

# Jupiter: KING of the PLANETS



## Jupiter: KING of the PLANETS

- Jupiter
  - **Often called a Gas Giant or Jovian Planet**
  - 5.20 AU from the Sun
  - 483,000,000 miles
  - **Meaning over 990 Earth's could fit inside**



## Jupiter: KING of the PLANETS

- Jupiter
  - 5.20 AU from the Sun
  - 483,000,000 miles
- *Jupiter generates more heat than it receives from the Sun*
- *This heat is radiated as infrared light*



**For the most part  
this energy  
comes from the  
slow escape of  
gravitational  
energy left from  
its formation  
some 4.5 billion  
years ago.**

Jupiter: KING of the PLANETS



## Jupiter: KING of the PLANETS

- Jupiter
  - Light from Earth takes about  $\frac{1}{2}$  hour to get there
  - **ROLE of the PLANET: is to deflect objects**
  - The density is less than any terrestrial but almost the same as the earth





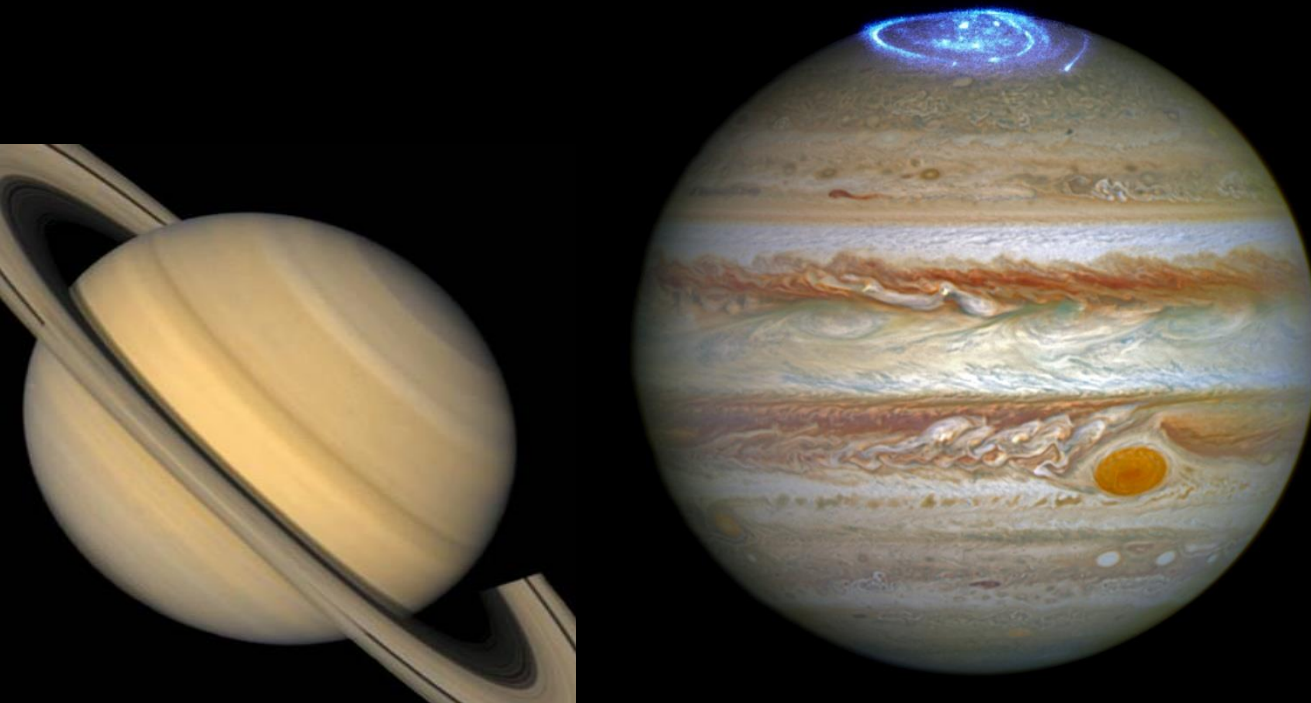
- Jupiter

Jupiter: KING of the PLANETS

- 300x Earth's mass

- *The MASS is twice the size of any other planet combined*

- e.g.  
compared to  
Saturn,  
Jupiter is  
about 3x  
more  
massive and  
denser



- Jupiter

Jupiter: KING of the PLANETS

- Revolution:

- 11.86 years

- *Tilt is 3.08 degrees*

- *Similar to Mercury*

- Incline plane  
1.31 degrees



Jupiter: KING of the PLANETS

- Jupiter
  - Rotates:
    - 9 hours/55 minutes at higher Latitude
    - 9 hours/50 minutes at equatorial

*The fastest  
rotating planet*





Because gas acts  
differently  
than a solid  
there is a  
different  
rotation rate  
between the  
poles and the  
larger  
equatorial  
region

Jupiter: KING of the PLANETS



Since the poles  
and the  
equatorial  
region rotate  
differently  
**Scientists call  
this:**

***Differential  
Rotation***

Jupiter: KING of the PLANETS



... and since  
they do rotate  
quickly, the  
*Jovian planets*  
*are noticeably*  
*oblate because*  
*they are fluid*  
*bodies of gas*

