

# NASA Planetary Science Programs



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Presentation at OPAG

# Outline

- Mission events
- Passed FY15 Budget elements
- President's FY16 Budget
- Discovery and New Frontiers Status
- Mars Program Status
- Outer Planets Mission Status

# Planetary Science Missions Events

## 2014

July – *Mars 2020* Rover instrument selection announcement

\* Completed

August 6 – 2<sup>nd</sup> 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 JU<sub>3</sub>

## 2015

March 6 – *Dawn* inserted into orbit around dwarf planet Ceres

Early April – *MESSENGER* spacecraft impacts Mercury

April – Europa instrument Step 1 selection

May – Discovery 2014 Step 1 selection

July 14 – *New Horizons* flies through the Pluto system

## 2016

March – Launch of Mars missions *InSight* and ESA's *ExoMars Trace Gas Orbiter*

March – Europa instrument Step 2 selection

July – *Juno* inserted in Jupiter orbit

July – ESA's *Bepi Colombo* launch to Mercury

August – Discovery 2014 Step 2 selection

September – *InSight* Mars landing

September – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu

September – *Cassini* begins to orbit between Saturn's rings & planet

# Planetary Budget



# Passed FY15 Appropriations Bill

- Planetary Total Budget: \$1,438M
- \$255.8M for Planetary Science Research, including \$165.4M for Research and Analysis and \$40M for Near Earth Object Obs;
- \$255M for Discovery, including not less than \$25M for Future Discovery Missions;
- \$286M for New Frontiers, including not less than \$5M for Future New Frontiers Missions and \$224.8M for OSIRIS-REx;
- \$305M for Mars Exploration, including not less than \$100M for a Mars 2020 Rover that meets scientific objectives laid out in the most recent Planetary Science decadal survey;
- \$181M for Outer Planets, including not less than \$100M for a Jupiter Europa mission as described in the House report; and
- \$155M for Technology, including \$18M for technologies for the study and characterization of the surface and subsurface of Europa

# President's FY16 Budget Request (\$M)

[-----Notional-----]

	<b>FY15</b>	<b>FY16</b>	<b>FY17</b>	<b>FY18</b>	<b>FY19</b>	<b>FY20</b>
<b>Planetary Science</b>	<u>\$1,437.8</u>	<u>\$1,361.2</u>	<u>\$1,420.1</u>	<u>\$1,458.0</u>	<u>\$1,502.4</u>	<u>\$1,527.8</u>
Science Research		276.3	282.0	292.0	291.7	285.7
Discovery		156.1	201.6	277.2	337.4	344.9
New Frontiers		259.0	124.0	81.5	85.7	137.8
Mars Exploration		411.9	539.3	561.3	531.5	464.2
Outer Planets		116.2	117.7	81.6	87.6	110.5
Technology		141.7	155.5	164.4	168.5	184.7

# Planetary Budget Features: What's Changed

- Initiates formulation for a mission to Jupiter's moon Europa, to explore the most likely host of current life beyond Earth
- Releases the next New Frontiers AO in 2016
- Maintains Stirling technology development to support future radioisotope power systems
- Establishes the Planetary Missions Program Office at MSFC to manage Discovery, New Frontiers, **JUICE** and **Europa** flight projects
- **Lunar Reconnaissance Orbiter** and **Opportunity** rover not funded in 2016 budget given higher priorities
  - Will reassess condition and cost of maintaining LRO and Opportunity this summer
- Increase in funding for Near Earth Object Observation Program to accelerate hazardous asteroid detection and characterization

# Planetary Budget Features: What's the Same

- Continues development of **InSight** and **OSIRIS-REx** missions for launches in 2016
- Continues development work on **STROFIO**, **MOMA**, and **JUICE** instruments in collaboration with ESA missions to Mercury, Mars and Jupiter, respectively, as well as on-going operations of **Rosetta** and **Mars Express** with ESA and planned operations of **Akatsuki** and **Hayabusa-2** with JAXA.
- Supports Planetary missions with mission operations and navigation tools, data archiving, and sample curation
- Continues supporting research and technology selections and awards, and maintains DOE capabilities to produce radioisotope power generators and the Plutonium-238 to fuel them



# Discovery and New Frontiers Status

# Discovery and New Frontiers

- ◆ Address high-priority science objectives in solar system exploration
- ◆ Opportunities for the science community to propose full investigations
- ◆ Fixed-price cost cap full and open competition missions
- ◆ Principal Investigator-led project



- ◆ Established in 1992
- ◆ **\$450M cap** per mission excluding launch vehicle (FY15)
- ◆ Open science competition for all solar system objects, except for the Earth and Sun

