

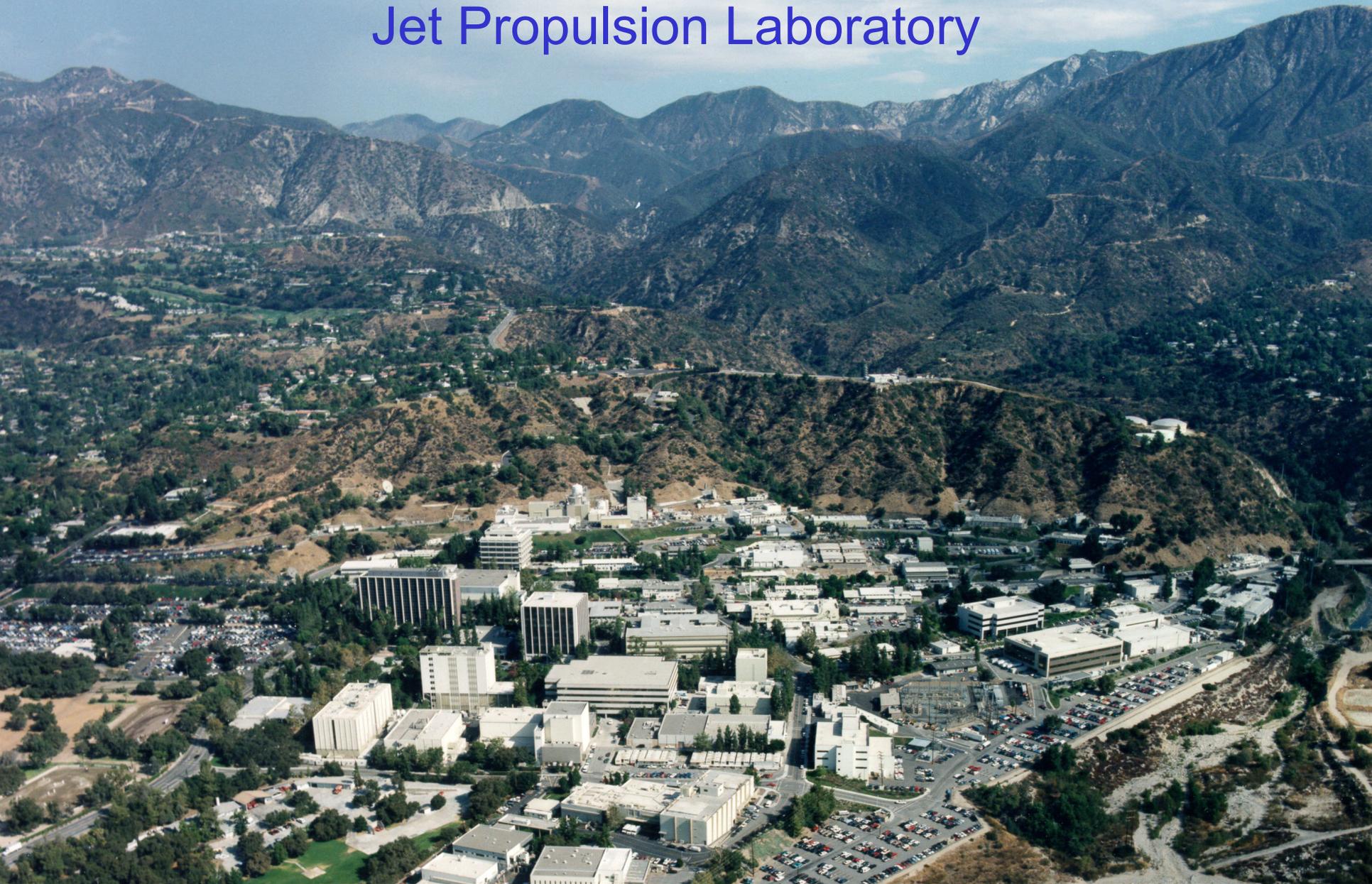
# NASA

## Quo Vadimus?

### Where are we going?

Dr. David H. Atkinson  
Jet Propulsion Laboratory  
California Institute of Technology  
1 October 2018  
[David.H.Atkinson@jpl.caltech.edu](mailto:David.H.Atkinson@jpl.caltech.edu)

# Jet Propulsion Laboratory



Upper Arroyo Seco and San Gabriel Mountains foothills, Pasadena, Altadena, La Canada-Flintridge

# Deep Space Network

**Golds**



**Madrid**



**Canberra**

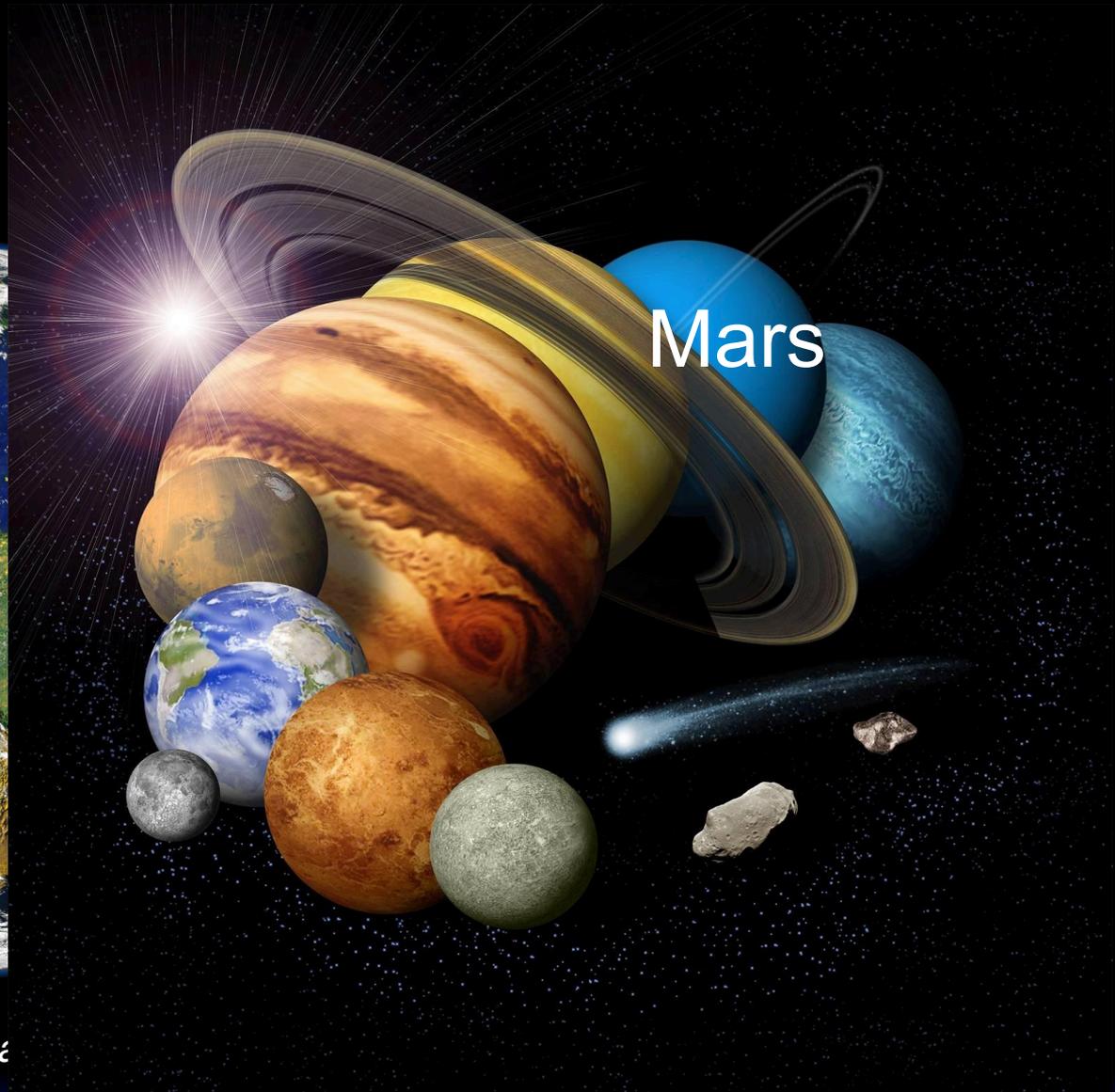


Photo credits: NASA

# Solar System

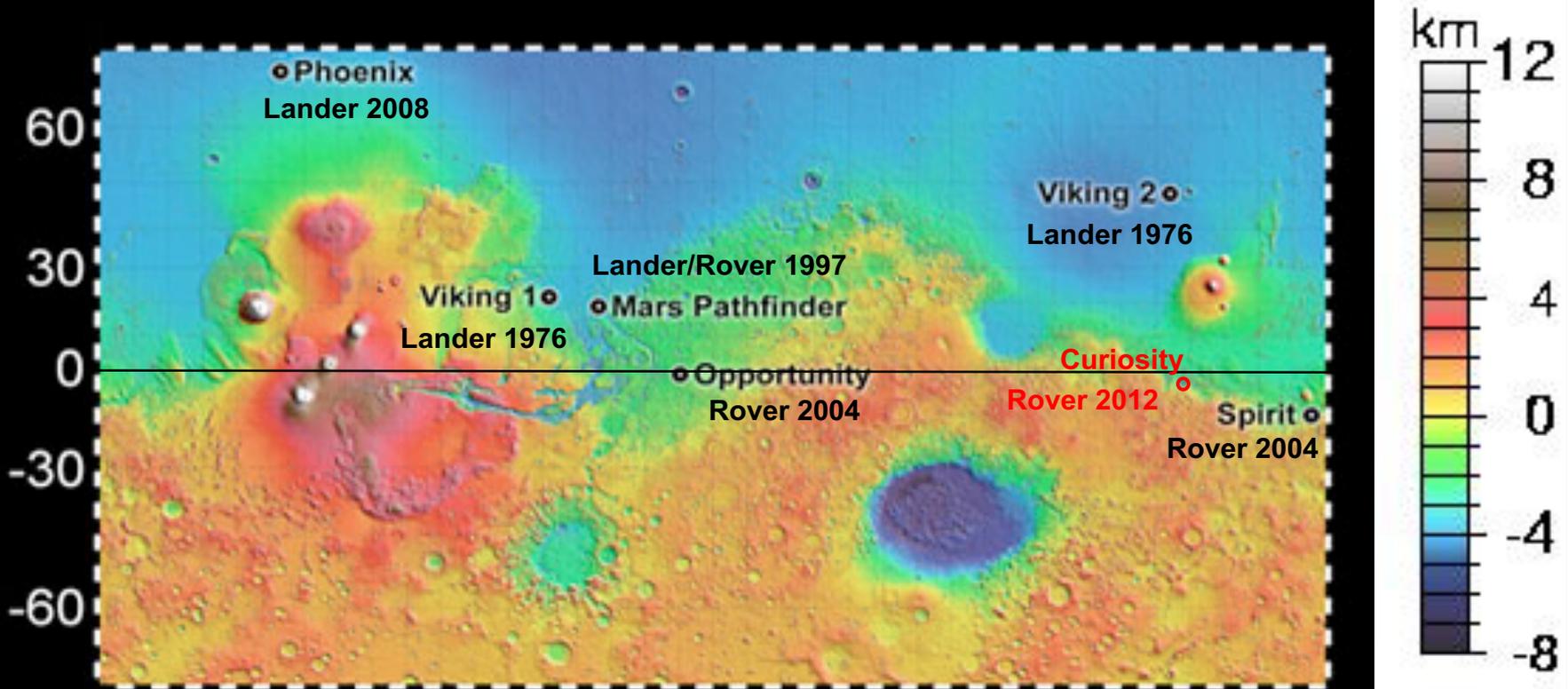


12,742 km dia





# Where we are on Mars



# Curiosity on Mars



Photo credits: NASA

# Mars Insight

*Interior Exploration using Seismic Investigations,  
Geodesy and Heat Transport*

Is Mars  
Geologically Active?

