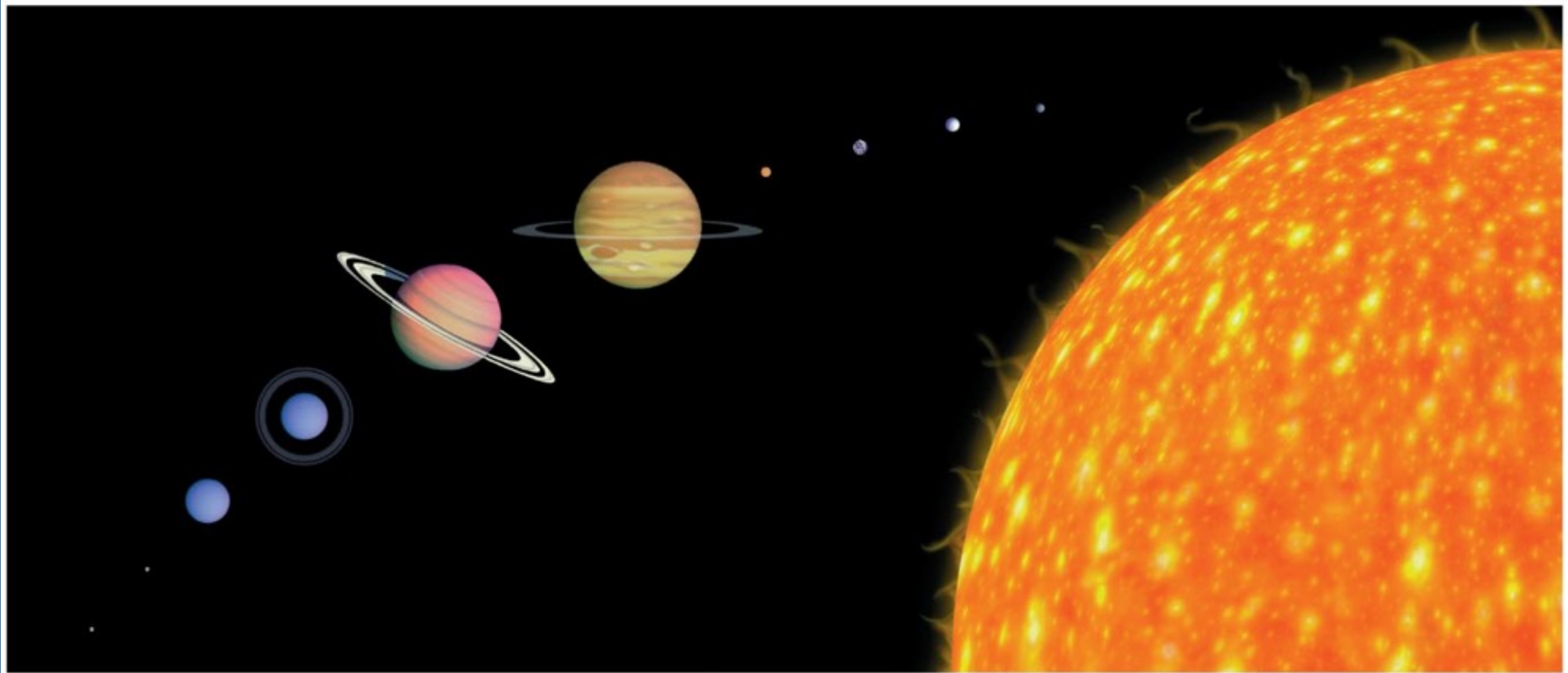


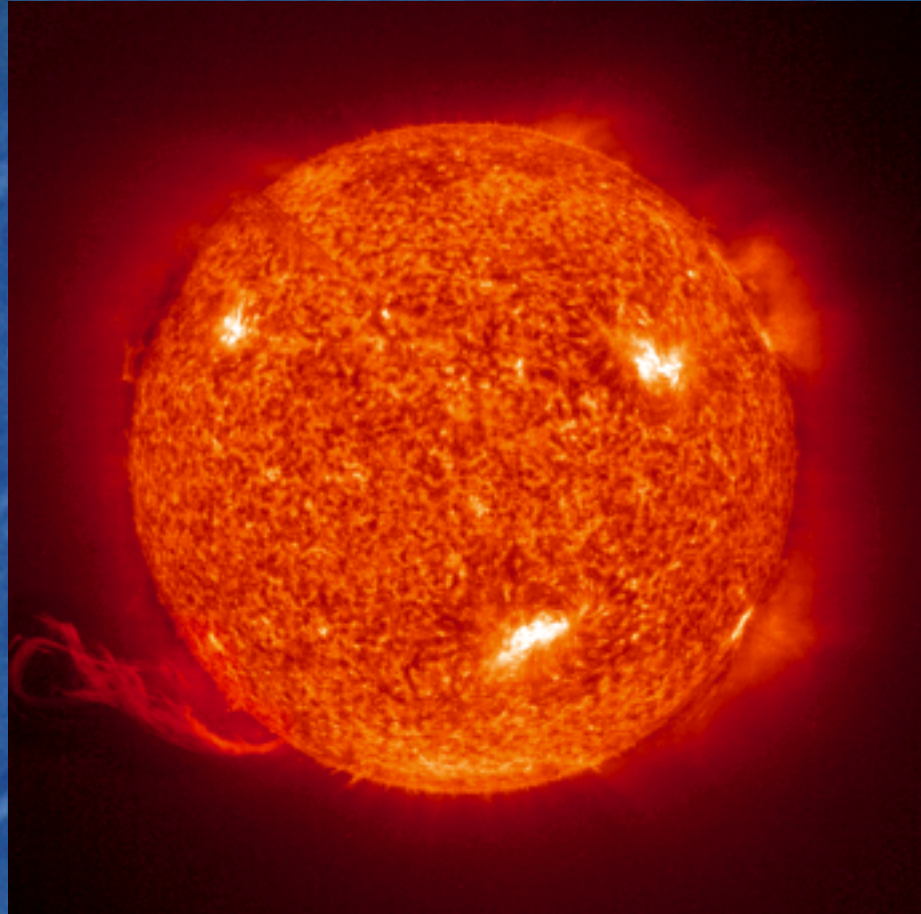
The Solar System



The Solar System

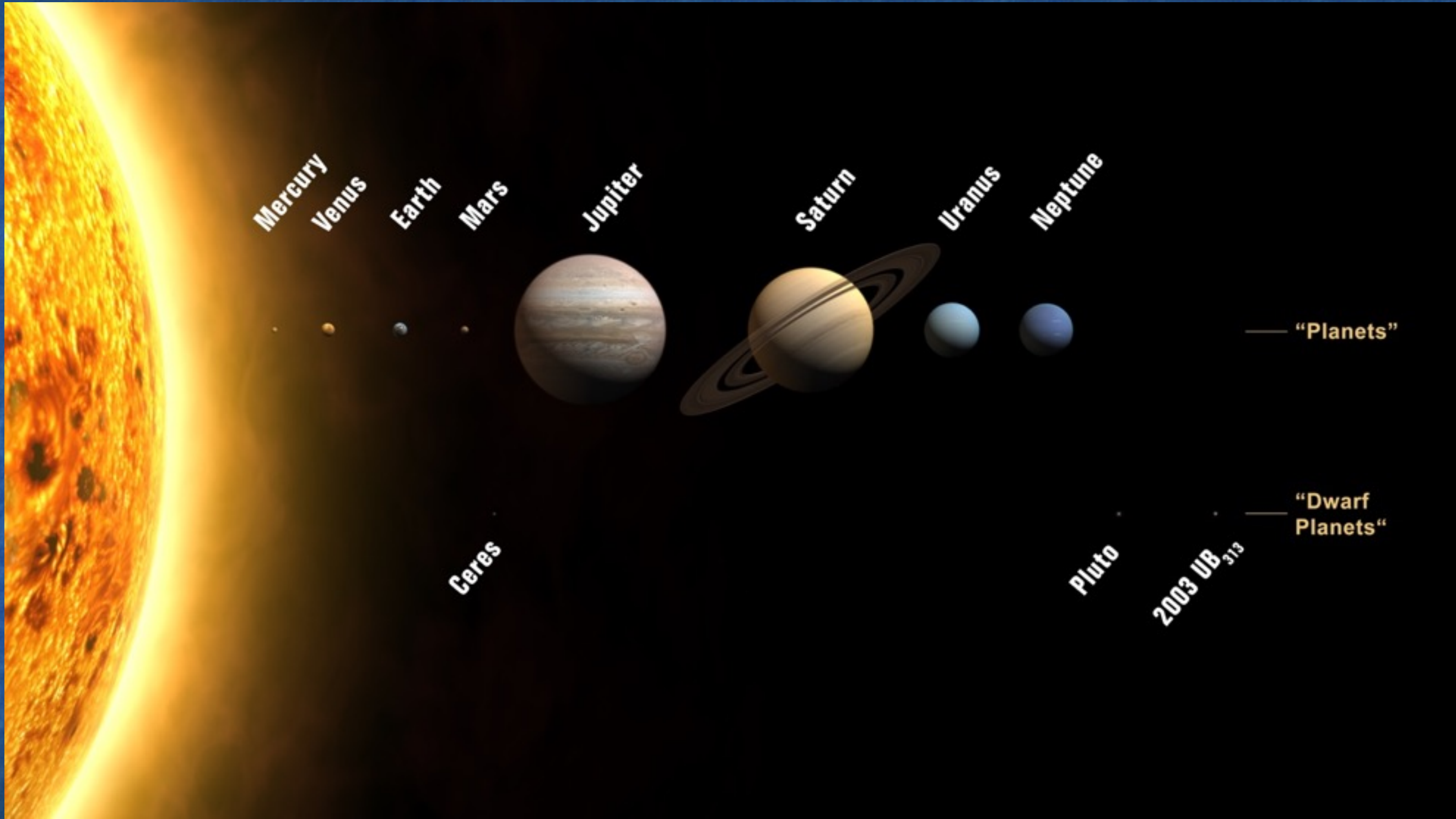
- The Solar System as a life bearing habitat.
- The Sun
- The Terrestrial worlds
- The Jovian worlds
- The Grand Tour: Voyager and Pioneer
- The outer solar system: TNOs, the Kuiper Belt, the Oort Cloud
- The Habitable Zone
- The creation of the Solar System

