

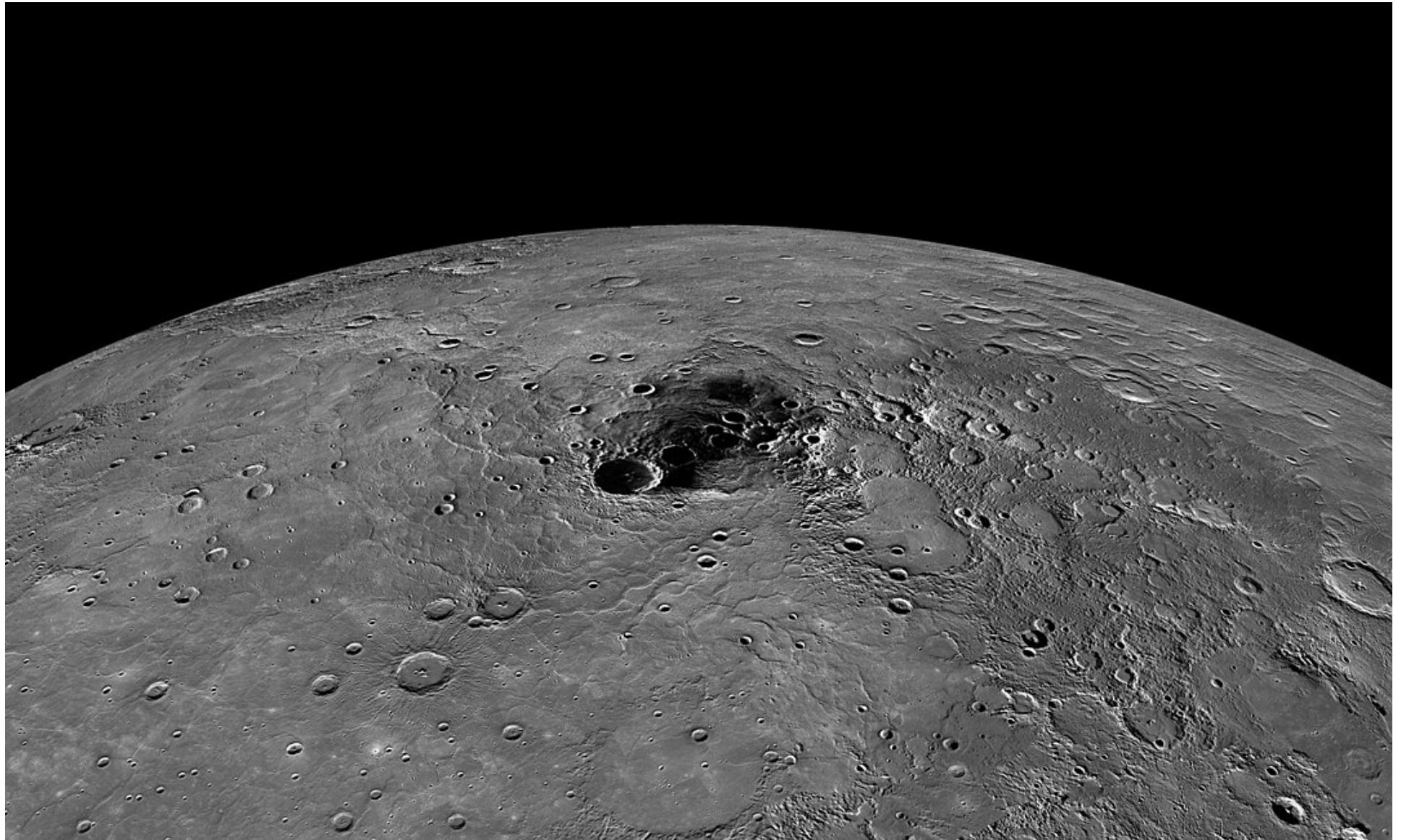
Our Solar System

The grand tour

Richard J Edgar, Learners Feb 2020

Mercury

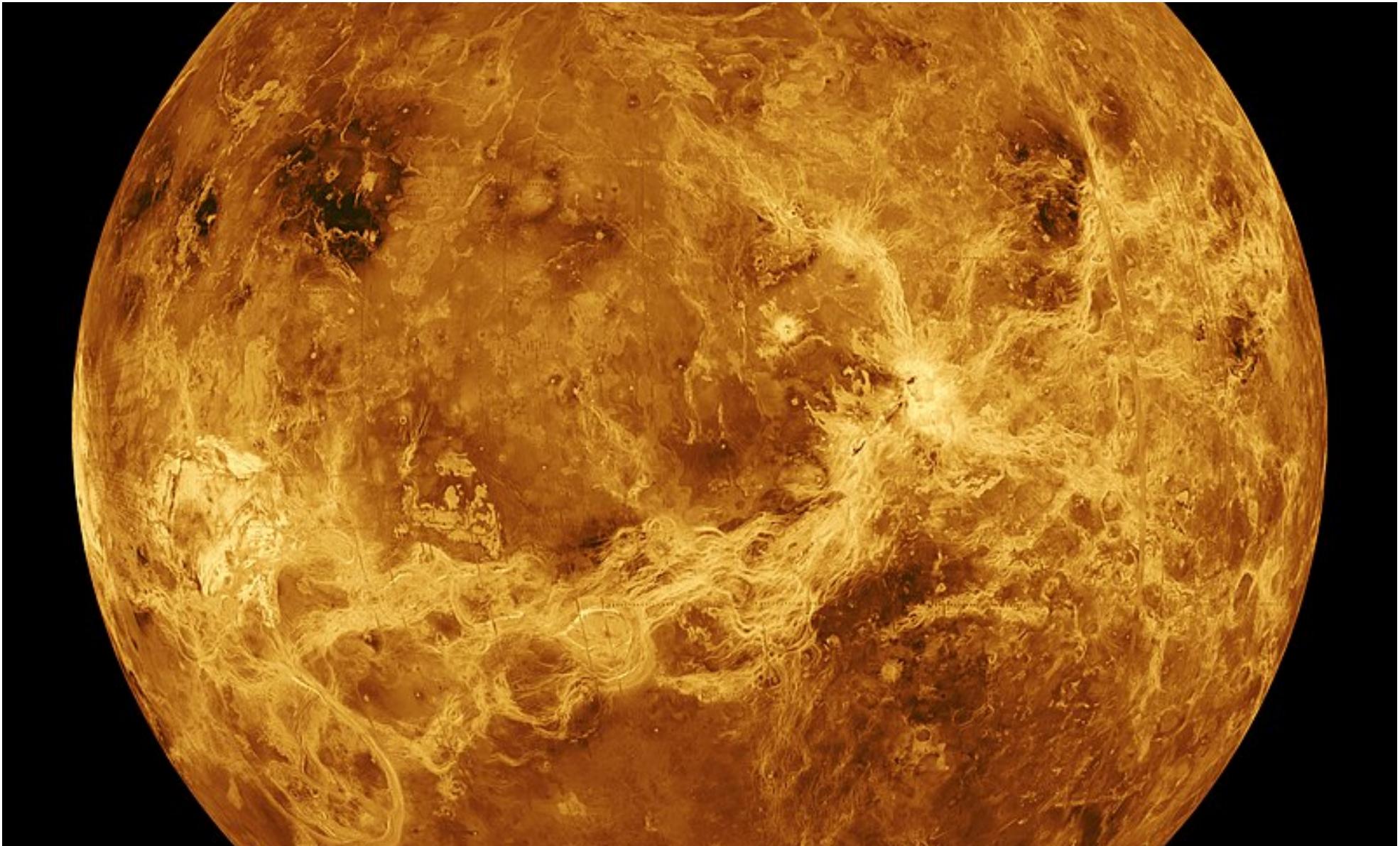
- Small rocky world
- Surprisingly dense at 5.4 g/cm^3
- Has a magnetic field, and so a molten iron core
- Visited recently by Messenger (US) and Bepi Columbo (ESA, still en route).
- Slow rotator (3 rotations @ 58.6 days per 2 revolutions around the sun @ 88 days)
- Surface gravity $3.7 \text{ m/s}^2 = 0.38 \text{ g}$



North pole of Mercury, seen from Messenger

