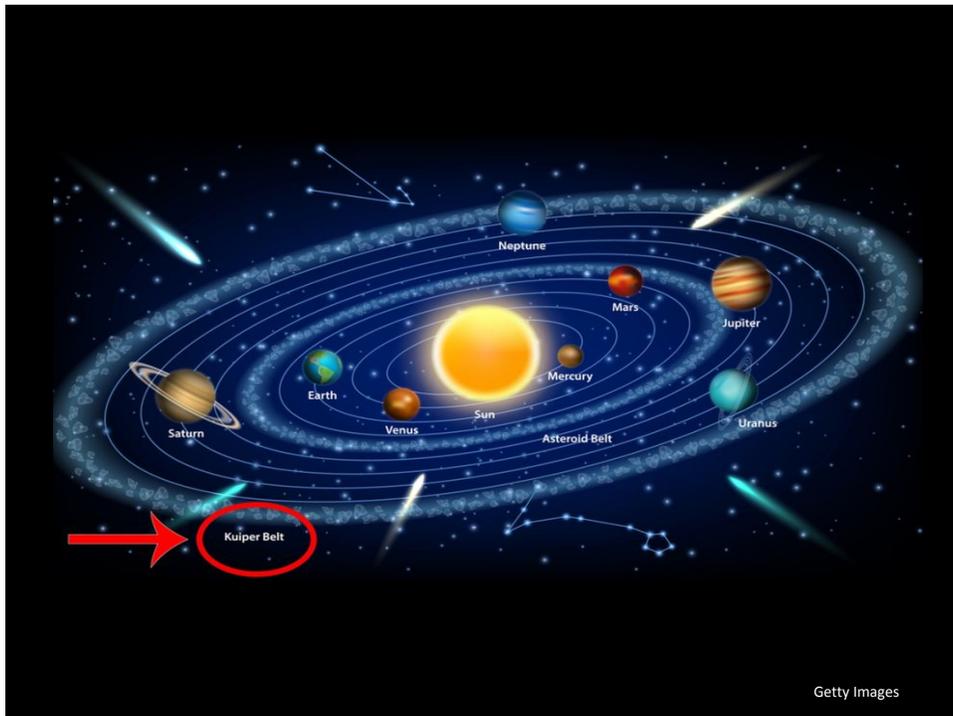


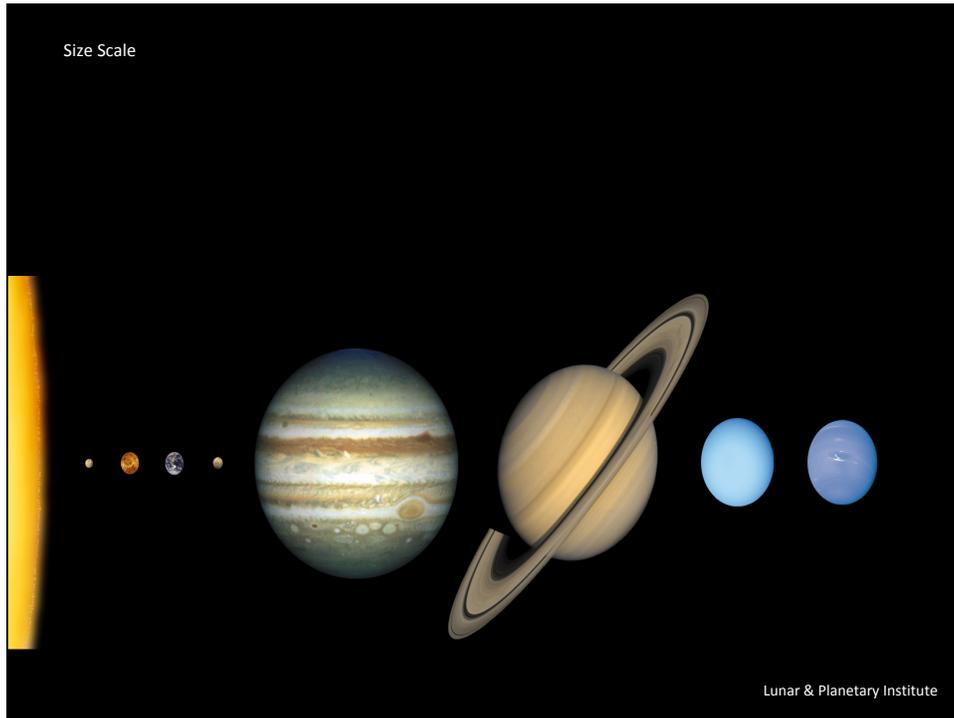
# Our Solar System

Peterborough Astronomical Association  
Novice Astronomy Class #4  
May 6, 2022  
Brett Hardy

NASA, Apollo 8, Bill Anders  
Processing: Jim Weigang



Getty Images



Sun

- Age: ~ 4.5 billion years
- Composition: hydrogen (72%) & helium (26%) plasma
- Yellow dwarf
- Nuclear fusion
- Most massive object in solar system
- Mass: 99.8%
- Diameter: 1,392,000 km (864,938 mi)
- 1.3 million Earth's would fit inside
- Distance to galactic centre: 26,000 light years
- 230 million years to orbit Milky Way
- Distance to Sun from Earth: 150 million km (93 million mi) – 1 AU
- Fleet of spacecraft constantly monitoring our Sun: SOHO, Solar Orbiter, Parker Solar Probe, etc.

October 22, 2014