The Sun



- The Sun is a star at the centre of the Solar System.
- The Sun contains 99.86% of the mass of the Solar System
- The Sun is composed of hydrogen (74%), helium (25%) and trace elements.
- The surface of the Sun is called the photosphere.
- The Sun is powered by nuclear fusion reactions occurring in its core (hydrogen fuses into helium).
- In addition to light, the Sun emits a stream of energetic particles into space – the solar wind.

The Planets



Distances to the planets

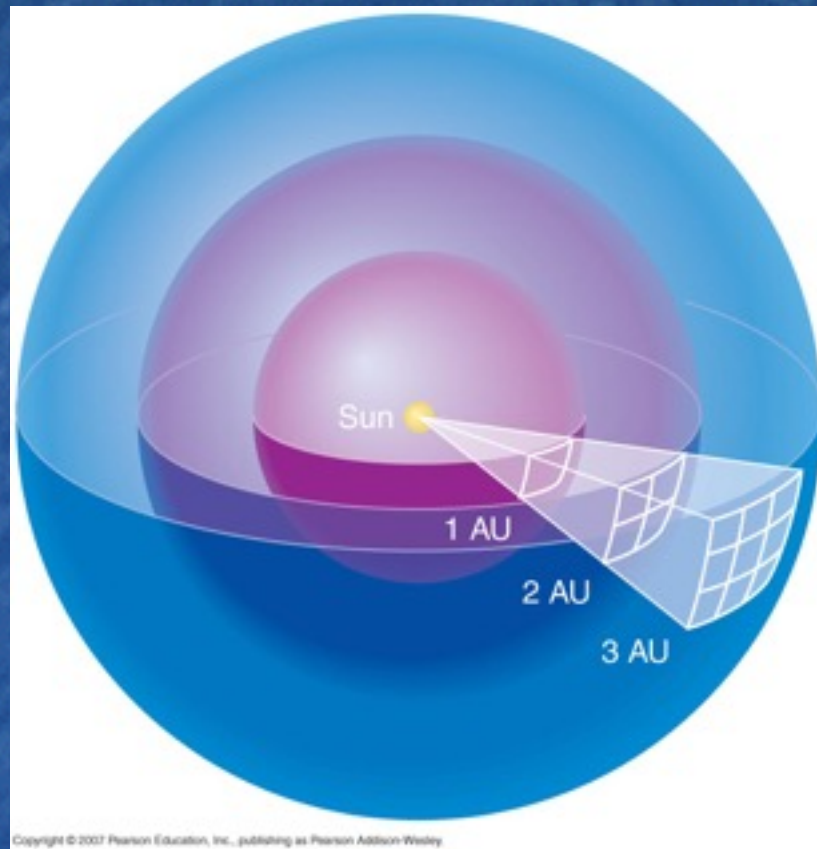
Planet	Mean distance (AU)	Light travel time
Mercury	0.39	3 minutes
Venus	0.72	6 minutes
Earth	1	8 minutes
Mars	1.52	12 minutes
Jupiter	5.2	42 minutes
Saturn	9.54	1 hour 16 minutes
Uranus	19.14	2 hours 33 minutes
Neptune	30.06	4 hours
Pluto	39.53	5 hours 20 minutes

The physical distance between the Earth and Sun is 148 million km.

This distance is defined as 1 astronomical unit (AU).



Solar energy received by the planets

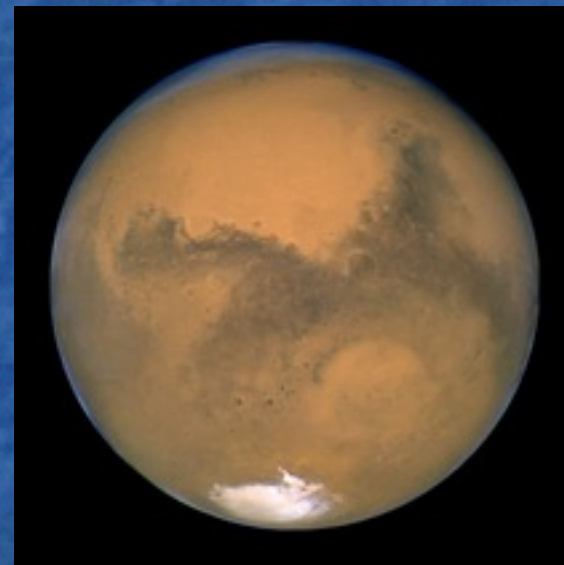
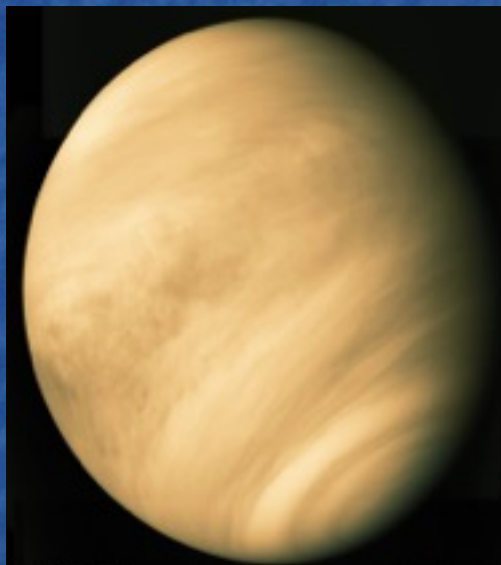
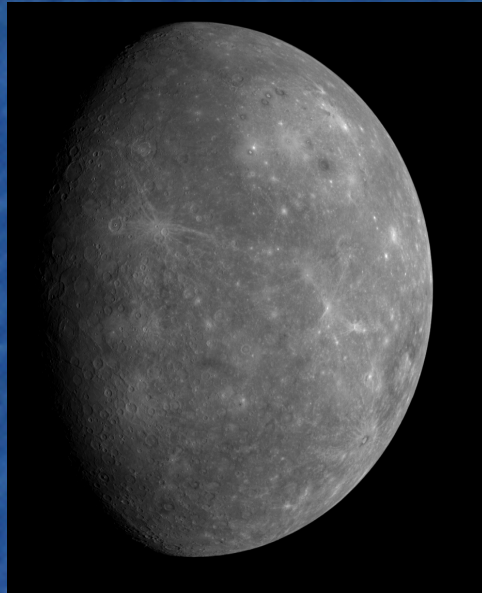


The Earth receives 1378 W of solar energy per square metre. This energy powers our weather and almost all life on Earth.

Planet	Relative energy flux
Mercury	6.6
Venus	2
Earth	1
Mars	0.44
Jupiter	0.036
Saturn	0.01
Uranus	0.003
Neptune	0.001
Pluto	0.0006



The Terrestrial Worlds



- The rocky planets show a number of similar characteristics: they are all approximately Earth-sized, they are made of dense, rocky material (silicates) and they possess few if any moons.
- They differ in terms of their atmospheres, surface temperatures, magnetic fields and geology.