Launch: May, 2018

Instruments:

- Seismometer
- Heat Transfer  
Probe
- Rotation & Interior  
Structure

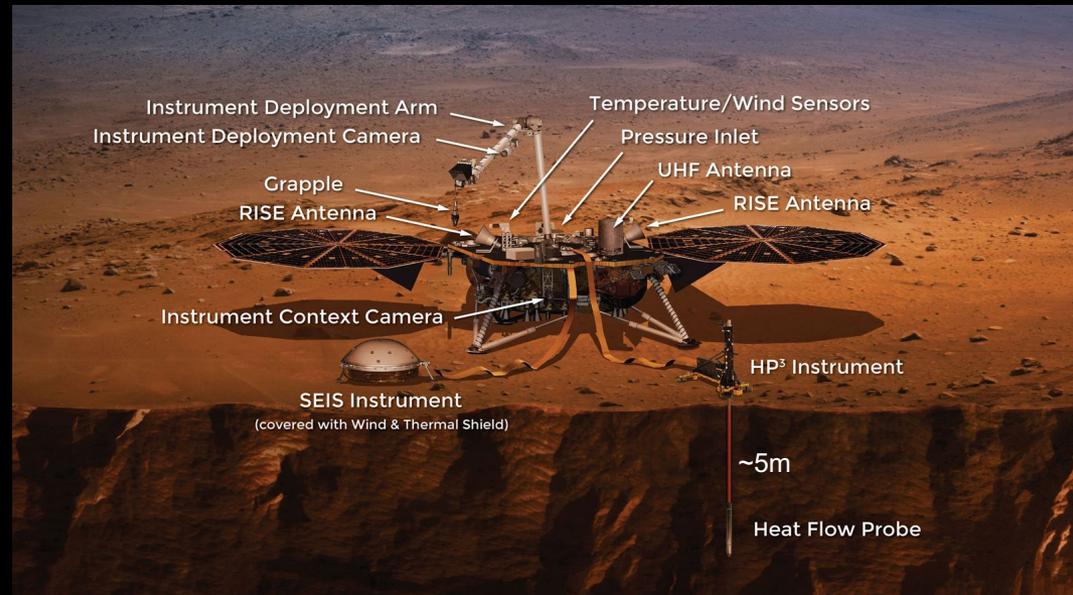


Photo credit: NASA

# Mars 2020

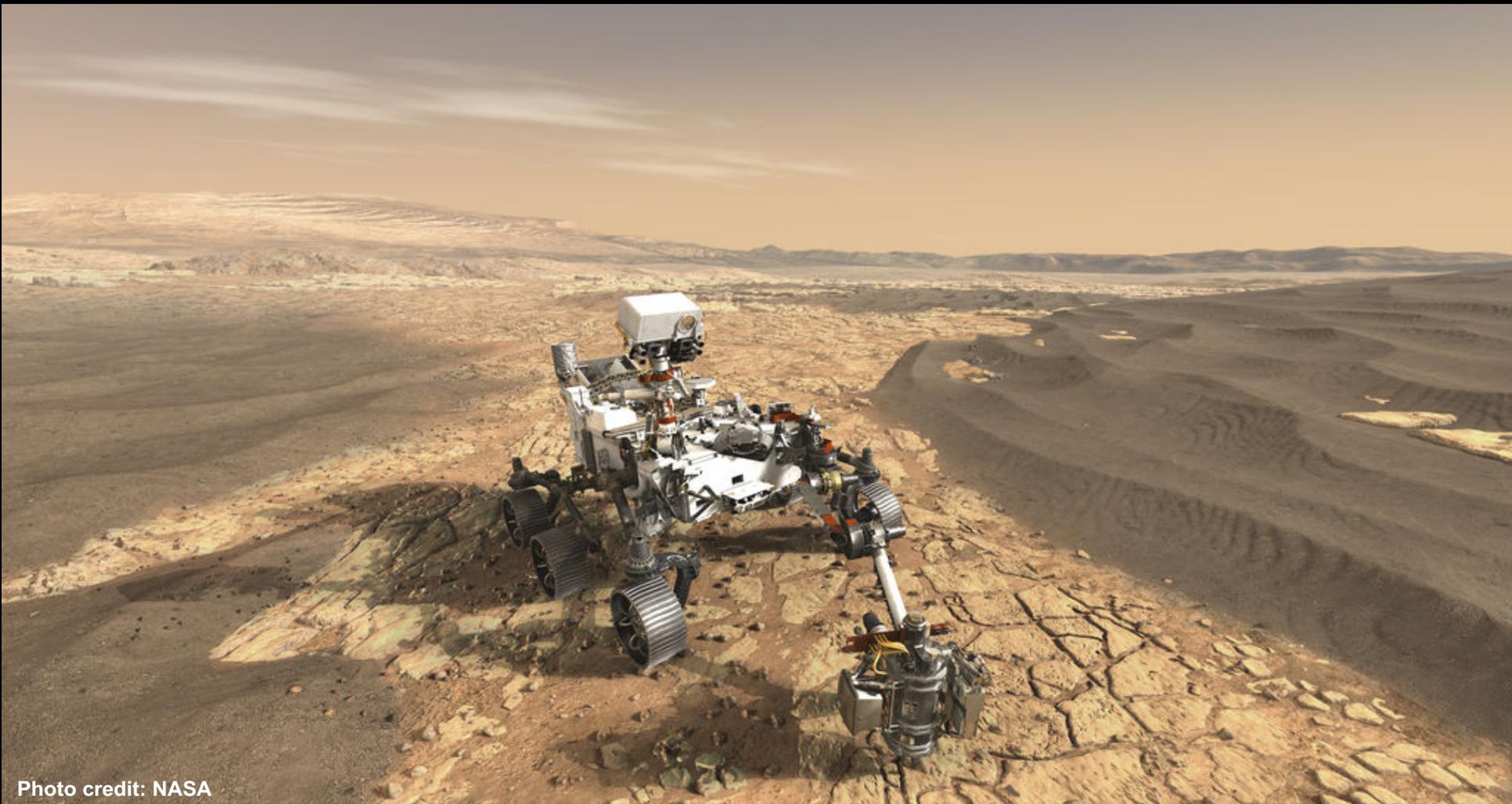


Photo credit: NASA

Rover will include a sample container for future return to Earth

# Potential Mars Sample Return



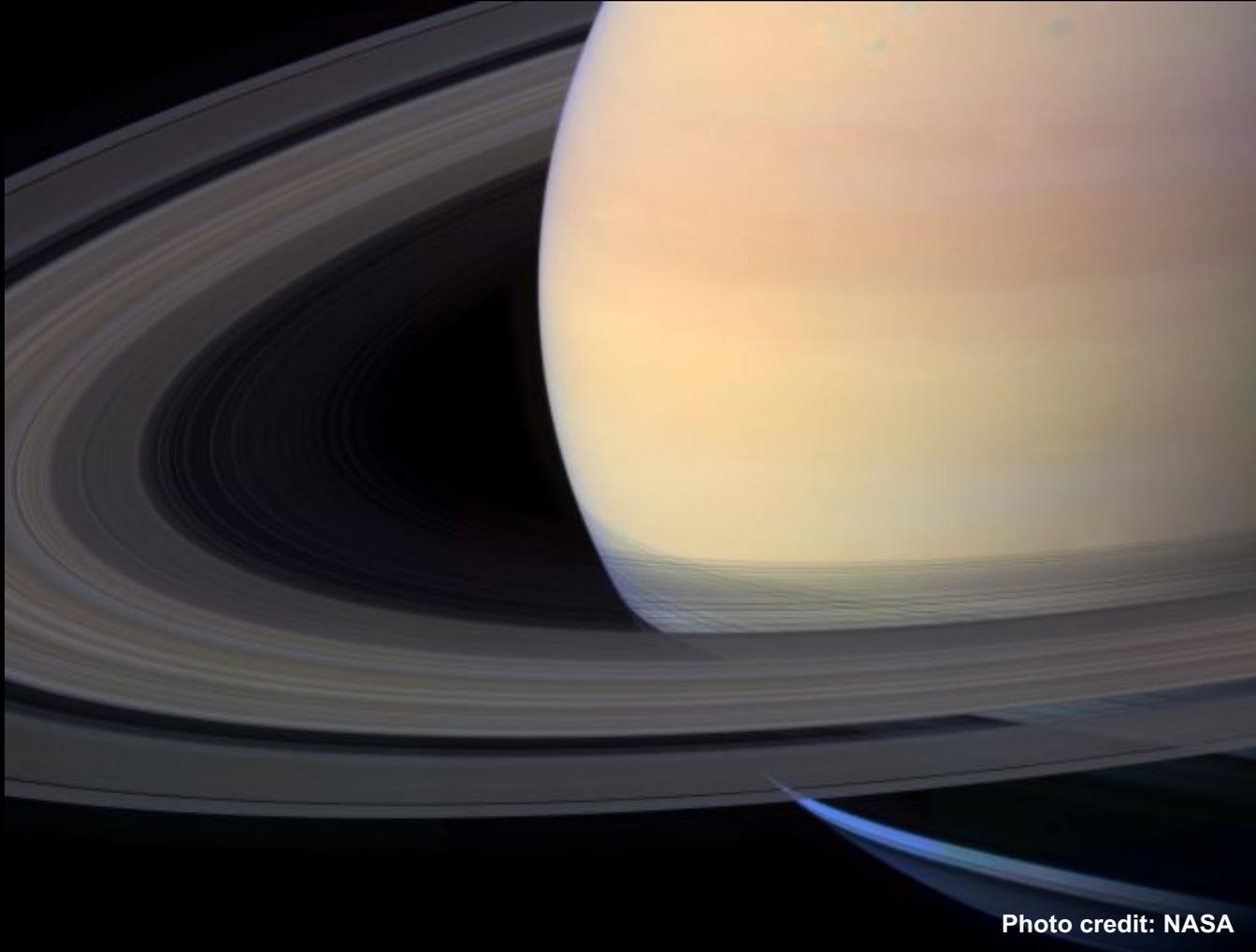
**Mars Sample Launch (2020+)**

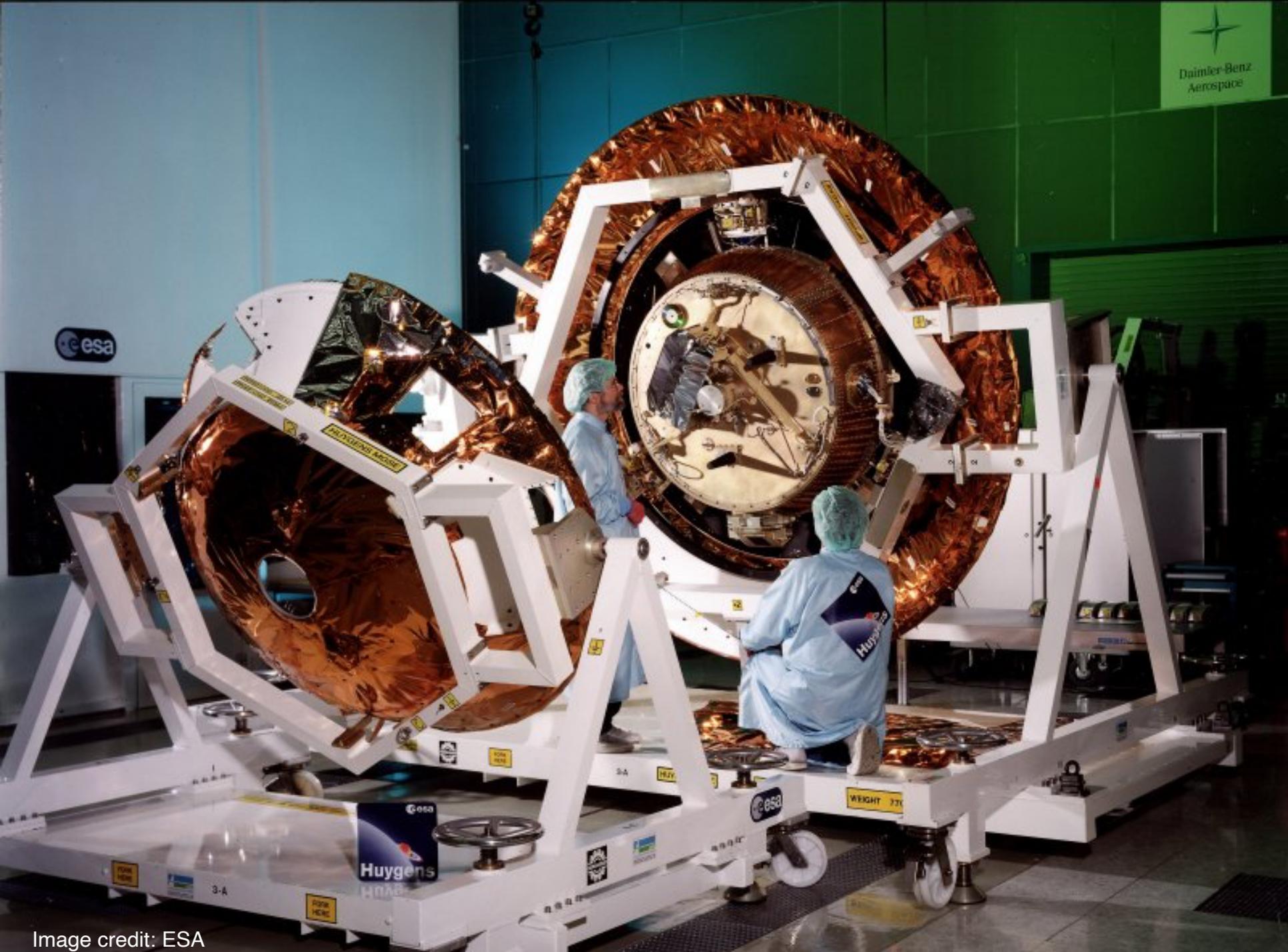
Pre-Decisional Information -- For Planning and Discussion Purposes Only

