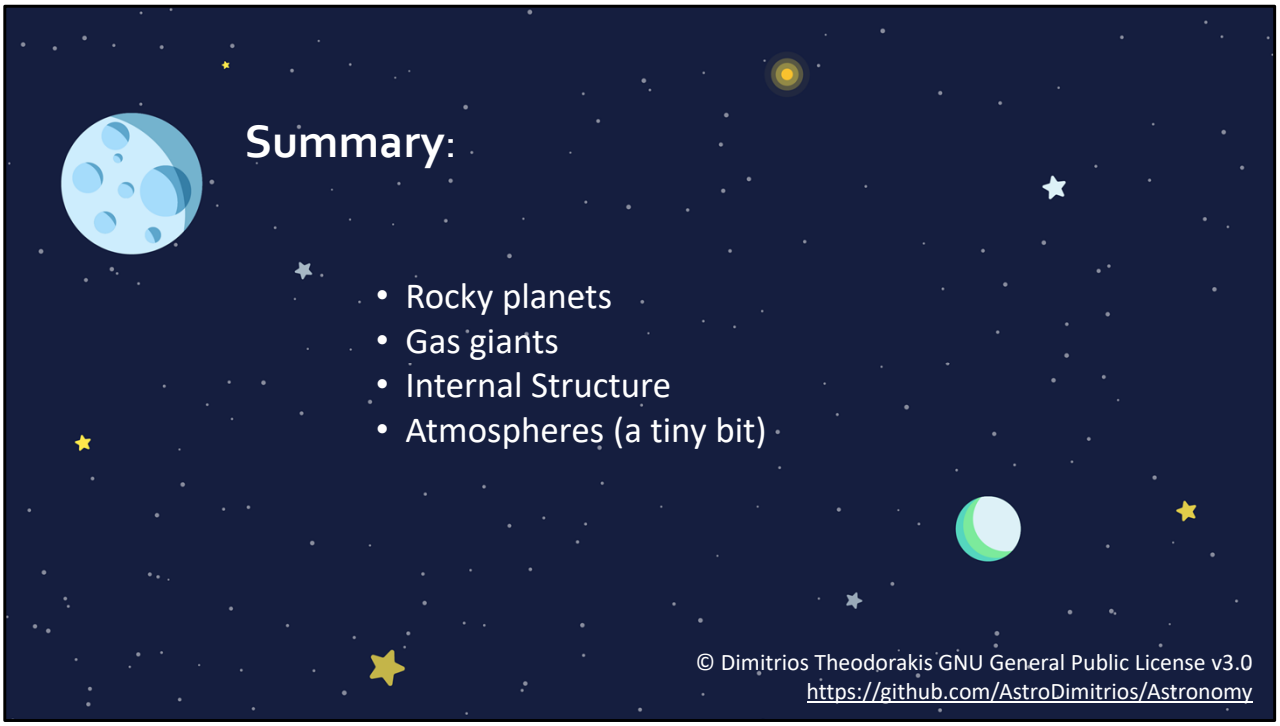


Great Kurzgesagt video on the Solar System:
https://www.youtube.com/watch?v=KsF_hdjWJjo


The Planets
© Dimitrios Theodorakis GNU General Public License v3.0
https://github.com/AstroDimitrios/Astronomy

Recap

1. What lies in-between Mars and Jupiter?
2. Where is the edge of the solar system?
3. What happened when Uranus and Neptune swapped positions during the formation of the SS?

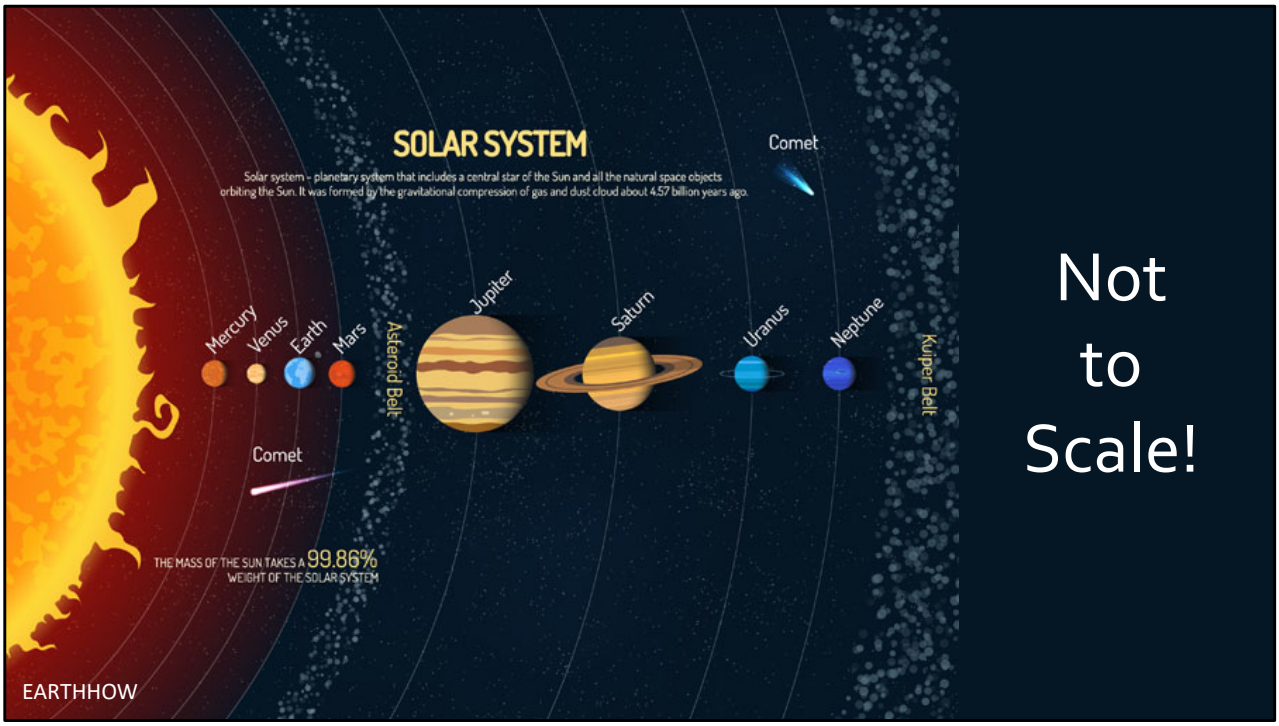
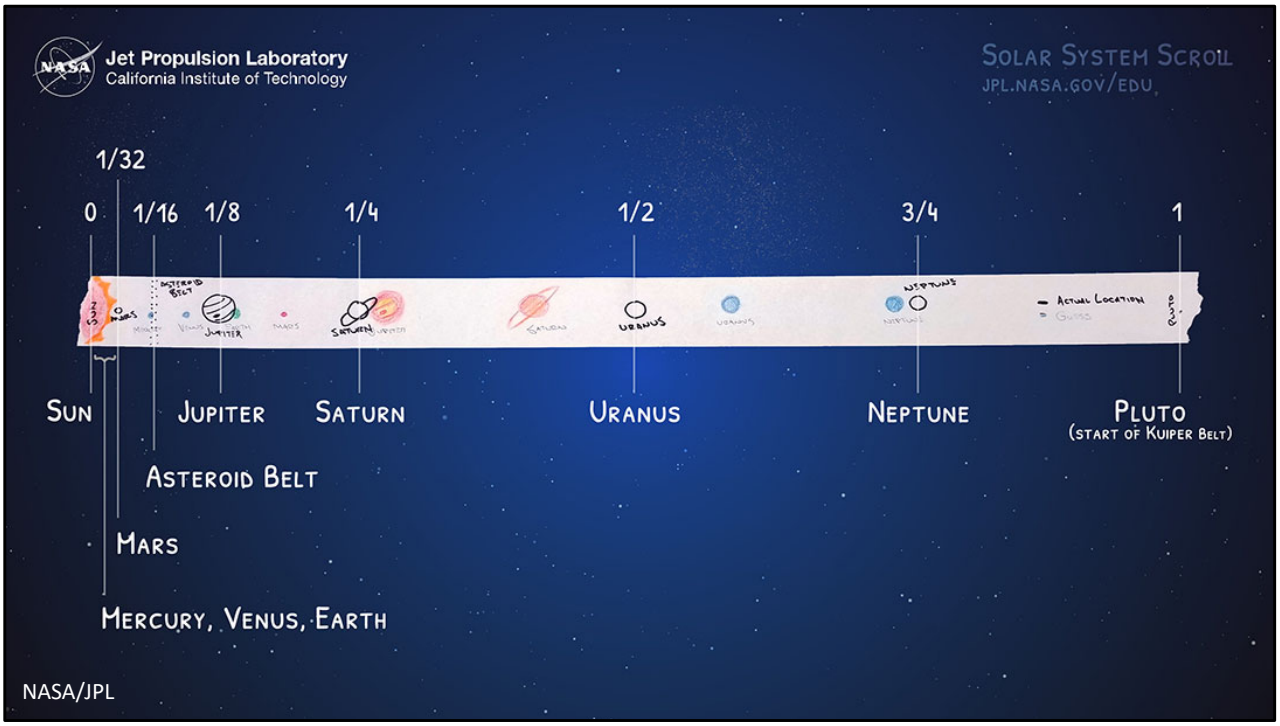


Diagram of the SS by EarthHow: https://earthhow.com/solar-system-facts/

Oort cloud not shown!

Formed 4.571 billion years ago
Earth ~ 4.543 billion years



Actual positions! – we did this practical last lesson

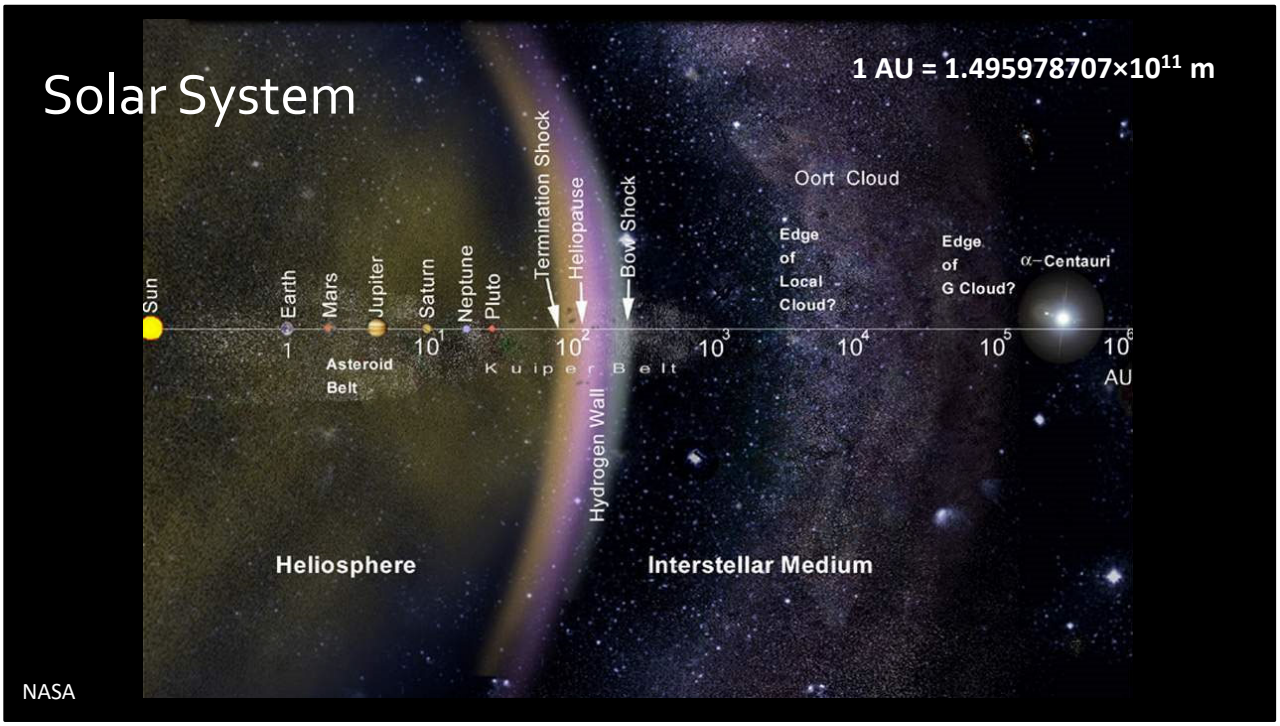


Image from an article about Voyager: https://voyager.jpl.nasa.gov/mission/did-you-know/

