11.998	11.880
Mars Multi-Mission DA & Data Products	1.126	0.274	0.054
Mars Fundamental Research Program	7.091	7.601	8.767
Mars Data Analysis Program (MDAP)	7.737	8.375	9.073
Mars Phoenix DAP	0.000	1.093	0.804
MER Participating Scientist Program	4.172	0	0.000
Mars Instrument Development Prog (MIDP)	2.677	1.051	0.000
Sample Ret Lab Inst & Data Anlys (SRLIDAP)	3.947	10.693	9.513
Discovery Data Analysis (DDAP now PMDAP)	2.094	2.516	3.500
Messenger Participating Scientist Program	1.146	2.240	2.376
DAWN Participating Scientist Program	0.555	1.670	1.710
Planetary Geology & Geophysics (PGG)	10.044	12.116	11.889
Cosmochemistry (COSMO)	11.670	12.331	14.507
Planetary Astronomy (PAST)	9.963	9.045	10.163
Planetary Atmospheres (PATM)	8.753	8.915	9.100
Planetary Instrument Def & Dev (PIDDP)	10.086	8.503	10.946
Origins of the Solar System (ORIGINS)	5.267	5.272	7.118
Neo-Wise/NEO	1.800	0.660	0.276
Planetary Protection	3.190	2.512	2.540
Astrobio Sci & Tech for Expl Planets (ASTEP)	6.157	9.530	13.322
Astrobiology Inst Development (ASTID)	6.805	7.684	8.128
National Astrobiology Institute (NAI)	19.875	20.790	27.292
Exobiology/Evolutionary Biology (EXO)	14.744	16.52	15.000
Planetary R&A (misc)	13.201	3.307	4.530
Venus Express	1.080	1.056	1.080
Planetary Science US Particpating Investigator Program	0.752	0.712	0.305
NLSI	11.535	13.859	9.319
Lunar Reconaissance Orbiter Participating Scientist (LRO PSP)	1.290	0.866	0.000
Lunar Advanced Science & Exploration Research (LASER)	4.325	6.878	8.419
Moon and Mars Analog Mission Activities	0.714	0.580	0.711
GRAIL Guest Scientist Program			0.750
Total R&A Budget	**205.639**	**220.527**	**249.109**
Overall Planetary Budget	**1,364.400**	**1,446.180**	**1500.000**
R&A as % of Budget	15.1%	15.2%	16.6%

Yearly Totals

FY03: $152M

FY04: $177M

FY05: $185M

FY06: $163M

FY07: $149M

FY08: $180M

FY09: $207M

FY10: $206M

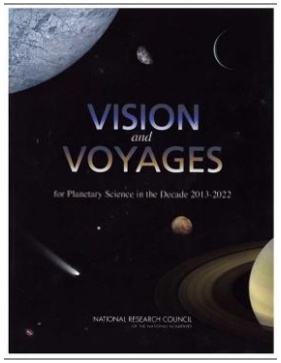
FY11: $221M

FY12: $249M

(Planned)

Activities with Human Exploration

Interaction With Human Exploration



- Some solar system bodies are likely targets of future human exploration:
  - Earth's Moon
  - Mars and its moons
  - Asteroids

- *It is vital to maintain the science focus of peer-reviewed NASA missions to these bodies.*

- Both the Space Science program and the human exploration program can benefit from carefully crafted intra-agency partnerships (LRO is a good recent example).

Science & Exploration Activities

The Planetary Sciences Division and the Exploration Systems Mission Directorate (ESMD) have a successful history of working together. A selection of past successes:

- Hardware:
  - Lunar Reconnaissance Orbiter (LRO): Joint AO
  - Mars Science Laboratory (MSL) payloads: Radiation Assessment Detector (RAD) and Mars Entry, Descent, & Landing Instrumentation (MEDLI)
- Co-funded R&A:
  - Lunar Advanced Science & Exploration Research (LASER), NASA Lunar Science Institute (NLSI)
  - Analog studies: Desert Research & Technology Studies (D-RATS)
- Working Groups:
  - Joint charters for analysis groups: Lunar Exploration Analysis Group (LEAG), Mars Exploration Program Analysis Group (MEPAG), and Small Bodies Analysis Group (SBAG); the Tempe conference convened by the NASA Advisory Council (NAC) for science and exploration
  - Human Exploration Framework Team (HEFT), Exploration Precursor Robotic Missions (xPRM), Near Earth Asteroid User Team (NUT), Near Earth Object Observation (NEOO), Blue Sky, Near Earth Asteroid Working Group (NEA-WG)
- Personnel Exchange:
  - LRO/LCROSS personnel coordination and exchange during development

