

NASA's New Horizons Mission To Pluto



Wits Department of Physics
Johannesburg, August 2013

Dr. Henry Throop
Planetary Science Institute
Tucson, Arizona, USA

This is a Galaxy. It has 100,000,000,000 stars.



The Sun is just one star in the Galaxy.

Our Solar System



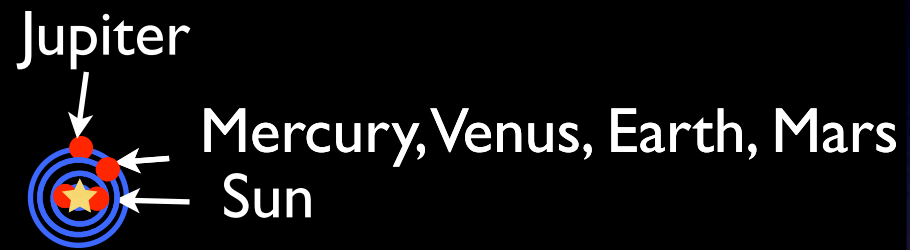
★ ← Sun

A diagram of the Solar System. At the center is a yellow star labeled 'Sun'. Eight planets are shown in elliptical orbits around the Sun. The planets are: Mercury (small, grey), Venus (yellowish), Earth (blue and green), Mars (reddish), Jupiter (large, orange and white), Saturn (large, yellow with rings), Uranus (medium, blue-green), and Neptune (medium, blue). The orbits are represented by thin grey lines. The background is a dark blue gradient.

Our Solar System



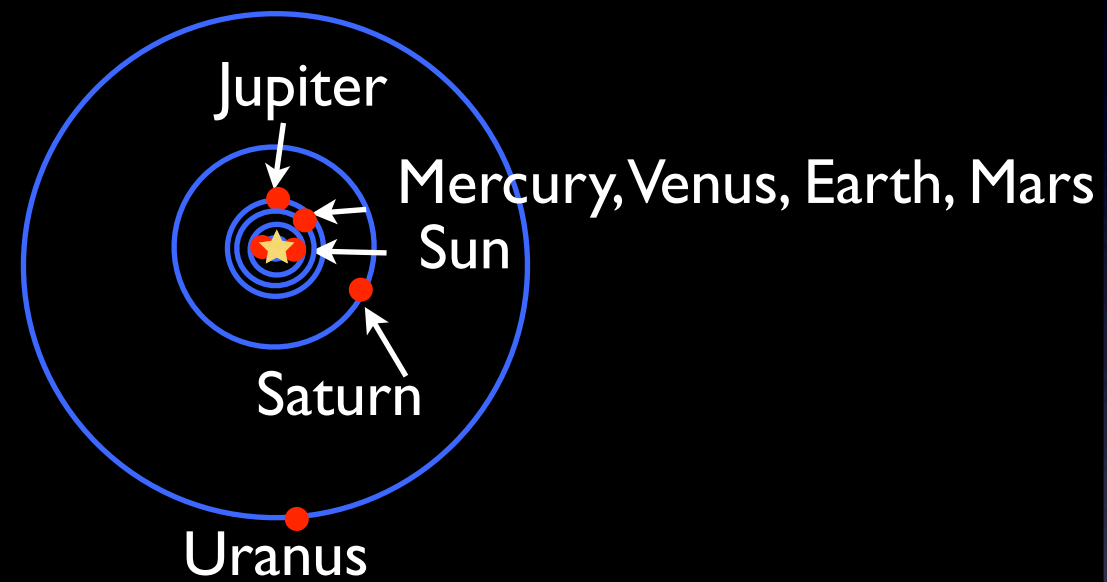
Our Solar System



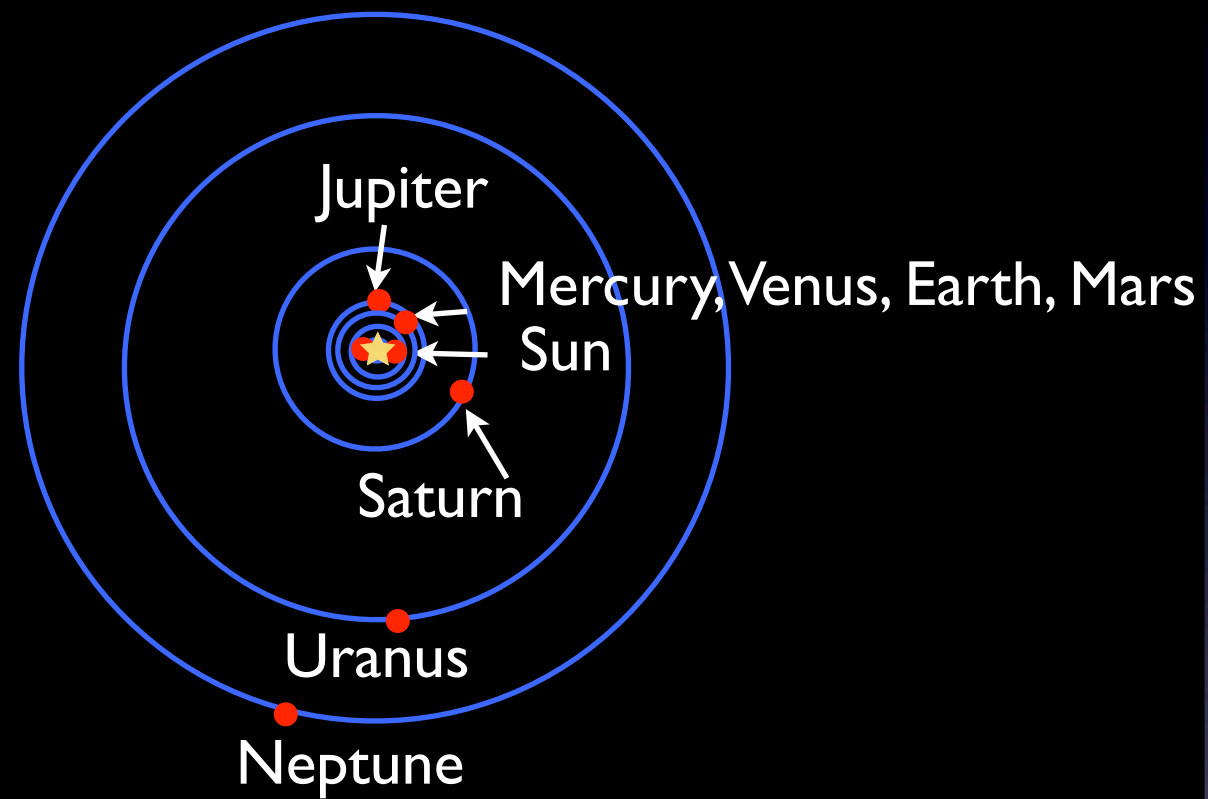
Our Solar System



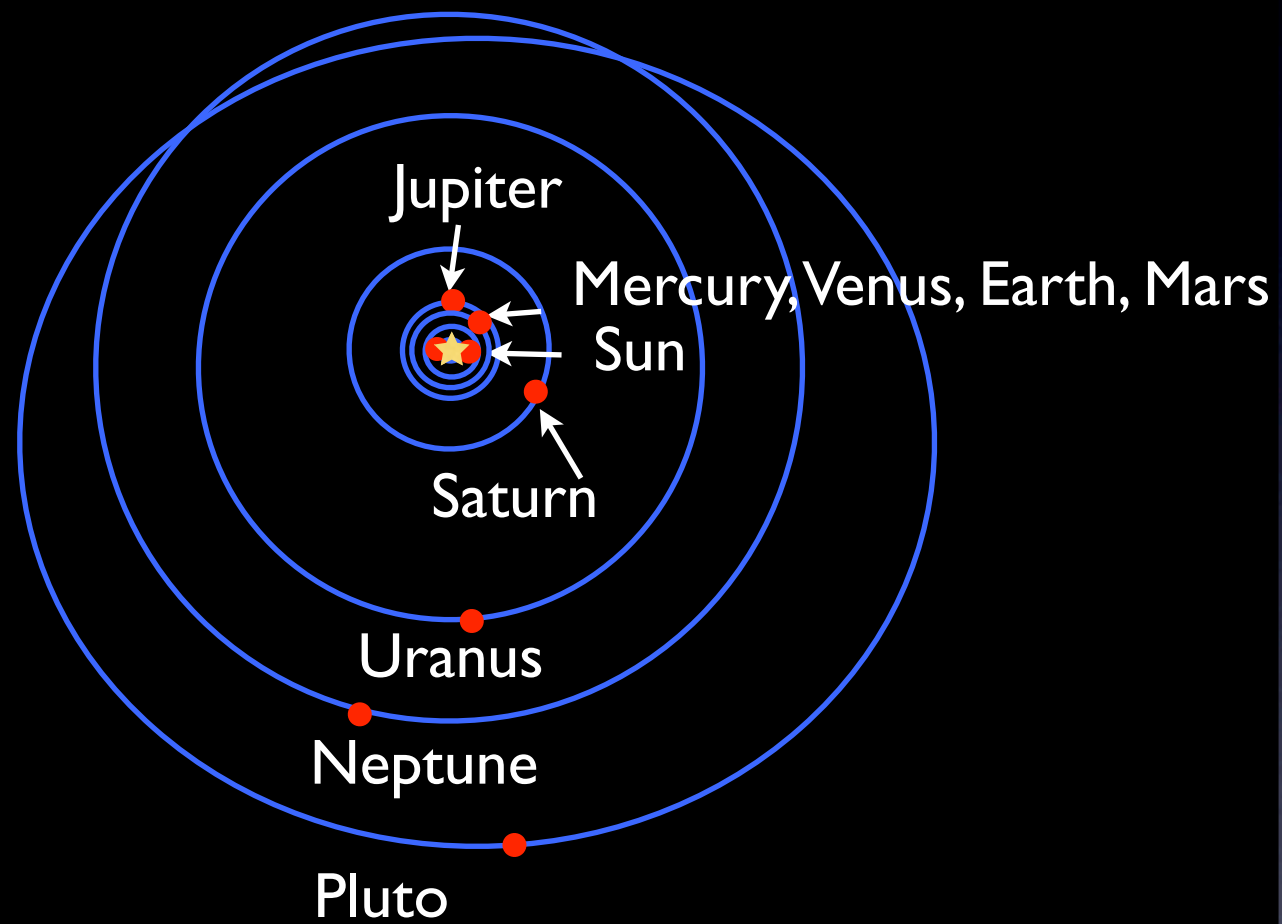
Our Solar System



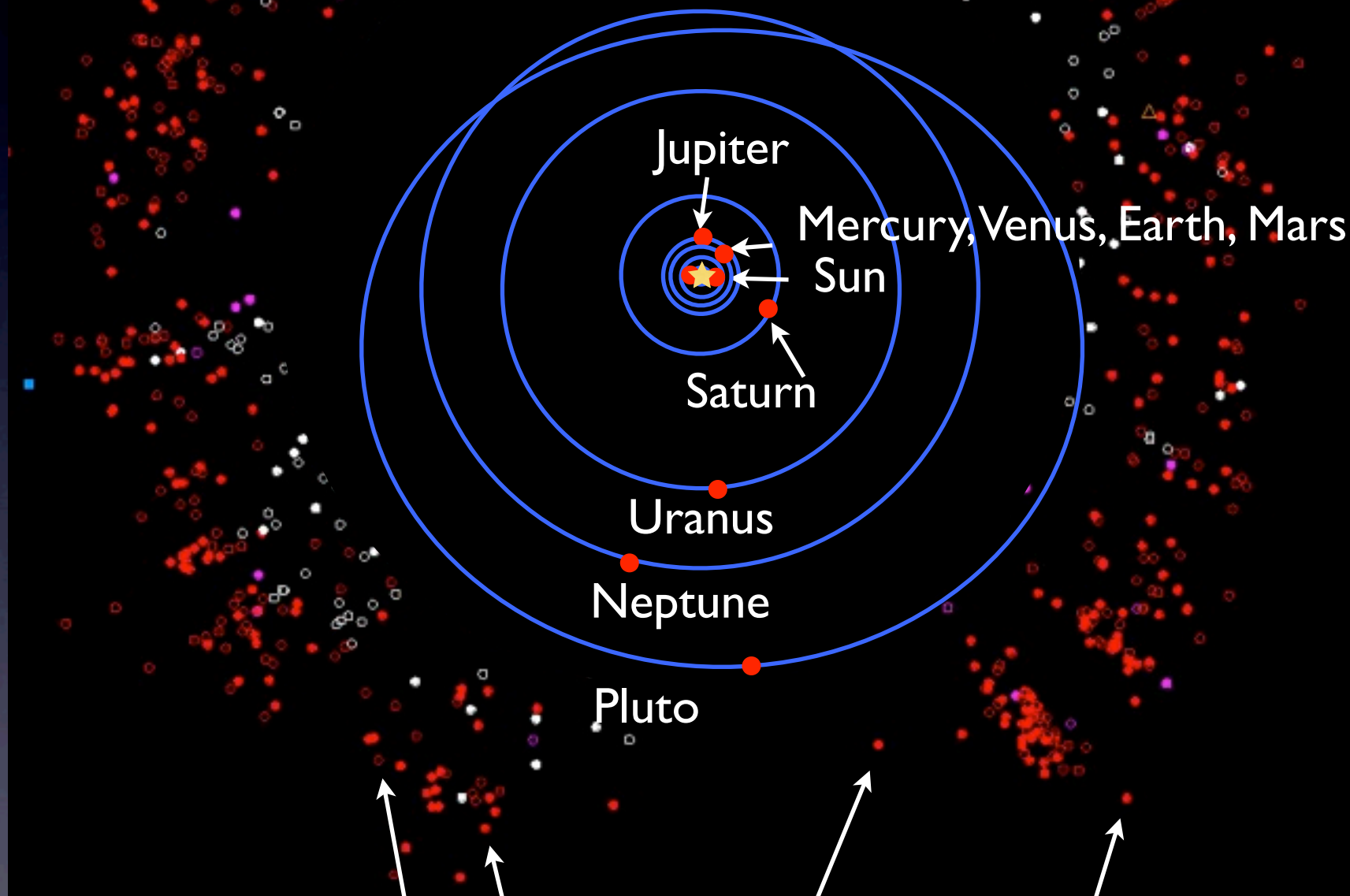
Our Solar System



Our Solar System



Our Solar System



Kuiper Belt



Easy to see:

Sun

Moon

Mercury

Venus

Earth

Mars

Jupiter

Saturn

Hard to see:

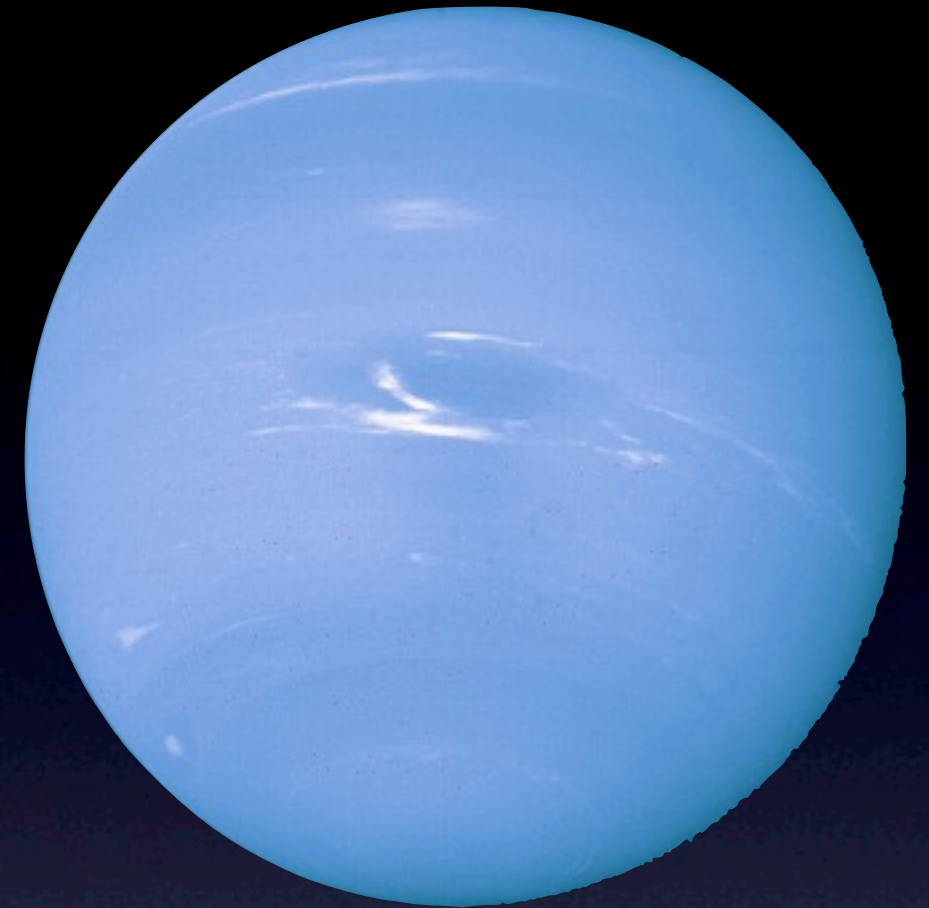
Uranus

Neptune

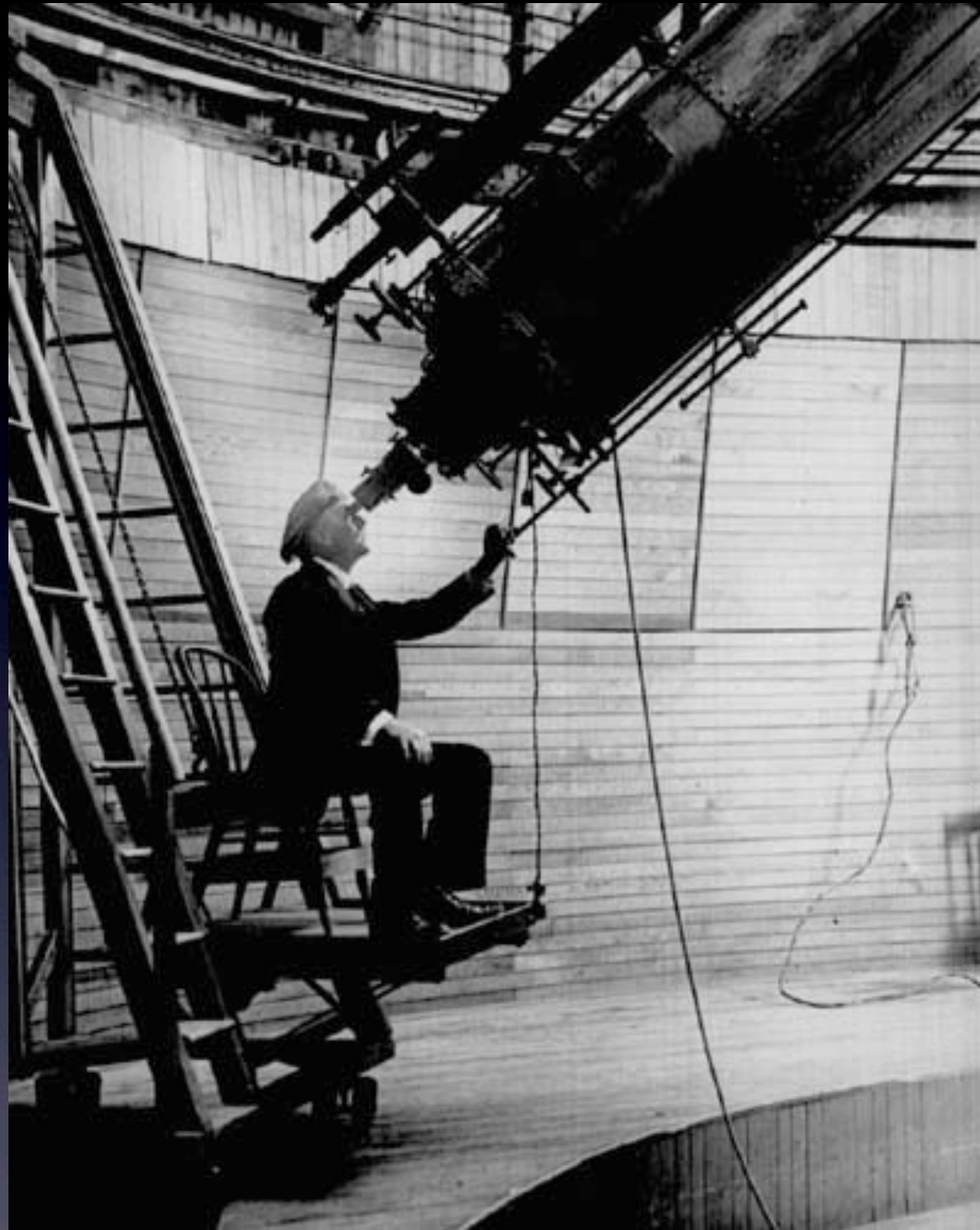
Pluto

Asteroids

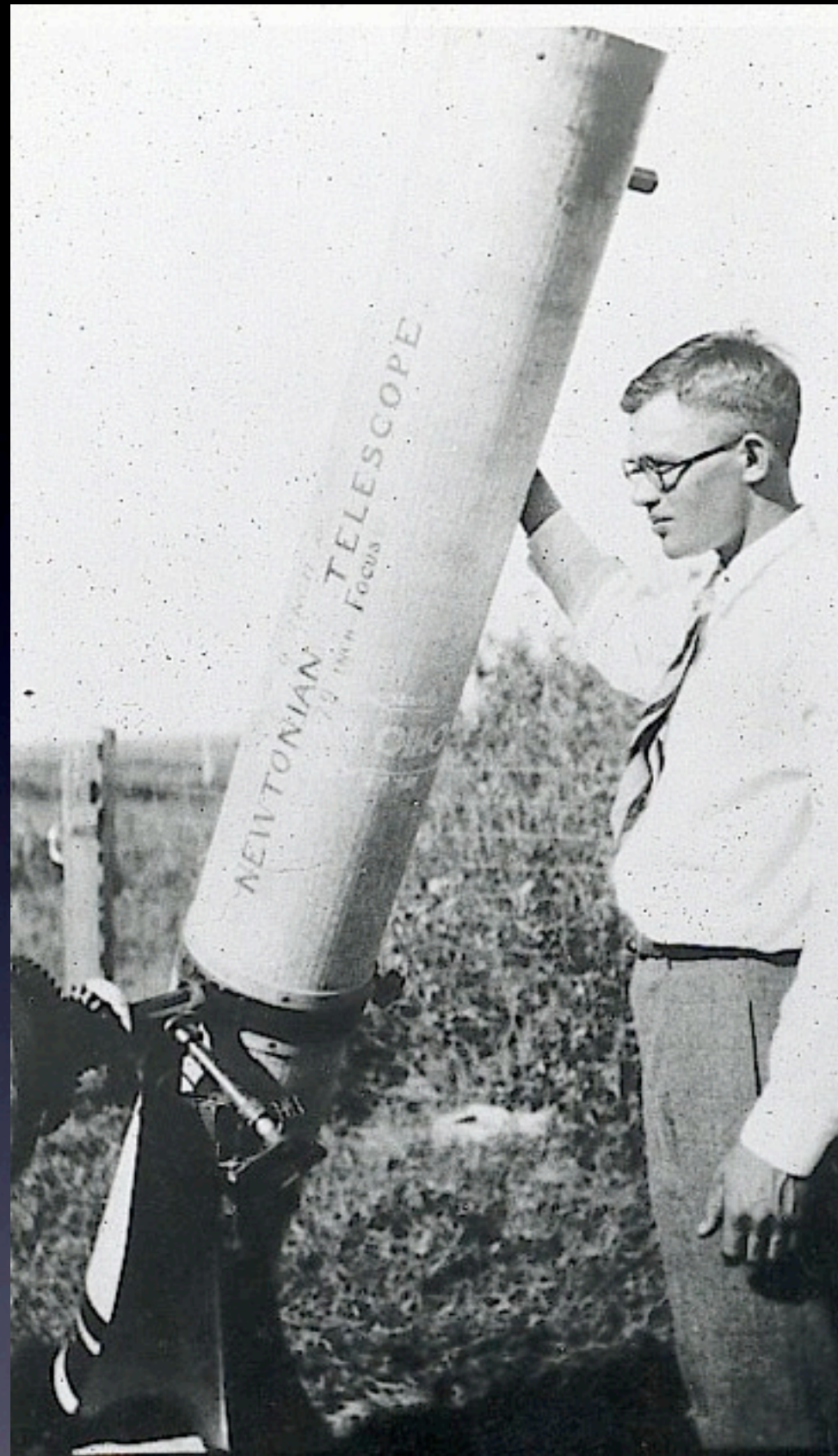




1874: French Astronomer Le Verrier found errors in the position of Uranus, and discovered Neptune the next night.



1905: Percival Lowell started the search for 'Planet X' at Lowell Observatory, Arizona, USA.



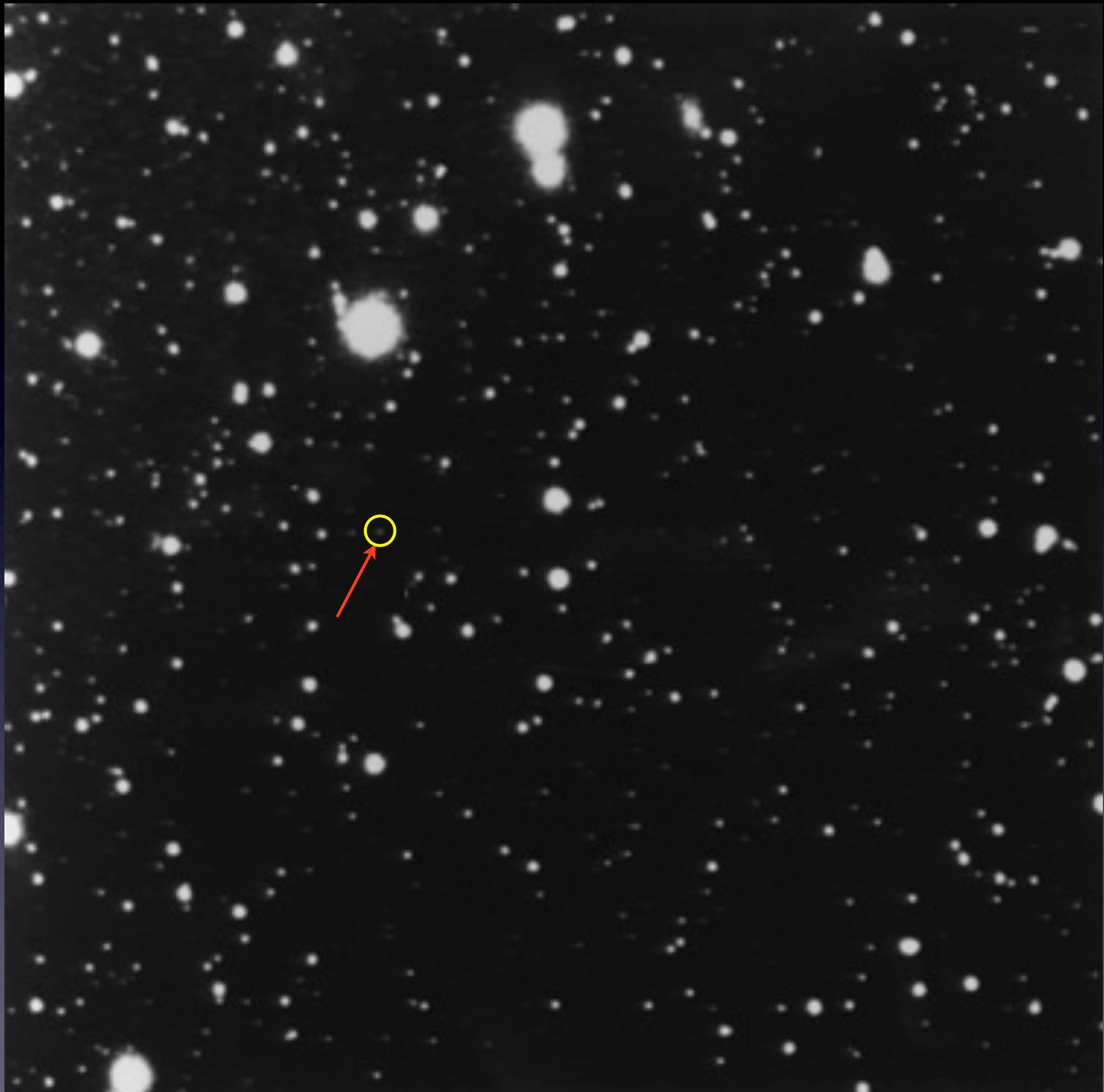
1925: Clyde Tombaugh is hired to search for Planet X at Lowell Observatory in Arizona.