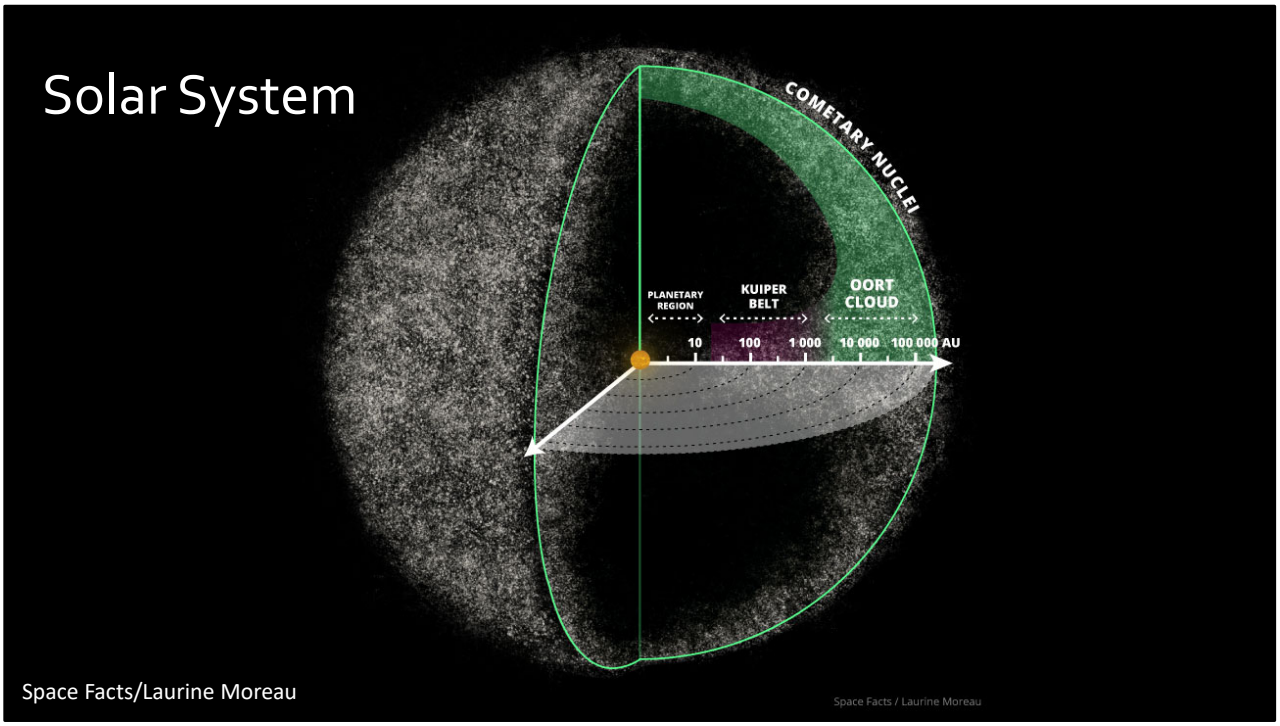
The Oort cloud extends to 1/5 the distance to the nearest star!

Notice the log scale

Termination shock – particles slow to less than the speed of sound
Heliopause – pressure from outside is the same as from the solar wind

Theoretical wall of Hydrogen just after the heliopause
Little to no bow shock around our Sun.

Oort cloud marks edge of gravitational influence of the Sun. All of that is embedded in the Local Cloud next to the G cloud which contains alpha Centauri. Outside the Oort cloud is interstellar space.



Zoomed out to see the spherical shape of the cloud

Hard to visualise large numbers try making as many tallies on a piece of paper that you can in 60 s. How long would it take us to make a million tallies?
These are huge numbers!

Inner Oort cloud is disk shaped after Kuiper Belt and the outer cloud is spherical.
Source of long period comets!

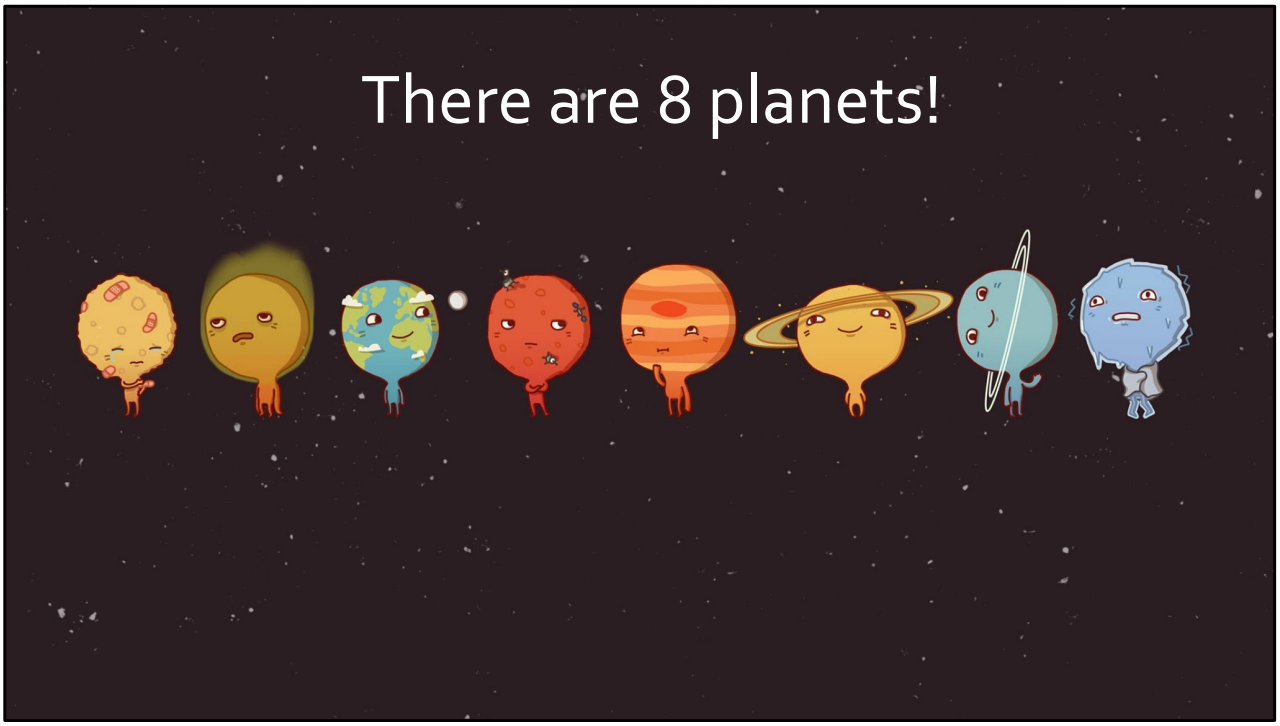
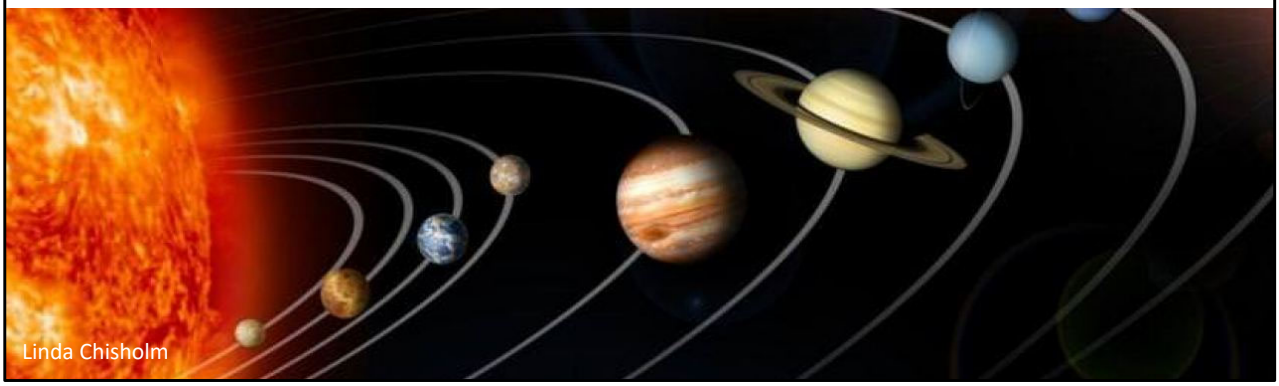


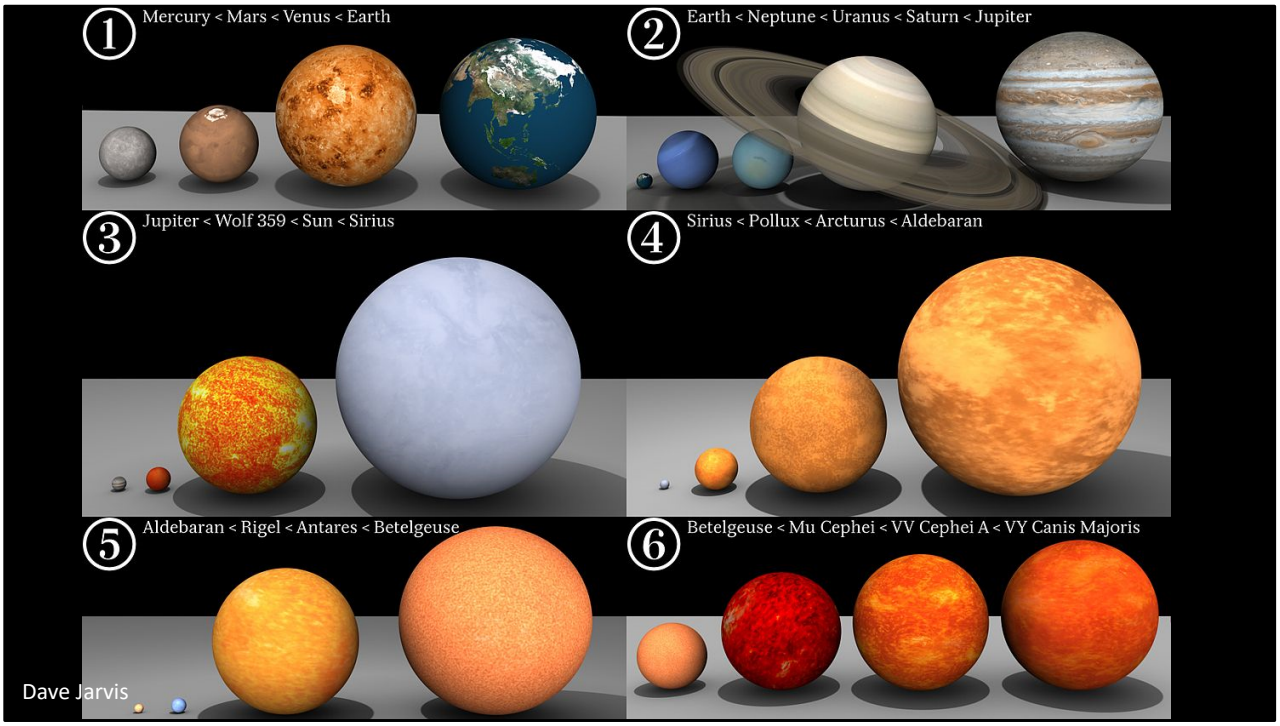
Image Author Unknown

Can you name the planets in order?

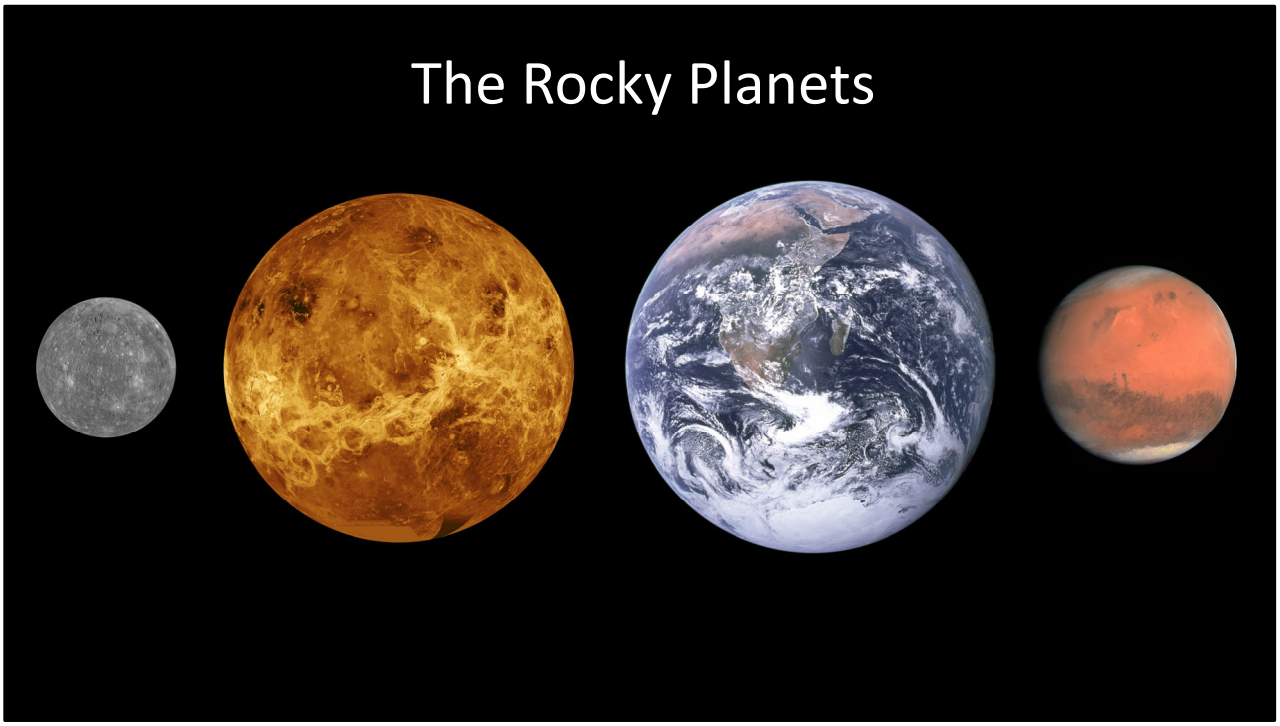
Mercury	My
Venus	Vicious
Earth	Earthworm
Mars	Might
Jupiter	Just
Saturn	Swallow
Uranus	Us
Neptune	Now



Easy way to remember the order.