The Terrestrial Worlds

Planet	Atmosphere	Magnetic field	Surface temperature	Geology
Mercury	X	X	650K (100K)	X
Venus	✓	X	737K	✓
Earth	✓	✓	293K	✓
Mars	X	X	210K	?

The Jovian Worlds

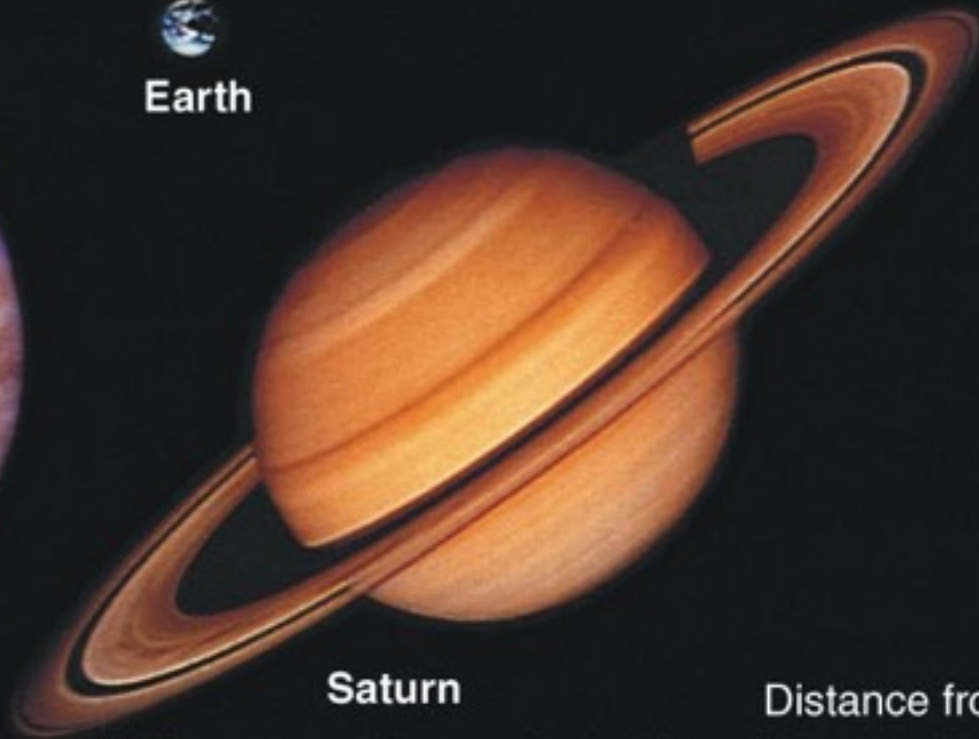


Earth



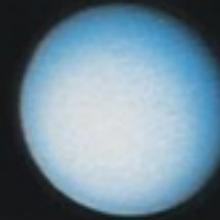
Jupiter

Distance from Sun = 5.20 AU
Mass = $318 M_{\text{Earth}}$
Radius = $11.19 R_{\text{Earth}}$
Density = 1.33 g/cm^3
Composition: mostly H, He



Saturn

Distance from Sun = 9.54 AU
Mass = $95 M_{\text{Earth}}$
Radius = $9.46 R_{\text{Earth}}$
Density = 0.71 g/cm^3
Composition: mostly H, He



Uranus

Distance from Sun = 19.2 AU
Mass = $14 M_{\text{Earth}}$
Radius = $3.98 R_{\text{Earth}}$
Density = 1.24 g/cm^3
Composition: H compounds,
rock, H and He

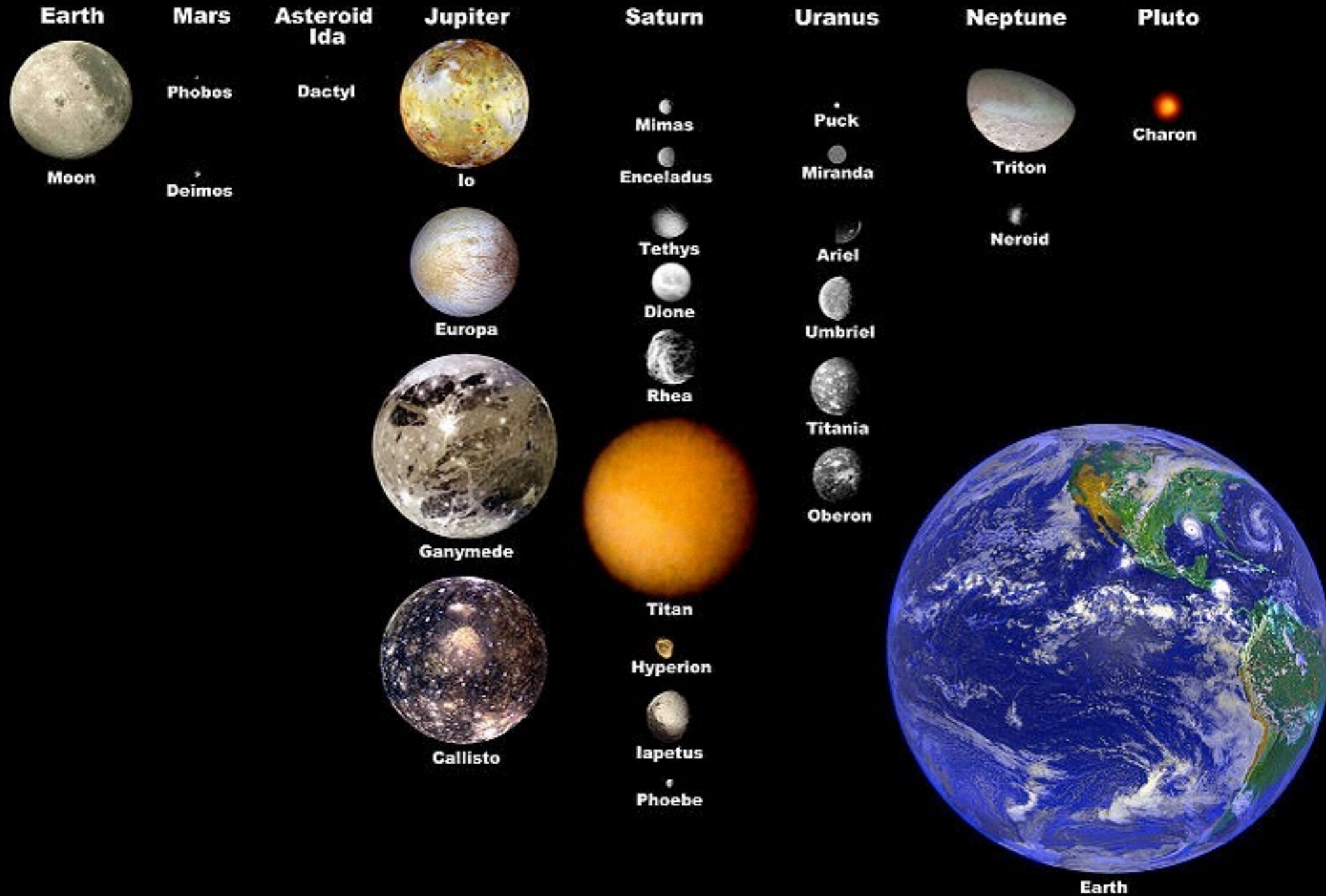


Neptune

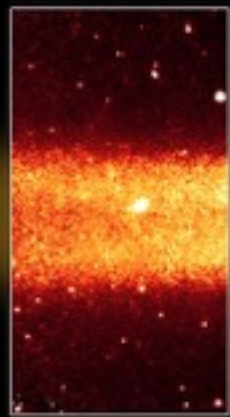
Distance from Sun = 30.1 AU
Mass = $17 M_{\text{Earth}}$
Radius = $3.81 R_{\text{Earth}}$
Density = 1.67 g/cm^3
Composition: H compounds,
rock, H and He

