

Chapter 4: Earth and its Moon

Prof. Douglas Laurence

AST 1002

Spring 2018

Physical Properties of Earth and the Moon



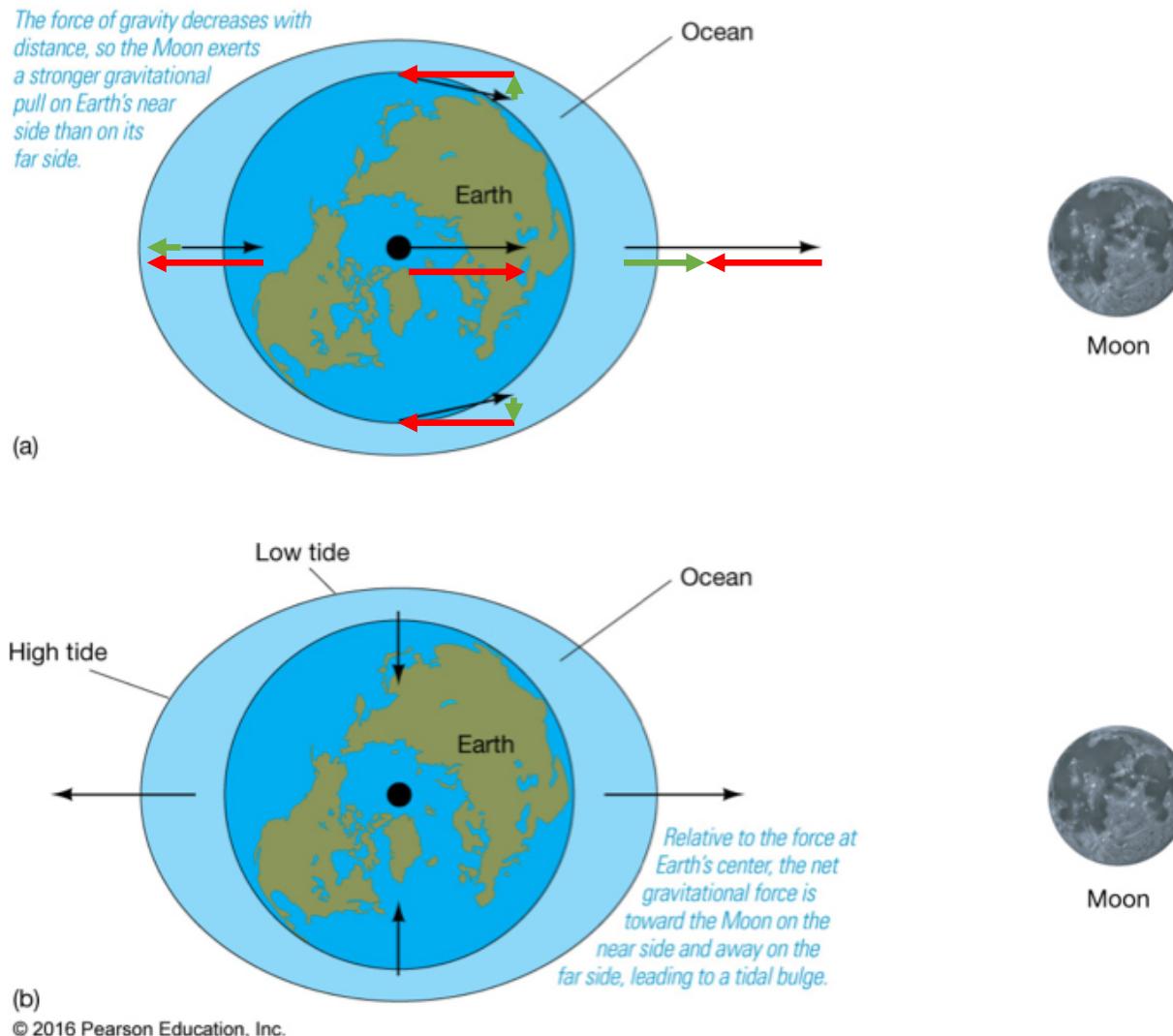
Earth and Moon, two very different worlds, shown to scale. Earth is roughly 4 times larger and 80 times more massive than its airless companion.

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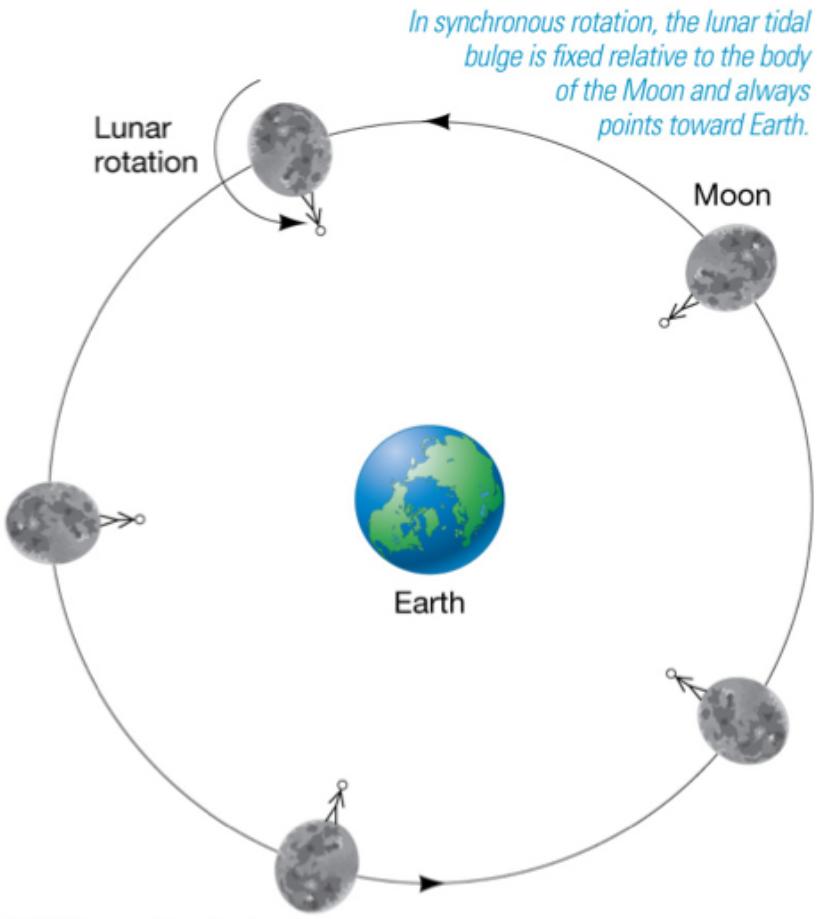
Measurement	Earth	Moon
Mass	6.0×10^{24} kg	7.4×10^{22} kg
Radius	6400 km	1700 km
Surface Gravity	9.81 m/s ²	1.62 m/s ²
Escape Velocity	11.2 km/s	2.38 km/s
Surface Temperature (Av.)	58.7 °F	-63.7 °F
Surface Pressure (Av.)	101,300 Pa	10^{-7} Pa
Distance between Earth and Moon: 384,000 km		

The Moon and the Tides

“Subtract” the force at the center of the Earth to find the forces we would see on Earth, or the forces “relative” to an observer on Earth.



Tidal Locking of the Moon

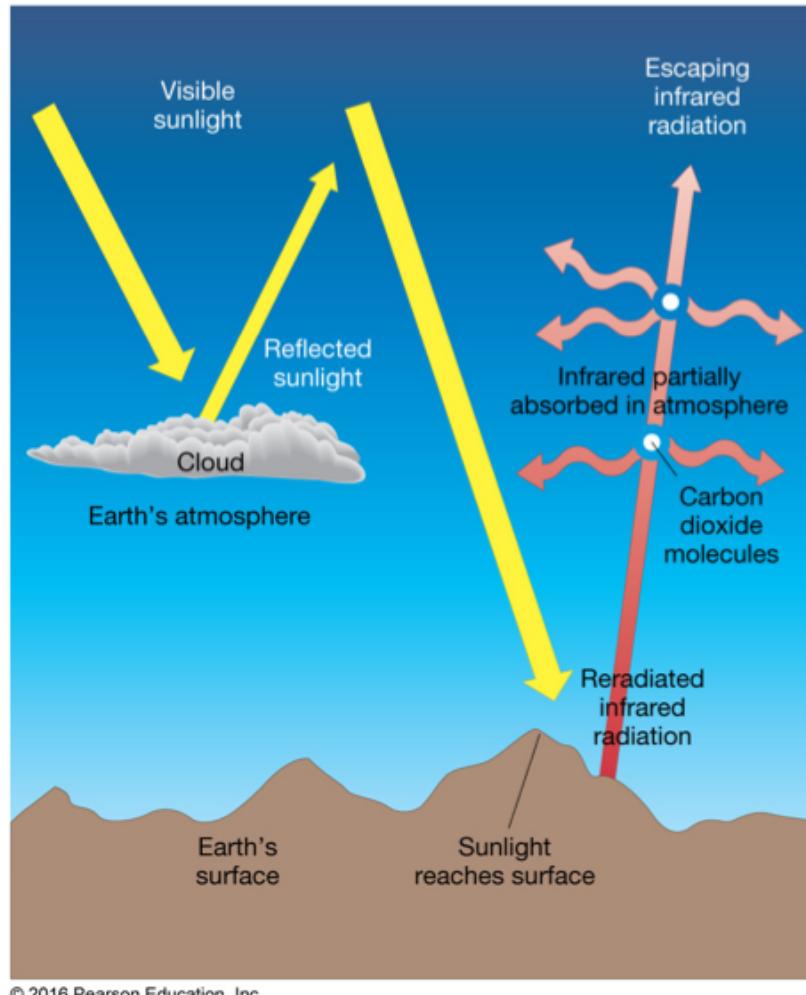


The Moon's tidal action on the Earth explains our two tides per day.

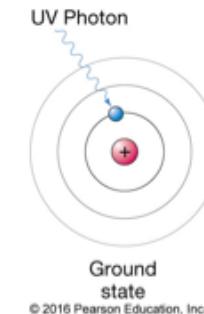
The Earth's tidal action on the Moon is more dramatic: the Moon is in a **synchronous orbit** around the Earth, so that we always see the same face of the Moon. This is known as **tidal locking**, and is a common feature of all moons in the Solar System.

Tidal locking takes a large amount of time to occur, but our Solar System is around 5 billion years old, which is plenty of time for it to occur.

