Dec 3, 2014

Discovering the Solar System

Rosetta and New Horizons in 2015

by Mark Graybill http://saundby.com/

Rosetta and Philae

Originally destined for 46P/Wirtanen failure of the Ariane 5ECA Hotbird 7 launch on 11 Dec 2002 caused a launch delay from planned 12 Jan 2003. Rosetta was retargeted to 67P/Churyumov/Gerasimenko.

Launched 2 March, 2004 on an Ariane 5G+

Flyby of Mars on 25 Feb, 2007 was called “The Billion Euro Gamble”

250km/160mi above Mars, in the dark, out of communications.

Craft was put into standby mode with solar panels folded and batteries not designed for these conditions.

En-route, Rosetta flew by Earth (3 times), Mars, asteroid 2867 Steins and 41 Lutetia.

During its second flyby, it was imaged by the Catalina Sky Survey. Later “discovered”, it was mistaken for a near Earth asteroid and designated 2007 VN84.

Comet 67P/Churyumov-Gerasimenko

Believed to originate in Kuiper Belt

A “Jupiter” comet (aphelion of 5-6AU), its orbit has been repeatedly changed by Jupiter to its present form.

A Dusty comet, dust to gas emission ratio is about 2:1

Observed on 7 approaches to the Sun, 1969 (discovery), 1976, 1982, 1989, 1996, 2002, 2009

<1840, Perihelion was 4AU, too far to vaporize or form tails. It was dormant.
1840-1959 perihelion decreased to 2.77AU
1959: Jupiter altered perihelion to 1.29AU

Orbit now takes 6.55 years, from 1.24 to 5.68AU

There are no rocks on a comet, only undifferentiated materials and ice.

Comets can come from the Kuiper belt or the Oort cloud.

Interesting Stuff About 67P

The surface is very tough. Philae's MUPUS probe failed to penetrate the surface, which makes it tougher than acrylic.

Underneath the tough outer layer, there's a bouncy layer that's not very dense.

The overall density of 67P is about 0.4 g/cm (40% of the density of water.)

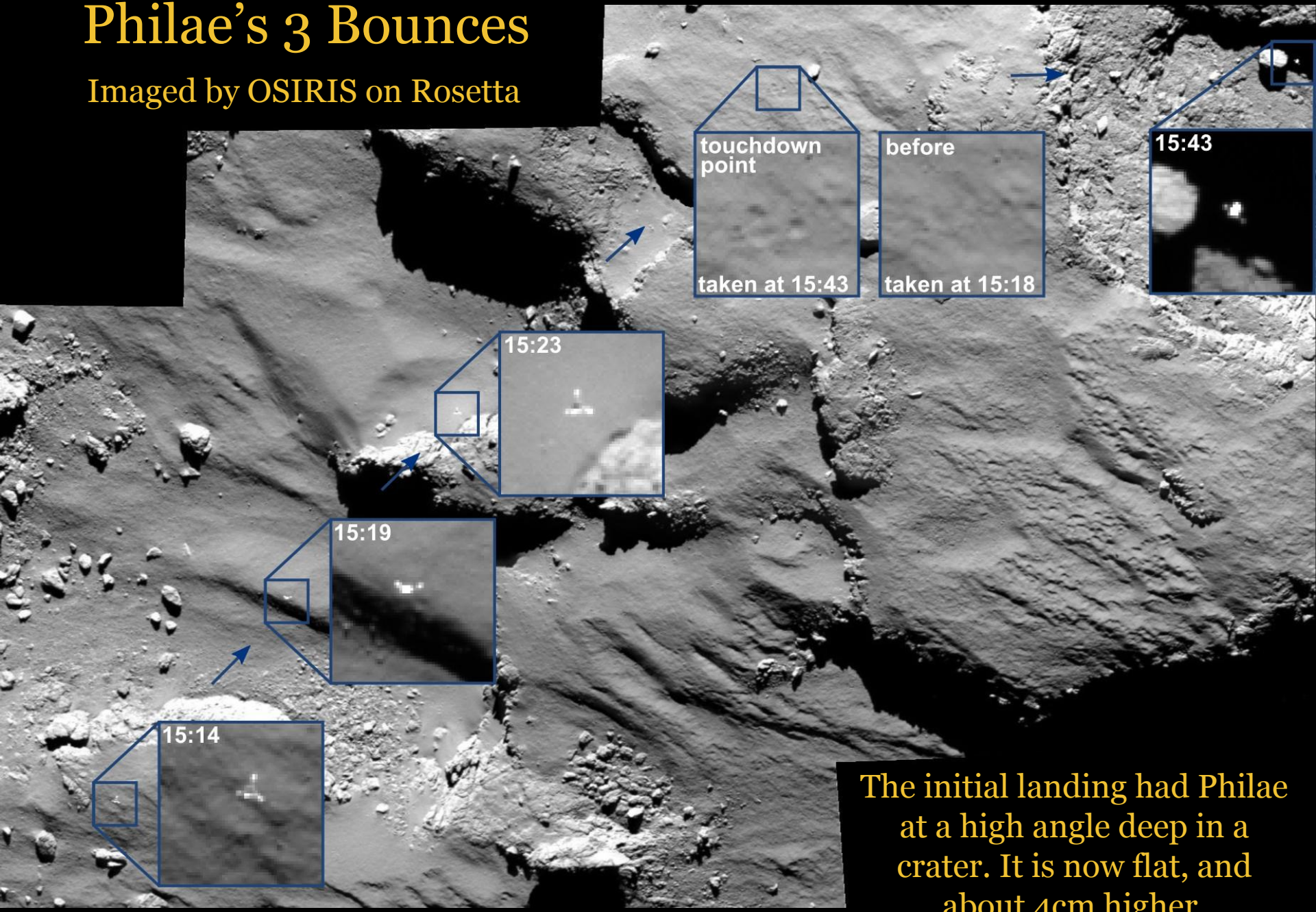
Philae is about the size of a refrigerator, but weighs about 1 gram on 67P.

The dust it landed in is about -153 to -163 degrees C (LN2 boils at -196 degrees.)

A number of complex carbon compounds were obtained in the surface samples. Data analysis continues, but a number of rich organic compound signatures are in the data returned from the COSAC instrument.