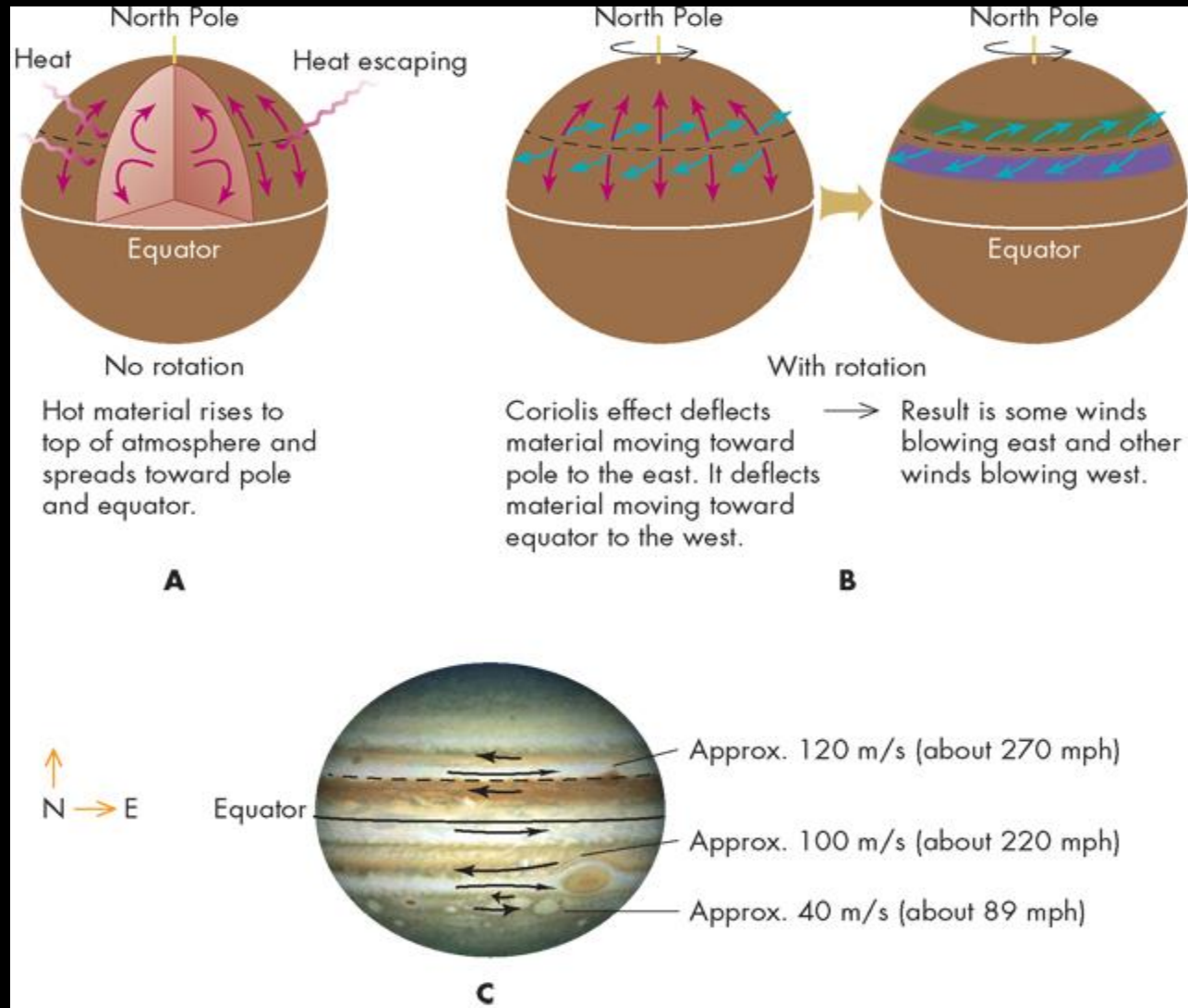
Jupiter: KING of the PLANETS



# Jupiter's rapid rotation gives rise to strong Coriolis forces, and very high winds!

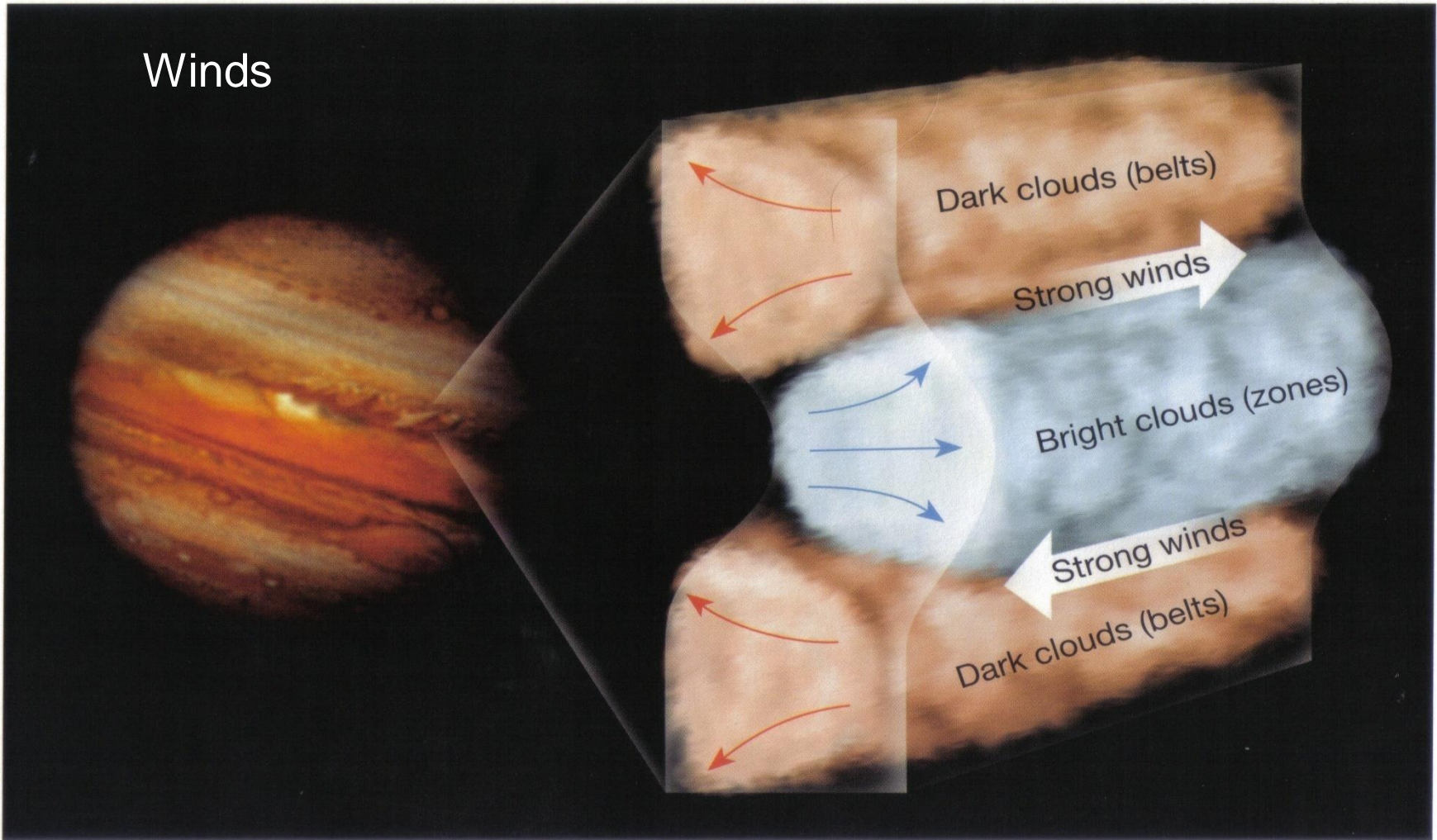
Winds

- Measured wind speeds are around ~211 mph at Jupiter, and faster at Saturn!