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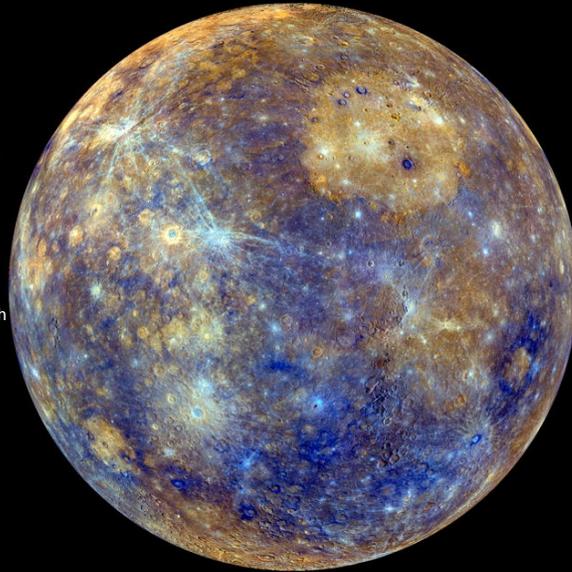
Jupiter

Earth

NASA SDO/HMI

### Mercury

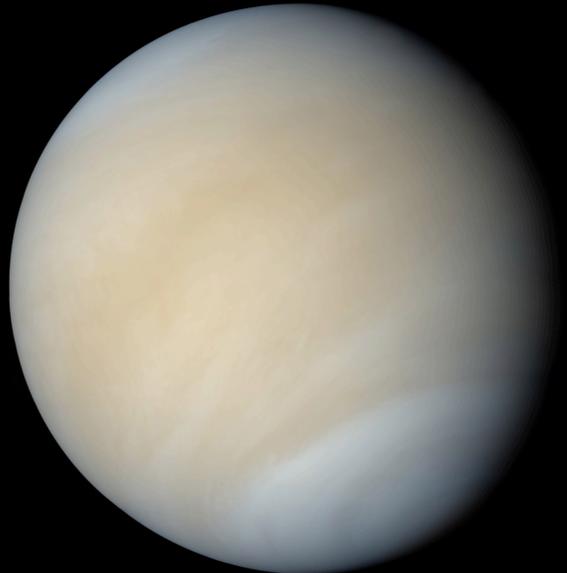
- Smallest planet - slightly larger than Earth's Moon
- Second hottest planet
- Rotates once in 176 Earth days
- Year: 88 Earth days
- Thin atmosphere composed of oxygen, sodium, hydrogen, helium and potassium
- Shaped by solar wind and micrometeoroid impacts
- 430° C daytime , -180° C night
- Large metallic core (85%) partly molten
- Water ice in deep crevators at north and south poles
- ESA-JAXA BepiColombo mission launched October 20/18 and arrives 2025
- Will study the internal structure, nature of the surface, evolution of geologic features and solar wind impact
- Greatest elongation April 29