Philae's 3 Bounces

Imaged by OSIRIS on Rosetta

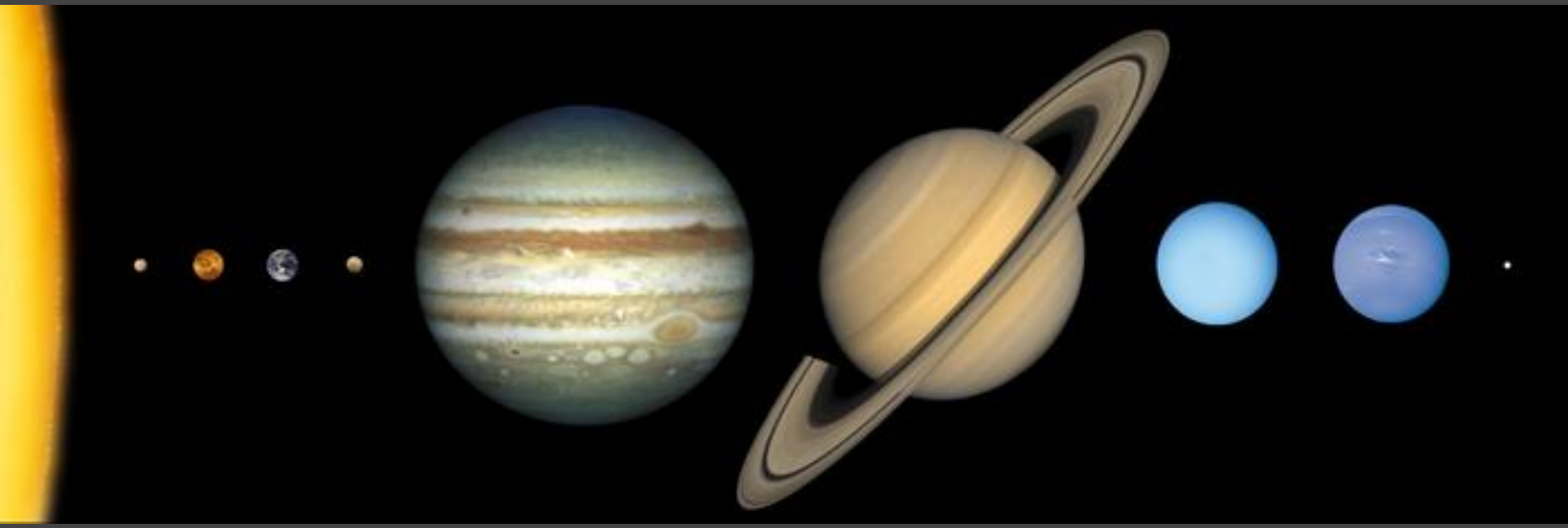


The initial landing had Philae at a high angle deep in a crater. It is now flat, and about 4cm higher.

The Solar System We "Know"