The Jovian Moons

Moons of the Solar System Scaled to Earth's Moon



Giant dust ring around Saturn

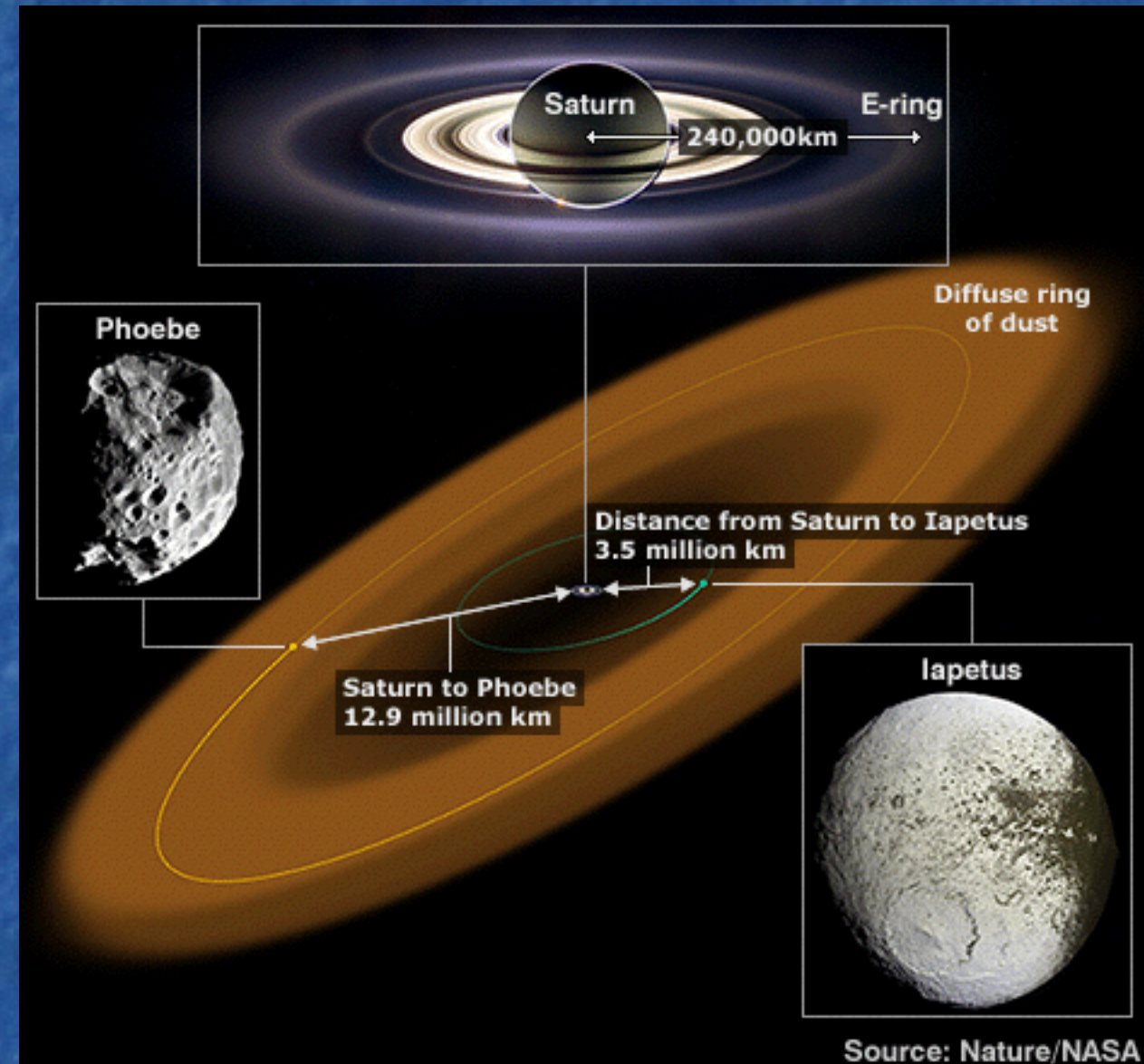


Dust Ring

Infrared View of Saturn's Largest Ring
NASA / JPL-Caltech / A. Verbiscer [Univ. of Virginia]



Spitzer Space Telescope • MIPS
ssc2009-19a

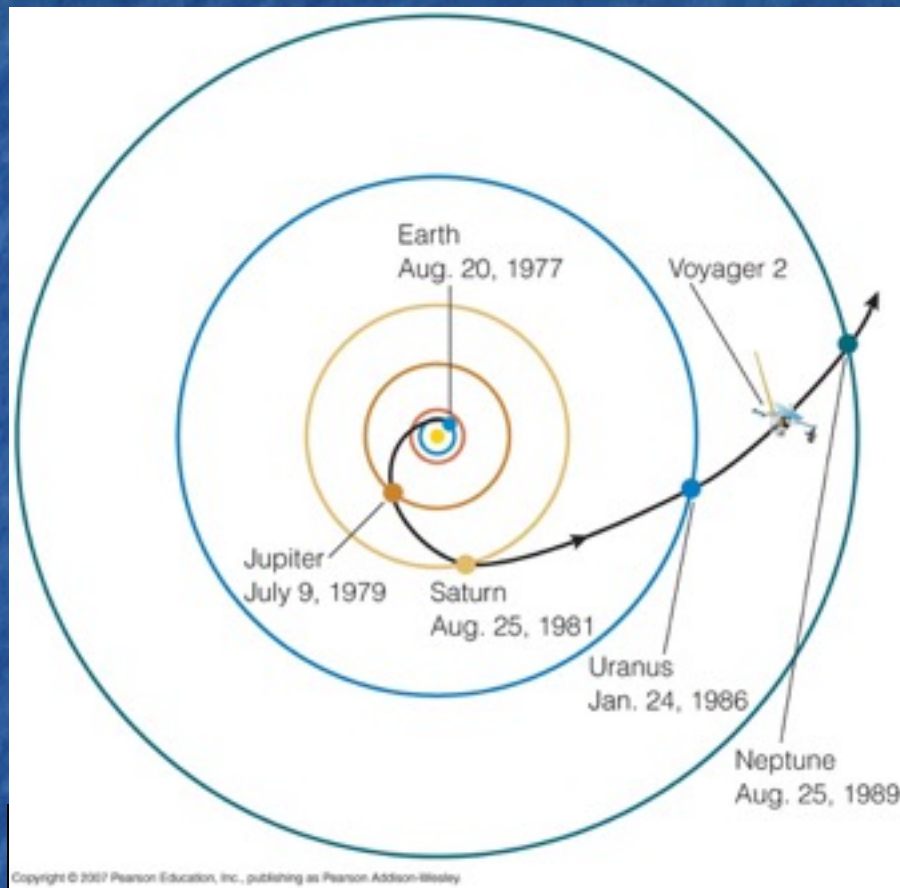


Source: Nature/NASA

Enceladus continually replenishes the E-ring



Voyager 2: The Grand Tour



- Voyager 2 is a NASA flyby mission launched in 1977.
- Using a favourable configuration of the Jovian planets it was designed to “slingshot” around each world to perform a Grand Tour of the outer Solar System.
- Voyager 2 visited Jupiter (1979), Saturn (1981), Uranus (1986) and Neptune (1989).
- Voyager 2 carried high resolution cameras that provided stunning close-ups of the Jovian worlds.
- Voyager 2 is now travelling past the very edge of the Solar System to interstellar space.