## Winds

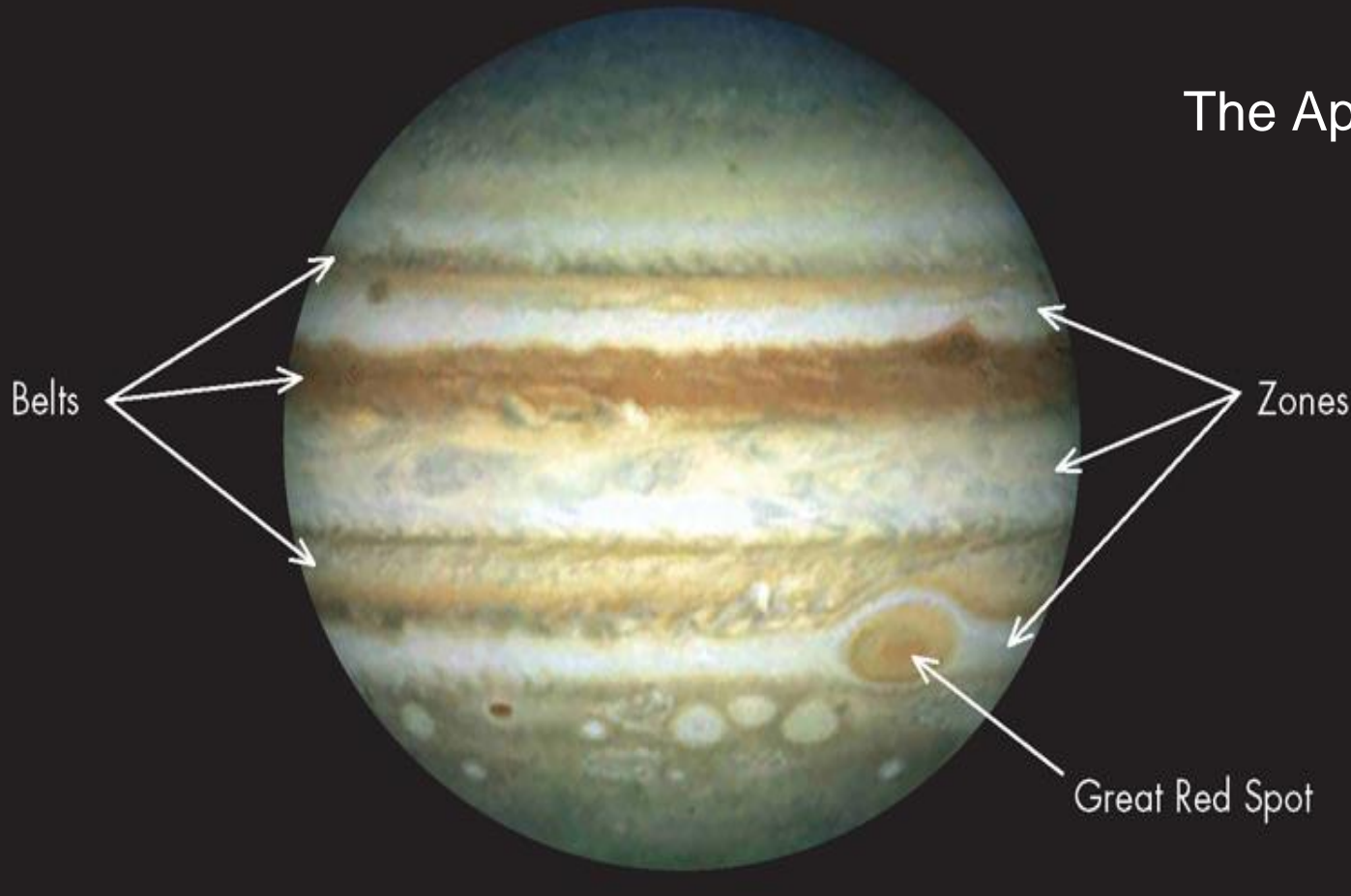


- Structure of Jupiter's Atmosphere

**Zonal flows of clouds move in opposite directions, creating very large wind shears. This is similar to Earth's jet stream**