Venus

- Nearly earth size (95% radius) and mass (86%), 0.94 g.
- Very hot (464 C or 867 F) with a thick atmosphere of CO₂ (surface pressure 91 earth atmospheres, like 1km deep in earth's oceans). Sulfuric acid clouds obscure the surface.
- Slowly rotates backwards (!)
- No magnetic field.
- Observed using radar from Magellan, Venus Express (ESA) and Akatsuki (Japan)
- Russian soft lander in 1966



Radar image of the surface of Venus

Earth

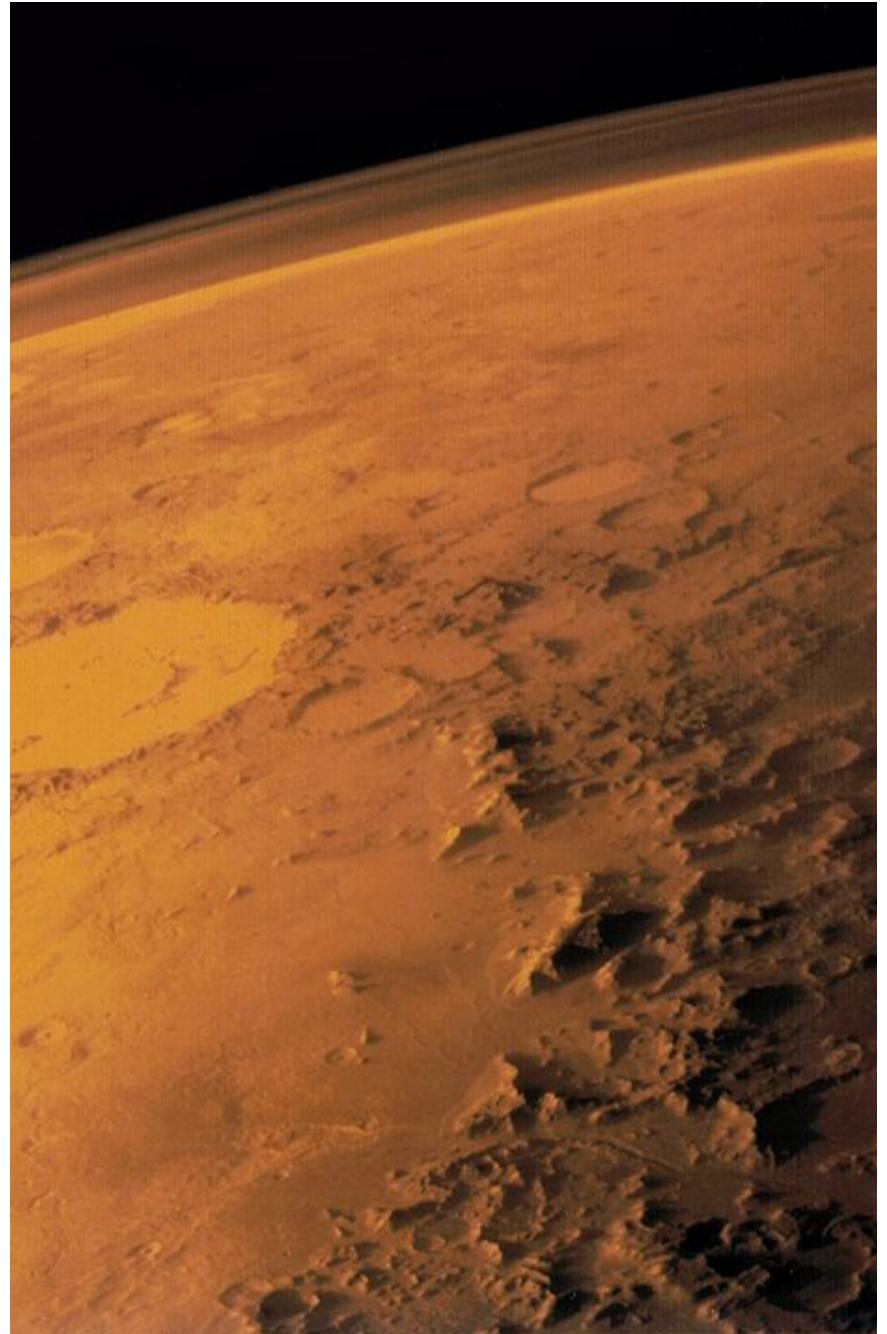
Go outside and look at it.