Inner Solar System

Outer Solar System



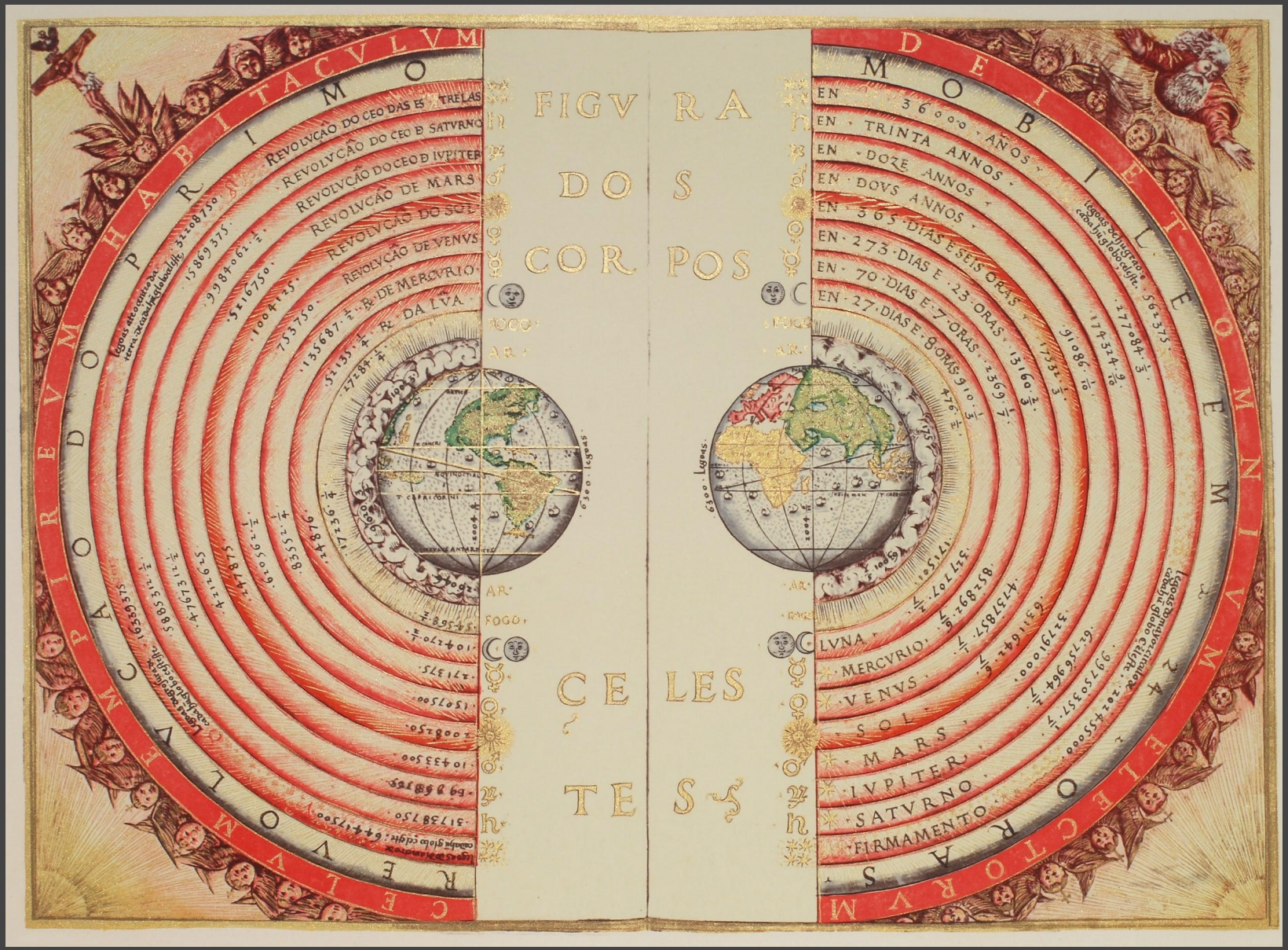
Little Rocky Planets

Giant Gas/Ice Planets

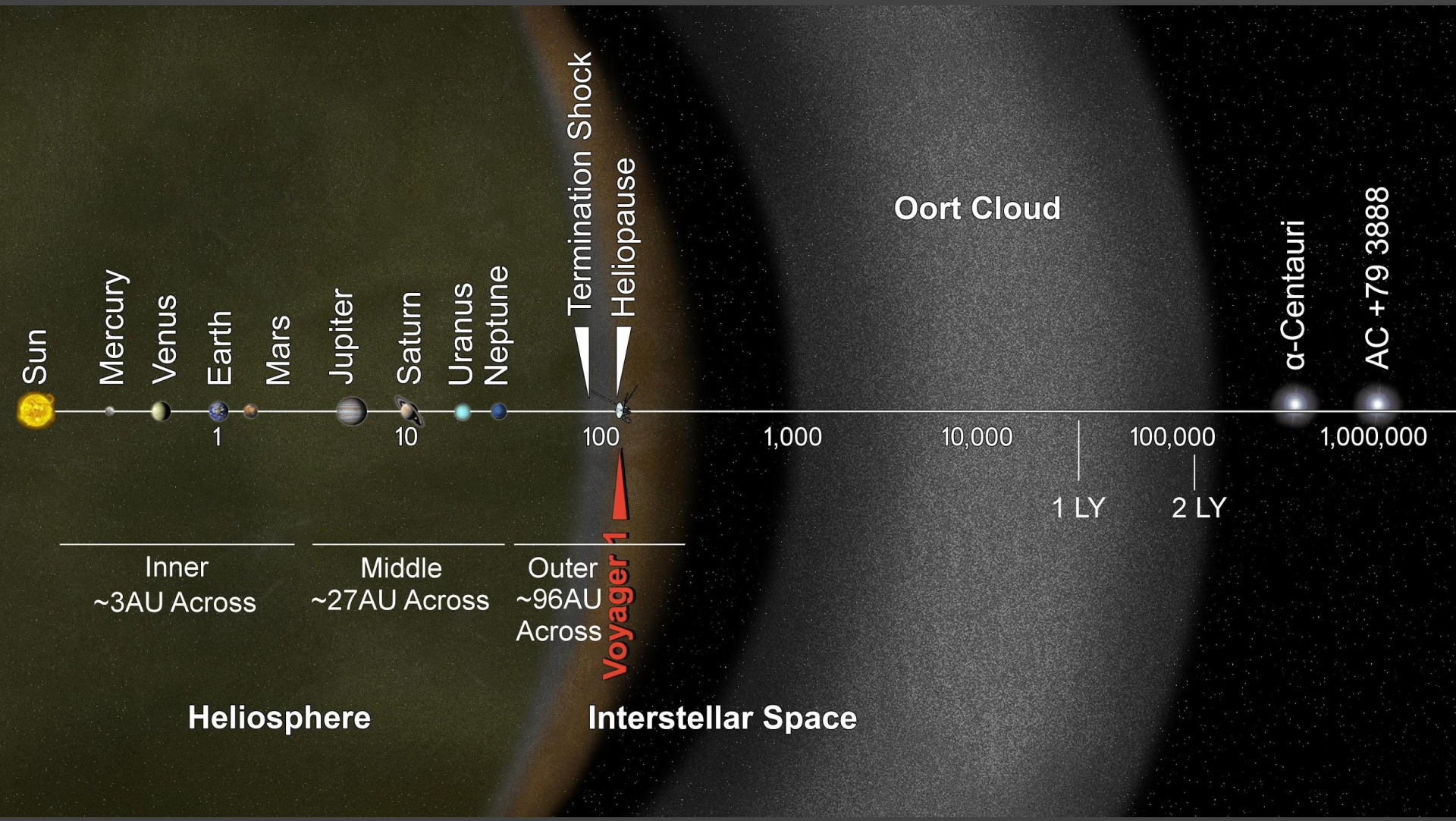
Left-Over Junk

Another Solar System Model

Which also has a misleading sense of structure.