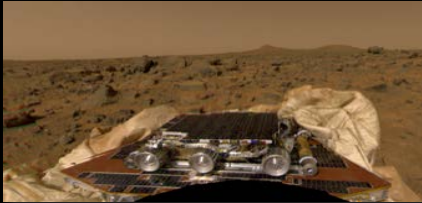


- ◆ Established in 2003
- ◆ **\$1,000M cap** per mission excluding launch vehicle (FY15)
- ◆ Addresses high-priority investigations identified by the National Academy of Sciences

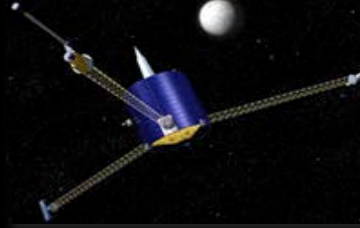
# Discovery Program

Completed

Mars evolution:  
Mars Pathfinder (1996-1997)



Lunar formation:  
Lunar Prospector (1998-1999)



NEO characteristics:  
NEAR (1996-1999)



Solar wind sampling:  
Genesis (2001-2004)



Completed

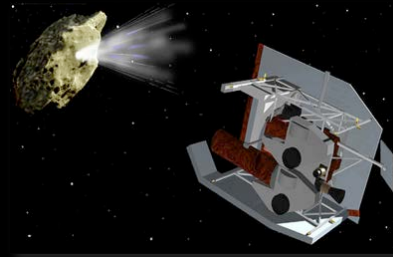
Comet diversity:  
CONTOUR (2002)



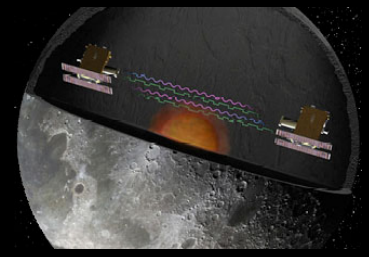
Nature of dust/coma:  
Stardust (1999-2011)



Comet internal structure:  
Deep Impact (2005-2012)

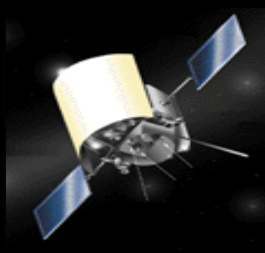


Lunar Internal Structure  
GRAIL (2011-2012)

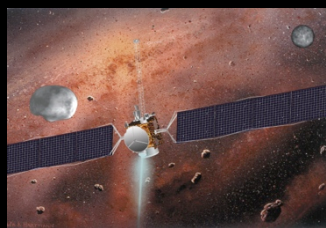


In Flight / In Development

Mercury environment:  
MESSENGER (2004-2015)



Main-belt asteroids:  
Dawn (2007-2016)



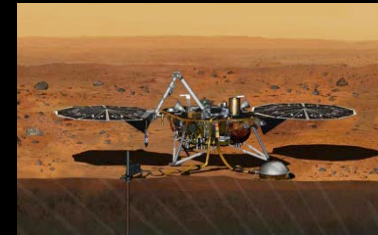
Lunar surface:  
LRO (2009-TBD)



ESA/Mercury Surface:  
Strofio (2016-TBD)



Mars Interior:  
InSight (2016-TBD)





