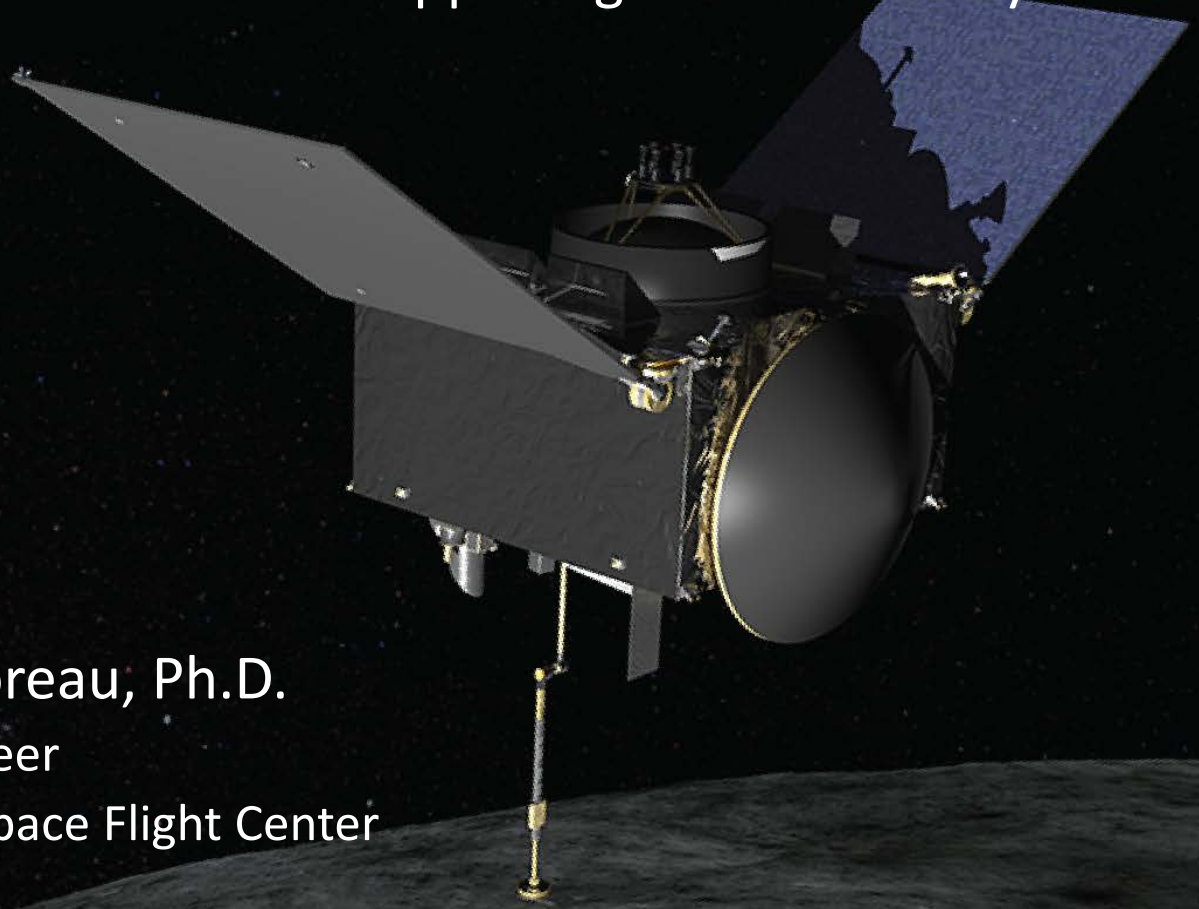
OSIRIS-REx

A NASA Mission to a Near Earth Asteroid!

…and other recent happenings in the Solar System

OSIRIS-REx™
ASTEROID SAMPLE RETURN MISSION



Michael C. Moreau, Ph.D.
Aerospace Engineer
NASA Goddard Space Flight Center



Outline

- Goddard Space Flight Center – Where I work
- Recent robotic explorers of the Solar System
- A little bit about ASTEROIDS, and the OSIRIS-REx Asteroid Sample Return Mission
- What does it take to pull-off a project like OSIRIS-REx?

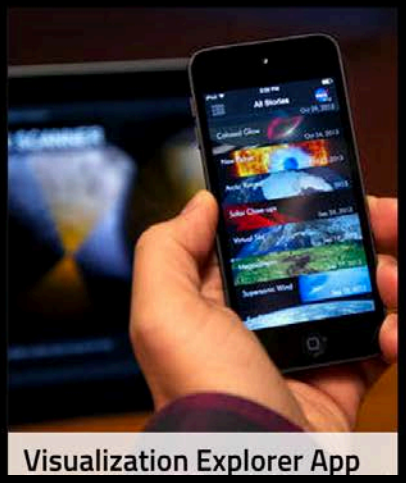
Goddard Space Flight Center



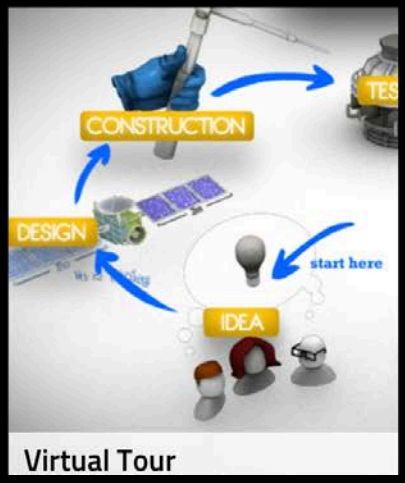
President of South Korea to Visit NASA Goddard



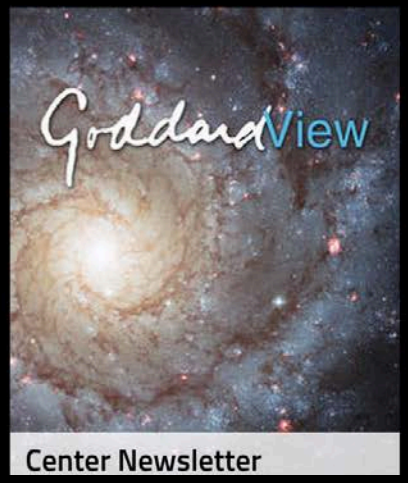
NASA | Jupiter in 4k Ultra HD



Visualization Explorer App



Virtual Tour



Center Newsletter

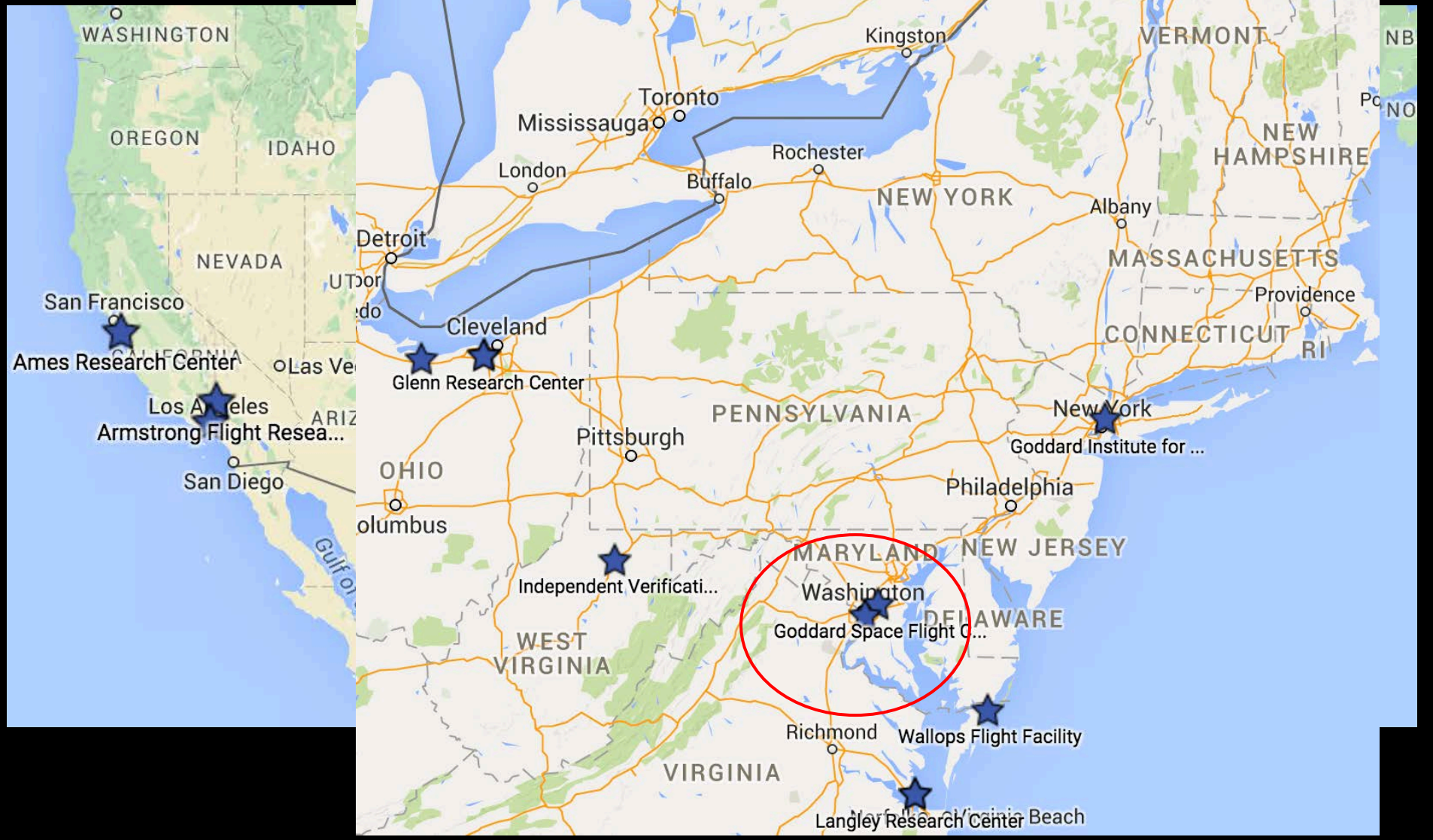
About Goddard

Named for rocketry pioneer Dr. Robert H. Goddard, NASA established the center as its first space flight complex in 1959. The center studies Earth, the sun, our solar system and the universe.