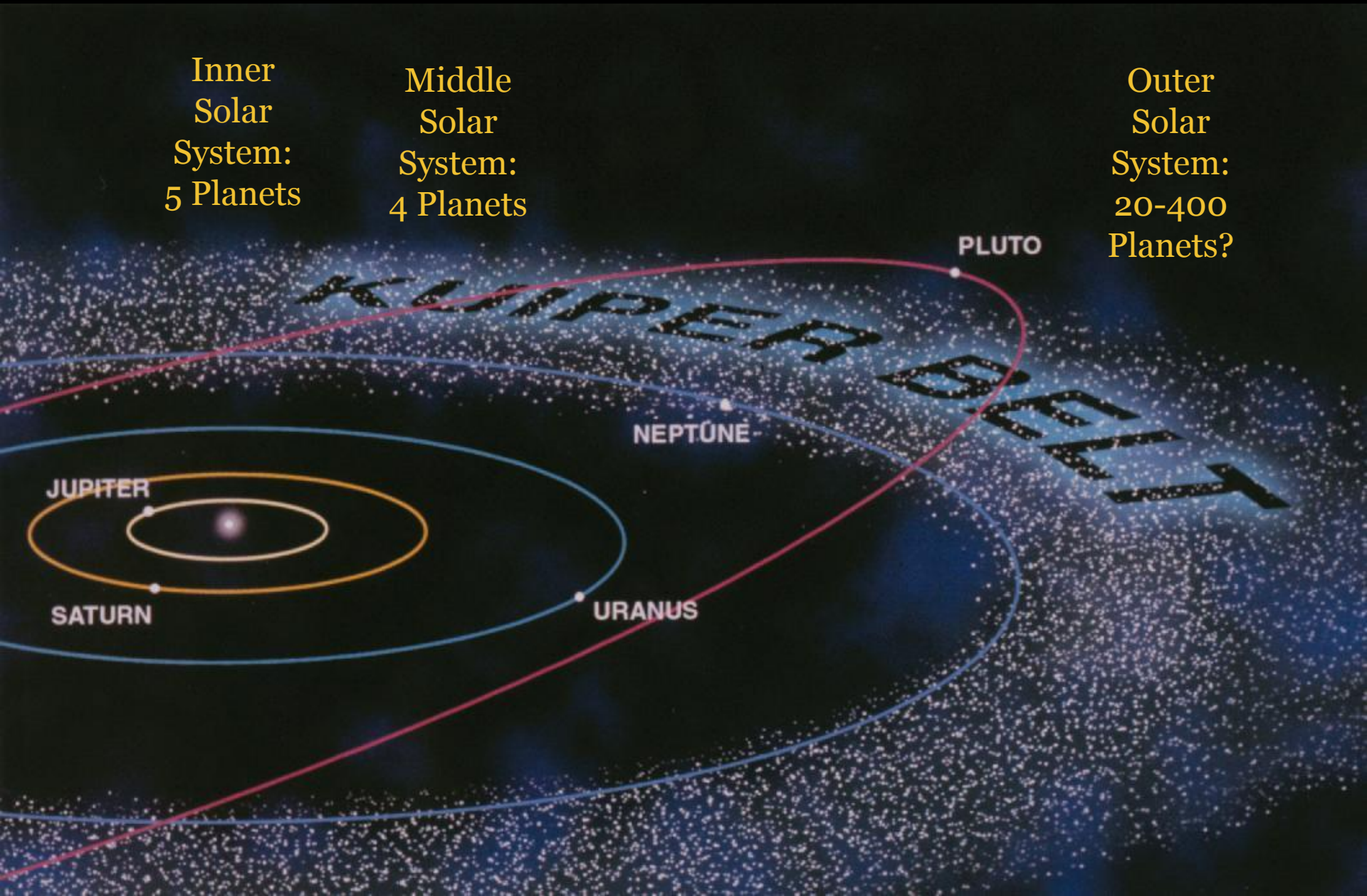


An Updated Model: Three Parts of the Solar System



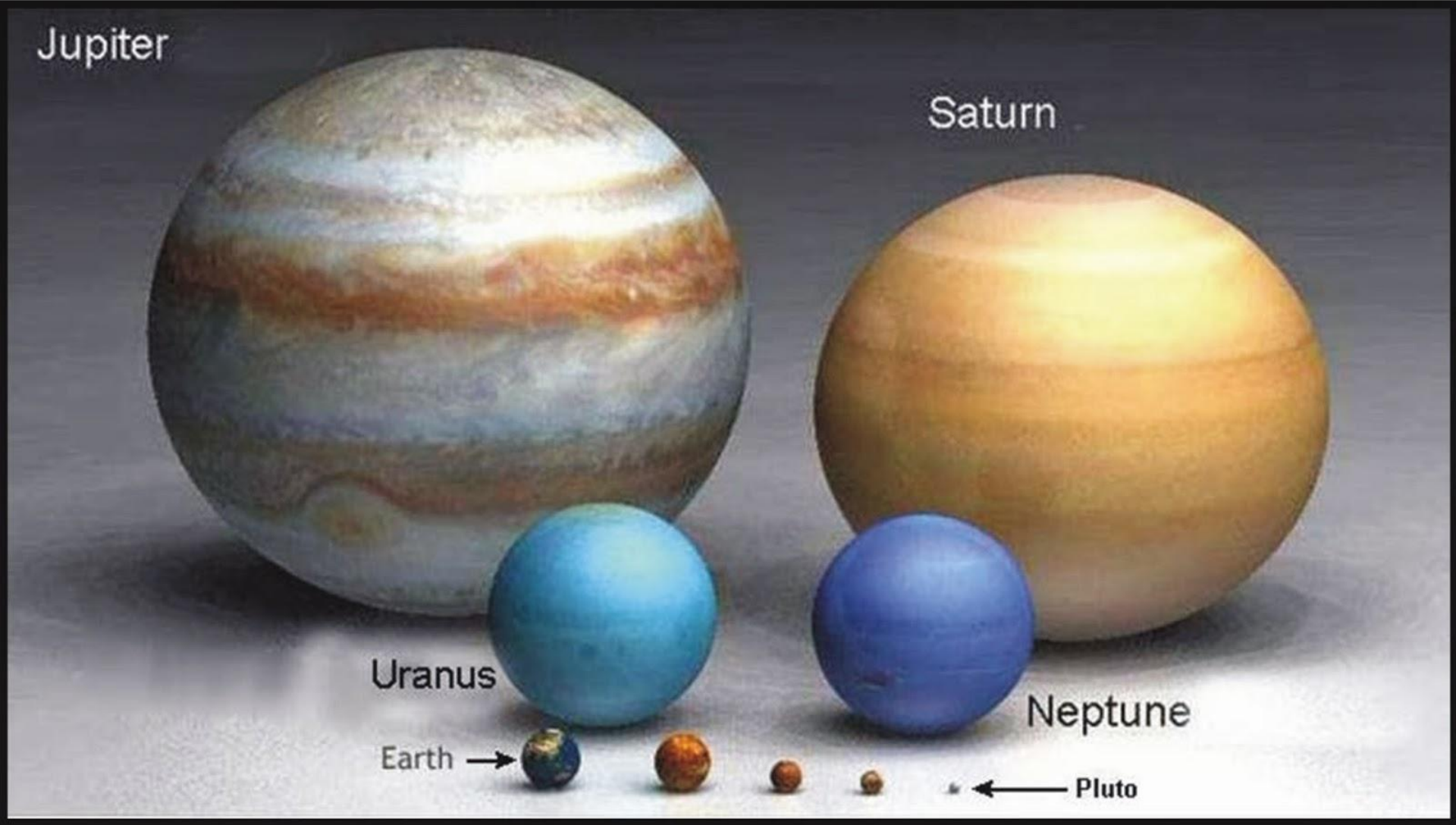
The Outer Solar System Contains More Planets
Than The Other Two Combined