NASA: Messenger

### Venus

- Often called Earth's twin: size, density
- 6<sup>th</sup> largest planet
- Thick atmosphere 90 x as dense as Earth's
- Mostly CO<sub>2</sub>
- Sulfuric acid clouds and rain
- 462° C
- Russian Venera 13 lasted only two hours
- Rotates clockwise (retrograde)
- Day = 243 Earth days
- Year = 225 Earth days
- Recent modelling suggests Venus was probably habitable until about 700 million years ago
- Proposed missions: Davinci+ & Veritas
- Launch: 2028-2030



NASA/JPL: Mariner 10

### Earth

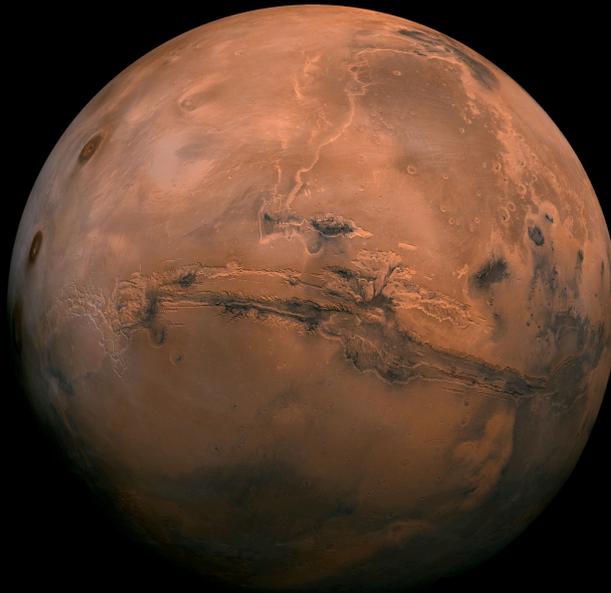
- The only planet in our solar system to have an oxygen atmosphere, liquid water oceans on its surface and life
- Fifth largest planet
- Magnetic Field: Magnetosphere
- Weakened by 10% since 19<sup>th</sup> century
- One moon  $\frac{1}{4}$  the size of Earth
- Total lunar eclipse May 16<sup>th</sup>



NASA/NOAA

### Mars

- 7<sup>th</sup> largest planet – half the size of Earth
- Day: 24.5 hours
- Year: 687 Earth days
- $\frac{1}{3}$  Earth's gravity
- Thin CO<sub>2</sub> atmosphere
- Moons: Phobos, Deimos
- Obvious signs of past active geology
- The most explored planet outside Earth
- Six rovers: Sojourner, Opportunity, Spirit, Curiosity, Perseverance, Zhurong
- 18 orbiters, 8 active
- 21 landers, Insight active



