

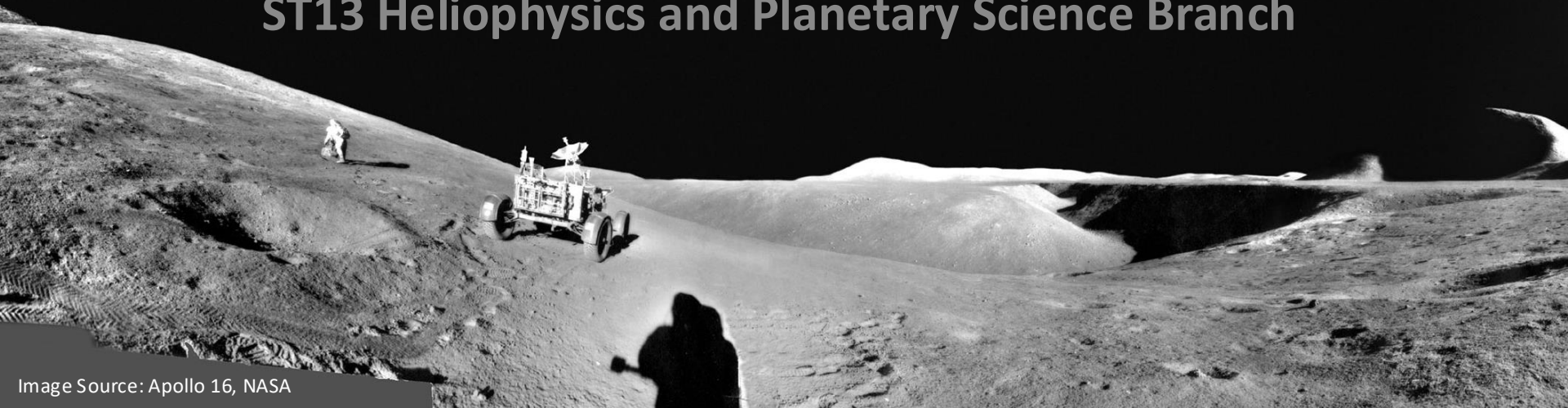
Planets, Moons, & More

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NASA Marshall Spaceflight Center

ST13 Heliophysics and Planetary Science Branch



Overview

- What is a Planet?
- How do we learn about Planets?
- How do we live in Space?

Image Source:
Clementine, NASA

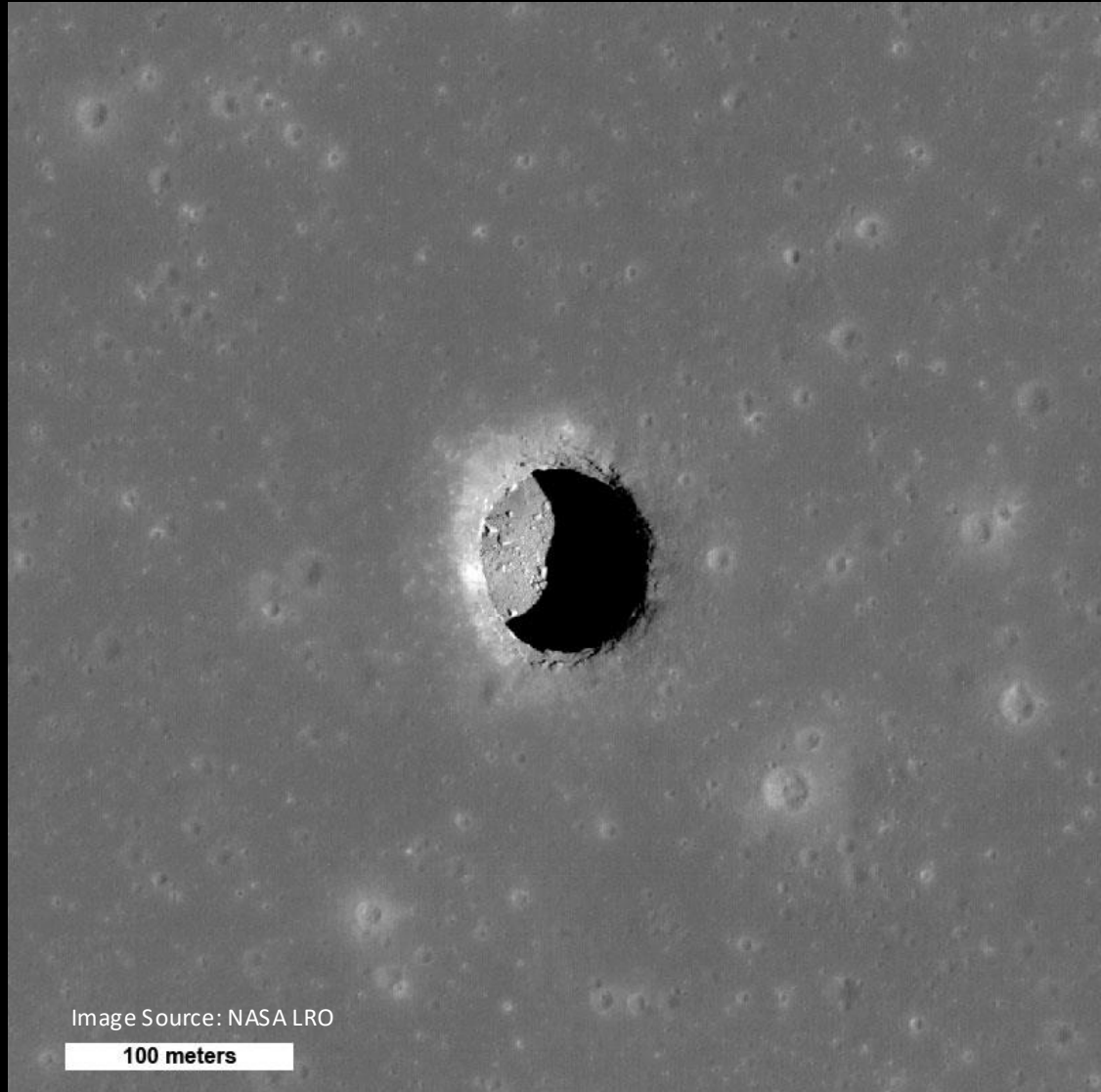
Dr. Heidi Fuqua Haviland



- PhD, Planetary Science, University of California, Berkeley
- Masters of Science, International Space University, Strasbourg, France
- Bachelors of Science, Engineering, Univ. Southern California (USC)
- Bachelors of Science, Physical Science, Biola University, La Mirada, California
- San Marcos High School, San Marcos, California
- Lincoln Middle School, Vista, California
- Beaumont Elementary School, Vista, California



What is a planet?