Learn More
Contact NASA Goddard
Center Implementation Plan
2014 Annual Report (11 MB pdf)

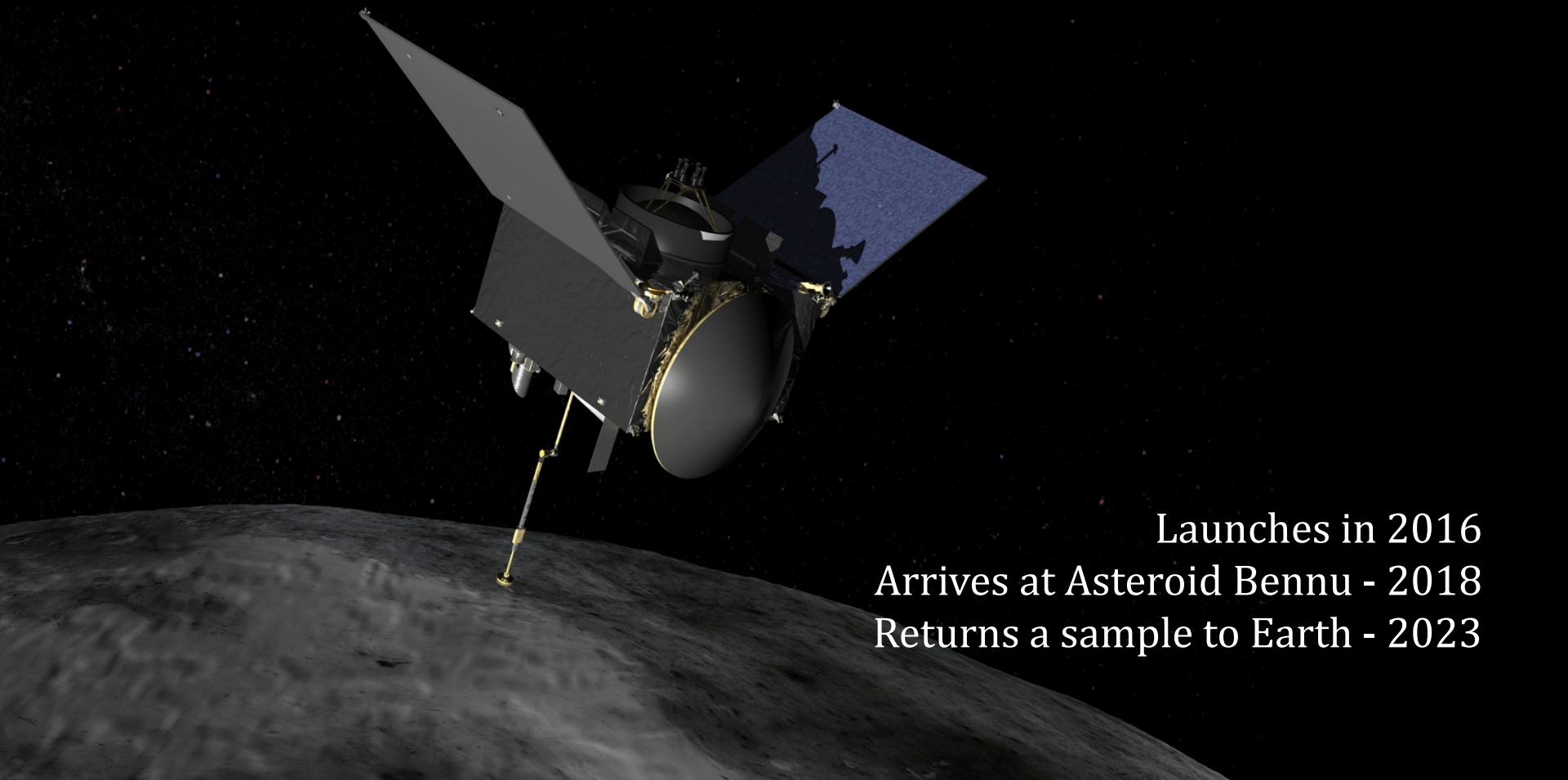
http://www.nasa.gov/centers/goddard/home/index.html

NASA Facilities – Goddard Space Flight Center outside of Washington, DC



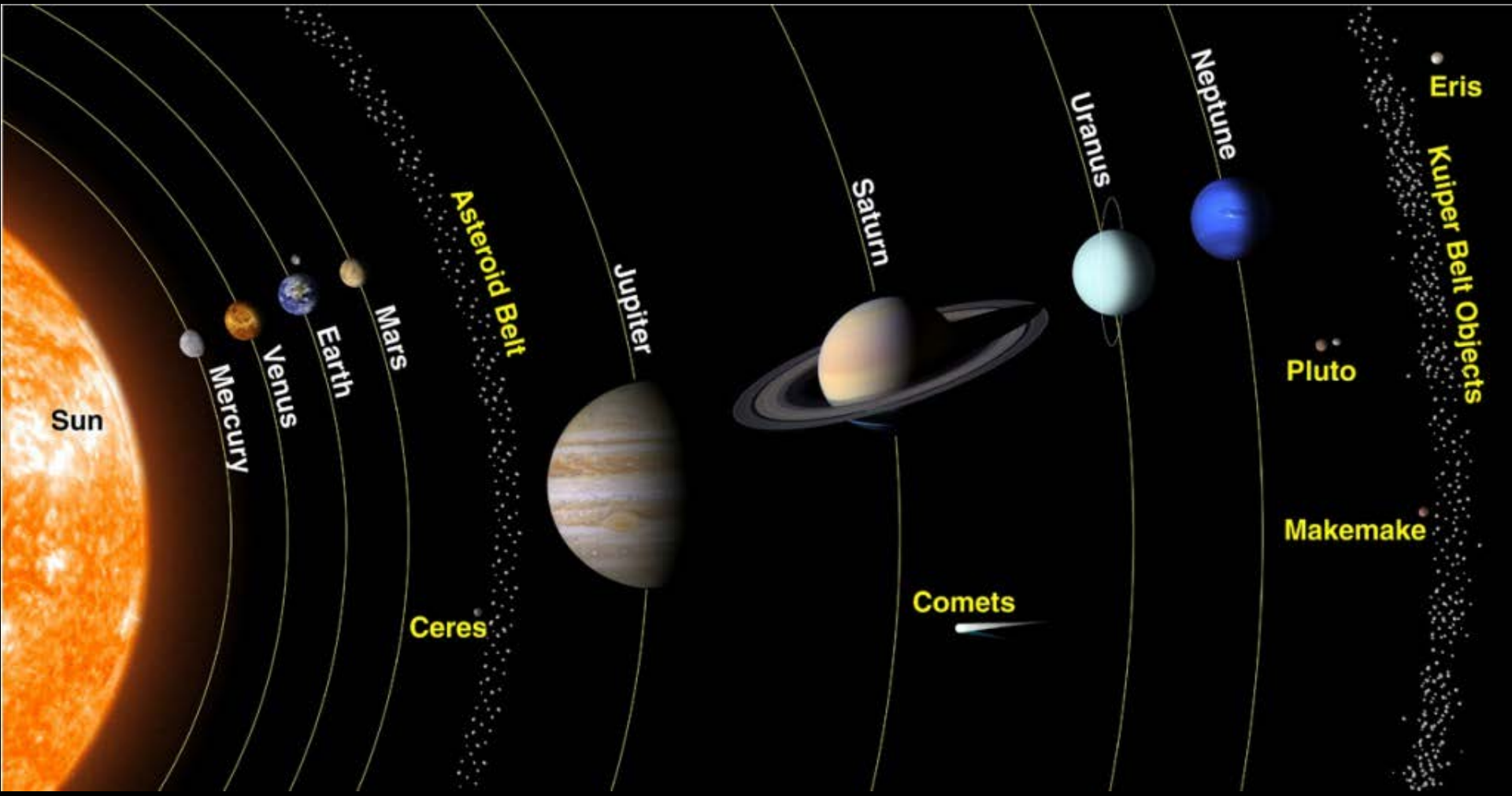
The OSIRIS-REx Mission

The mission, OSIRIS-REx, will visit an asteroid and return a sample from the early Solar System to help us understand how our Solar System formed.