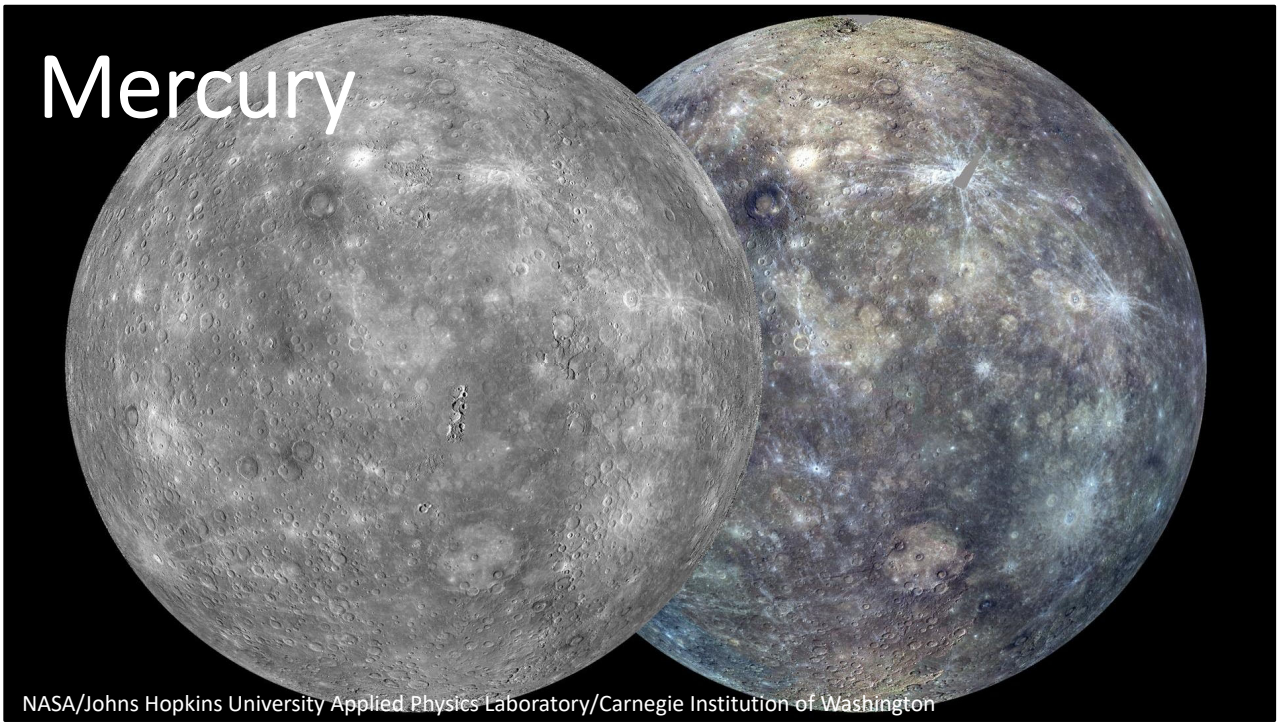


Planets to scale with stars for comparison.



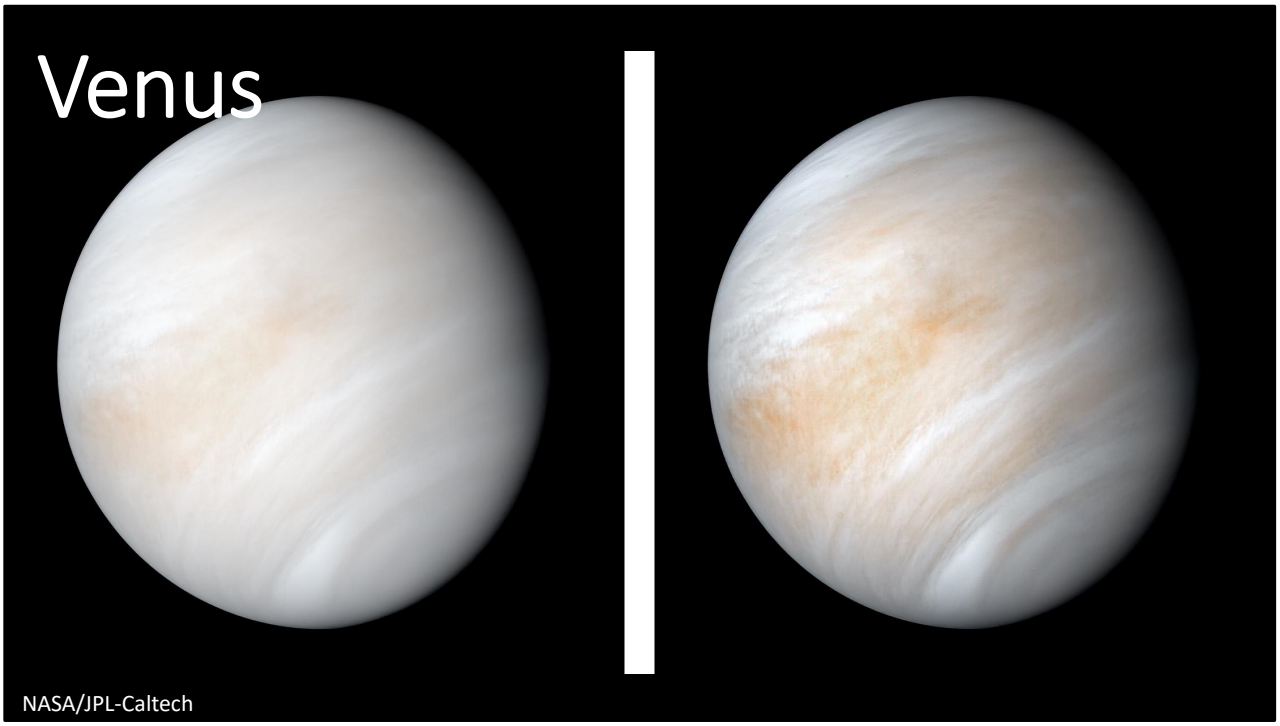
Mercury image: NASA/JHUAPL
Venus image: NASA
Earth image: NASA/Apollo 17 crew
Mars image: ESA/MPS/UPD/LAM/IAA/RSSD/INTA/UPM/DASP/IDA

Scales are roughly correct, distances between them not so much.



Original Caption Released with Image: The view shown here is similar to an earlier one, posted in October 2011, but now the coverage is more complete. The globe on the left was created from the MDIS monochrome surface morphology base map campaign. The globe on the right was produced from the MDIS color base map campaign. Each map is composed of thousands of images, and the color view was created by using 3 of the 8 color filters acquired. (1000, 750, and 430 nm wavelengths are displayed in red, green, and blue, respectively.) On March 8, 2013, these global maps will be publicly released at full resolution by NASA's Planetary Data System.
Instrument: Mercury Dual Imaging System (MDIS)
Center Latitude: 0°
Center Longitude: 75° E
Scale: Mercury's diameter is 4880 kilometers (3030 miles).
Map Projection: orthographic

PIA16858



PIA23791: Venus from Mariner 10
Right is enhanced colour
Images taken on 7 and 8th of Feb 1974.

PIA00104: Venus - Computer Simulated Global View Centered at 180 Degrees East Longitude

Original Caption Released with Image: This global view of the surface of Venus is centered at 180 degrees east longitude. Magellan synthetic aperture radar mosaics from the first cycle of Magellan mapping are mapped onto a computer-simulated globe to create this image. Data gaps are filled with Pioneer Venus Orbiter data, or a constant mid-range value. Simulated color is used to enhance small-scale structure. The simulated hues are based on color images recorded by the Soviet Venera 13 and 14 spacecraft. The image was produced by the Solar System Visualization project and the Magellan science team at the JPL Multimission Image Processing Laboratory and is a single frame from a video released at the October 29, 1991, JPL news conference.

https://www.nasa.gov/image-feature/brilliance-at-night-the-americas-in-darkness

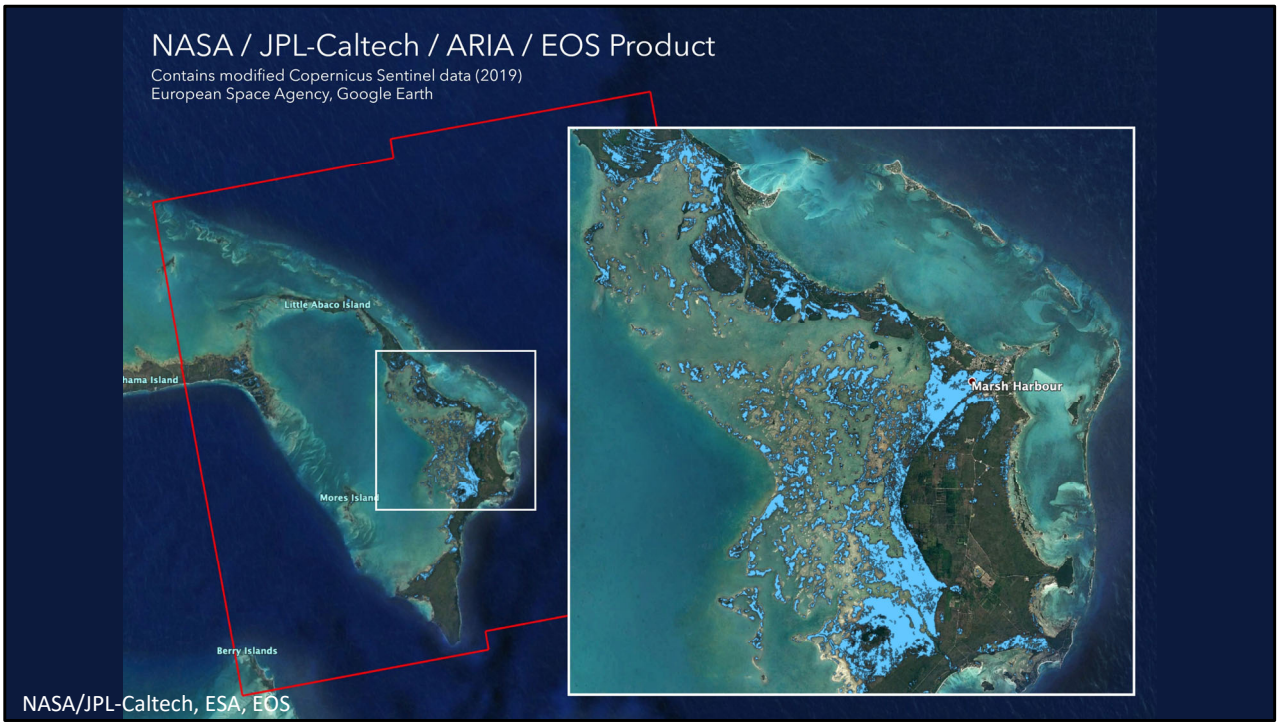
This image's striking nighttime view was made possible by Suomi's "day-night band" of the Visible Infrared Imaging Radiometer Suite. VIIRS detects light in a range of wavelengths from green to near-infrared and uses filtering techniques to observe dim signals such as city lights, gas flares, auroras, wildfires and reflected moonlight. In this case, auroras, fires and other stray light have been removed to emphasize the city lights.

https://www.nasa.gov/image-feature/hurricane-florence-as-it-was-making-landfall

iss056e162819 (Sept. 14, 2018) --- Hurricane Florence is pictured from the International Space Station as a category 1 storm as it was making landfall near Wrightsville Beach, North Carolina.

https://www.nasa.gov/image-feature/earth-enveloped-in-airglow

On October 7, 2018, an astronaut aboard the International Space Station (ISS) shot this photograph while orbiting at an altitude of more than 250 miles over Australia. The orange hue enveloping Earth is known as airglow—diffuse bands of light that stretch 50 to 400 miles into our atmosphere. The phenomenon typically occurs when molecules (mostly nitrogen and oxygen) are energized by ultraviolet (UV) radiation from sunlight. To release that energy, atoms in the lower atmosphere bump into each other and lose energy in the collision. The result is colorful airglow.