# Solar System: Outer Planets



# Cassini at Saturn





Daimler-Benz  
Aerospace

esa

esa  
Huygens  
H11AB

esa

WEIGHT 77K

3-A

ROCK  
HEIC

3-A

HUY

Image credit: ESA

# Cassini Finale

Sept. 15, 2017



Photo credit: NASA

# Juno Mission to Jupiter



*37 Orbits during 20-month Prime Mission*

*Launch 2011 August 5*

*Arrived 2016 July 4*

*Orbit: ~~14~~ days 53 days*

# Ocean Worlds

## Enceladus: It's Active!

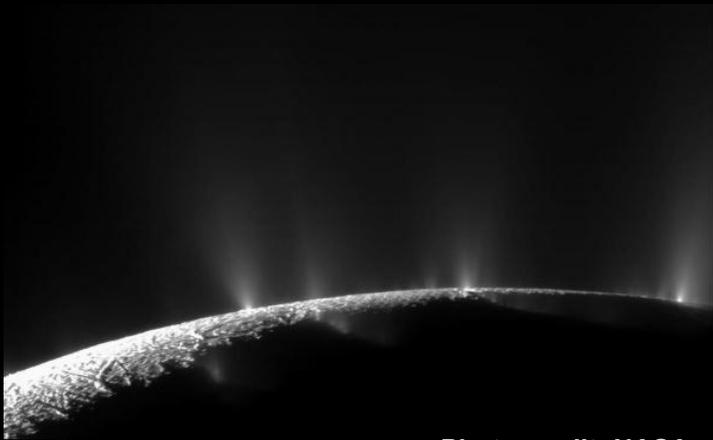
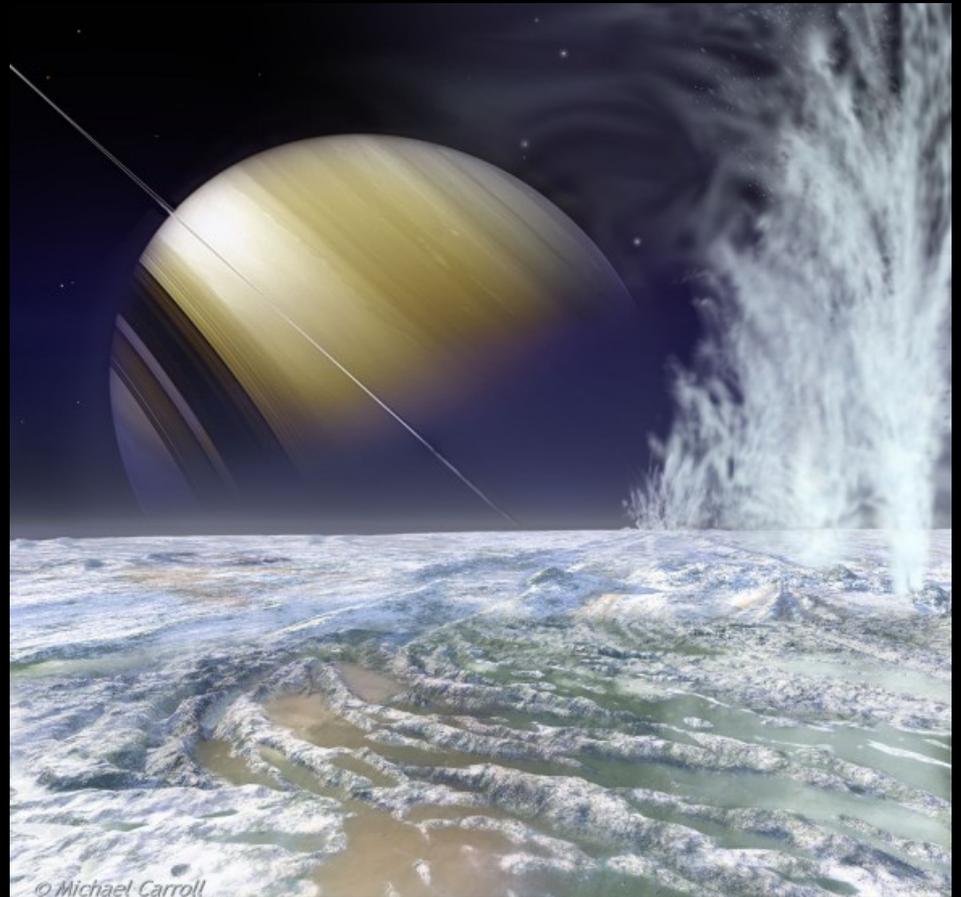