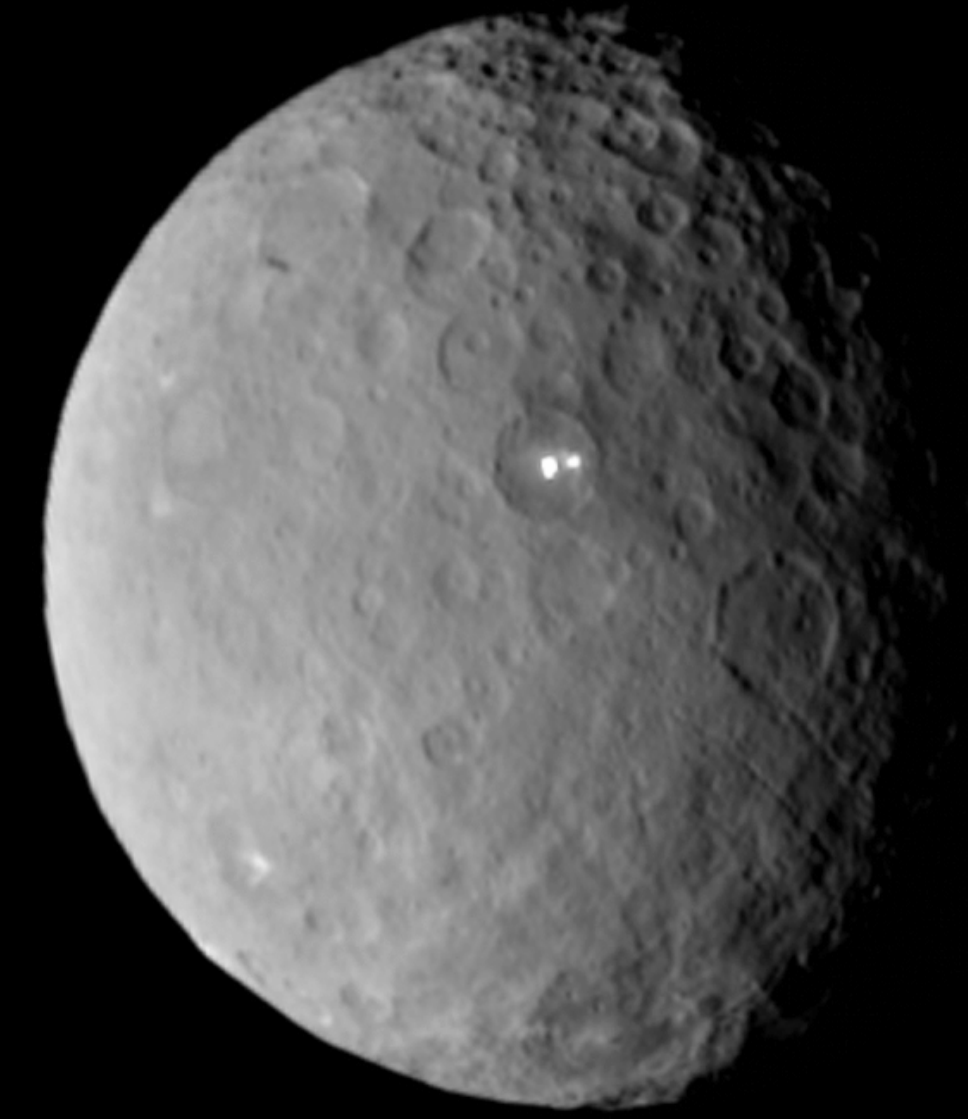


Launches in 2016
Arrives at Asteroid Bennu - 2018
Returns a sample to Earth - 2023

Satellites are exploring all over the Solar System Today!