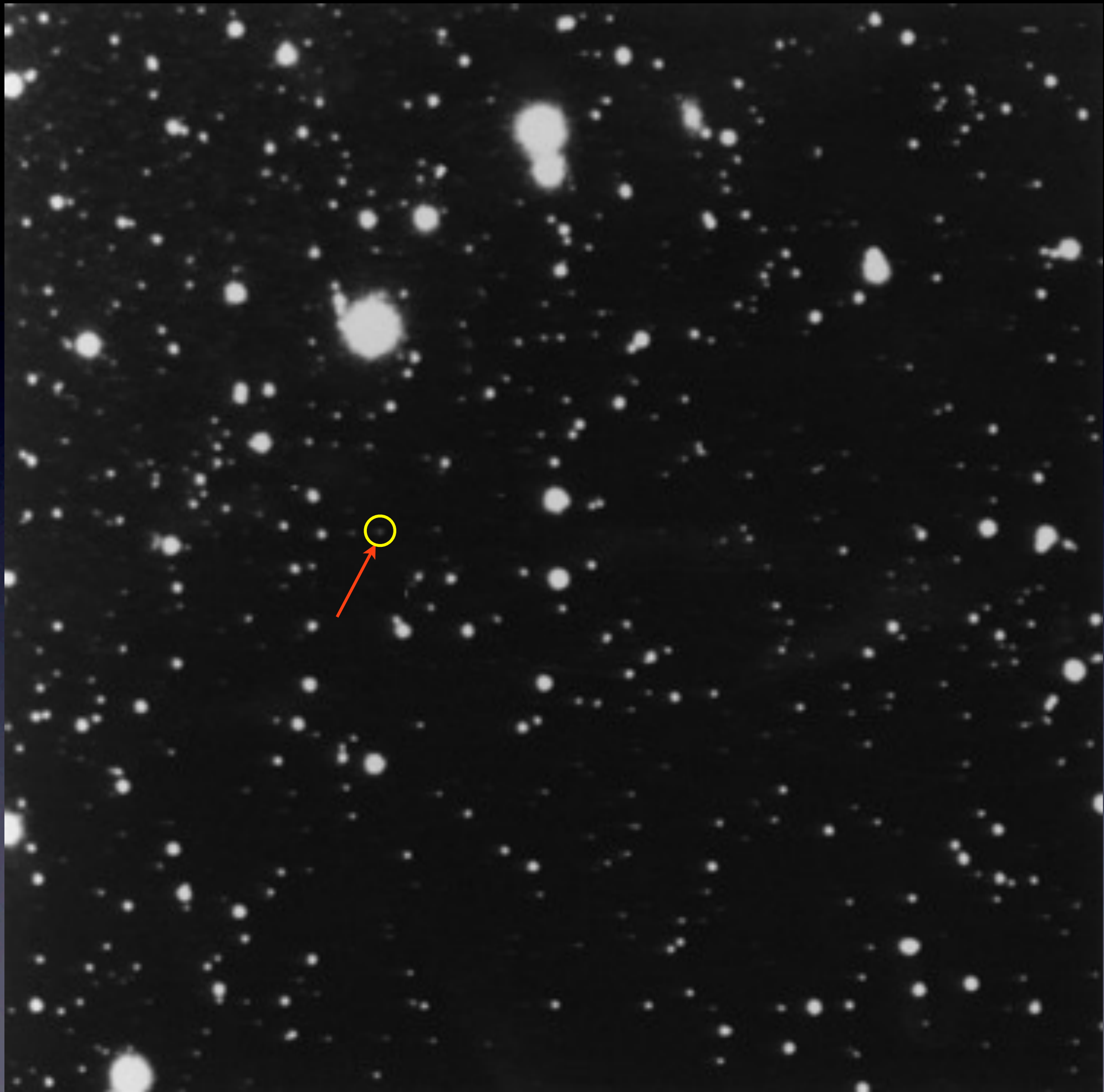




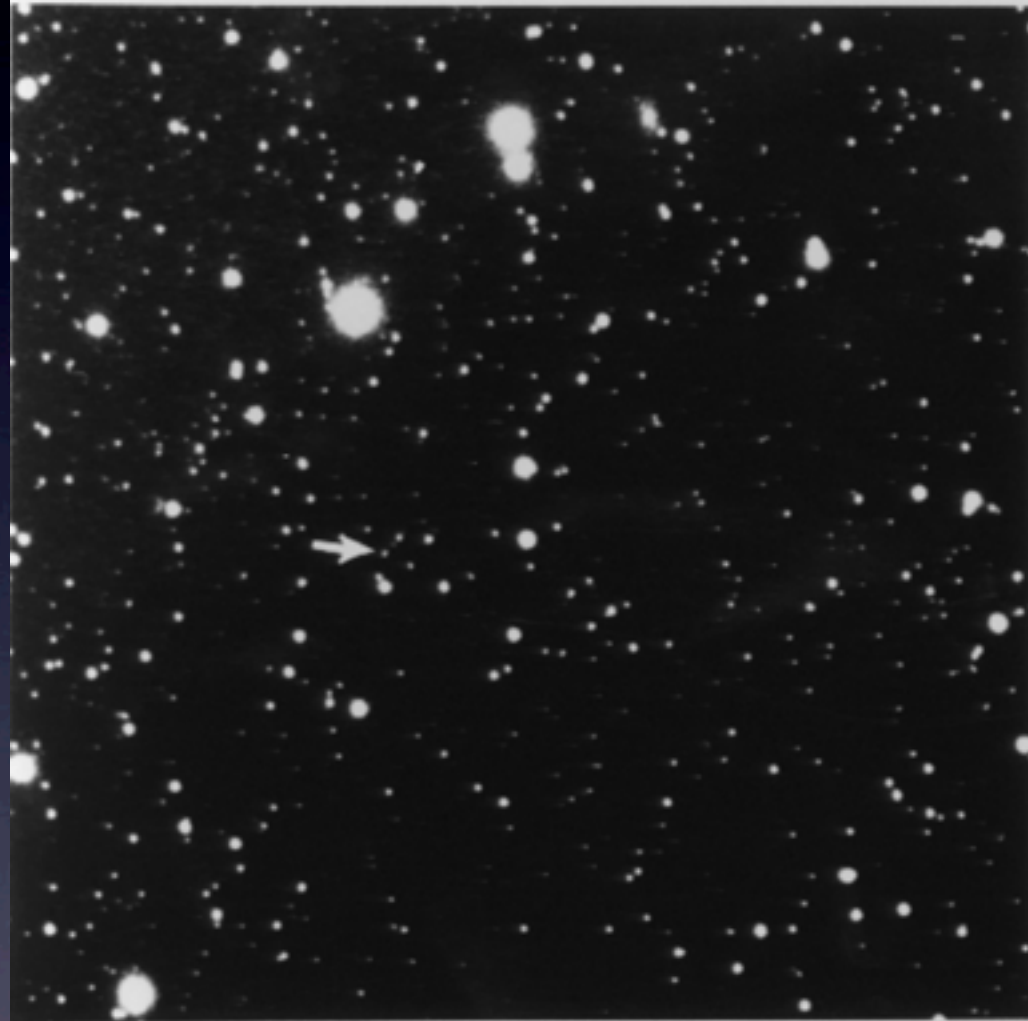




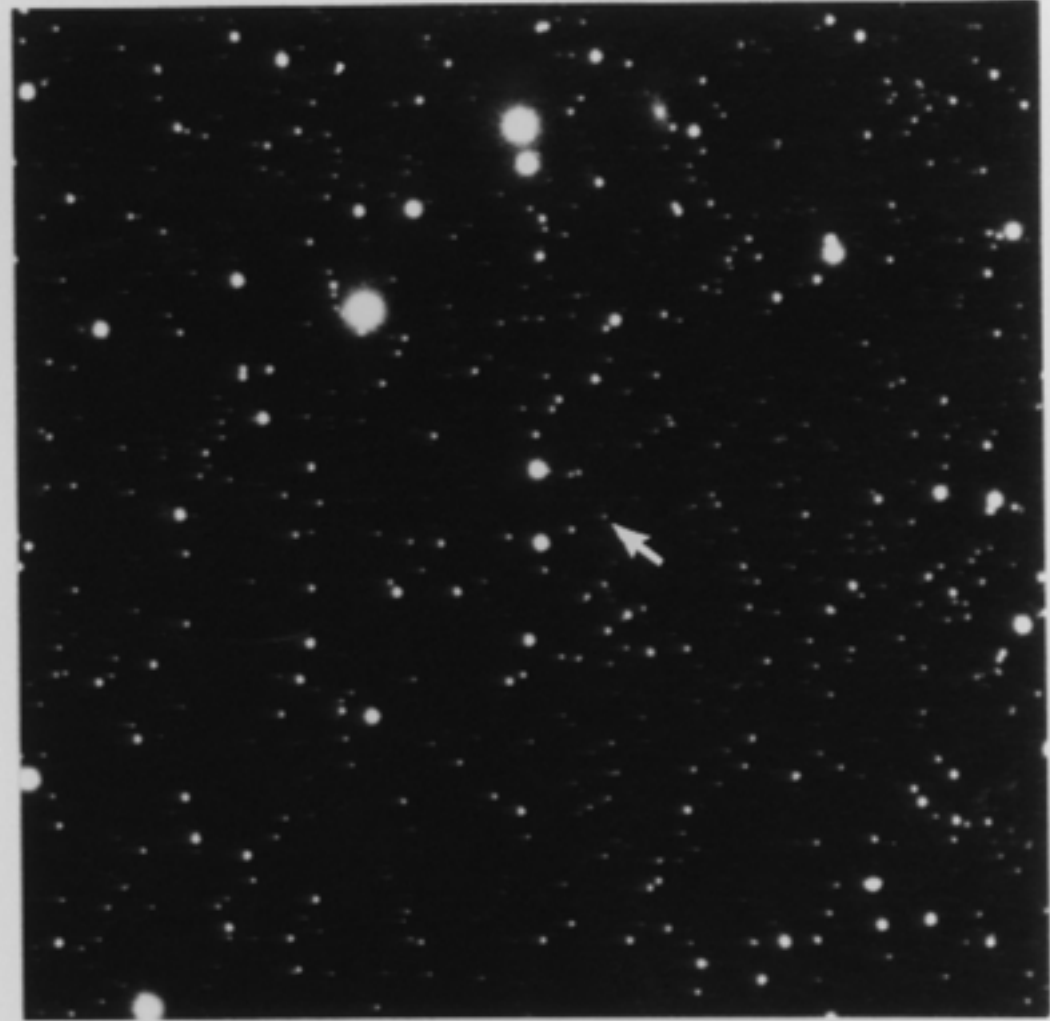




DISCOVERY OF THE PLANET PLUTO



January 23, 1930

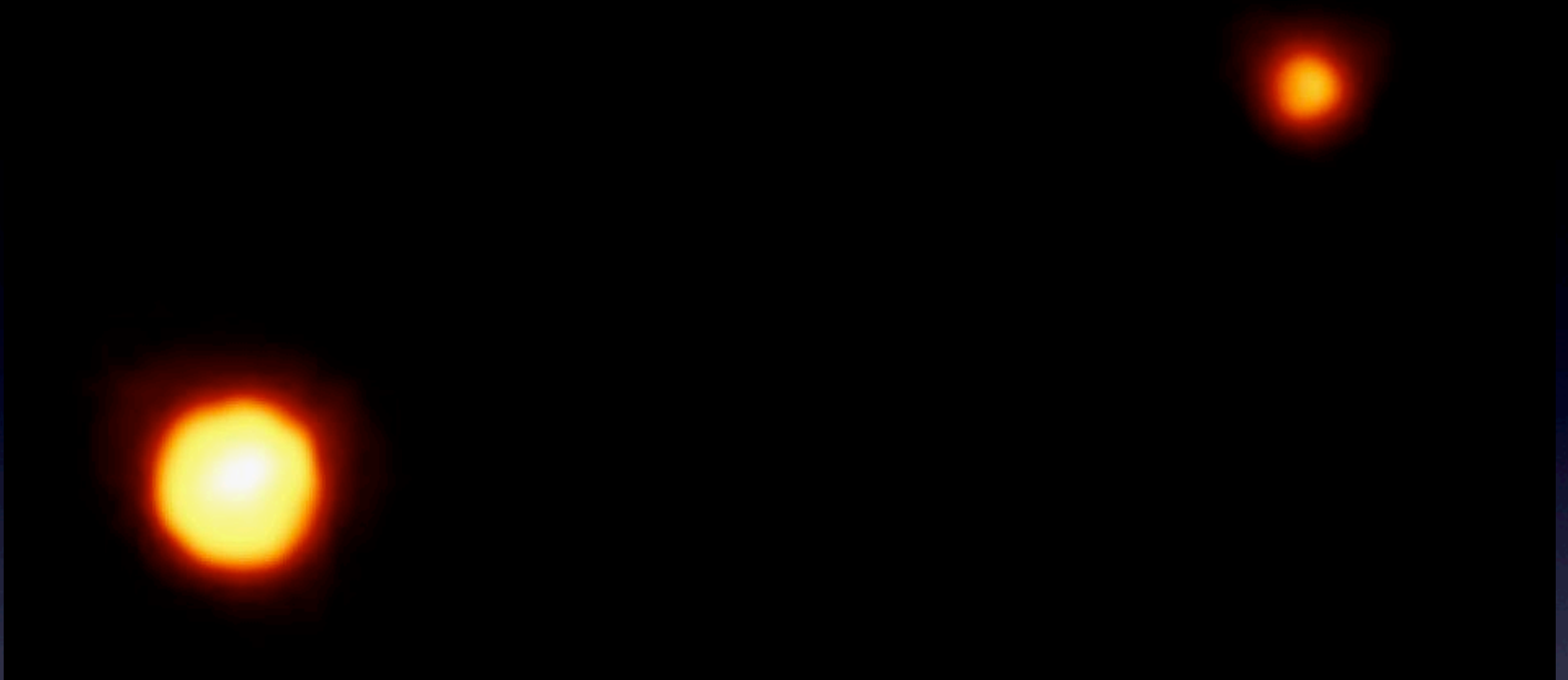


January 29, 1930

1930: Discovery of Pluto

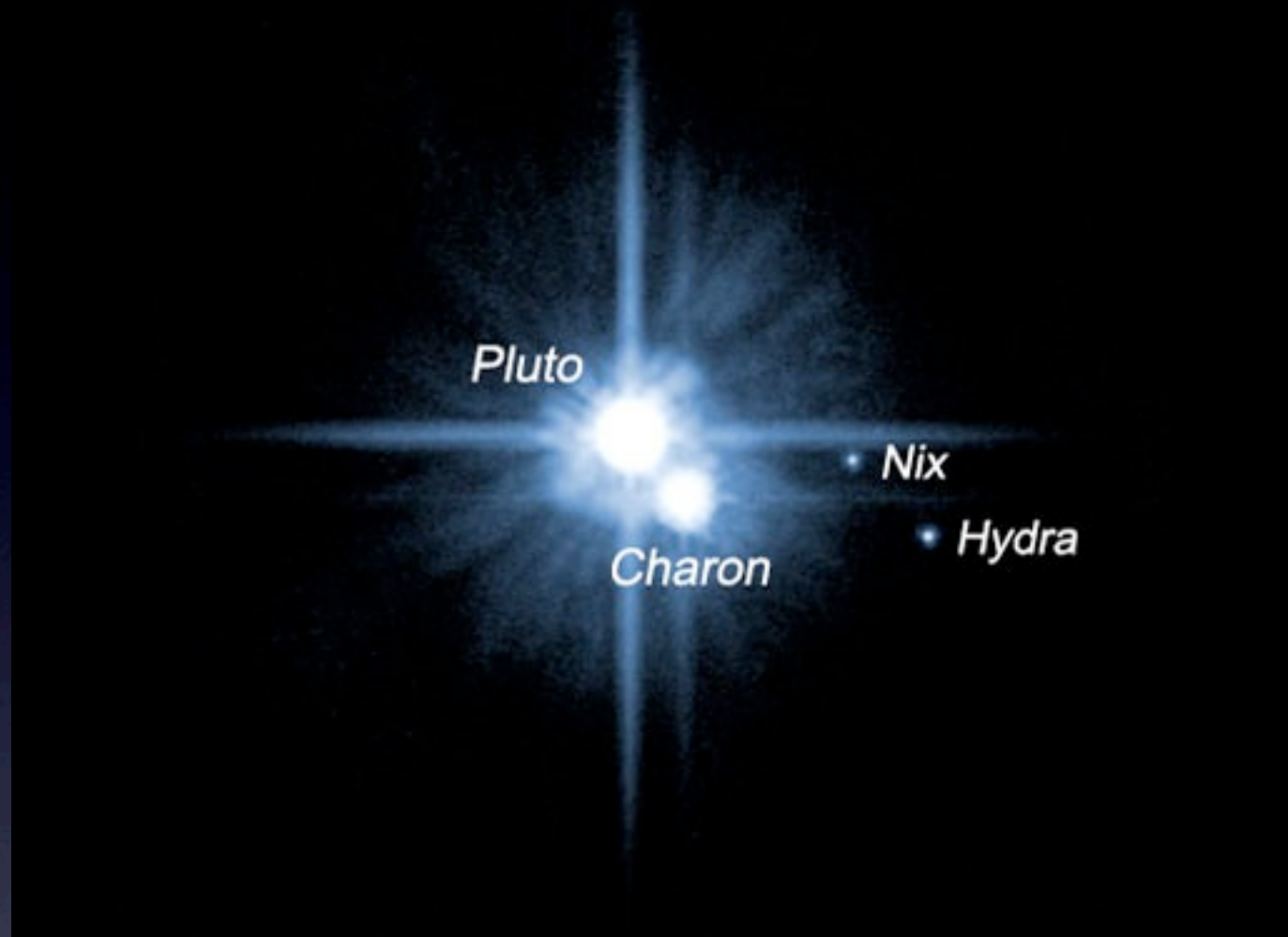


1932: Walt Disney also discovers Pluto



1930: Pluto

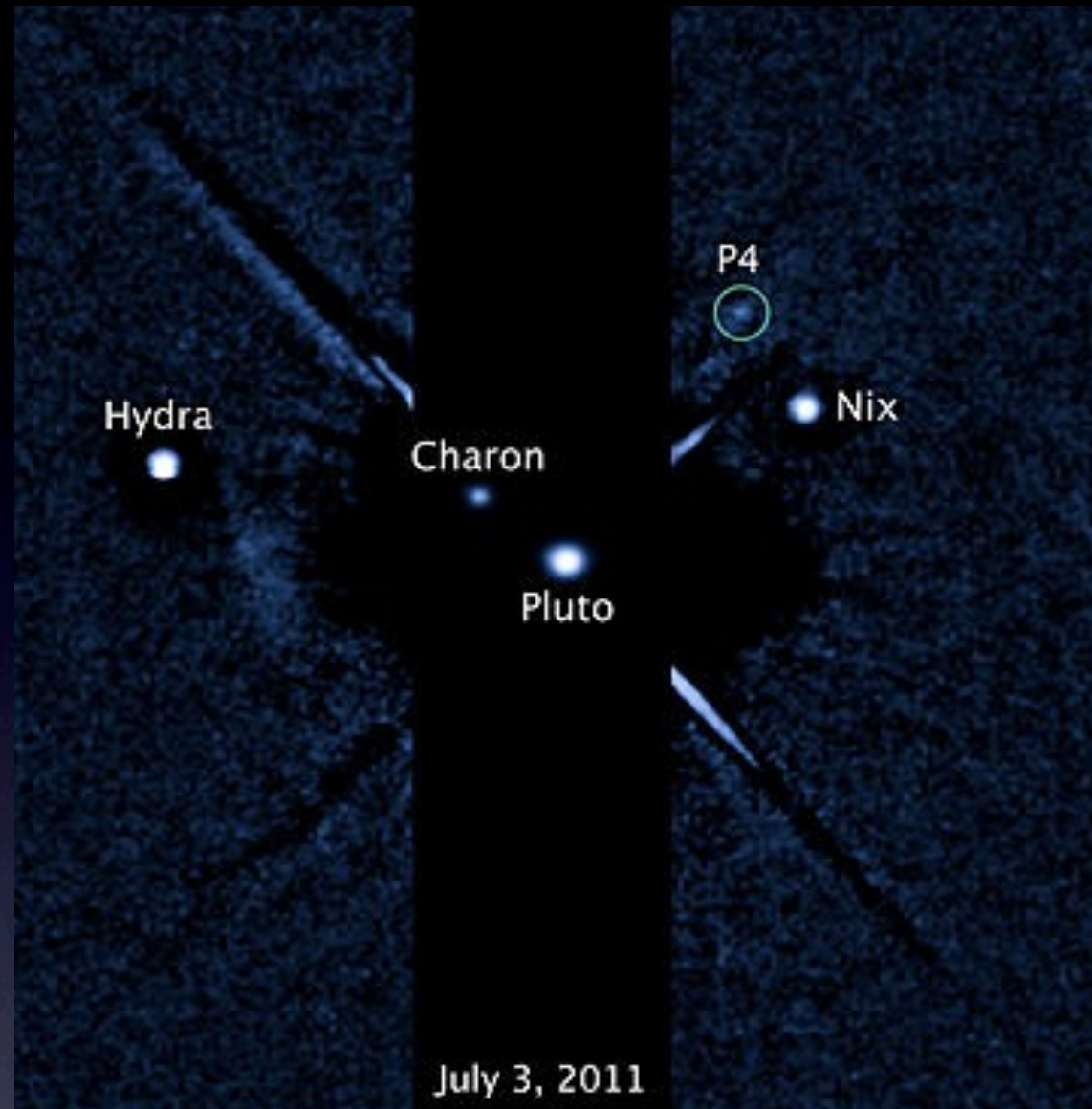
1978: Pluto + Charon Discovered



1930: Pluto

1978: Pluto + Charon

2006: Pluto + Charon + Nix + Hydra Discovered

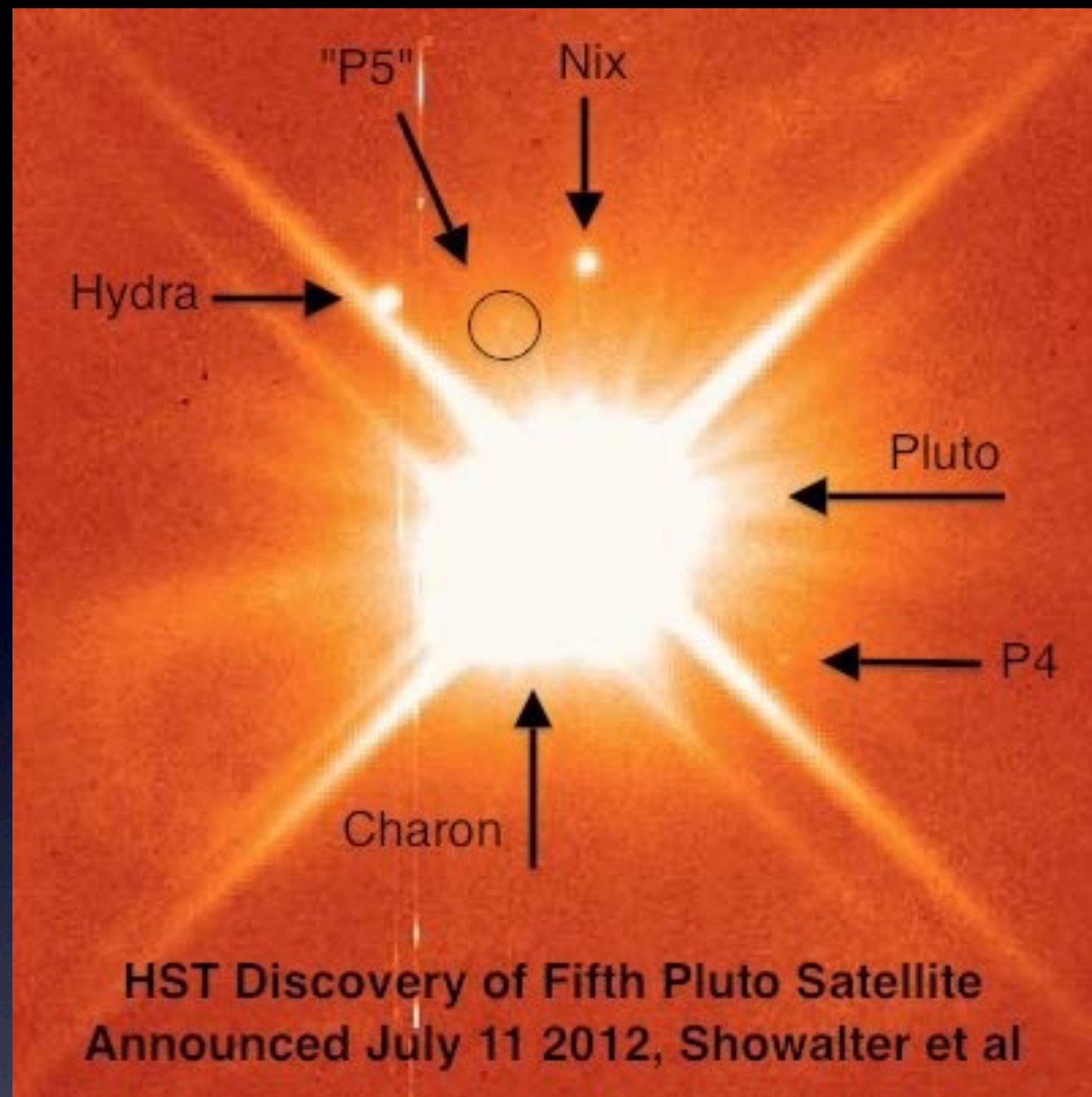


1930: Pluto

1978: Pluto + Charon

2006: Pluto + Charon + Nix + Hydra

2011: Pluto + Charon + Nix + Hydra + P4 Discovered



HST Discovery of Fifth Pluto Satellite
Announced July 11 2012, Showalter et al

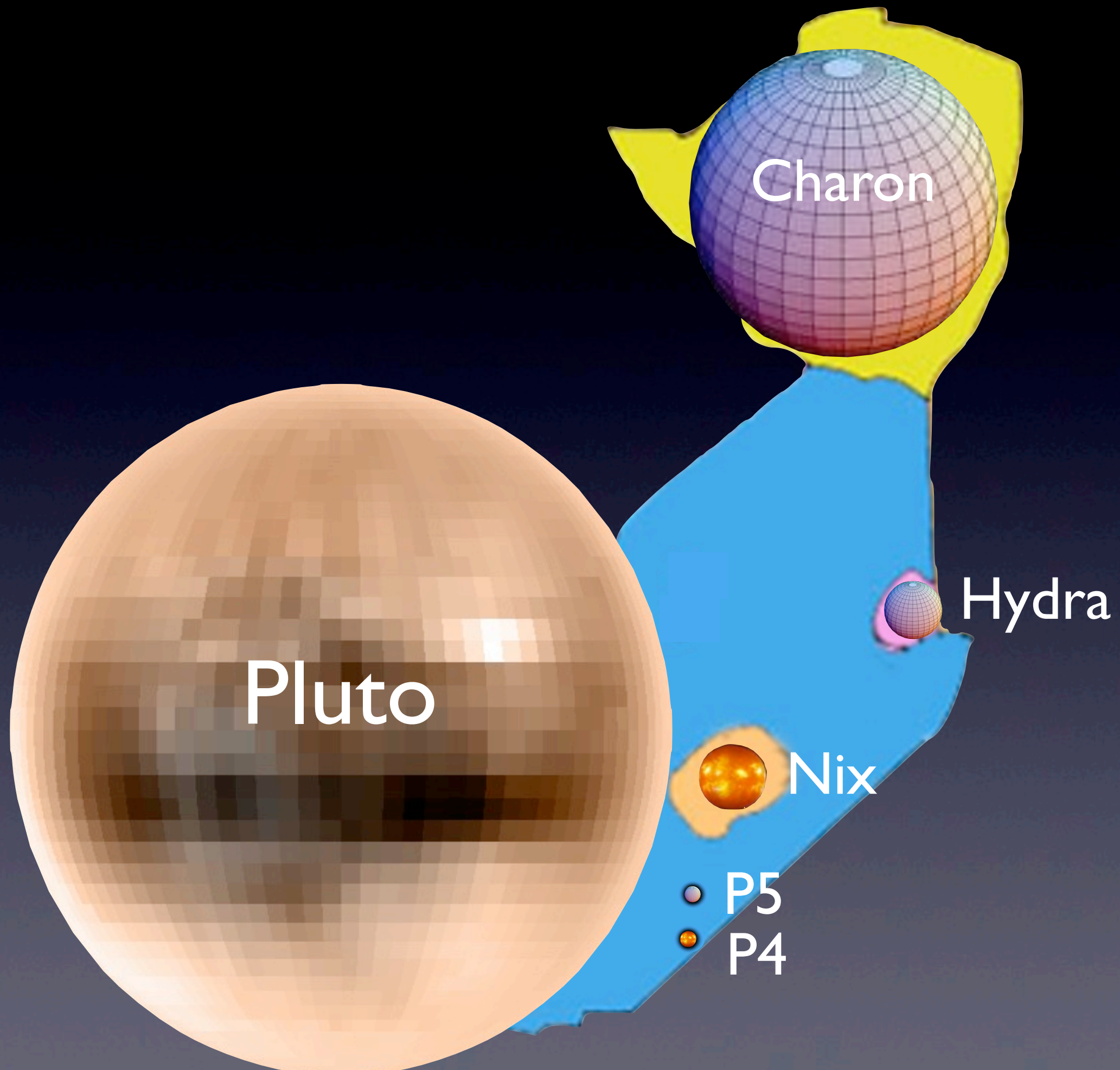
1930: Pluto

1978: Pluto + Charon

2006: Pluto + Charon + Nix + Hydra

2011: Pluto + Charon + Nix + Hydra + P4

2012: Pluto + Charon + Nix + Hydra + P4 + P5



Pluto Is...