Joint Robotic Precursor Activity (JRPA) Overview

Goal: Inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration while maximizing the mutual benefit to both science and exploration

- To meet this goal, NASA will jointly fund and conduct Robotic Precursor Activities
  - These activities will provide the strategic knowledge required to inform human spaceflight (HSF) planning. By developing an integrated set of priorities NASA will leverage mission opportunities, data, and the talents of both the exploration and science communities to enable human missions to NEAs, the Moon, and ultimately Mars.
- Such activities will include:
  - Develop instruments for NASA and non-NASA missions to destinations relevant to human exploration beyond LEO to gather needed information
  - Research and Analysis efforts to generate strategic knowledge in support of human spaceflight planning and systems development
  - Perform strategic studies and hold joint workshops to further inform and leverage community participation
  - Lay the groundwork for future precursor missions, should funding improve
- A new strategy for Mars exploration has begun and will include closer ties to HEOMD and OCT (Doug to present)

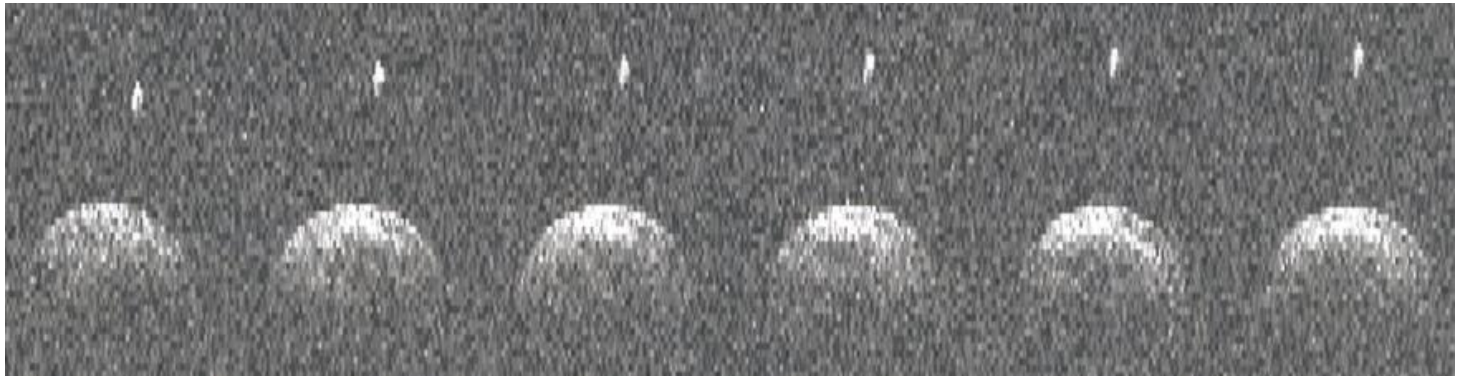
Updates: Senior Review, NEOs, Pu-238

Senior Review

- Issued draft guidelines for Senior Review Sept. 30
  - Comments received and guidelines revised
- Issued request for proposals in January 31, 2012
- Proposals due May 31, 2012
- Senior Review (June-July 2012)
- Final report to PSD Director (July 2012)
- Senior Review results executed beginning of FY13

NEO Update

- Contract with Arecibo supporting Radar at $2M/yr
  - Many more NEO's can now be observed with radar



Arecibo images of *Marco Polo-R* mission target (1996 FG3)

PU-238 & RPS Status

- DoE passed FY12 Omnibus Appropriations:
  - "The conferees provide no funds for the Plutonium-238 Production Restart Project"

- NASA/PSD has provided funding in FY12 to complete the necessary study and assessments
  - Expect the assessment to be completed this CY
  - Develop a new funding strategy to enable restart but with a larger share of the funding from NASA