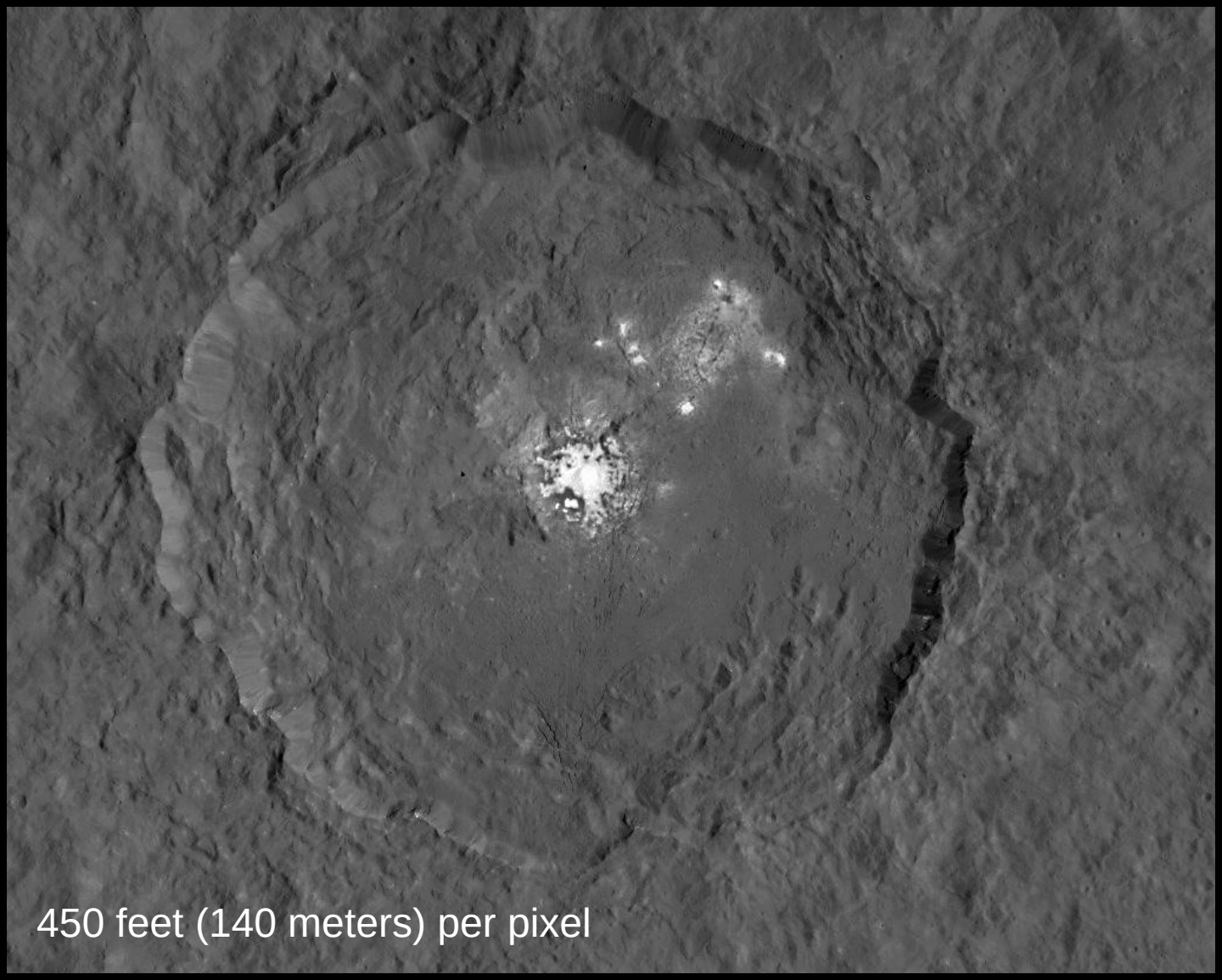


DAWN Spacecraft – Departed Vesta in 2012 - Just arrived at Ceres February 2015



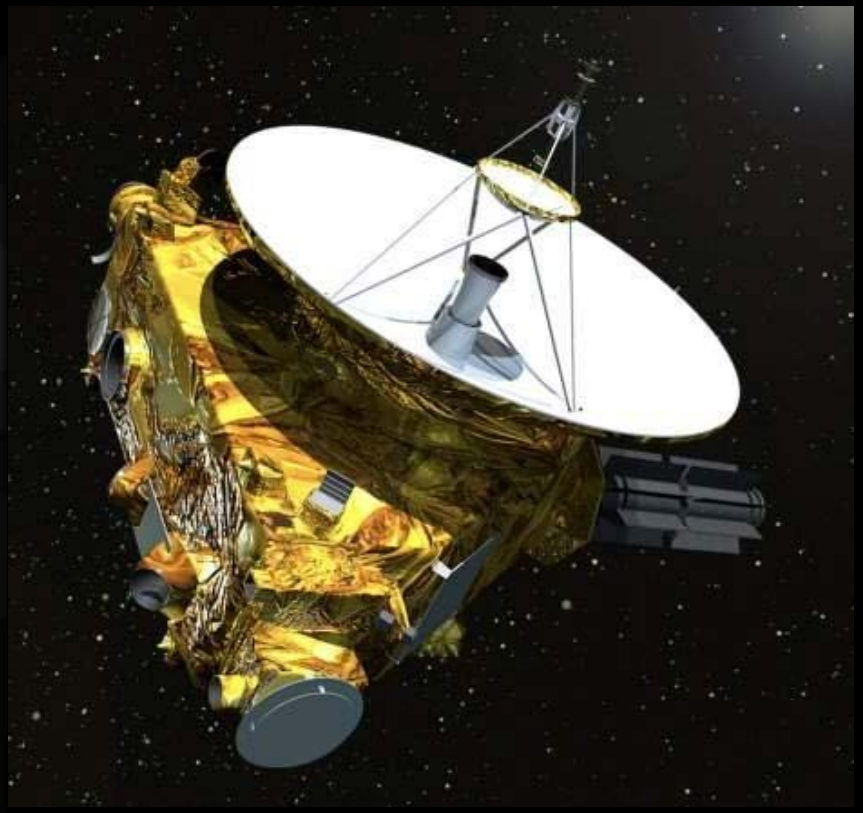


Occator crater on Ceres, home to a collection of intriguing bright spots…



New Horizons Spacecraft
Encounter with Pluto July 2015

200 km/pix



Our best image of Pluto ca.1994



New Horizons MVIC Color Imager

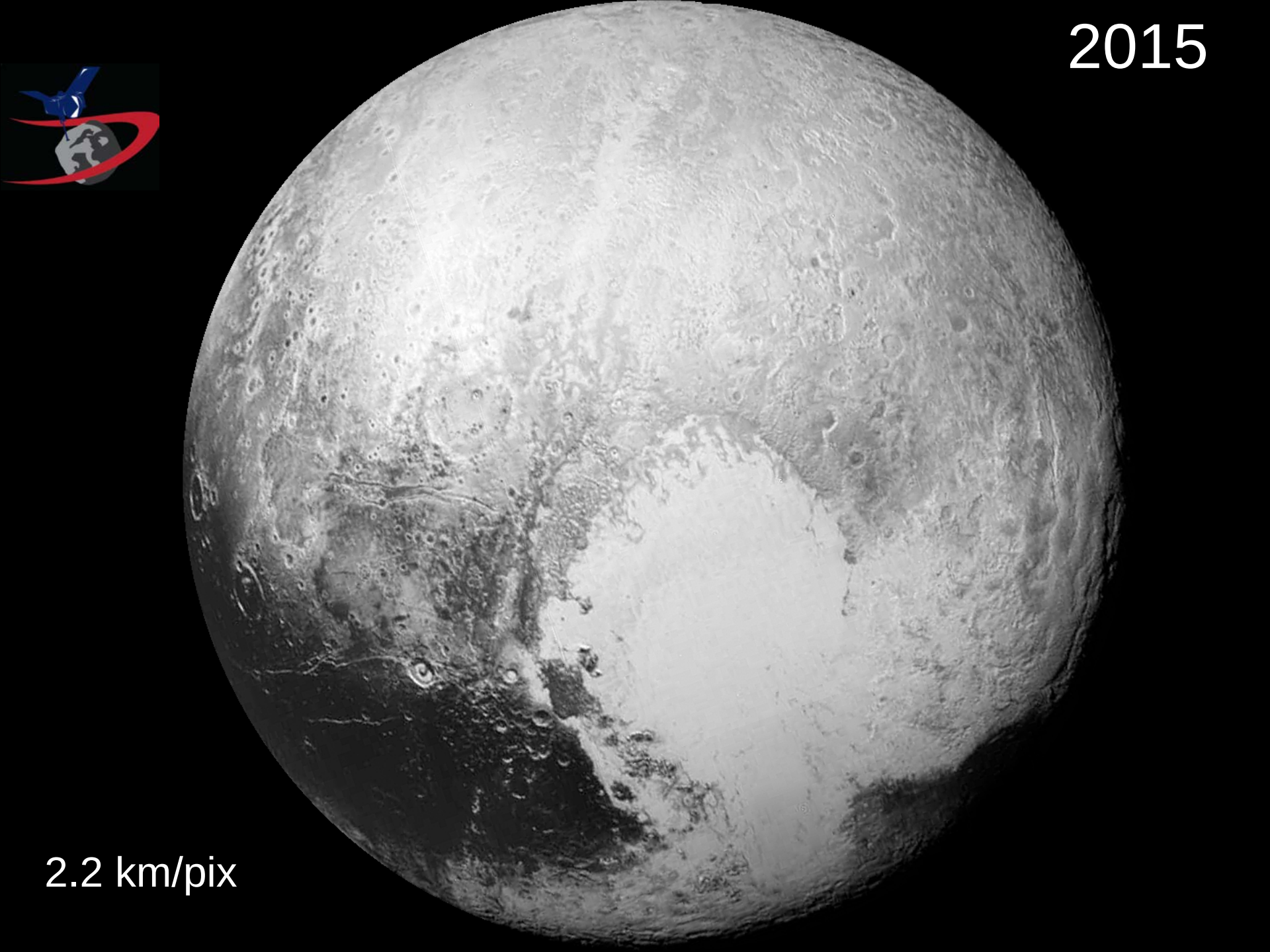
Distance from Pluto: 54.8 million km

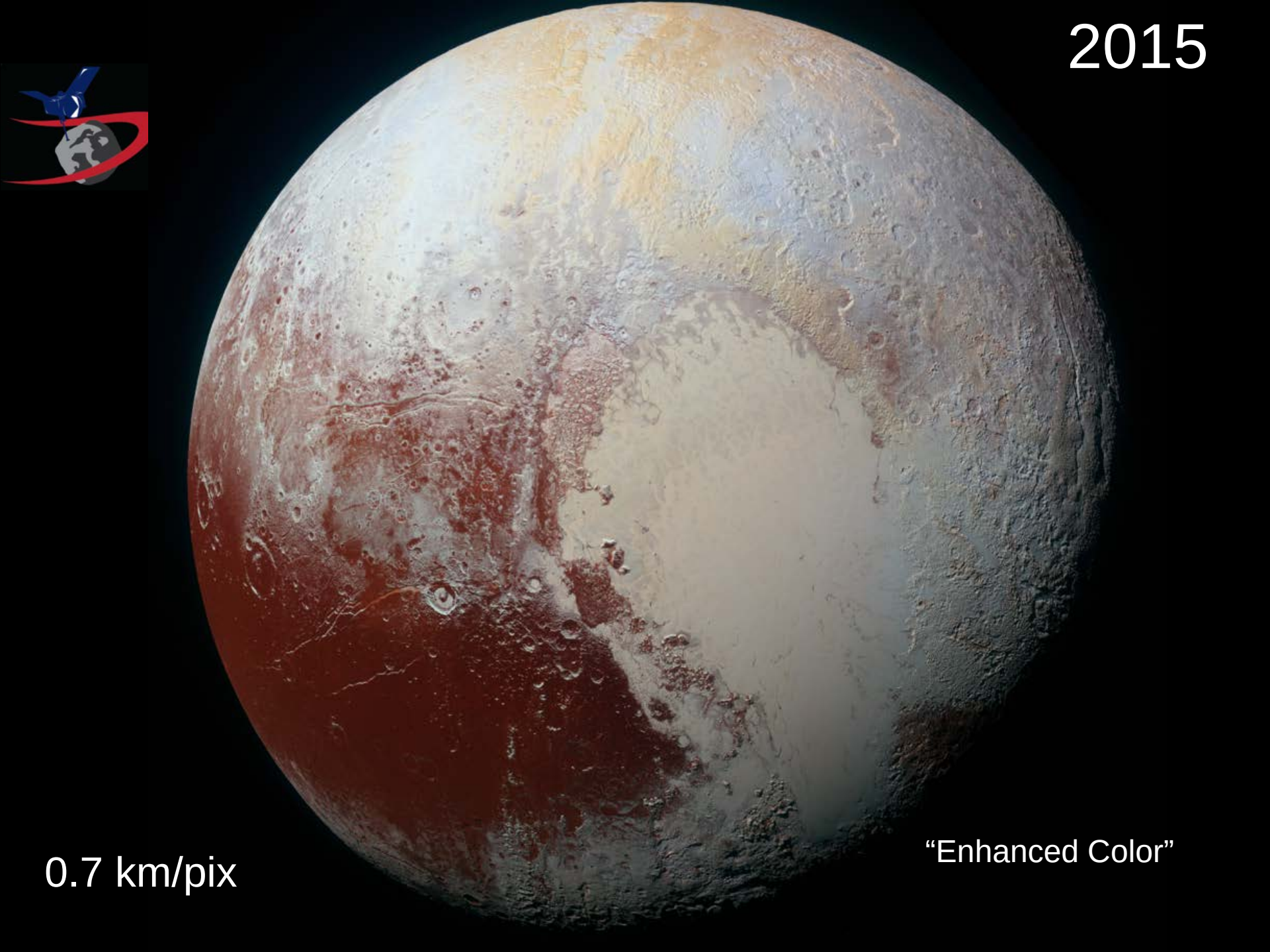
Date: 2015-05-29 11:38 UTC

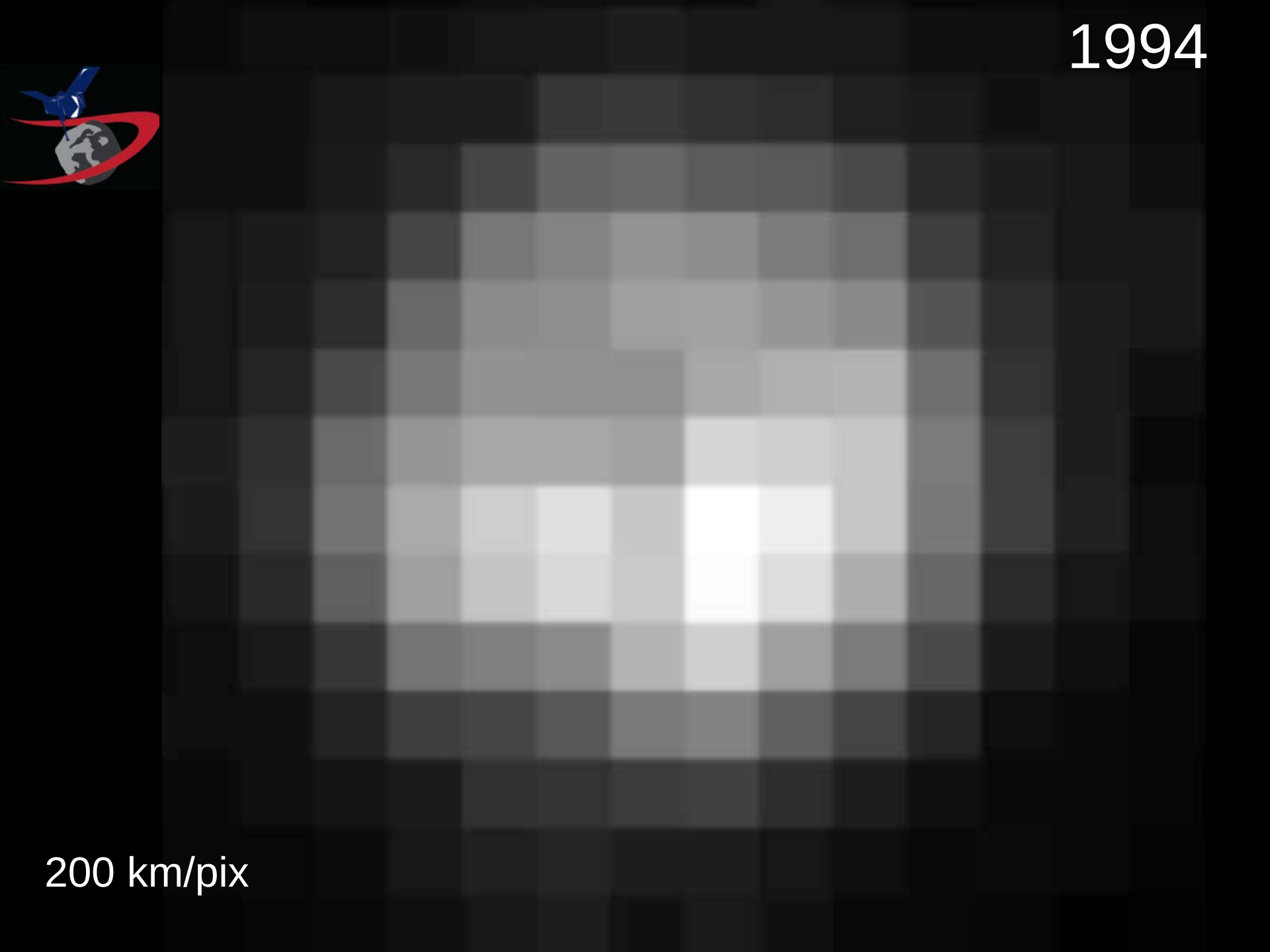
Barycentric view

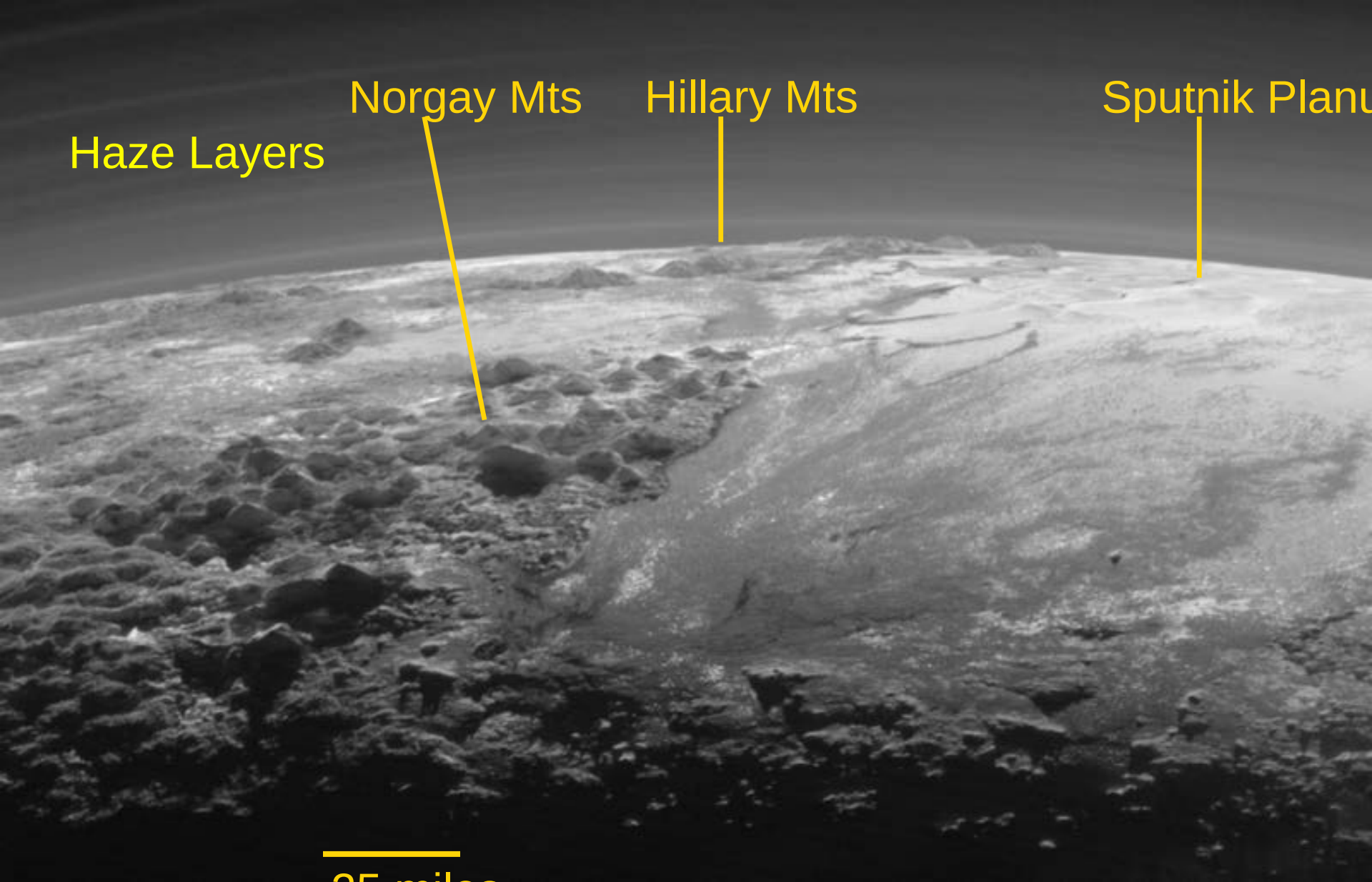





2015
2.2 km/pix


2015
0.7 km/pix
“Enhanced Color”


1994
200 km/pix