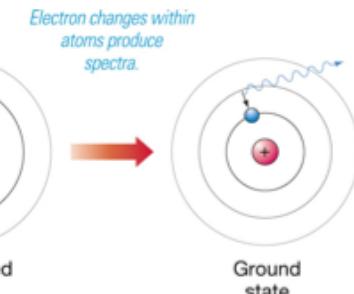
Greenhouse Effect



Absorption of sunlight photon



Emission of infrared photon



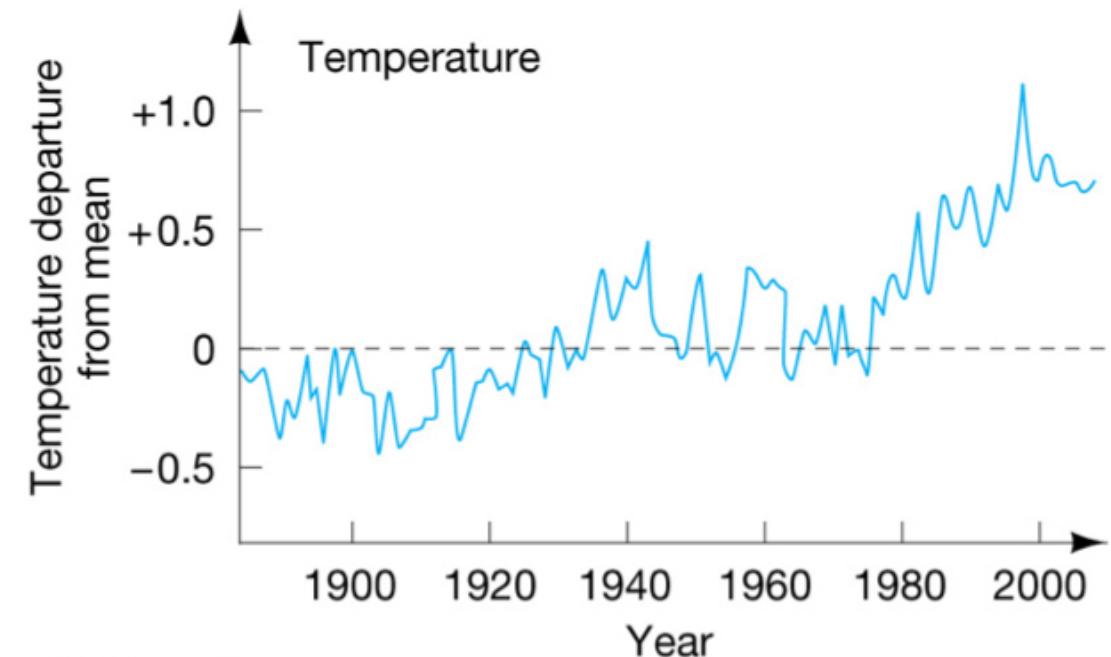
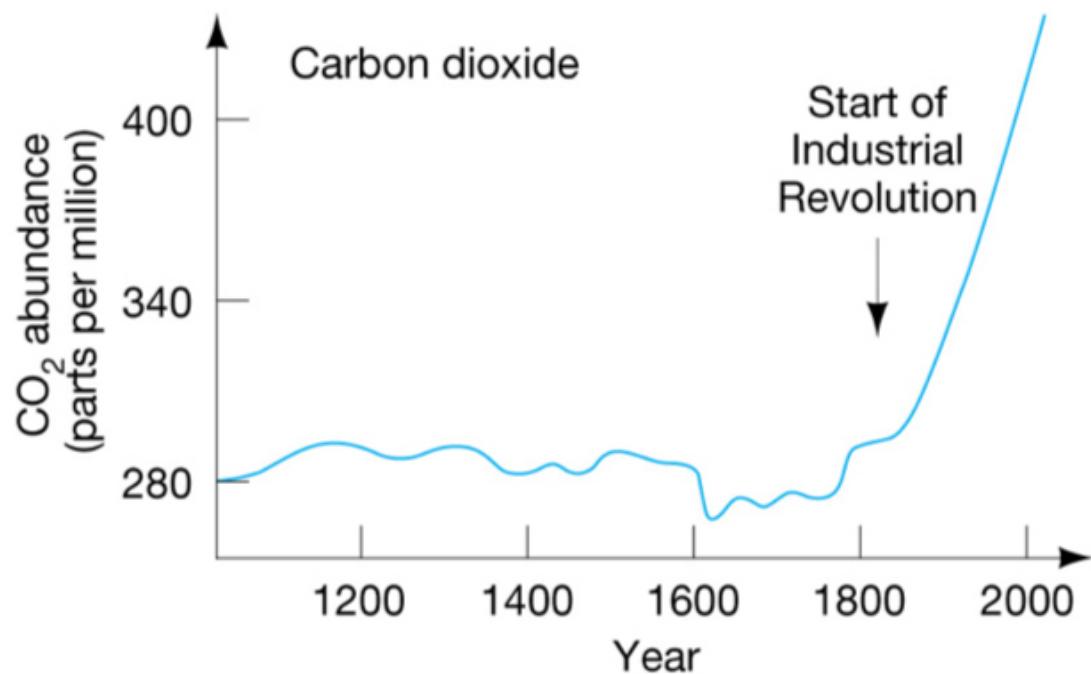
Emission occurs in a random direction!

Random direction → Longer time to escape → Warmer atmosphere

Four major Greenhouse Gases:

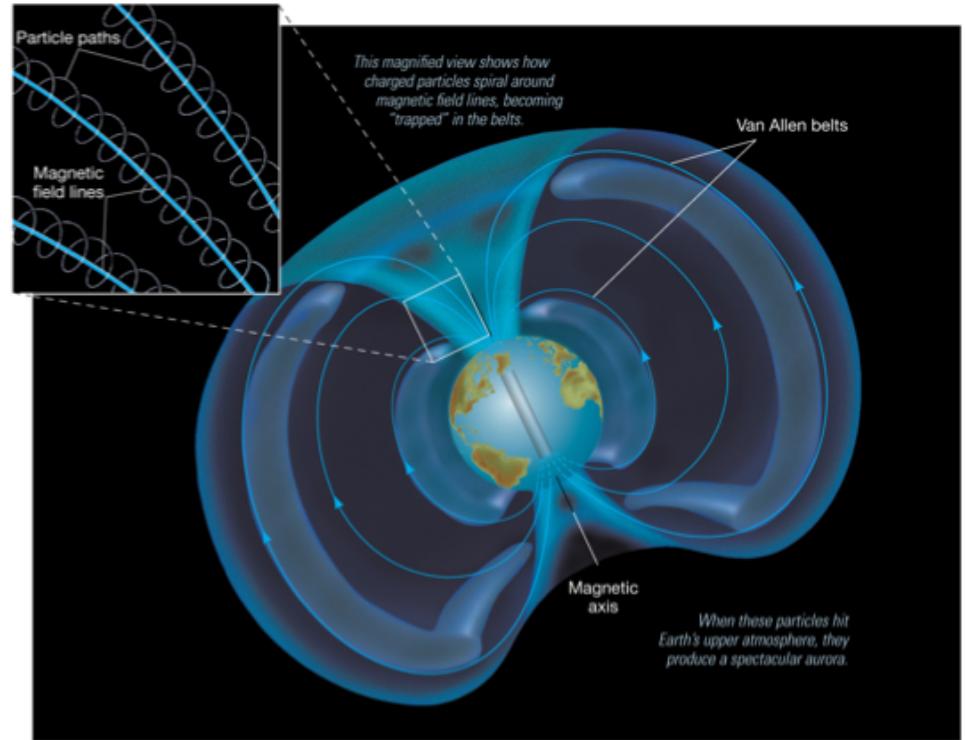
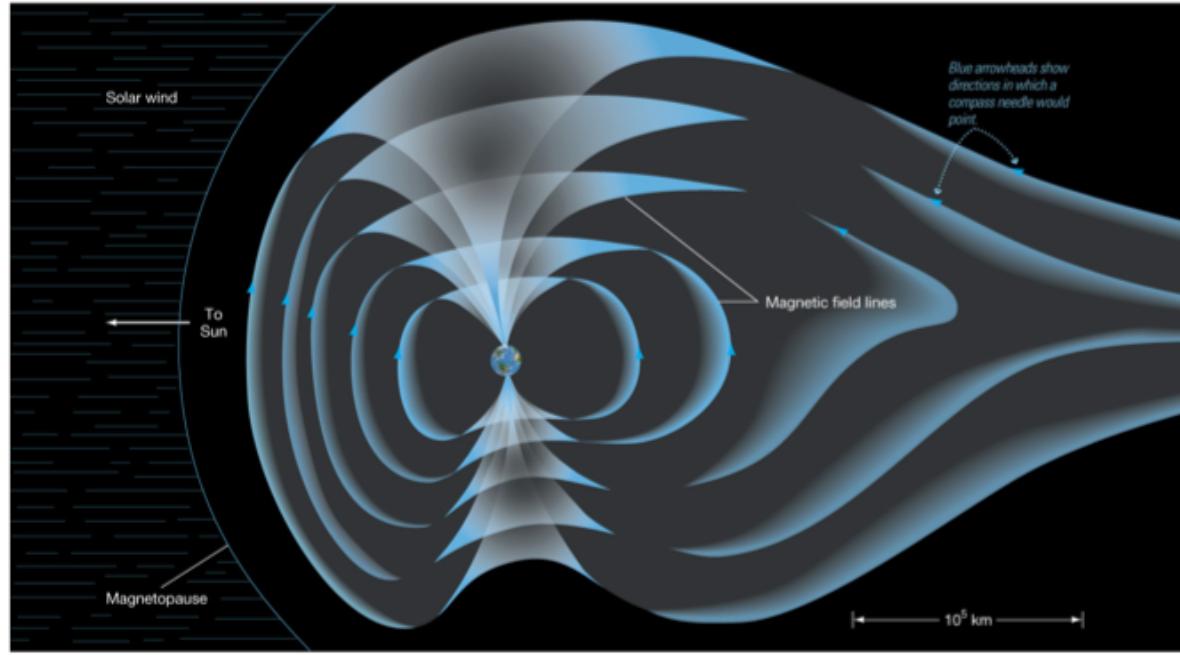
- Water Vapor (36% – 70%)
- CO₂ (9% – 26%)
- Methane (4% – 9%)
- Ozone (3% – 7%)

Global Climate Change



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Earth's Magnetosphere



Manned Missions to the Moon

Project Mercury: (1958 – 1963) Original 7 astronauts, the “Mercury 7,” included Alan Sheppard and John Glenn. Mission were simply to test whether or not humans could survive spaceflight. For instance, doctors thought that the eye was meant to focus in Earth’s gravity, and the micro-gravity of space would lead to a deformation of the eye and an inability to focus, meaning astronauts would be effectively blind in space. This turned out not to be true.

Project Gemini: (1961 – 1966) The next 9 astronauts, the “New 9,” included Neil Armstrong and Jim Lovell. The third wave of astronauts, who also participated in Project Gemini, included Buzz Aldrin. The project was aimed at perfecting maneuvers necessary to make it to the Moon, such as rendezvous in space. Notable mission: Gemini 7, which lasted just under 14 days.