NASA/JPL

Martian eclipse of the Sun

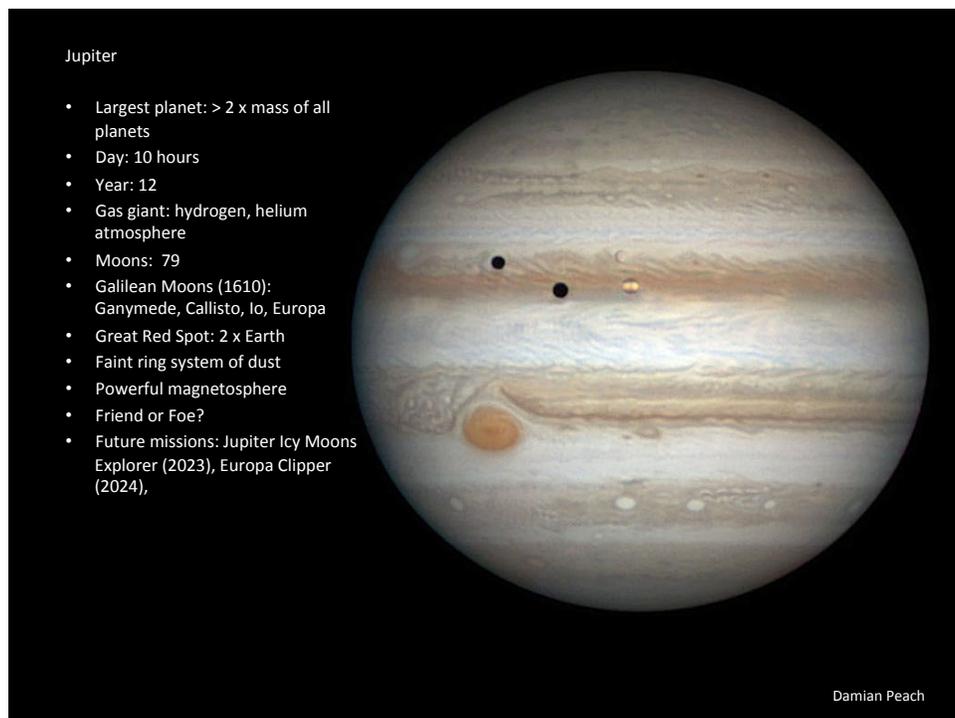
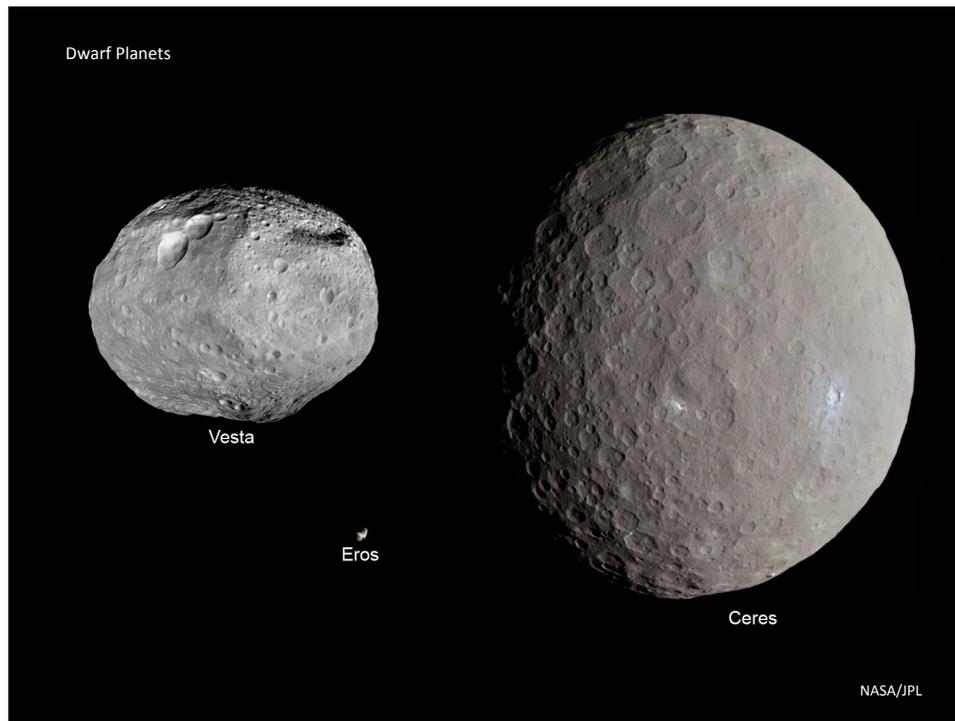
# NASA's Perseverance Rover Sees Solar Eclipse on Mars



Asteroid Belt

- Widely spaced: ~ 1,000,000 km
- Millions or billions of objects – most pebble size or dust grains
- 200 larger than 100 km
- 0.7-1.7 million 1 km or >
- Ceres comprises about ¼
- Total mass < Moon
- 1,409 potentially hazardous
- Meteoroid, Meteor, Meteorite
- Future resources?