The Outer Solar System is the Largest Part, And It Has the Most Planets



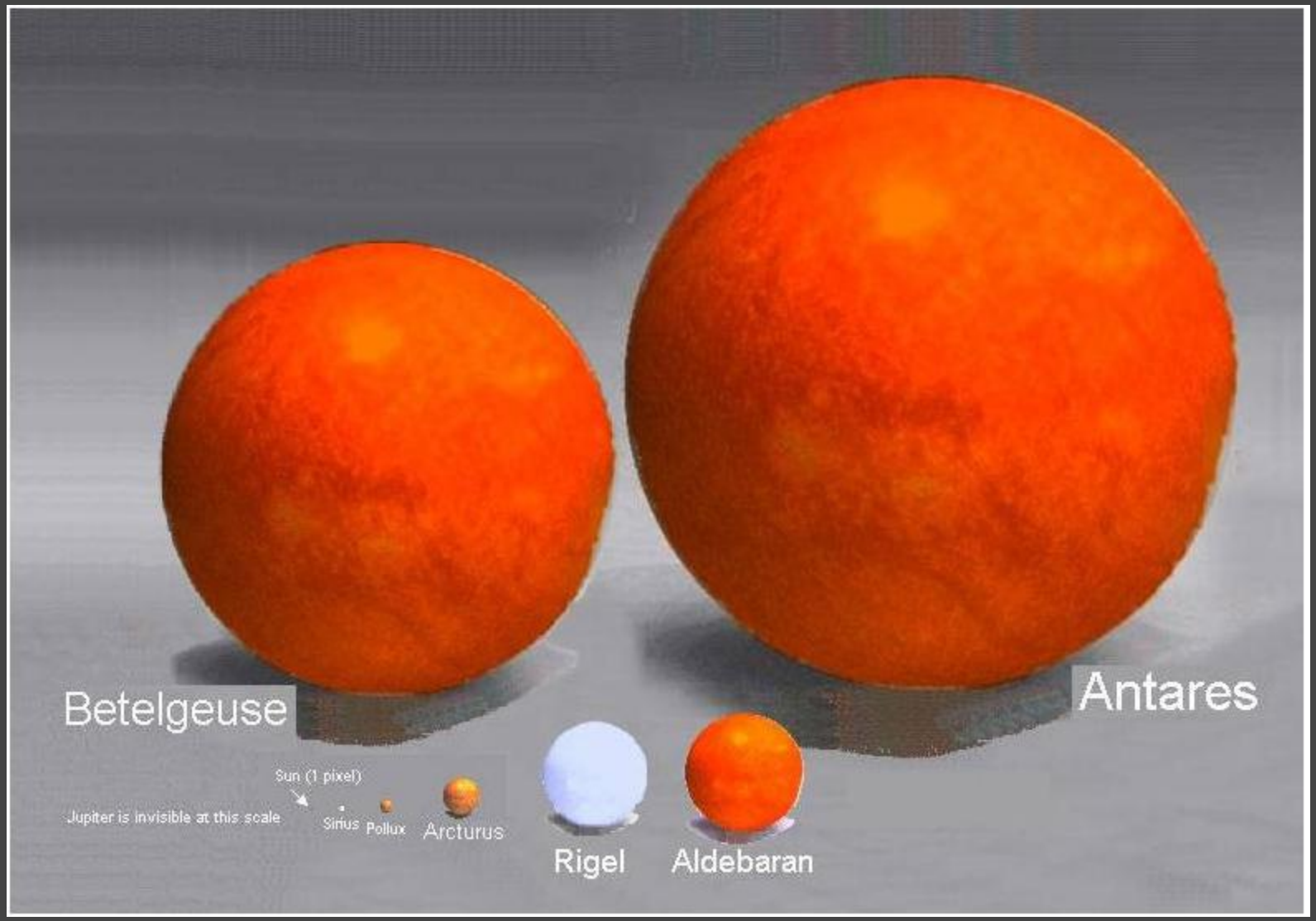
Planets Come in a Wide Range of Sizes

Accepted properties of a planet among planetary researchers (suitable for any system):
It doesn't do fusion,
it doesn't contain degenerate matter,
it's massive enough that gravity overcomes material strengths,
it's in a primary orbit around a star or orbits no star ("rogue" planets).



Just as Stars Come in All Sizes…

The difference in size between a stellar giant and the Sun (a dwarf star) is greater than the difference between a Jupiter and Pluto. Most stars are smaller than the Sun.



Pluto is Not a Comet or Asteroid

Solar System Objects by Size:

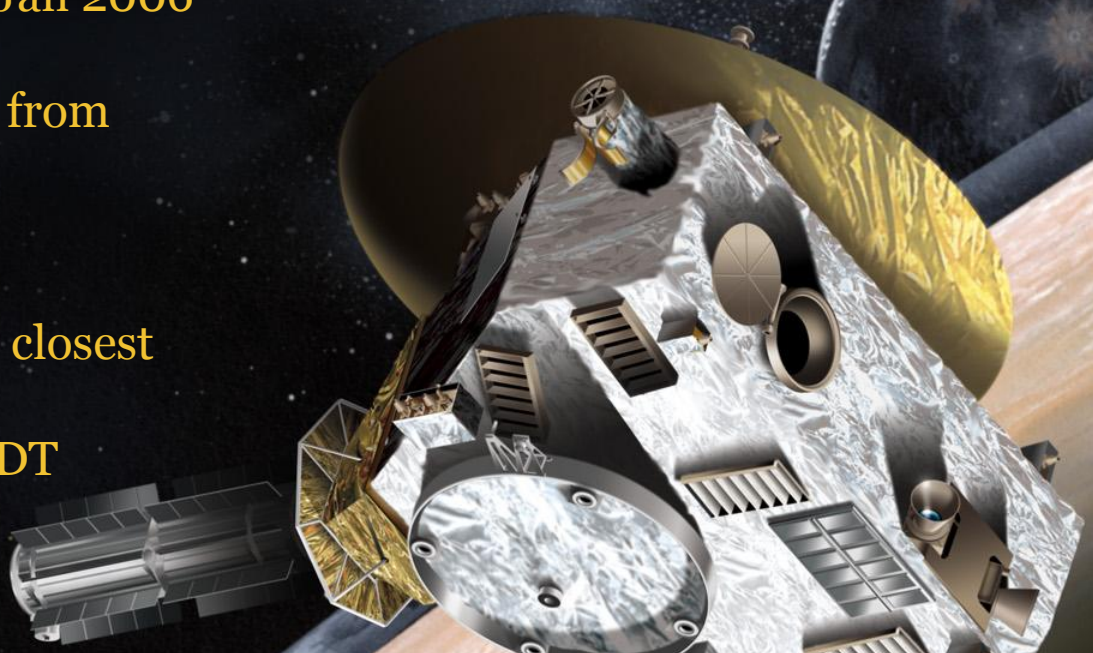
1.	Sun	17.	Pluto	33.	Ceres
2.	Jupiter	18.	Eris	34.	2002 MS4
3.	Saturn	19.	Titania	35.	Orcus
4.	Uranus	20.	Rhea	36.	Salacia
5.	Neptune	21.	Oberon	.	
6.	Earth	22.	Iapetus	.	
7.	Venus	23.	Makemake	.	
8.	Mars	24.	2007 OR10	63.	Pallas
9.	Ganymede	25.	Haumea	...	
10.	Titan	26.	Charon	65.	Vesta
11.	Mercury	27.	Umbriel		
12.	Callisto	28.	Ariel		
13.	Io	29.	Dione		
14.	Moon	30.	Quaoar		
15.	Europa	31.	Tethys		
16.	Titan	32.	Sedna		