A ONCE IN A LIFETIME GETAWAY

THE GRAND TOUR

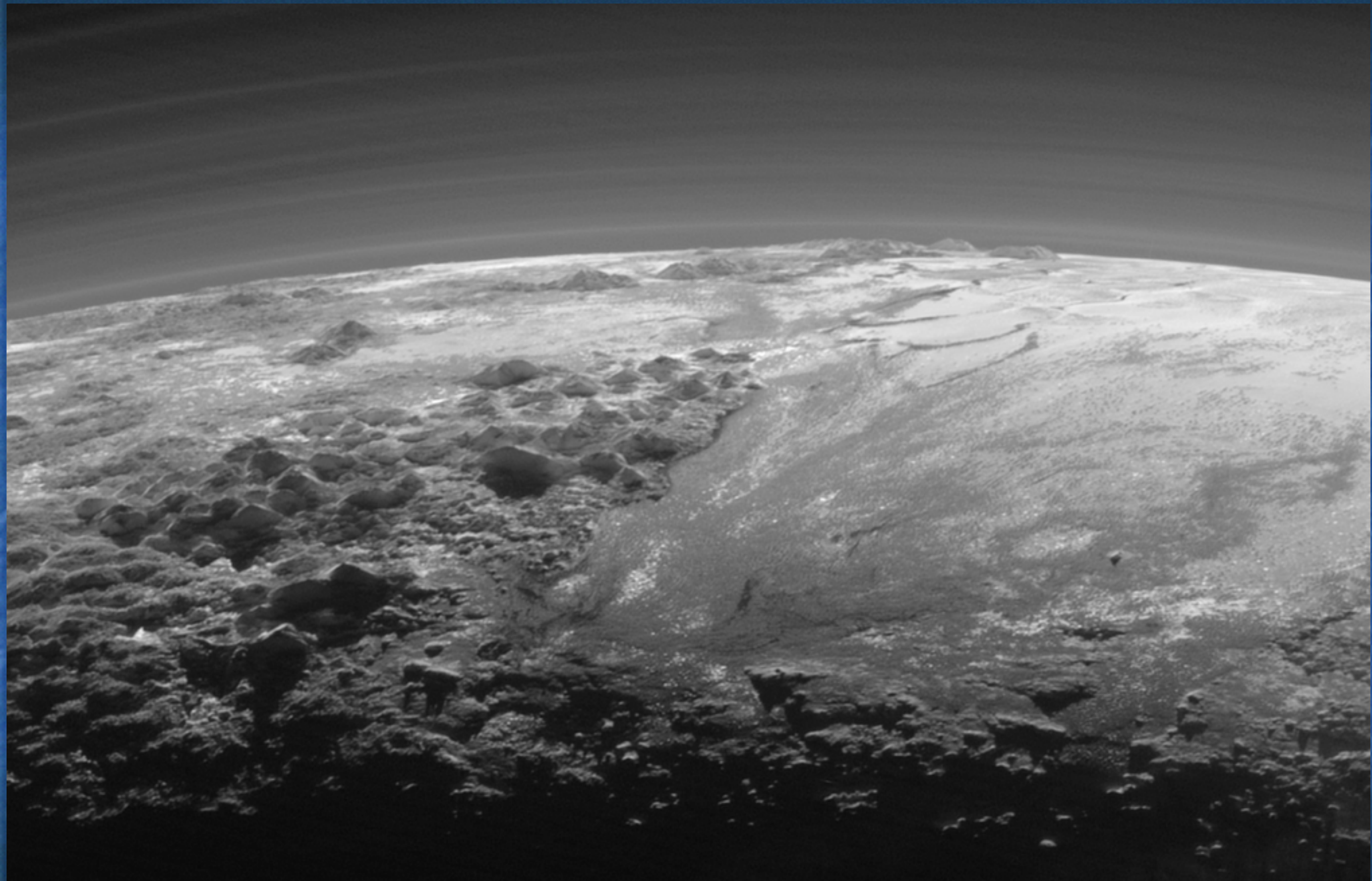
JUPITER / SATURN / URANUS / NEPTUNE
EXPERIENCE THE CHARM OF GRAVITY ASSISTS