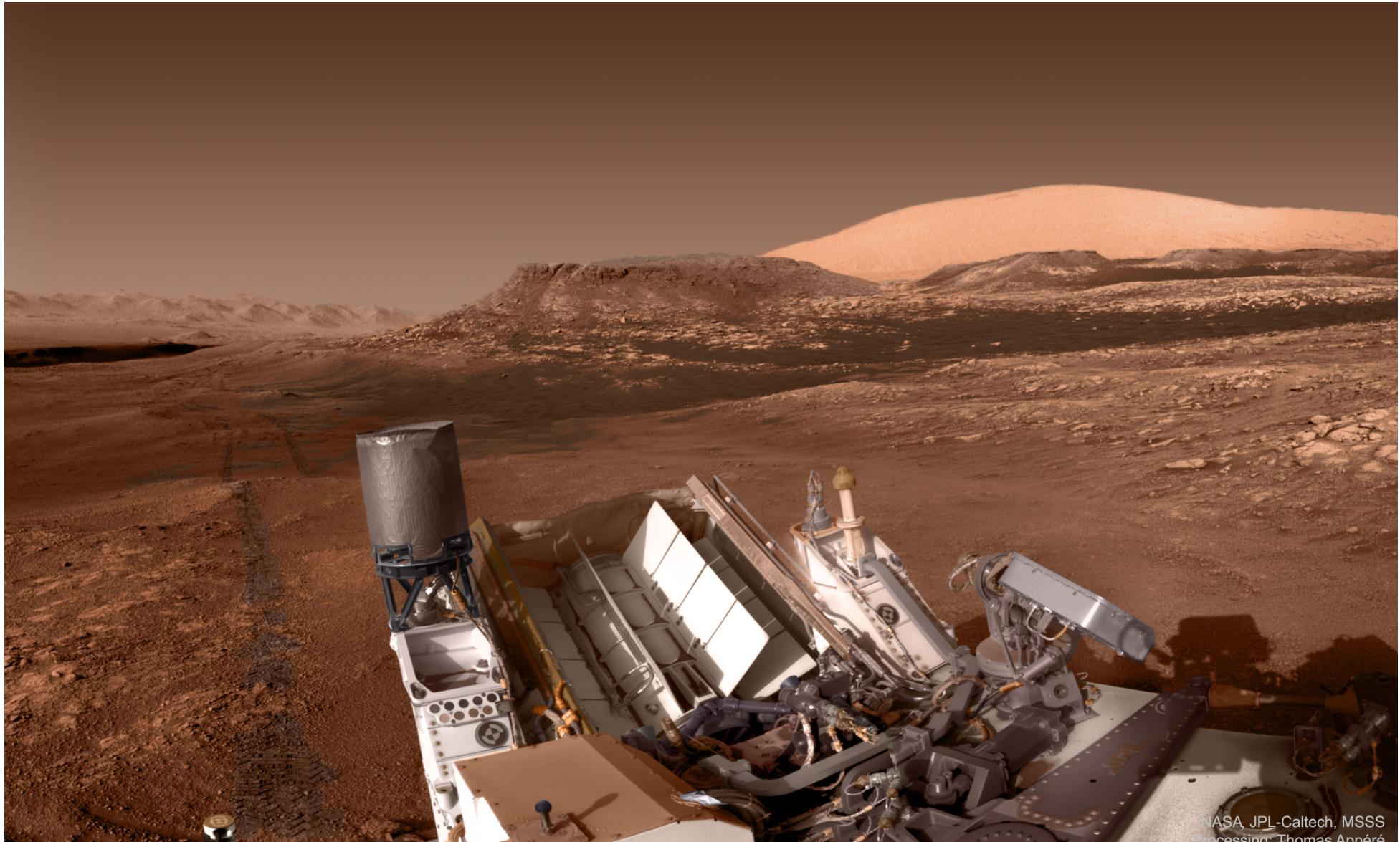


Mars

- Small (0.1 earth mass) rocky planet (density 3.9 g/cm³) 0.38 g gravity
- Thin CO₂ atmosphere: pressure 0.6% earth atmosphere. Evidence of running surface water (geological) and some subsurface ice, plus polar caps.
- Mean temp -82 F or -63 C
- No magnetic field... atmosphere being lost to space by solar activity.
- May have had an earth-like climate 3.5 Gyr ago
- Is there microbial life, below the surface?