0.35 km/pix	km	Jul 14 12:00:41	147.2°



On Earth, a skier heading straight down a 30-degree slope will accelerate to 11 miles per hour in one second.

The same skier on Pluto would "tear" down the same hill at 0.7 mph (1 ft/s) after one second.



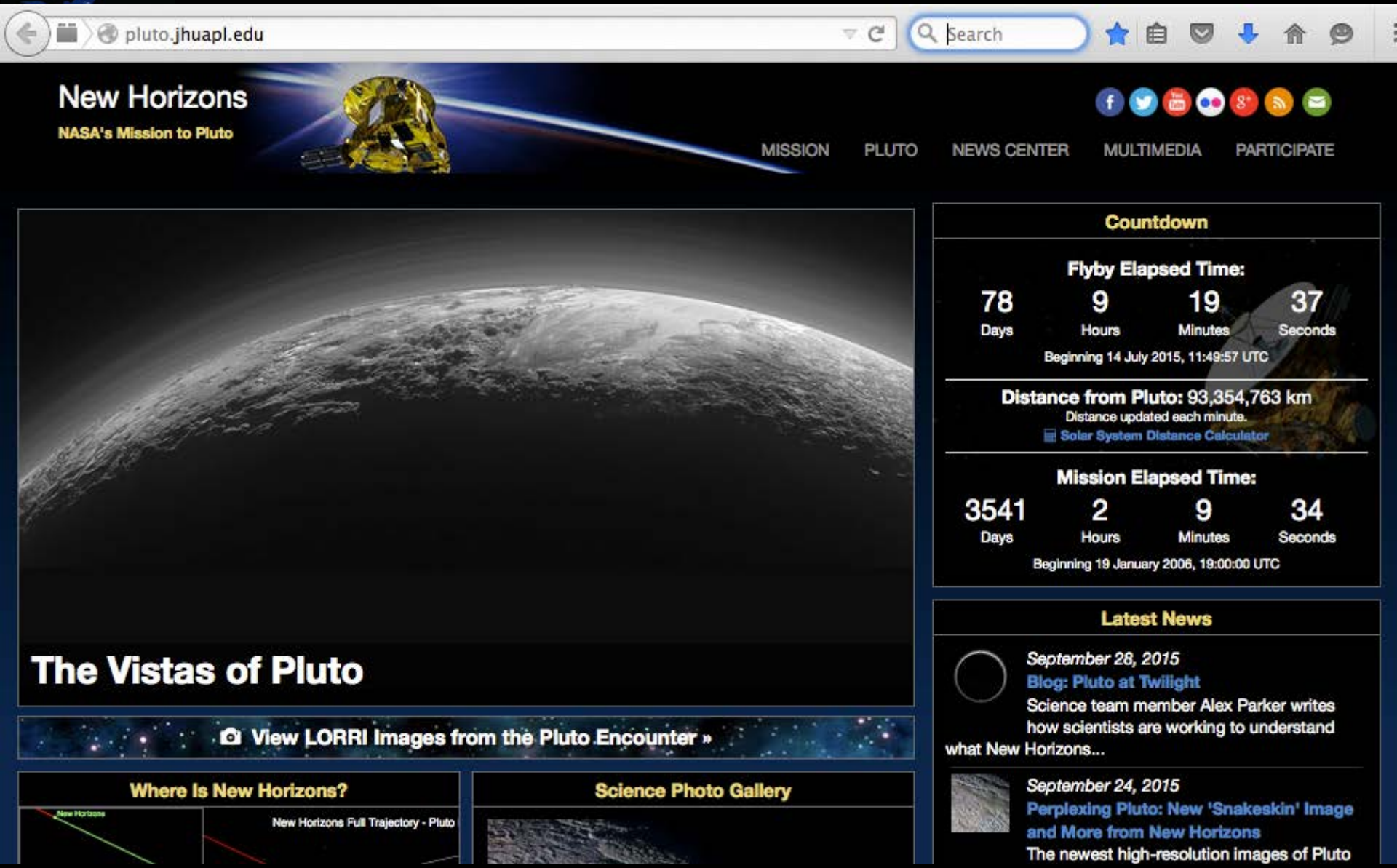
Gravity on Pluto is 6% that of Earth…

Not exactly packed power conditions Ice, being N_2+CH_4, does not act like water when pressure applied…

Even colder than Jay Peak…

http://www.stevethomasart.com

Continue to learn with us! http://pluto.jhuapl.edu



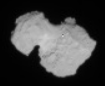
Rosetta Spacecraft at Comet Churyumov–Gerasimenko (or C.G. …)



Amazing Results from Rosetta and Philea!