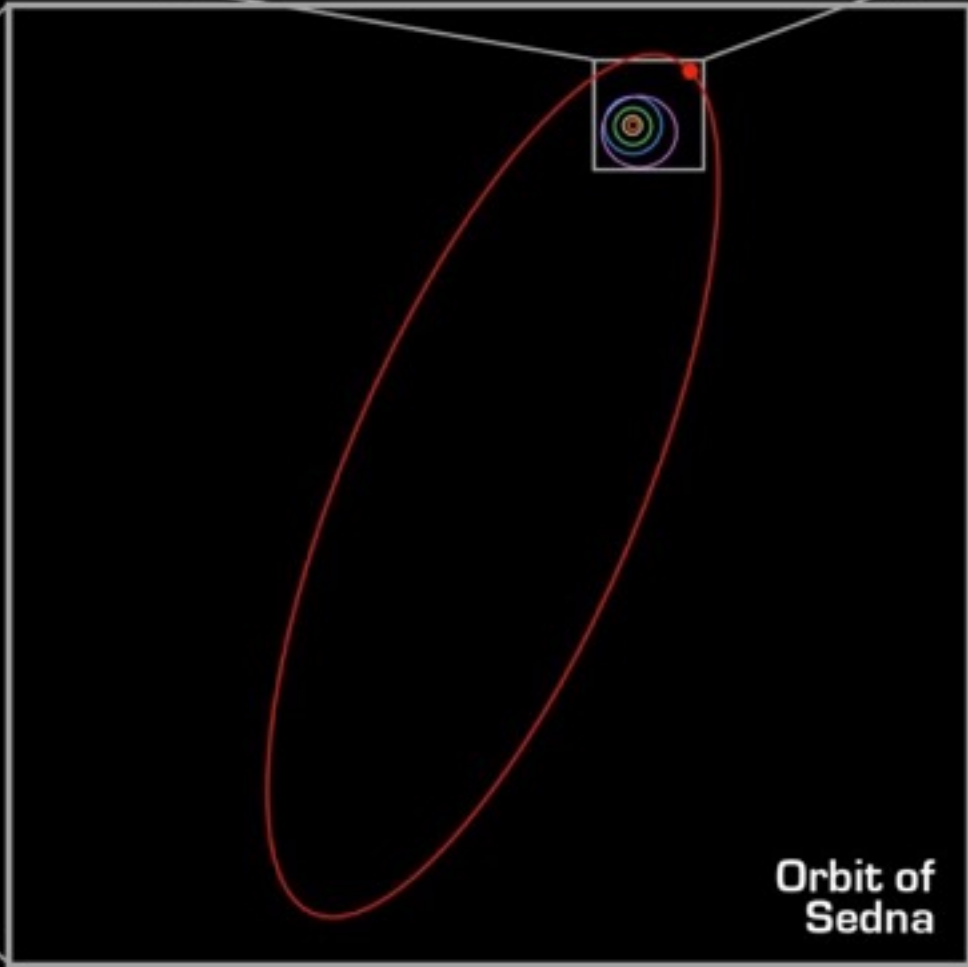
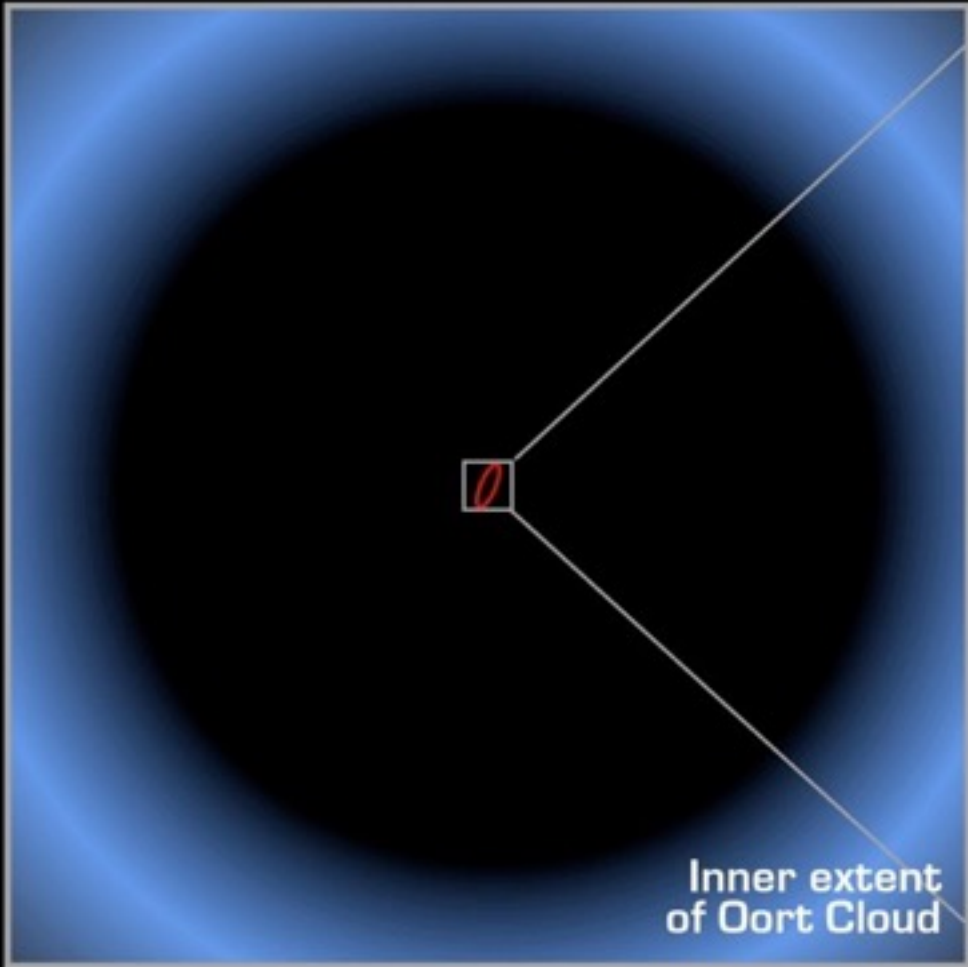
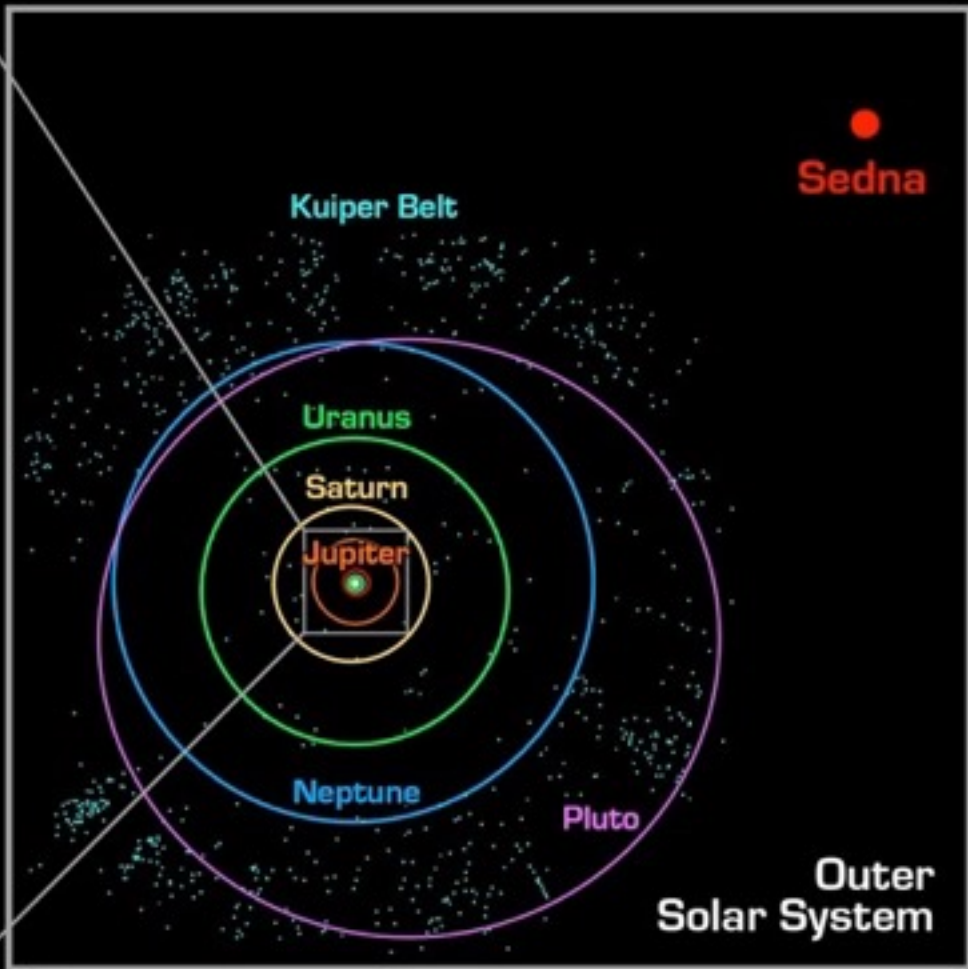
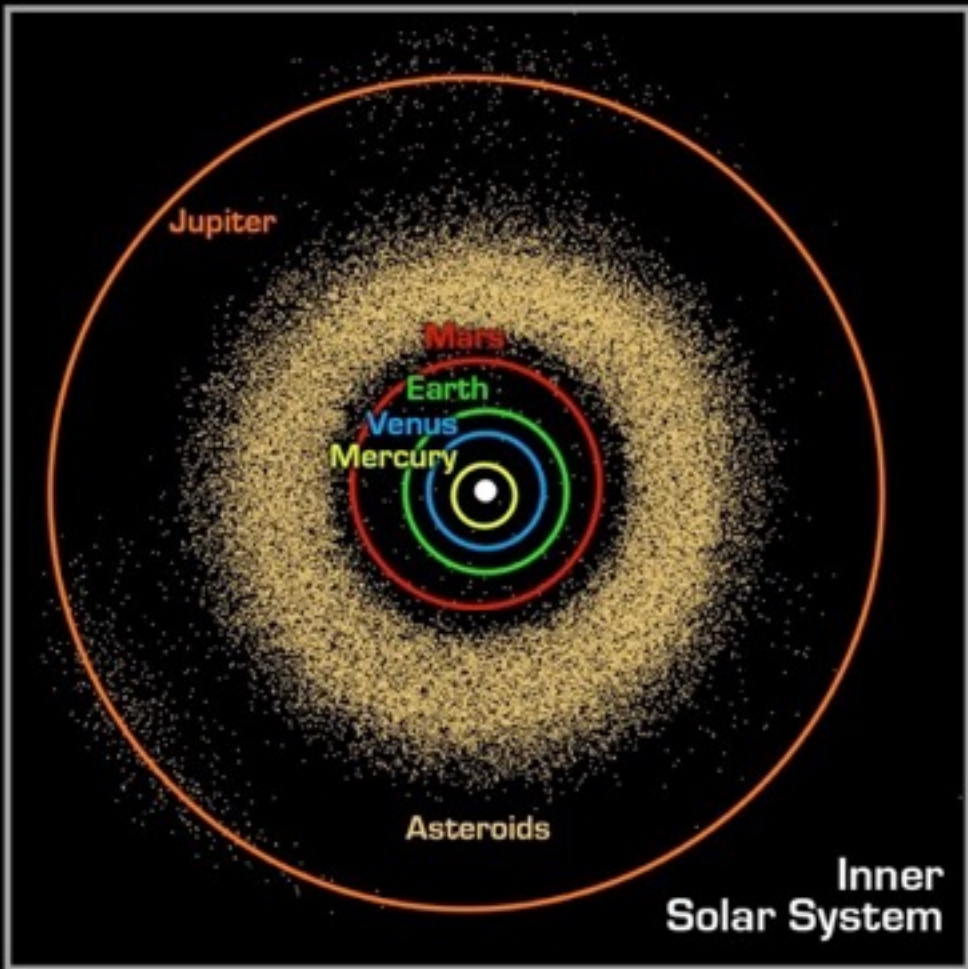
EVERY 175 YEARS