Photo credit: NASA

Fountain-like Plumes



© Michael Carroll

Courtesy: Michael Carroll

# Europa Clipper

Launch ~2023

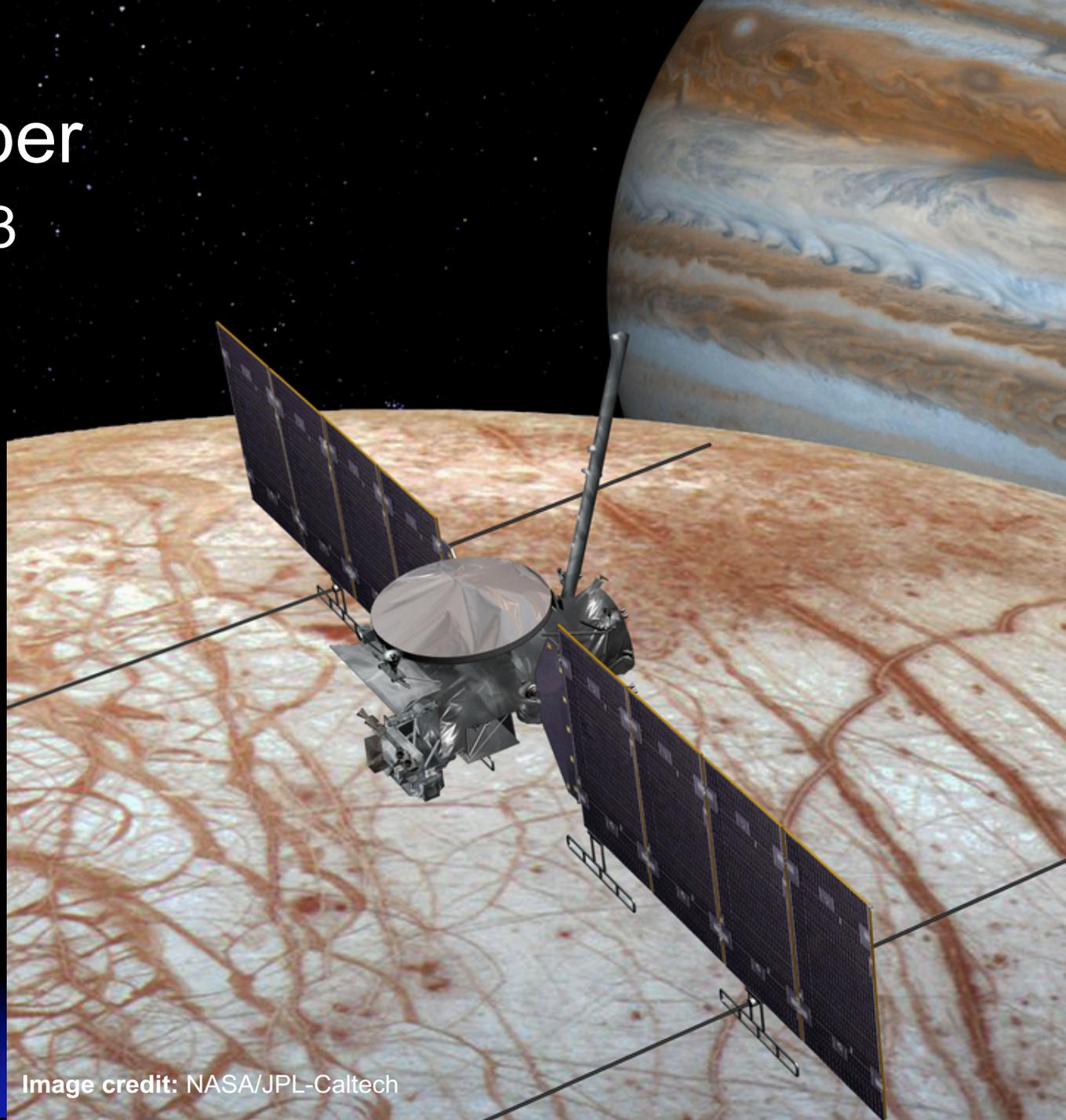


Image credit: NASA/JPL-Caltech

# Europa Lander Mission Concept

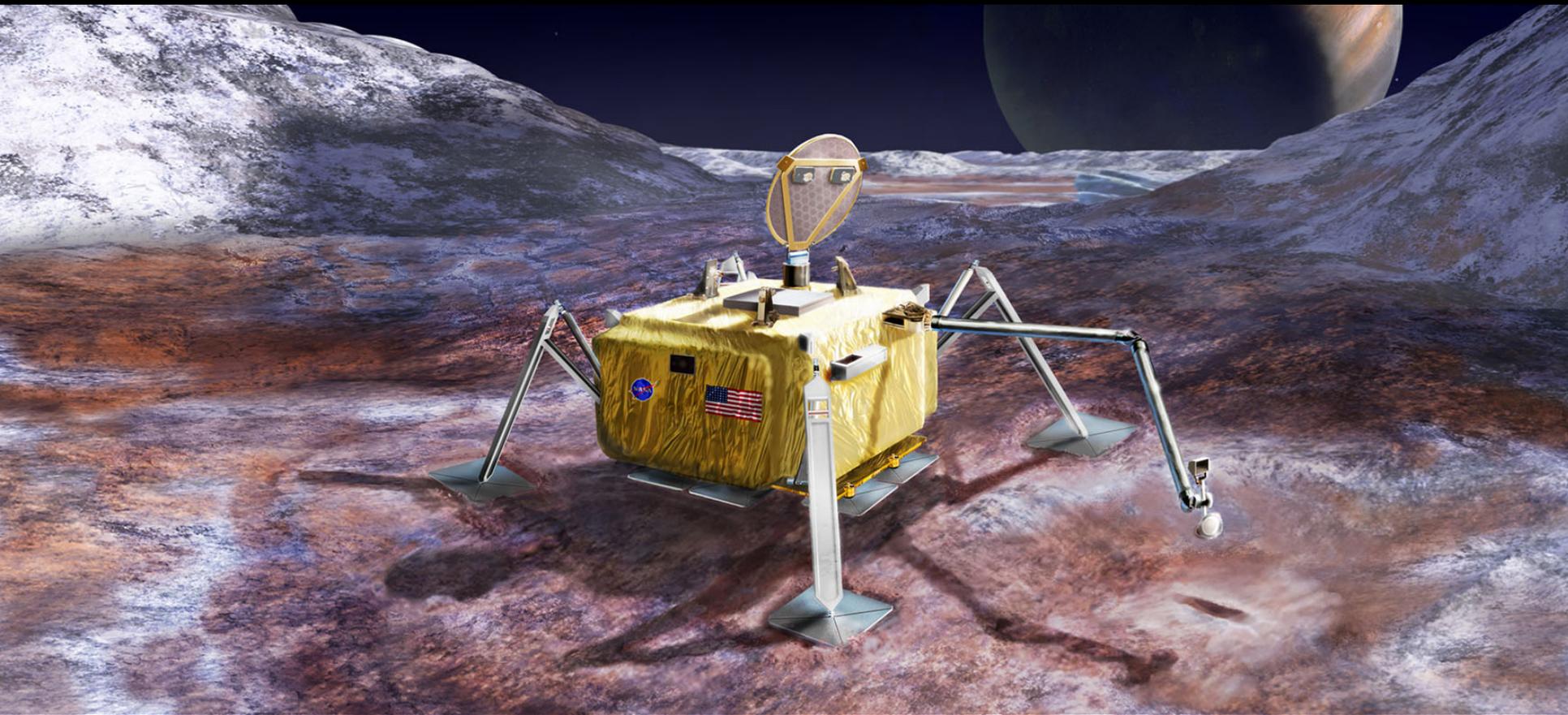


Photo Credit: NASA/JPL-Caltech

Pre-Decisional Information -- For Planning and Discussion Purposes Only

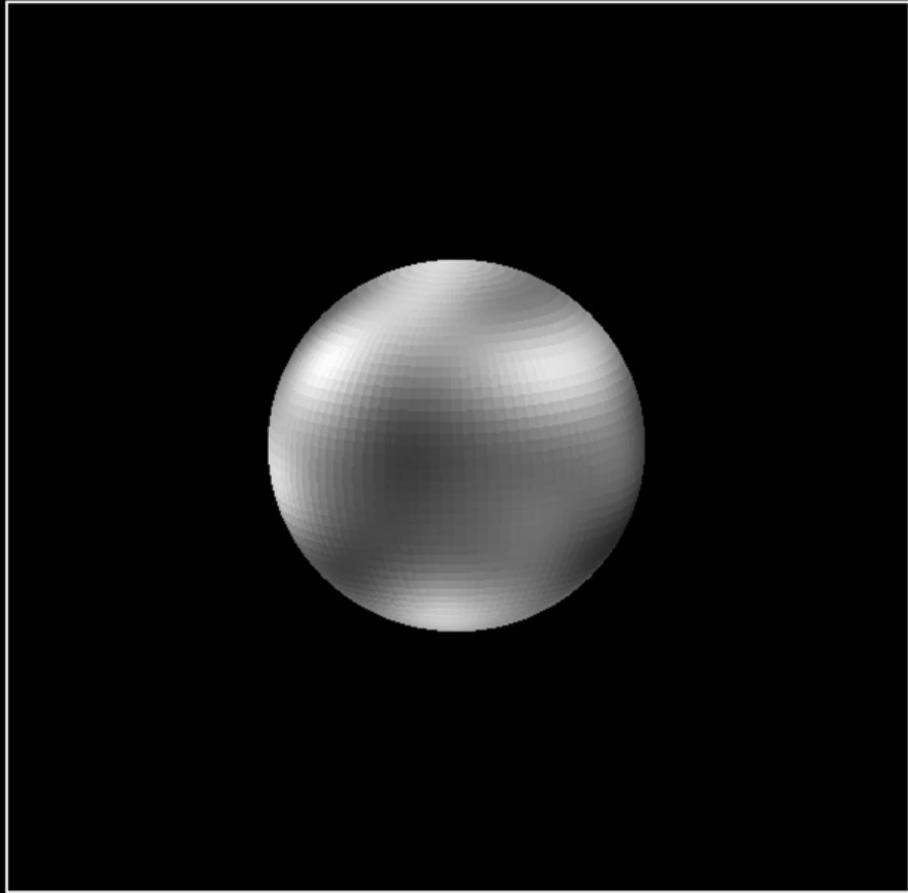
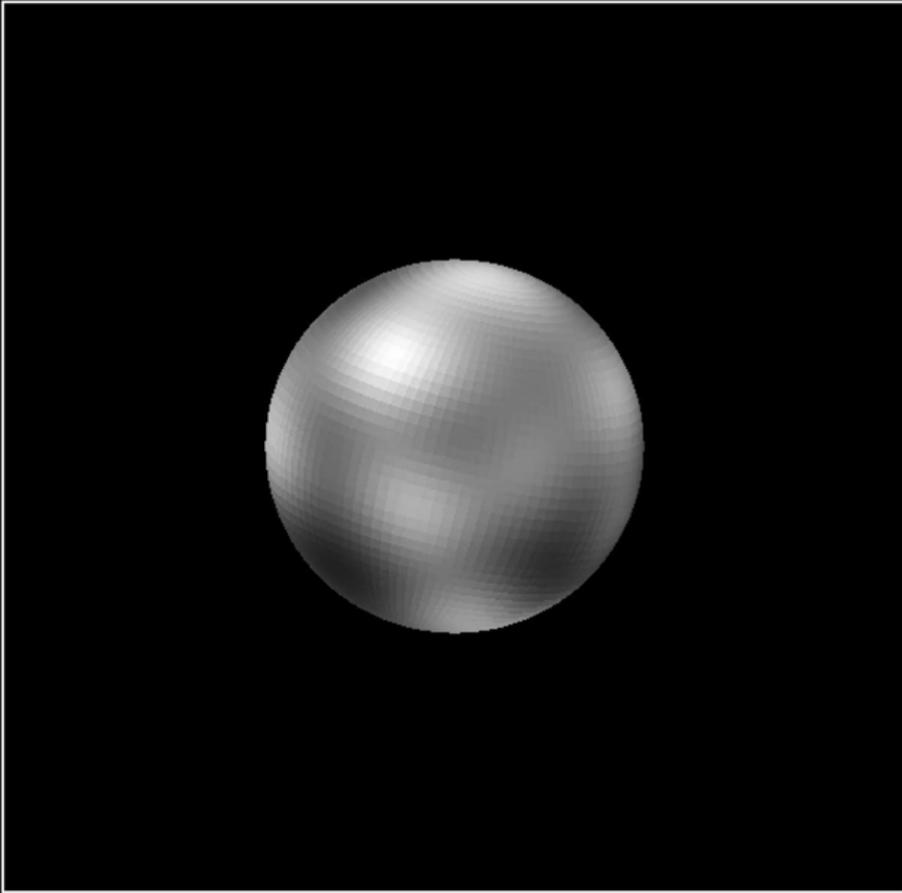
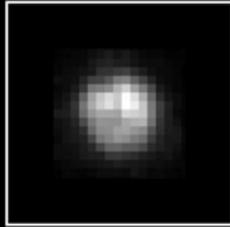
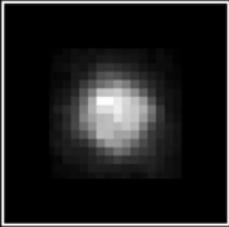