- Very far away
- Very cold
- Very small
- Very old

... and that is almost all we know!

We know what Earth looks like...
What will Pluto be like?













Meteor Crater, Arizona, USA





Tswaing Impact Crater, South Africa

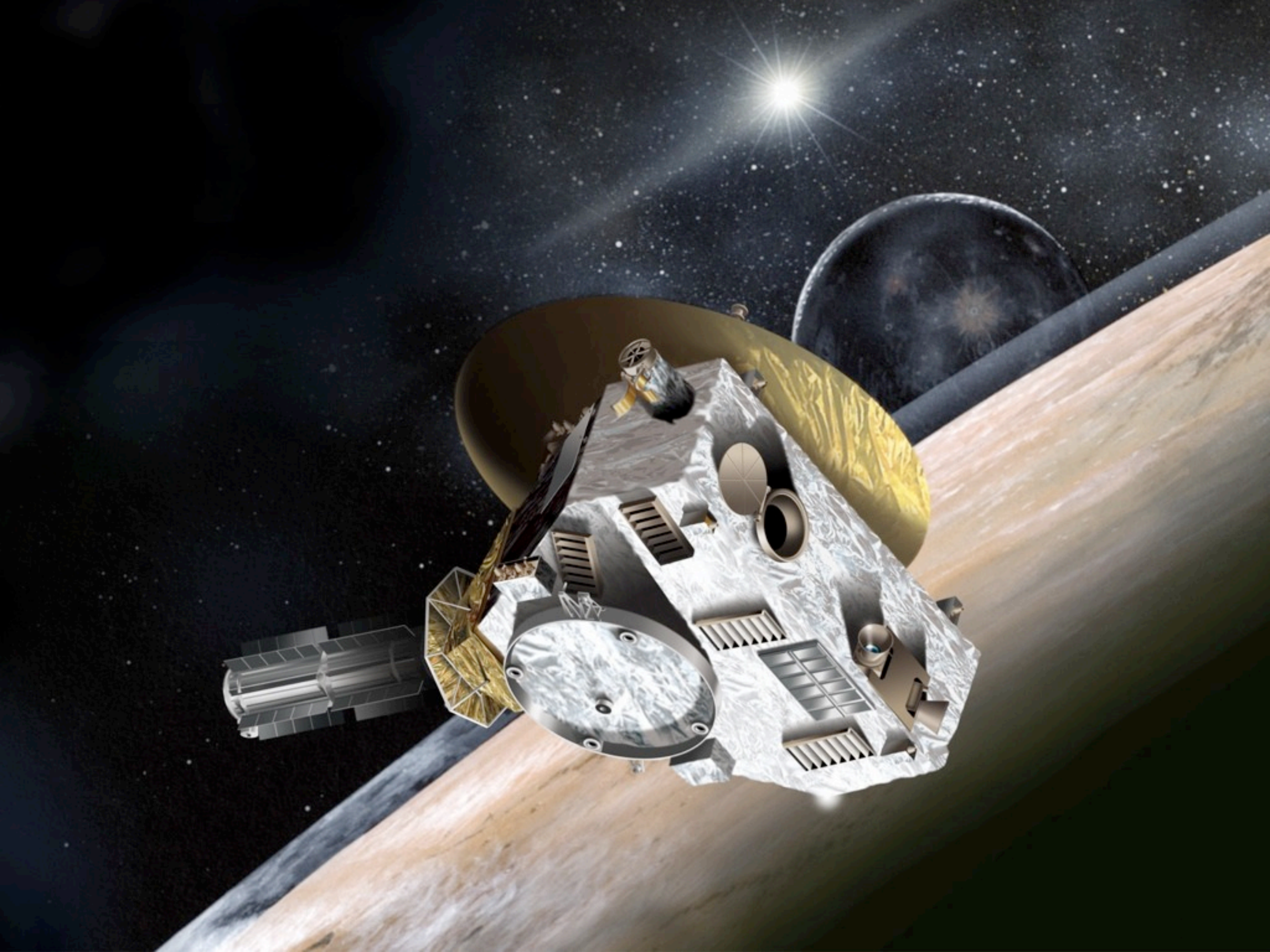


Why Study Pluto?

Pluto's surface is probably the oldest in the whole Solar System.

So, studying Pluto tells us what the Solar System was like 5 billion years ago!





New Horizons Spacecraft

\$700M USD, from NASA

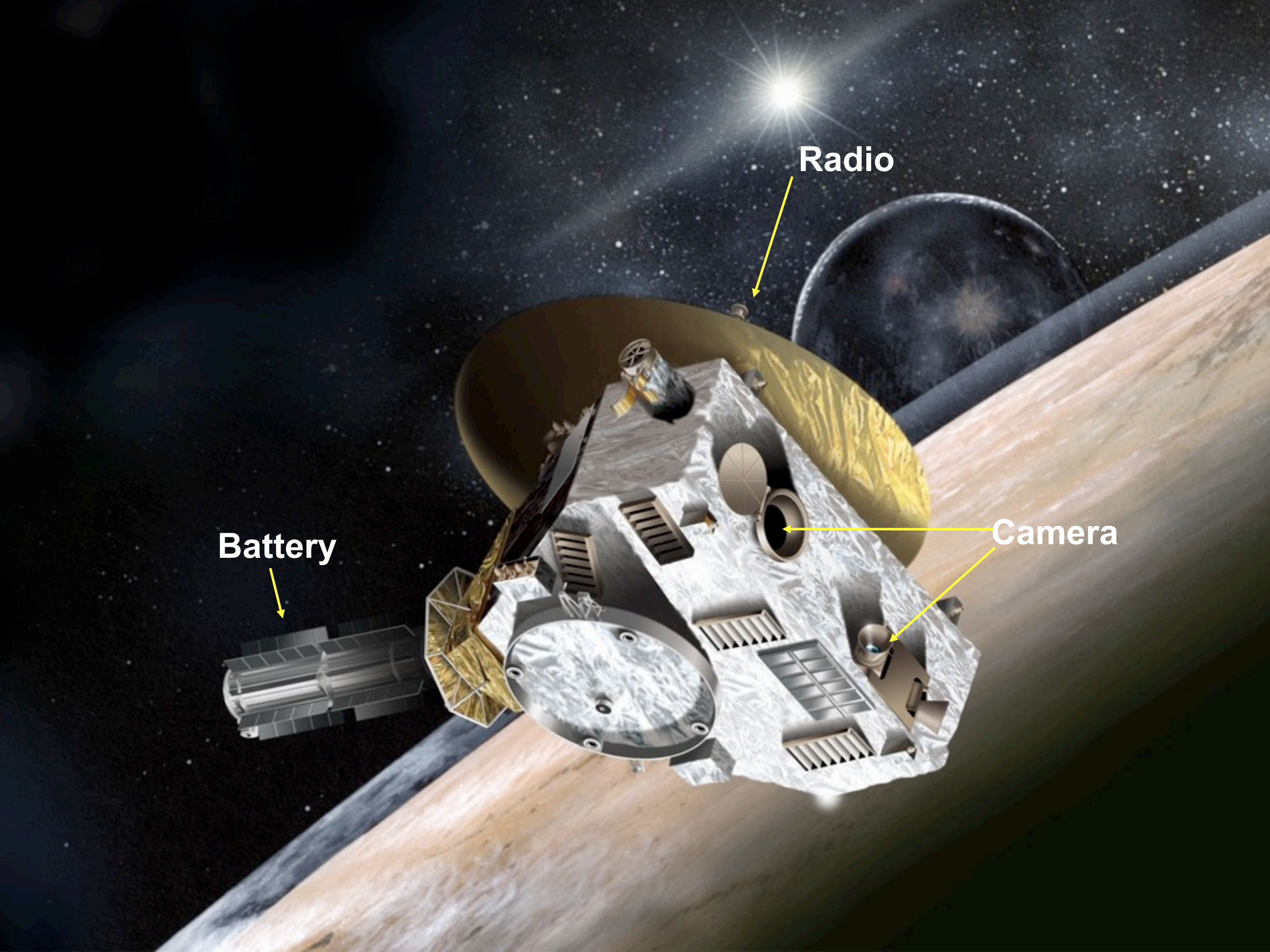
Size of a very small car

It is a robot - no people on it!

It will fly past Pluto, take pictures, and send them back over its radio.

It will keep flying - it doesn't land, and it never comes back to Earth.





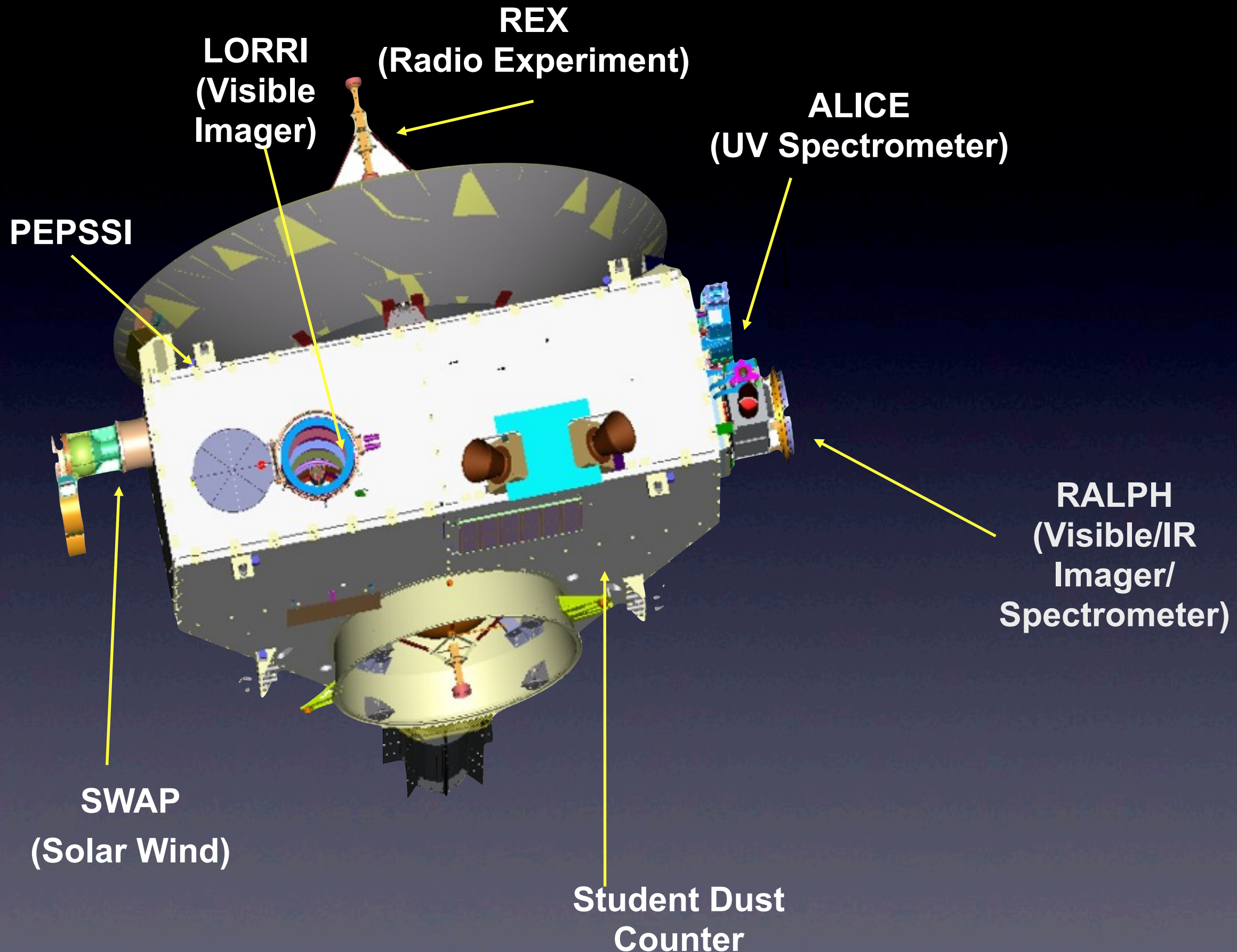
Radio

Camera

Battery

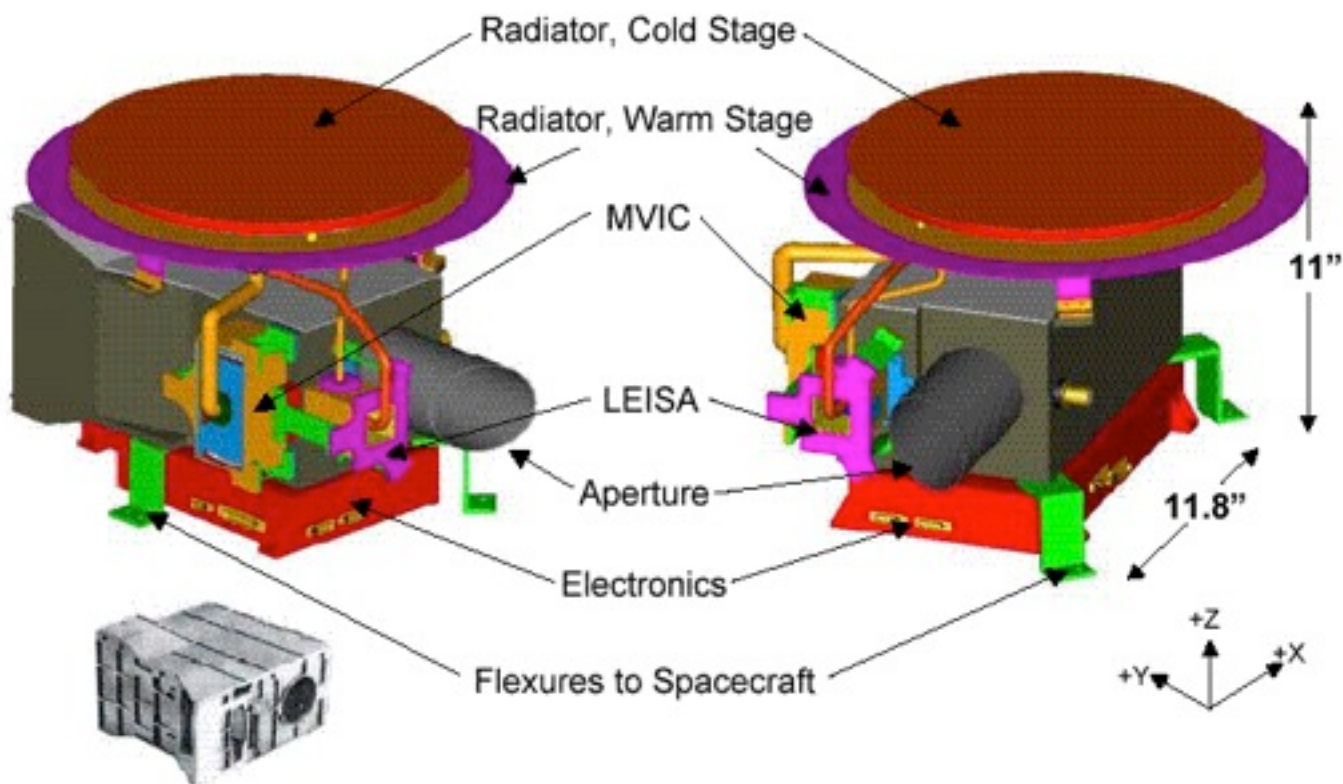


New Horizons Spacecraft





'Ralph' Remote Sensing Package

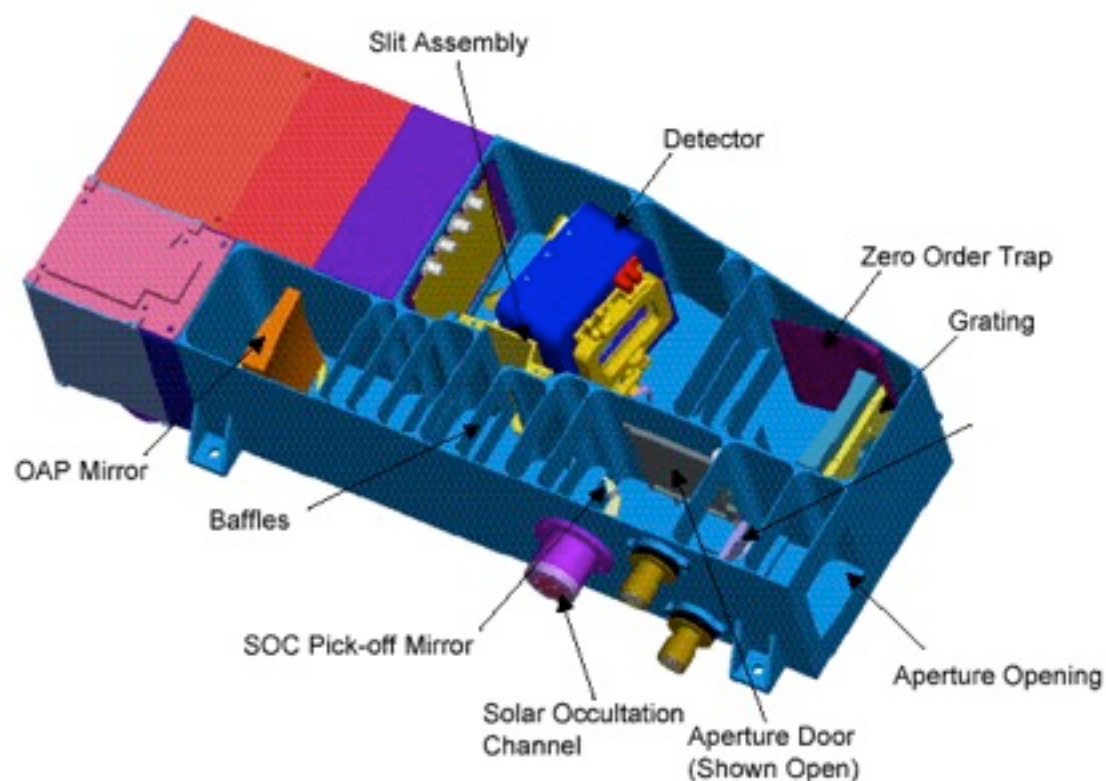


Objectives:

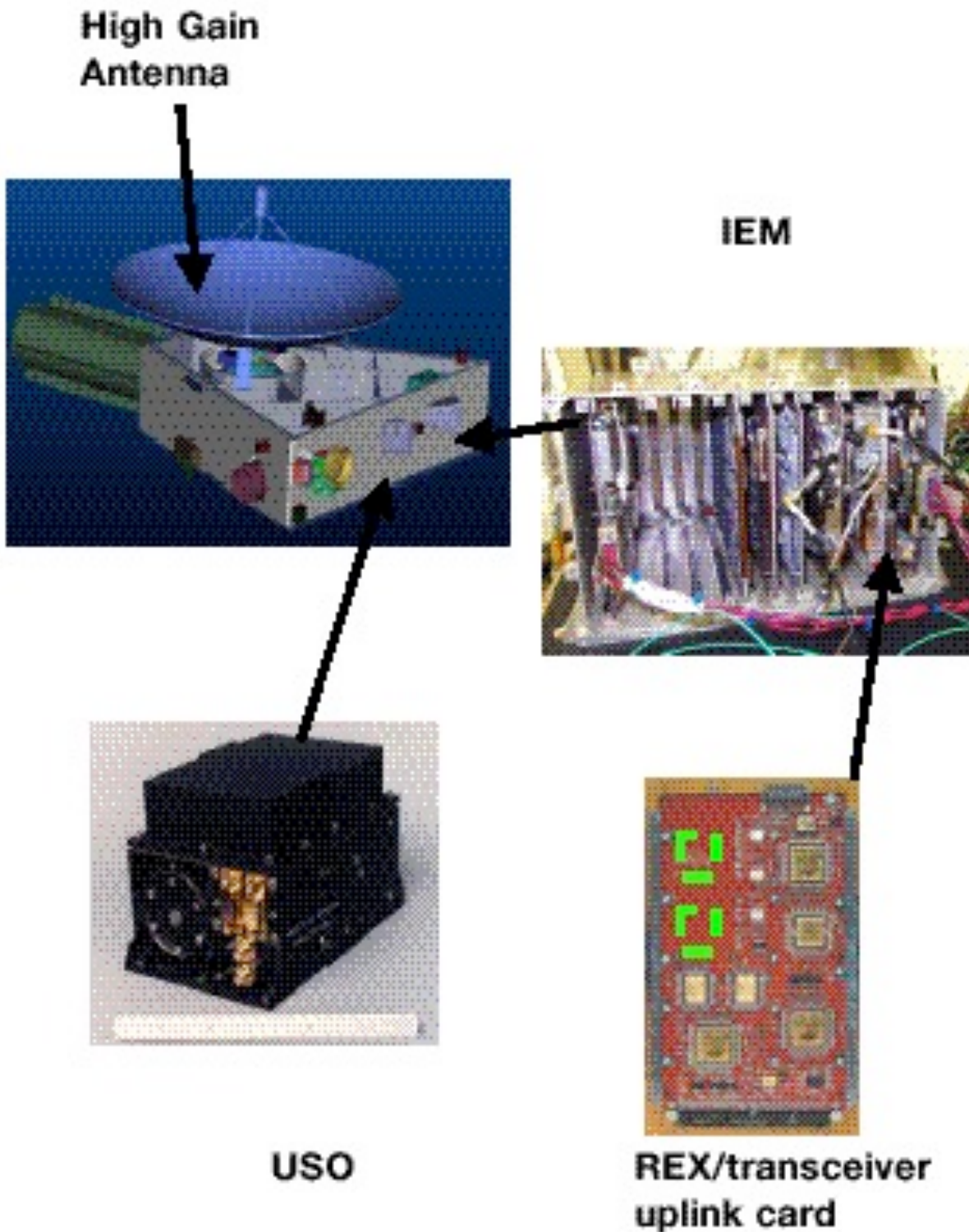
➤ **Ralph/MVIC:** Global geology and geomorphology. Stereo and terminator images. Refine radii and orbits. Search for rings and satellites. Search for clouds and hazes.

➤ **Ralph/LEISA:** Global composition maps, high resolution composition maps, temperatures from NIR bands.

➤ **ALICE:** UV airglow and solar occultation to characterize Pluto's neutral atmosphere. Search for ionosphere, H, H₂, and C_xH_y. Search for Charon's atmosphere.



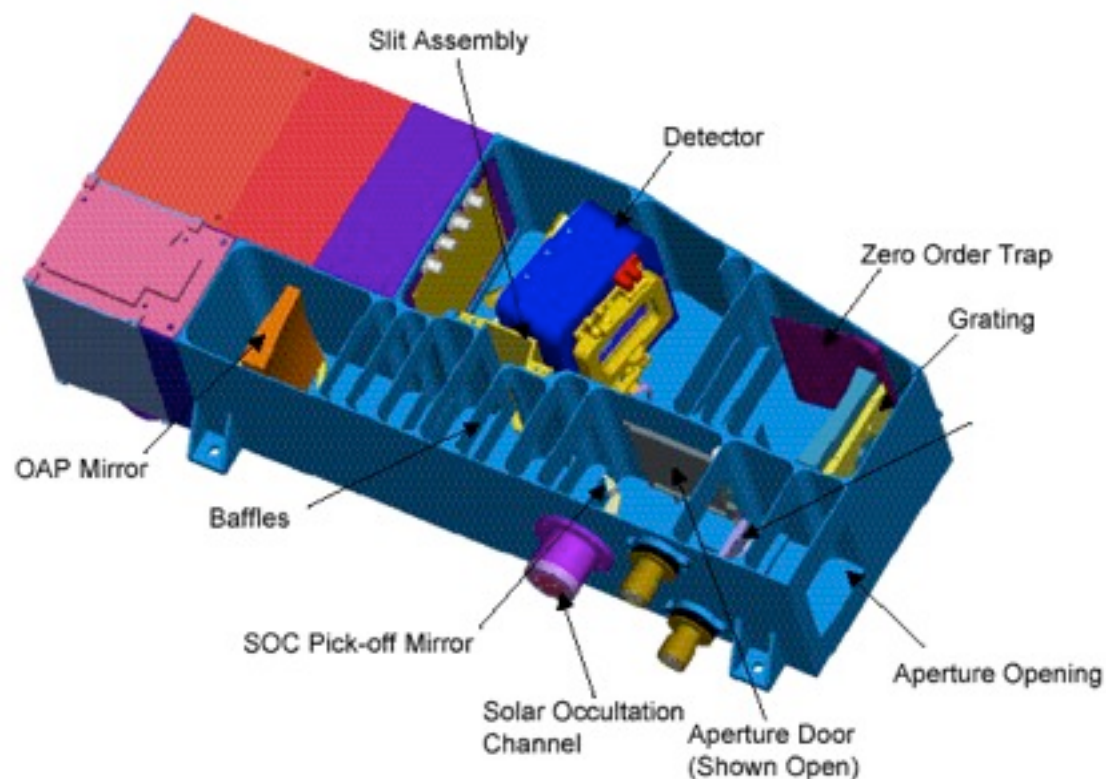
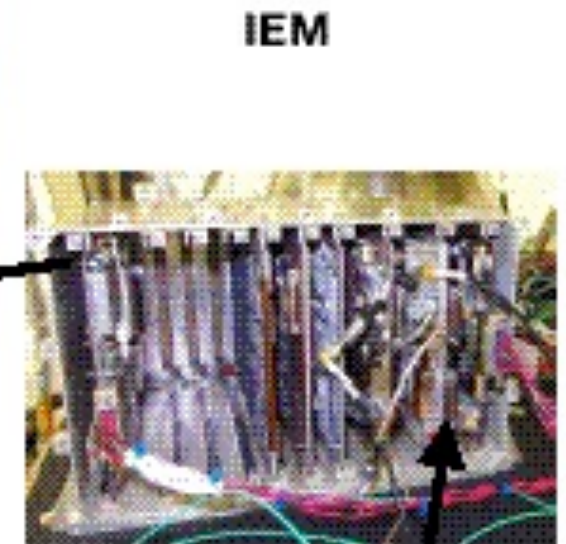
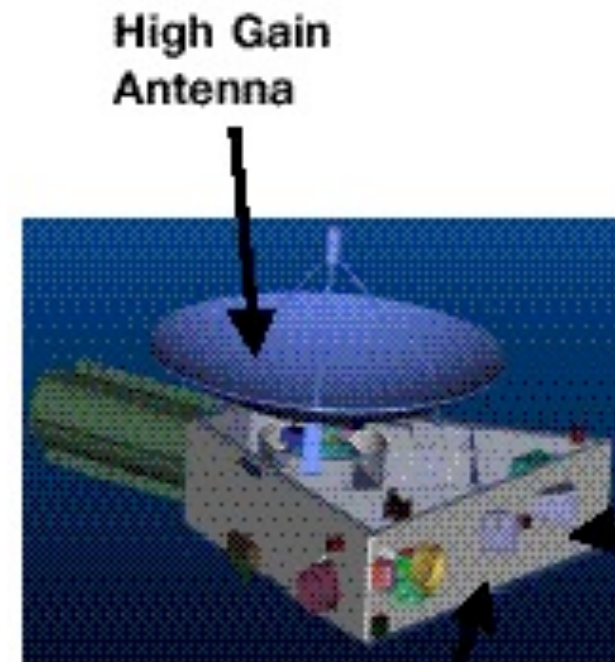
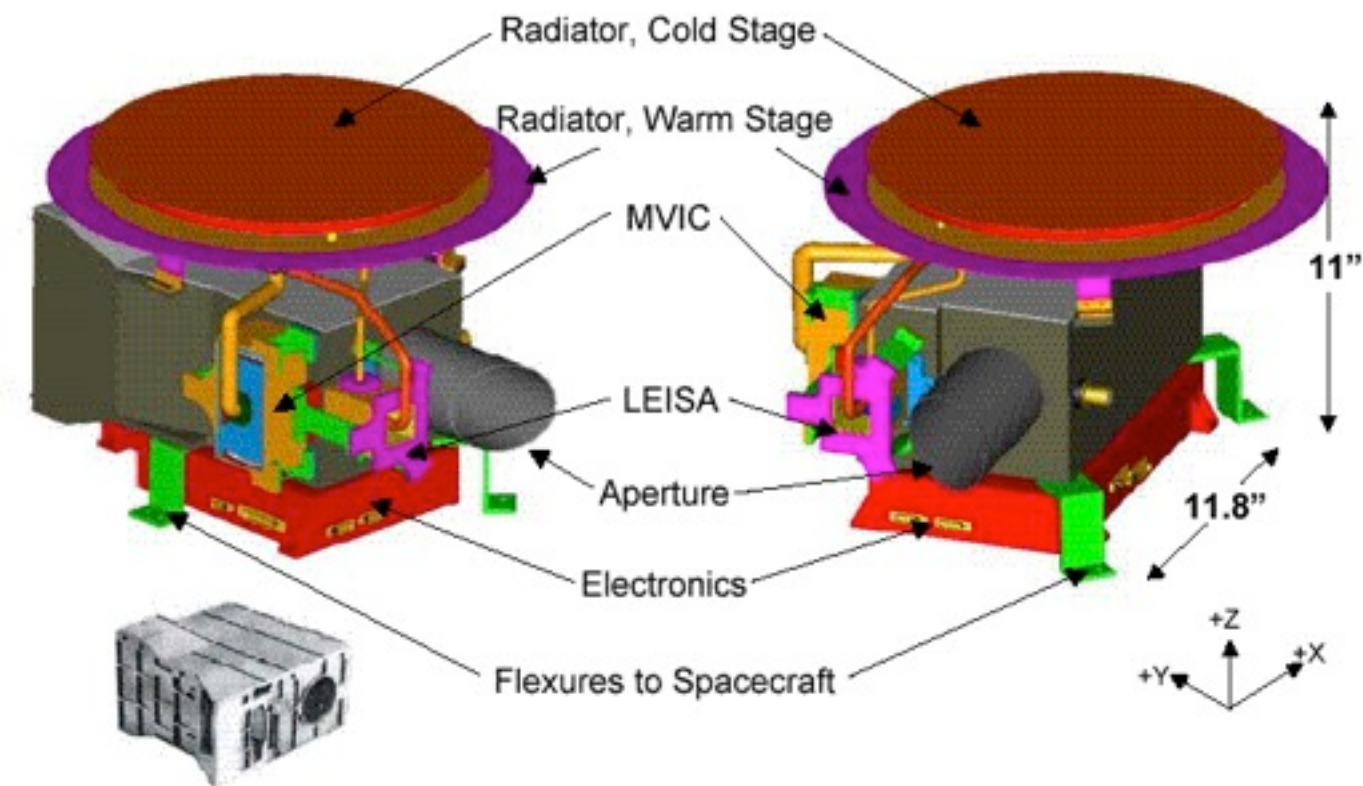
REX Radio Experiment



Objectives:

- Profiles of number density, temperature, and pressure in Pluto's atmosphere, including conditions at surface.
- Search for Pluto's ionosphere.
- Search for atmosphere and ionosphere on Charon.
- Measure masses and radii of Pluto and Charon, and masses of flyby KBOs.
- Measure disk-averaged microwave brightness temperatures (4.2 cm) of Pluto and Charon.

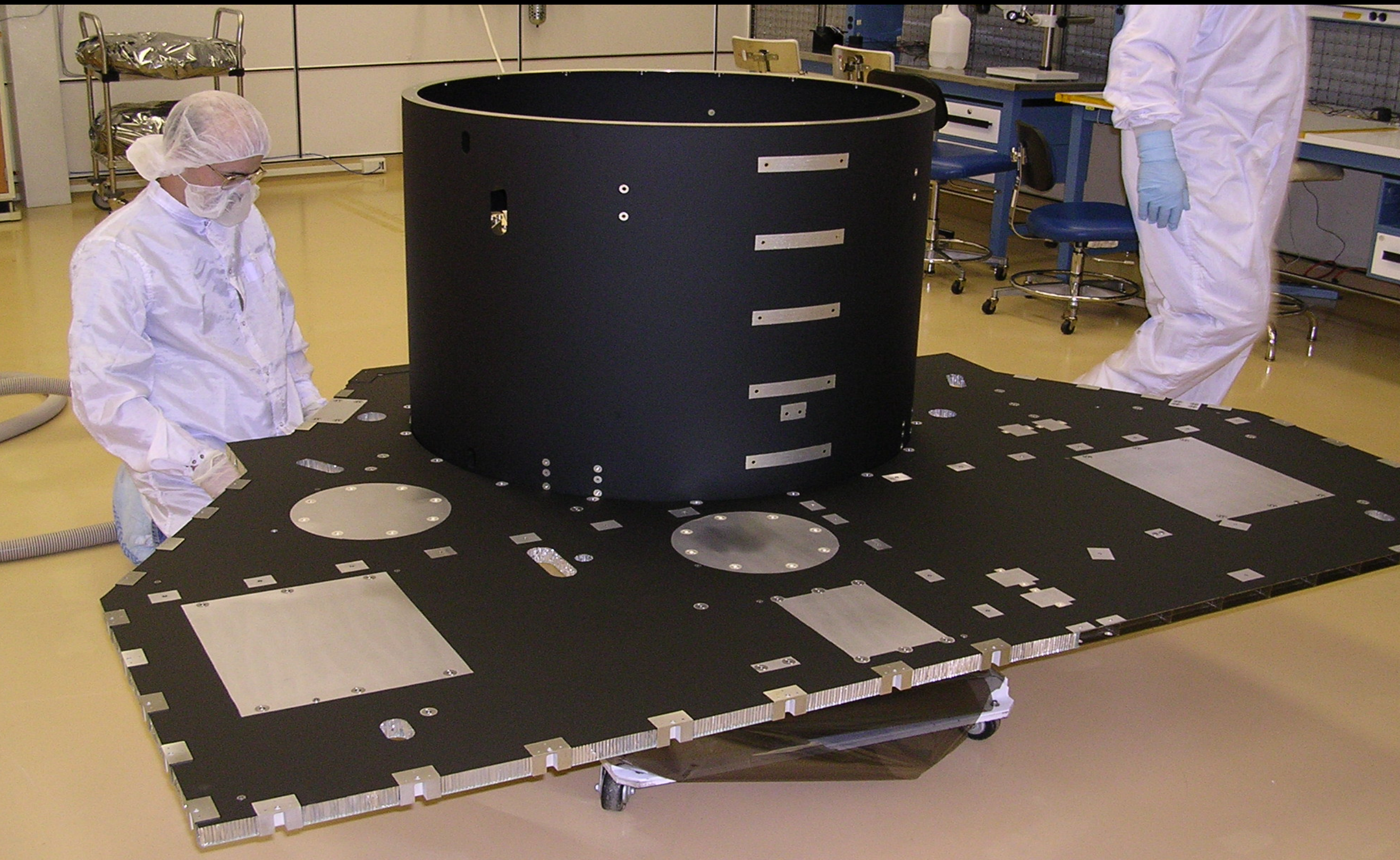
Core: Ralph, Alice, REX

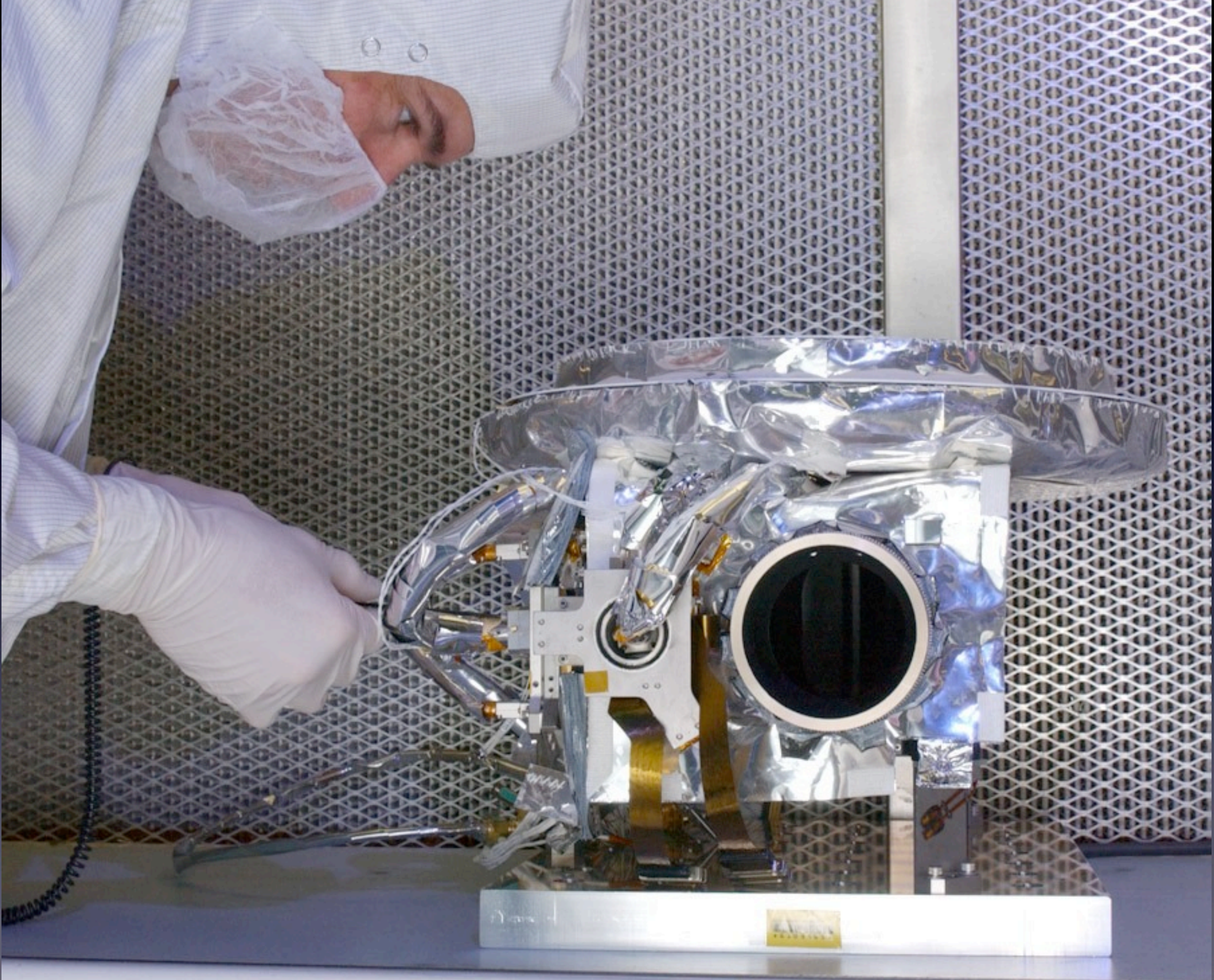


USO



REX/transceiver
uplink card















SKOAL

M&M's

WAL-MART
ALWAYS LOW PRICES. Always.