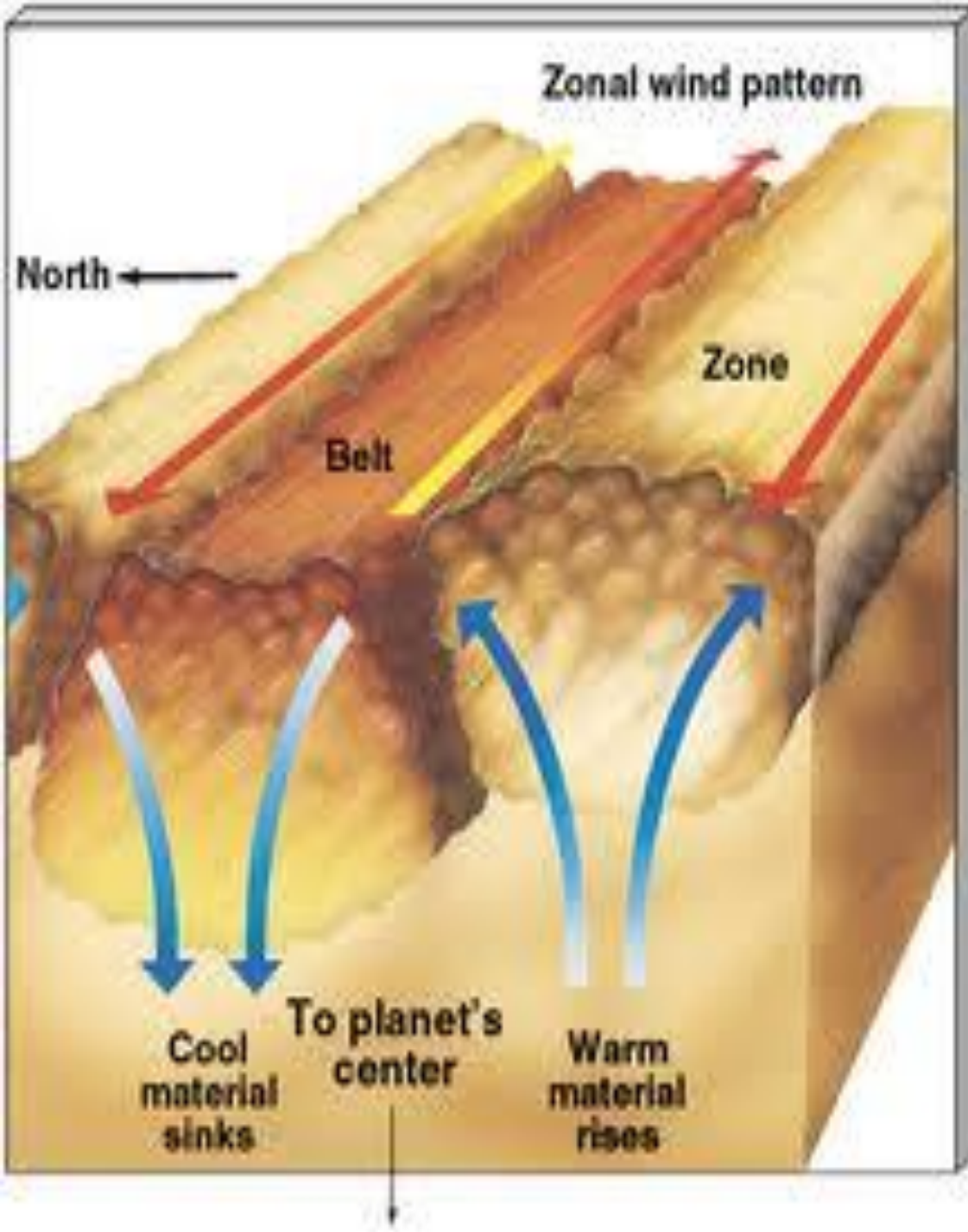
## The Appearance of Jupiter

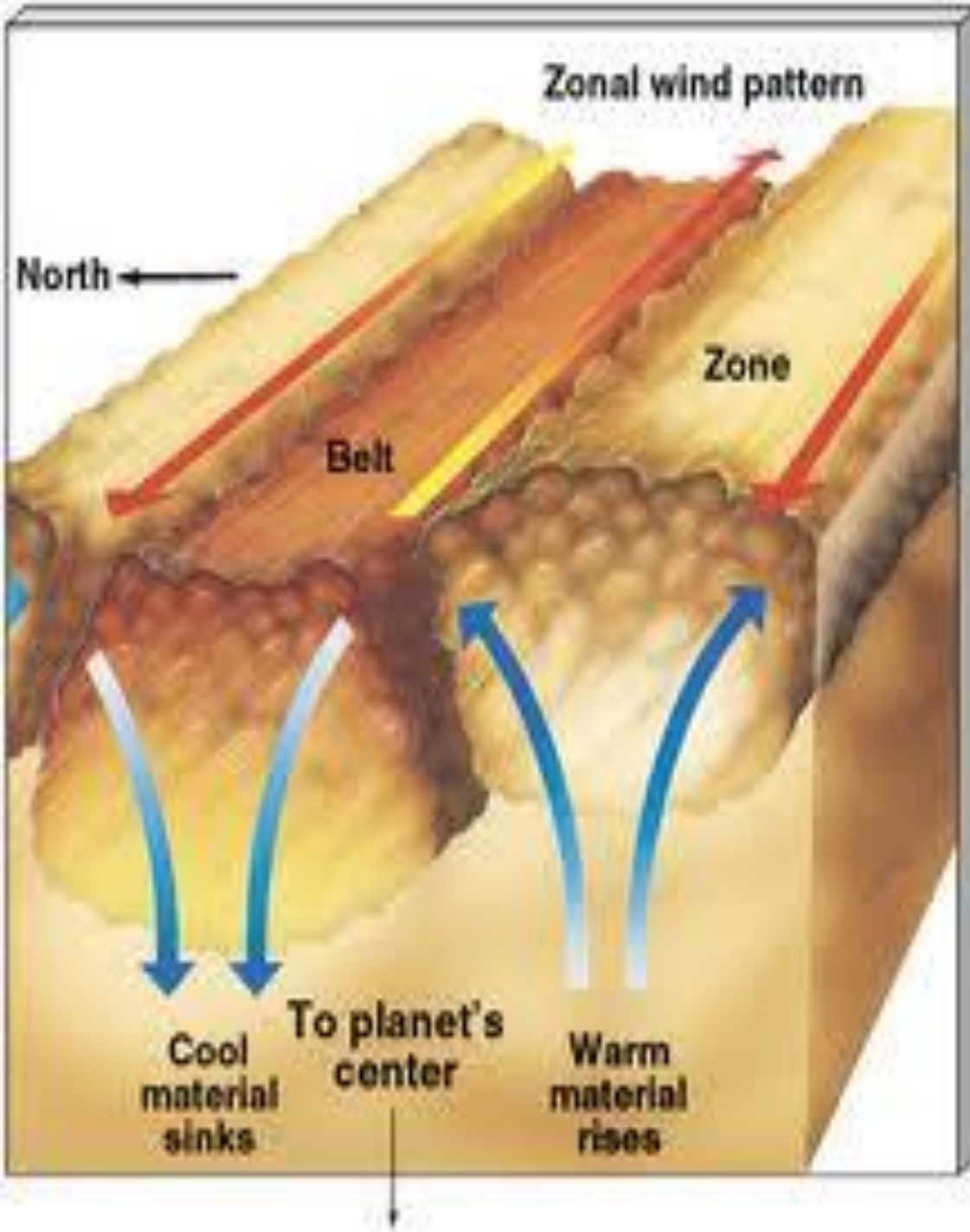


Parallel bands (**Stripes**) of rising and sinking gas clouds from the internal heat of Jupiter create: **Dark belts & Light zones** which can be seen from ground base telescope from

## The Appearance of Jupiter

- **Light (white) Zones**
  - Regions of upward movement of warm rising convection (cell) current believed to be ammonia ice clouds & ice water particles.