Image Credit: [nssdc.gsfc.nasa.gov](http://nssdc.gsfc.nasa.gov)

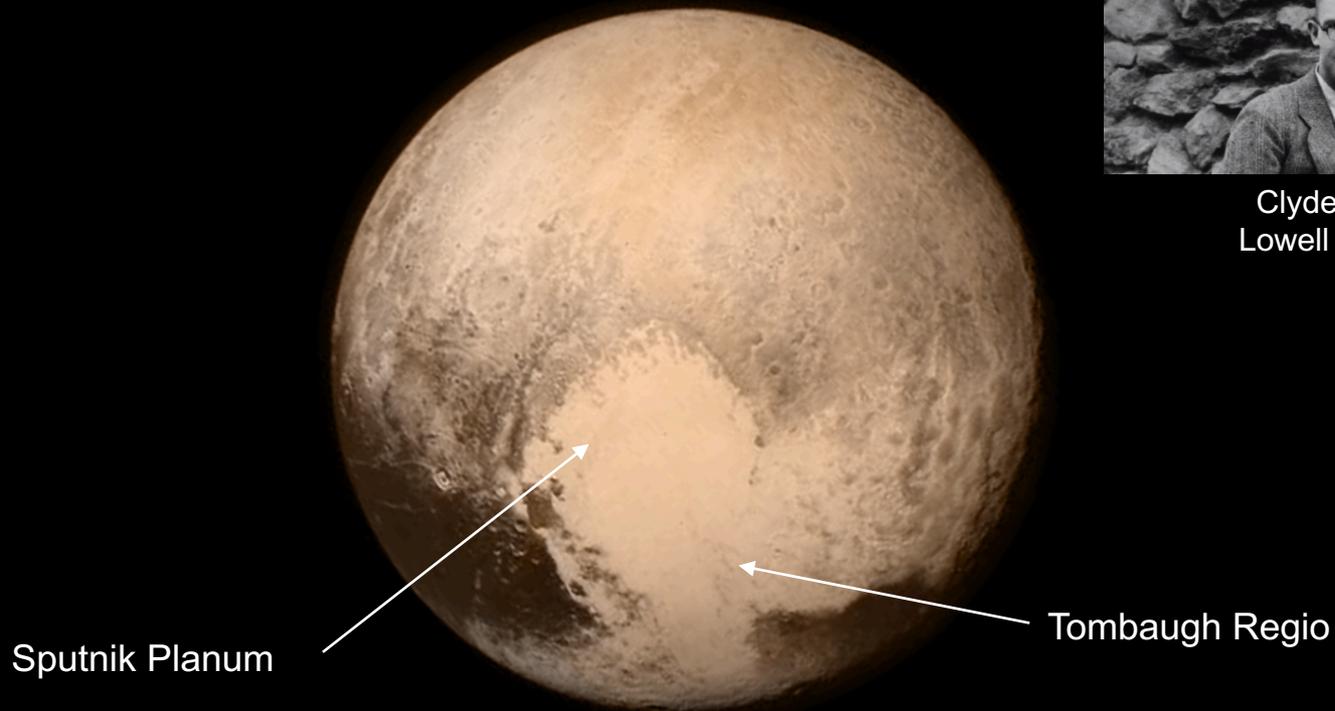


Image Credit: NASA

# Pluto - Planet or Kuiper Belt Object?



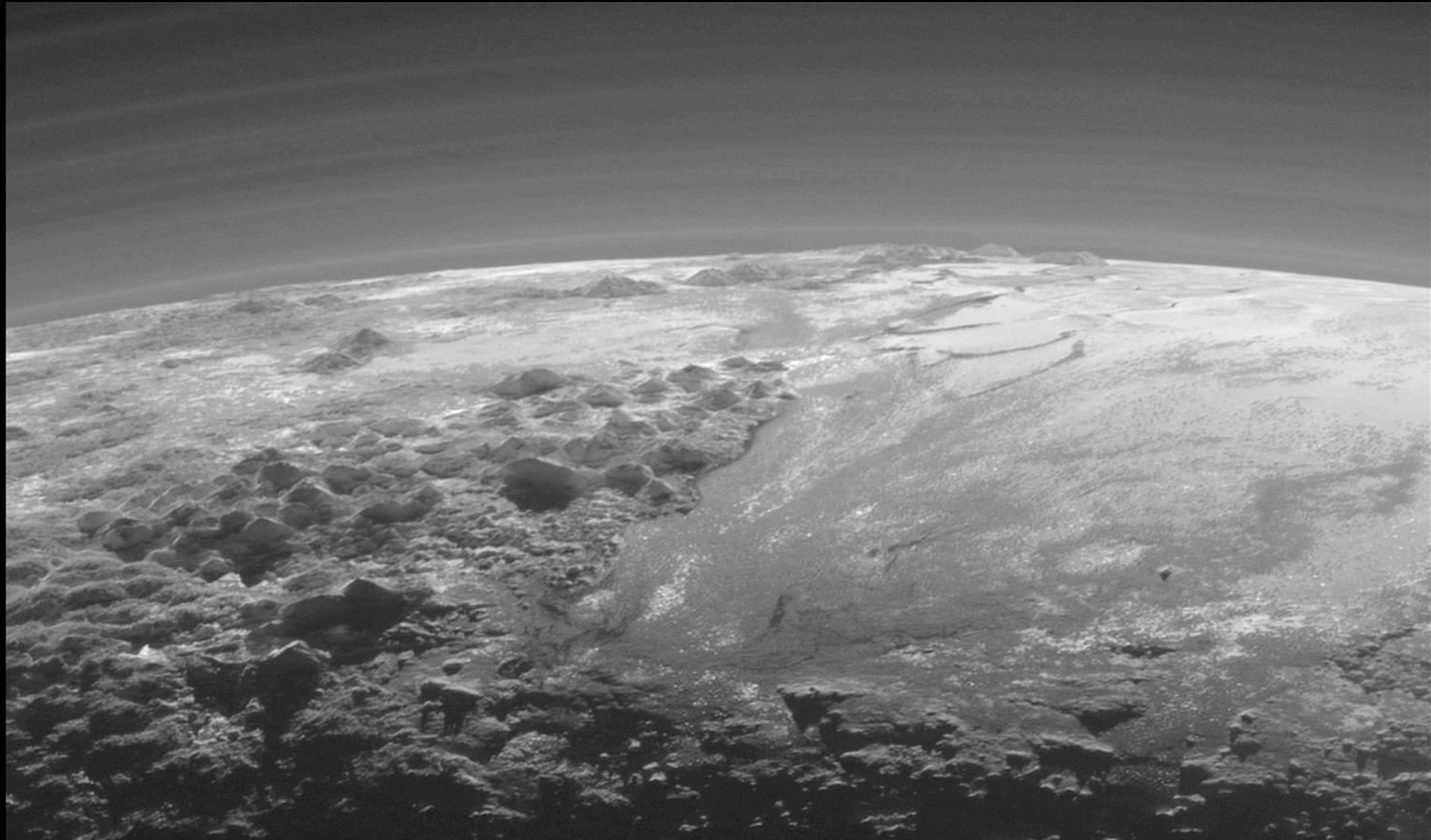
Clyde Tombaugh  
Lowell Observatory  
1930