Mars from orbit, showing the atmosphere.





NASA, JPL-Caltech, MSSS
Processing: Thomas Appéré

Gale Crater on Mars, from the Curiosity rover.



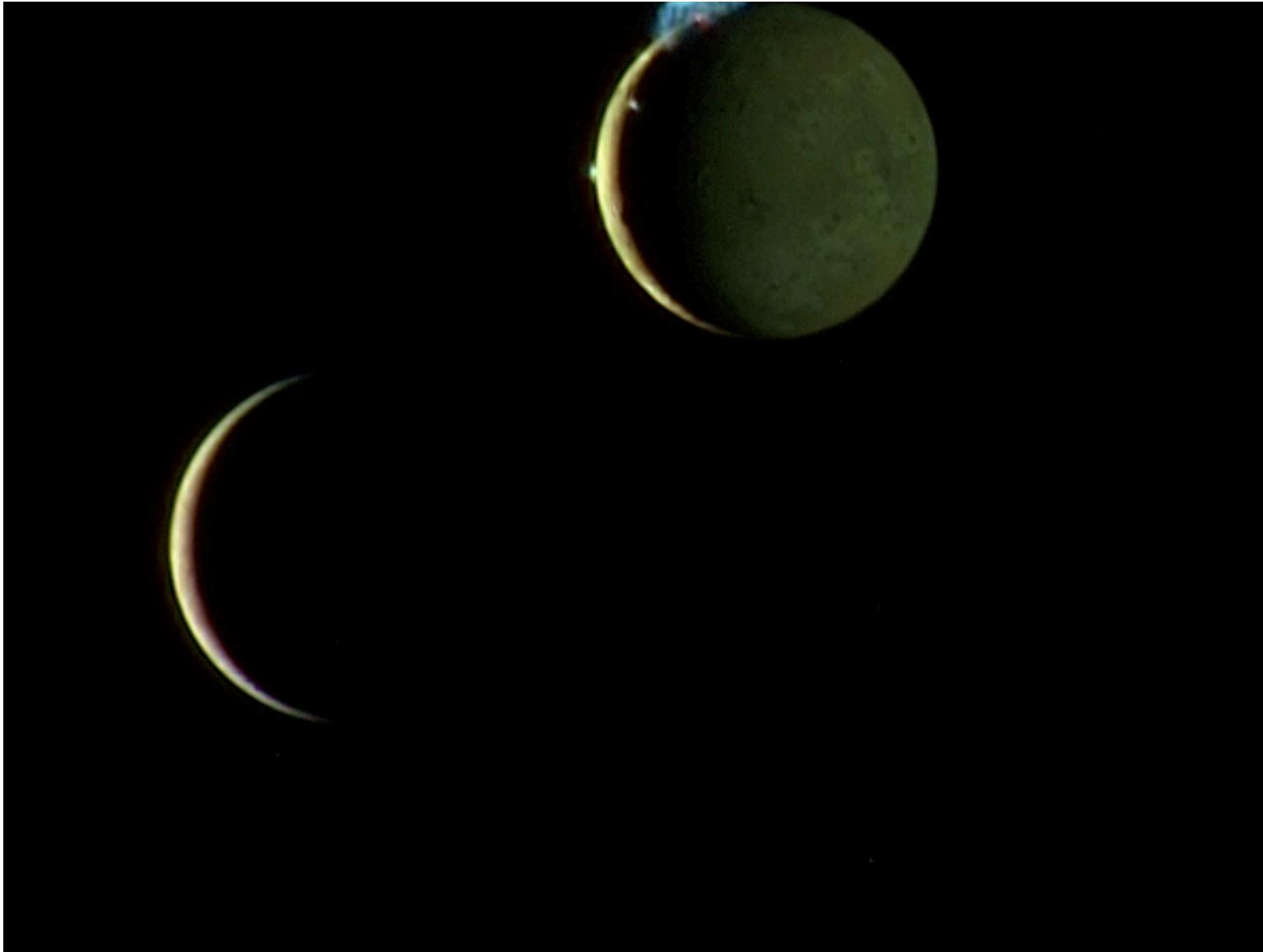
Sunset from earth (left) and Mars (right).

Jupiter

- Giant planet, very deep atmosphere of hydrogen, helium, methane, ammonia, water, etc.
- Has several interesting moons including 4 large ones: Io, Europa, Ganymede, and Callisto.
- Strong magnetic field
- 317 earth masses, 1/1000 of the sun. Missed being a star by a factor of 80 (not even close).
- Currently visited by Juno, in a polar orbit