- ASRG - will complete Engineering & Qual units and continue with life testing

Outer Planets Activities

JUICE Selection for ESA's L1

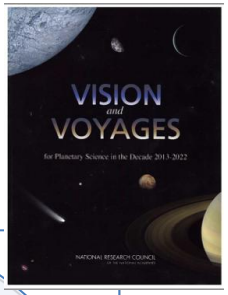
- Letter from Fabio Favata (Head of Sci Planning & Community Coord. Office-ESA) received March 27th
  - Requesting a formal statement from NASA indicating level of interest
  - Kind and amount of contribution envisioned by NASA for US scientists participation in JUICE payload
  - If JUICE selected as the L1 mission intension is to issue an AO immediately
  - NASA statement needed before end of April
- NASA's response coordinated with OMB and OSTP arriving before the ESA-SPC
  - NASA proposes to be a minor partner at ~$100M payload contribution
- Expect a joint announcement next week

NASA Europa Studies Status

- Congress FY12 Approps: “The conferees understand that required descoping studies for planetary flagship missions [Europa] are at or near completion and direct that those studies be submitted to the Committees on Appropriations as soon as possible…”
- JPL-Europa studies were delivered to NASA HQ (orbiter, fly-by, and lander missions)
- Although preliminary versions of the analysis have been presented at OPAG the reports will be reviewed internally *FIRST* before being released
- Next steps: Report back to Congress

Planetary's Future Budget

Planetary Program Architecture
Recommended by the Planetary Decadal Survey



Large Missions ("Flagship"-scale)

"Recommended Program"
(budget increase for JEO new start)

1) Mars Astrobiology Explorer-Cacher – descoped
2) Jupiter Europa Orbiter (JEO) – descoped
3) Uranus Orbiter & Probe (UOP)
4/5) Enceladus Orbiter & Venus Climate Mission

"Cost Constrained Program"
(based on FY11 Request)

1) Mars Astrobiology Explorer-Cacher – descoped
2) Uranus Orbiter & Probe (UOP)

"Less favorable" budget picture than assumed
(e.g., outyears in FY12 request)

Descope or delay Flagship mission

Discovery

$500M (FY15) cap per mission (exclusive of launch vehicle) and 24 month cadence for selection

New Frontiers

$1B (FY15) cap per mission (exclusive of launch vehicle) with two selections during 2013-22

Research & Analysis (5% above final FY11 amount then ~1.5%/yr)

Technology Development (6-8%)

Current Commitments (ie: Operating Missions)

Planetary Science Budget Features

What Changed:

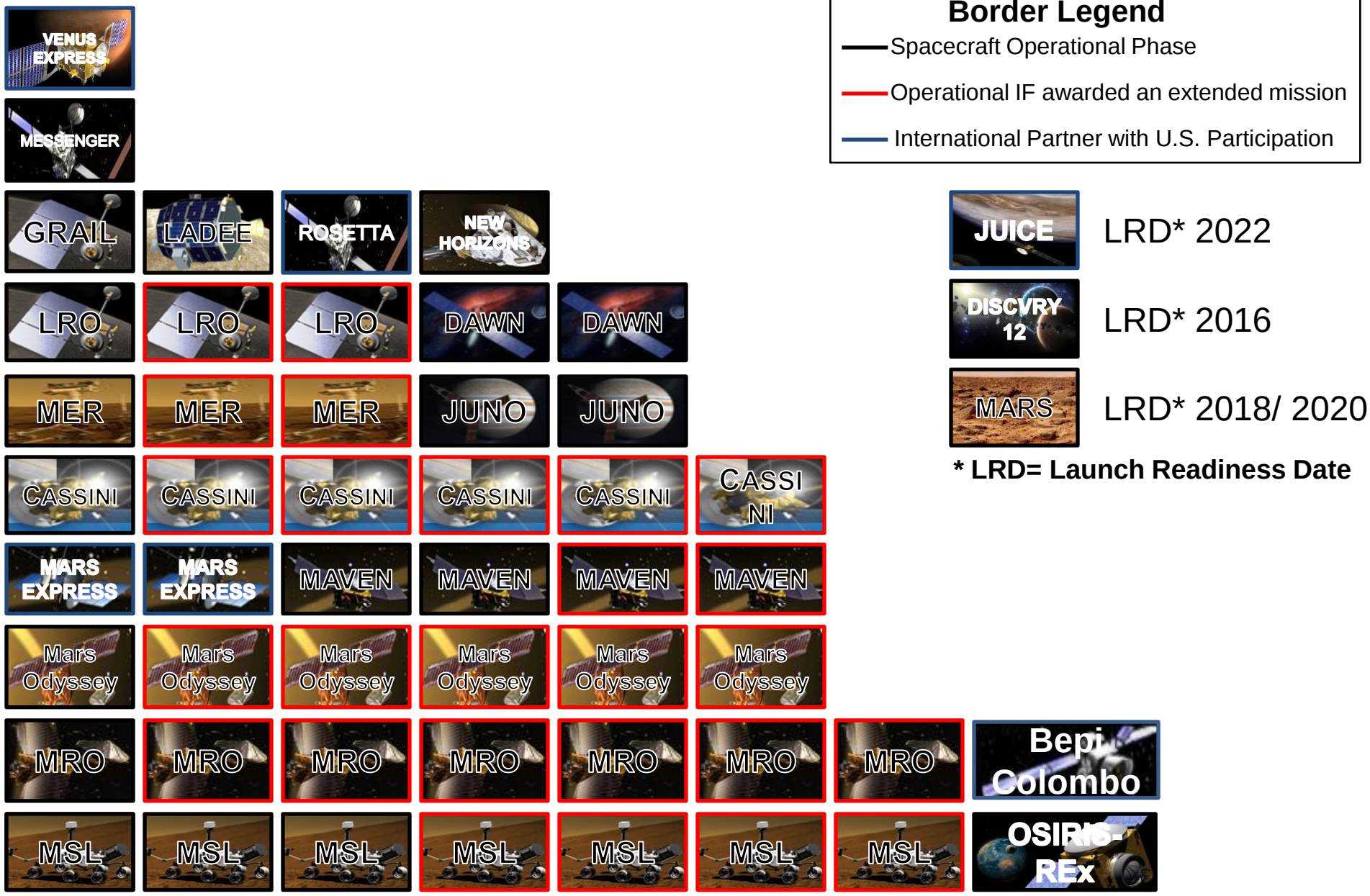
- Initiate a new Mars exploration strategy as an integrated approach by partnering with Human Exploration and the Office of the Chief Technologist:
  - Ending work on 2016 ExoMars Trace Gas Orbiter and Mars 2018 ExoMars rover
- Reduced Discovery flight rate with Discovery 13 AO release moved to FY15
- Reduced New Frontiers flight rate – 4 AO release moved to FY16
- Lunar Quest Program phased out after LADEE with remaining activities absorbed into Planetary Research Programs (NLSI & LASER) and Discovery (LRO)
- Establishes a Joint Robotic Precursor Activity with HEOMD

President's FY13 Budget

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
Planetary Science	$1,450.8	$1,501.4	$1,192.3	$1,133.7	$1,102.0	$1,119.4	$1,198.8
Planetary Science Research	$158.8	$174.1	$188.5	$222.5	$233.4	$231.7	$230.3
Lunar Quest Program	$130.2	$139.9	$61.5	$6.2			
Discovery	$192.0	$172.6	$189.6	$242.2	$235.6	$193.8	$134.3
New Frontiers	$213.2	$160.7	$175.0	$269.8	$279.6	$259.9	$155.1
Mars Exploration	$547.4	$587.0	$360.8	$227.7	$188.7	$266.9	$503.1
Outer Planets	$91.9	$122.1	$84.0	$80.8	$78.8	$76.2	$76.3
Technology	$117.3	$144.9	$132.9	$84.6	$85.9	$90.9	$99.6

- Grey region is a "notional" budget – top line remains the same but details within may change
- Congress is deliberating on additional funding in FY13 for PSD

Planetary Science Operating Missions by Year 2012-2022




50 YEARS
Washington, D.C.,
25-26 October 2012.
solar system exploration
http://solarsystem.nasa.gov/50th

Questions?