What is your favorite space object?

comets

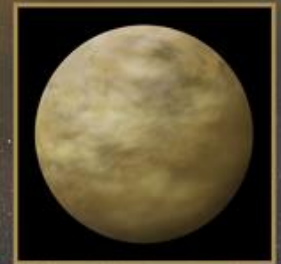
stars

dust

moons

planets

asteroids

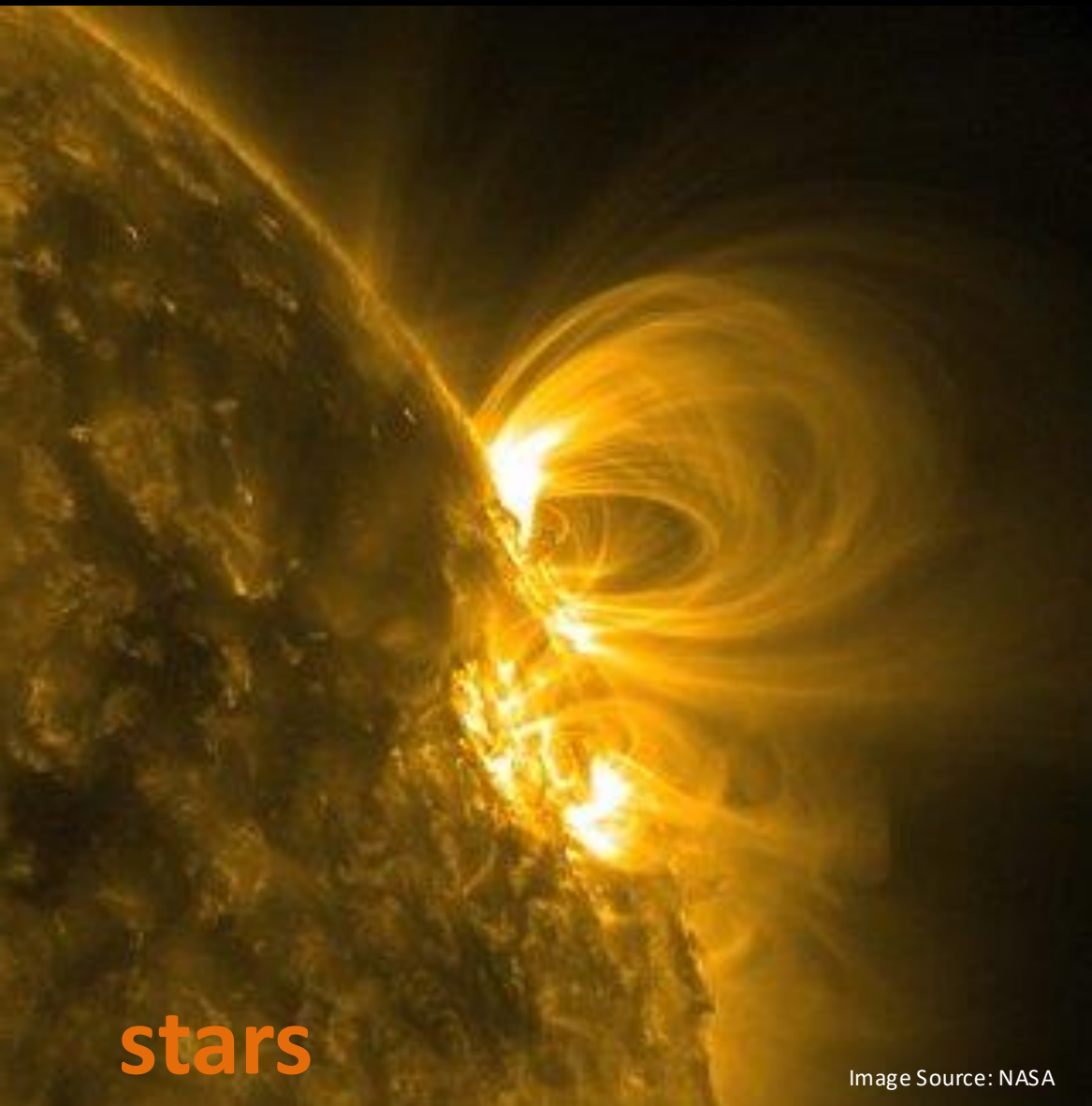


Solar System

Planetary Science

Image Source: NASA

Other than Planets: Space Objects

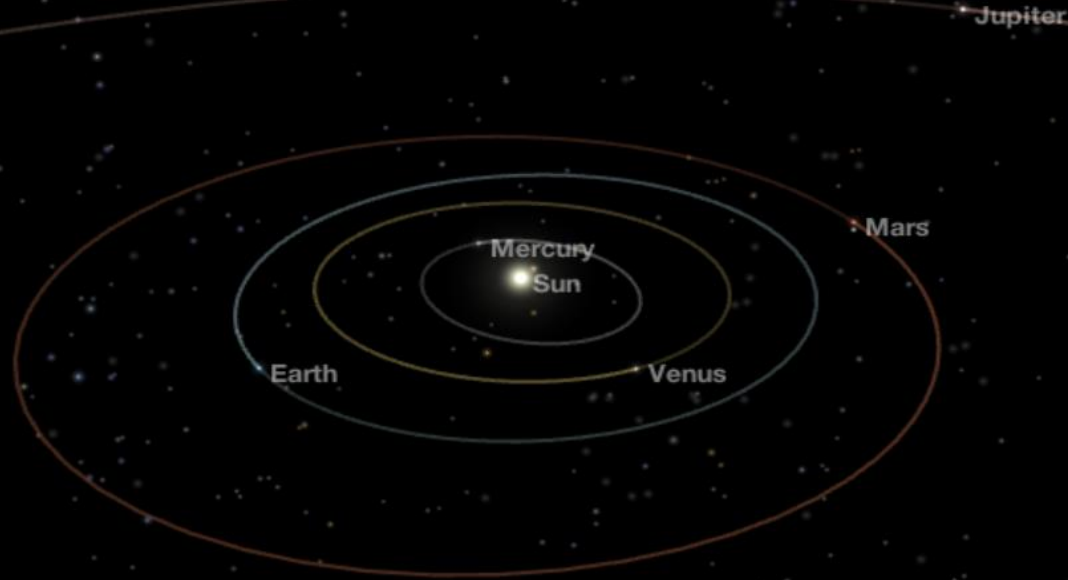


What is a planet?