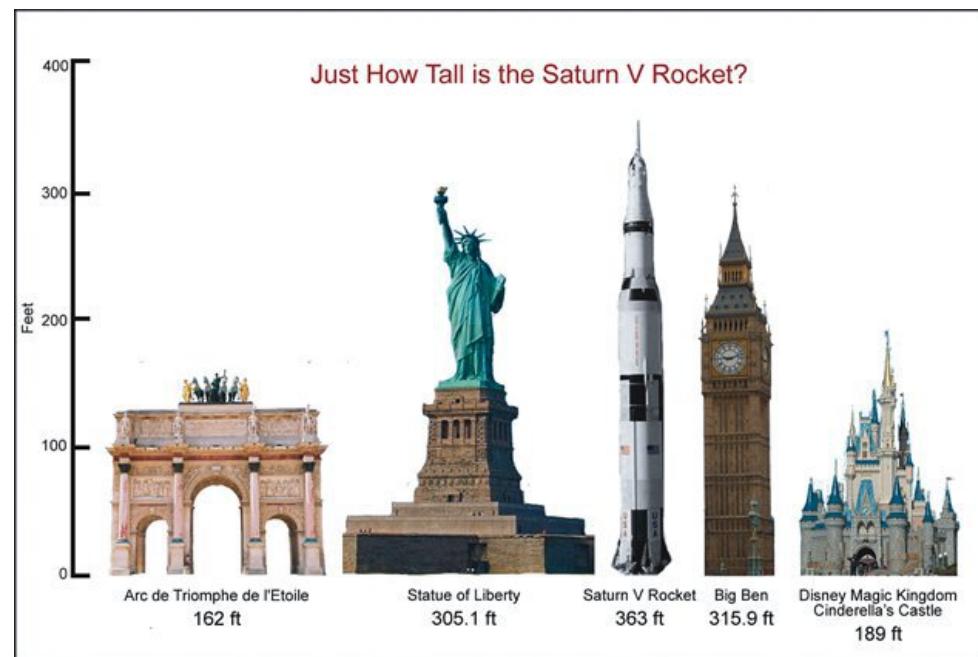
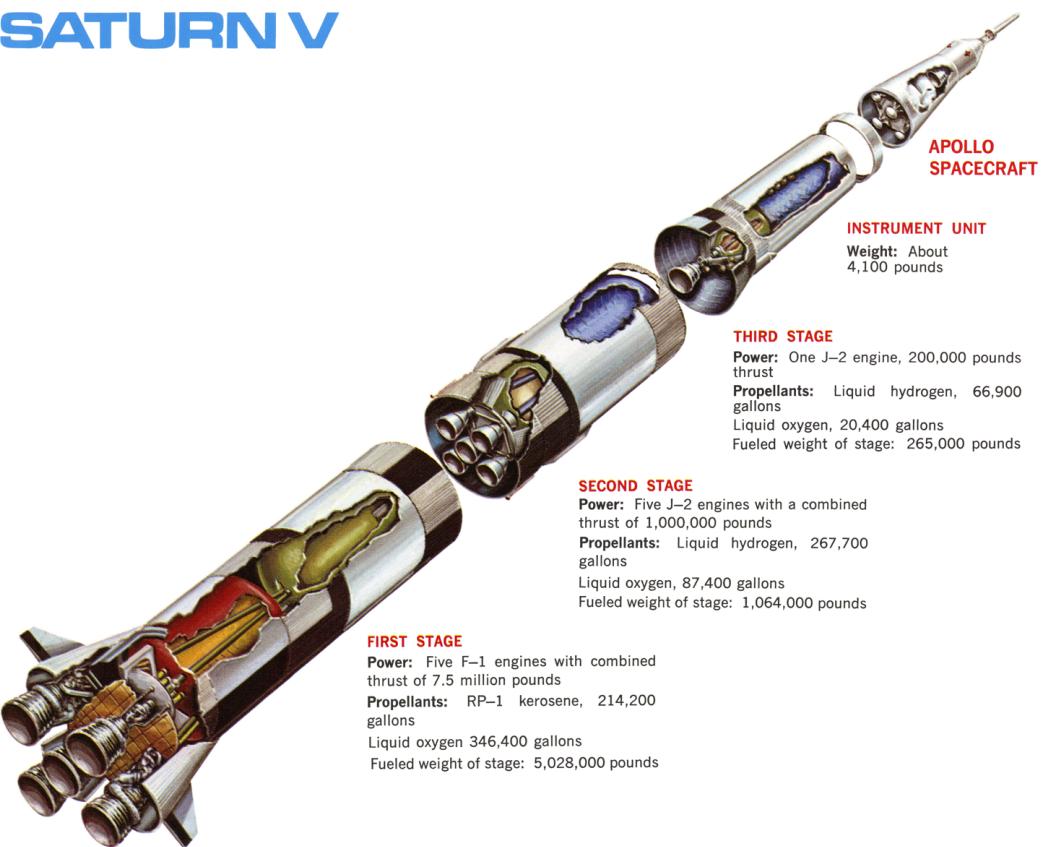
Project Apollo: (1961 – 1972) The actual missions to the moon. Notable missions: Apollo 1, which was a failed mission leading to the deaths of 3 astronauts; Apollo 8, the first mission to the Moon; and Apollo 11, the first time we landed on the Moon.

My wife and I in a (replica) Gemini capsule. They are very small!



The Saturn V Rocket

SATURN V



Neil Armstrong: the First Man on the Moon

Watch **Nova: First Man on the Moon** documentary about Neil Armstrong's life.

<http://www.pbs.org/video/nova-first-man-moon/>

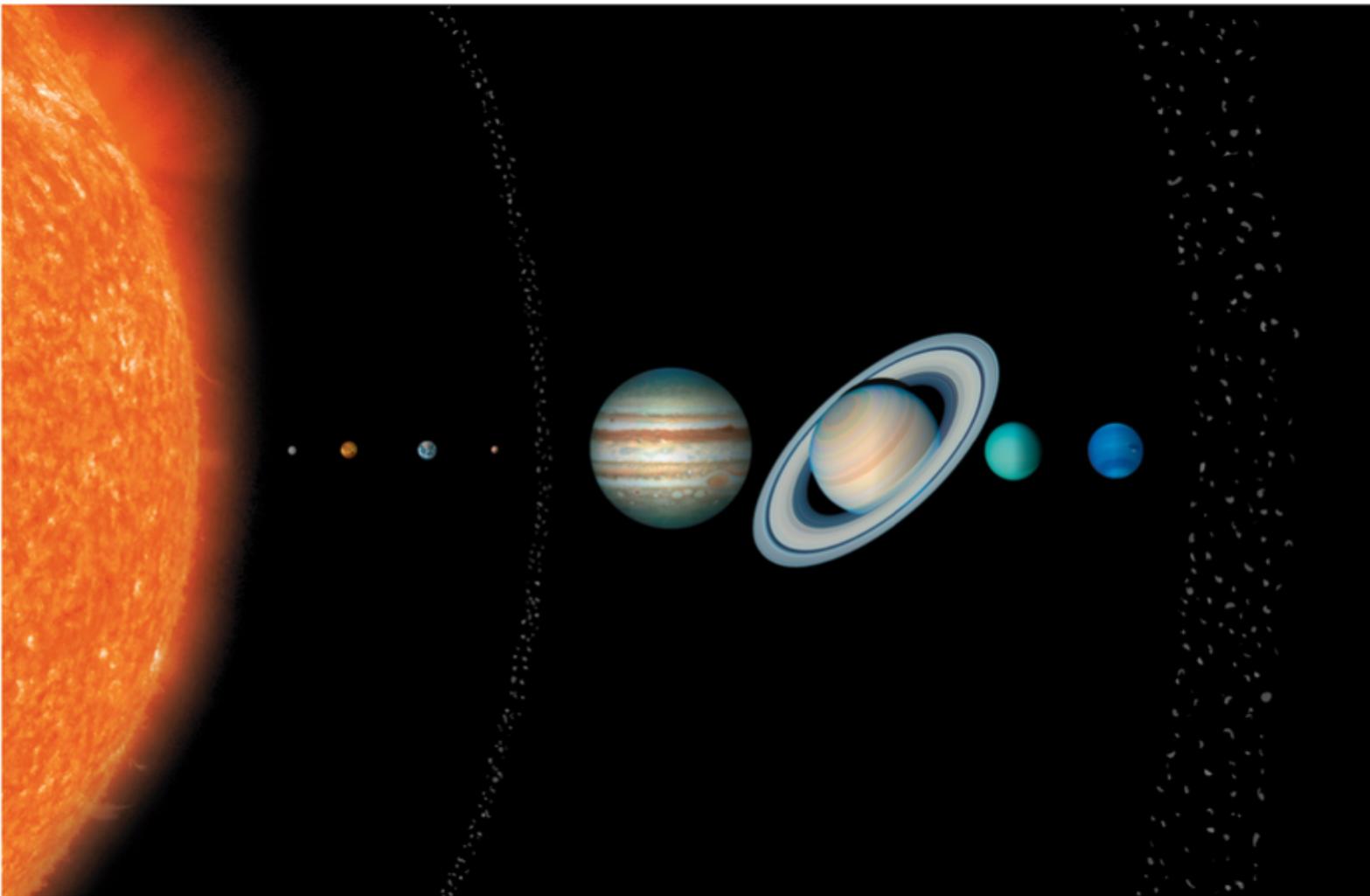
Chapter 5: The Eight Planets

Prof. Douglas Laurence

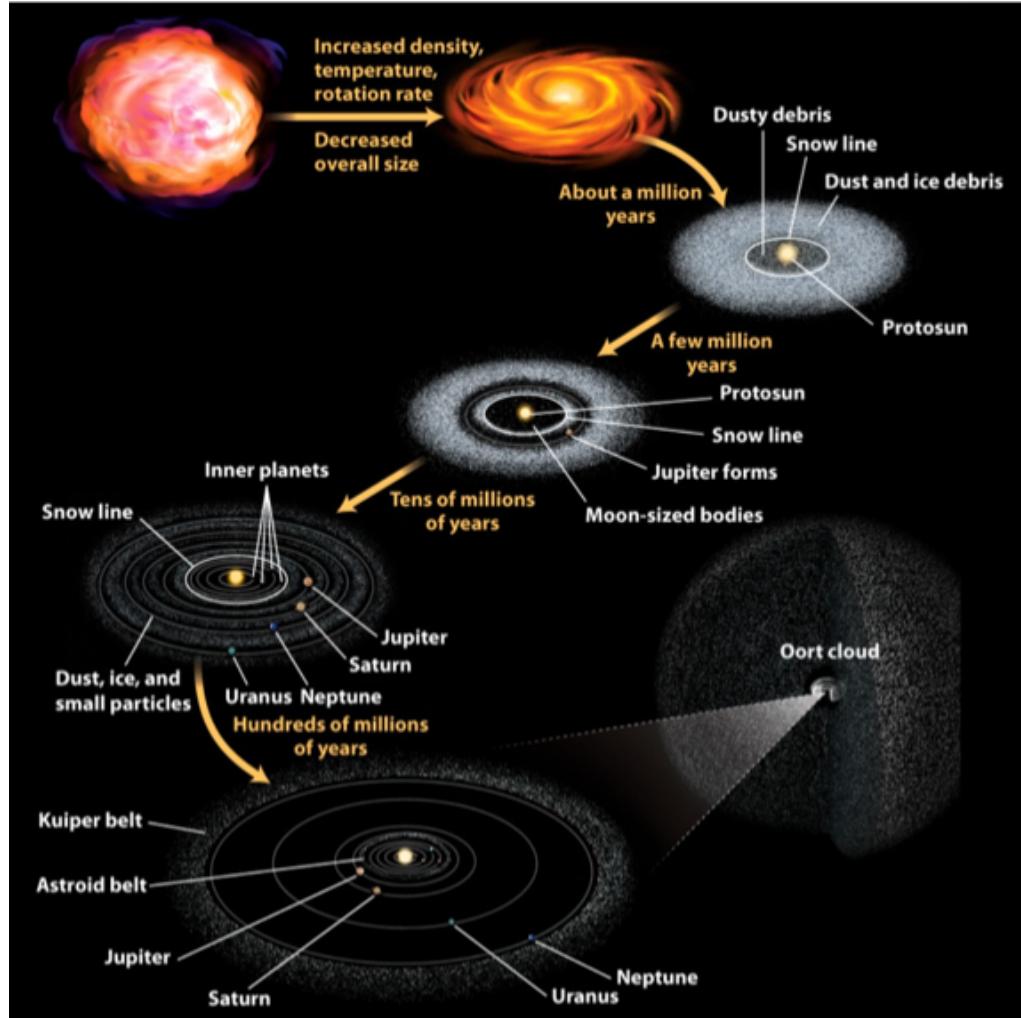
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The Solar System