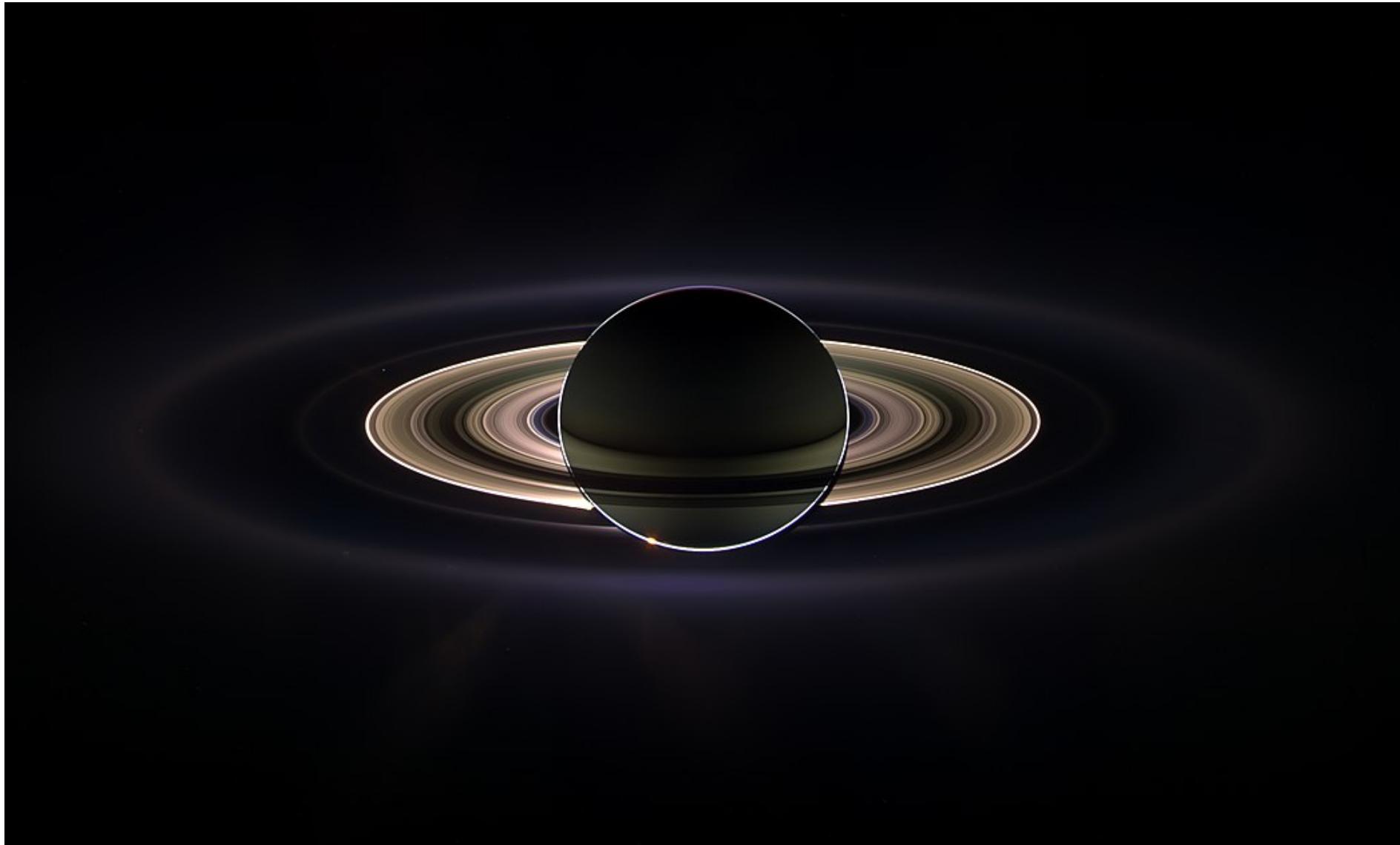
A movie of pictures of Jupiter taken from Juno, in a polar orbit around the planet.



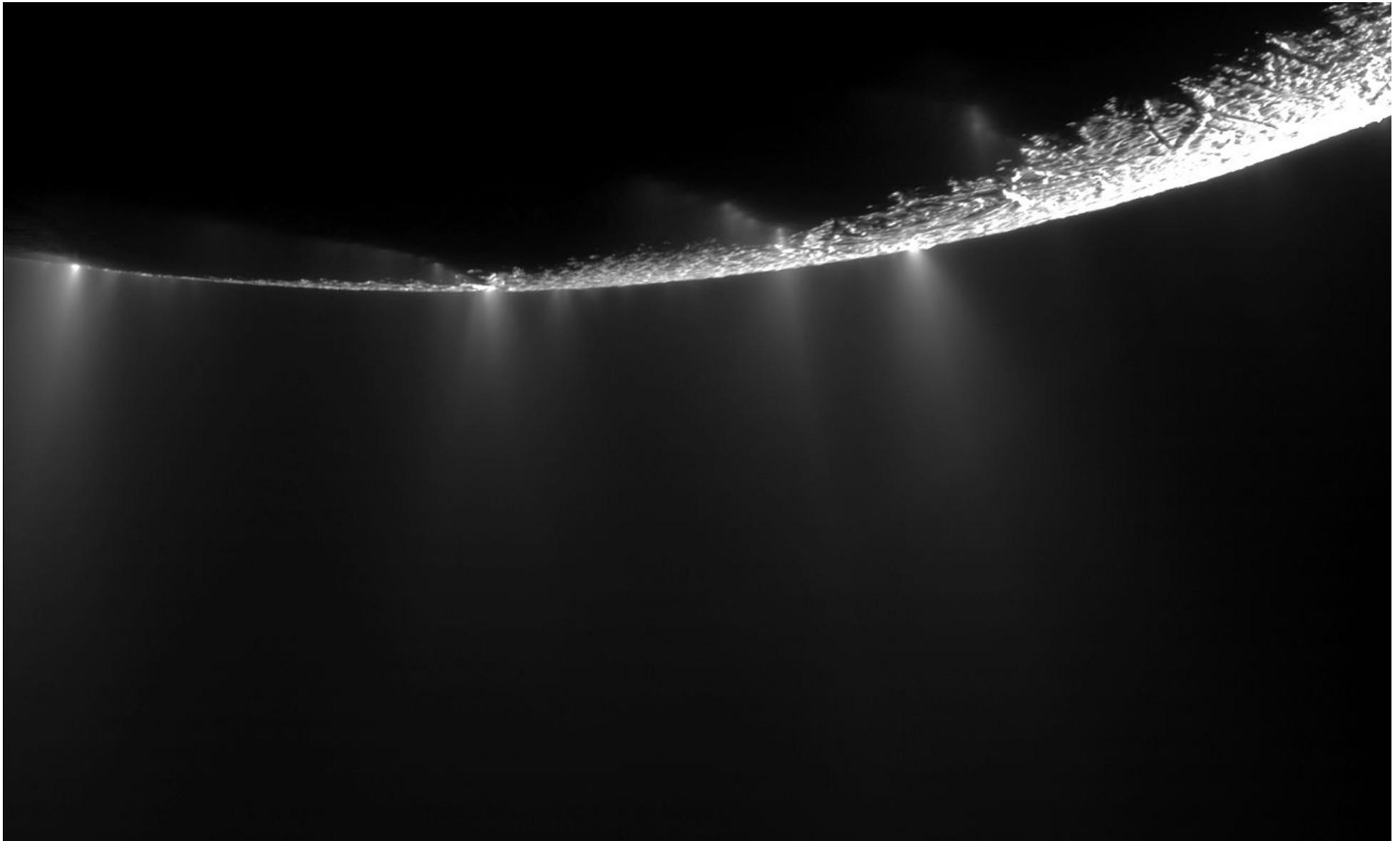
- Io and Europa backlit, from the Galileo space probe.