Jet Propulsion Laboratory
California Institute of Technology

EYES ON THE SOLAR SYSTEM



1. Orbits the Sun

Image Source: NASA



DESTINATIONS

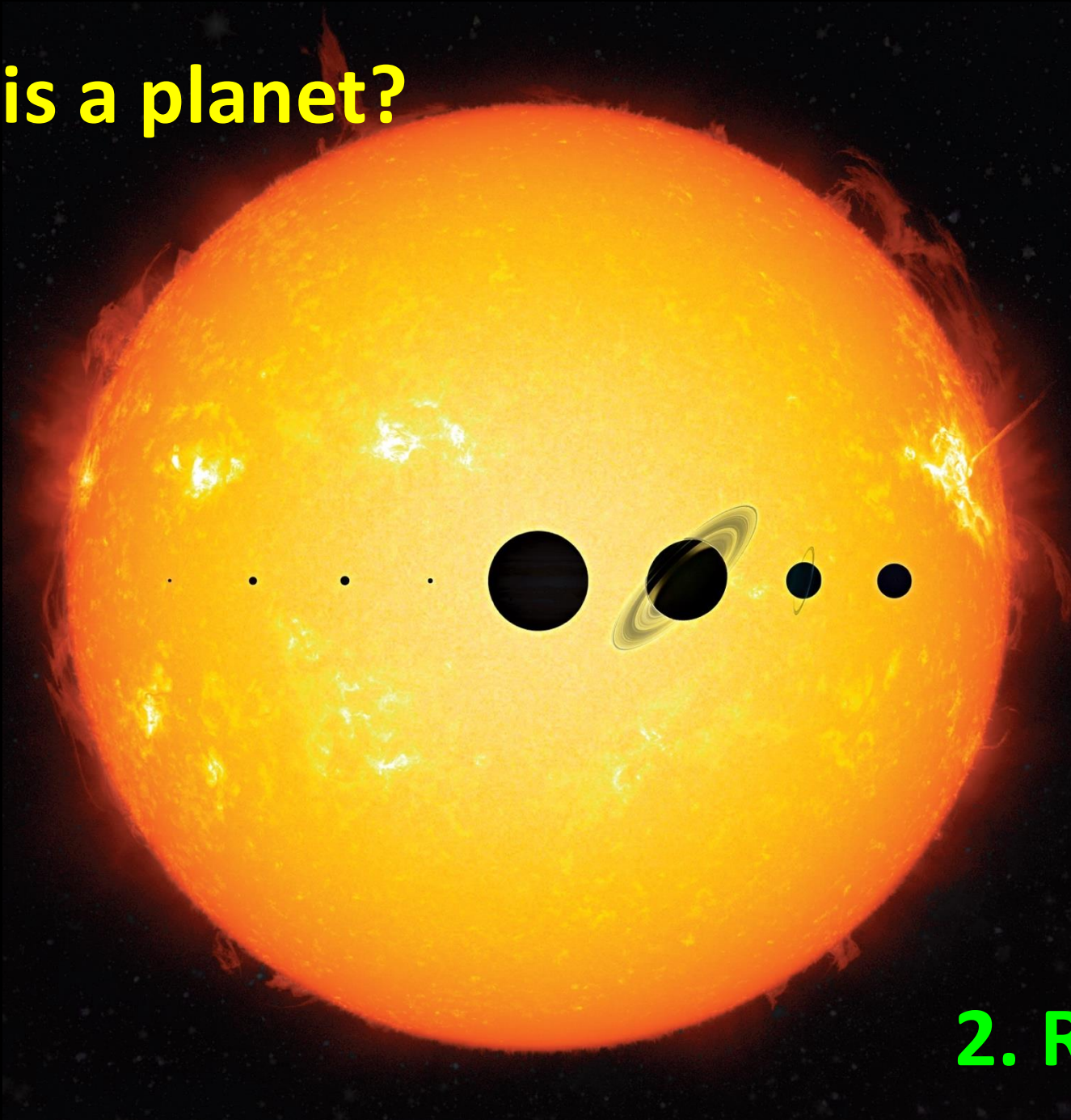
MISSIONS

NEWS

PEOPLE



What is a planet?



2. Round

Image Source: NASA

Pluto & the Kuiper Belt



COMPUTER SIMULATION
(LIVE)

New Horizons Pluto Flyby

MODE
▶ LIVE
▶▶ REPLAY

CAMERAS
⦿ OVERVIEW
👤 RIDE-ALONG
🚀 SPACECRAFT

EXIT

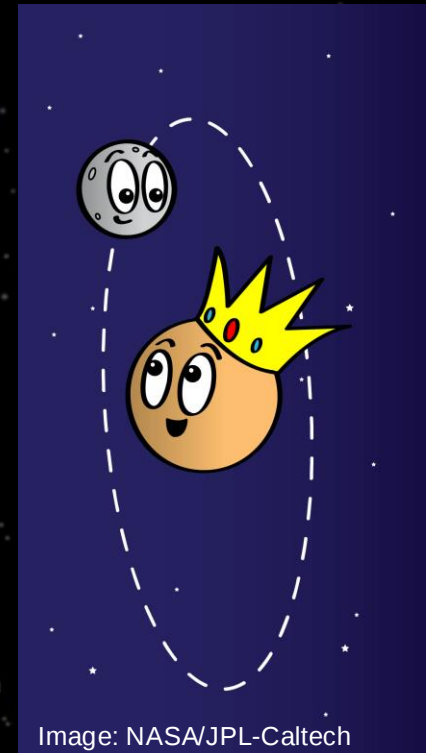
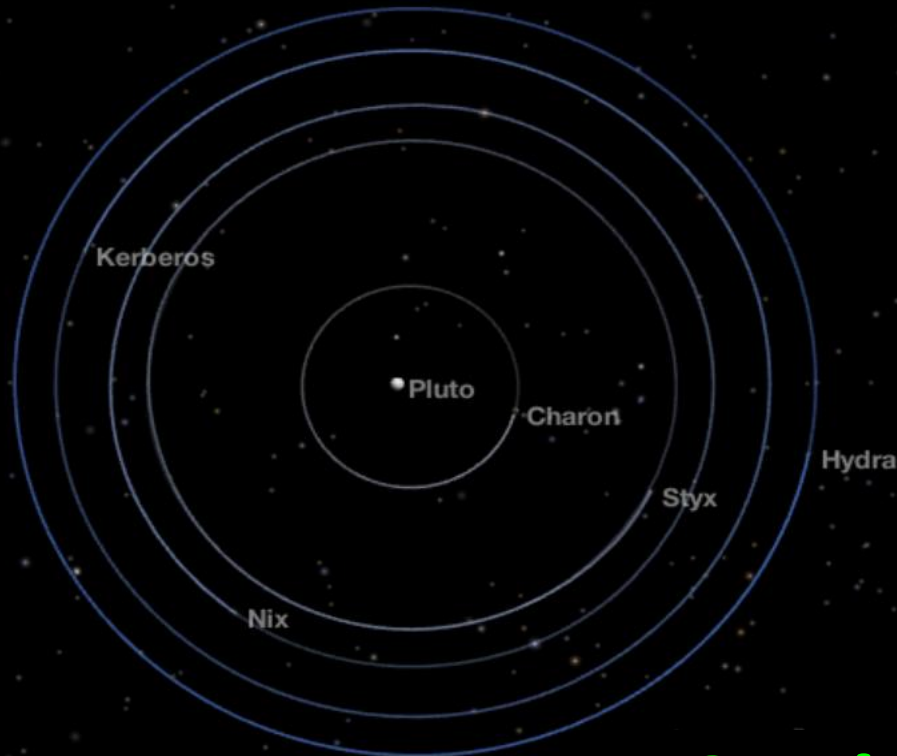