Coors
LIGHT

Energizer

INTERSTATE
BATTERIES

McDonald's
I'm lovin' it

Lowe's
Empowering Better Living

WINN-DIXIE

Budweiser

HOOTERS

BEEF 'n BRADS



DUPONT
MOTORSPORTS

THE HOME
DEPOT

GOODYEAR

Damn
Wind!

VIAGRA
(sildenafil citrate) tablets

Goody's

WAFFLE
HOUSE

STP

Advance
Auto Parts

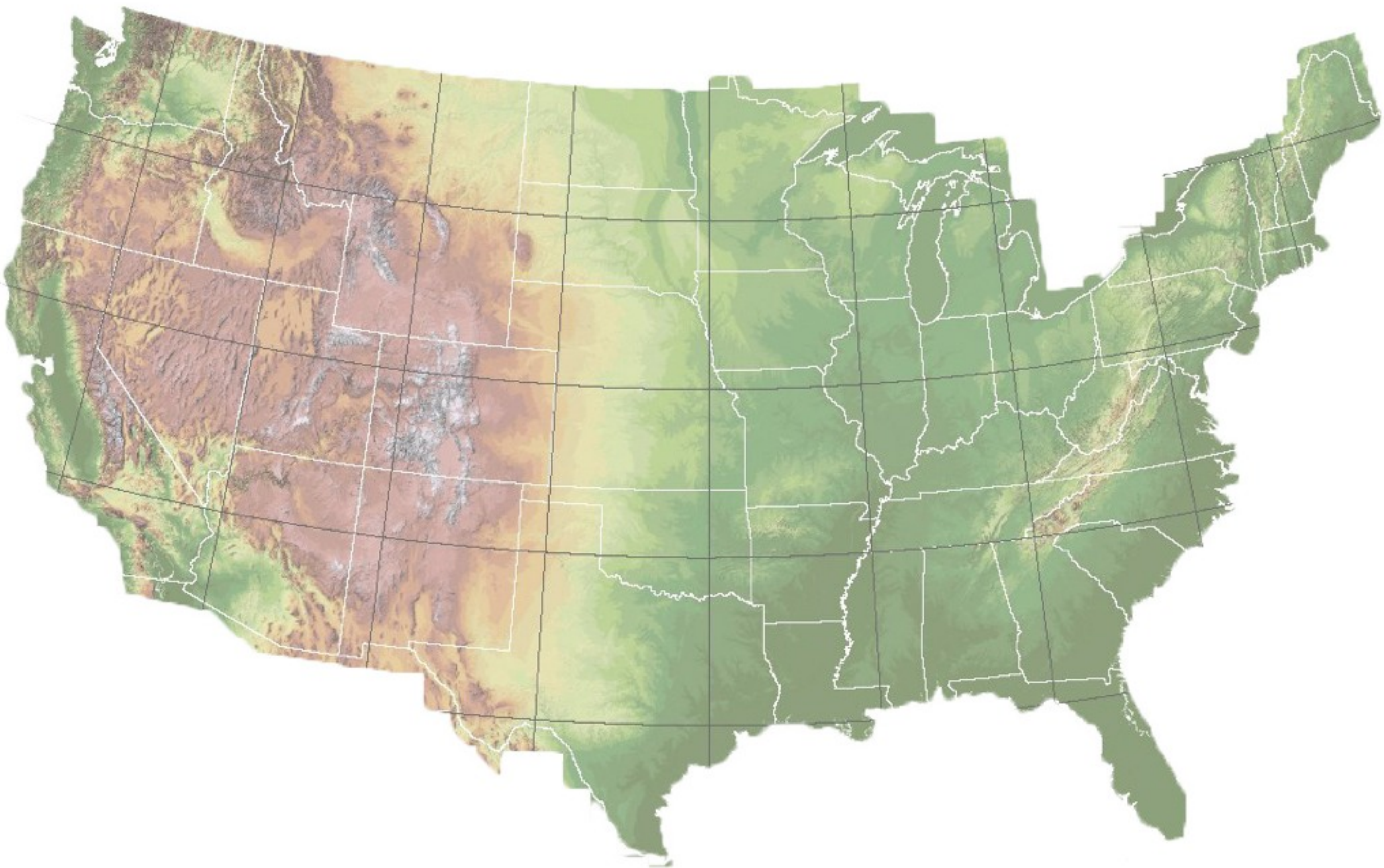


New Horizons Team



New Horizons
Shedding Light on Frontier Worlds





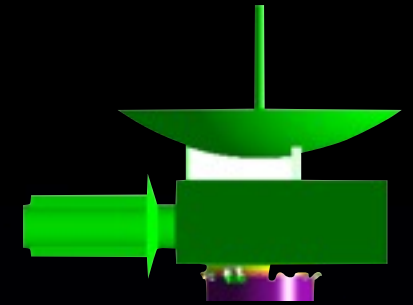






Lockheed-Martin Atlas V Rocket

Rocket: 575,198 kg
Spacecraft: 478 kg
Cameras: 20 kg



















NASA







UTO
HORIZONS

LOCKHEED MARTIN









New Horizons is the ***fastest*** spacecraft ever launched!

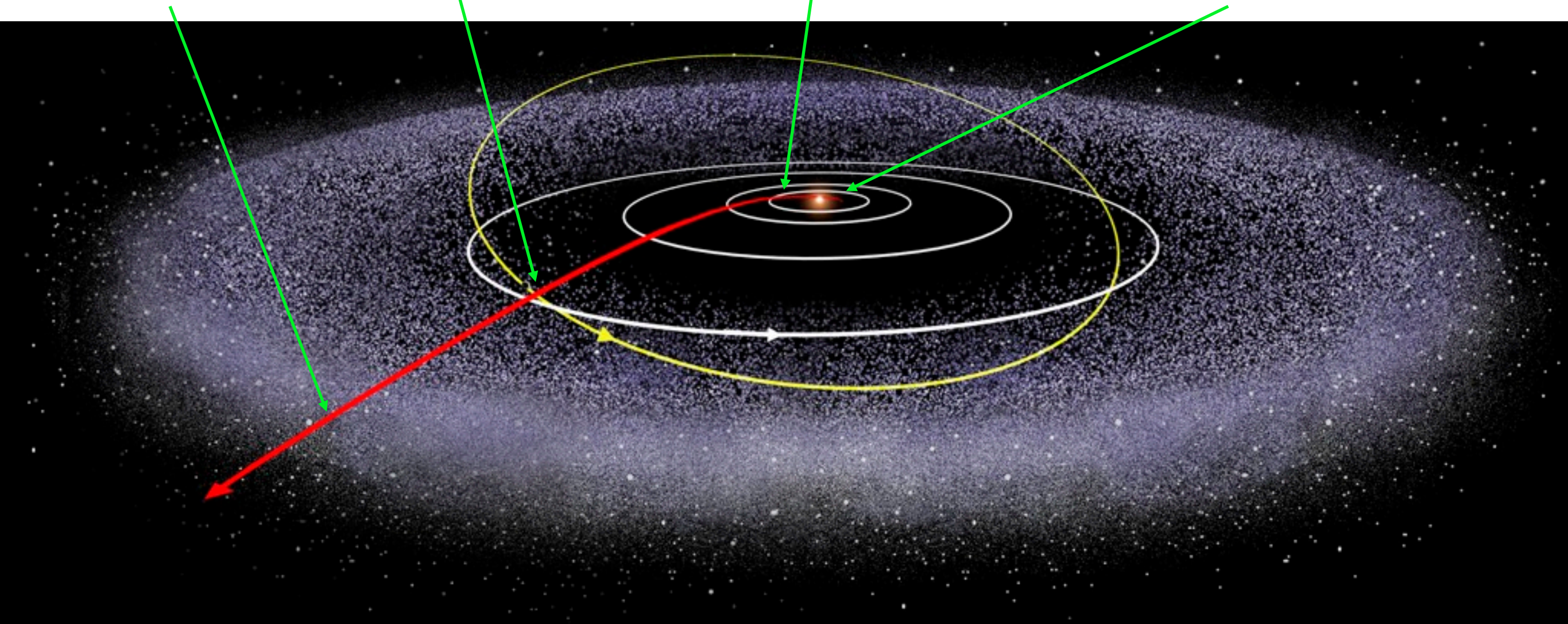
| Mission | Time to get to the Moon's distance |
|----------------|---|
| New Horizons | 4 hours |
| Apollo 11 | 96 hours |
| Bloodhound | 251 hours |

**Pluto:
July 2015**

**Jupiter:
March 2007**

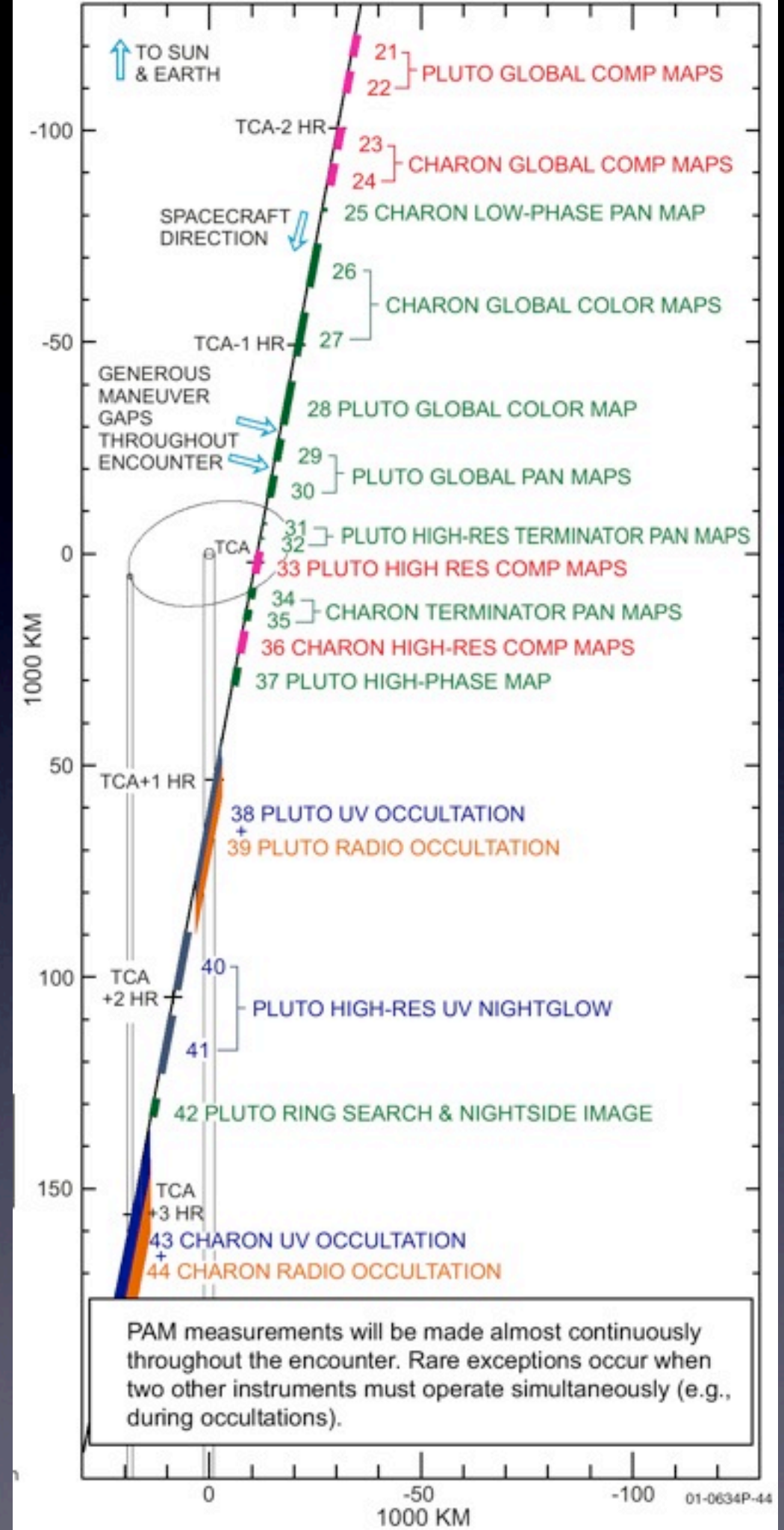
**Kuiper Belt:
2016-2020**

**Earth:
January 2006**



2015: Pluto-Charon Encounter

- Six months of encounter science.
- Exceed Hubble resolution for 150 days.
- 5000x5000 pixel map of Pluto (500 m/pix)
- High-res 'postage stamps' of selected portions of surfaces (50 m/pix)
- Map Pluto night-side frost in Charon-light.
- Global composition maps.
- Radio & UV occultations of Pluto & Charon.
- Map surface temperatures.
- Directly measure Pluto's escape rate.
- Release all encounter data to public.



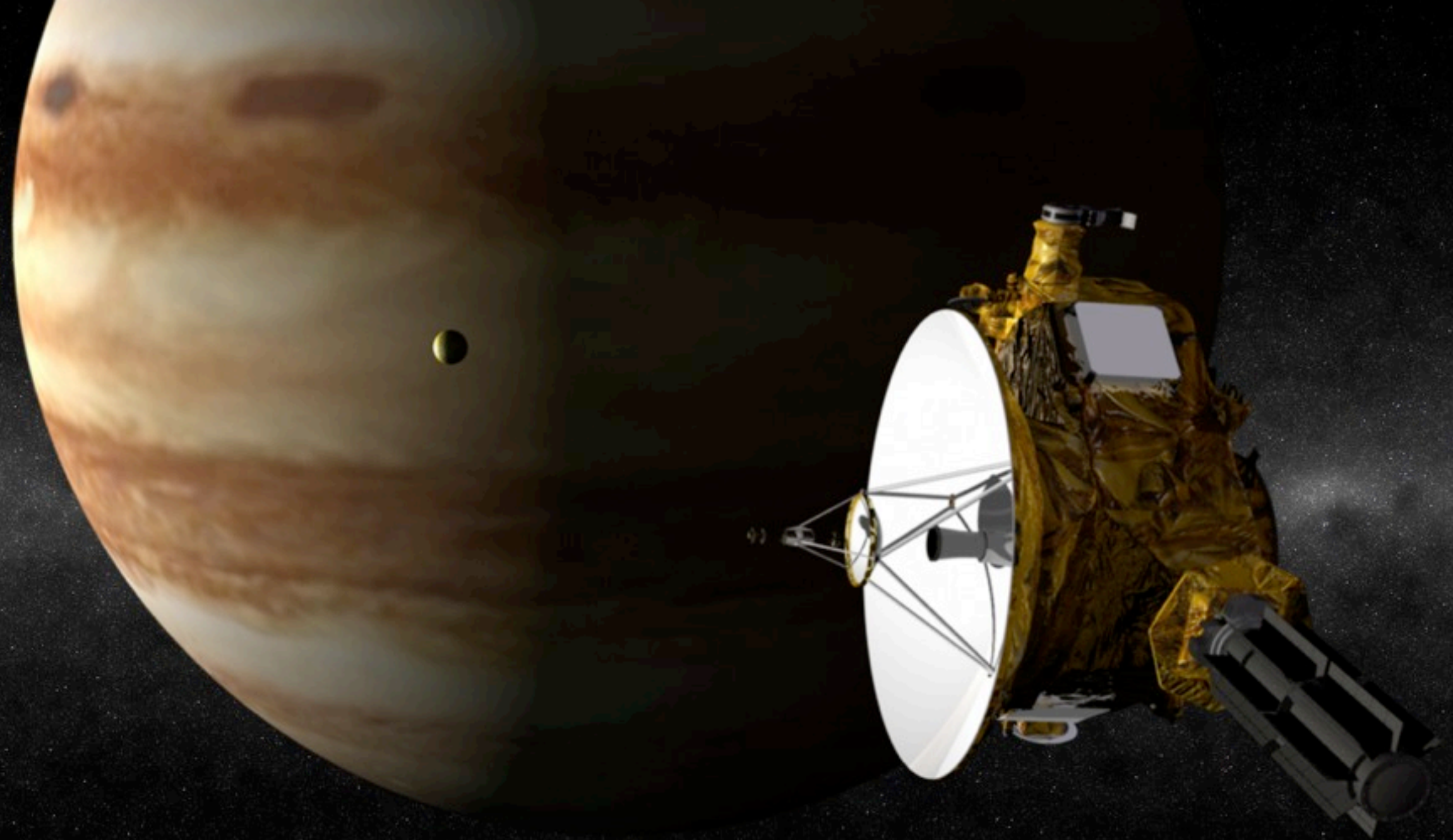
New Horizons KBO Encounters

- Expect one or two KBO encounters with KBOs that have diameters of 40 to 90 km.
- Identical measurement objectives to Pluto-Charon.
- Same geometry and design as Pluto-Charon encounter.
- Observing begins 4 weeks before encounter.
- Post-encounter studies continue for 2 weeks.
- All data to Earth within 2 months.
- Currently searching for target KBO from ground-based telescopes.