New Horizons: First Mission to an Outer Solar System Planet

Launched 19 Jan 2006

Last wake-up from hibernation:
6 Dec 2014

Pluto-Charon closest approach:
5:49:59 am PDT
14 July, 2015



Distance on 3 Dec 2015:

New Horizons: Why Study Pluto?

Pluto is the only place in the solar system where we can observe the hydrodynamic escape of a primordial planetary atmosphere like that of the early Earth.

The origin of Charon and Pluto's other moons is likely the same as that of the Moon: the result of an impact. By studying the Pluto-Charon system we will understand more about how our own Moon was formed.

Pluto is still in its "summer" phase, with an active atmosphere, which will not occur for another 230 years.

Pluto is the first among many newly discovered planets in the outer solar system to be studied.

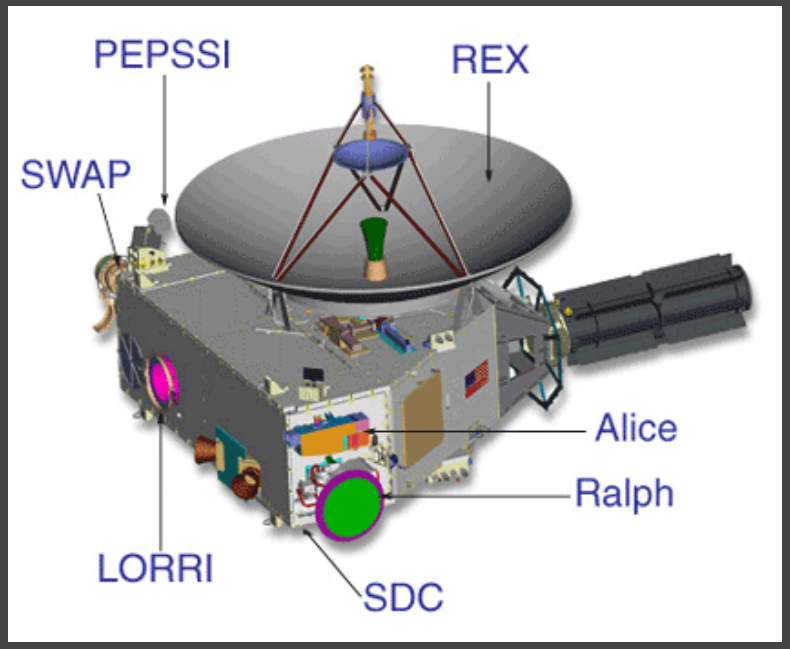
Opportunity to study a representative of early large-planet formation & study its composition, including organics, nitriles, etc.

The New Horizons Mission was chosen as the #1 priority by the 2003-2013 Planetary Science Decadal Survey