Image: NASA/JPL-Caltech



DISTANCE TO PLUTO
227,723,261.9 Miles

RELATIVE SPEED
30,814.11 MPH

CLOSEST APPROACH
+307d 16h 01m 12.7s

3. King of it's orbit

Image Source: NASA

Pluto & the Kuiper Belt

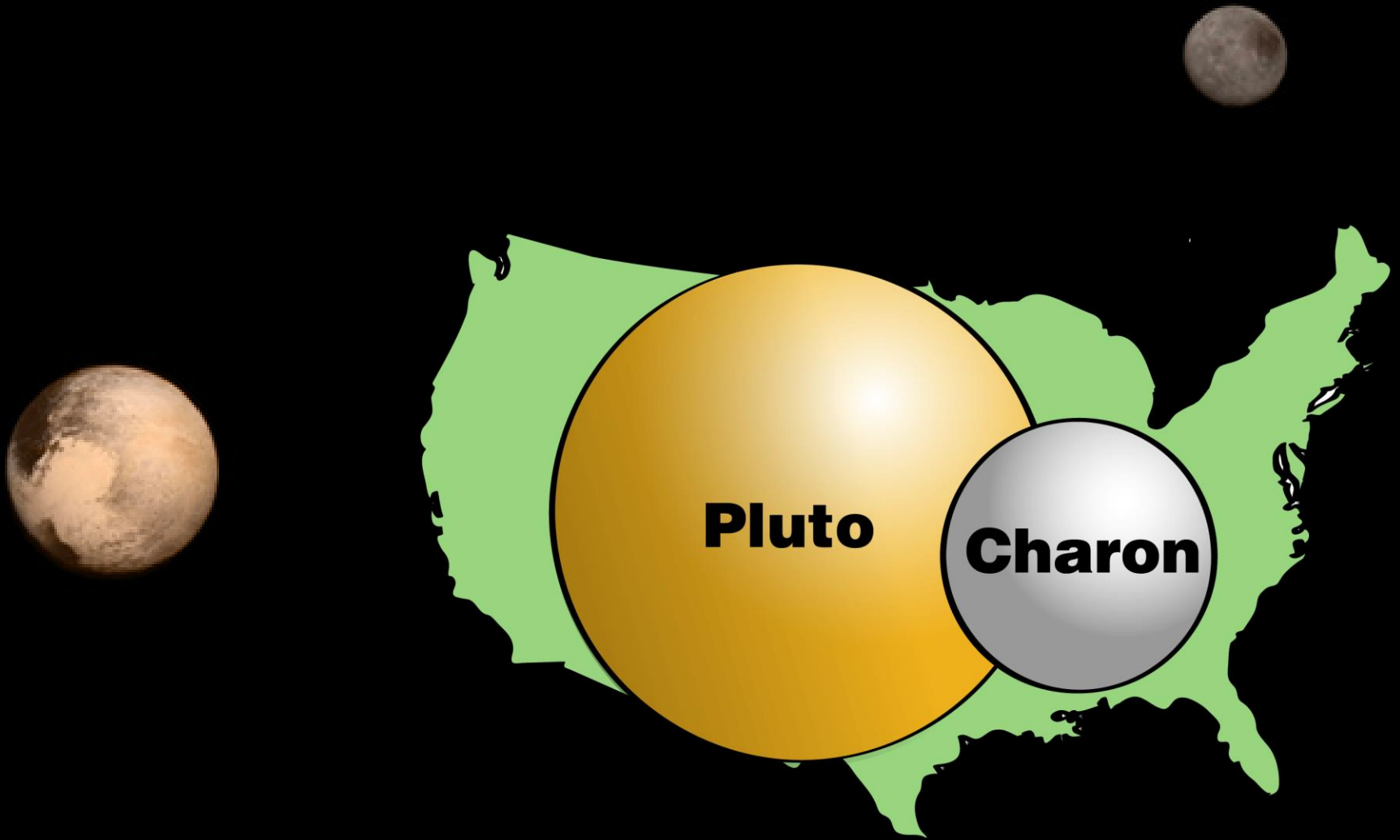


Image: NASA/JPL-Caltech
Image Source: NASA New Horizons

How do we learn about Planets?