The Appearance of Jupiter

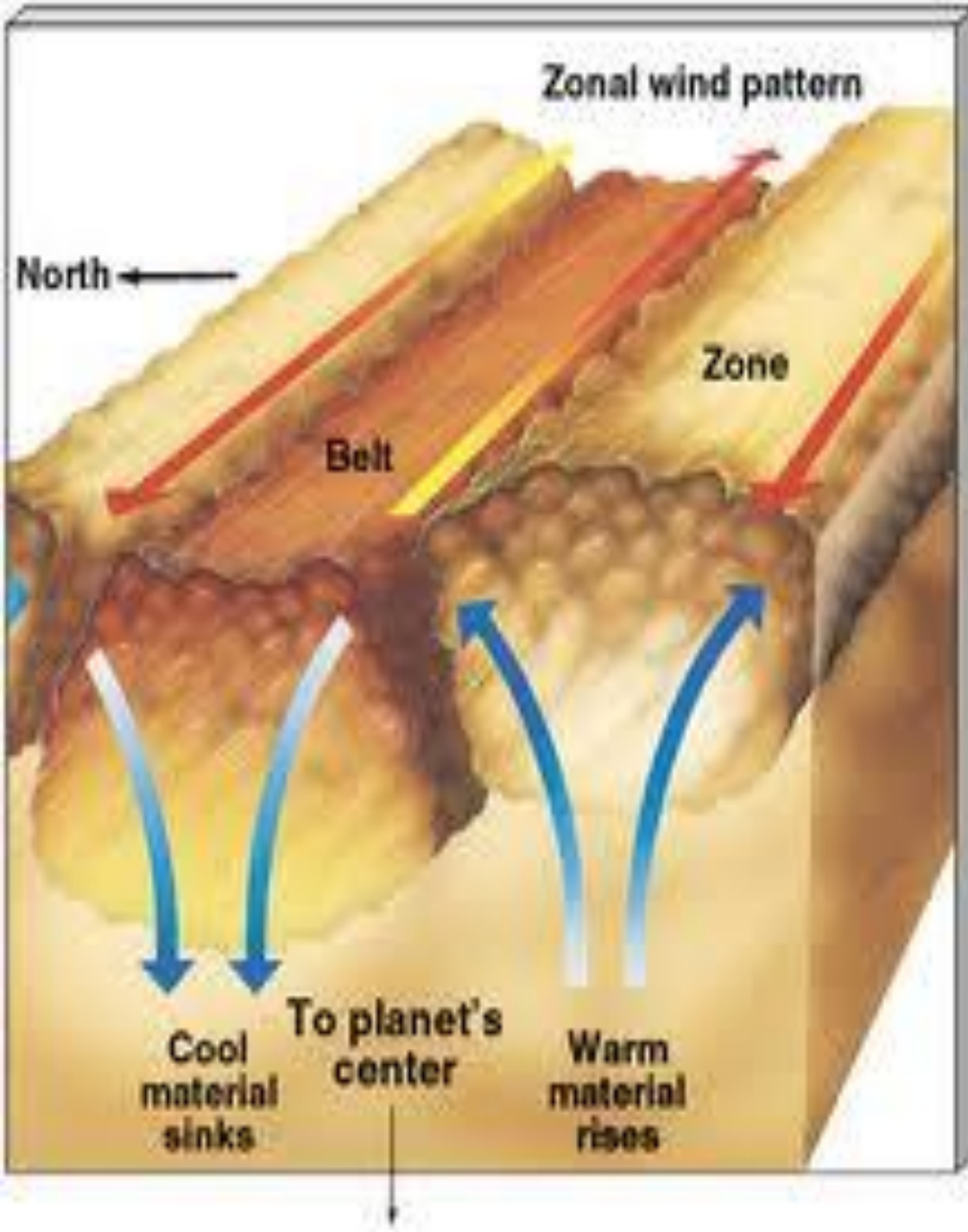
## Light (white) Zones

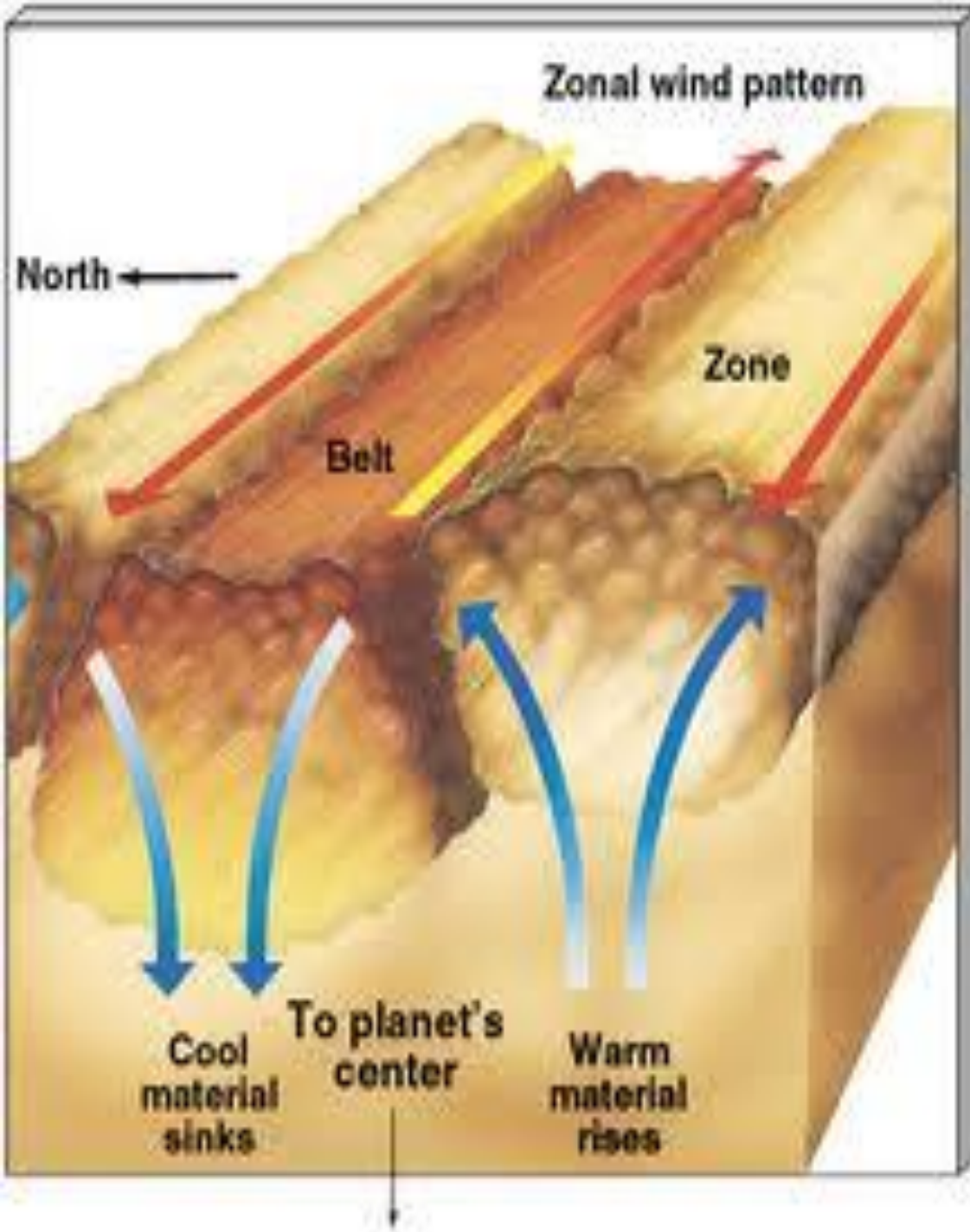
- They **masks out these lower clouds** from view. **Thus,** upward moving **gases** in Jupiter's atmosphere **bring white clouds of ammonia/water ice** from lower layers.



## The Appearance of Jupiter

- Dark belts
  - This complex coloration of chemistry creates a downward movement of cool convection current of material and it's a Low pressure system





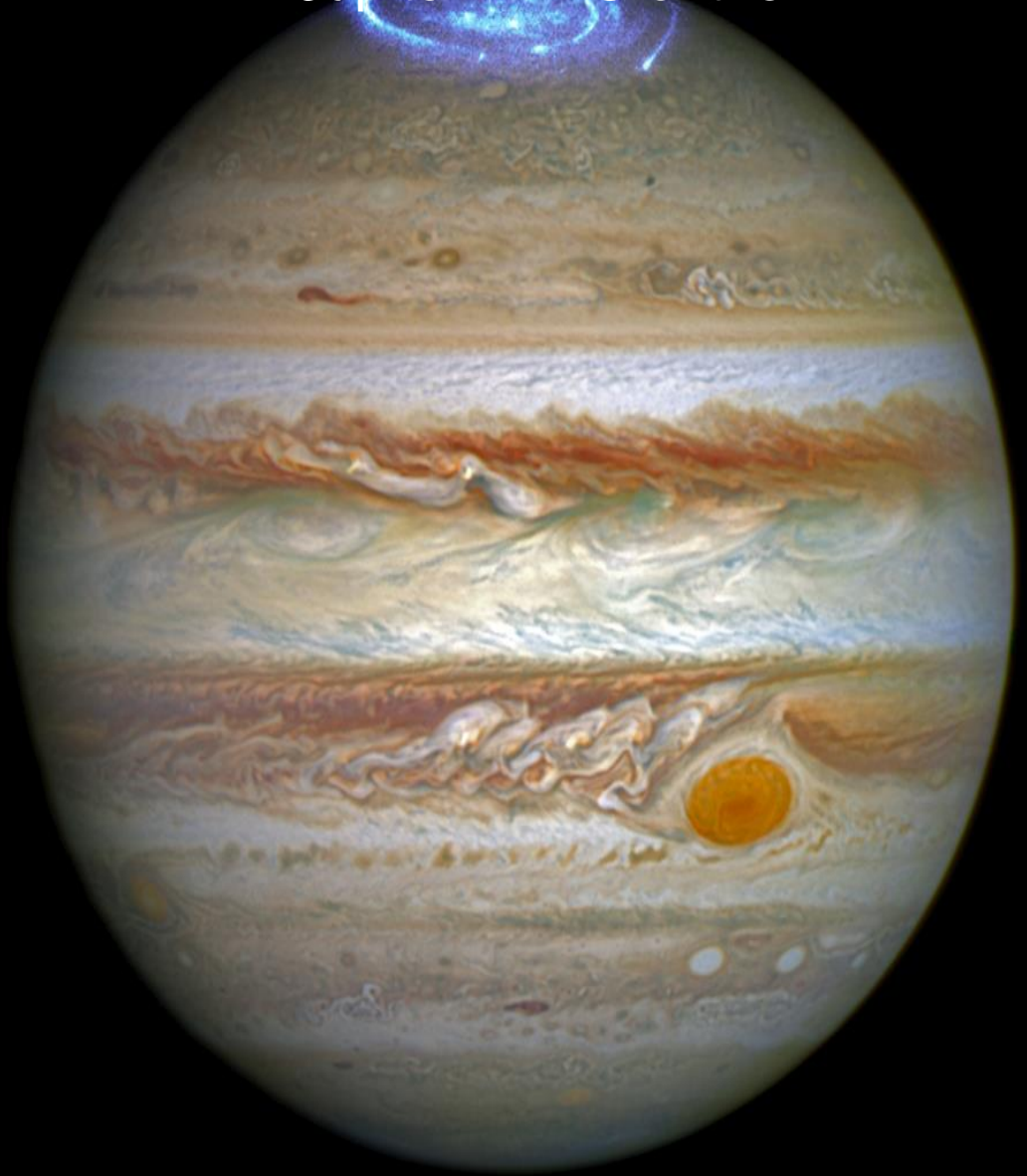
## The Appearance of Jupiter

- **Dark belts**
  - it's a Low pressure system
- **Downward moving gases sink and allow us to view the lower, darker layers.**