Planetary R&A Programs Elements

- PGG - Planetary Geology & Geophysics – supports scientific investigations of planetary surfaces & interiors, satellites, ring systems, comets & Asteroids
- Cosmochemistry - supports scientific investigations of extraterrestrial material aimed at understanding solar system bodies as well as dust.
- LARS - Laboratory Analysis of Returned Samples – goal is to maximize scientific return of returned samples from missions such as Stardust, Genesis & Hayabusa
- Planetary Astronomy - supports ground-based astronomical observations and suborbital investigations using sounding rockets & balloons from UV to radio wavelengths
- Planetary Atmospheres - supports scientific investigations to understand origins and evolution of atmospheres, planets & satellites and comets.
- NEOO - Near Earth Object Observations – goal is to discover all NEOs with diameters ≥ 1 km and to characterize that population.
- Origins - Origins of the Solar System – seeks to understand how the terrestrial planets, moons, giant planets were formed and evolved into our present state
- Planetary Protection Research – goal is to prevent biological contamination on outbound and sample return missions to other planetary bodies.
- PIDDP - Planetary Instrument Definition & Development Program - supports the advancement of spacecraft-based instrumentation technology that shows promise in scientific investigations on future planetary missions

Astrobiology (NAI, ASTID, ASTEP, Exobiology)

- NAI - NASA Astrobiology Institute
- Astrobiology: Exobiology & Evolutionary Biology – goal is to understand the origin, evolution, distribution and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments and implications for life elsewhere
- ASTID - Astrobiology Science & Technology for Instrument Development - goal is to develop instrumentation to help meet astrobiology science requirements on future flight missions as well as unique astrobiology objectives on Earth
- ASTEP - Astrobiology Science & Technology for Exploring Planets – support the development of astrobiologically relevant, miniaturized instrumentation capable of extensive operations on lunar & planetary surfaces throughout the Solar System
- Mission Concept Development for Astrobiology Small Payloads

Lunar Science Research

- These programs are jointly supported by PSD and HEOMD/ESMD for the last several years
- NLSI - NASA Lunar Science Institute
- LASER - Lunar Advanced Science & Exploration Research – funds basic and applied lunar science and exploration.
- MMAMA - Moon & Mars Analog Missions Activities – addresses the need for integrated interdisciplinary field experiments as an integral part of preparation for planned human and robotic missions to asteroids, the Moon and/or Mars.
- LRO PSP – Lunar Reconnossiance Orbiter Participating Scientist Program – objective is to enhance the scientific return of the LRO mission by broadening the scientific participation in the mission science planning and data analysis.

Outer Planets

- OPR - Outer Planets Research – supports diverse scientific investigations that contribute to the understanding of the outer Solar System including the giant planets, their satellites and smaller bodies including comets, asteroids, and Kuiper Belt objects.
- CDAP - Cassini Data Analysis Program – goal is to enhance the scientific return of the Cassini mission by broadening the scientific participation in the analysis & interpretation of the returned data. Also supports participating scientists.

Discovery Research

- PMDAP - Planetary Mission Data Analysis Program – objective is to enhance the scientific return of Planetary Science Division missions by broadening the scientific participation in the analysis of archived data collected by those missions (e.g. Dawn, Deep Impact, Deep Space 1, EPOXI, Galileo, Giotto, Hayabusa, Magellan, NEAR, MESSENGER, Pioneer Venus, Stardust-NExT, + others)

- PSP - MESSENGER Participating Scientist Program - objective is to enhance the scientific return of the MESSENGER mission by broadening the scientific participation in the mission science planning and data analysis.

Mars Research & Technology

- MDAP - Mars Data Analysis Program - objective is to enhance the scientific return from missions to Mars conducted by NASA and other space agencies

- MFRP - Mars Fundamental Research Program – seeks to sponsor the best and most innovative scientific research concerning the atmospheric, climatological, geologic, geophysical and geochemical processes on Mars.

- MIDP - Mars Instrument Development Project – supports the advancement of spacecraft-based instrumentation technology that shows promise in scientific investigations on future Mars missions

- Mars Technology Project – Seeks to ensure that appropriate spacecraft technologies are available in a sufficiently mature state to support the challenges of the Mars Exploration Program