Human Remote Sensing



Image Source: Pixabay



Image Source: NASA

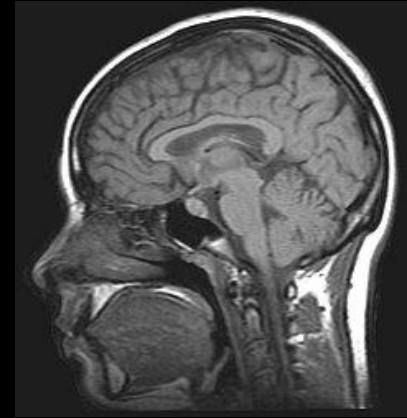


Image Source: NASA



Image Source: Pixabay

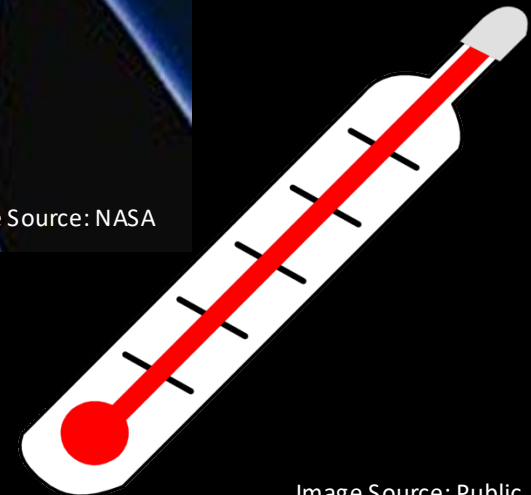


Image Source: Public
Domain Clip Art

Geophysics Remote Sensing

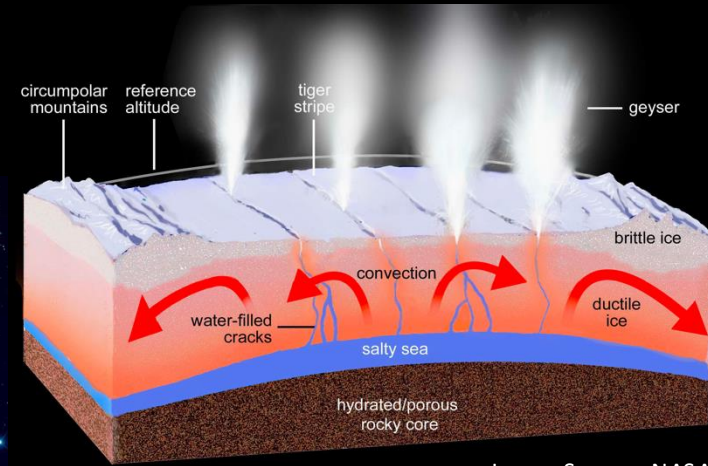
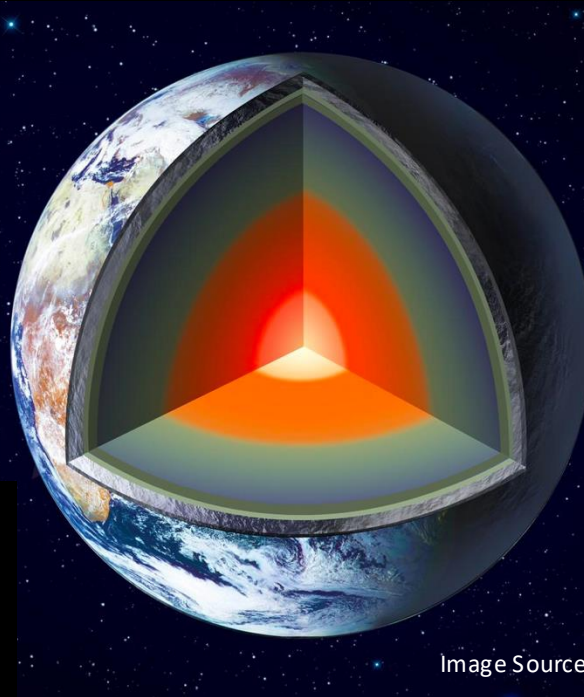
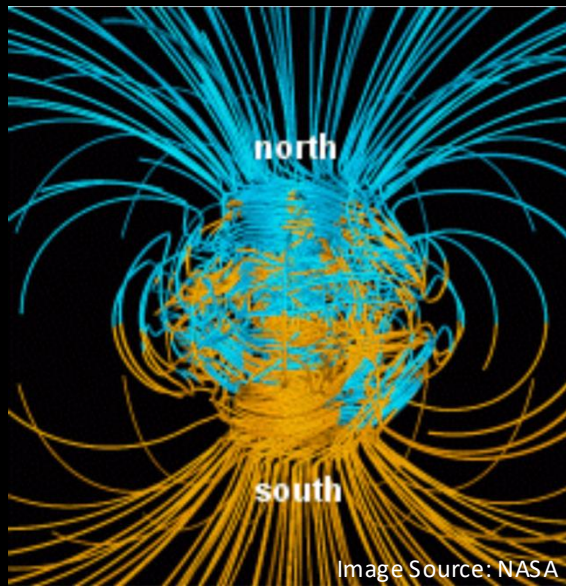


Image Source: NASA

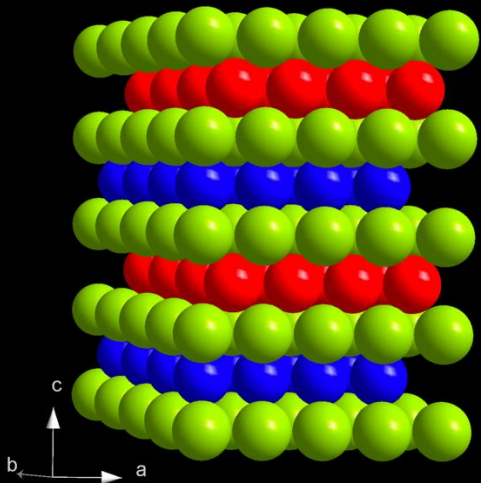


Image Source: Solid State, public domain

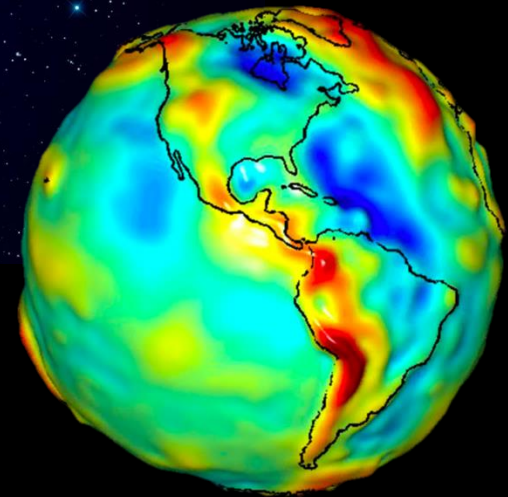


Image Source: GRACE
NASA

How do we learn about Planets?



Science

Image Source: NASA

How do we learn about Planets?