# Status of Discovery Program

Discovery proposals were due yesterday - February 18<sup>th</sup>

## Missions in Development

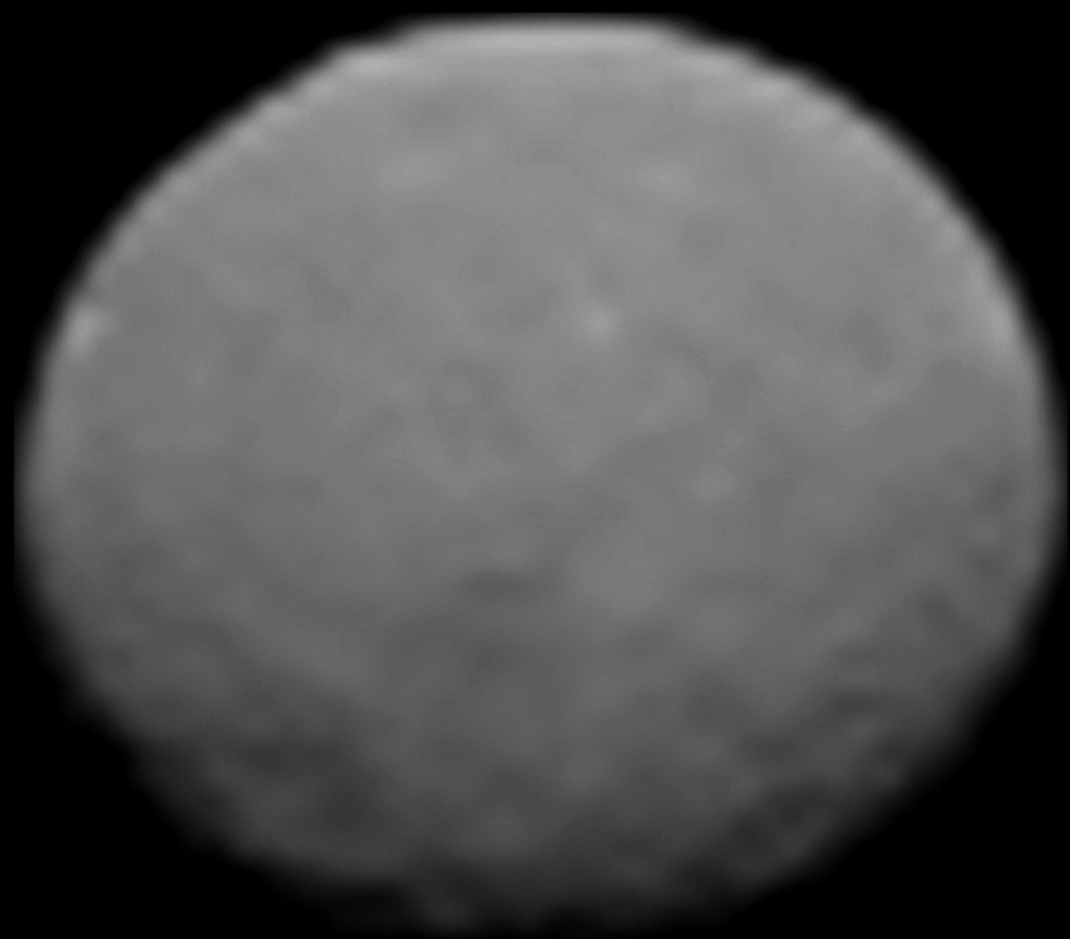
- InSight: Confirmed to begin Phase C on December 6, 2013
- Strofio: Delivered to SERENA Suite (ASI) for BepiColombo

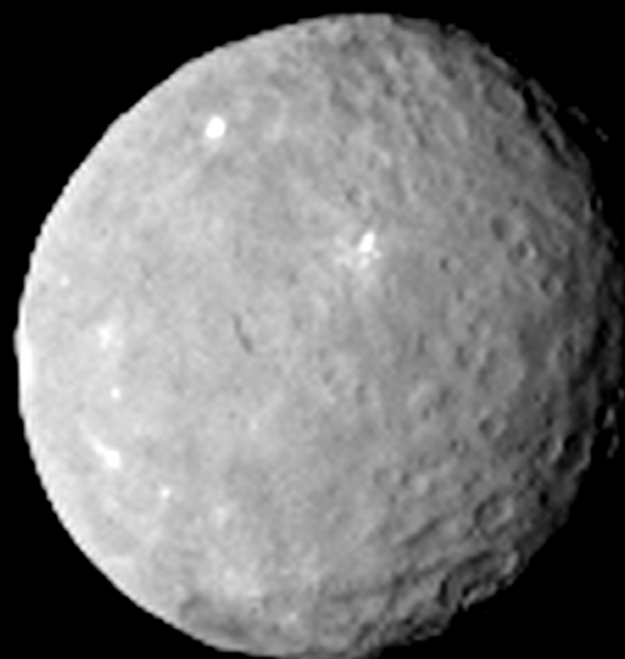
## Missions in Operation

- Dawn: Cruising to Ceres with orbit capture ~March 6

## Missions in Extended Operations

- MESSENGER: The spacecraft concluded its first hot-planet season of Mercury year 13 on February 28
- LRO: LRO spent its first three years in a low polar orbit collecting detailed information about the moon and its environment. After this initial orbit, LRO transitioned to a stable elliptical orbit, passing low over the lunar south pole.





# New Frontiers Program

1<sup>st</sup> NF mission  
New Horizons:

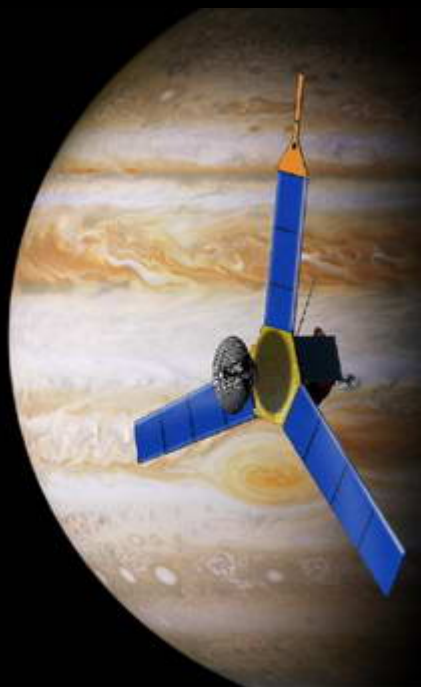
Pluto-Kuiper Belt



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

2<sup>nd</sup> NF mission  
JUNO:

Jupiter Polar Orbiter



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

3<sup>rd</sup> NF mission  
OSIRIS-REx:

Asteroid Sample Return



To be launched: Sept. 2016  
PI: Dante Lauretta (UA)



# Overview of New Frontiers Program

Next New Frontiers AO to be released in Fiscal Year 2016

## Missions in Development

### – OSIRIS REx:

- Launch in Sept 2016 & encounter asteroid Bennu in Oct 2018.
- Operate at asteroid Bennu for over 400 days.
- Will return a sample (arrives in 2023) that scientists will study for decades with ever more capable instruments and new techniques.