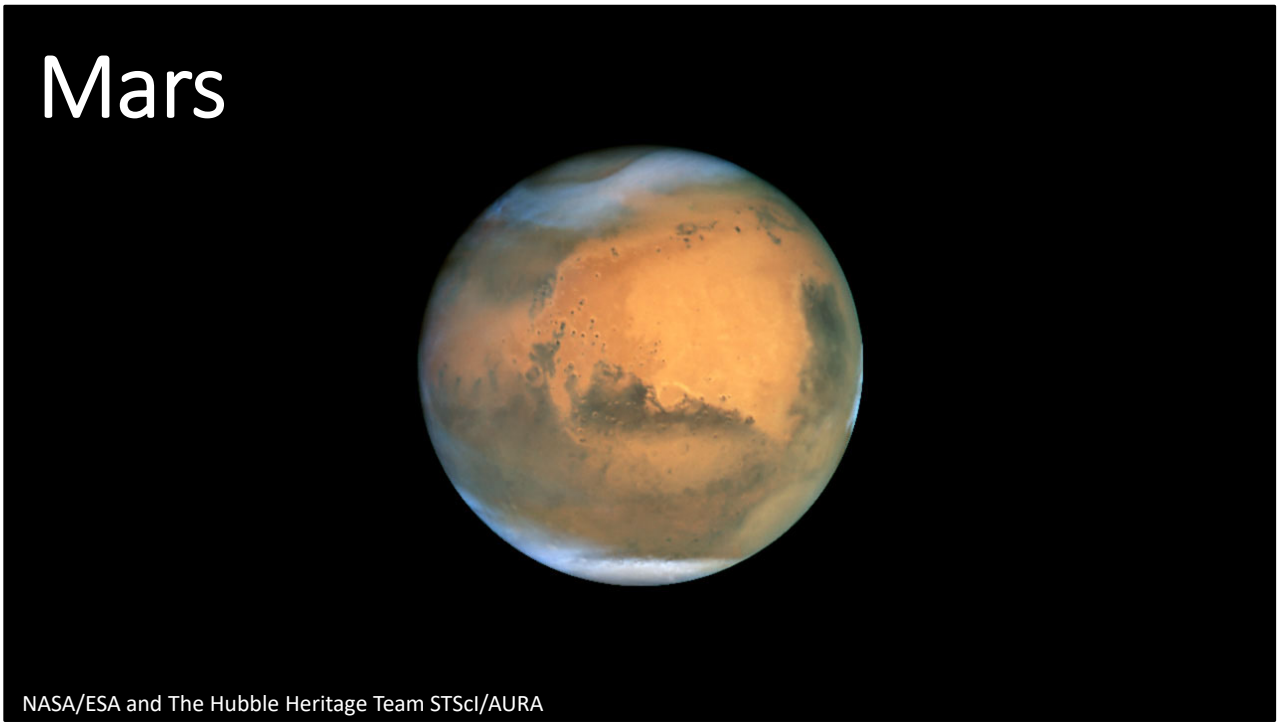


https://photojournal.jpl.nasa.gov/catalog/PIA23360

PIA23360: Flooding from Dorian Seen from Space

Flood map depicting areas of the Bahamas that are likely flooded (shown by light blue pixels) as a result of Hurricane Dorian. The map was derived from synthetic aperture radar (SAR) data acquired on Sept. 2, 2019, by the European Union's Copernicus Sentinel-1 satellites operated by the European Space Agency (ESA). The map covers an area of 109 miles by 106 miles (176 kilometers by 170 kilometers) shown by the large red polygon. Each pixel measures about 32 yards (30 meters) across.

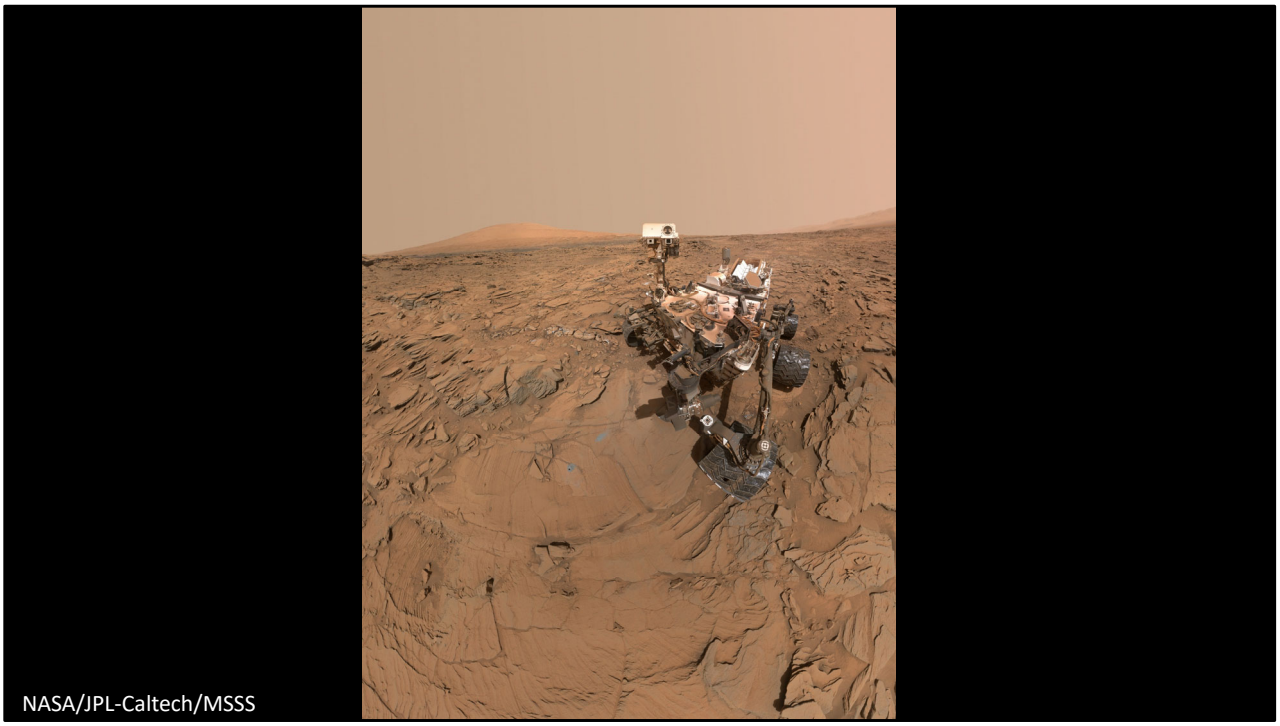
Mars



NASA/ESA and The Hubble Heritage Team STScI/AURA

https://www.spacetelescope.org/images/opo0124a/

Frosty white water ice clouds and swirling orange dust storms above a vivid rusty landscape reveal Mars as a dynamic planet in this sharpest view ever obtained by an Earth-based telescope. The Earth-orbiting Hubble telescope snapped this picture on June 26, when Mars was approximately 43 million miles (68 million km) from Earth - its closest approach to our planet since 1988. Hubble can see details as small as 10 miles (16 km) across. Especially striking is the large amount of seasonal dust storm activity seen in this image. One large storm system is churning high above the northern polar cap [top of image], and a smaller dust storm cloud can be seen nearby. Another large duststorm is spilling out of the giant Hellas impact basin in the Southern Hemisphere [lower right].



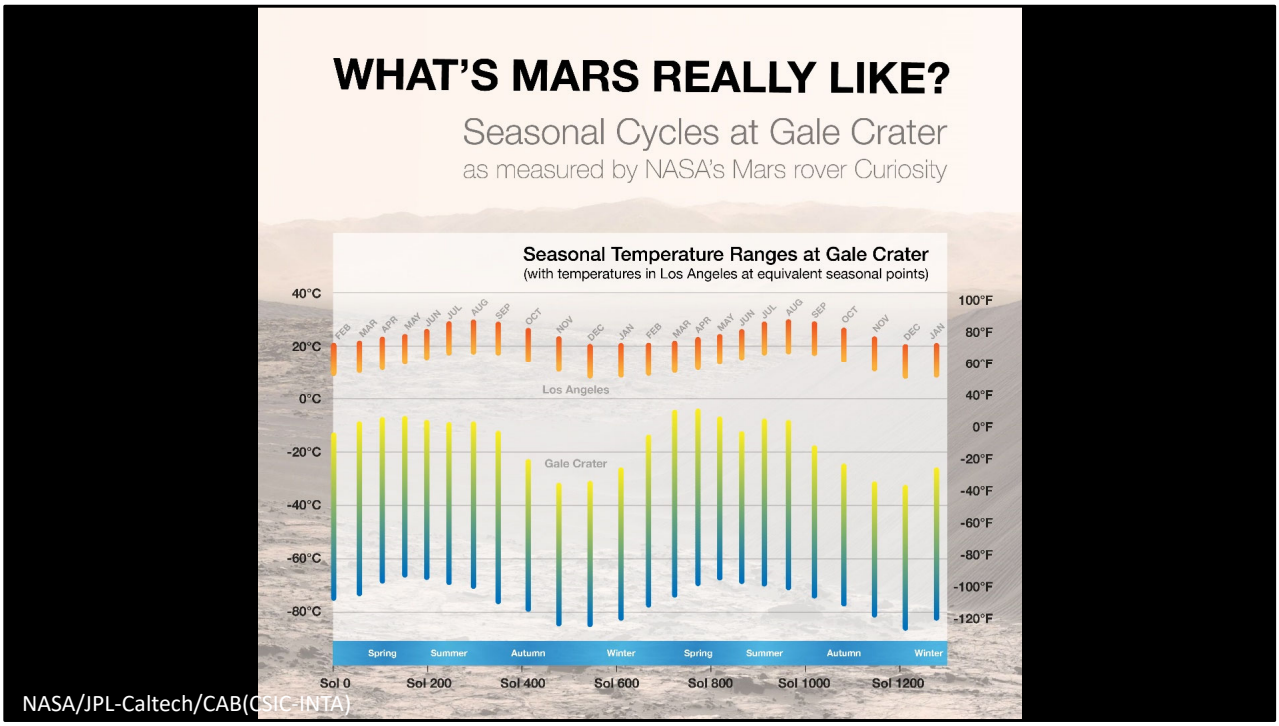
Curiosity Self-Portrait at 'Okoruso' Drill Hole

https://mars.nasa.gov/resources/7856/curiosity-self-portrait-at-okoruso-drill-hole/?site=msl

NASA/JPL-Caltech/SSI

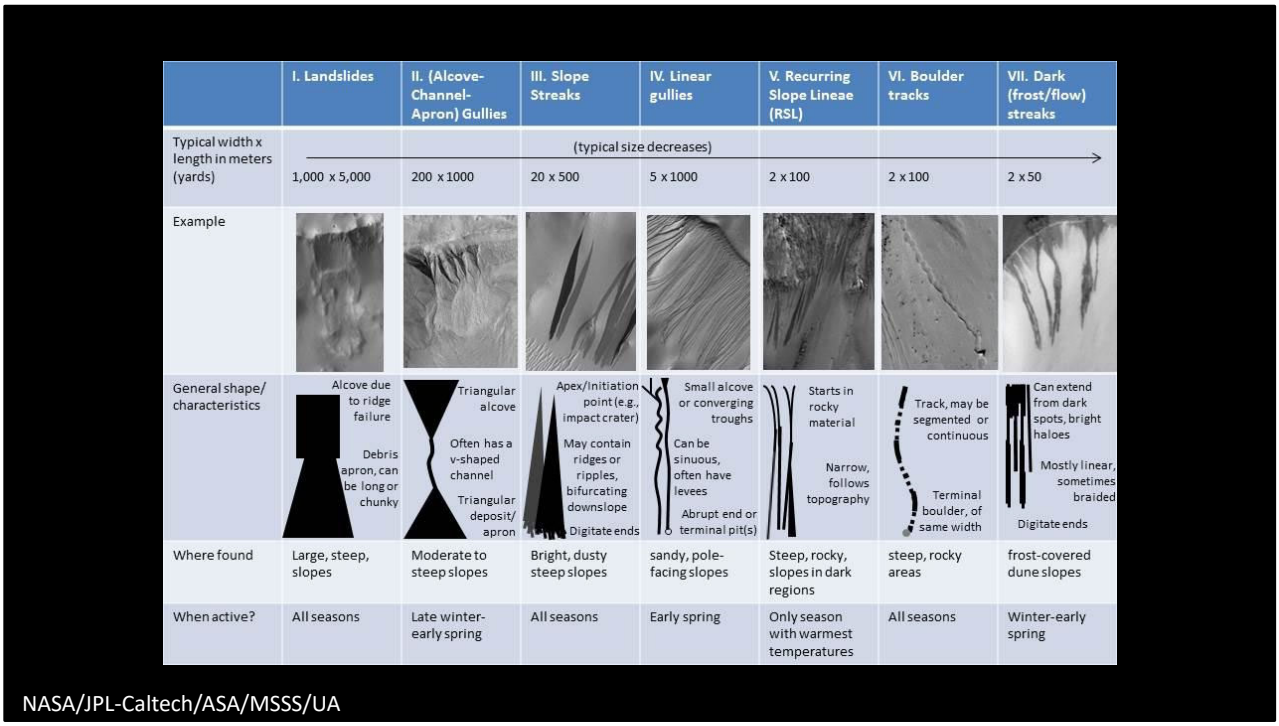
Curiosity Spots a Dust Devil in the Hills

https://mars.nasa.gov/resources/25235/curiosity-spots-a-dust-devil-in-the-hills/?site=msl



NASA/JPL-Caltech/CAB(CSIC-INTA)

https://mars.nasa.gov/resources/7818/seasonal-cycles-in-curiositys-first-two-martian-years/?site=msl



NASA/JPL-Caltech/ASA/MSSS/UA

Martian Features Formed When Material Moves Downslope

As on the Earth, many processes can move material down a Martian slope. This graphic compares seven different types of features observed on Mars that appear to result from material flowing or sliding or rolling down slopes.