Formation of the Solar System



Heavier elements like iron migrate towards the center of the orbit, i.e. the Sun → **terrestrial planets** formed near the Sun

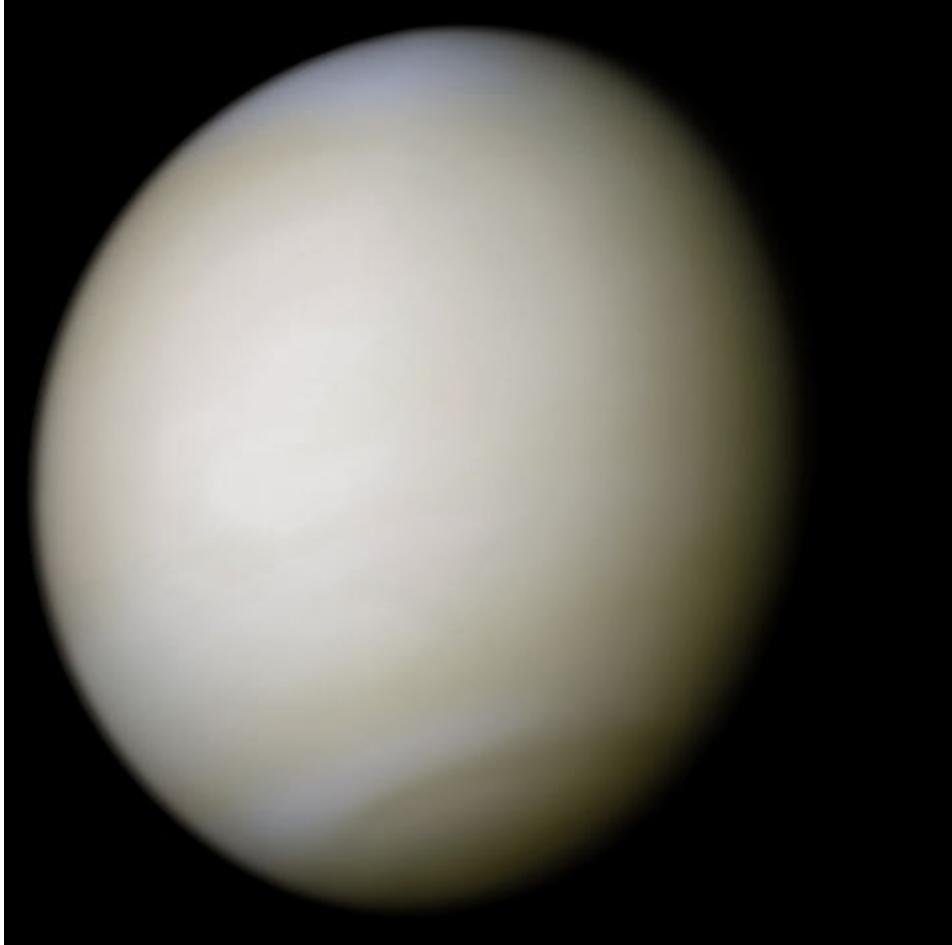
Lighter elements like hydrogen, a gas, migrate towards the outer orbit → **Giant gas planets** formed away from the Sun

Mercury



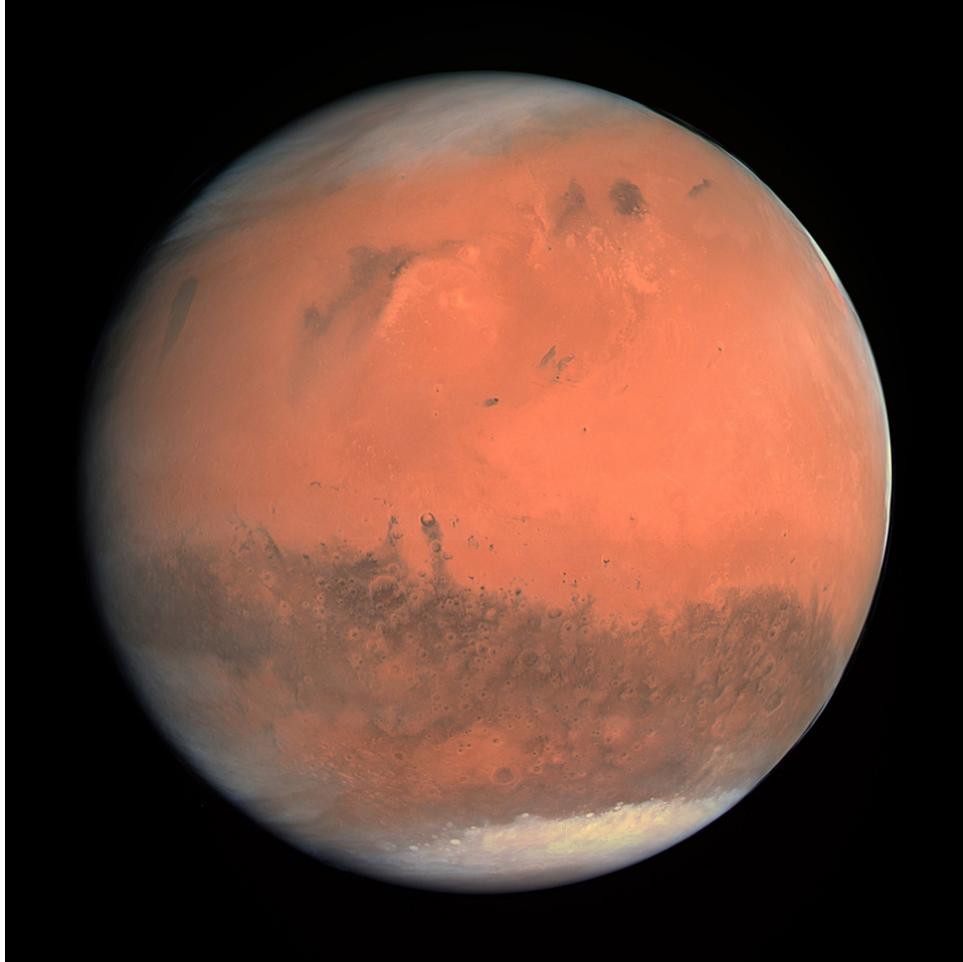
- First confirmed record of Mercury dates to about the 14th century BC, by the Assyrians.
- No moons.
- *Almost no atmosphere* (10^{-9} Pa, about 10 trillion times less than Earth).
- *Mariner 10* and *Messenger* missions to Mercury in 1973 and 2008, respectively.
- Surface shows evidence of many collisions with smaller bodies, similar to the moon.
- Distribution of collisions suggest that Mercury is 4 billion years old.

Venus



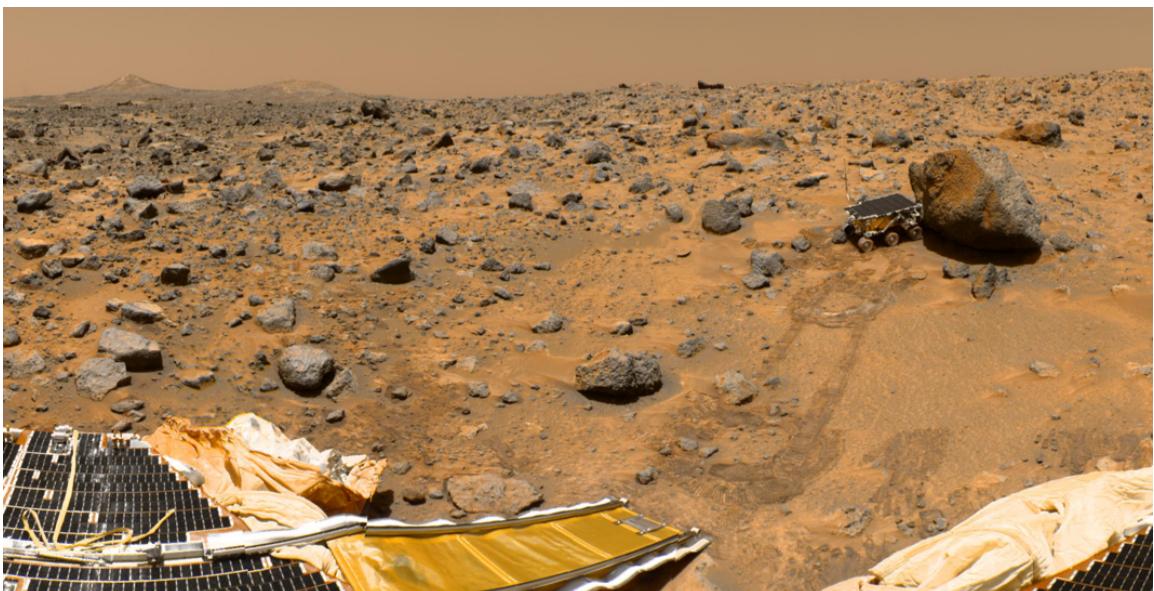
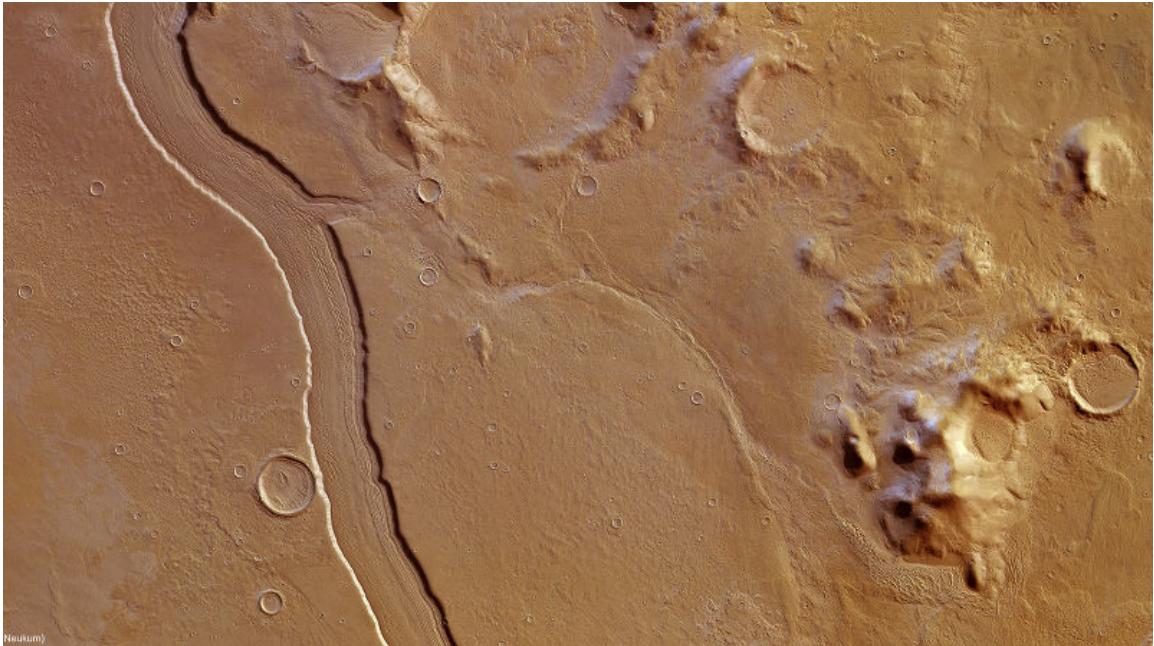
- First observed by the Sumarians in the 2nd millennium BC.
- No moons.
- Has an atmosphere (10^7 Pa, about 100 times greater than Earth), made mostly of CO₂ and sulfuric acid, so is toxic. Venus is also very hot, at an average temperature of 872°F.
- Several *Mariner* missions went to Venus in the 1960's and 1970's.
- Smooth surface with two continent-sized land features.
- Highly volcanic (hence the toxic atmosphere).