Animation of images During Approach

Courtesy European Space Agency



Rosetta Spacecraft's Trajectory Near C.G.

Amazing Results from Rosetta and Philea!



Rosetta navigation camera image taken from a distance of 10.0 km from the surface of Churyumov-Gerasimenko, on 17 October 2014.

Courtesy European Space Agency

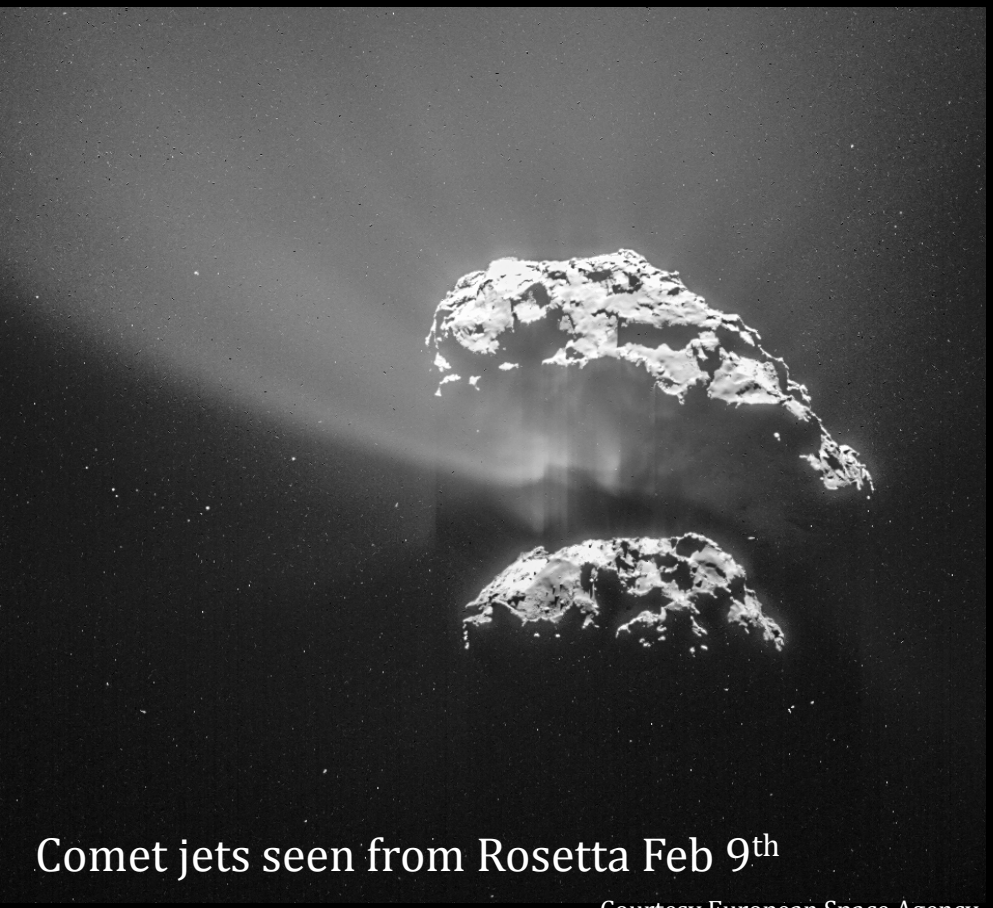
Amazing Results from Rosetta and Philea!

Rosetta's Lander Philea on the surface

Courtesy European Space Agency



Amazing Results from Rosetta and Philea!



Comet jets seen from Rosetta Feb 9th

Courtesy European Space Agency

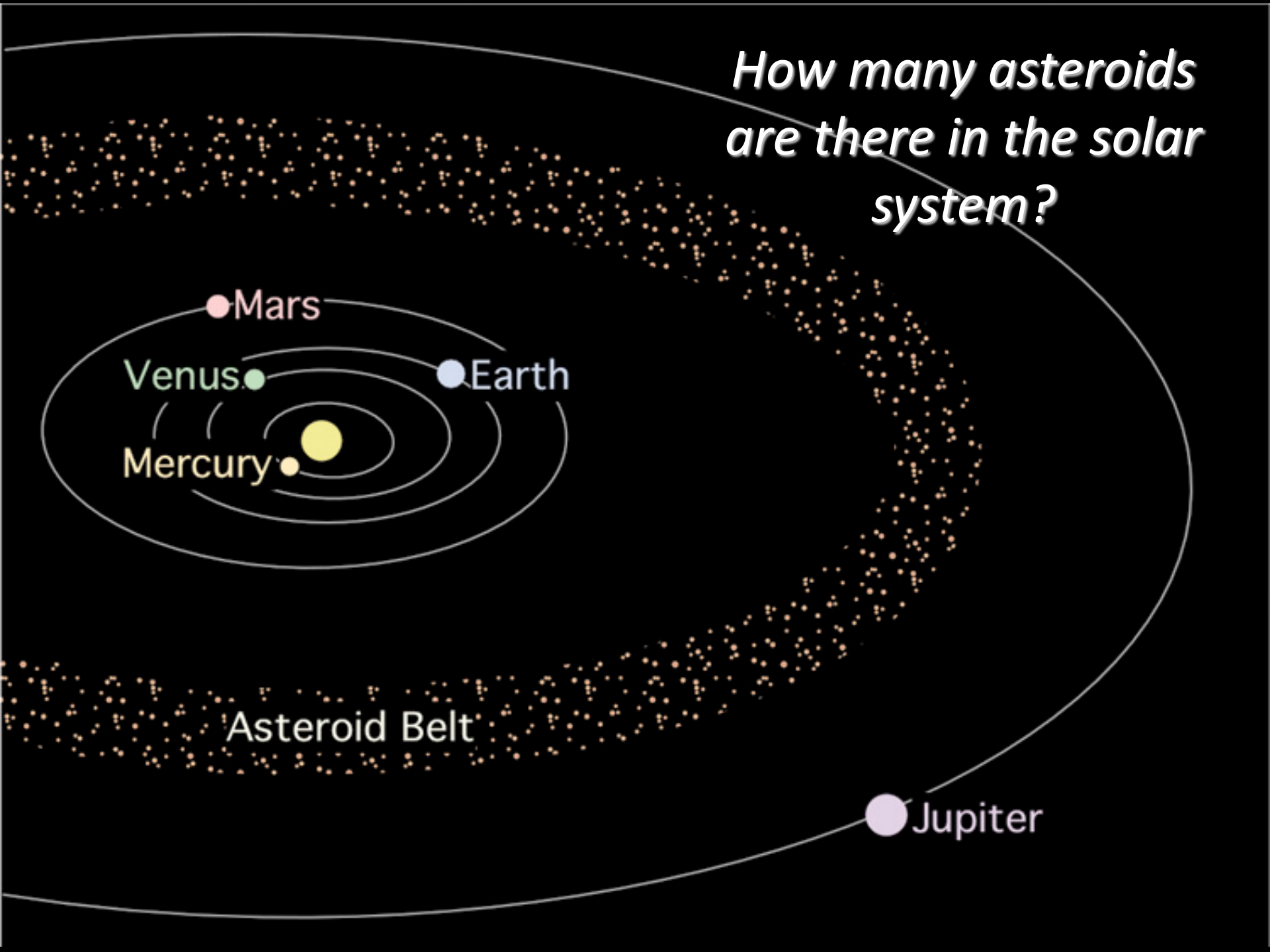


Comet Jets – August 2015

Courtesy European Space Agency

Introduction to the OSIRIS-REx Mission

How many asteroids are there in the solar system?



Over 600,000 asteroids, and counting!



About 13000 Near Earth Asteroids –
1600 potentially hazardous!