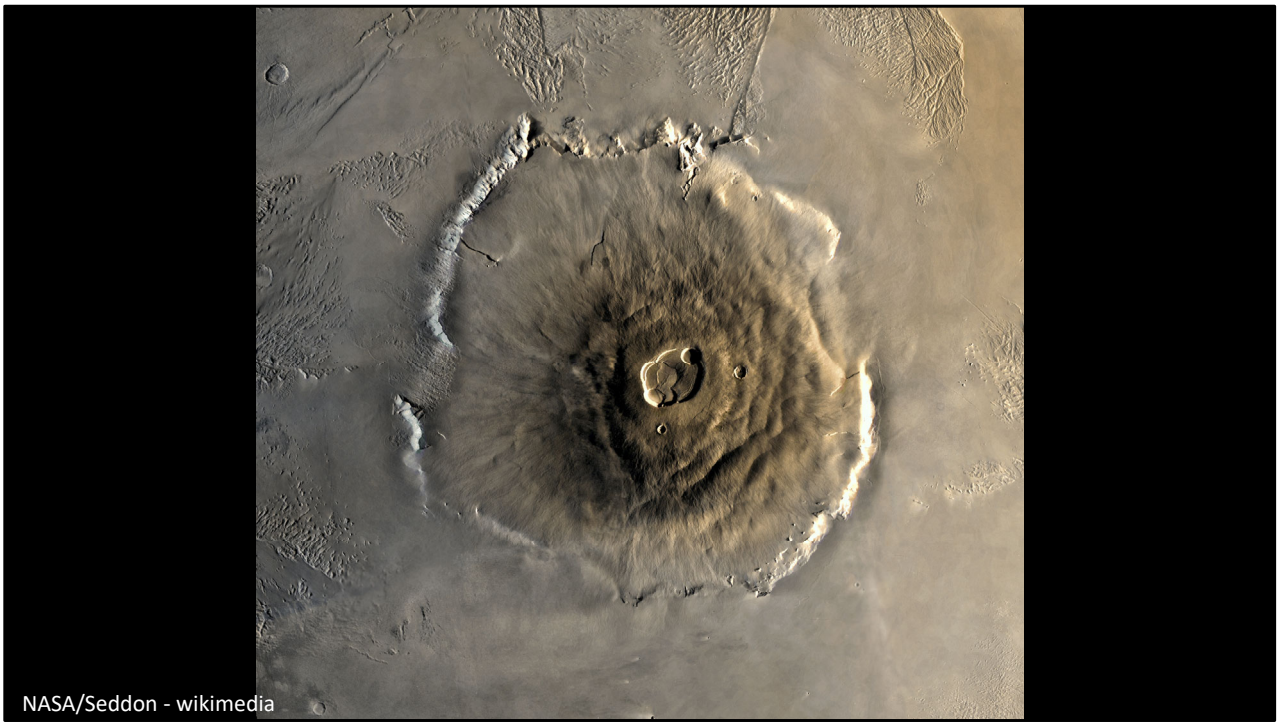
Processes that explain one type of downslope feature may be irrelevant to another type. Some processes depend on the presence of a fluid, some are driven by seasonal changes in the environment, and others occur randomly when gravity is able to pull down unstable slope material.

These different processes can generate a wide range of feature shapes, though sometimes different processes can yield similar-looking results. Thus, to figure out how a feature may have formed, more must be considered than its shape. For example, researchers examining images from Mars orbiters have found differences in

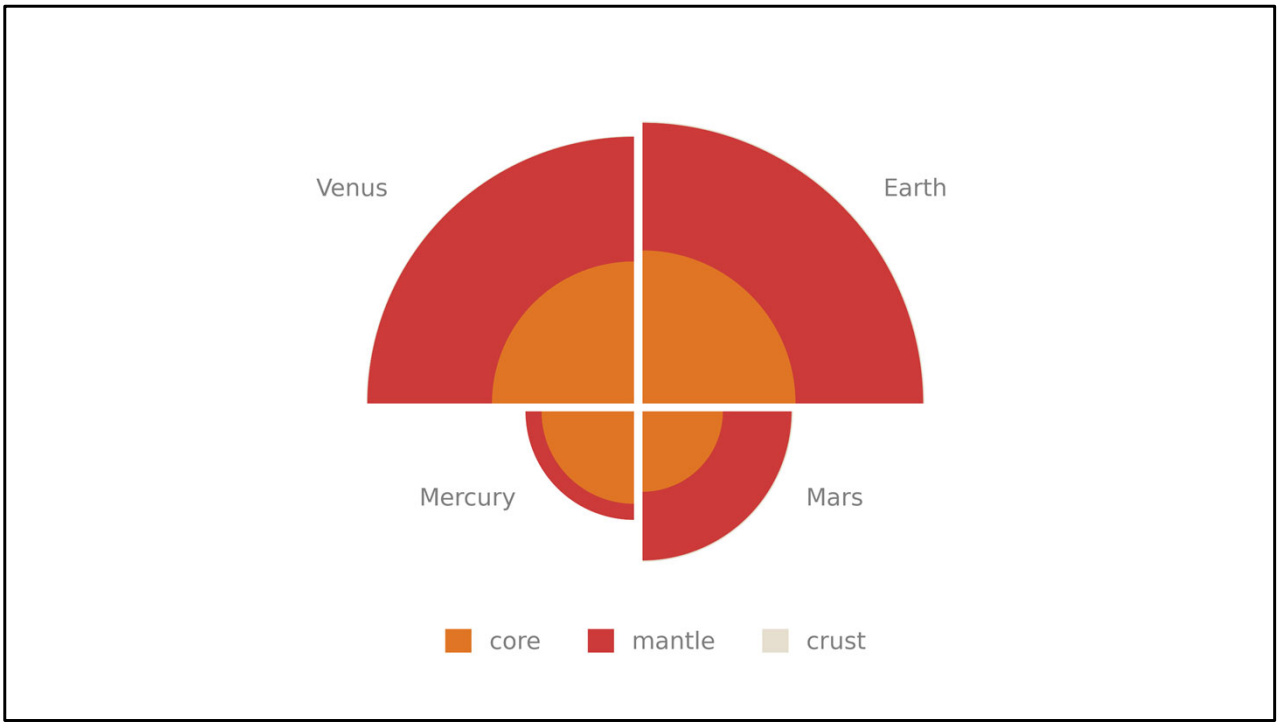
1. the season when the features are formed or are active (e.g., the features called "recurring slope lineae" or RSLs appear during late spring and summer, but linear gullies are active only during early spring);
2. the features' sizes (e.g., slope streaks can extend for miles or kilometers, but dark frost streaks on dunes extend only up to 100 yards, or meters); and

3. the types of terrain on which a feature is found (e.g., gullies with an alcove-channel-apron shape are found both on rocky
slopes and on sandy slopes, but linear gullies are only found on sandy slopes; dark frost streaks are formed on frozen dune
slopes, but RSLs are formed on dark, warm slopes).

https://photojournal.jpl.nasa.gov/beta/catalog/PIA17079

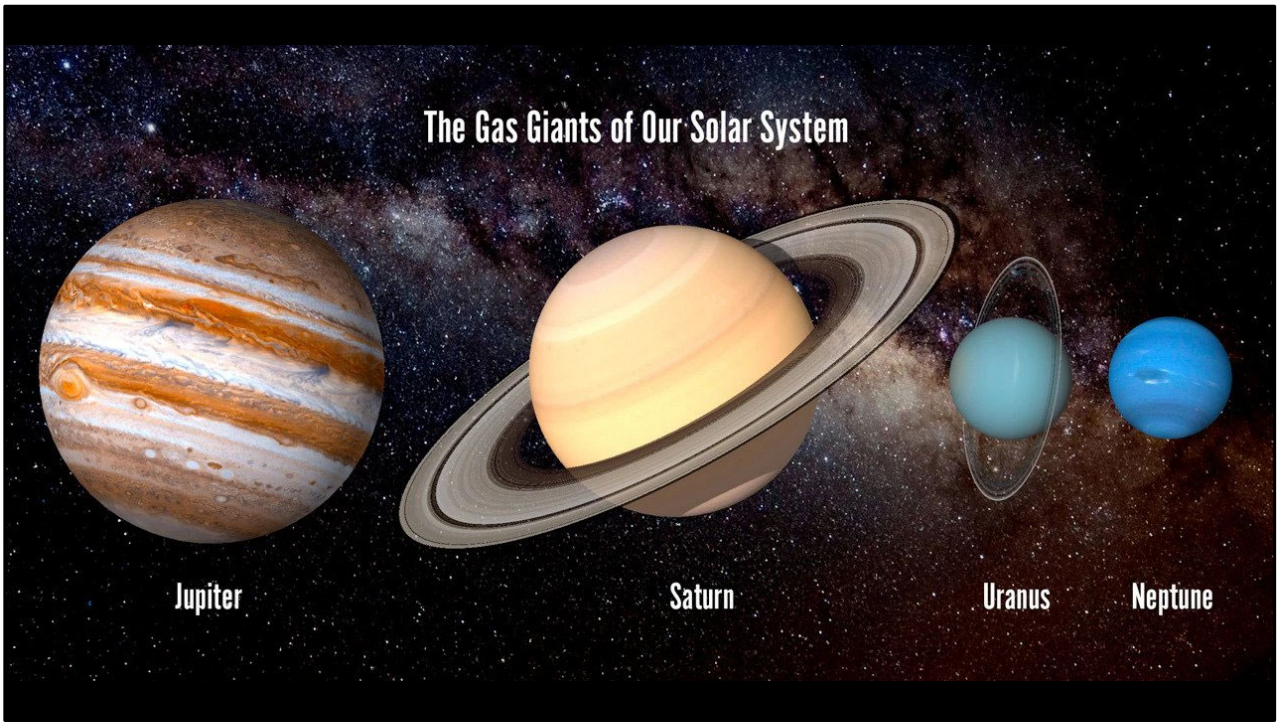


This image is a mosaic of Olympus Mons. The mosaic was created with the medium-resolution black and white MDIM combined with a low resolution color image mosaic acquired on the 735 orbit of Viking 1 on June 22, 1978. The central edifice of Olympus Mons has a summit caldera 24 km above the surrounding plains. Surrounding the volcano is an outward-facing scarp 550 km in diameter and several kilometres high. Beyond the scarp is a moat filled with lava, most likely derived from Olympus Mons. Farther out is an aureole of characteristically grooved terrain, just visible at the top of the frame. Image Processing by Jody Swann/Tammy Becker/Alfred McEwen, using the PICS (Planetary Image Cartography System) image processing system developed at the U.S. Geological Survey in Flagstaff, Arizona.