*Viewed through the  
Space Telescope  
Arrived 2015 July 14*

# Pluto – Sputnik Planum

New Horizons



*Taken 15 minutes after Closest Approach of Sputnik Planum (3 km high peaks)*



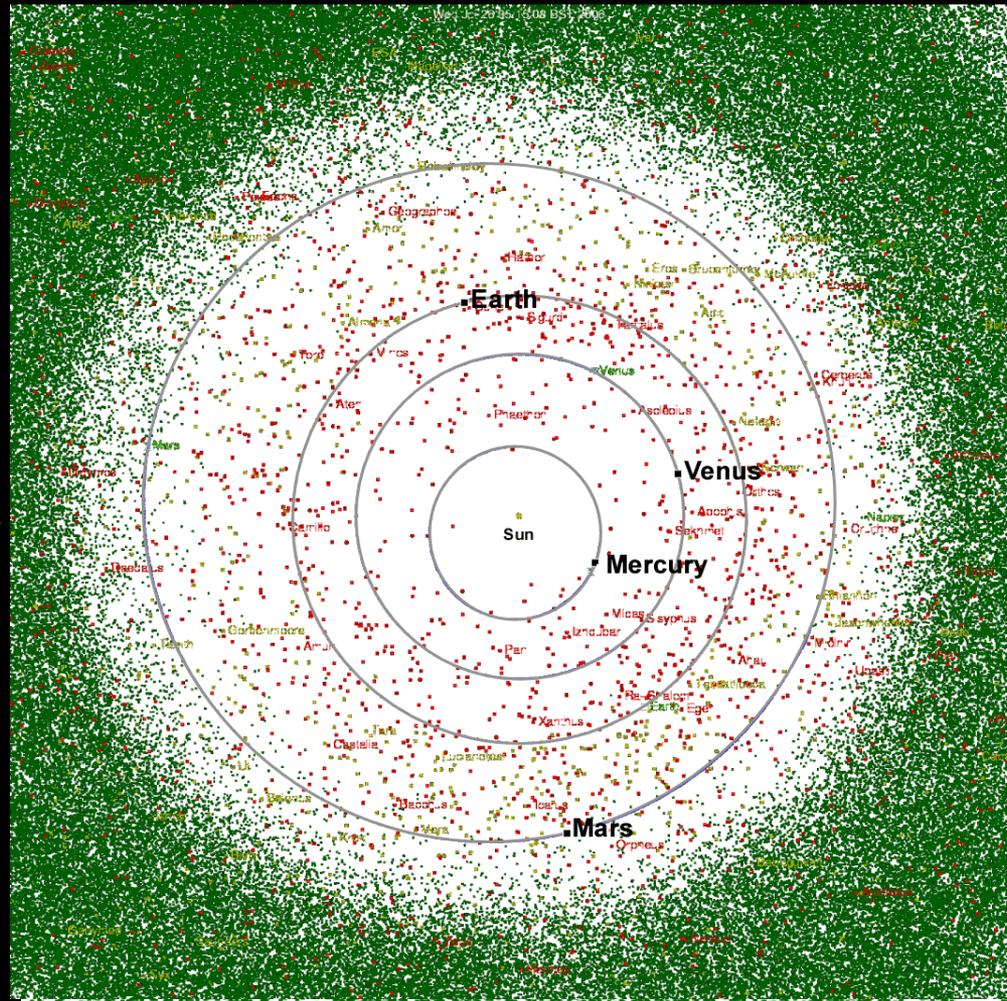
# Minor Bodies of the Solar System



# Exploring Asteroids

2016

- Earth Crossing
- Outside of Earth's Orbit

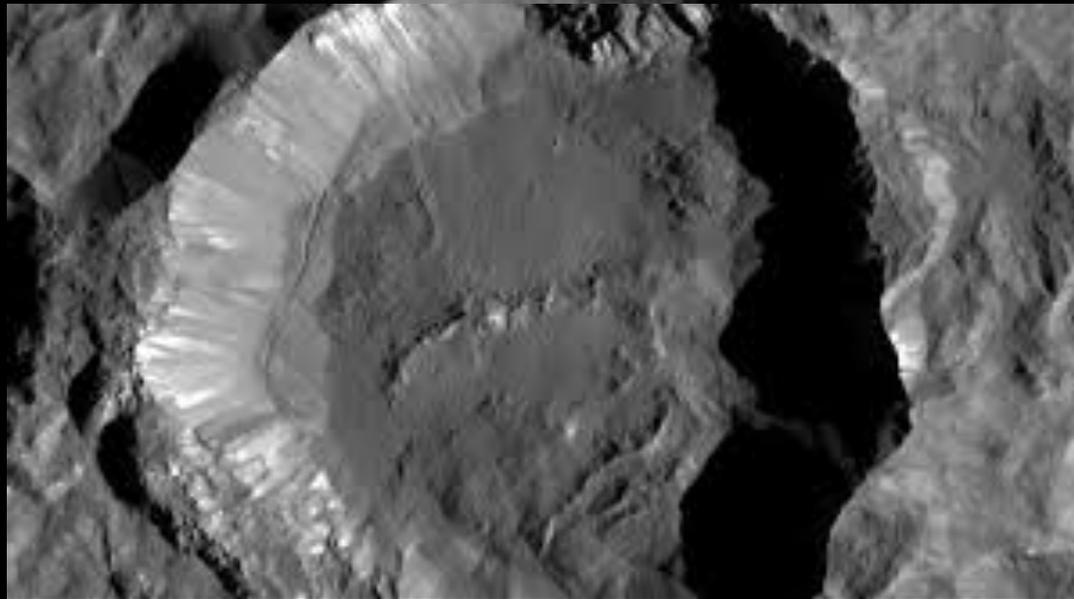


Known  
709,706 Minor Planets

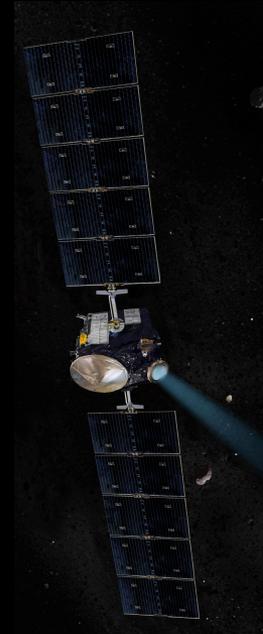
- 12,430 NEO
- 1,570 PHO

Courtesy: Scott Manley/Don Yeomans

# Exploring Asteroids - Dawn



*Vesta Arrived  
2011 July 6*



*Dawn - Launched  
2007 Sept 27*



Where Next?  
What Next?

# OSIRIS-Rex

Origins, Spectral Interpretation, Resource Identification,  
Security, Regolith Explorer



Launch: Sept 8, 2016

Destination: asteroid Bennu

Arrival: August, 2018

Sample Return: 2023

# NASA Discovery 2017

NASA Small-Class, High Focused Solar System  
Exploration missions,  $\leq$ \$450M



Lucy (SWRI/GSFC)

Launch: 2021  
Mission: Explore >6 Trojan asteroids at  
Jupiter L4, L5 locations (2027-2033)

Psyche (ASU/JPL)



Launch: 2023  
Mission: Will explore giant metal  
asteroid 16 Psyche (2023-2025)

# Cosmic Vision 2015 - 2025

European Space Agency

Long term space science mission program

L-Class:  $\leq$  \$900M Euros

M-Class:  $\leq$  \$450M Euros

# Jupiter Icy Moons Explorer (JUICE)

## ESA L-class mission

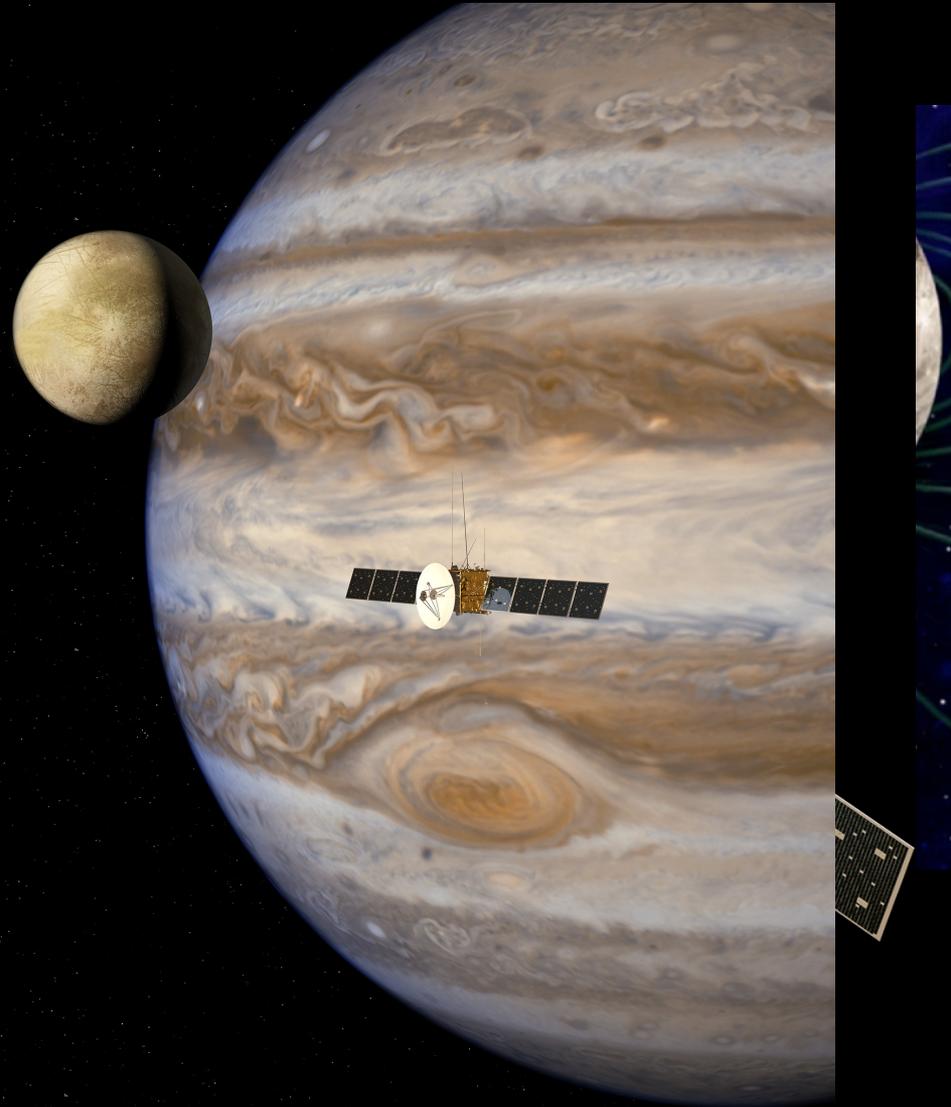
Launch: 2022

Jupiter Arrival: 2030

Ganymede Orbit : 2033

Goal: To study Jupiter's moons Europa, Ganymede and Callisto, all of which are thought to have oceans of liquid water beneath their surfaces, making each moon potentially habitable.

First spacecraft to orbit a moon of another planet.



# New Frontiers, 2017

## NASA Medium-Class Solar System Exploration Missions, $\leq$ \$850M

12 Proposals Submitted, 7 from JPL

- Comet Surface Sample Return,
- Lunar South Pole-Aitken Basin Sample Return
- Ocean Worlds – Titan
- Ocean Worlds – Enceladus
- Saturn Probe (JPL: SPRITE)
- Trojan Tour and Rendezvous
- Venus In Situ Explorer (JPL: VISAGE)
- Venus In Situ Explorer (GSFC: VICI)

Phase A (Step 1) selections in December, 2017

Final flight mission selection ~Spring, 2019.



Photo credit: NASA

Quadcopter to fly to multiple locations to determine surface composition, investigate Titan's organic chemistry & habitability, monitor atmospheric and surface conditions, investigate geological processes, and perform seismic studies.