### Saturn

- Second largest planet
- Spectacular ring system
- Water ice and rock 282,000 km in extent, 10 metres thick
- Range in size - dust to mountains
- Comets, asteroids, destroyed moons?
- Day: 10.7 hours
- Year: 29 Earth years



- Atmosphere mostly H<sub>2</sub>, He
- Moons: 82
- Titan: second largest moon
- Dense atmosphere, liquid hydrocarbons on surface
- Future missions: Dragonfly

NASA STSci

### Uranus

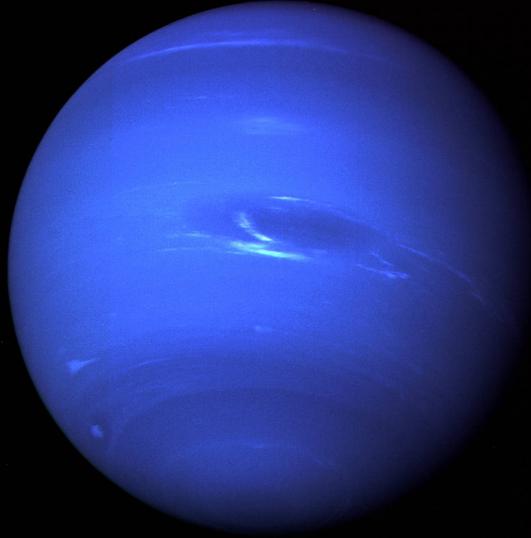
- First planet discovered with a telescope by William Herschel in 1781
- Ice giant
- Most of the mass is made up of a hot dense fluid of "icy" materials: water, ammonia and methane above a small rocky core
- Atmosphere of hydrogen, helium and methane
- Clouds of Hydrogen sulfide
- Day: 17 hours 14 minutes
- Year: 84
- Retrograde rotation
- Rotates on its side
- Moons: 27
- Faint ring system
- Future missions: ESA's MUSE (2026)
- NASA ?



NASA Voyager 2 (1986)

### Neptune

- First planet predicted by mathematics (Urbain Le Verrier) and discovered by Johann Gottfried Galle in 1846
- Ice giant
- Most of the mass is made up of a hot dense fluid of "icy" materials: water, ammonia and methane above a small rocky core
- Atmosphere of hydrogen, helium and methane
- Day: 16 hours
- Year: 165
- Moons: 14
- Faint ring system
- Supersonic winds > 2,000 km/h
- 2011 marked the first full orbit of the Sun since discovery
- Future missions: ?



NASA Voyager 2 (1989)

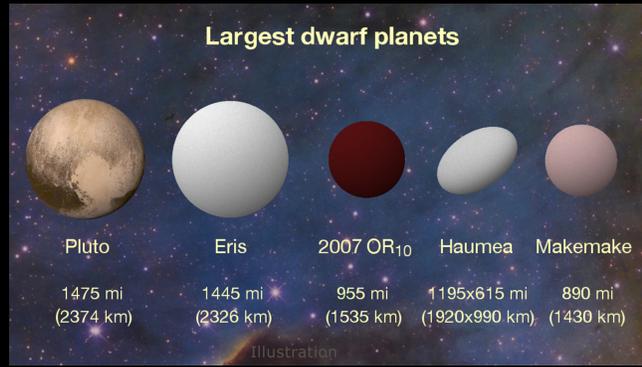
### Kuiper Belt

- Comets
- Day: 6.4
- Year: 148
- Moons: 5
- New Horizons 2015 flyby of Pluto
- Unusually smooth surface
- Mountain range 3,500 metres; no more than 100 million years old
- Water-ice hills floating in liquid nitrogen