Saturn

- Smaller than Jupiter but still a very large gas giant planet.
- Rings! (Possibly a recent phenomenon? 1 Myr or so?)
- Two interesting moons:
 - Titan, with N₂ atmosphere and CH₄ haze. We're sending a quadcopter there. Rain, rivers and lakes of hydrocarbons.
 - Enceladus, a small moon with a sub-surface ocean and geysers. If there's mid-ocean ridge type life there, evidence could be in the geyser ejecta.
- Visited by Voyager (1980s) and Cassini (2000s)



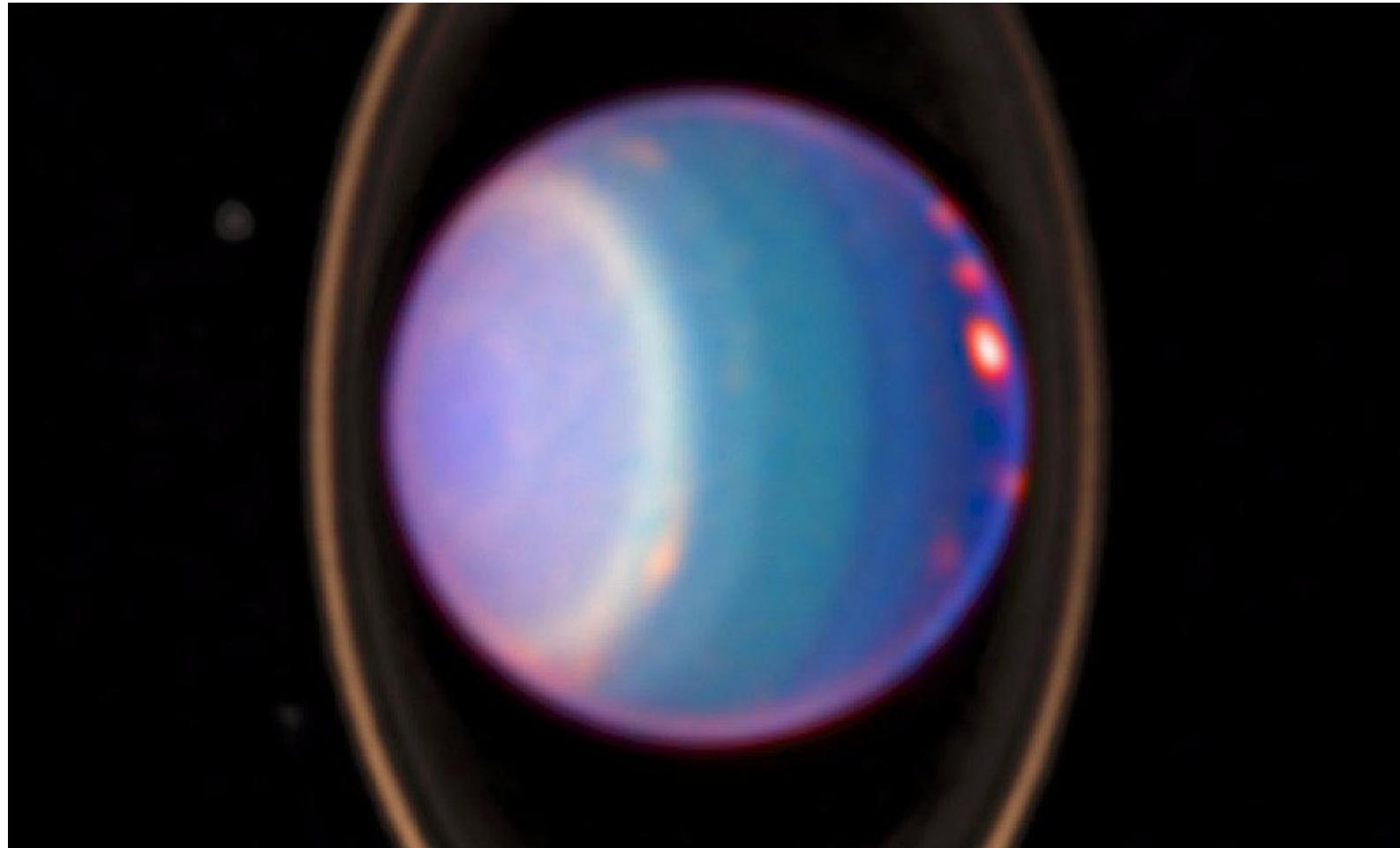
Saturn seen from the far side by Cassini. Note the faint outer F ring.