## Missions in Operation

### – New Horizons:

- Spacecraft is 31.4 AU from the sun and 1.45 AU from Pluto
- Pluto system encounter July 14, 2015
- Using HST observations 2 potential KBO's identified beyond Pluto

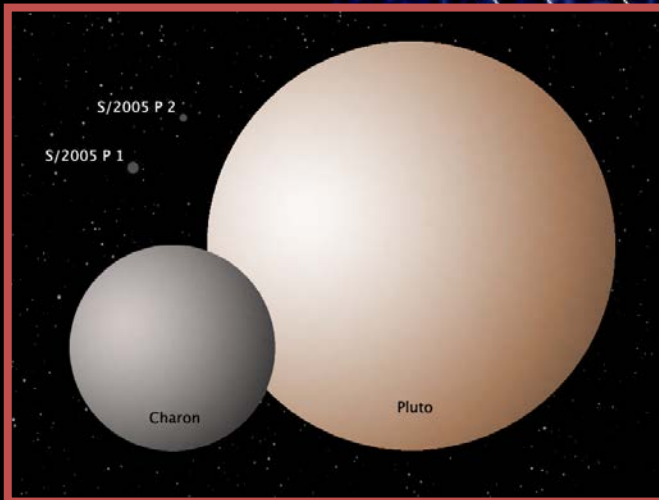
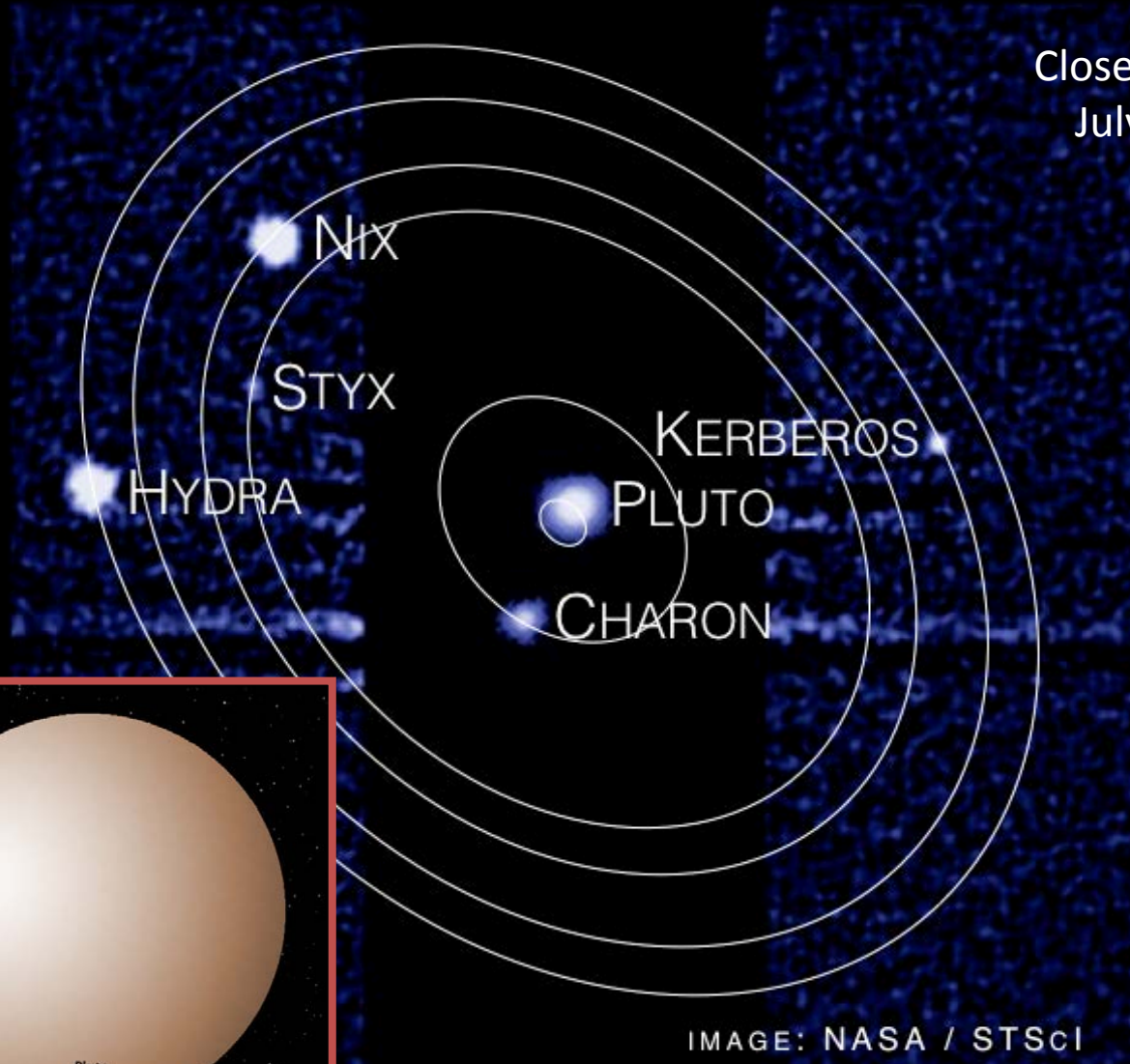
### – Juno:

- Earth flyby last October provided a 4 km/s boost
- Spacecraft is 4.22 AU from the sun and 1.66 AU from Jupiter
- Orbit insertion is July 4, 2016



# The New Pluto System

Closest Approach  
July 14, 2015



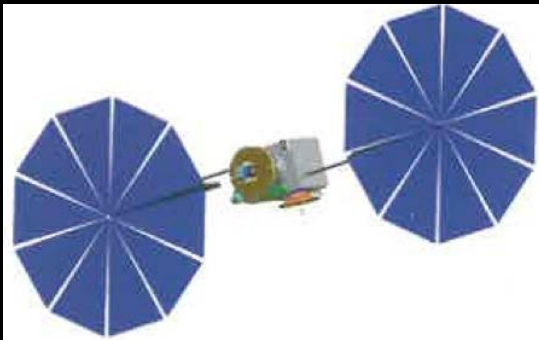
# Pluto-Charon



NH LORRI OPNAV CAMPAIGN 2  
2015-01-25 02:01:00 UTC  
DISTANCE TO PLUTO: 202976224 km  
(PROPER MOTION)

# New Frontiers #4 Focused Missions

Comet Surface  
Sample Return



Lunar South Pole  
Aitken Basin Sample  
Return



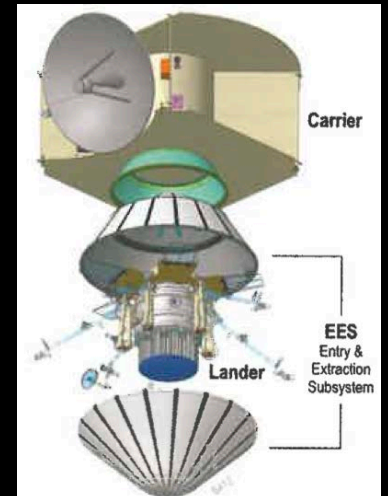
Trojan Tour &  
Rendezvous



Saturn Probes



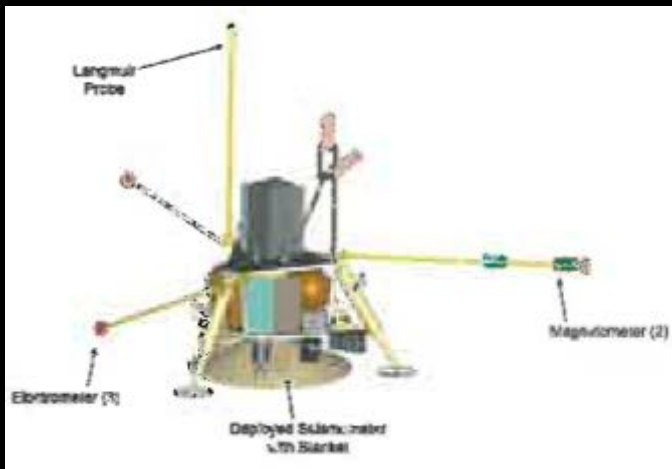
Venus In-Situ Explorer



# New Frontiers #5 Focused Missions

- Added to the remaining list of candidates:

Lunar Geophysical Network



Io Observer

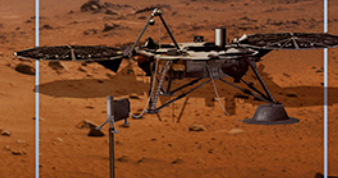
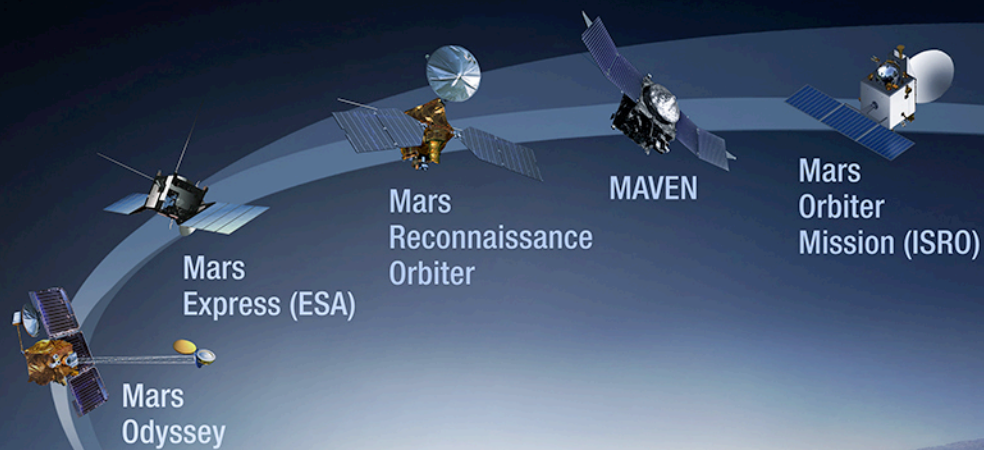


Operational 2001–2015

2016

2018

2020



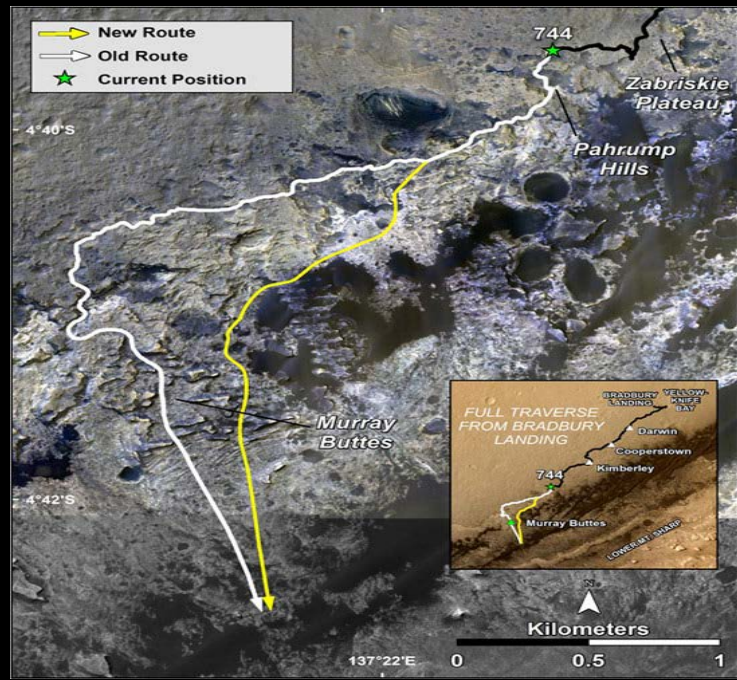
*Follow the Water*

*Explore Habitability*

*Seek Signs of Life*

*Prepare for Future Human Explorers*

# Curiosity Arrives at Mt. Sharp

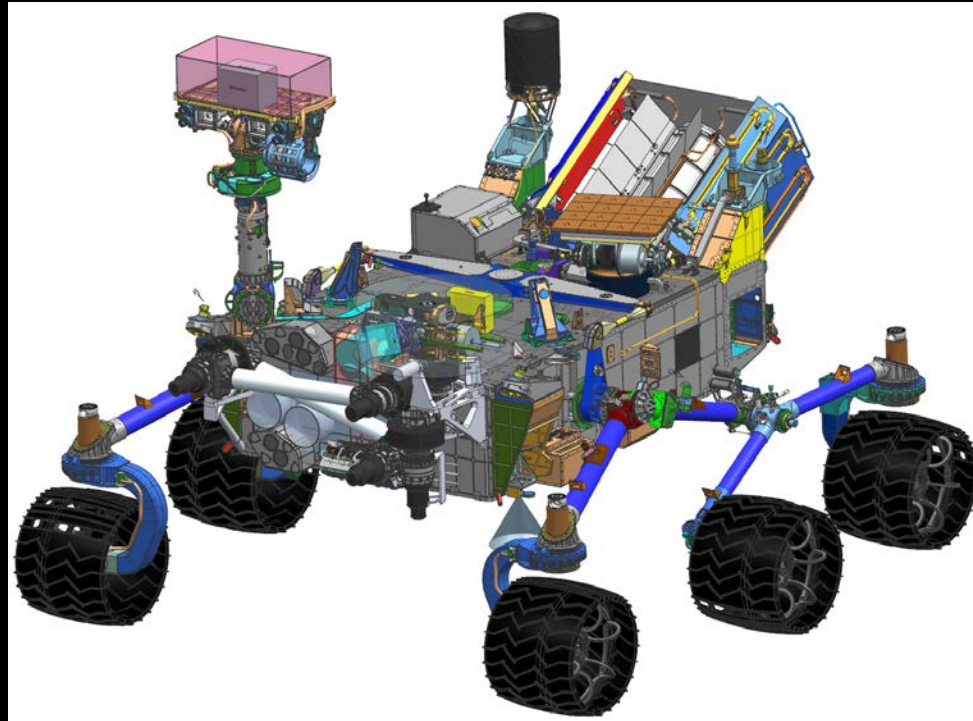


# Seeking signs of life: Mars 2020 Rover

Conduct rigorous  
*in situ* science

Geologically  
diverse site of  
ancient  
habitability

Coordinated,  
nested context  
and fine-scale  
measurements



Enable the future

Critical ISRU and  
technology  
demonstration  
required for  
future Mars  
exploration