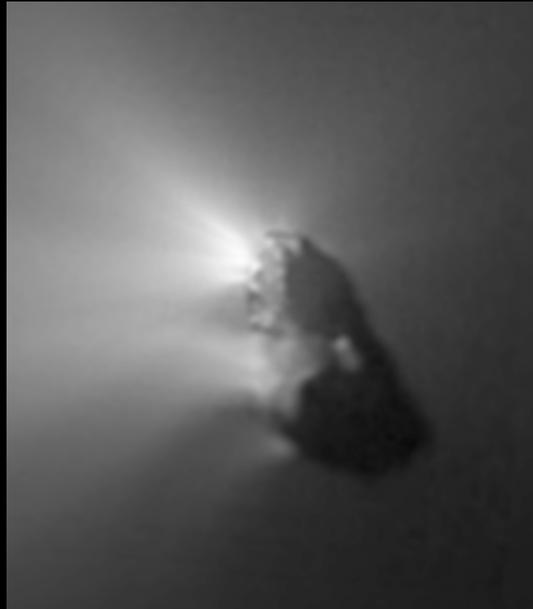
NASA

Kuiper Belt Objects

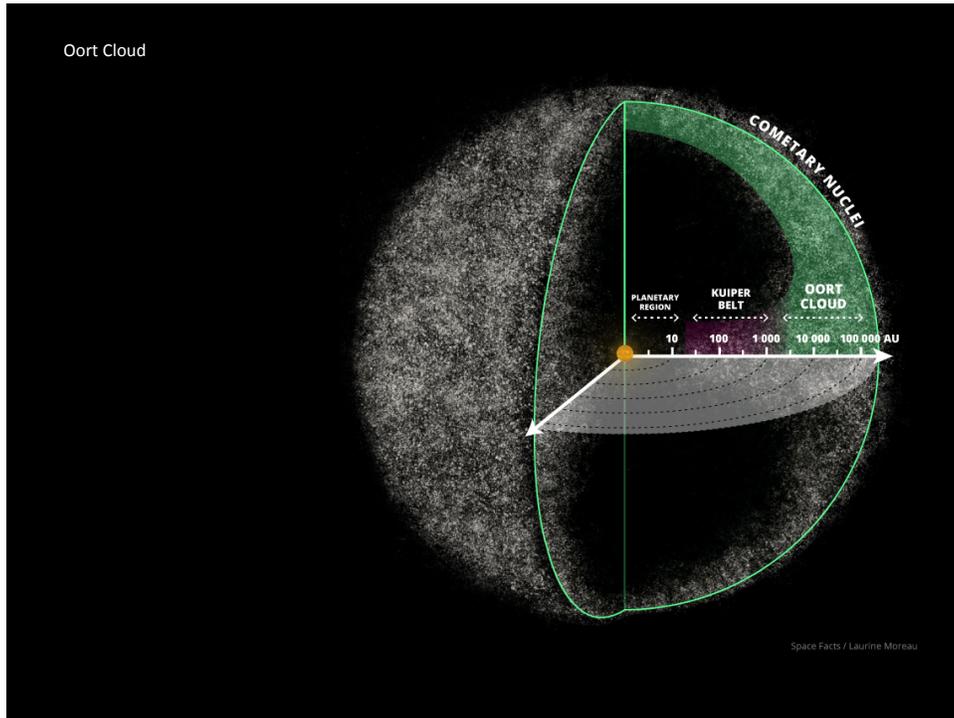


Hungarian Astronomical Association/NASA/JHUAPL/SwRI

- Halley's Comet nucleus
- Giotto Mission 1992
- 76 year orbit
- 2061 return date



ESA



Life in our Solar System

- Mars
- ALH: 4.5 billion years old
- Impact on Mars 16 million years ago
- Fell in Antarctica 13 thousand years ago
- Contains organic carbon that can be formed from non-biological processes
- Controversy over reported fossilized microbes