Venus
Earth
Mercury
Mars
core
mantle
crust

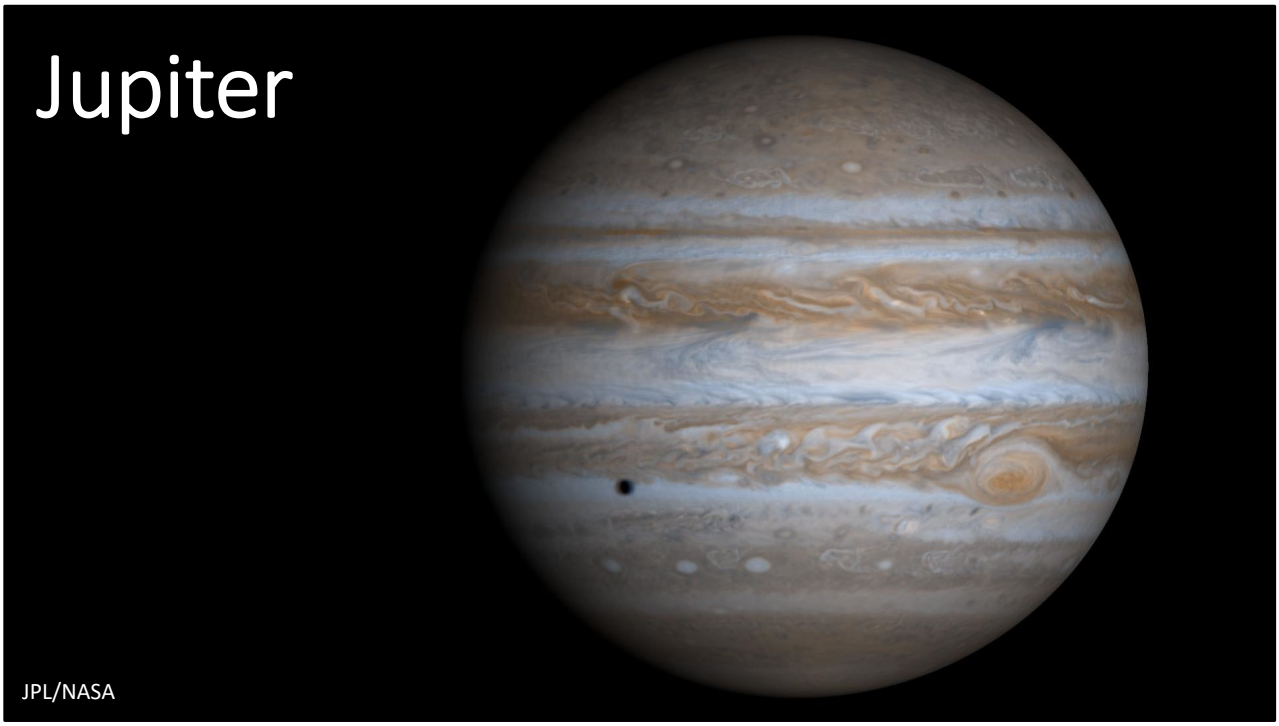
Quick Quiz

1. Why are the first four planets called the 'Rocky' planets?
2. Mercury's surface is covered in what?
3. What landforms provide evidence for water on Mars?



Author Unknown

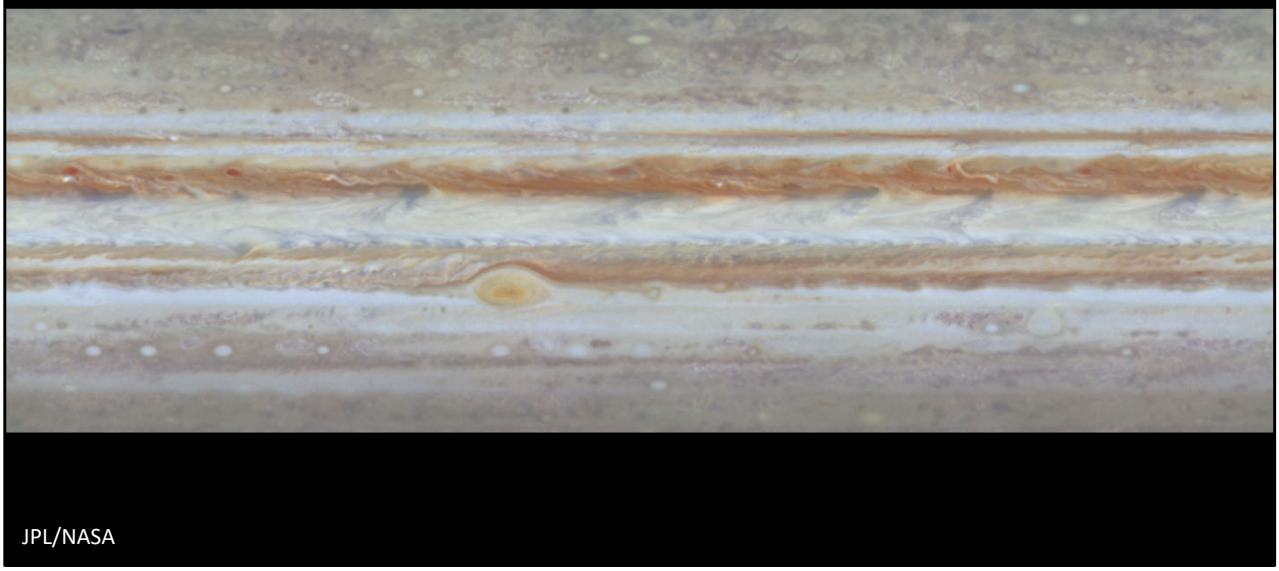
Jupiter



JPL/NASA

Cassini Comp. with Europa shadow
Molecular hydrogen 80-90% helium
All four have rings RADIO JOVE you can hear the radio emission from Jupiter
Any solid surface at high pressures deep within / red sulphur or phosphorus belts are convection cycles-Coriolis
Metallic hydrogen 400 GPa behaves like a crystal lattice

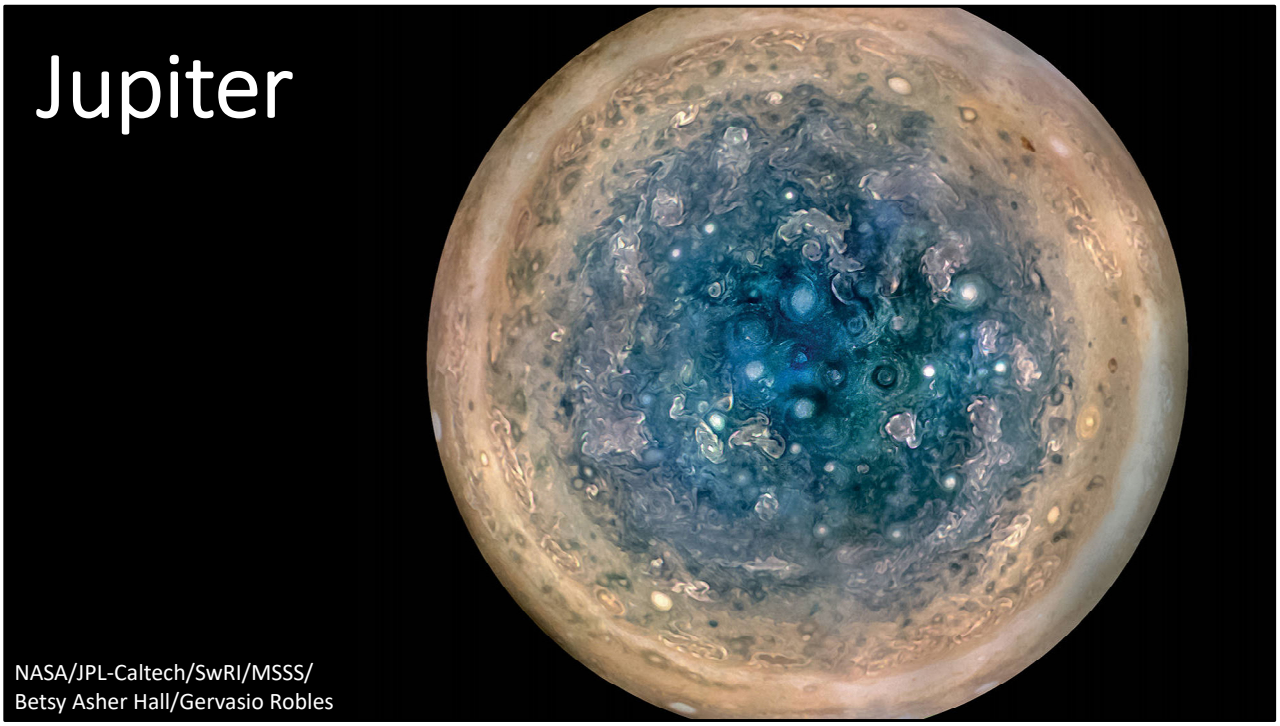
Jupiter



JPL/NASA

1 year timelapse of 60 deg north to south. Shadows and satellites of Jupiter visible.

Jupiter



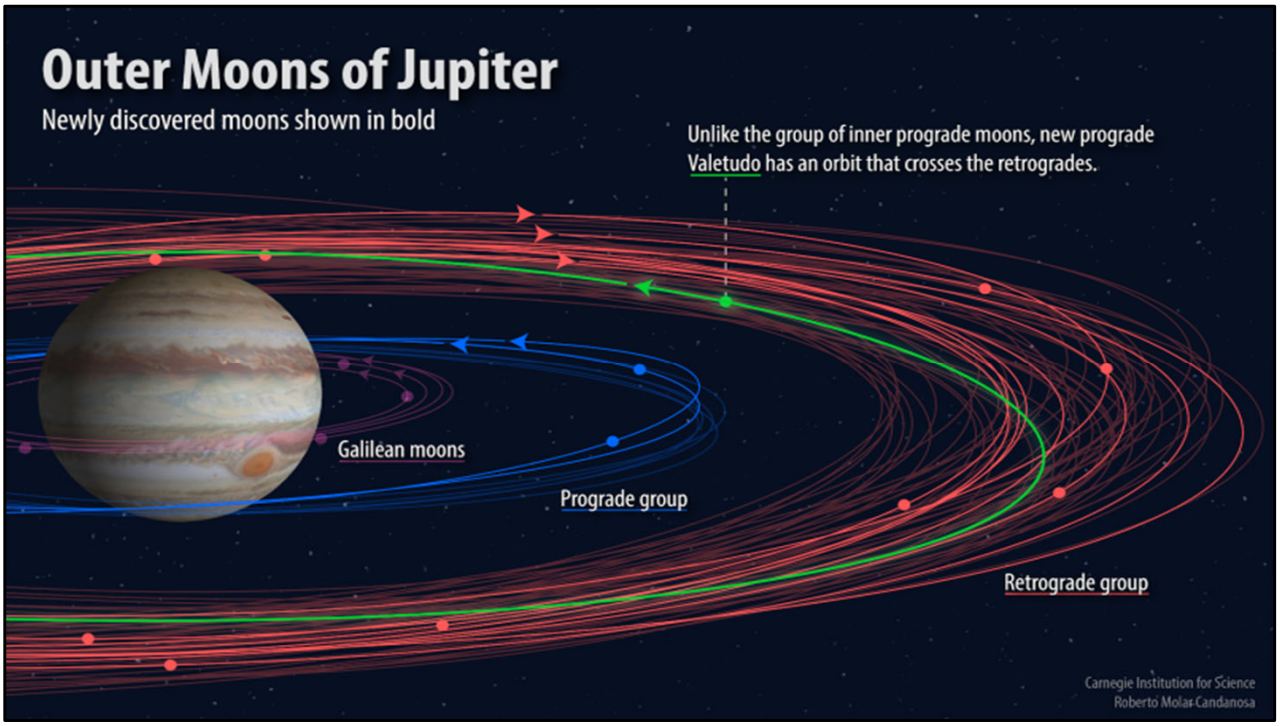
NASA/JPL-Caltech/SwRI/MSSS/
Betsy Asher Hall/Gervasio Robles

Juno Orbiter image of South pole's cyclones up to 1000 KM in diameter (~top Scotland John O'groats to Brighton)
Enhanced Colour