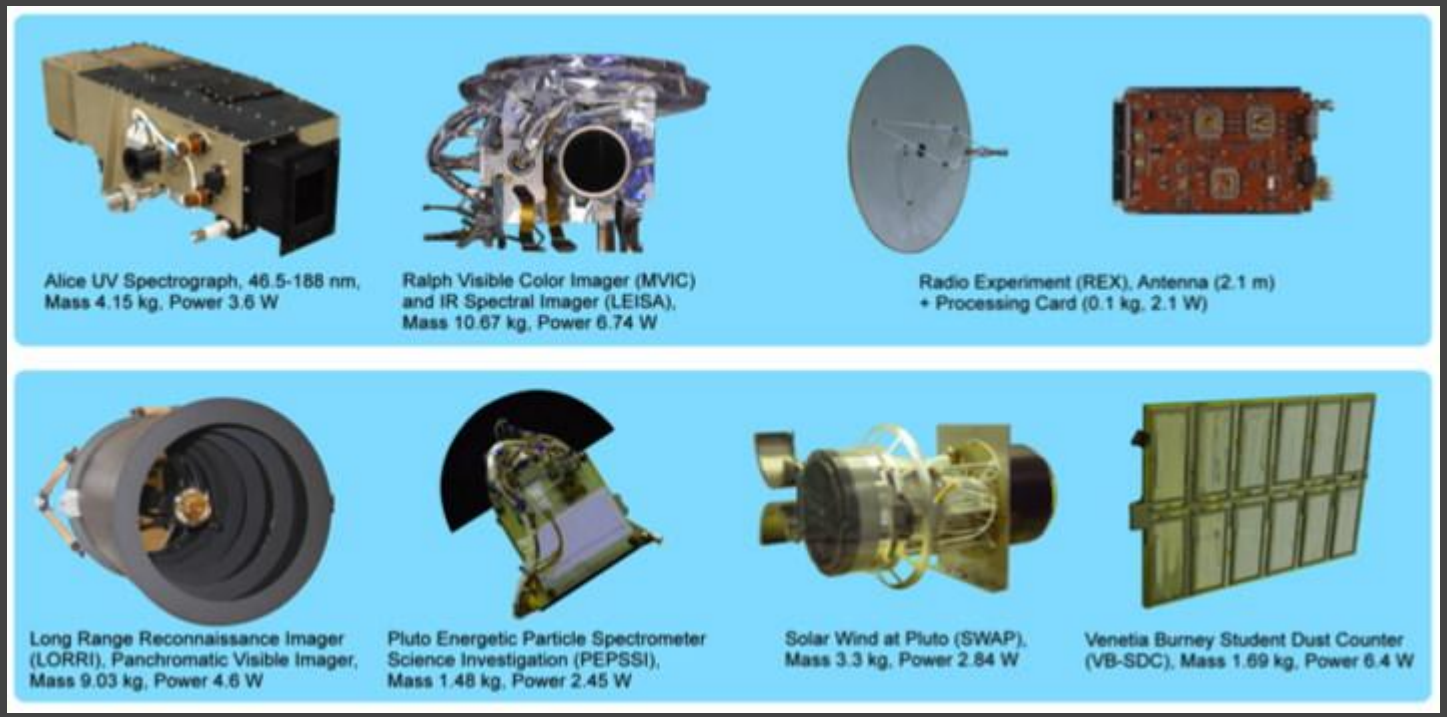
Typical Anatomy of a Space Mission Team

Proposal Phase: ~40-60, ~6-10 core
Engineering Phase: ~2500-4000
Flight Checkout: ~120-200
Cruise: ~5-12
Encounter: ~400-600
Post-Encounter Data Analysis: ~100-200

New Horizons Core Mission Team: 2004



The Instruments of New Horizons



New Horizons Imagery Detail

Summary of Best Resolution of Pluto and its 5 moons

Target	Panchromatic	Color	Infrared
Pluto	0.46 km/pixel hemispheric 0.09 km/pixel regional *Group 1: 0.5 km/pixel*	0.64 km/pixel *Group 1: 5 km/pix*	6.0 km/pixel hemispheric 2.7 km/pixel local *Group 1: 10 km/pix*
Charon	0.61 km/pixel hemispheric 0.15 km/pixel regional *Group 1: 0.5 km/pixel*	1.40 km/pixel *Group 1: 5 km/pix*	8.4 km/pixel hemispheric 4.7 km/pixel local *Group 1: 10 km/pix*
Nix	0.46 km/pixel 0.29 km/pixel possible	1.98 km/pixel	3.6 km/pixel
Hydra	1.14 km/pixel	4.6 km/pixel	14.6 km/pixel
Styx (P4)	3.2 km/pix 2.0 km/pix possible	(44 km/pix) 8 km/pix possible	(24 km/pix)
Keberos (P5)	3.2 km/pix	8 km/pix	(200 km/pix)

Resolutions in parentheses indicate unresolved targets.

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Best: About 90m/pixel on Pluto

What Will We See?

A Complex and Possibly Colorful Surface

Nitrogen Volcanos

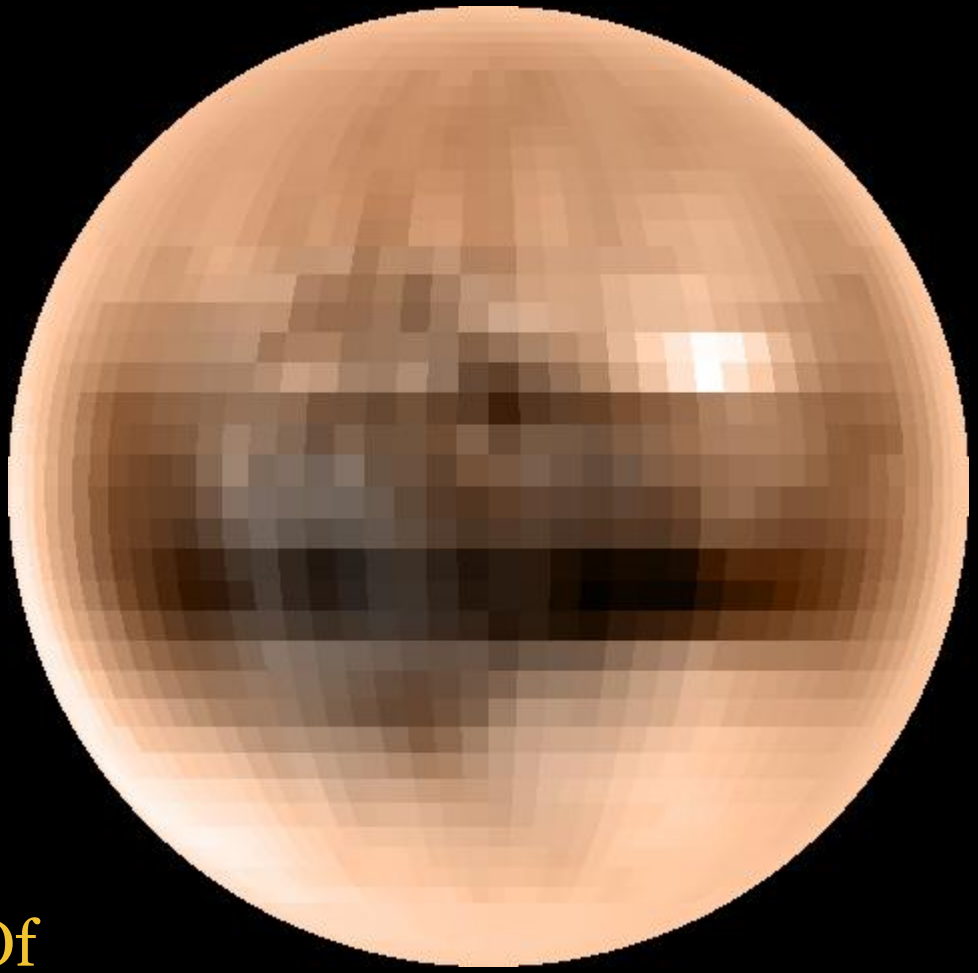
Active Geology

Polar Caps

More Satellites?

Organics?

Things We Never Thought Of



Extras:

Clyde Tombaugh's ashes ========>

"Send Your Name to Pluto" CD-ROM
(434,738 names)

New Horizons project personnel photos on CD-ROM.