ALH84001,0

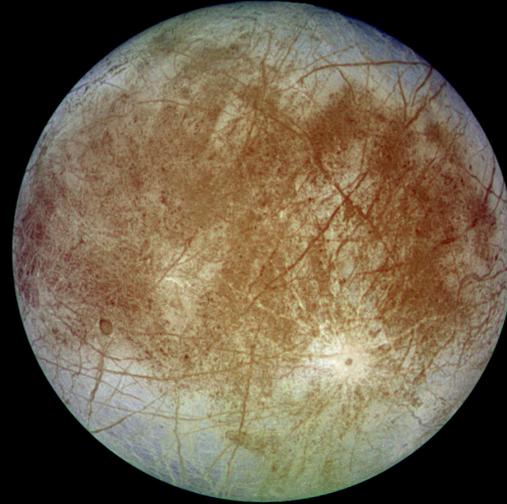
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NASA/JSC/Stanford University

NASA

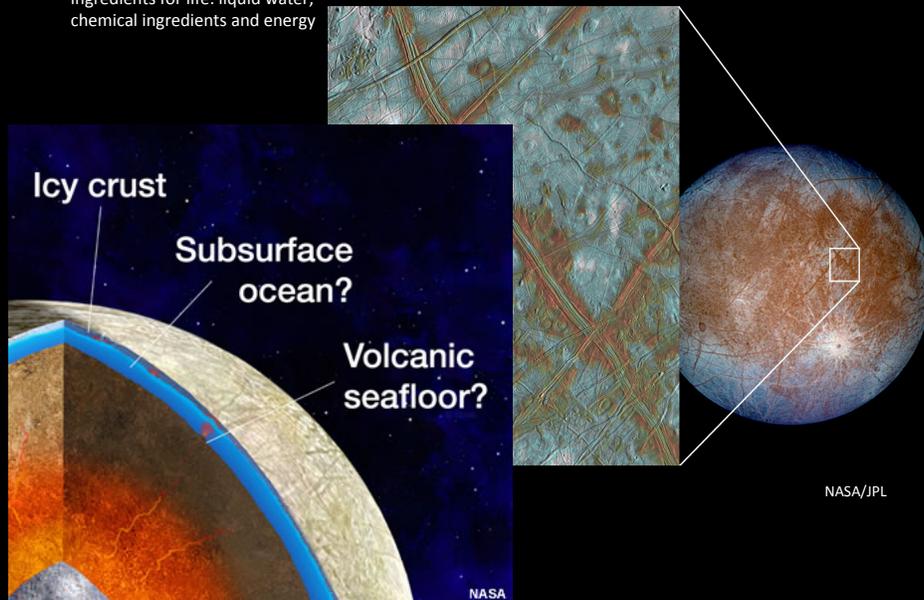
Europa

- Salty liquid ocean under an ice crust
- Europa Clipper mission to have 40-45 flyby passes to take high resolution images of the surface and investigate its composition and structure of the interior and icy shell



NASA/JPL: Galileo

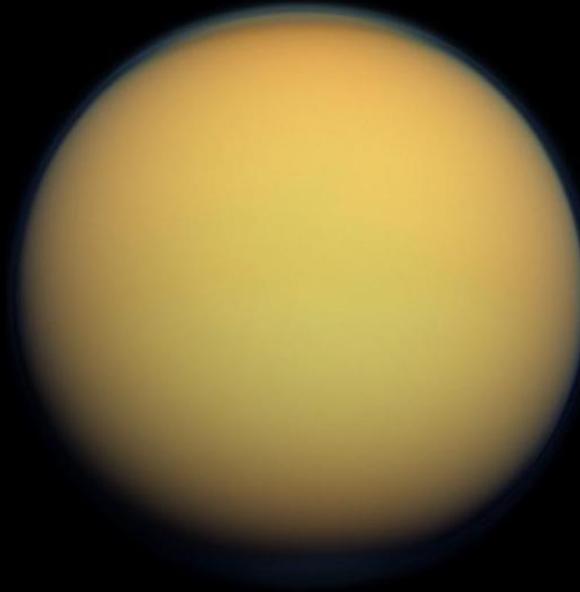
- Goal is to determine if Europa is habitable; having all three ingredients for life: liquid water, chemical ingredients and energy