Returnable cache  
of samples

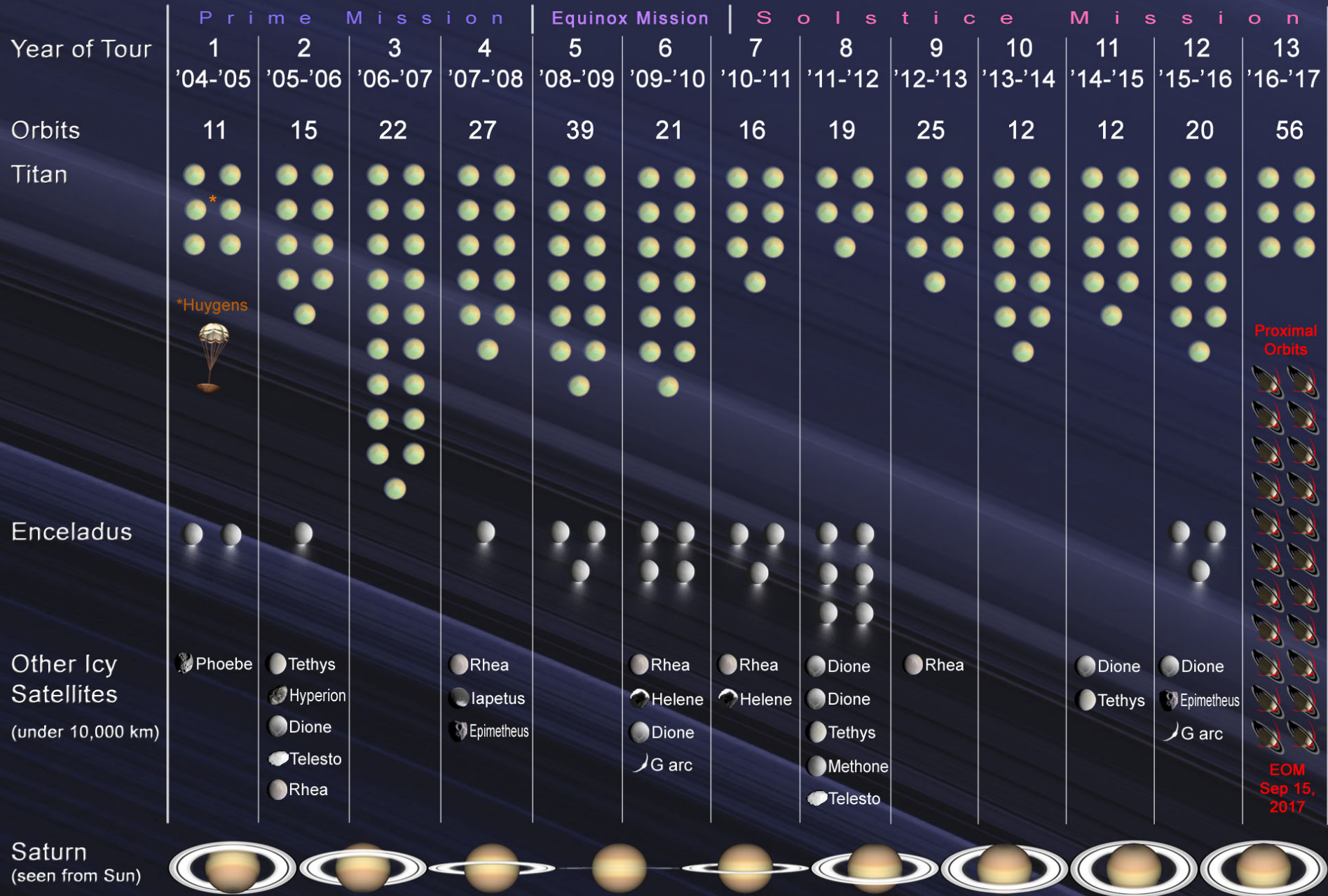


# Outer Planets Missions



# Cassini Mission Overview

Four-Year Prime Tour, Equinox Mission, and Solstice Mission (Proposed), July 2004 - July 2017