Mars

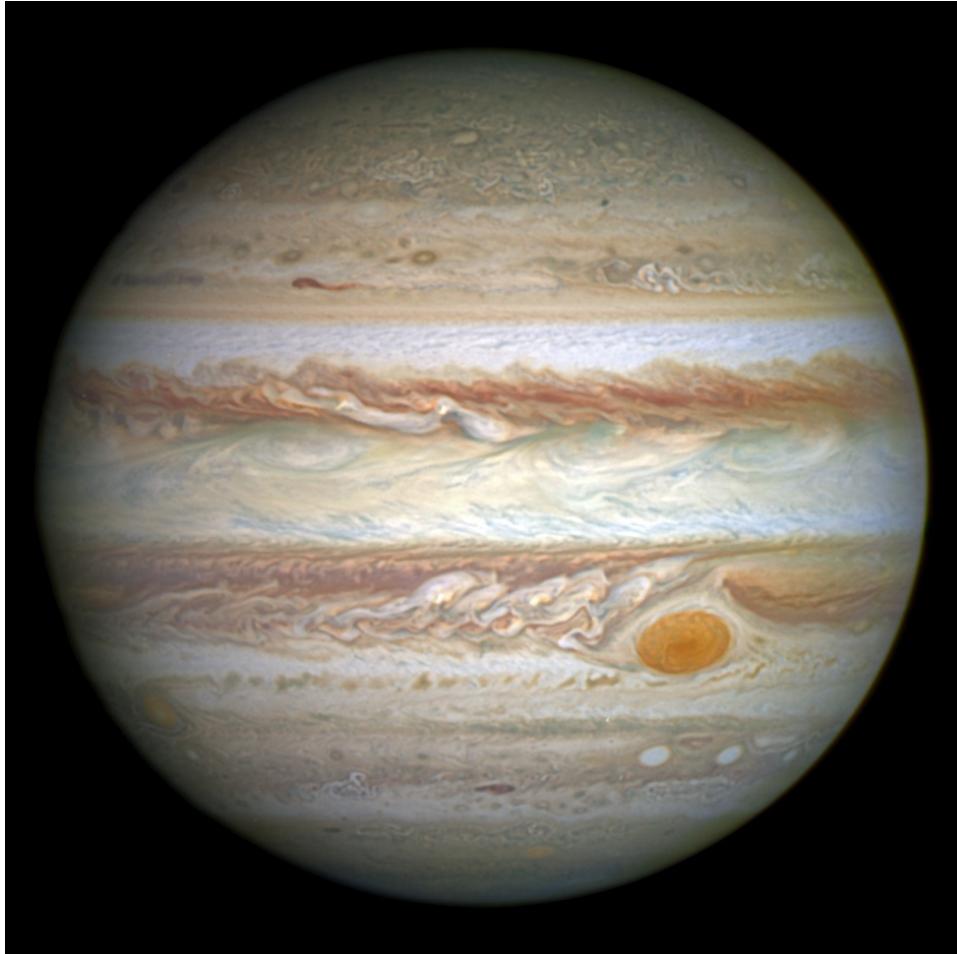


- First observed by the Sumerians in the 2nd millennium BC.
- Two moons, Phobos and Deimos.
- Very little atmosphere (600 Pa, about 100 times less than that of the Earth's), mostly CO².
- We've landed rovers on Mars (currently *Curiosity*).
- Evidence found for previous existence of liquid water on Mars.
- Loss of Martian atmosphere possibly due to loss of magnetosphere:
https://en.wikipedia.org/wiki/File:Solar_Wind_Stripsthe_Martian_Atmosphere.webm

Cool Pictures of Mars

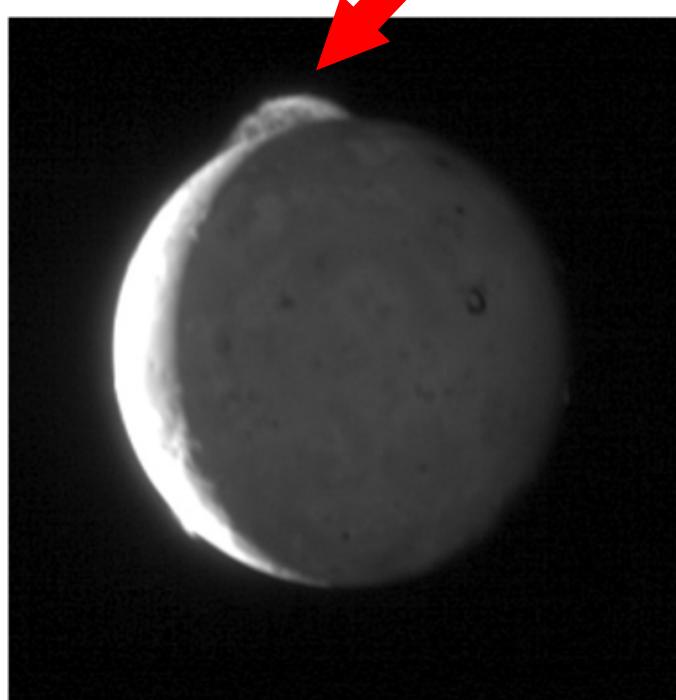
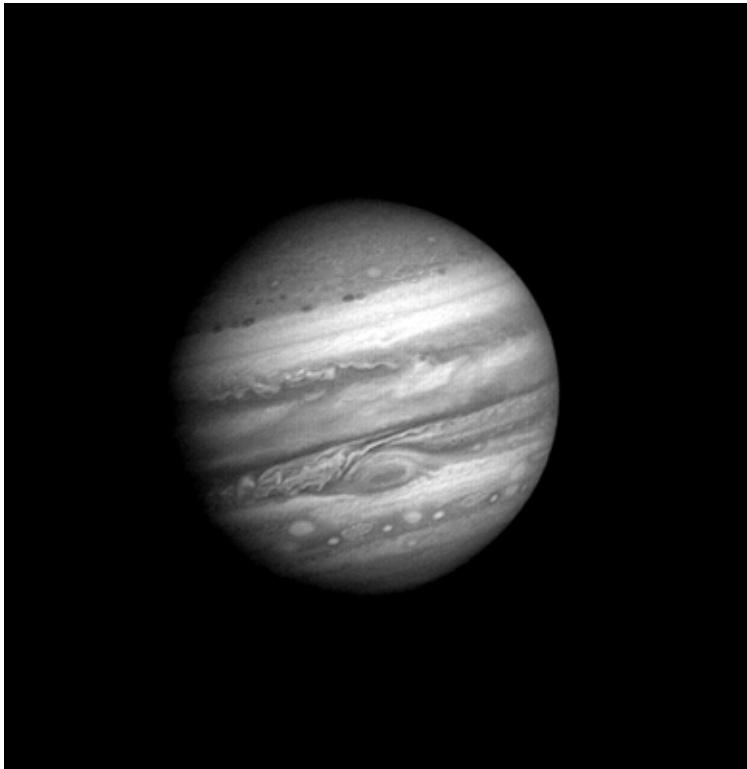


Jupiter



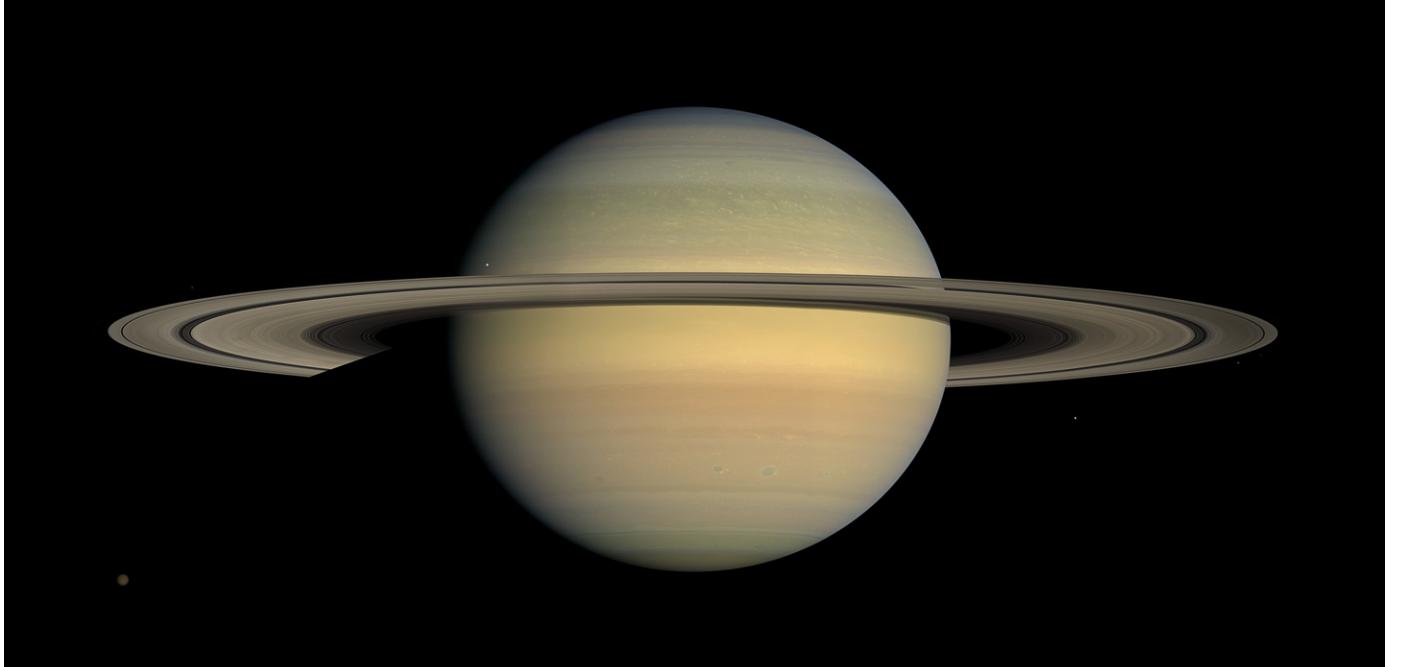
- Jupiter dates back to the Babylonians, around the 8th or 7th century BC.
- 67 moons, the 4 **Galilean moons** are Io, Europa, Ganymede, and Callisto.
- Atmosphere of hydrogen and helium in about the same proportions as the sun (roughly 75% hydrogen, 25% helium).
- Jupiter has a strong magnetosphere which protects it and most of its moons.
- The *Voyager* missions (1979) and the *New Horizons* mission (2007) passed Jupiter, along with many other missions.
- Jupiter has rings like Saturn.