NOW BOARDING

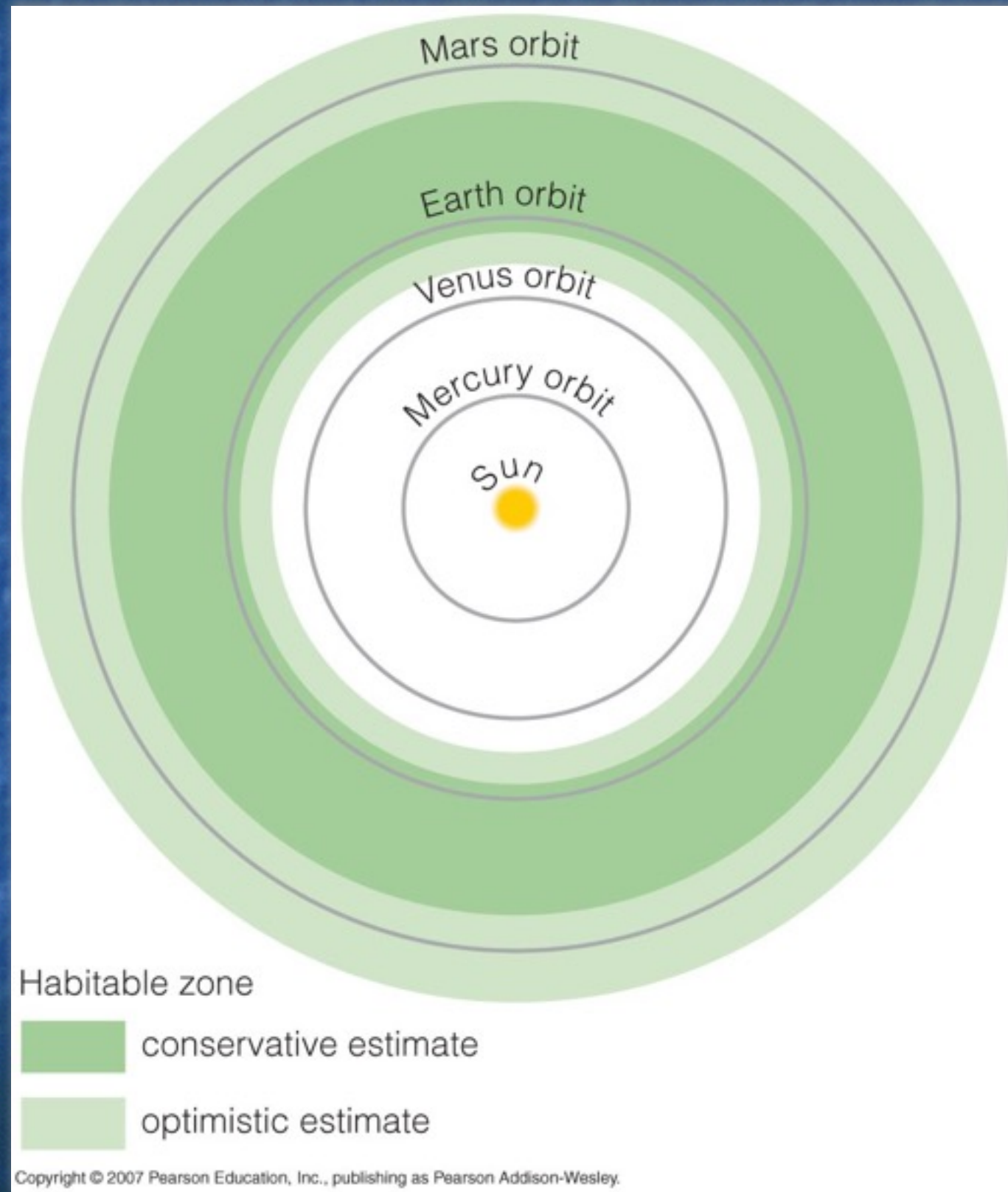
The outer solar system

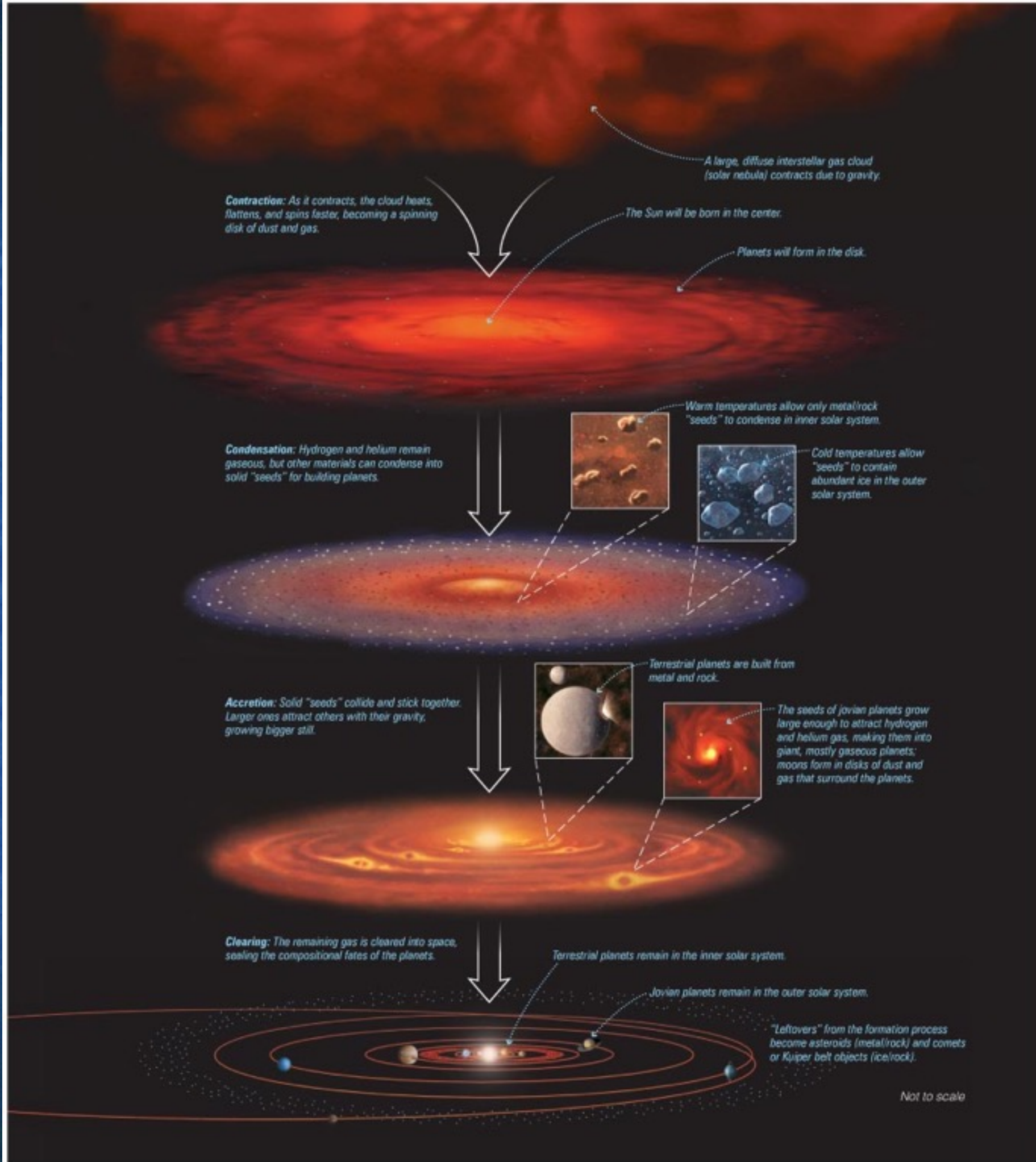
- Neptune is the last Jovian world as we head further out.
- Pluto is a very different world: small, rocky and icy.
- The discovery of Eris in 2005 (larger than Pluto) forced astronomers to reconsider what we term a planet.
- Pluto, Eris and thousands of other small bodies make up the Kuiper Belt of objects orbiting beyond Neptune.
- Further beyond the Kuiper Belt lies the Oort Cloud. Lying at some 50000 AU (1 Ly) from the Sun it is thought to contain up to 1 trillion small icy bodies that, if perturbed by a passing star, fall into the Solar System to be observed as comets.