New Horizons Pluto Kuiper Belt Mission Profile





New Horizons at Jupiter: February 28 2007



New Horizon at Jupiter

February 28, 2007

Red = 1.59 μm (Deep Clouds)

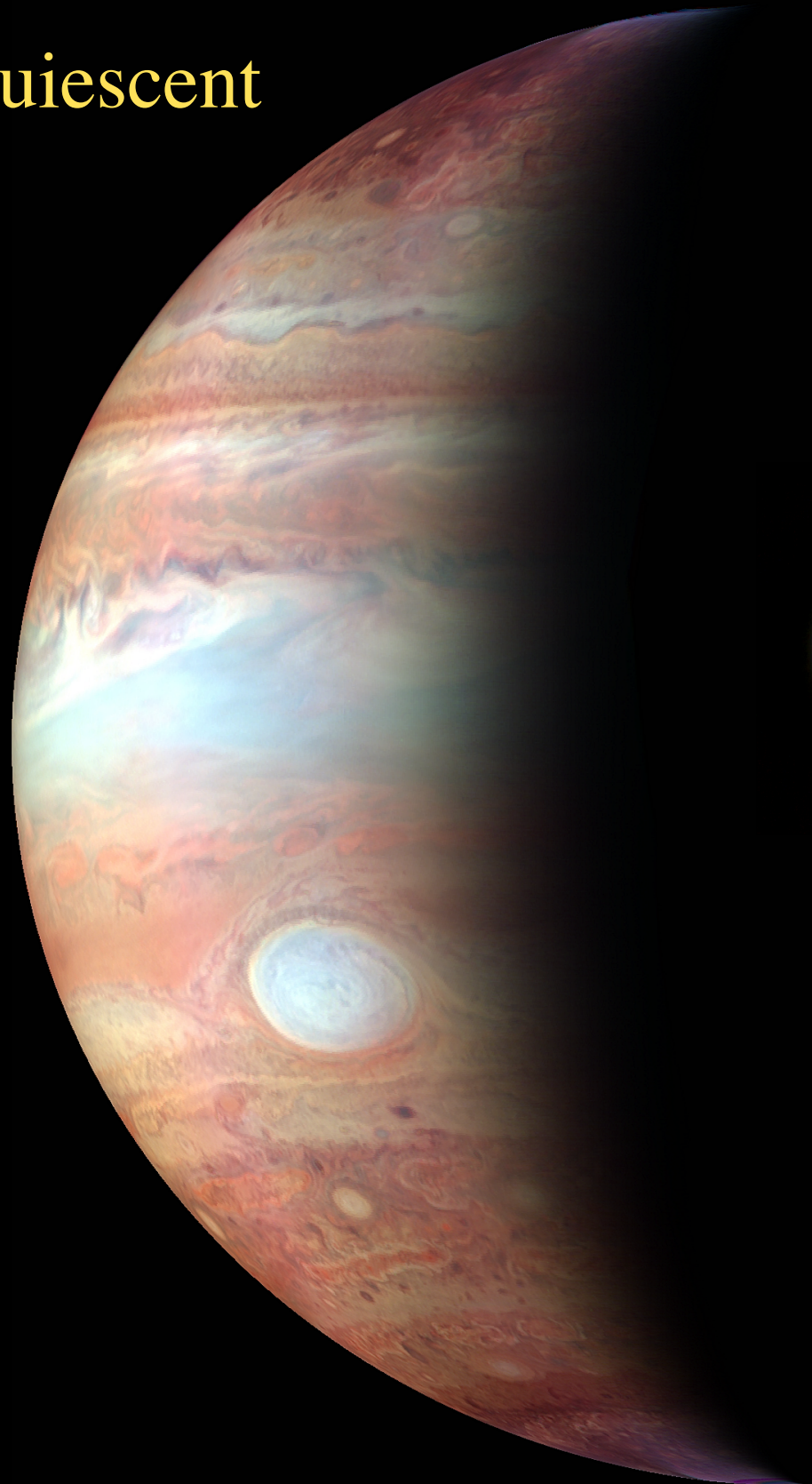
Green = 1.90 μm (Mid-level Clouds)

Blue = 1.85 μm (Upper-Level Hazes)

New Frontiers/LEISA
February 28, 2007

Cassini/ISS
December 29, 2000

Quiescent



Active



Jovian Polar Lightning

Lightning Strike Sequence

7:06:03



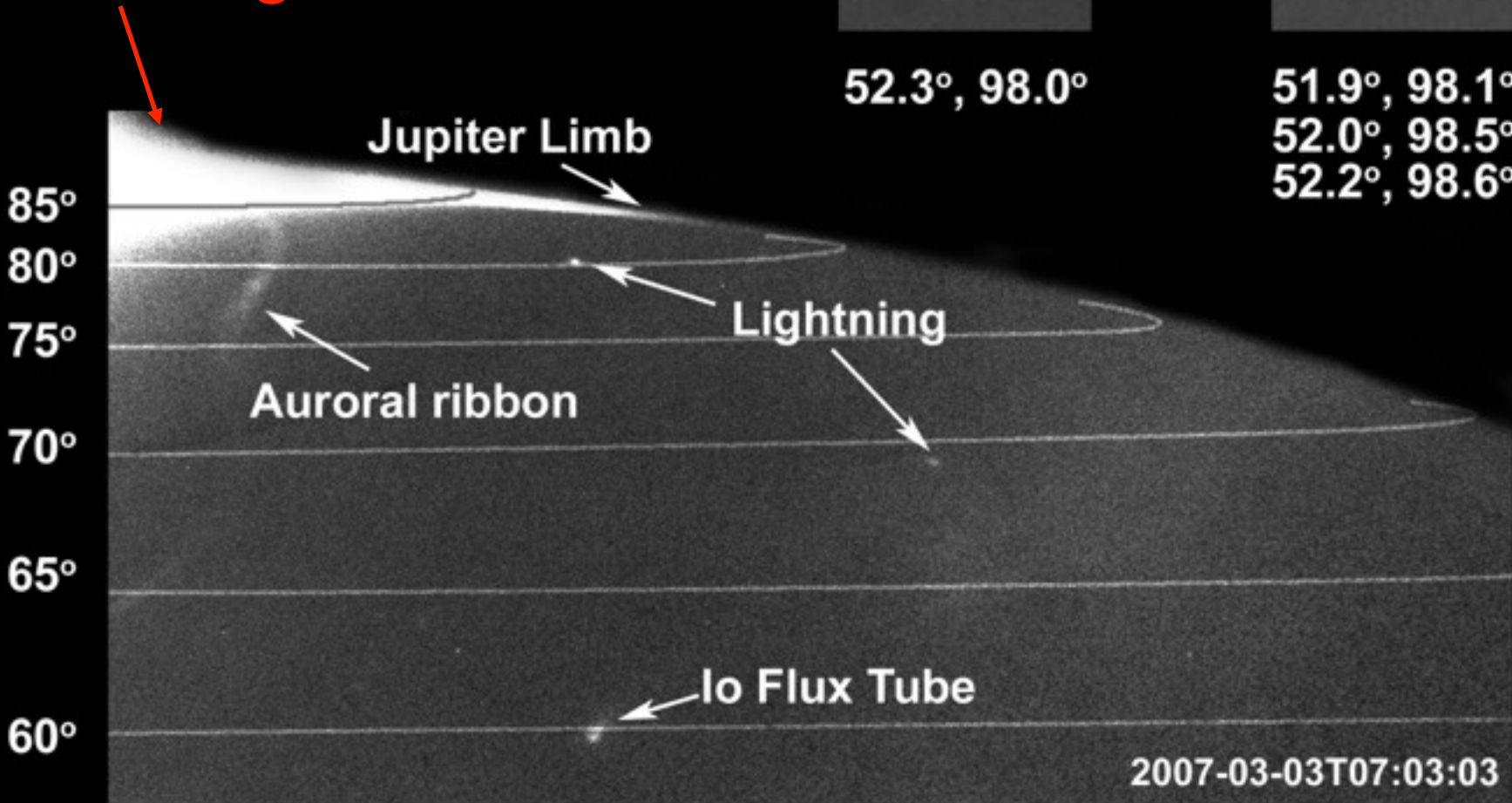
52.3°, 98.0°

7:06:08



51.9°, 98.1°
52.0°, 98.5°
52.2°, 98.6°

Cleaned Image



80.4°, 123.5°



79.6°, 208.5°



69.7°, 121.4°



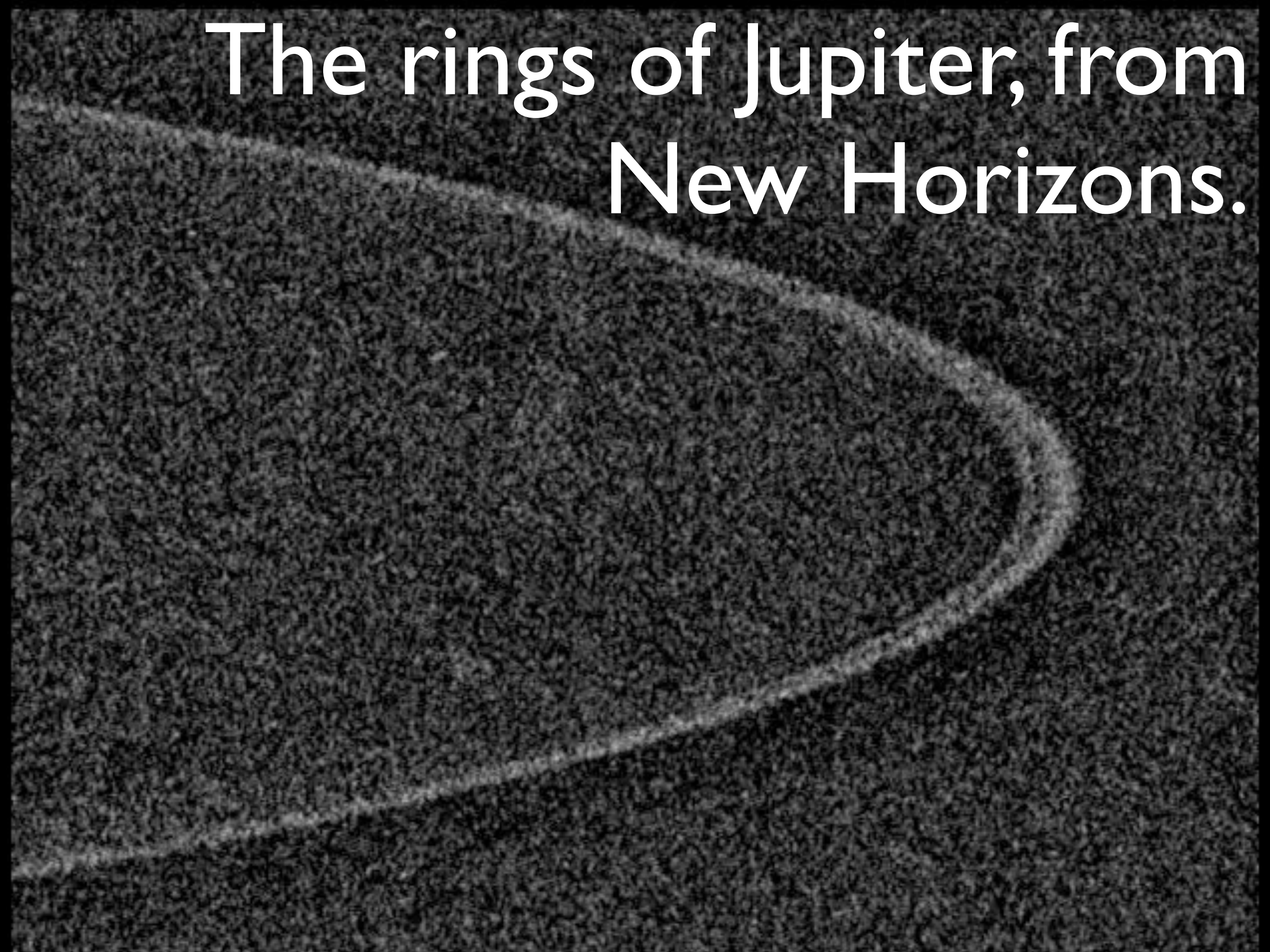
-66.0°, 190.0°



-68.9°, 222.6°

Examples of Polar Lightning Strikes

The rings of Jupiter, from New Horizons.



New Horizons searched for
and found NO new small
moons around Jupiter with
size < 10 km.

What does this mean?

12. After migration, only the two largest bodies remain.

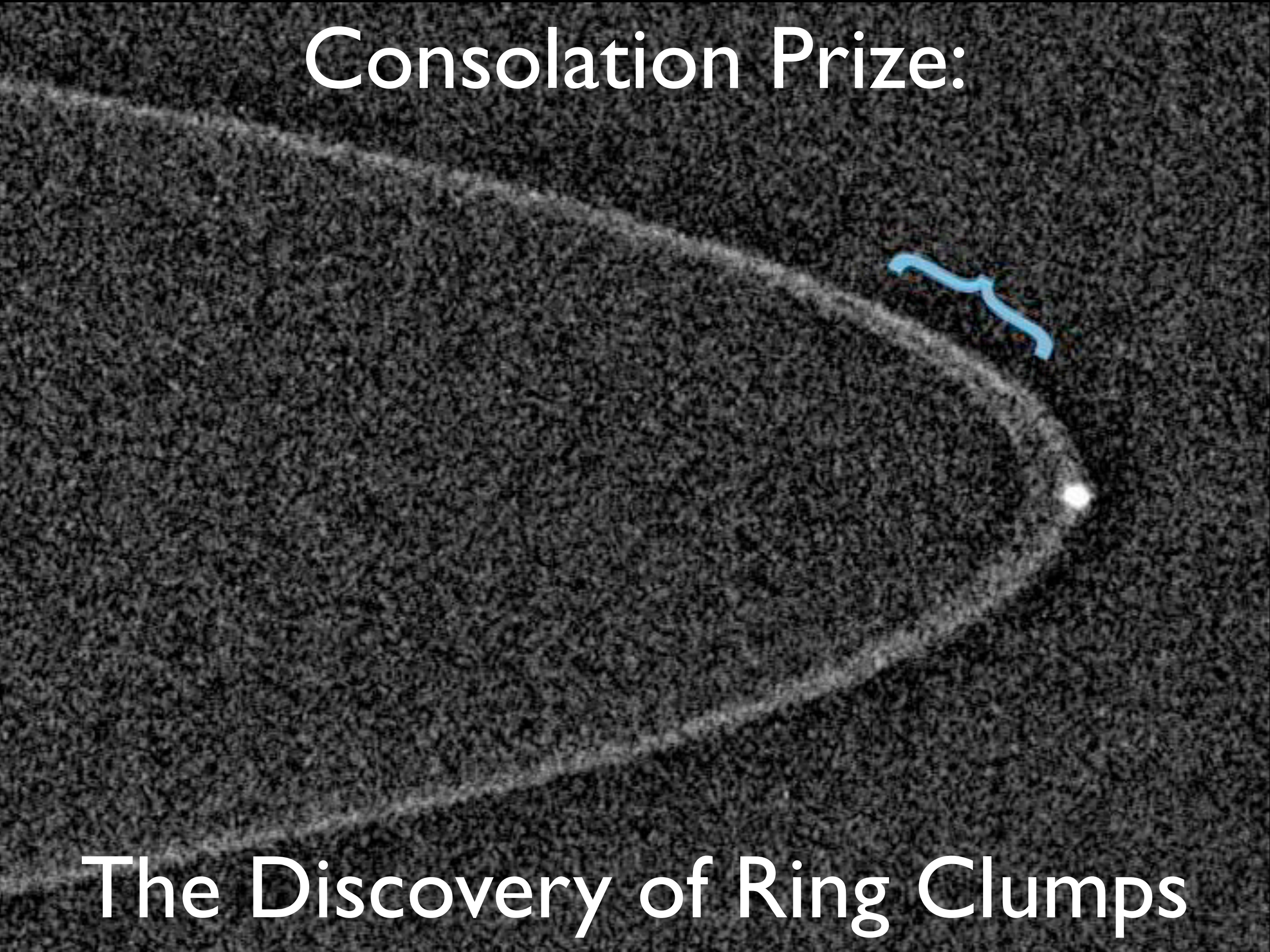


Metis

...with perhaps a few more too tiny to see.

Adrastea

Consolation Prize:



The Discovery of Ring Clumps

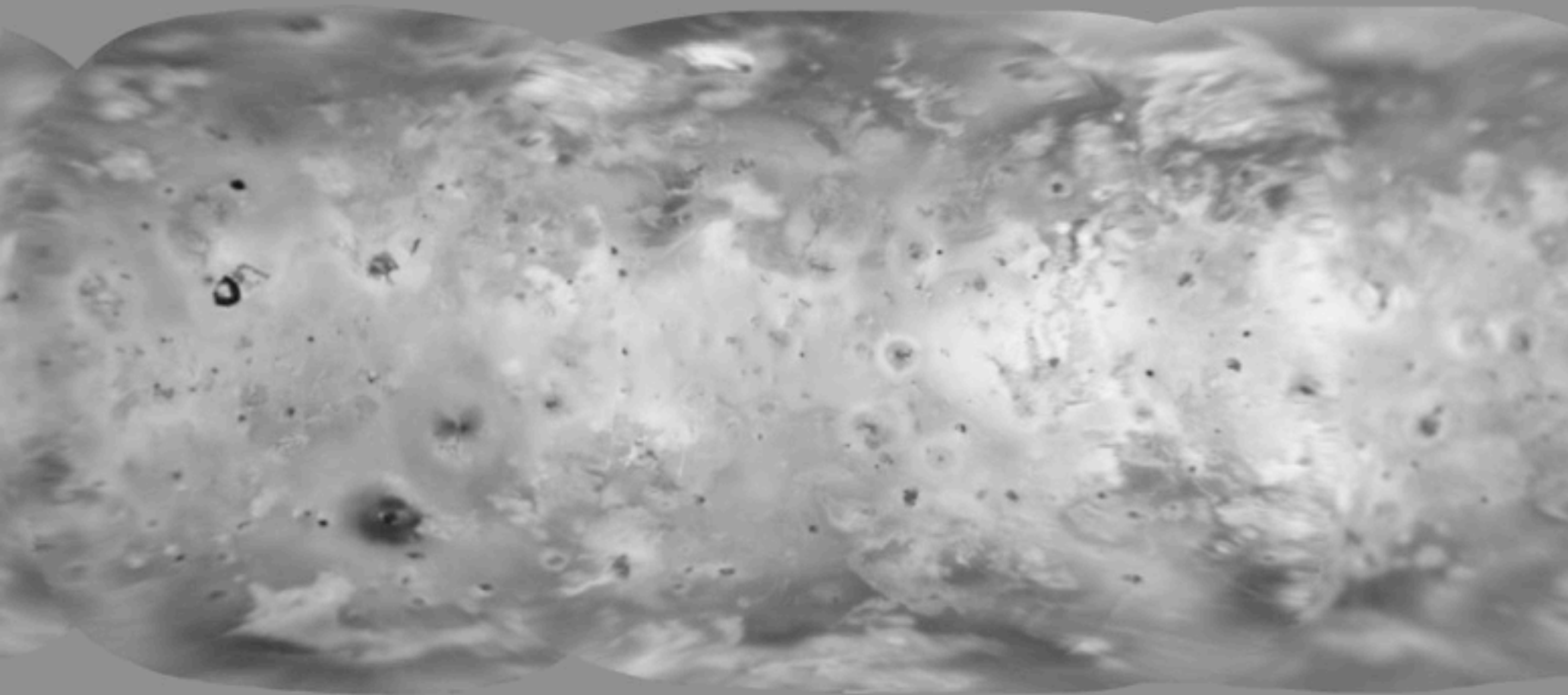
Volcanoes on Jupiter's Moon "Io"