Cool Pictures of Jupiter



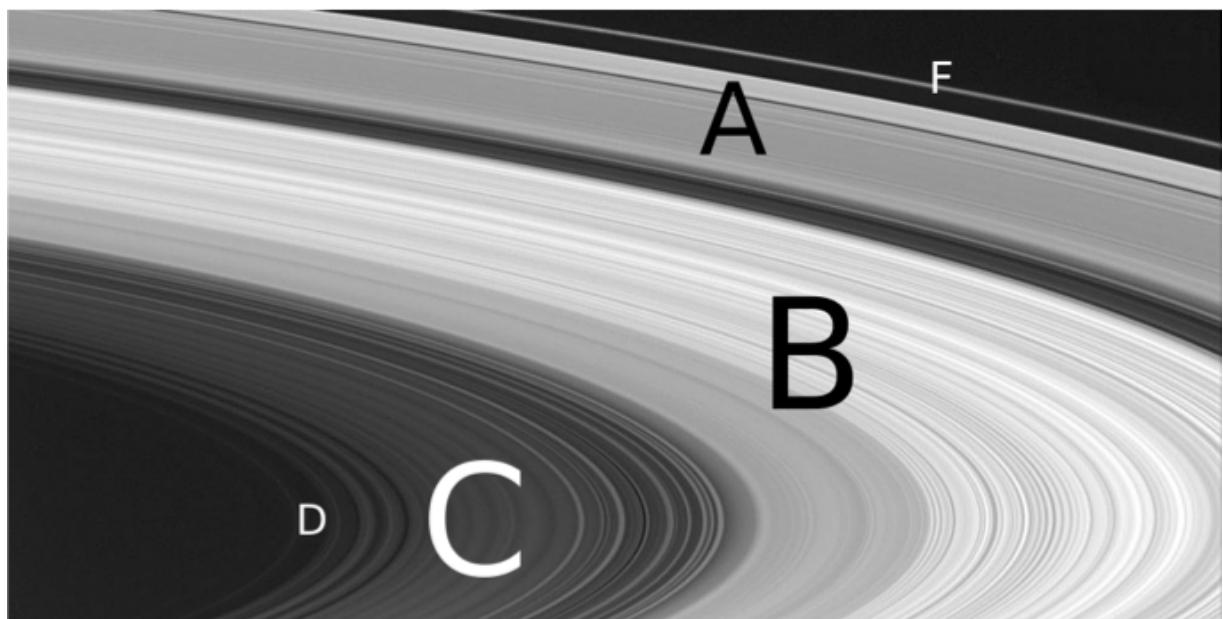
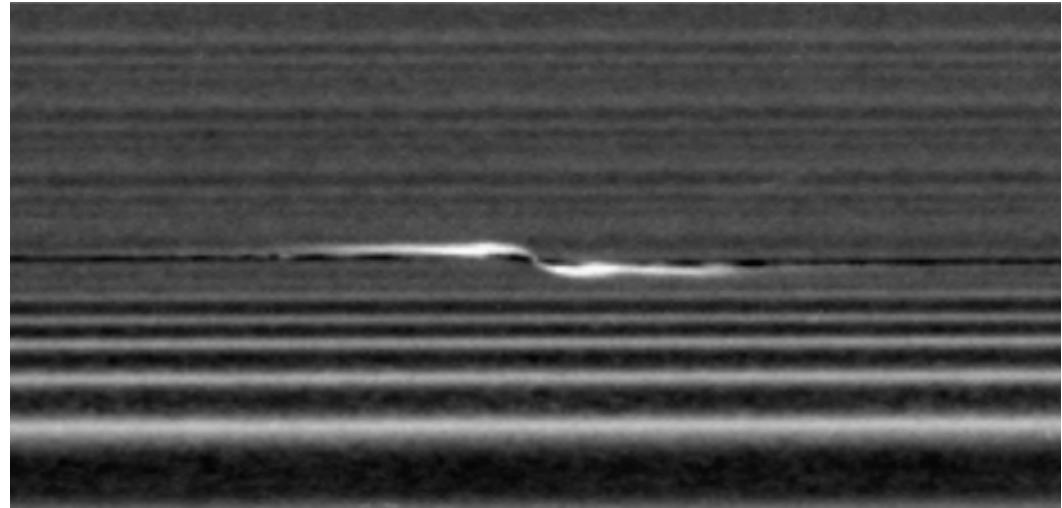
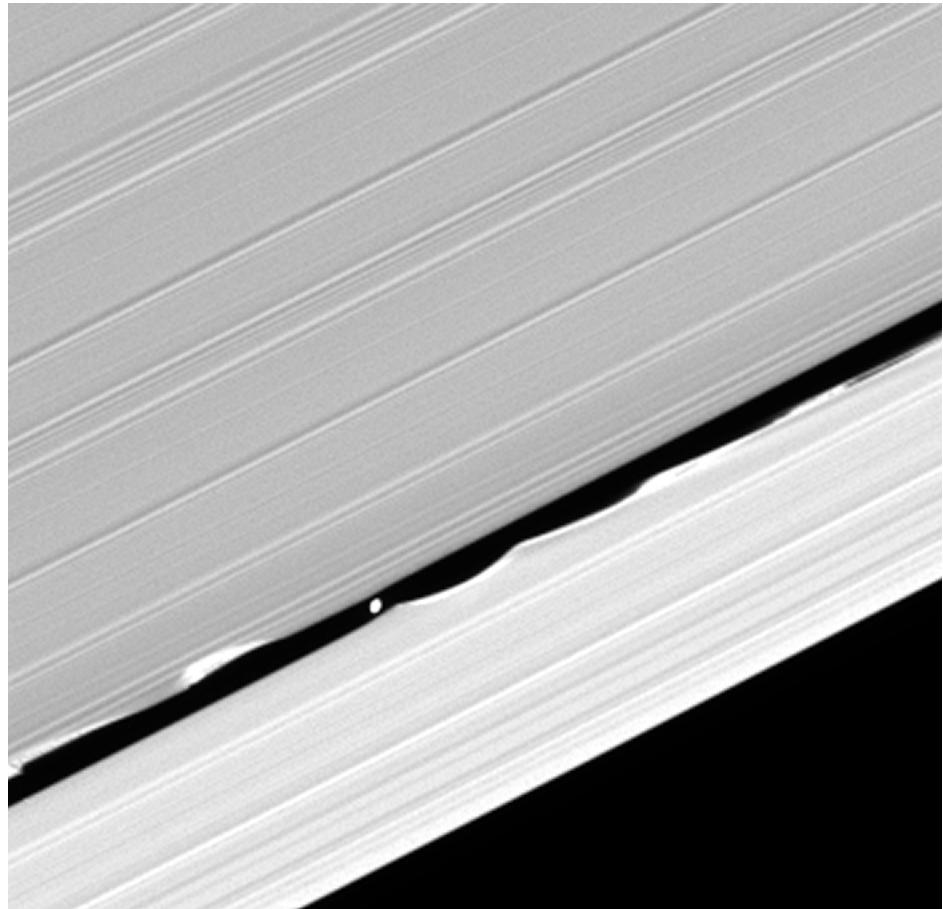
[https://en.wikipedia.org/wiki/Exploration
of_Jupiter#/media/File:790106-
0203_Voyager_58M_to_31M_reduced.gif](https://en.wikipedia.org/wiki/Exploration_of_Jupiter#/media/File:790106-0203_Voyager_58M_to_31M_reduced.gif)

Saturn

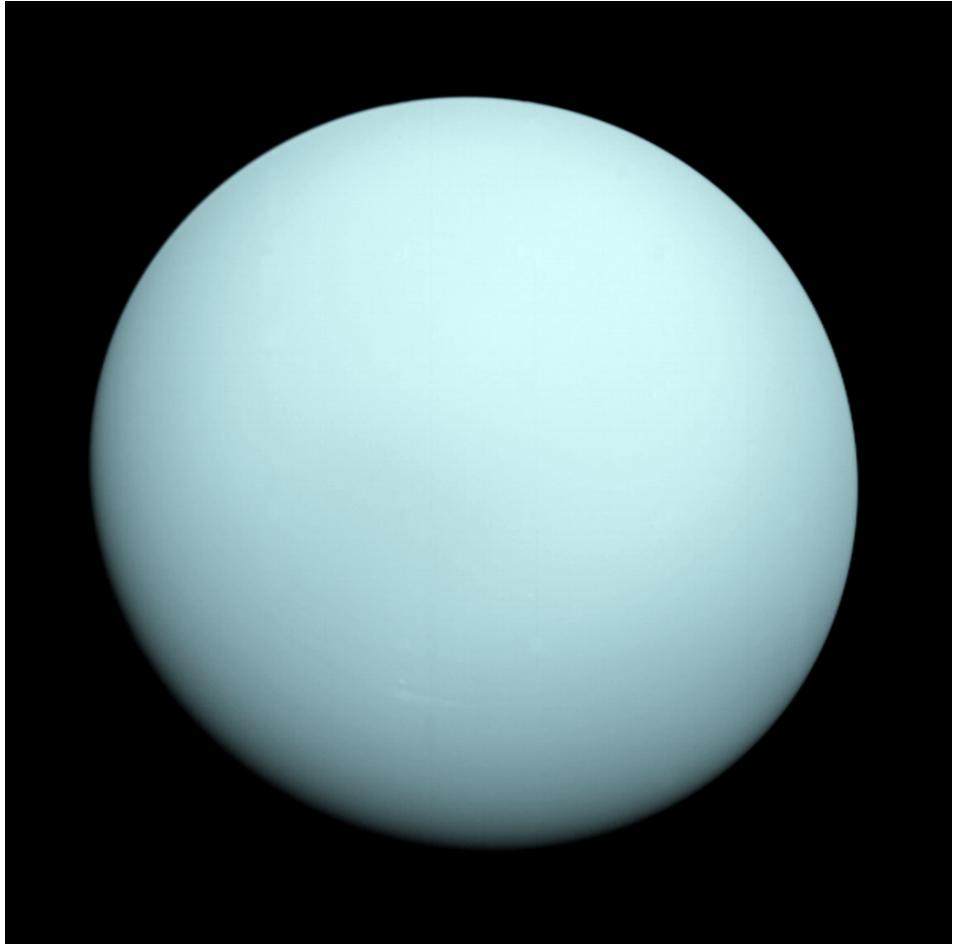


- Observed in pre-historic times, so no precise date exists.
- 62 moons.
- Atmosphere is about 96% hydrogen and 4% helium.
- A few missions to Saturn, including the *Voyager* missions in the 1970's.
- Rings around Saturn are made of tiny dust particles, ranging from a micrometer to a meter in size. Gaps in the rings are explained by the presence of moons in them.