Jupiter's Moons

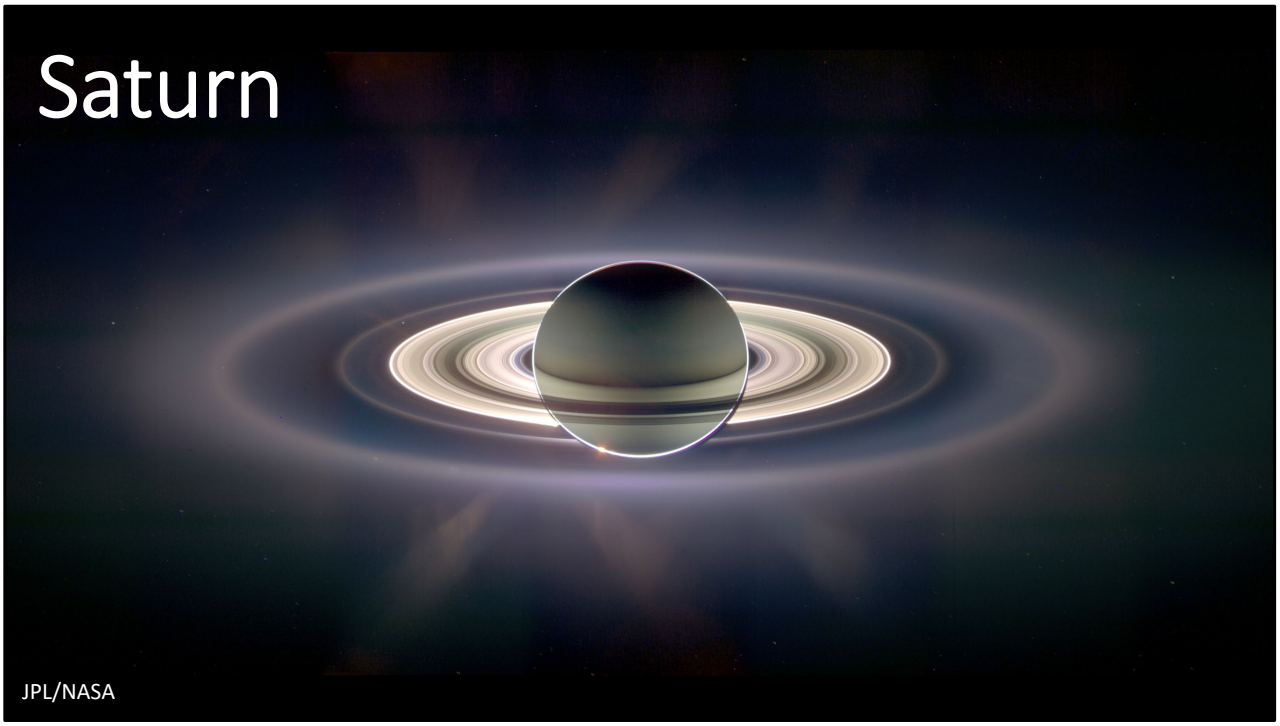
JPL/NASA

Io Galileo
Europa
Ganymede – Bigger than any dwarf planet
Callisto

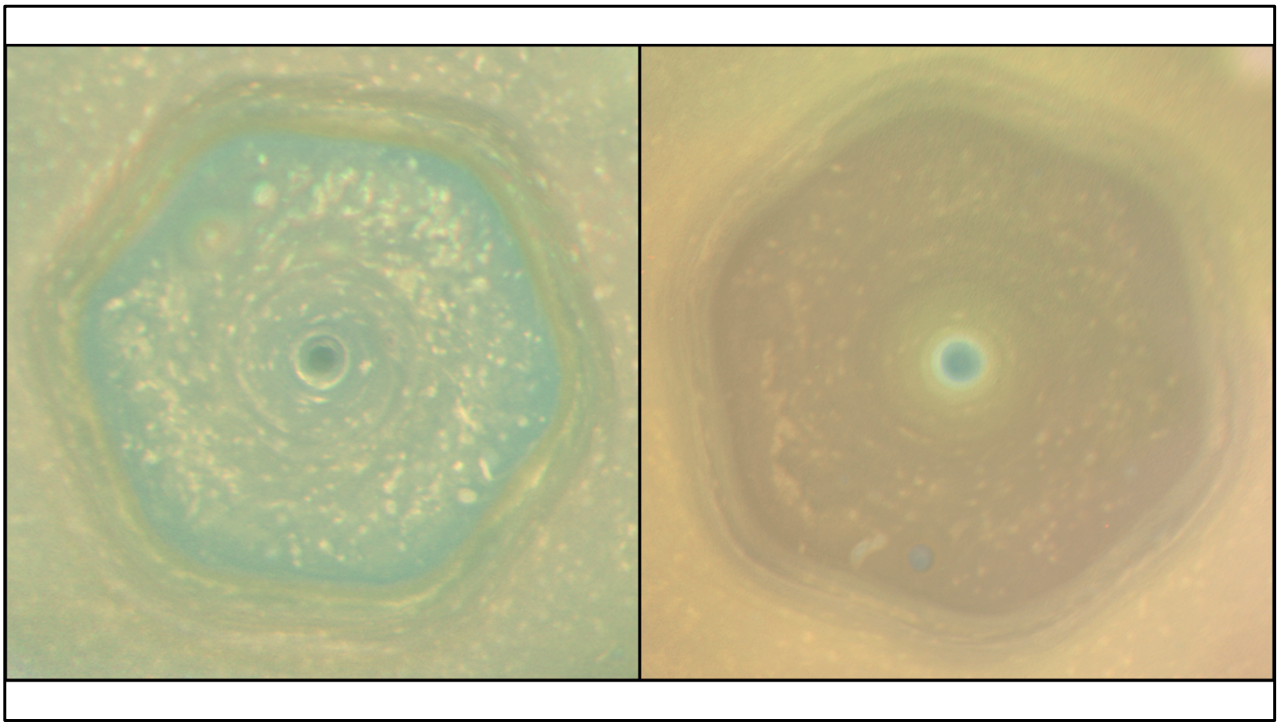


79 total 11 with DECAM (Dark Energy Camera from the DES survey)
https://carnegiescience.edu/news/dozen-new-moons-jupiter-discovered-including-one-%E2%80%9Coddball%E2%80%9D

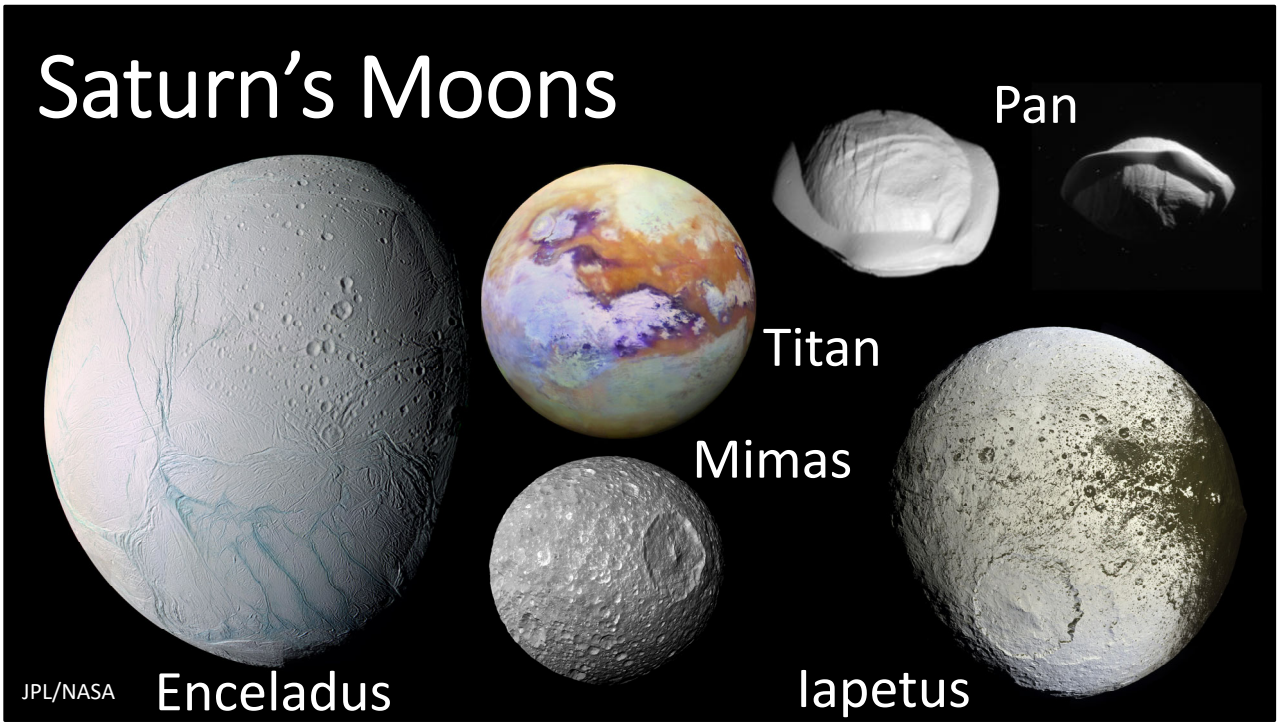
Cassini Comp. with Europa shadow



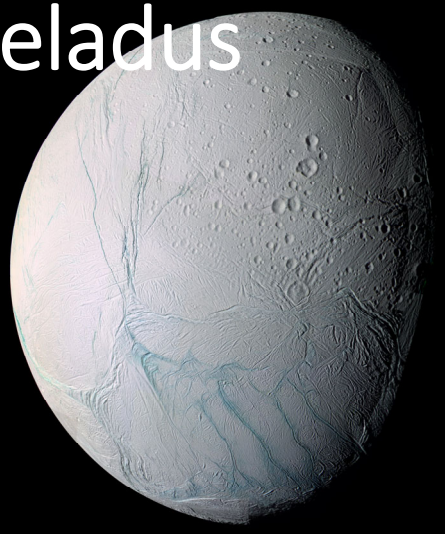
Cassini Comp. enhanced colour to reveal new rings and differences in composition.

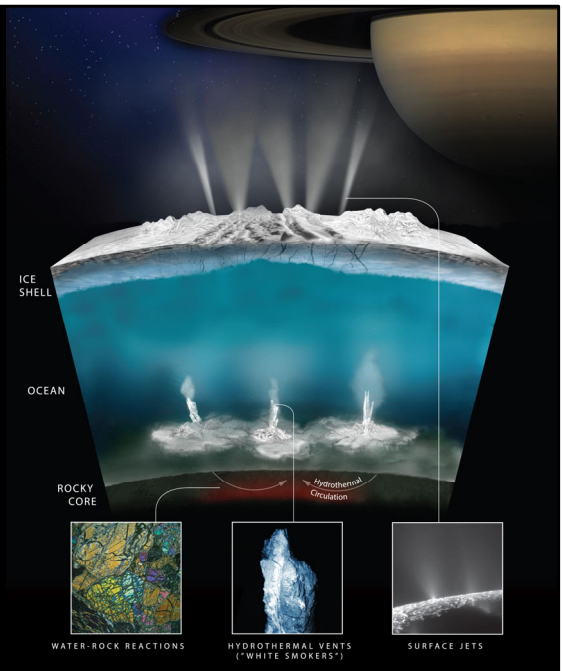


Have form from early 2010s to 2017 due to change in tilt more UV exposure create red haze organic chemicals