Some Asteroids We Have Already Visited

Galileo at Gaspra (1991)



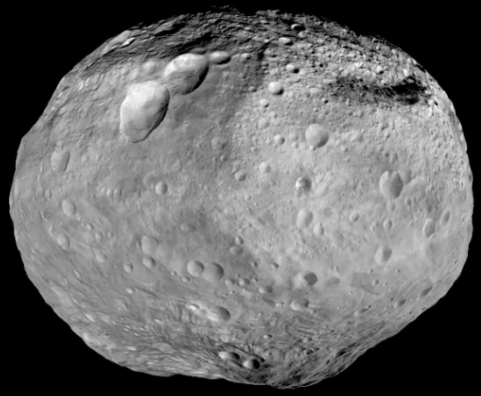
NEAR-Shoemaker at Eros (2000)



Hayabusa at Itokawa (2005)



Dawn at Vesta (2012)



Rosetta at Lutetia (2010)

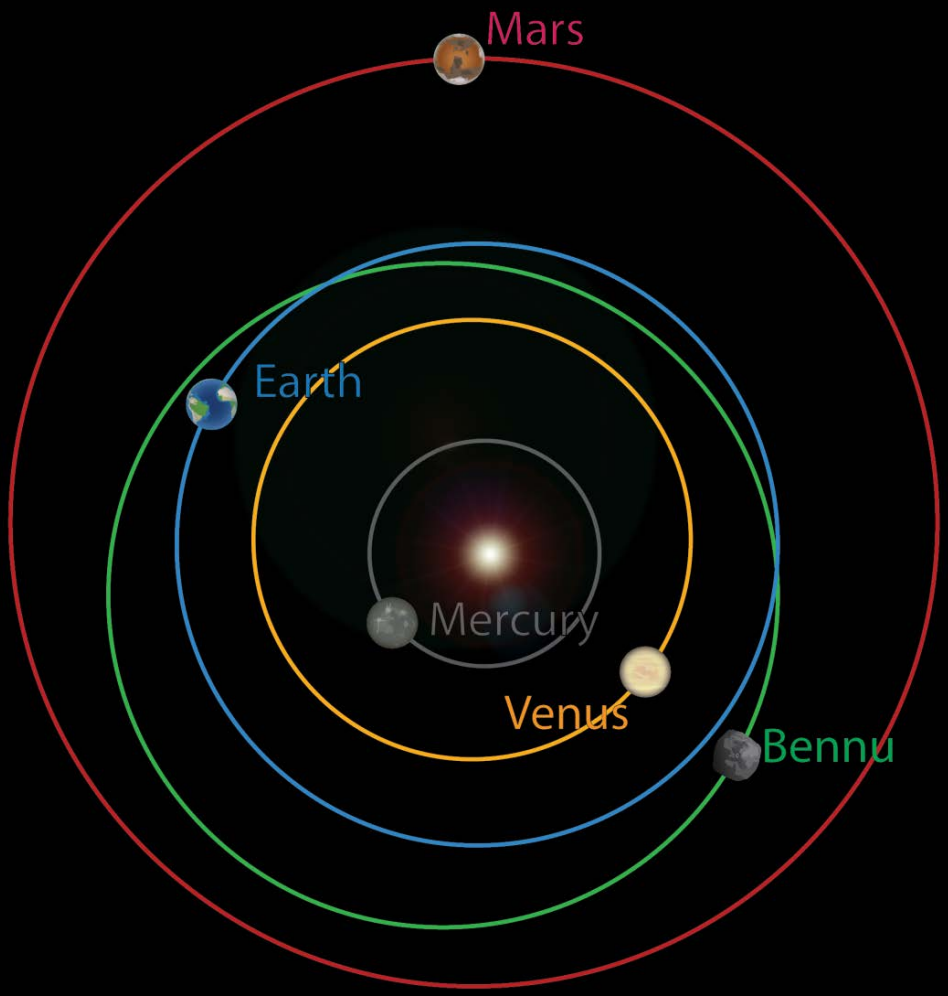


WHERE IS OSIRIS-REx GOING?
*Near-Earth Asteroid **Bennu***

Why did we pick Bennu?

A potentially dangerous asteroid!

Yarkovsky Effect



What causes asteroid orbits to change over time? The Yarkovsky Effect

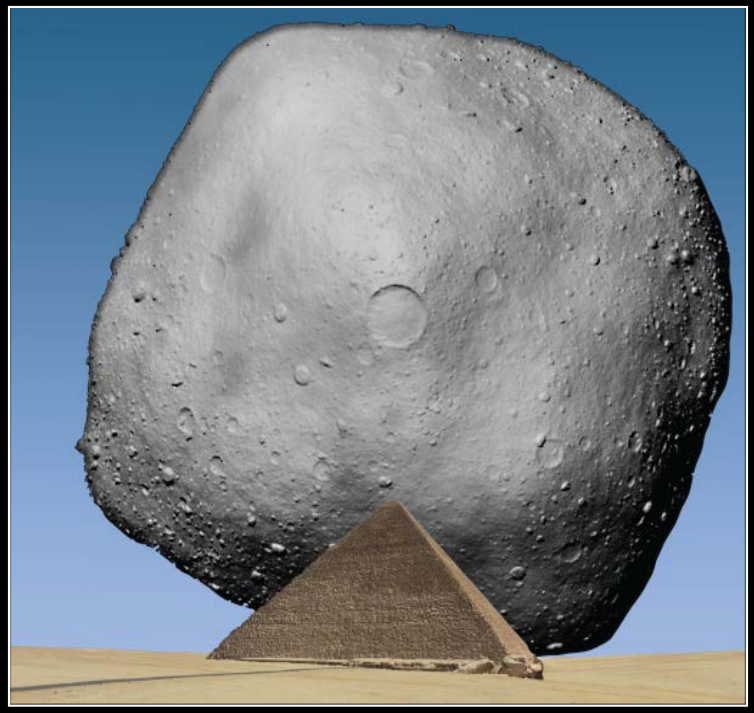
Bennu Facts

ASTEROID FAST FACTS

- Near-Earth asteroid
- About 500 meters (⅓ mile) diameter
- 4.3-hour rotation period
- 436.6-day orbit of Sun at 27.8 km/s (62,120 mph)
- Collection of materials into a rubble pile
- Ancient carbon and volatiles such as water
- Potential hazard to Earth

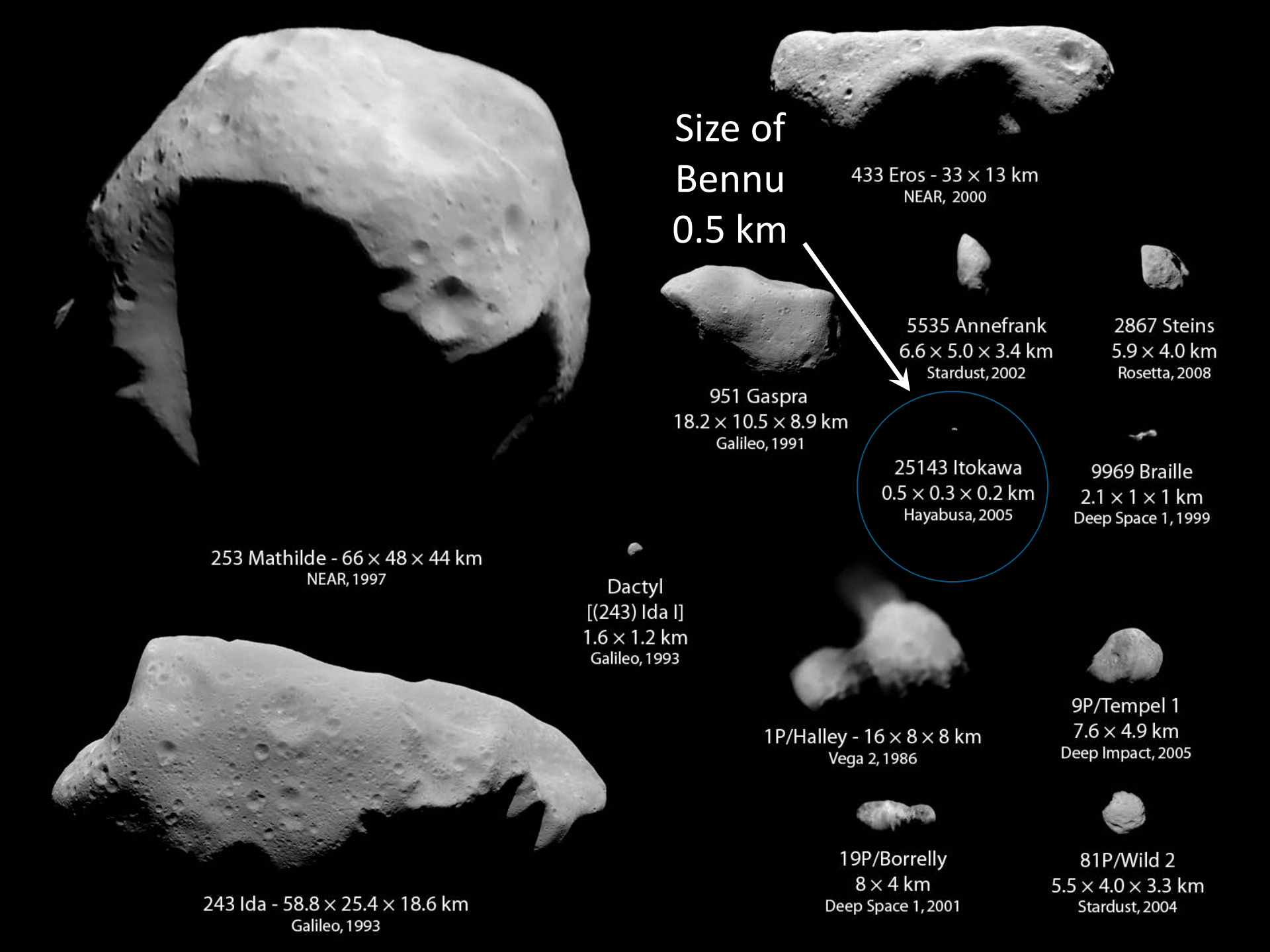
The Primary Mission Objective: Return a sample of regolith to Earth!
at least 60 grams or 2.1 ounces
(and as much as 2 kg or 4.4 pounds)
= a *time capsule from the early Solar System*!

***A Near-Earth Asteroid* Bennu**



How Big are Asteroids?