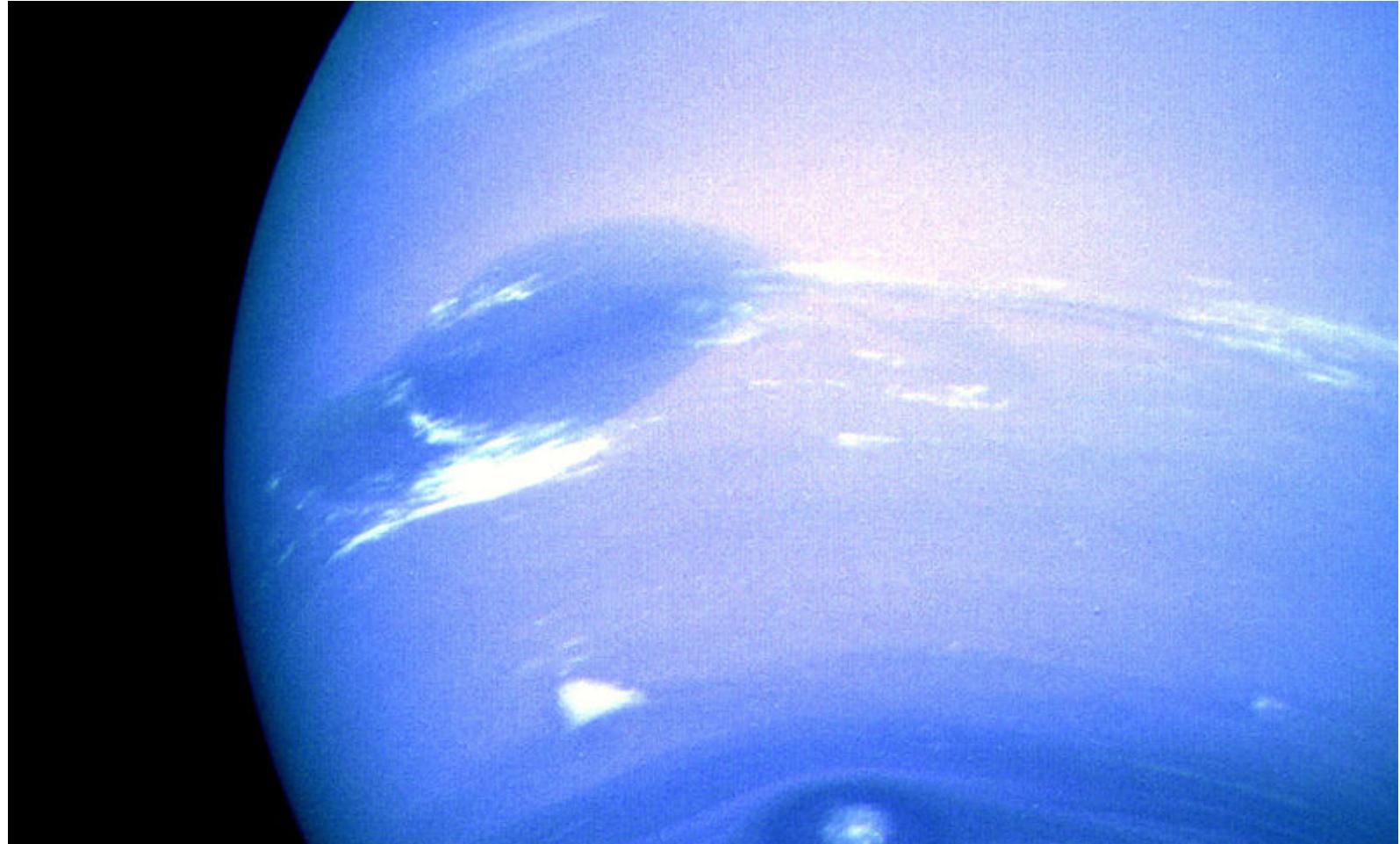
The geysers at the south pole of Enceladus, a moon of Saturn.
Cassini flew through one of these plumes and tasted it.

Ice Giants: Uranus and Neptune

- Smaller versions of Jupiter and Saturn, in a colder climate. 14.5, 17.2 earth masses. Both visited in the 1980s by Voyager 2.
- Note: there are no planets in our system between 1 and 14 earth masses.
- Uranus rotates on its side
- Neptune has a Pluto-like moon, Triton, in a retrograde orbit.



Uranus and rings. Near infrared shows cloud bands below the haze that blocks the visible light.