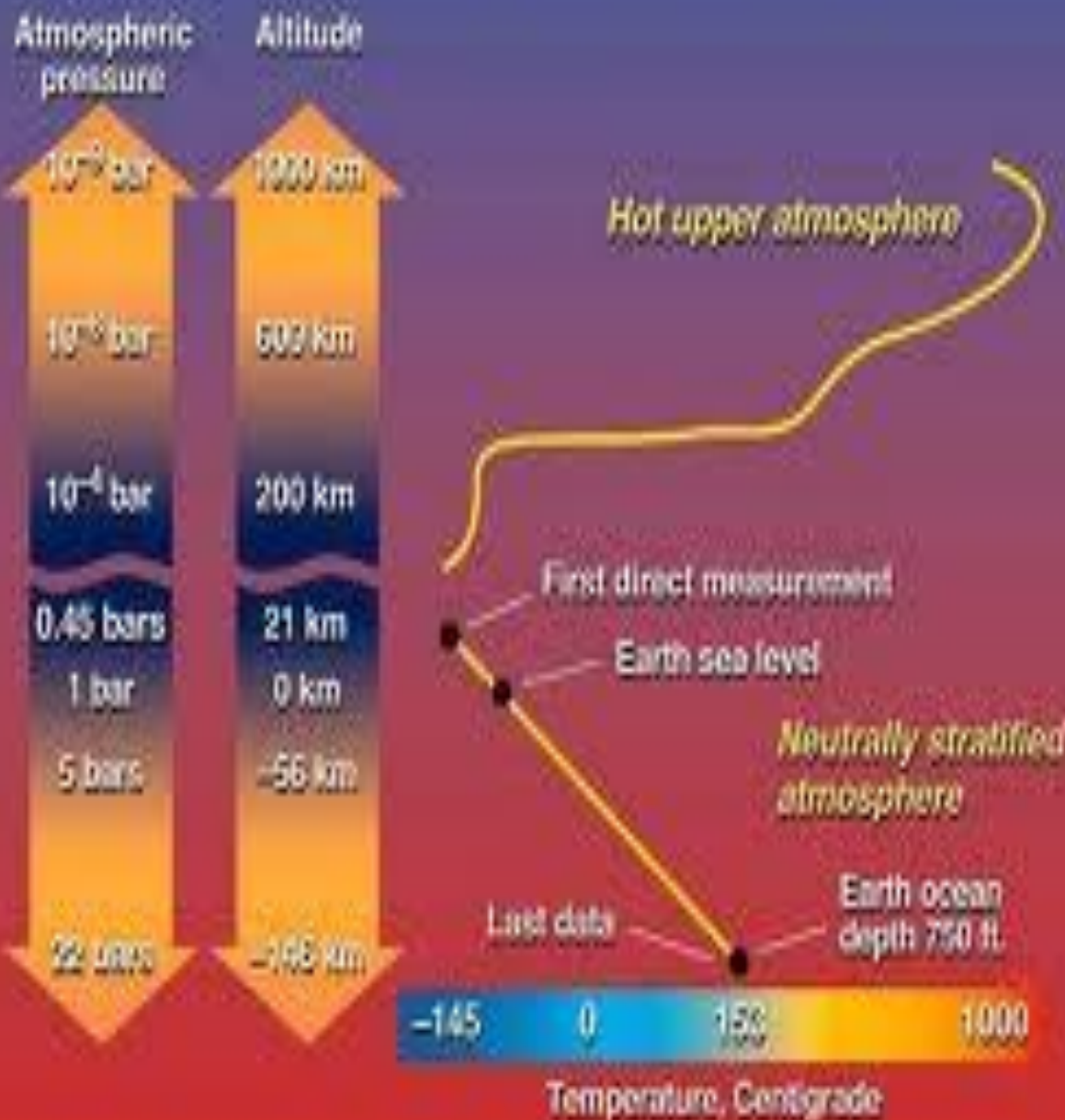


*These clouds of  
Belts and  
Zones make  
Jupiter the  
second  
brightest  
planet in the  
sky. Only the  
planet VENUS  
is brighter*

Jupiter: KING of the PLANETS



# Structure of Jupiter's Atmosphere



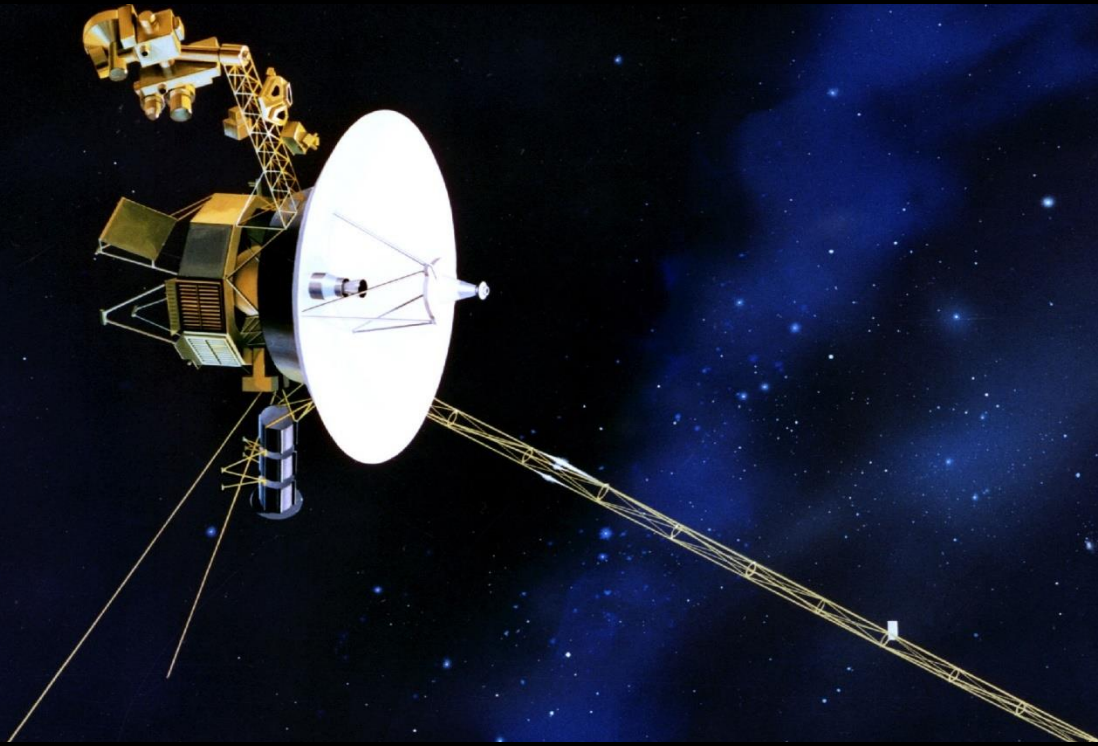
## The Appearance of Jupiter

### **Atmosphere** (air)

is mostly composed of:

- 89%  $H_2$ ,
- **10% He**,
- 1% traces of methane, ammonia and water

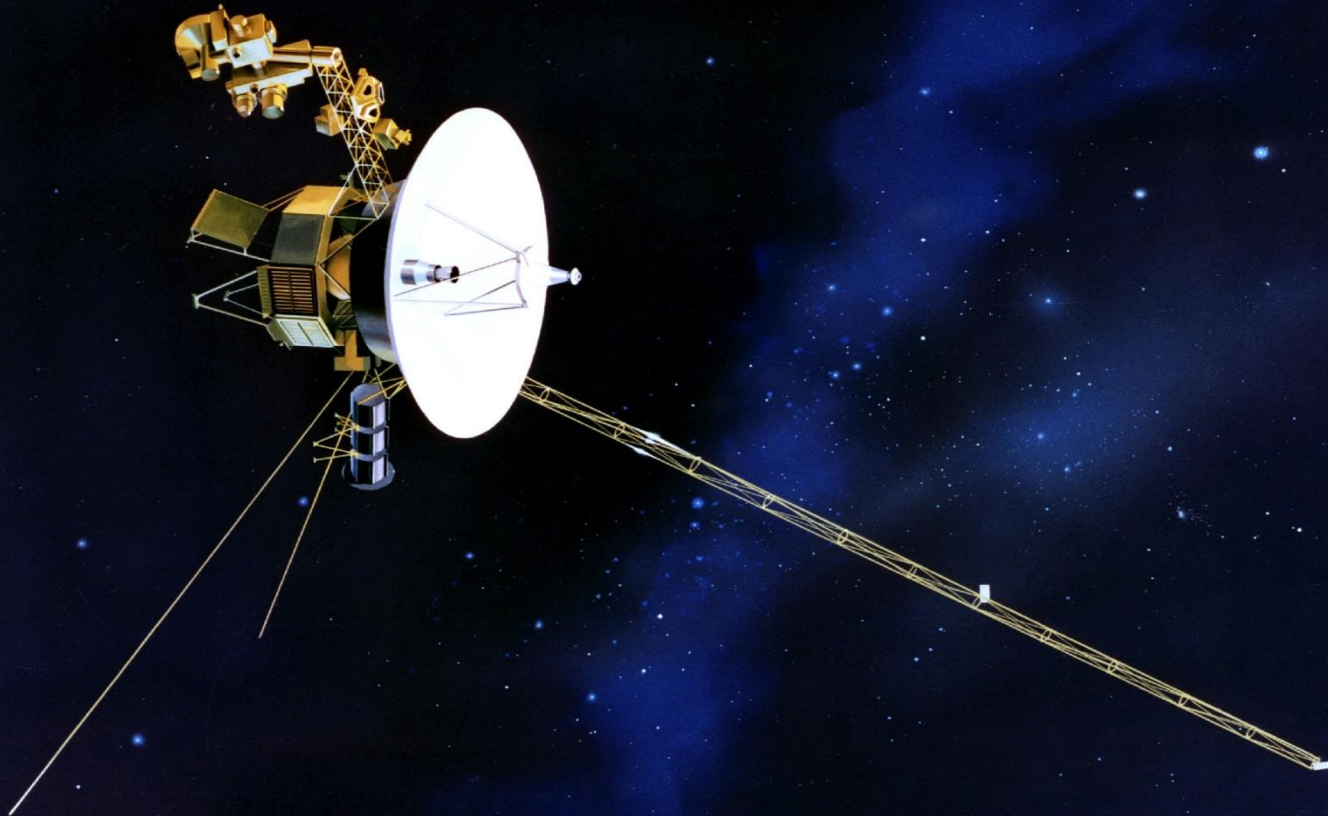
One of the first Space Probes to look at Jupiter was the Voyagers.



Even though we have received more information about Jupiter than any ground base or Hubble Space telescope this information still left many questions unanswered.



**Why is Jupiter NOT a star?** It has everything that the Sun has.





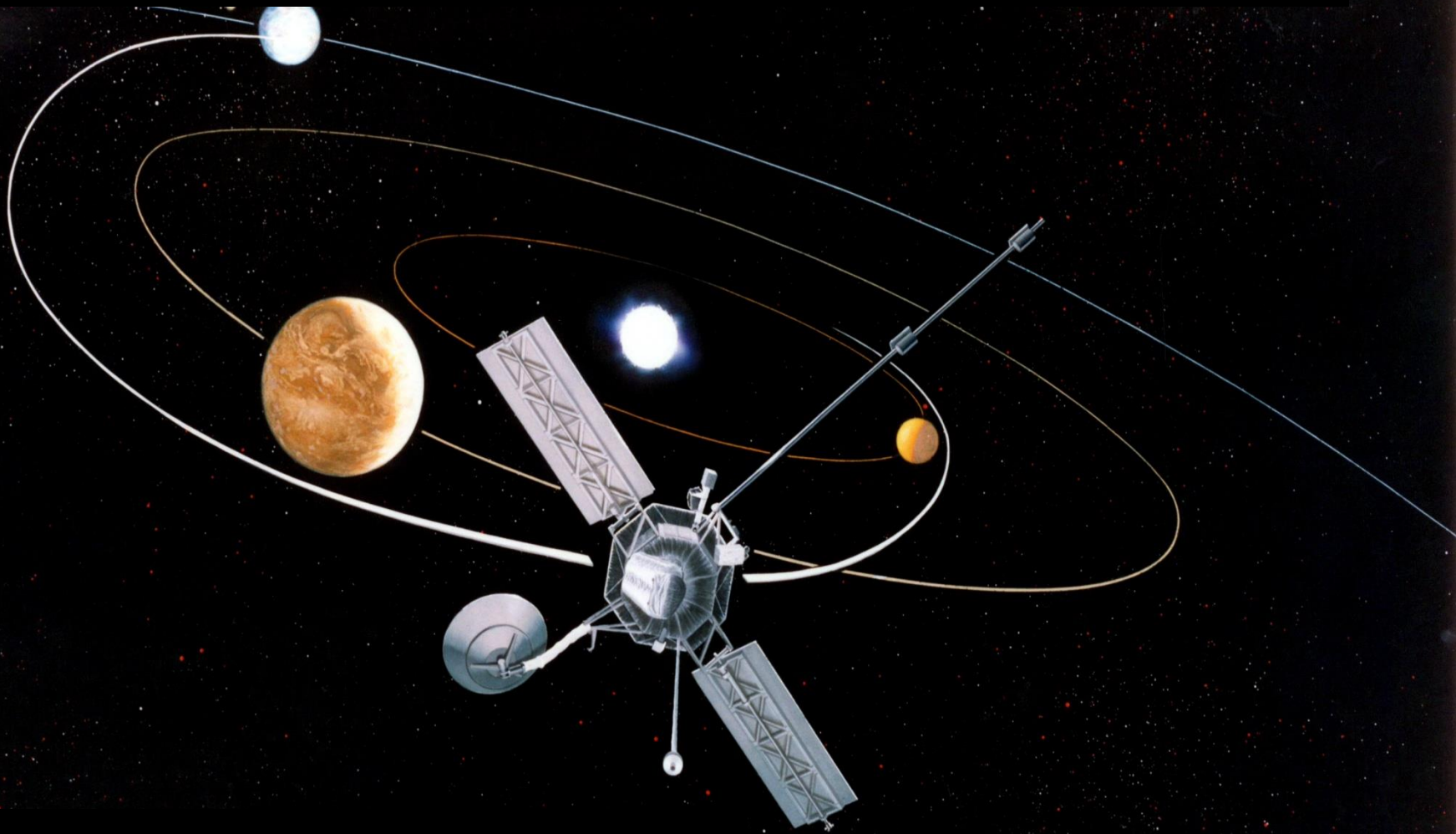
Even though it has everything needed to be a star it **does lack SIZE**. It's just **not big enough**, yet it is twice the size of any other planet.

**You would need to add 80 more Jupiter's mass to become a star.**

**Hydrogen fusion starts when a star has roughly 1/12 of the Sun's mass**



Galileo Space Probe was launched on Oct 18 1989  
and with the assist of gravitational slingshot...