NASA/JPL

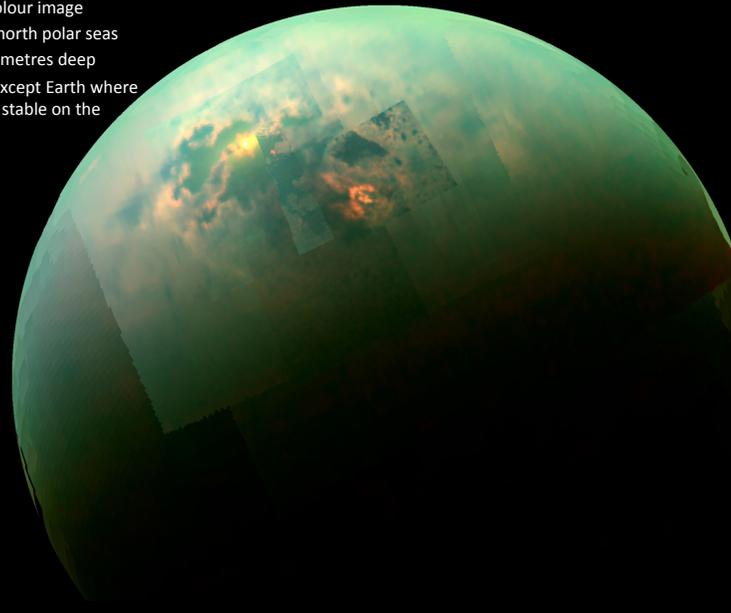
Titan

- Thick obscuring atmosphere
- Nitrogen (90%), methane
- Hydrocarbon Cycle similar to Earth's Water Cycle, but with liquid ethane and methane
- Subsurface water ocean
- Origin?
- Nitrogen isotope ratio measured by Huygens probe resemble comets from Oort cloud



NASA/JPL

- Near-infrared colour image
- Sun glinting off north polar seas
- Lakes up to 100 metres deep
- The only place except Earth where a liquid remains stable on the surface



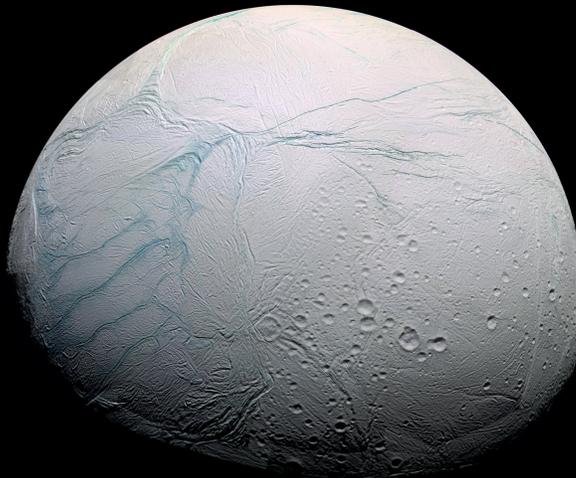
NASA/JPL

2027 launch; arrival 2034



#### Enceladus

- Most reflective solar system body
- Cassini probe's magnetometer discovered global salty ocean under icy crust
- Geysers: ice particles, water and simple organic chemicals
- Forms E-ring of Saturn
- Cassini probe found silica nanograins
- Only formed where liquid water and rock interact above 90° C



NASA/JPL

- Plumes of water ice and vapour
- Emanating from “Tiger Stripes” area near Enceladus’ south pole
- > 100 geysers have been identified



NASA/JPL: Cassini 2010

**Novice Astronomy Class #5**  
**The Moon**  
**June 3, 2022**



Rodger Forsyth