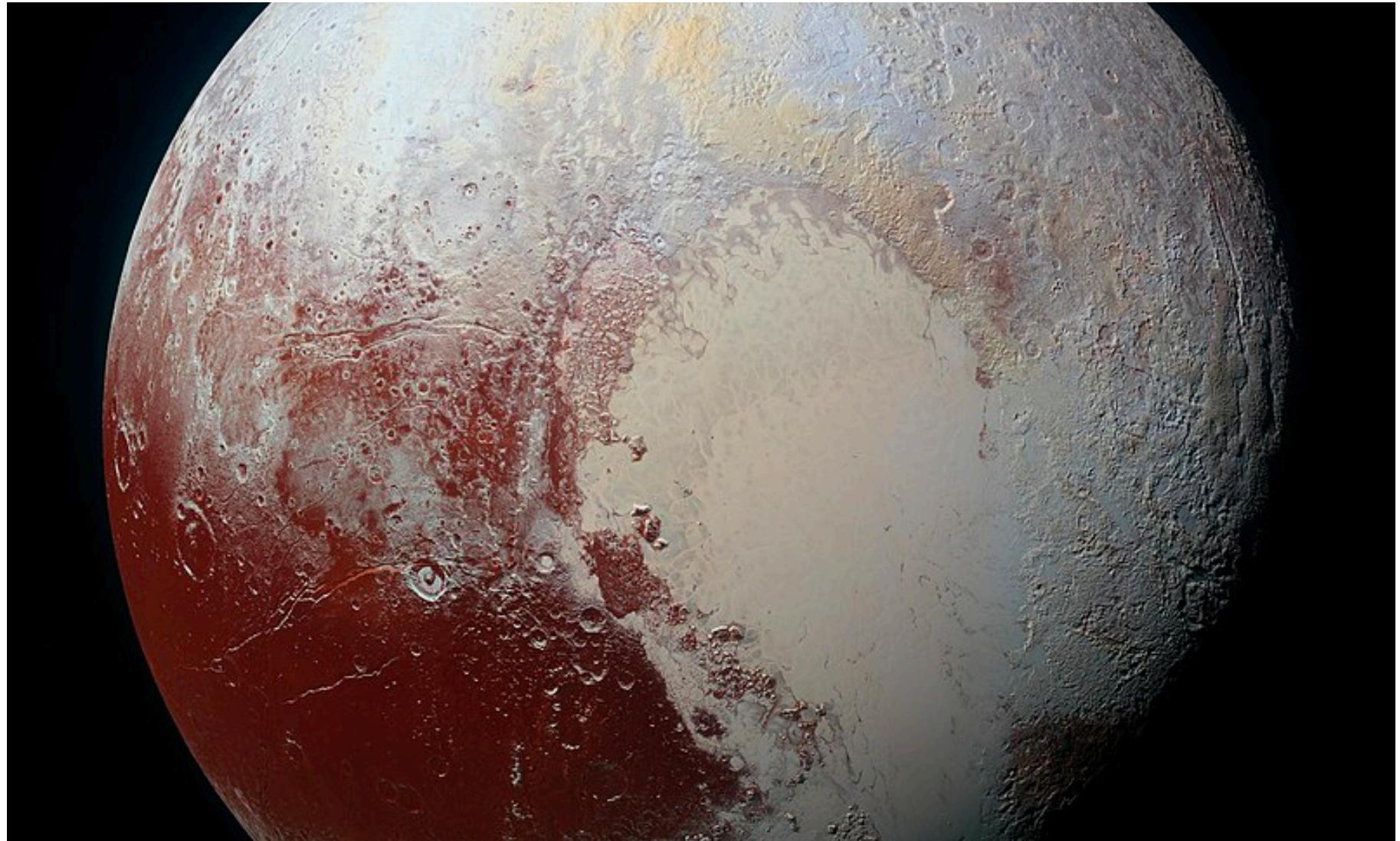
Neptune, showing the Great Dark Spot and some other storms.

Other stuff in the solar system

- Asteroids. Ceres is big enough to be spherical. Mostly small rocks or piles of rubble in orbits between Mars and Jupiter. Some orbits cross that of the earth.
- Comets. Dirty snowballs from the outer reaches of the solar system, which evaporate when they come close to the sun, making beautiful tails.
- The Kuiper Belt. Another asteroid-belt like place beyond the orbit of Neptune, with lots of icy objects, including Pluto, several other “dwarf planets” of similar size, and a lot of little stuff. Comets come from here.
- The Oort Cloud. A much larger spherical bunch of proto-comets.



The largest of the known trans-Neptunian objects (Kuiper Belt objects). Many have moons!



Pluto, up close and personal, from the New Horizons spacecraft.
Surface is water, nitrogen ices, and hydrocarbons (the reddish stuff).

A more typical Kuiper
Belt object, Arrokoth. It's
tiny: $36 \times 18 \times 10$ km.
From the New Horizons
spacecraft.



Oh, and, the Sun (of course)

- I can talk about the sun for weeks.
- Typical yellow middle-aged star. 75th %-ile by weight.
- Photosphere temperature is about 5800 Kelvin
- 75% H, 25% He by mass, with a part in a thousand of heavier elements.
- Age: 4.65 Gyr. Expected lifetime, 10 or 11 Gyr.
- Fate: Swells to a red giant, engulfing the inner planets. Blows off the envelope, exposing the core, shrunk to earth-size (but still nearly a solar mass! Very dense).
- Blows off a ‘wind’ of material, including flares, that can damage unprotected planets or spacecraft.



A solar flare, seen from Skylab.