Cool Pictures of Saturn

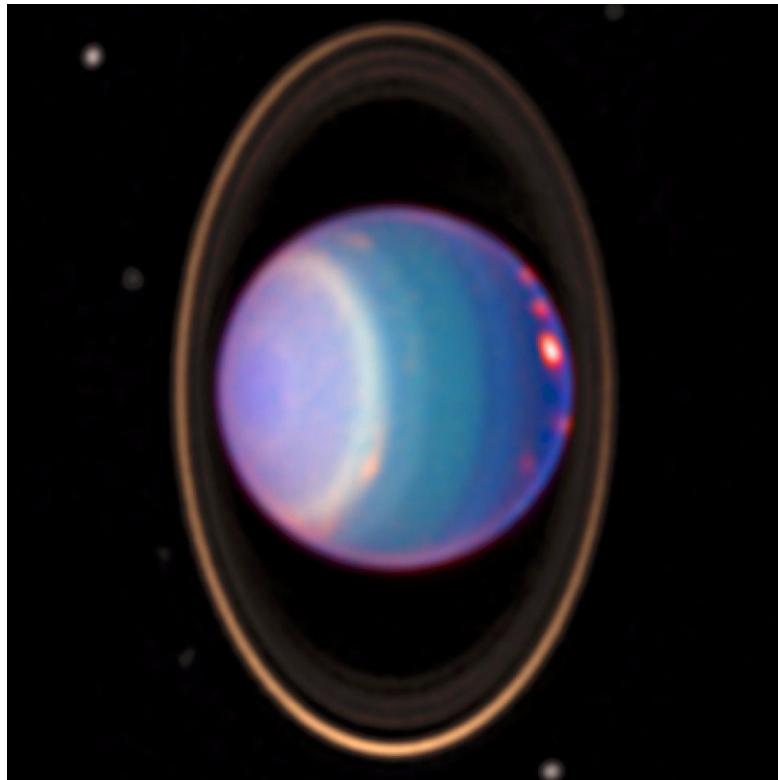


Uranus

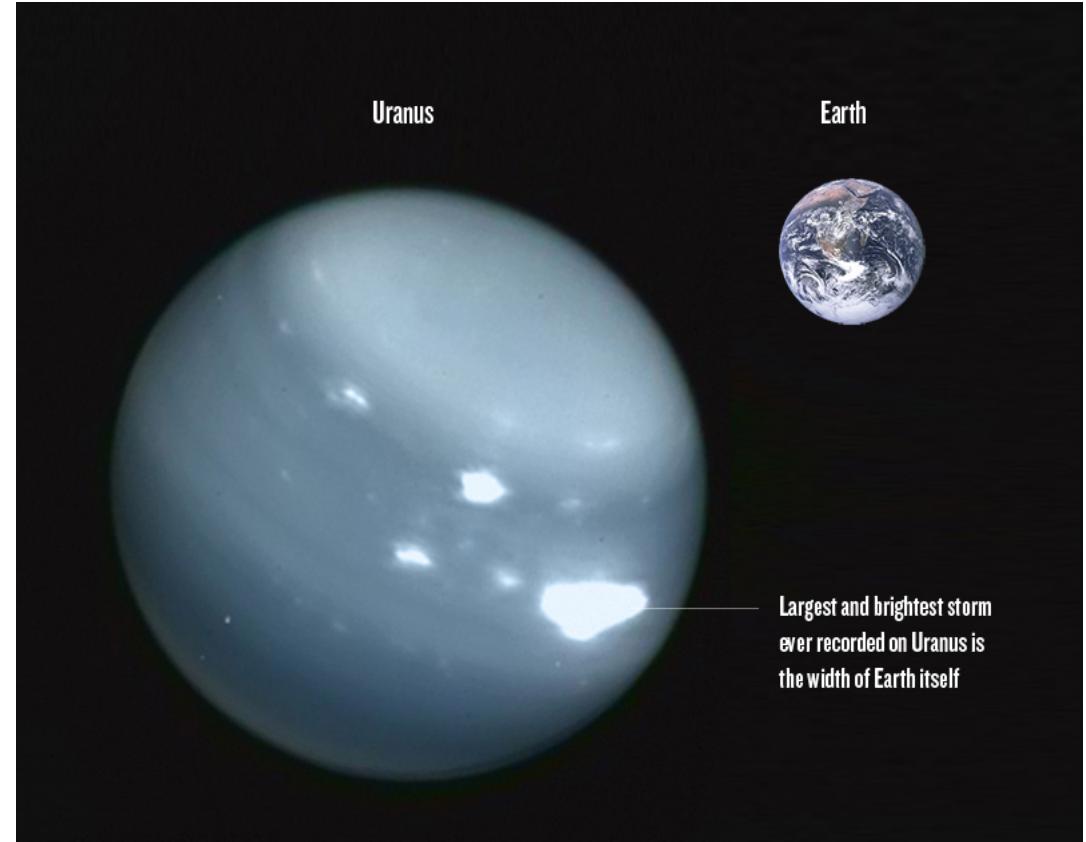


- First observed by the Sumerians in the second millennium, BC.
- 27 moons.
- Atmosphere is about the same as Jupiter (74% hydrogen, 26% helium).
- Only one mission to Uranus up to this date: *Voyager 2* in the 1970's.
- Uranus has rings.

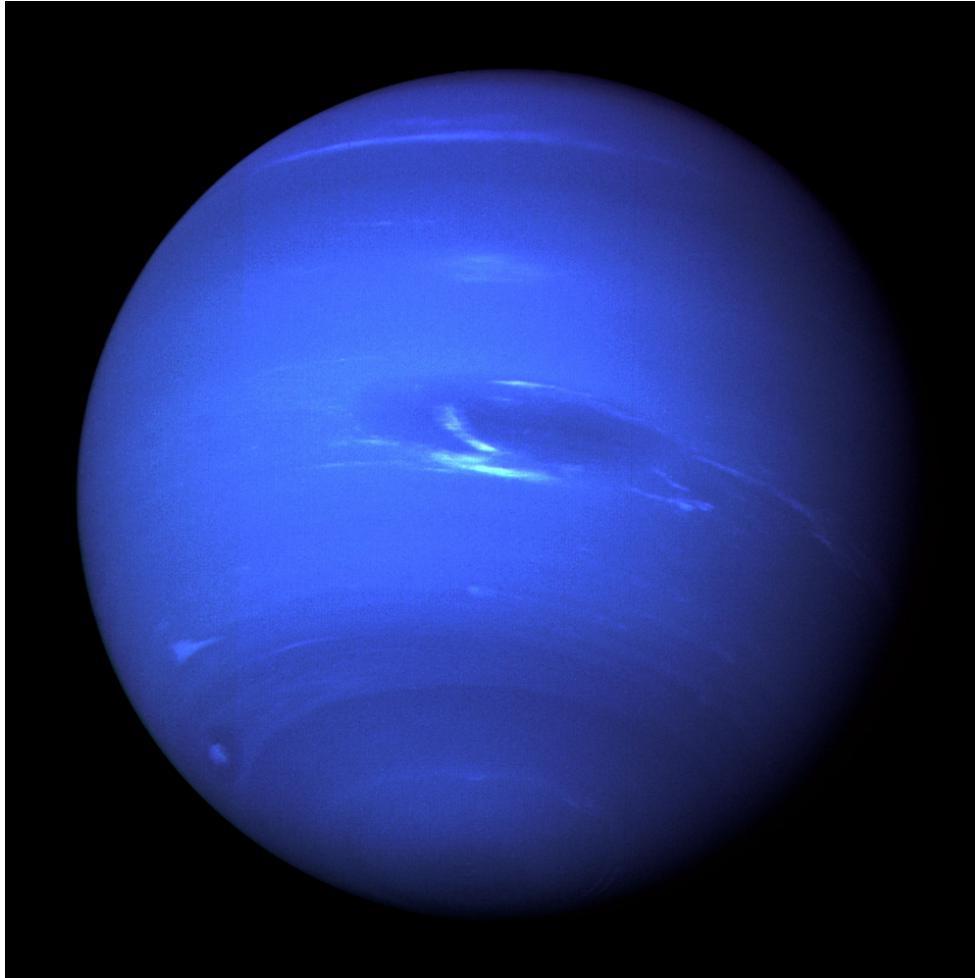
Cool Pictures of Uranus



Hubble near-IR false-color image.