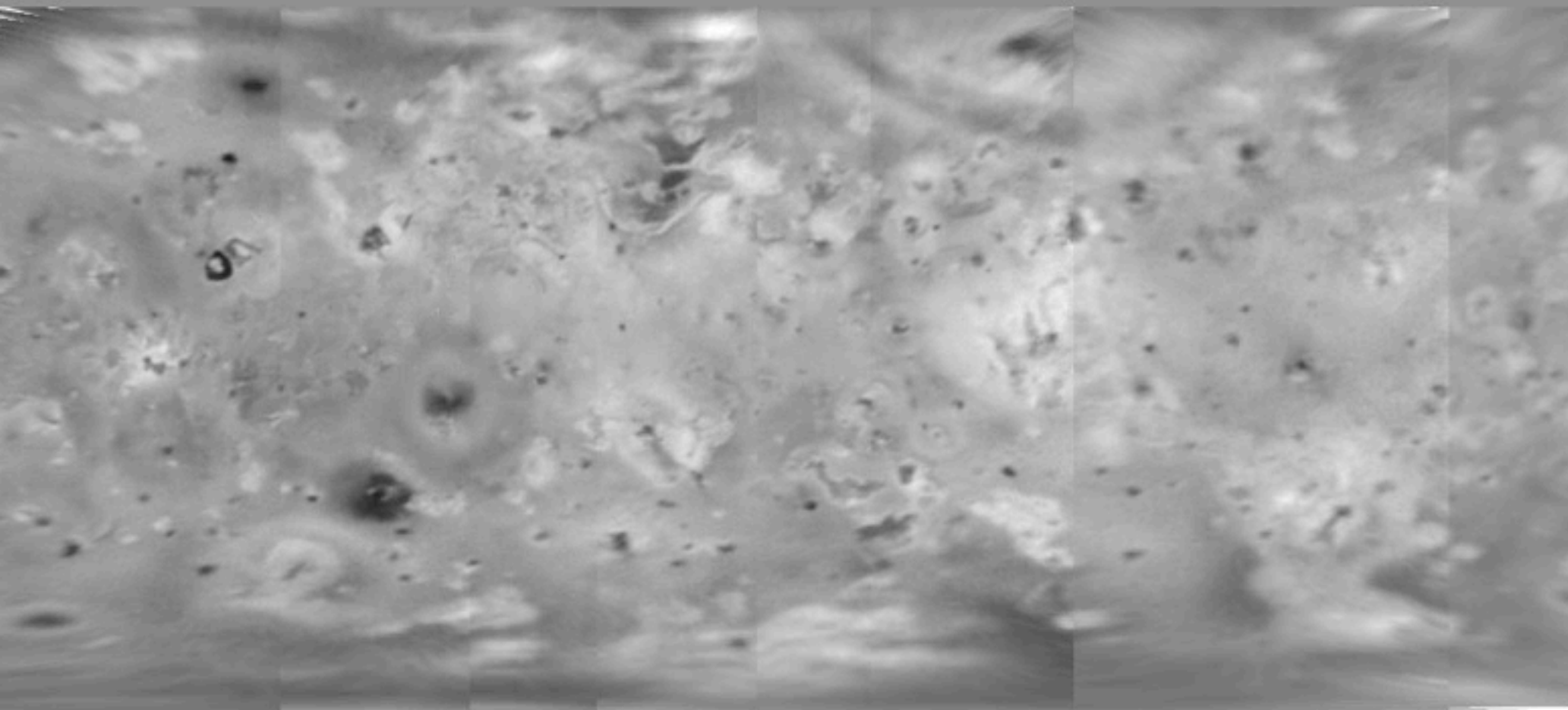


10 years of surface changes

Galileo
~1997



New
Horizons
2007



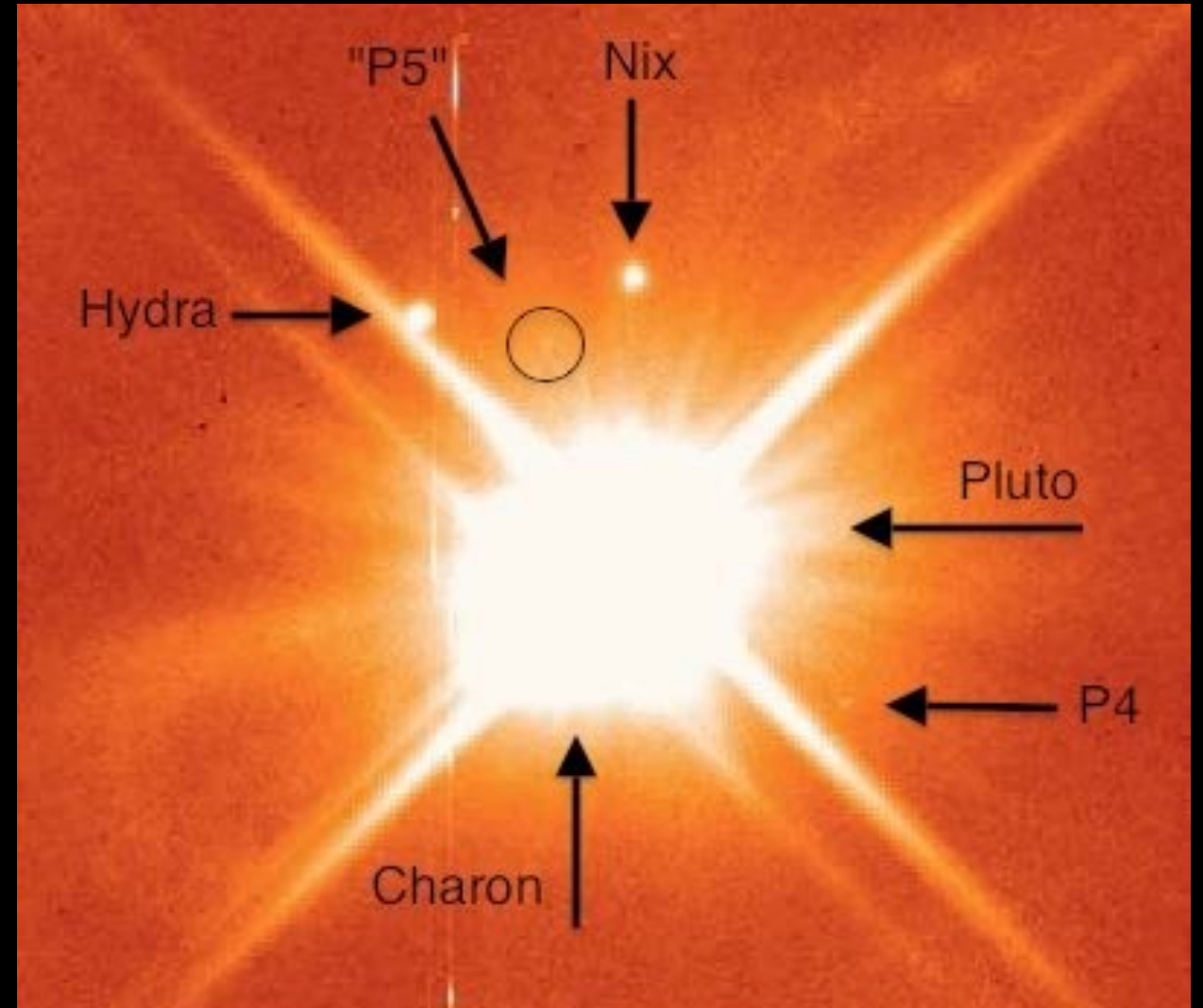
Volcanoes on Io



Five Missions for the Price of One

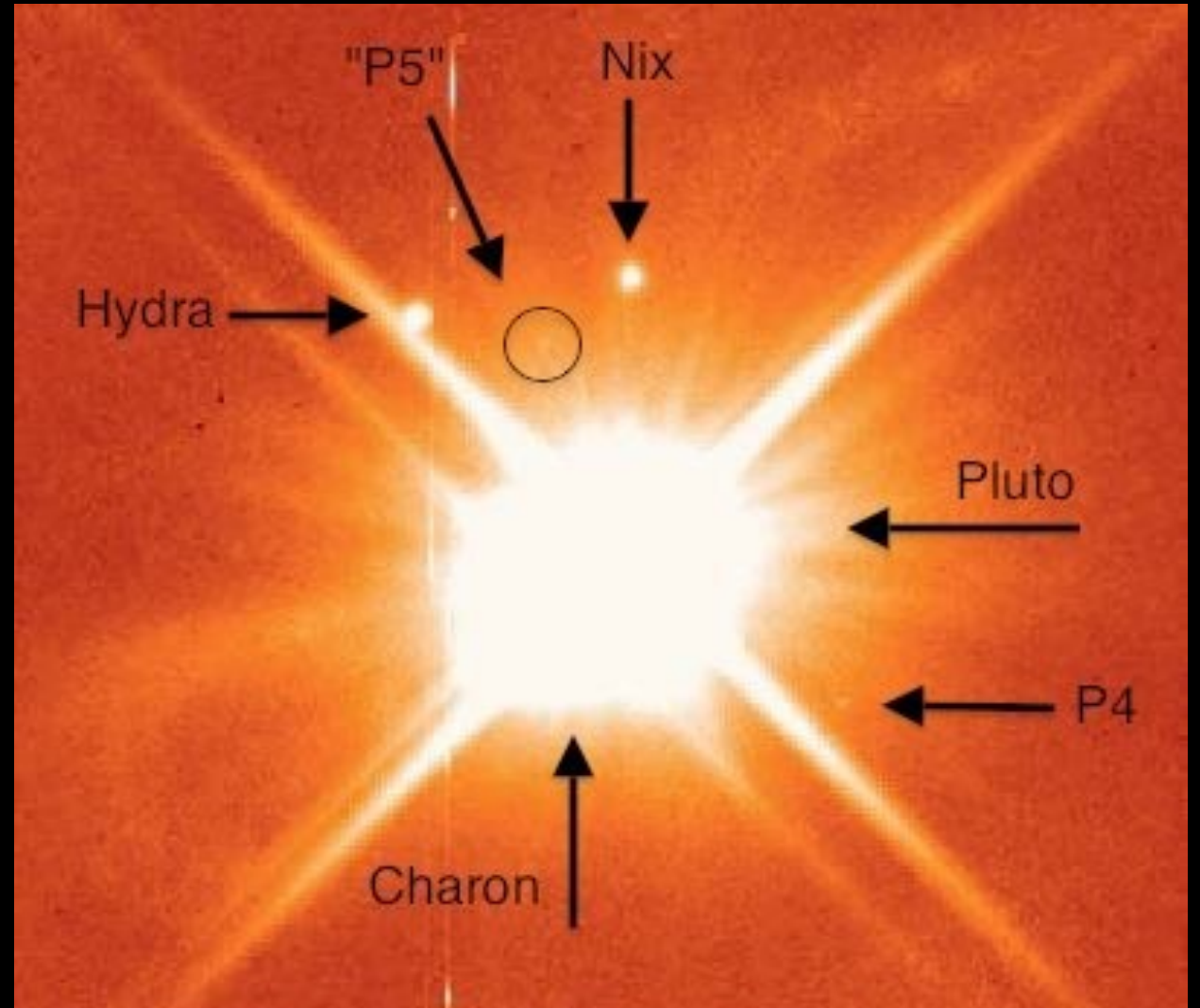
- 2003: When New Horizons was selected by NASA, Pluto had just one known moon, Charon.
- 2005: Two new moons discovered: Nix and Hydra
- 2006: Launch
- 2011: One more moon discovered: P4
- 2012: One more moon moon discovered: P5

All these new moons are great, but they give us a few problems...



I. If there are five moons, there may be more moons, more rocks, more dust that we cannot see... and *that* could be dangerous.

All these new moons are great, but they give us a few problems...



2. What do we call them??



Pluto Rocks

Help us name the smallest moons of Pluto

How to names Pluto's moons P4 and P5?

- We conducted one of the internet's largest polls ever at PlutoRocks.com
- Two weeks, 450,000 votes
- 180+ countries including South Africa, Zim, Namibia, Botswana, Lesotho...

Greek definition of Planet: 'Wandering star'

planet ('plænɪt), *n.*¹ Forms: 3-6 **planete**, (4-6 **-ette**, 5 **-ett**, *Sc.* **-ait**, 6 *Sc.* **-eit**, 7 **plannet(t)**, 5- **planet**.

[ME. *a.* OF. *planete* (F. *planète*), ad. late L. *planōta* or *planōtōs* (cited only in pl. *planōtæ* = cl. L. *stellæ errantes*), *a.* Gr. *πλανήτης* wanderer, hence, in *pl.* (*ἀστέρες*) *πλανῆται* wandering stars, planets, f. *πλανᾶν* to lead astray, in *pass.* to wander. (Another Gr. form was *πλάνης*, *-ητος*, in pl. *πλάνητες* *ἀστέρες*, L. *planōtes*.)]

† **1. a.** *Old Astron.* A heavenly body distinguished from the fixed stars by having an apparent motion of its own among them; each planet, according to the Ptolemaic system, being carried round the earth by the rotation of the particular sphere or orb in which it was placed. *Obs.*

The seven planets, in the order of their accepted distance from the Earth, were the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn.

[c1050 *Byrhtferth's Handbooc in Anglia* (1885) VIII. 320 þa steorran þe man hæi planete on lyden.]

a1300 *Cursor M.* 1550 (Cott.) þe planetes all ar went again O þair first making in to þe state.

c1400 *Destr. Troy* 4366 Venus the worthy..of planettes of prise has hor pure nome.

c1420 *LYDG. Assembly of Gods* 1695 The seuyn planetty's Hauē her propre names by astronomers.

c1470 *HENRY Wallace* xi. 500 Quhill day began to peyr; A thyk myst fell, the planet was not cleyr.

1481 *CAXTON Myrr.* i. xx. 60. A way that is comune to the vii planetes.

1600 *NASHE Summer's Last Will* D i. Resplendent Sol, chiefe planet of the heauens.

1621 *BURTON Anat. Mel.* i. ii. i. ii. (1651) 45 Gregorius Tholosanus makes seven kindes of ætherial spirits or angels, according to the number of the seven Planets, Saturnine, Jovial, Martial.

1687 tr. *Marana's Turkish Spy* i. xii. 35 It is a great while since we have had any Commerce here with the Sun; there being forty nine Days since this beauteous Planet appeared to us.

1727 *BAILEY* vol. II. s.v., There is none of the Planets, except the Sun that shines with his own Light.

1766 *PORNY Heraldry* (1787) 19 Arms..are blazoned..by Planets, when they belong to Sovereign Princes, Kings, and Emperors.

Is Pluto a Planet?

Yes !!!

- It orbits the Sun
- It is big enough so that its own gravity makes it into a round ball
- It has five moons
- It has an atmosphere
- We've always called it a planet

No !!!

- It's smaller than the other planets
- Its orbit is egg-shaped and tilted
- It's just like the other 500 Kuiper Belt objects, and we don't call them planets
- If it was discovered today, we would not call it a planet

August 2006: International Astronomical Union, Prague



This group voted to call Pluto a 'Dwarf Planet.'
But not everyone agrees, and this is how science works.

IAU Definition of Planet

"The IAU therefore resolves that "planets" and other bodies in our Solar System, except satellites, be defined into three distinct categories in the following way:

(1) A "planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighborhood around its orbit.

(2) A "dwarf planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite.

(3) All other objects except satellites orbiting the Sun shall be referred to collectively as "Small Solar-System Bodies".

Problem I: The 800+ extrasolar planets aren't 'planets'?

Problem II: But Jupiter isn't 'rigid'!

Problem III: Saturn isn't round!

Problem IV: Earth, Jupiter, Moon, etc have not 'cleared their neighborhood'!

HELP SUPPORT LOWELL OBSERVATORY

Vote with your wallet
on the question below

What should Pluto be called?

Planet

Dwarf
Planet

Other

I don't care!
I just want
to support
Lowell



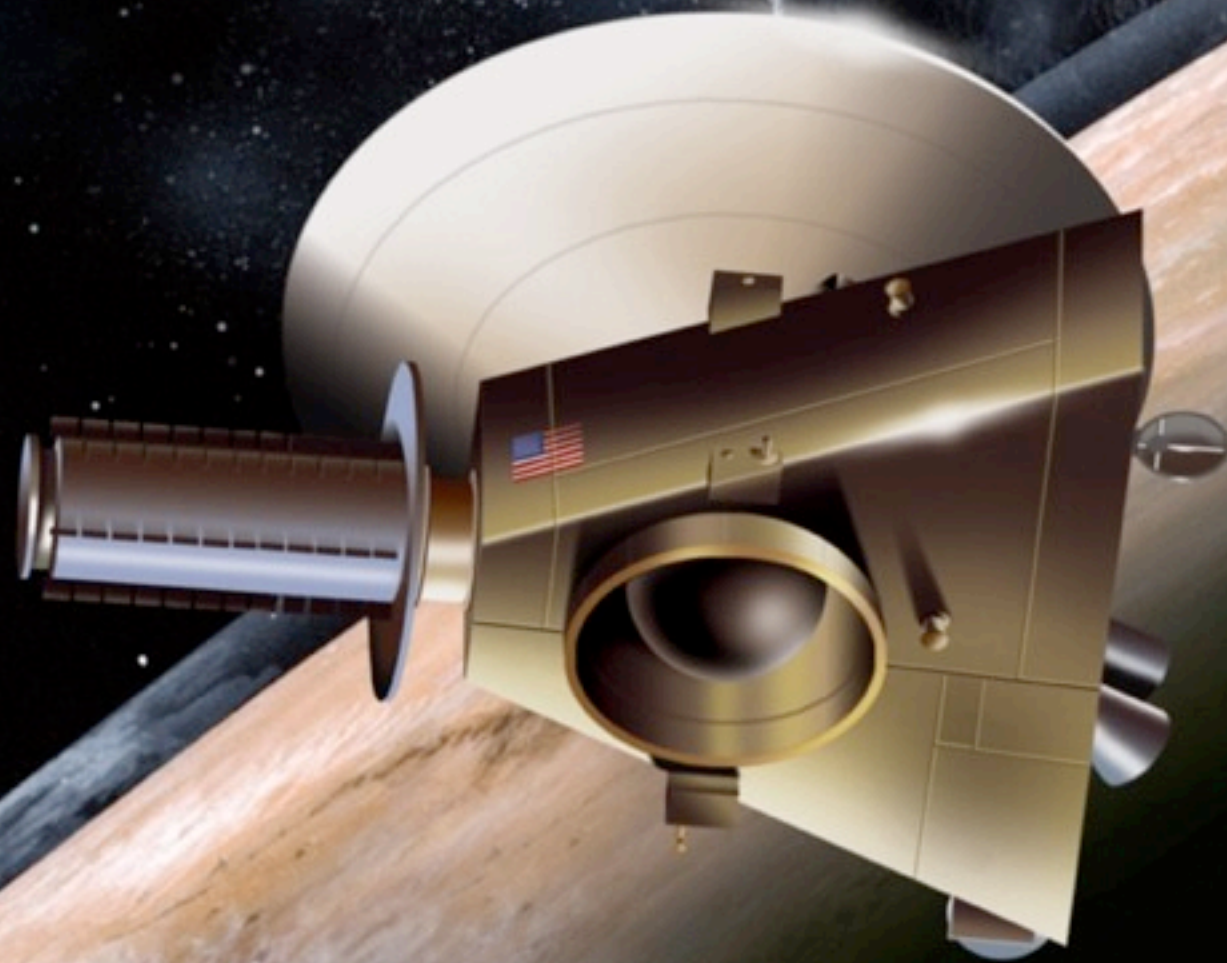
- What is the difference between a koppie and a hill? It's a fine line...
- Science is a human process and our names will continue to evolve as we learn more about the world around us.

Pluto is a Planet.

Get on with it and Look at the Sky!

You can track New Horizons as it gets
ready to arrive at Pluto July 14, 2015...

<http://pluto.jhuapl.edu/>



throop@psi.edu