PI: Elizabeth Turtle, Johns Hopkins University Applied Physics Laboratory (APL)

Pre-Decisional Information -- For Planning and Discussion Purposes Only

# CAESAR

(Comet Astrobiology Exploration SAmples Return)

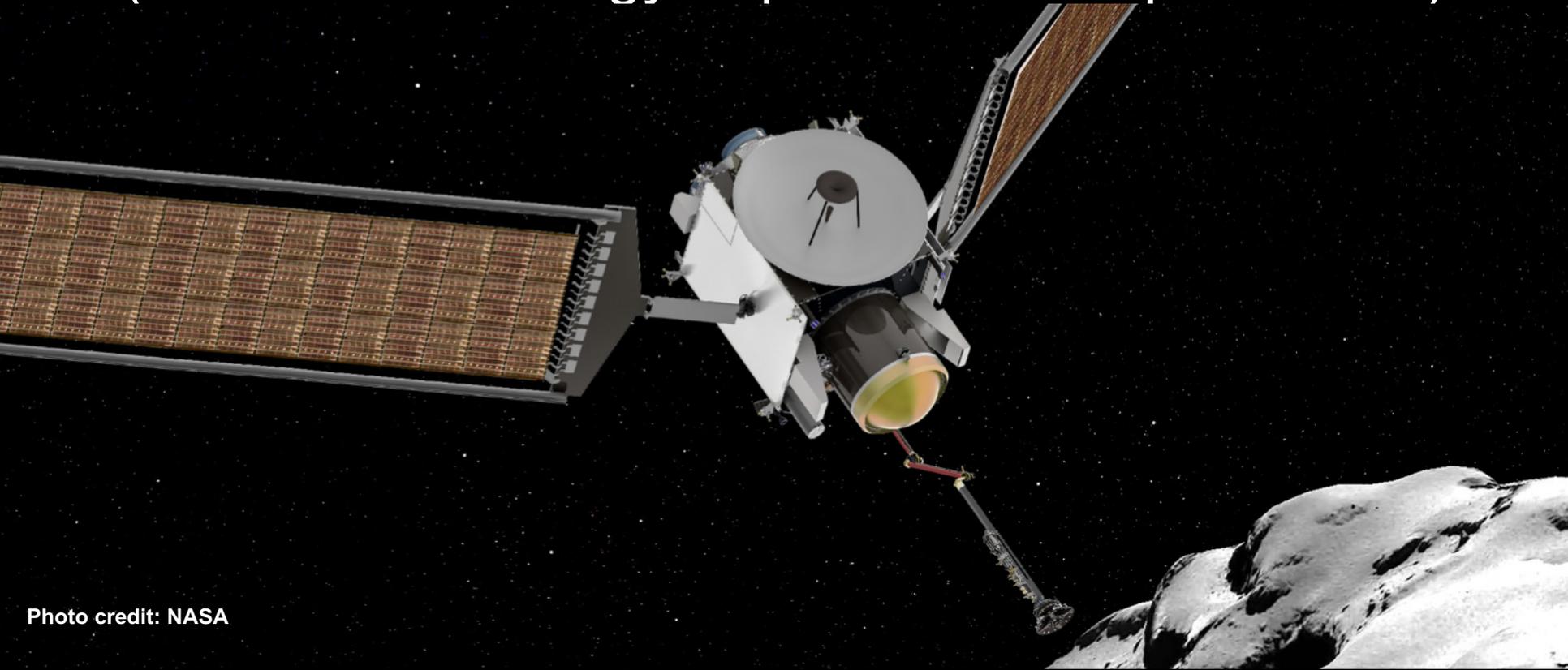


Photo credit: NASA

Will acquire a sample from the nucleus of comet Churyumov-Gerasimenko to return safely to Earth for analysis.

PI: Steve Squyres, Cornell University

Lead Center: Goddard Spaceflight Center

Pre-Decisional Information -- For Planning and Discussion Purposes Only

# NASA Small Satellites

“The Future is Small!”

Small Satellite: 100 kg – 500 kg

Microsatellite: 10 kg - 100 kg

Nanosatellite: 1 kg - 10 kg

Picosatellite: <0.1 kg - 1 kg

Femtosatellite: 10g – 100g

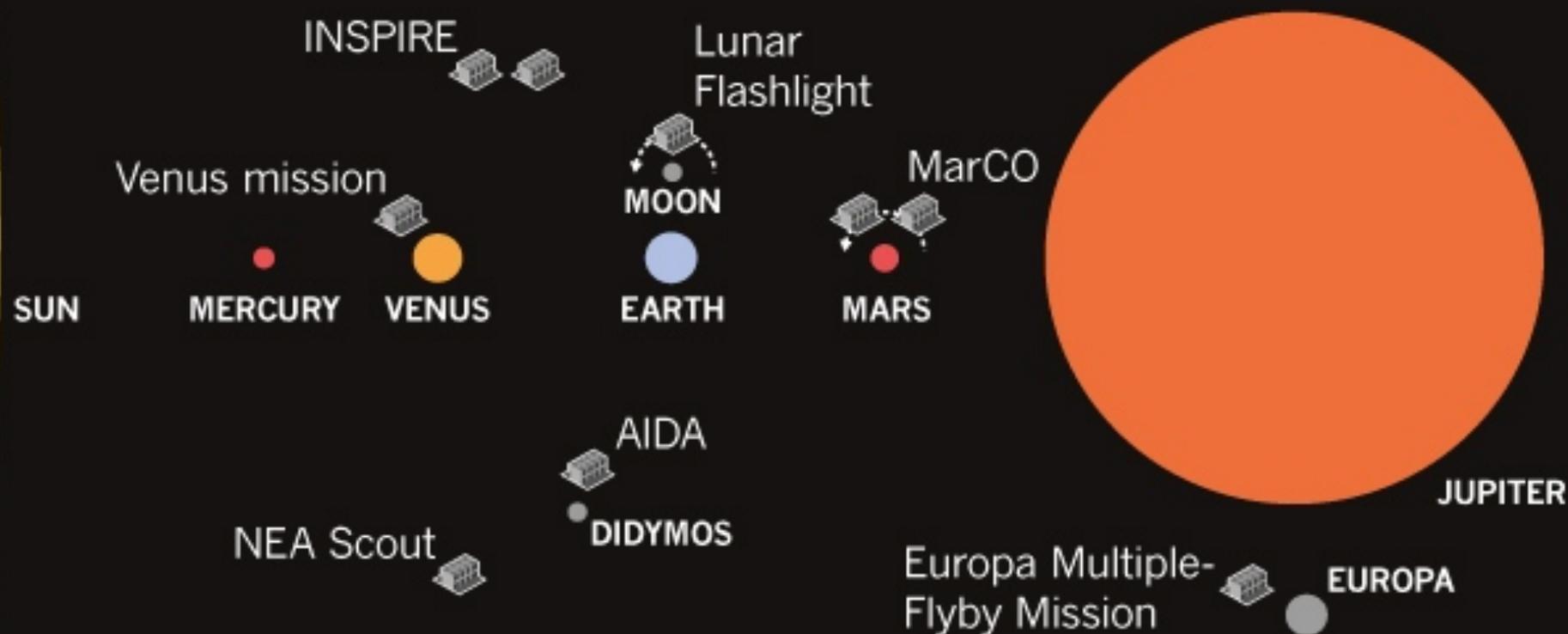
CubeSat – Self-contained satellite unit,  $10 \times 10 \times 10$  cm, ~1.3 kg.

Many Nanosatellites comprise multiple CubeSat Units, e.g., a 6U nanosatellite.



# MINIATURE EXPLORERS

Previously limited to Earth orbit by their diminutive size, shoe-box-sized CubeSat spacecraft are now poised to invade the rest of the Solar System, with missions planned to carry these craft as far as Jupiter.



Size and distance not to scale

©nature

# How to get involved?

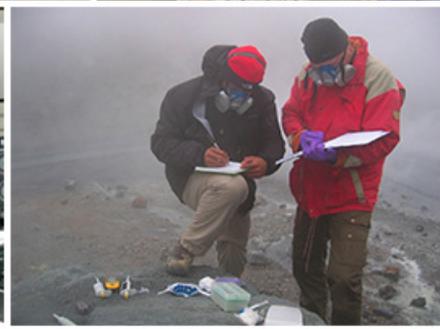
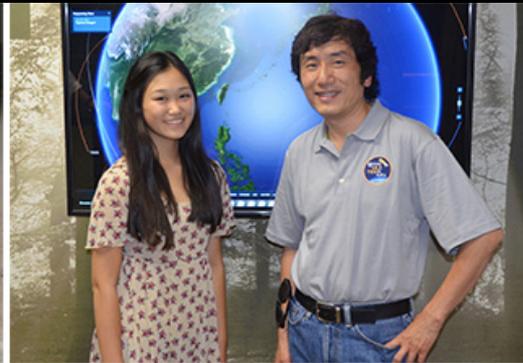
- Students
- Researchers
- Educators