Florida and Maryland State Quarters

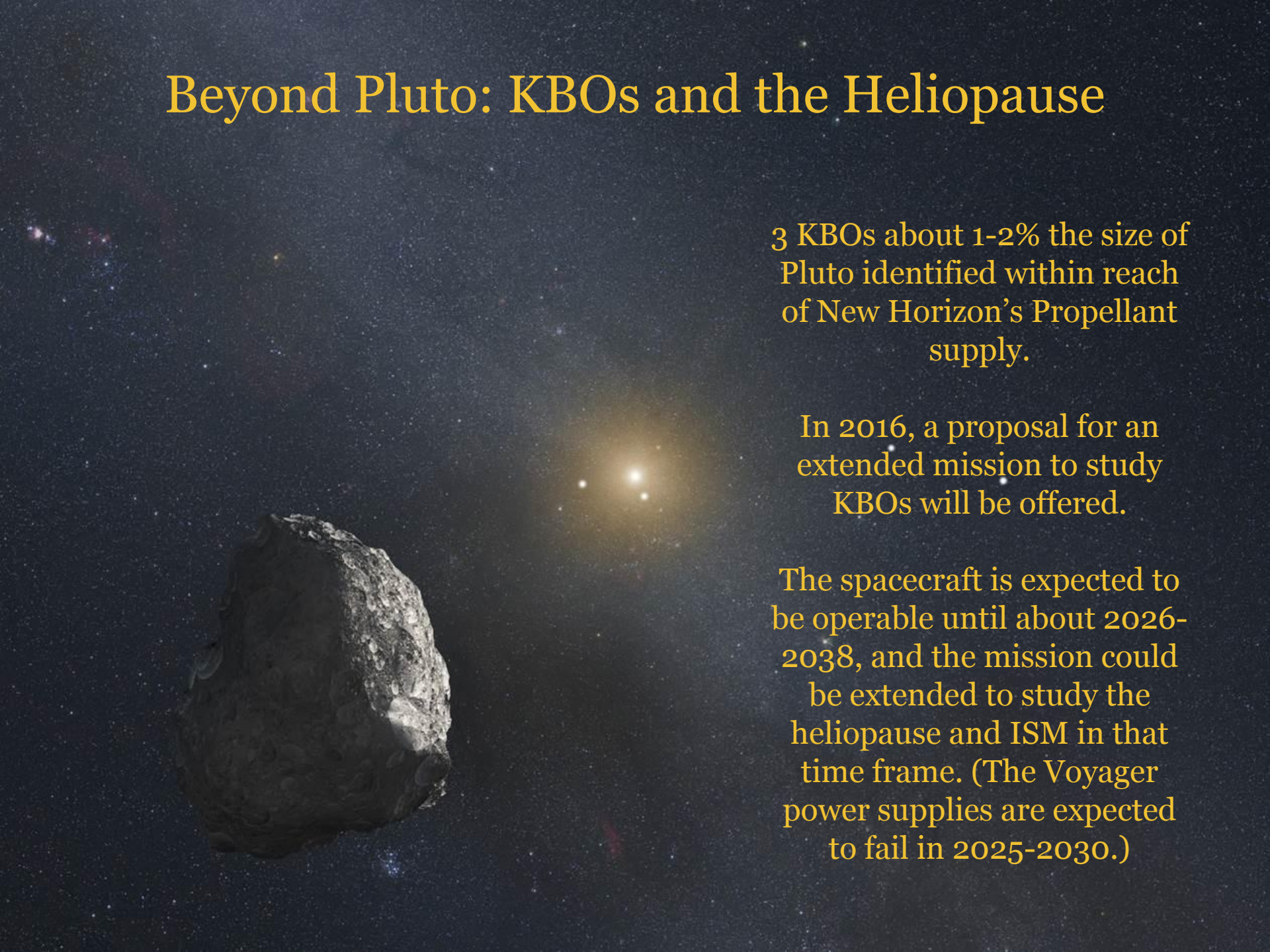
2 U.S. Flags

A Piece of SpaceShip One

1991 U.S. Pluto Stamp

Total: 9 Objects

Beyond Pluto: KBOs and the Heliopause



3 KBOs about 1-2% the size of Pluto identified within reach of New Horizon's Propellant supply.

In 2016, a proposal for an extended mission to study KBOs will be offered.

The spacecraft is expected to be operable until about 2026-2038, and the mission could be extended to study the heliopause and ISM in that time frame. (The Voyager power supplies are expected to fail in 2025-2030.)

2015: The Year the Solar System Grew

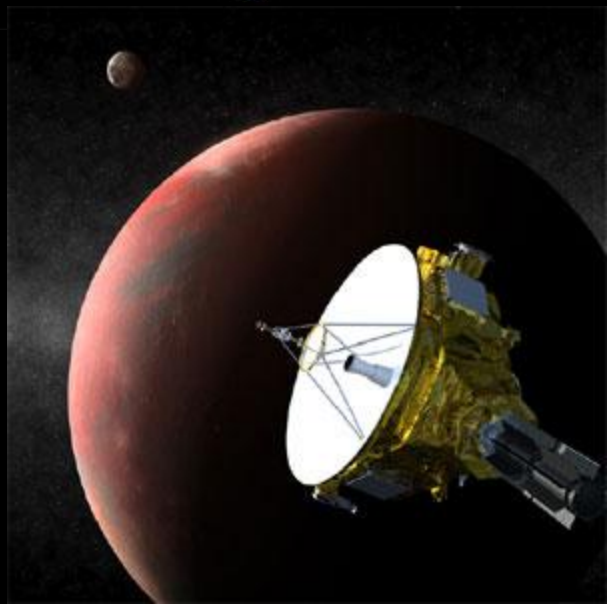
The events of 2015 will bring the true size and nature of the solar system into the public consciousness.

Rosetta will be returning continuous data from an outer solar system object that has recently entered the inner solar system.

It will follow it through perihelion on Aug 13, and fly with it as it goes out to ~6AU. Through it, we will learn much about the composition and formation of comets, and hopefully the origin of 67P (either Kuiper belt or Oort cloud.)

New Horizons will study the Pluto system for 9 months, with about 2 months of close observation peaking at 14 July. Data will flow in for another 2 months afterward.

The coordinated study of data from these two probes will bring a completely new understanding of the significance of the outer solar system to the public.



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