Engineering

Image Source: NASA

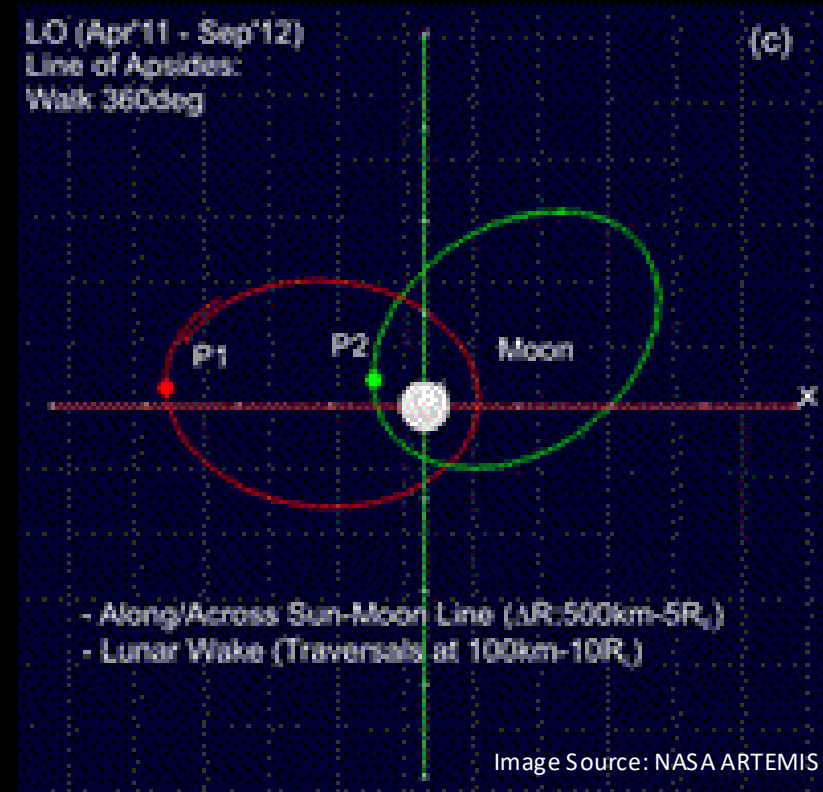
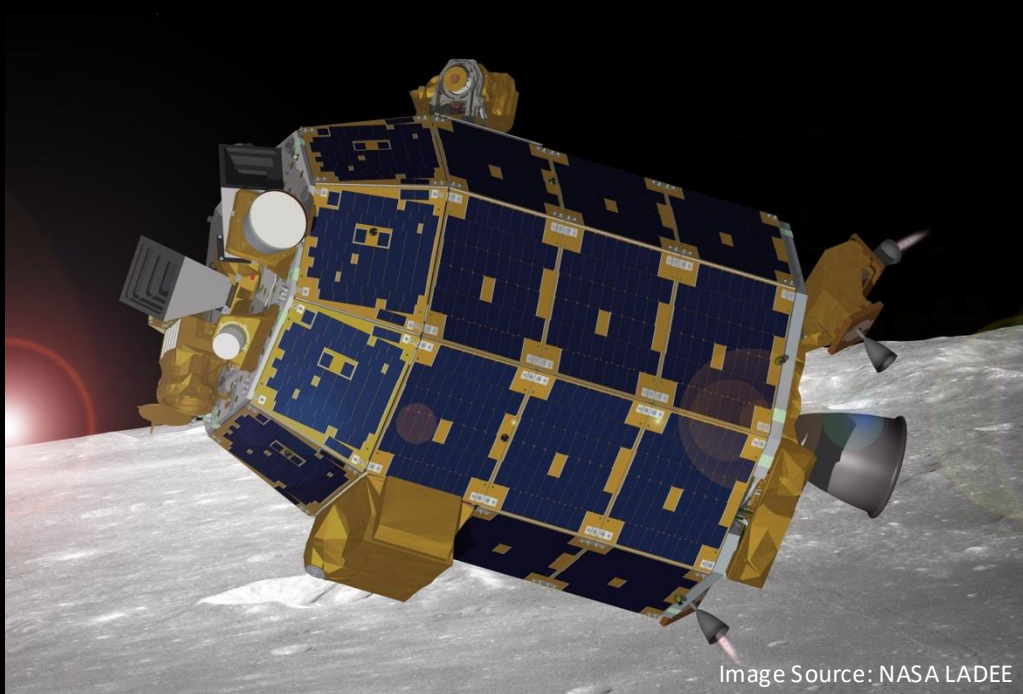
How do we learn about Planets?



Image Source: NASA Mars Rover

**Mission
Control
Center**

How do we learn about Planets?



Satellites



Image Source: NASA MAVEN

\$582.5M total mission

How do we get to outer space?



Image Source: NASA

Rockets



Image Source: NASA

Who wants to go to outer space?

...How are we going to get there?

...How do we live?

**...What are you going to do once you
get there?**

...How much does it cost?

Artemis Phase 1: Path to The Lunar Surface



Artemis I: First human spacecraft to the Moon in the 21st century

2025

Artemis II: First humans to orbit the Moon in the 21st century

Artemis Support Mission: First high-power Solar Electric Propulsion (SEP) system

Artemis Support Mission: First pressurized module delivered to Gateway

Artemis Support Mission: Human Landing System delivered to Gateway

Artemis III: Crewed mission to Gateway and lunar surface

Commercial Lunar Payload Services
- CLPS-delivered science and technology payloads

Early South Pole Mission(s)

- First robotic landing on eventual human lunar return and In-Situ Resource Utilization (ISRU) site
- First ground truth of polar crater volatiles

Large-Scale Cargo Lander
- Increased capabilities for science and technology payloads

Humans on the Moon - 21st Century
First crew leverages infrastructure left behind by previous missions