Size of
Bennu
0.5 km
433 Eros - 33 × 13 km
NEAR, 2000
5535 Annefrank
6.6 × 5.0 × 3.4 km
Stardust, 2002
2867 Steins
5.9 × 4.0 km
Rosetta, 2008
951 Gaspra
18.2 × 10.5 × 8.9 km
Galileo, 1991
25143 Itokawa
0.5 × 0.3 × 0.2 km
Hayabusa, 2005
9969 Braille
2.1 × 1 × 1 km
Deep Space 1, 1999
253 Mathilde - 66 × 48 × 44 km
NEAR, 1997
Dactyl
[(243) Ida I]
1.6 × 1.2 km
Galileo, 1993
1P/Halley - 16 × 8 × 8 km
Vega 2, 1986
9P/Tempel 1
7.6 × 4.9 km
Deep Impact, 2005
243 Ida - 58.8 × 25.4 × 18.6 km
Galileo, 1993
19P/Borrelly
8 × 4 km
Deep Space 1, 2001
81P/Wild 2
5.5 × 4.0 × 3.3 km
Stardust, 2004

OSIRIS-REx Spacecraft Facts

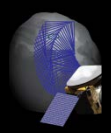
A tricked-out spacecraft!

SPACECRAFT FAST FACTS

- 2 meters (6.6 feet) per side
- 8.5 m^2 (91 square feet) of solar panels
- 5 Instruments:
  - Measurements in x-ray, visible and infrared
- 2 different laser ranging devices
- 6 cameras
- Robotic Arm
- Touch-and-Go Sampler
- Sample Return Capsule



Science Objectives of the Mission



Map the asteroid



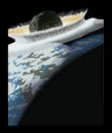
Sample and describe the sample site



Return the sample and analyze it

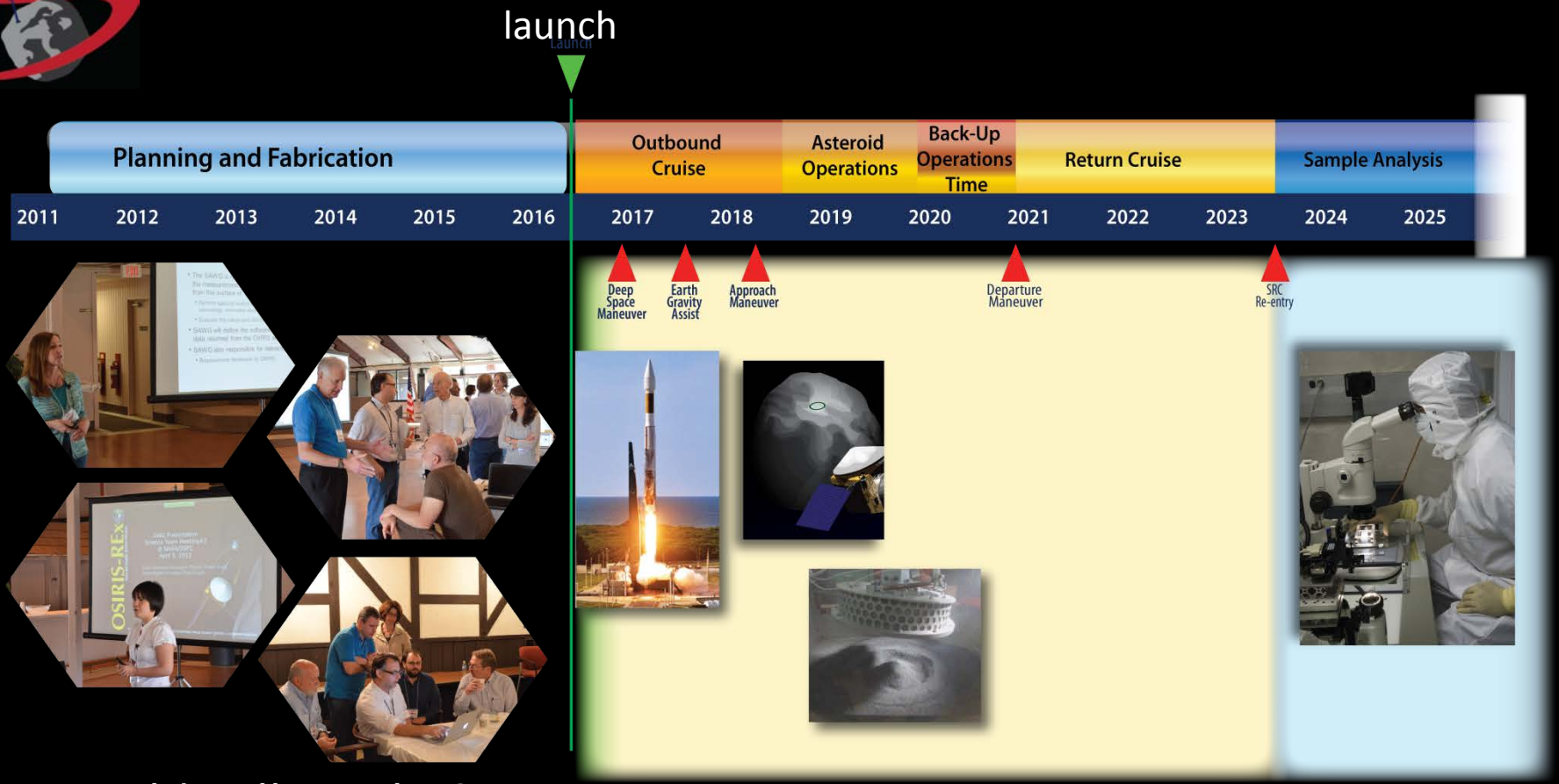


Compare data to Earth-bound observations



Refine orbital measurements

Fourteen Years from Start to Finish



How old will you be?

- At launch in 2016
- At rendezvous and sampling 2018-2021
- At sample return 2023

OSIRIS-REx, The Mission

Starring

a multi-generational team including the University of Arizona, Goddard Space Flight Center, and Lockheed Martin

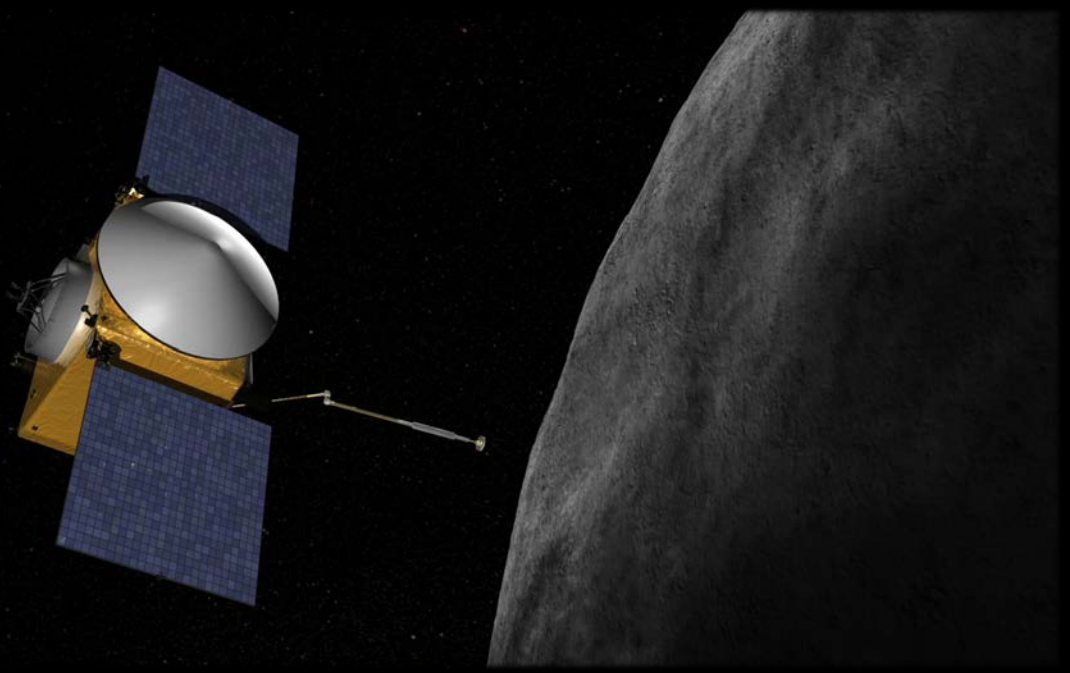
With

Aerospace Engineers, Electrical Engineers, Mechanical Engineers, Computer Programmers, Scientists, and researchers around the country



Generations of Scientists will use data from OSIRIS-REx to answer fundamental questions:

- How did the Solar System form and what kinds of material exist in the Solar System?
- How did life evolve in the Solar System?
- Are asteroids bringers of life or death – *or both*?



Those scientists, engineers and managers could be YOU!

Follow Along with the OSIRIS-REx Mission

Follow us on Twitter

@OSIRISREx

Visit the Website

http://www.asteroidmission.org/

Join in the mission

- *Observe with Target Asteroids!*
- *Become an OSIRIS-Rex Ambassador*
- *Attend local displays & talks*
- *Work on the project – for generations!*

Thank you!



Questions?

Some Links for you to check out

- Messenger Mission To Mercury
  - http://messenger.jhuapl.edu/
- Maven Mars
  - http://lasp.colorado.edu/home/maven/
- Juno Jupiter
  - http://missionjuno.swri.edu/
- DAWN – Vesta and Ceres
  - http://dawn.jpl.nasa.gov/
- Cassini Saturn
  - http://saturn.jpl.nasa.gov/
- Rosetta – Comet Chury
  - http://rosetta.esa.int/
- New Horizons – Pluto
  - http://pluto.jhuapl.edu/
- Asteroid Discovery 1980-2014
  - https://www.youtube.com/watch?v=2k2vkLEE4ko
- OSIRIS-REx Mission
  - http://www.asteroidmission.org/
- Bennu's Journey Movie
  - http://www.asteroidmission.org/movie/