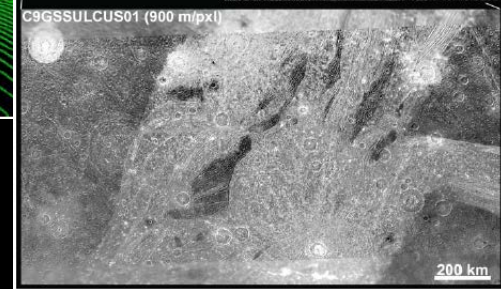
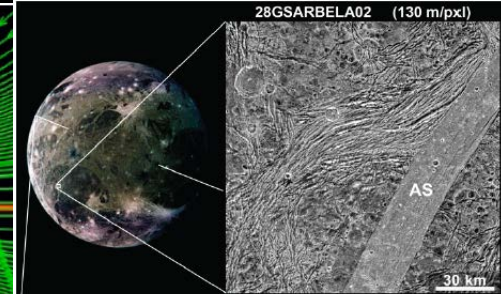
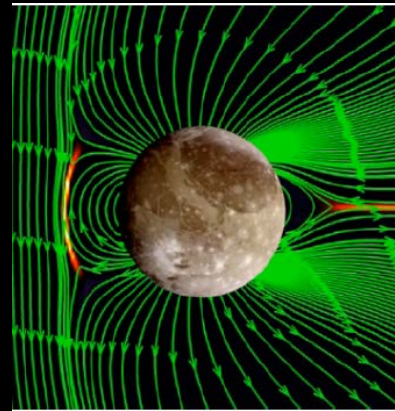
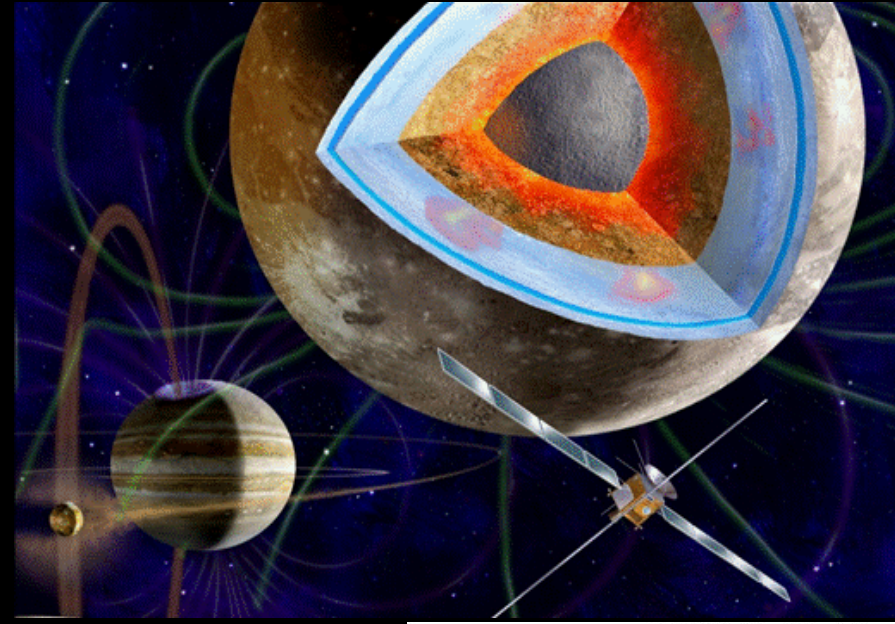


Proximal Orbits

EOM  
Sep 15,  
2017

# ESA's Jupiter Icy Moons Orbiter Explorer

- On May 2, 2012, the ESA formally selected JUICE as the first Large-class mission in ESA's Cosmic Vision Program
- The JUICE mission will investigate the emergence of habitable worlds around gas giants, characterizing Ganymede, Europa, and Callisto as planetary objects and potential habitats
- JUICE will first orbit Jupiter for  $\sim 2.5$  years, providing 13 flybys of Callisto and 2 of Europa, and then will orbit Ganymede for 9 months
- Launch is scheduled for 2022 with Jupiter arrival in 2030 and Ganymede orbit insertion in 2032
- NASA will contribute  $\sim \$100$ M in instruments and other support



# Recent Europa Activities

- Europa mission is present in the President's FY16 Budget
- Instrument selections for Europa mission expected late April
  - Released SALMON 2 PEA in July 2014 to solicit instrument investigations for an unspecified Europa mission
  - 33 proposals currently under evaluation
- Dedicated Hubble time to verify existence of Europa plumes
  - Not confirming their existence does not mean they don't exist. Variability factors are currently not understood.
- Workshop Feb. 18, 2015 with leading astrobiologists and Europa scientists to understand how to look for life
  - Previous 'plume' workshop fully endorsed mission concept and payload
  - Identify 'best' instruments and mission concepts to maximize likelihood of detecting current life if it exists
- Europa mission formulation continues
  - Solar power system selected as baseline
  - Highly successful Mission Concept Review held

# Questions?