Saturn's Moons
Pan
Titan
Mimas
JPL/NASA
Enceladus
Iapetus

Saturn/ Enceladus

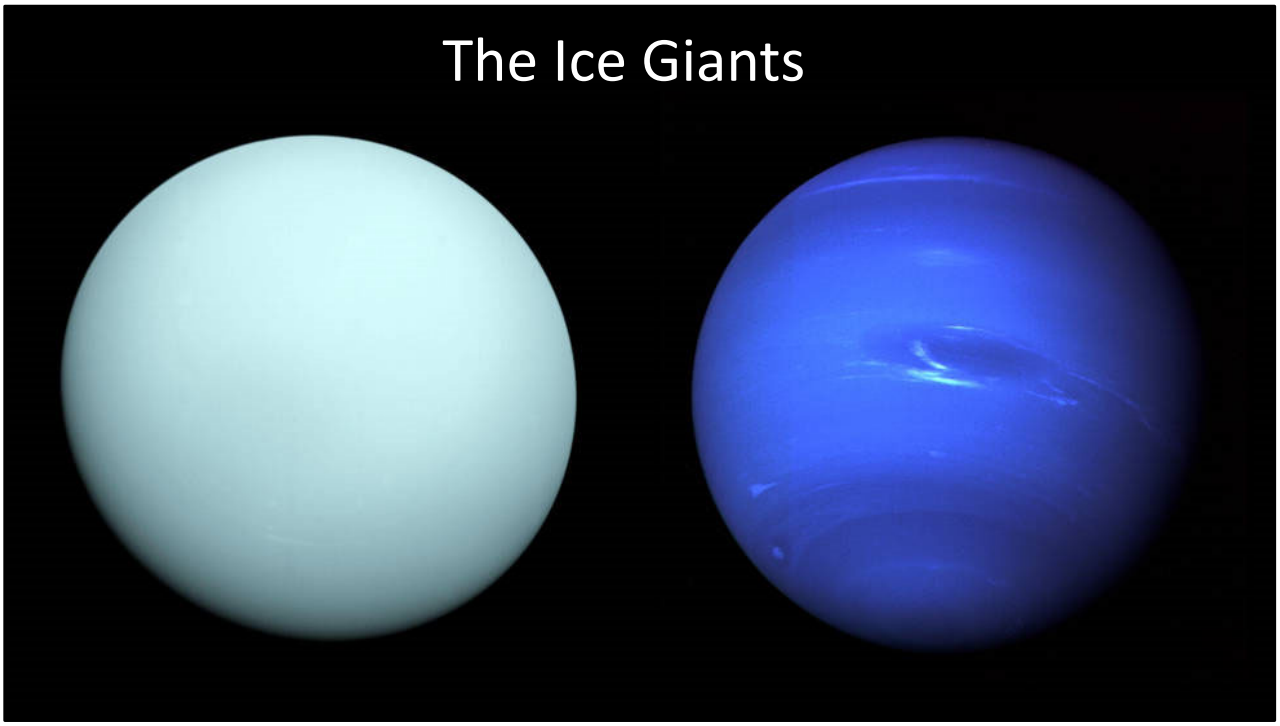




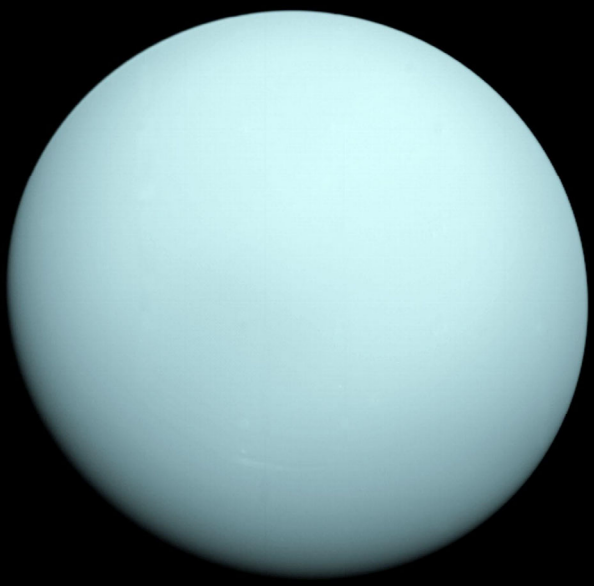
JPL/NASA

Life in subsurface ocean

The Ice Giants



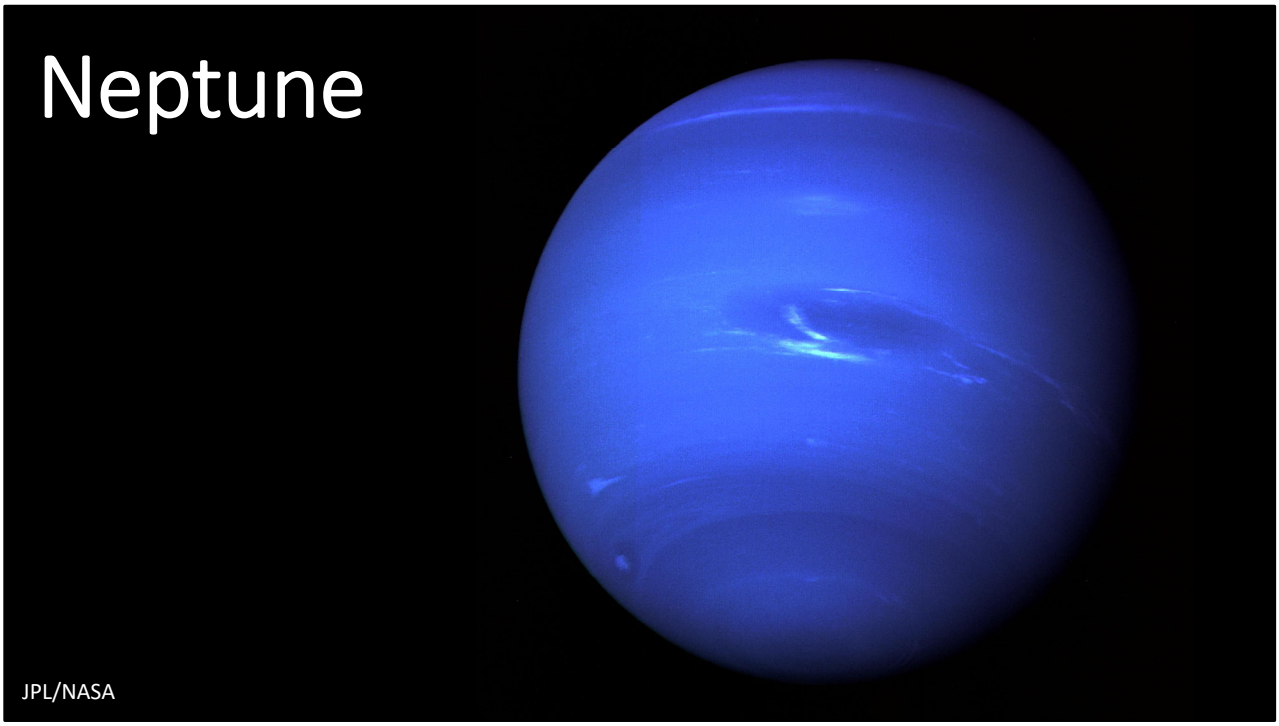
Uranus



JPL/NASA

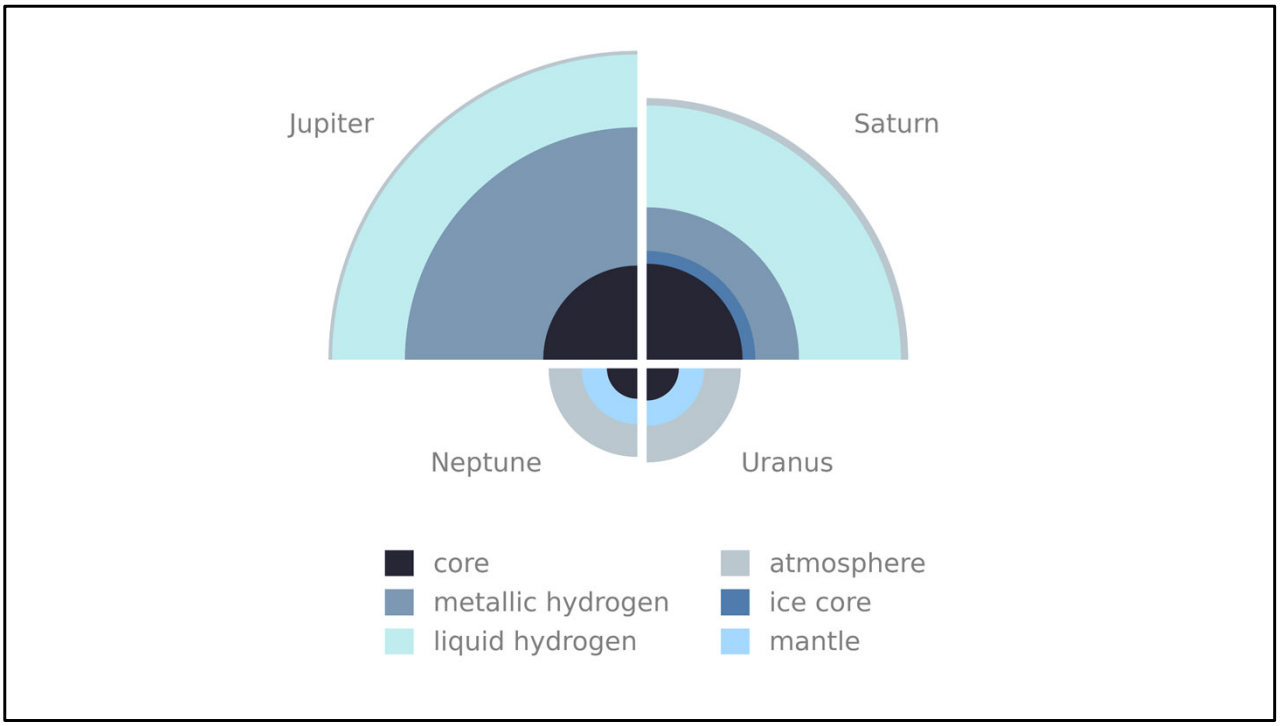
Only visited by voyager 2 – ICE GIANT
Ices suggest that water/brine ocean conducts elec and causes mag field
Rotates on its side? No idea why cant be impact – moons orbit the same

Neptune



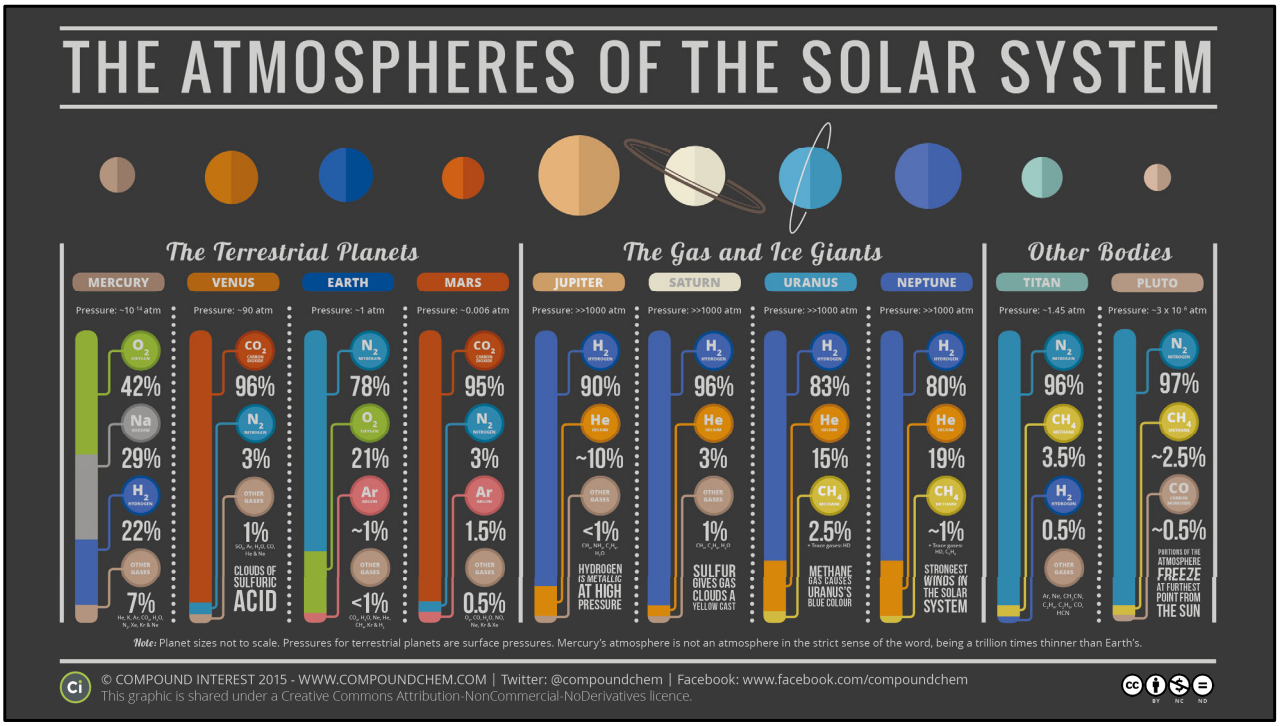
JPL/NASA

Only visited by voyager 2


Jupiter
Saturn
Neptune
Uranus
core
metallic hydrogen
liquid hydrogen
atmosphere
ice core
mantle

Quick Quiz

1. What gases are the Gas Giants made out of?
2. Do the gas giants have a solid surface?
3. Which gas giants have rings?


THE ATMOSPHERES OF THE SOLAR SYSTEM
The Terrestrial Planets
The Gas and Ice Giants
Other Bodies
MERCURY
VENUS
EARTH
MARS
JUPITER
SATURN
URANUS
NEPTUNE
TITAN
PLUTO
Pressure: ~10 -14 atm
42%
29%
22%
7%
Pressure: ~90 atm
96%
3%
1%
CLOUDS OF SULFURIC ACID
Pressure: ~1 atm
78%
21%
~1%
<1%
Pressure: ~0.006 atm
95%
3%
1.5%
0.5%
Pressure: >>1000 atm
90%
~10%
<1%
HYDROGEN IS METALLIC AT HIGH PRESSURE
Pressure: >>1000 atm
96%
3%
1%
SULFUR GIVES GAS CLOUDS A YELLOW CAST
Pressure: >>1000 atm
83%
15%
2.5%
METHANE GAS CAUSES URANUS'S BLUE COLOUR
Pressure: >>1000 atm
80%
19%
~1%
STRONGEST WINDS IN THE SOLAR SYSTEM
Pressure: ~1.45 atm
96%
3.5%
0.5%
Pressure: ~3 x 10 -6 atm
97%
~2.5%
~0.5%
PORTIONS OF THE ATMOSPHERE FREEZE AT FURTHEST POINT FROM THE SUN
Note: Planet sizes not to scale. Pressures for terrestrial planets are surface pressures. Mercury's atmosphere is not an atmosphere in the strict sense of the word, being a trillion times thinner than Earth's.
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Up next:
Planetary Surfaces
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https://github.com/AstroDimitrios/Astronomy