# Opportunities at JPL

Dare Might Things

Students Internships

<https://www.jpl.nasa.gov/edu/intern/>





07/02/2004

# Recent Graduates

<https://www.jpl.nasa.gov/opportunities/>

**Jet Propulsion Laboratory**  
California Institute of Technology

Page 1 of 2

Click Column Header to Sort

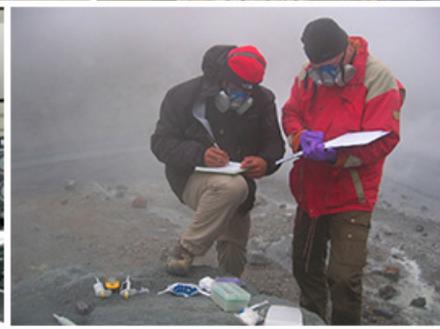
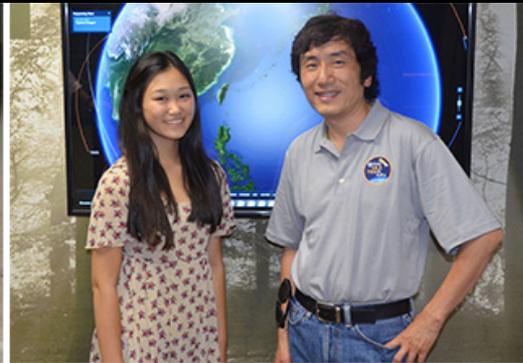
Requisition ID	Posting Title	Related Academic Majors	Requisition Post Information* : Posted Date
2017-8269	<a href="#">Systems Engineer I</a>	..	4/19/2017
2017-8179	<a href="#">Technical Information Compliance Analyst I</a>	..	3/28/2017
2017-8160	<a href="#">Engineering Undergraduate Student III</a>	Electrical Engineering, Physics, Systems Engineering	3/27/2017
2017-8115	<a href="#">Data Scientist I - Artificial Intelligence Group</a>	Computer Science	3/17/2017
2017-8089	<a href="#">Research Scientist II, Ice Sheet System Model (ISSM)</a>	Earth Sciences	3/22/2017
2017-8059	<a href="#">NASA JPL Software Engineer I</a>	Computer Science, Software Engineering	3/13/2017
2017-8058	<a href="#">NASA JPL Software Engineer II</a>	Computer Science, Information Systems, Software Engineering	3/13/2017
2017-8033	<a href="#">Flight Software Engineer I</a>	Computer Science, Electrical Engineering	3/7/2017
2017-7983	<a href="#">Research Scientist II, Geophysics and Planetary Geosciences Group</a>	..	2/28/2017
2017-7963	<a href="#">Planetary Protection Engineer I</a>	..	2/27/2017
2017-7945	<a href="#">Resource Analyst I</a>	Accounting, Business Administration	3/2/2017
2017-7920	<a href="#">Engineering Applications Software Engineer II</a>	Computer Science, Mathematics, Systems Engineering	4/18/2017
2017-7918	<a href="#">NASA JPL Software Year-Round Internship</a>	Computer Science, Mathematics, Systems Engineering	4/18/2017
2017-7896	<a href="#">Parts Engineer I</a>	Electrical Engineering	2/6/2017
2017-7820	<a href="#">Scientist II, WFIRST Coronagraph Scientist/Instrumentalist</a>	..	1/19/2017
2017-7786	<a href="#">Subcontract Manager 1, Commercial Subcontracts &amp; Strategic Sourcing Section</a>	Accounting, Business Administration, Finance, Supply Chain	1/25/2017
2016-7680	<a href="#">Optical Engineer - New Grad</a>	Computer Science, Electrical Engineering, Optical Engineering, Systems Engineering	2/22/2017
2016-7523	<a href="#">Software Engineer II - Data Services Group (397G)</a>	Computer Science, Software Engineering	4/7/2017
2016-7454	<a href="#">Thermal Engineer I</a>	Mechanical Engineering	10/11/2016
2016-7014	<a href="#">Flight Software Engineer II - Artificial Intelligence</a>	..	10/12/2016

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# Postdoctoral Opportunities

NASA Postdoctoral Program  
Caltech Postdoctoral Scholars  
JPL Postdoctoral Associate Program

<https://www.jpl.nasa.gov/opportunities/>



# Research Opportunities at JPL

<https://scienceandtechnology.jpl.nasa.gov/opportunities>

- Visiting Scholars Program
- Faculty Programs
- Early Career Hire Program
- Postdoctoral Programs

Summer Faculty Fellowship Program

<https://www.jpl.nasa.gov/edu/intern/apply/jpl-faculty-research-program/>

Senior Research Postdoctoral Program

<https://postdocs.jpl.nasa.gov/programs/npp/seniorfellows/>

# JPL Opportunities Teachers & Students

Activities, Resources, Workshops, Programs, Lesson Plans

<https://www.jpl.nasa.gov/edu/teach/>

Activities, Toolkits, Contests

<https://www.jpl.nasa.gov/edu/learn/>

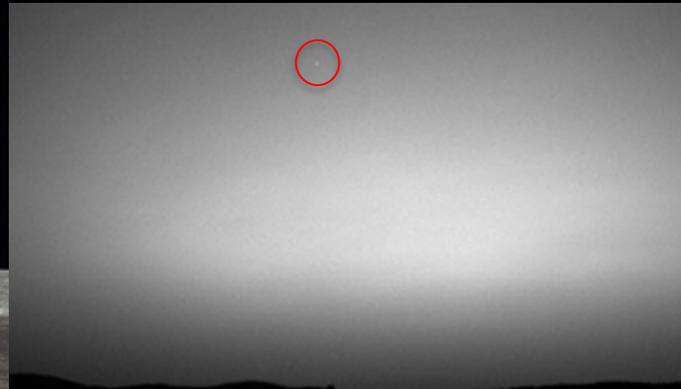
For questions on opportunities for  
students, researchers, and educators, please contact

Dr. Majid Jaridi, Director WV Space Grant / NASA EPSCoR: [Majid.Jaridi@mail.wvu.edu](mailto:Majid.Jaridi@mail.wvu.edu)

Dr. David H. Atkinson: [David.H.Atkinson@jpl.nasa.gov](mailto:David.H.Atkinson@jpl.nasa.gov)

Ms. Linda Rodgers, JPL University Affairs Officer: [Linda.L.Rodgers@jpl.nasa.gov](mailto:Linda.L.Rodgers@jpl.nasa.gov)





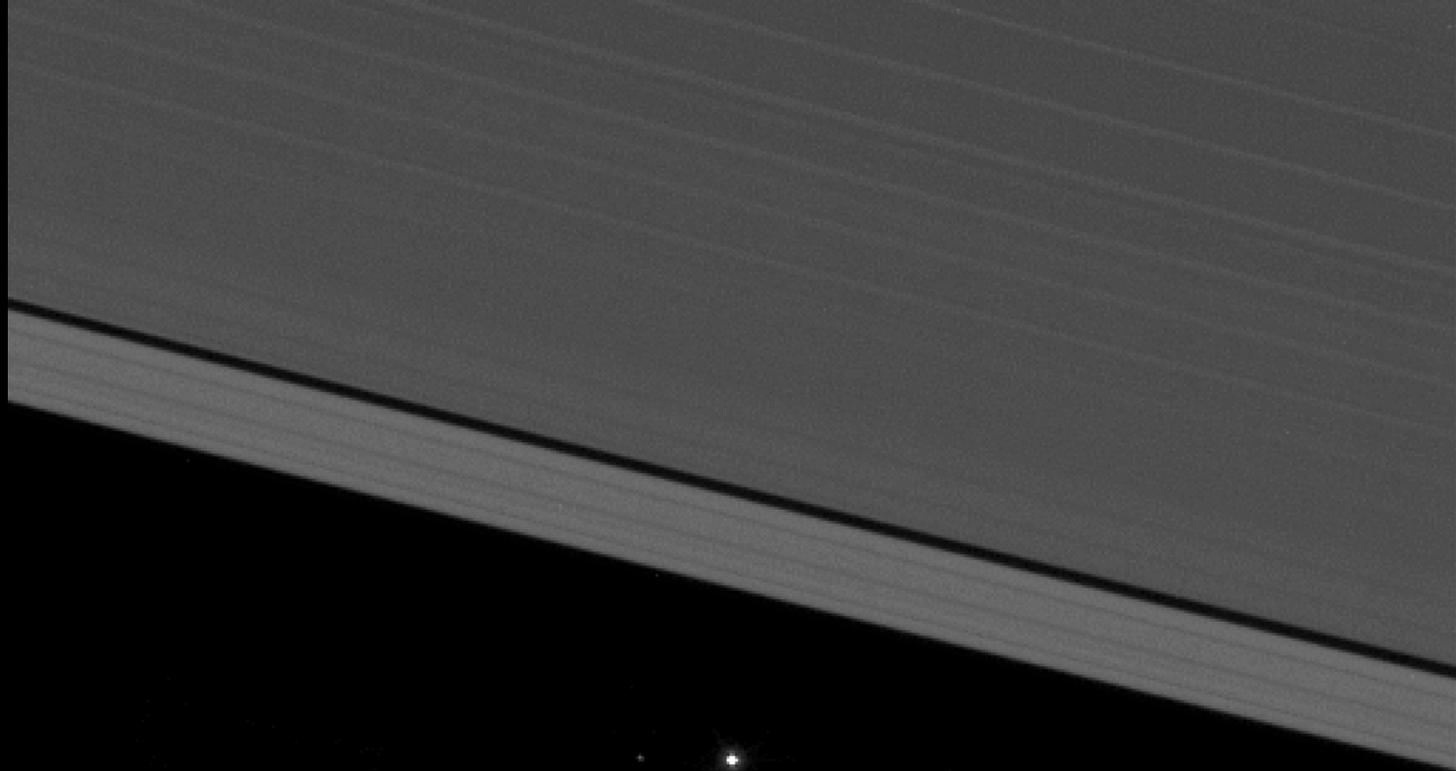


Photo credit: NASA



Photo credit: NASA

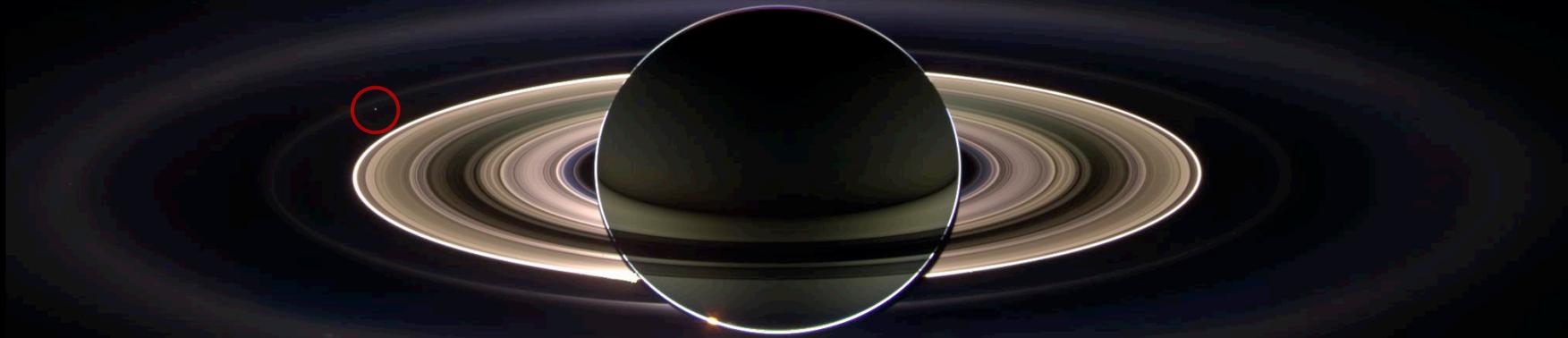


Photo credit: NASA



*“The Earth is the cradle of the mind,  
but one cannot live in the cradle forever.”*

- K. E. Tsiolkovsky

Ad astra!

To the Stars!

Thank You!