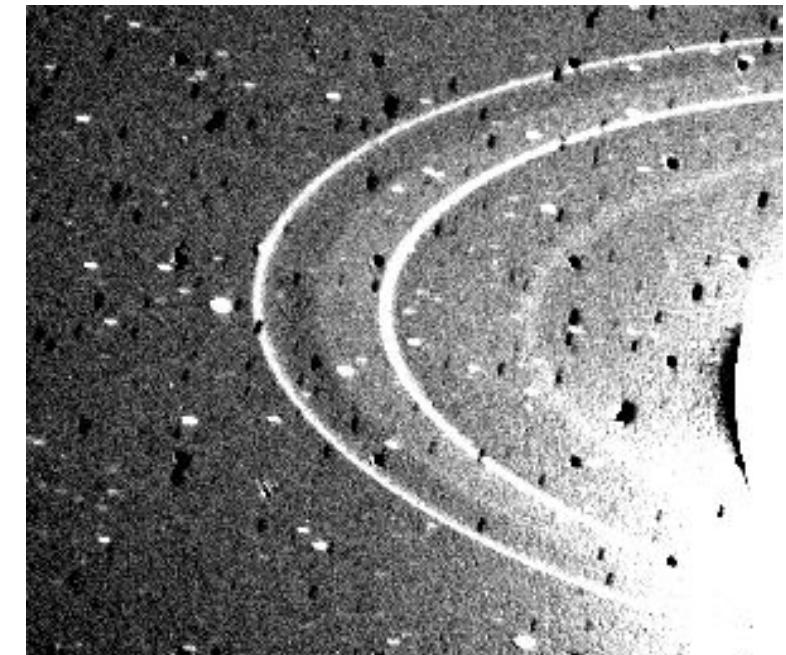
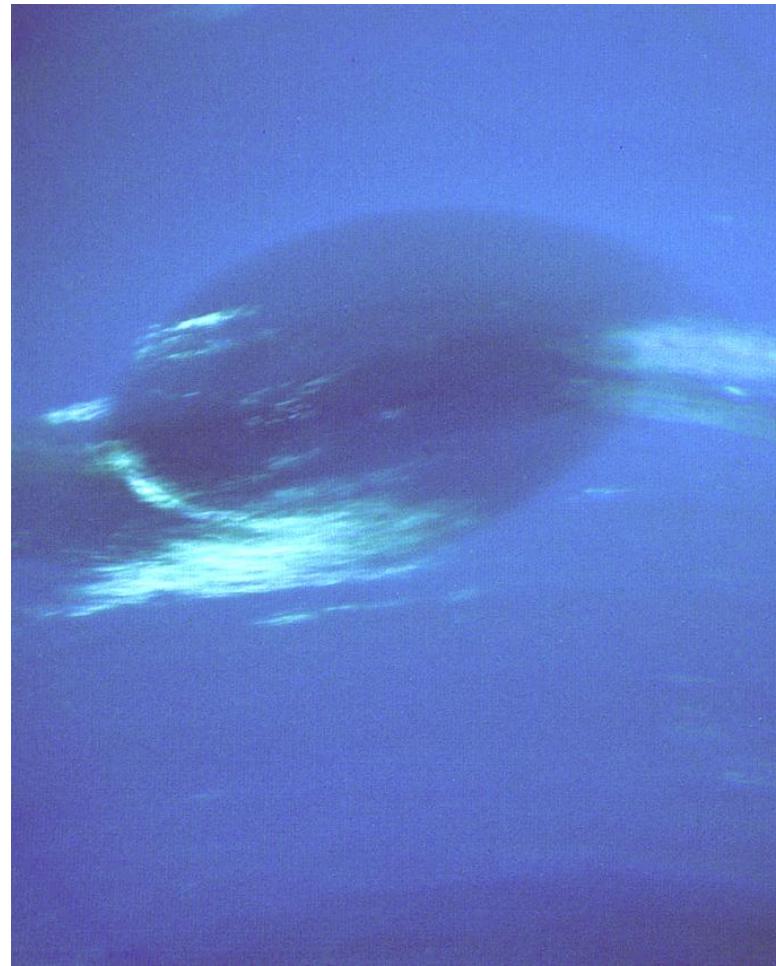
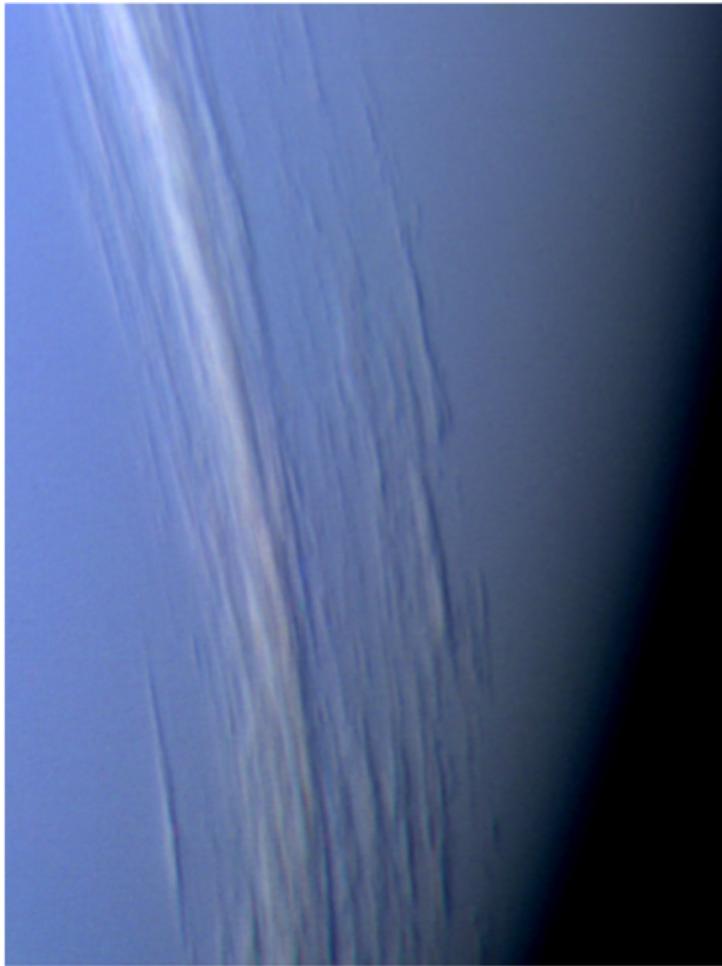


Neptune

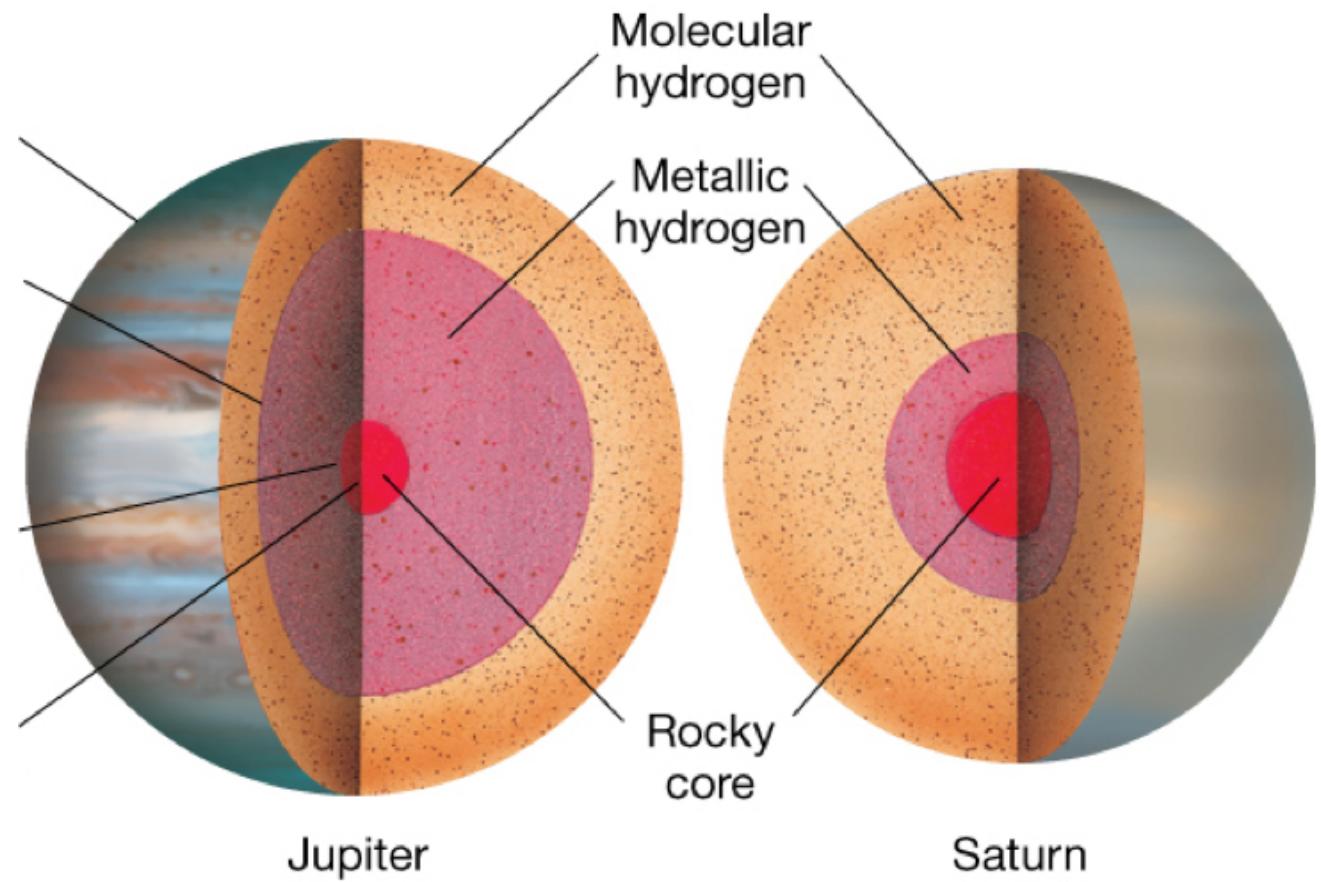
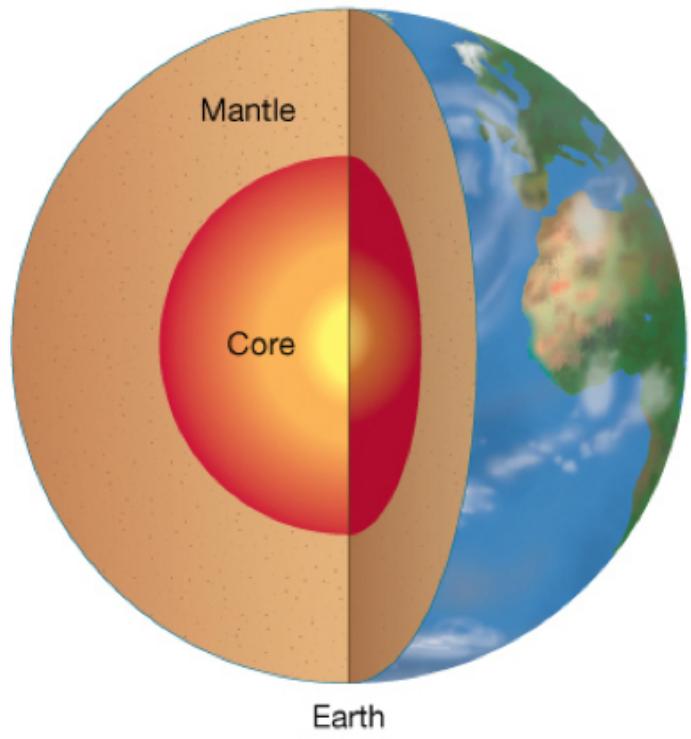


- First observed by the Sumerians in the second millennium, BC.
- 14 moons.
- Atmosphere is 80% hydrogen, 19% helium, and 1% methane.
- Only missions to Neptune was *Voyager 2*, in the 1970's.
- Like Jupiter, large storms exist on Neptune (the “Great Dark Spot” is the most famous).

Cool Pictures of Neptune



Planetary Interiors



Jovian Magnetic Fields