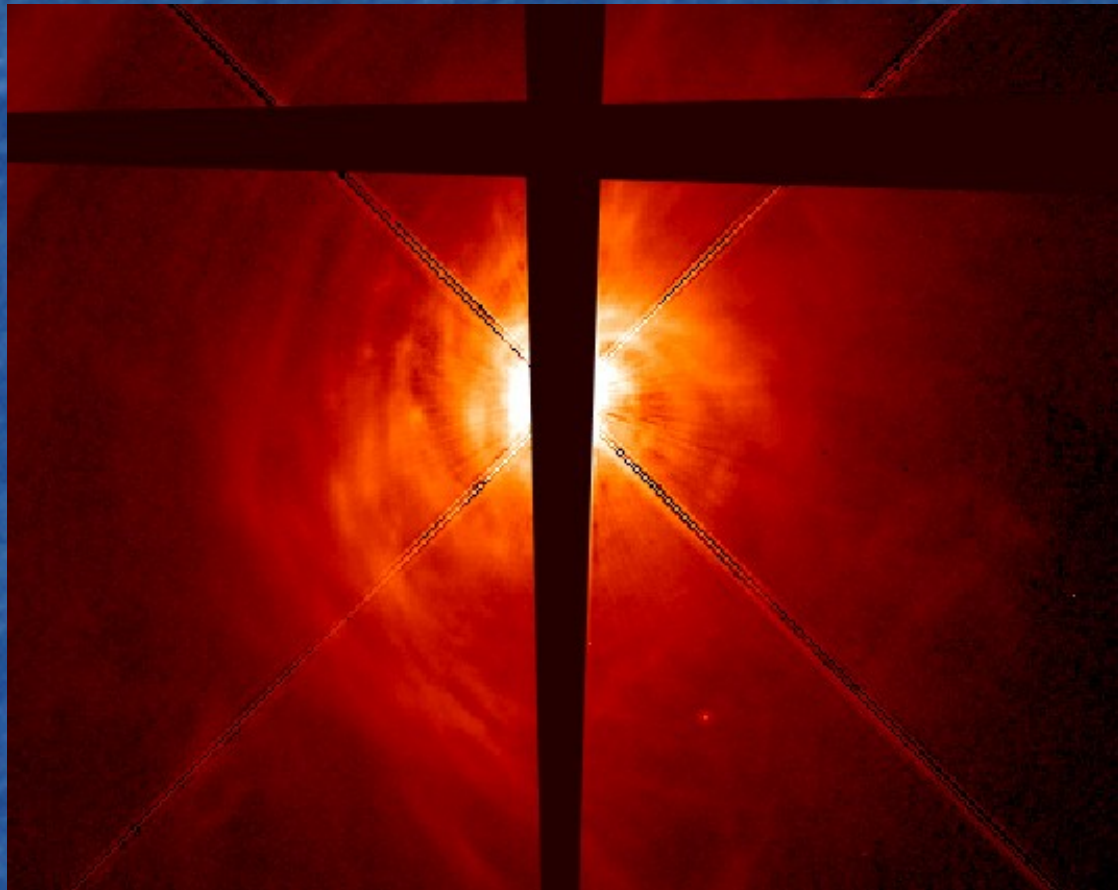


The Solar System's Habitable Zone

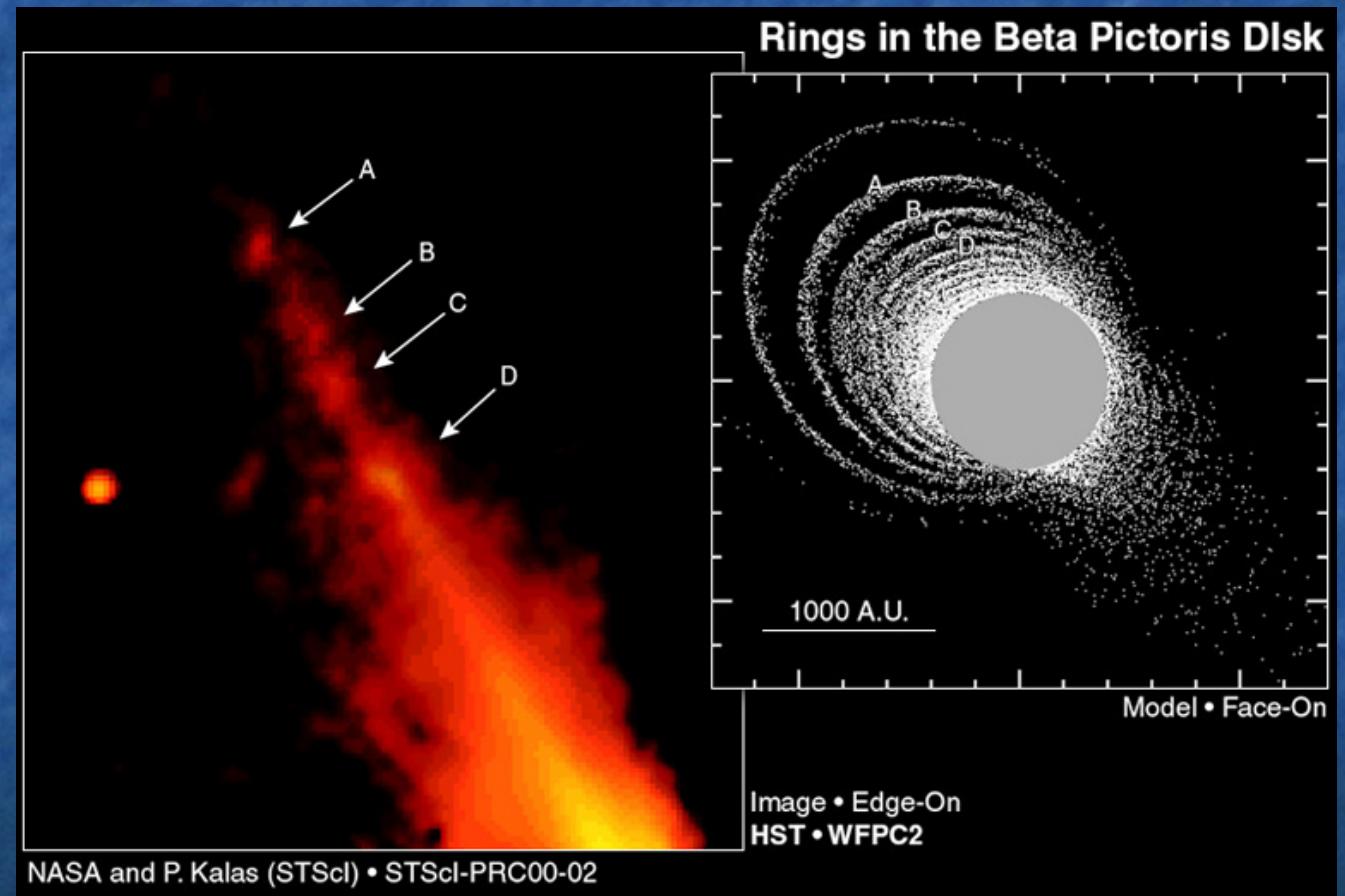




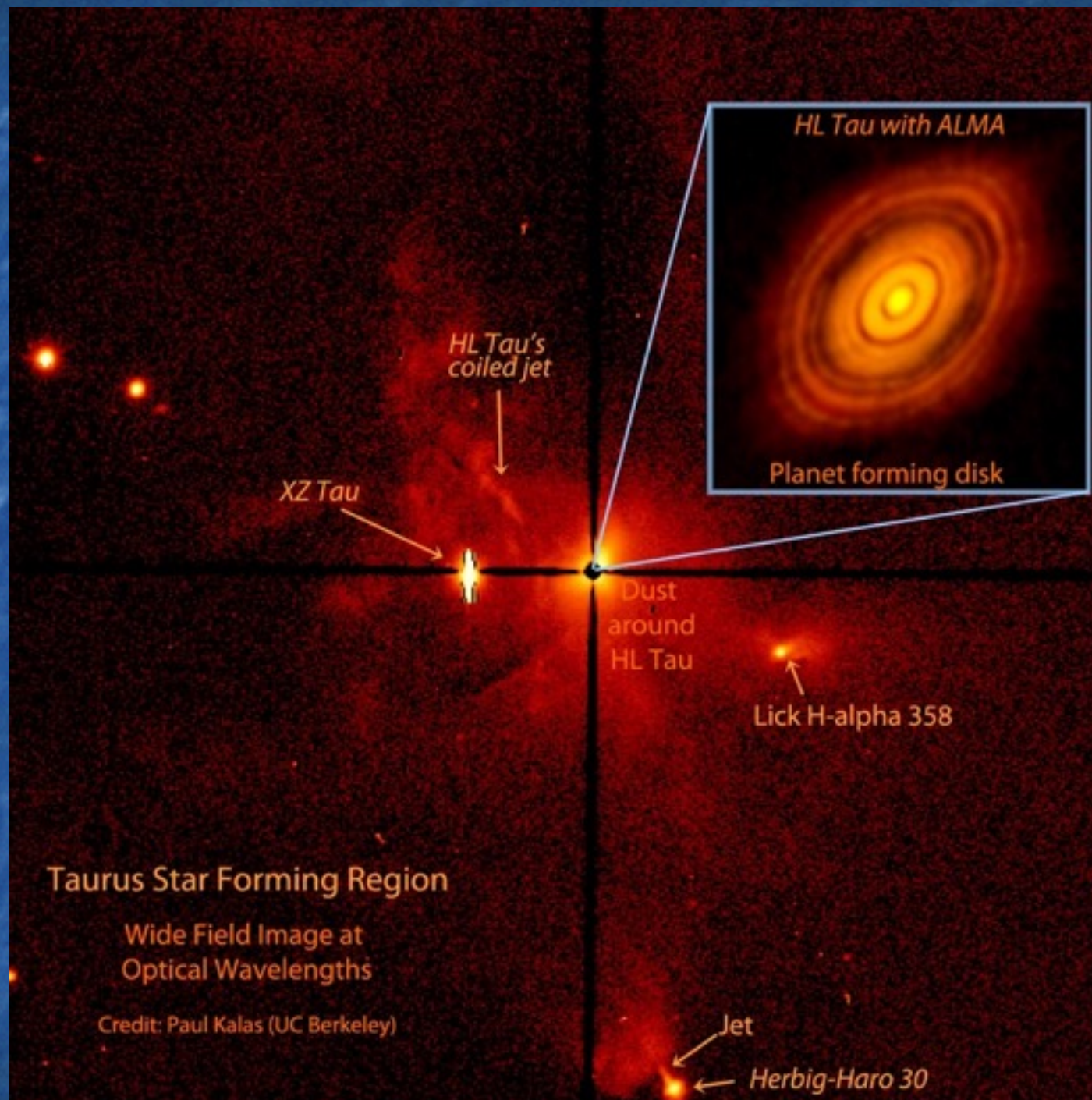
Disks Around Other Stars



AB Aurigae



Beta Pictoris



Taurus Star Forming Region

Wide Field Image at
Optical Wavelengths

Credit: Paul Kalas (UC Berkeley)

XZ Tau

HL Tau's
coiled jet

HL Tau with ALMA

Planet forming disk

Dust
around
HL Tau

Lick H-alpha 358

Jet

Herbig-Haro 30