LUNAR SOUTH POLE TARGET SITE

2020

UCLA SMART 2023

2026

Image Source: NASA

CLPS Deliveries

2024-2028

Delivery Site:
Gruithuisen Domes
Provider Firefly
PRISM 2a/CP-21 |
2028

Delivery Site:
Ina IMP
Provider TBD
CP-32 | 2027

Delivery Site:
Reiner Gamma
Provider Intuitive
Machines (IM)
CP-11 | 2025

Delivery Site:
Sinus Viscositas
Provider: Astrobotic
TO2-AB | Jan 2024

Delivery Site:
Mare Crisium
Provider: Firefly
TO 19D | Q1 2025

Delivery Site:
Farside
Provider: Firefly
TO CS3, CS4 |
2025

Delivery Site:
South Pole
Provider: IM
TO PRIME-1 | Q1 2025

Delivery Site:
South Pole
Provider:
Astrobotic
VIPER | Nov 2024

Delivery Site:
Malapert A
Provider: IM
TO2-IM | Feb 2024

Delivery Site:
Schrödinger Basin
Provider Draper
CP-12 | 2026

Delivery Site:
South Pole
Provider TBD
CP22 | 2027

Delivery Site:
South Pole
Provider TBD
CS6 | 2027

Updated 08/16/2024



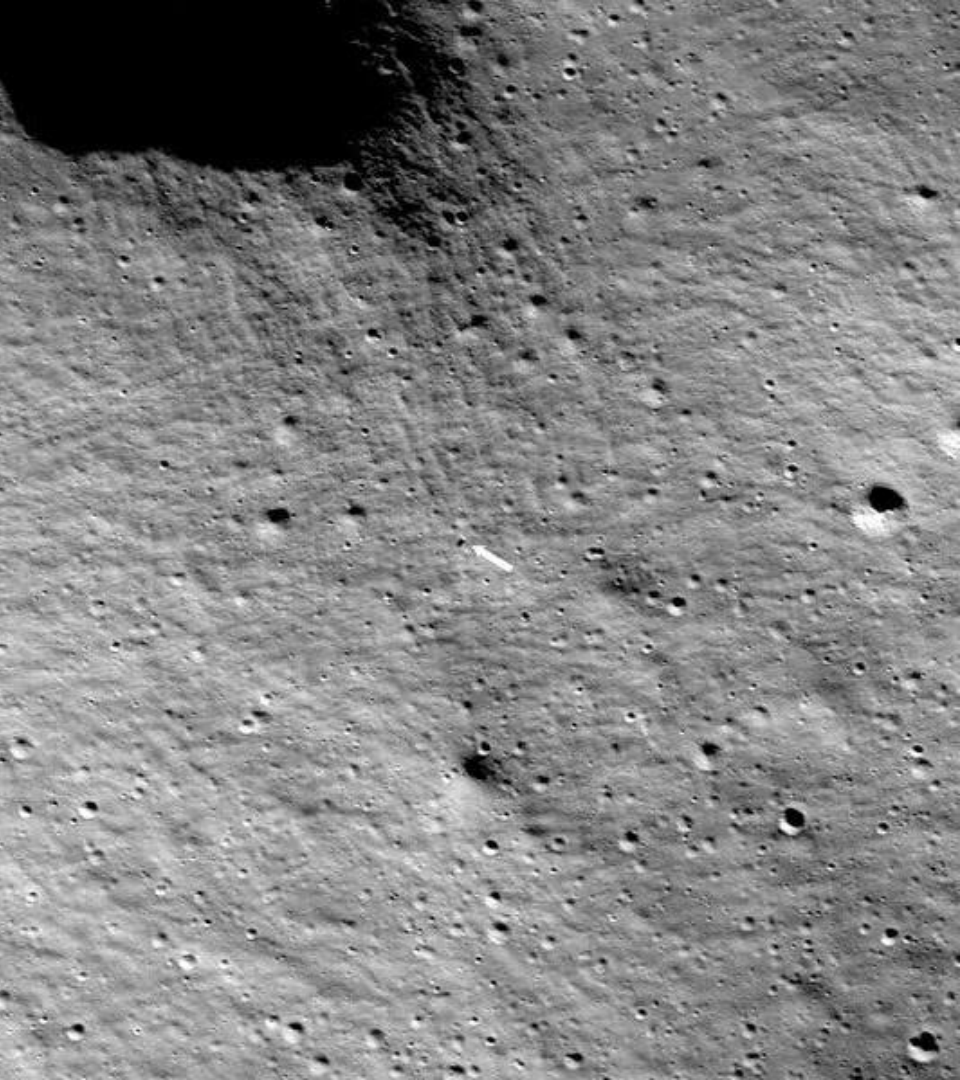
Upcoming Launch/Landing



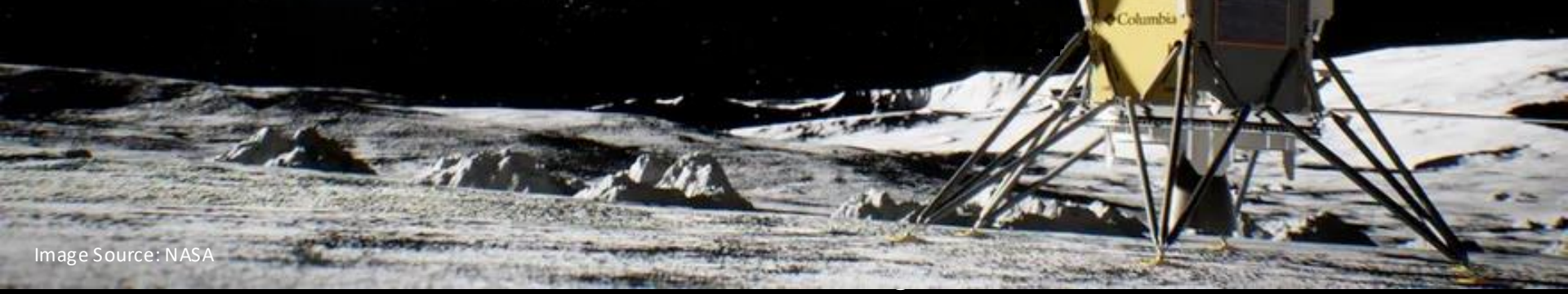
Successful



Not Successful



INTUITIVE
MACHINES





INTUITIVE
MACHINES

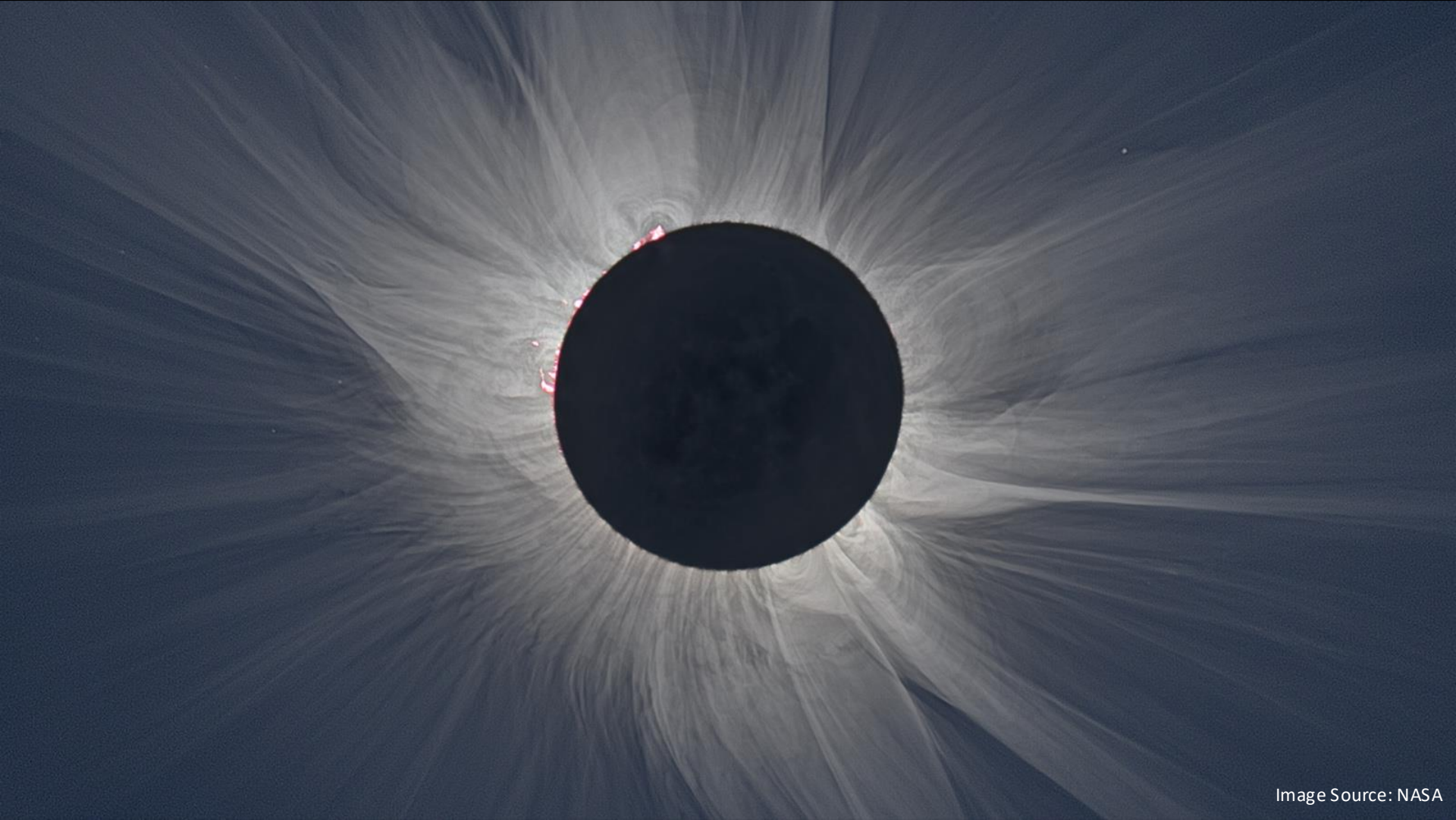


Image Source: NASA

Lunar Swirls



70 km = 43.5 miles

Image Source: NASA

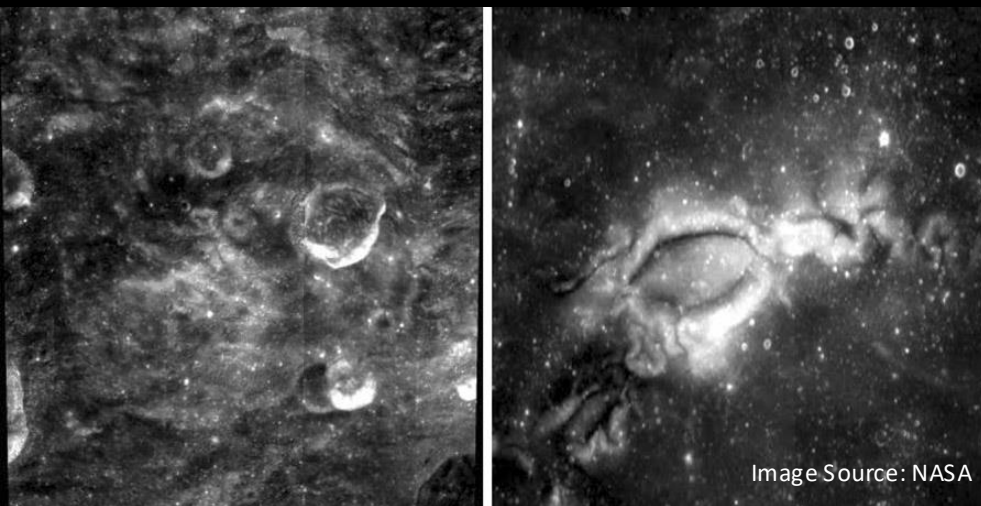


Image Source: NASA

Arrokoth

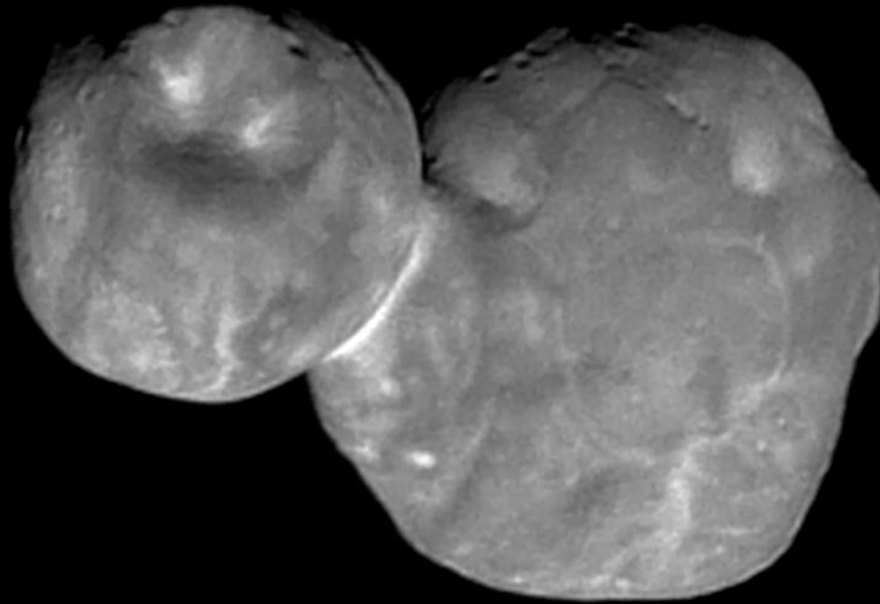


Image Source: NASA
New Horizons

Spacecraft: \$600M, total mission: \$780M

How do we get to outer space?

Satellites

Rockets

Crew Vehicles

What are we going to do once we get there?

Questions?



Image Source: NASA Apollo 8, Bill Anders