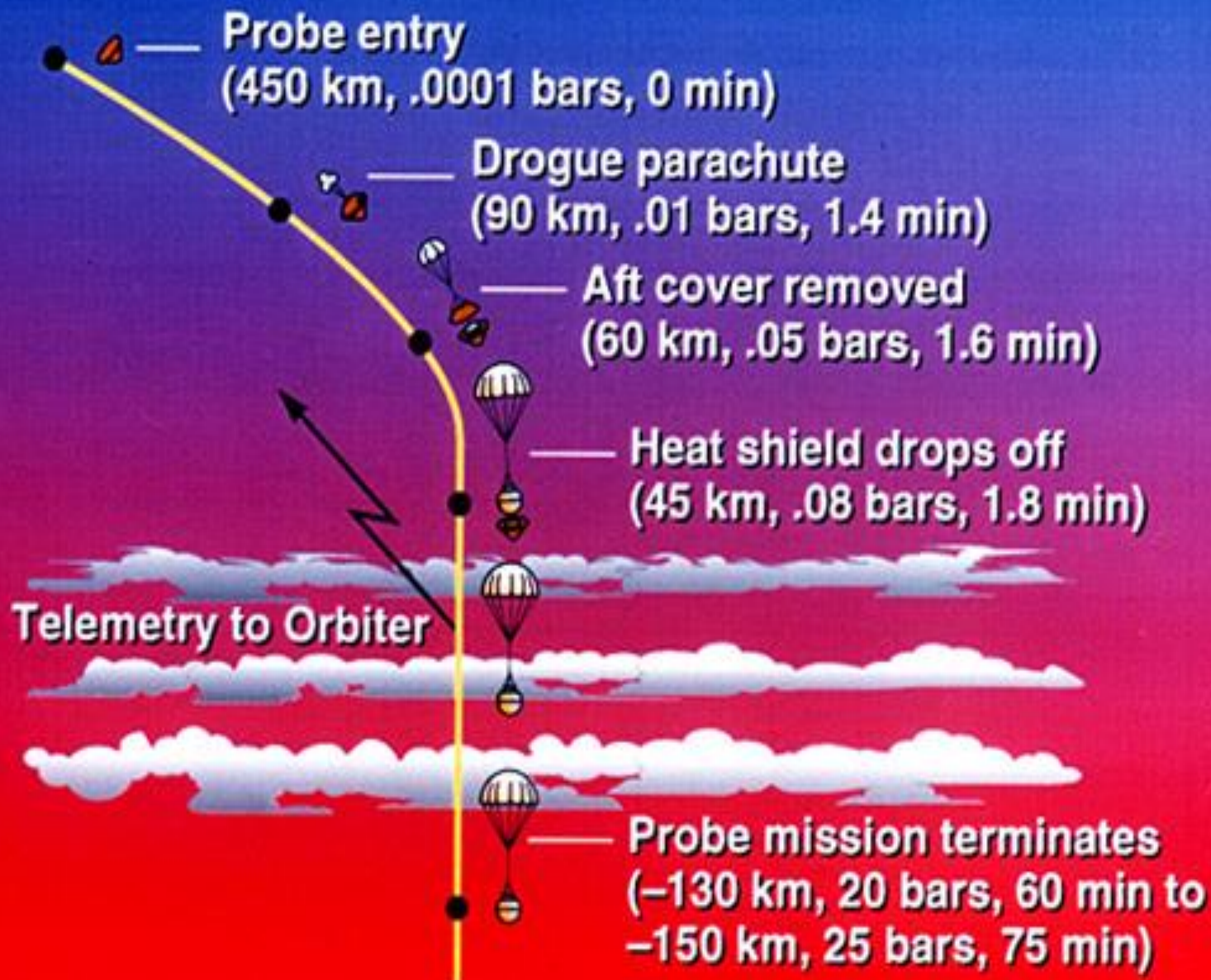
...from Earth and Venus...

...is traveling at 106,000 mph toward Jupiter

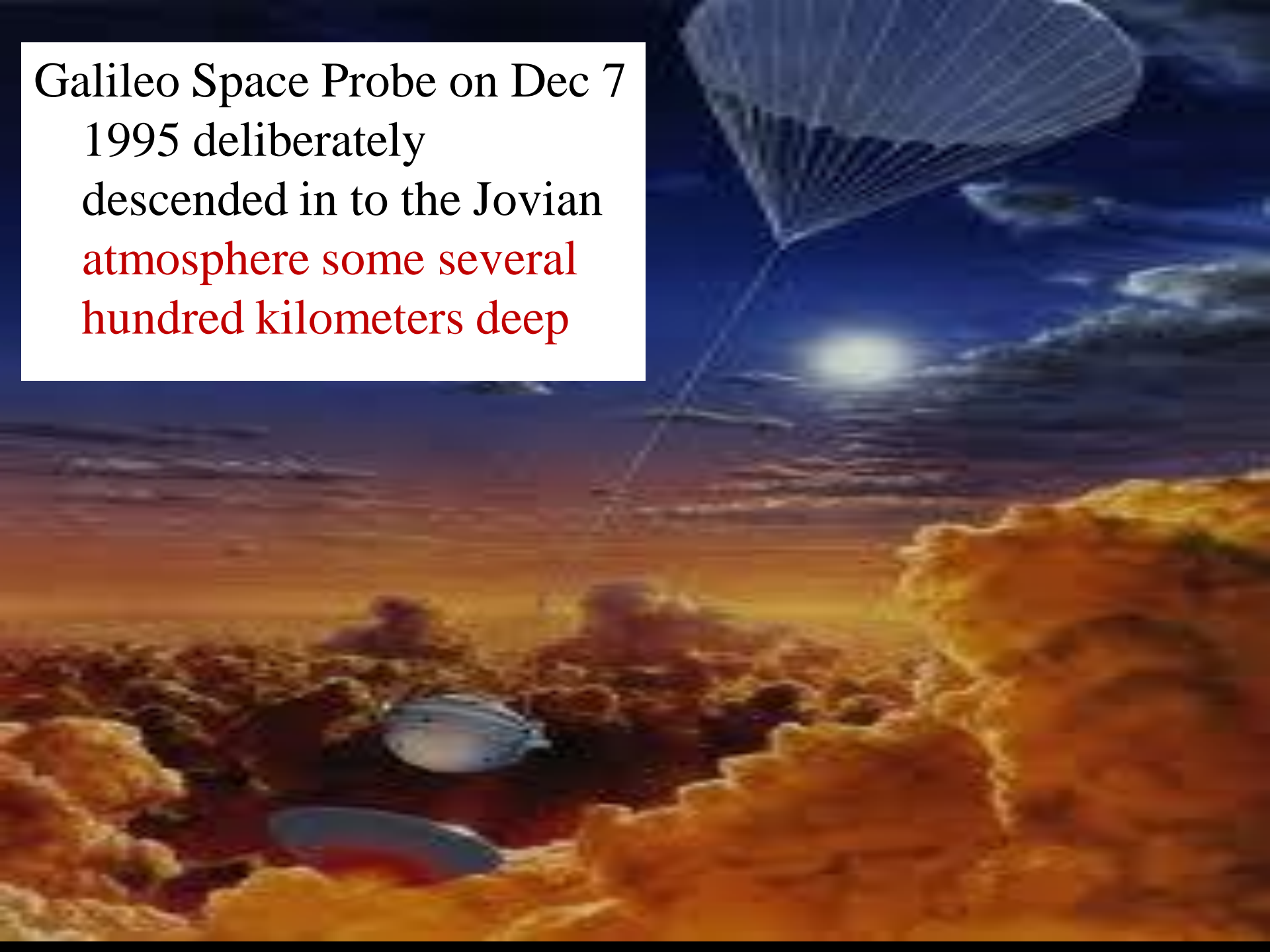




# Probe Mission



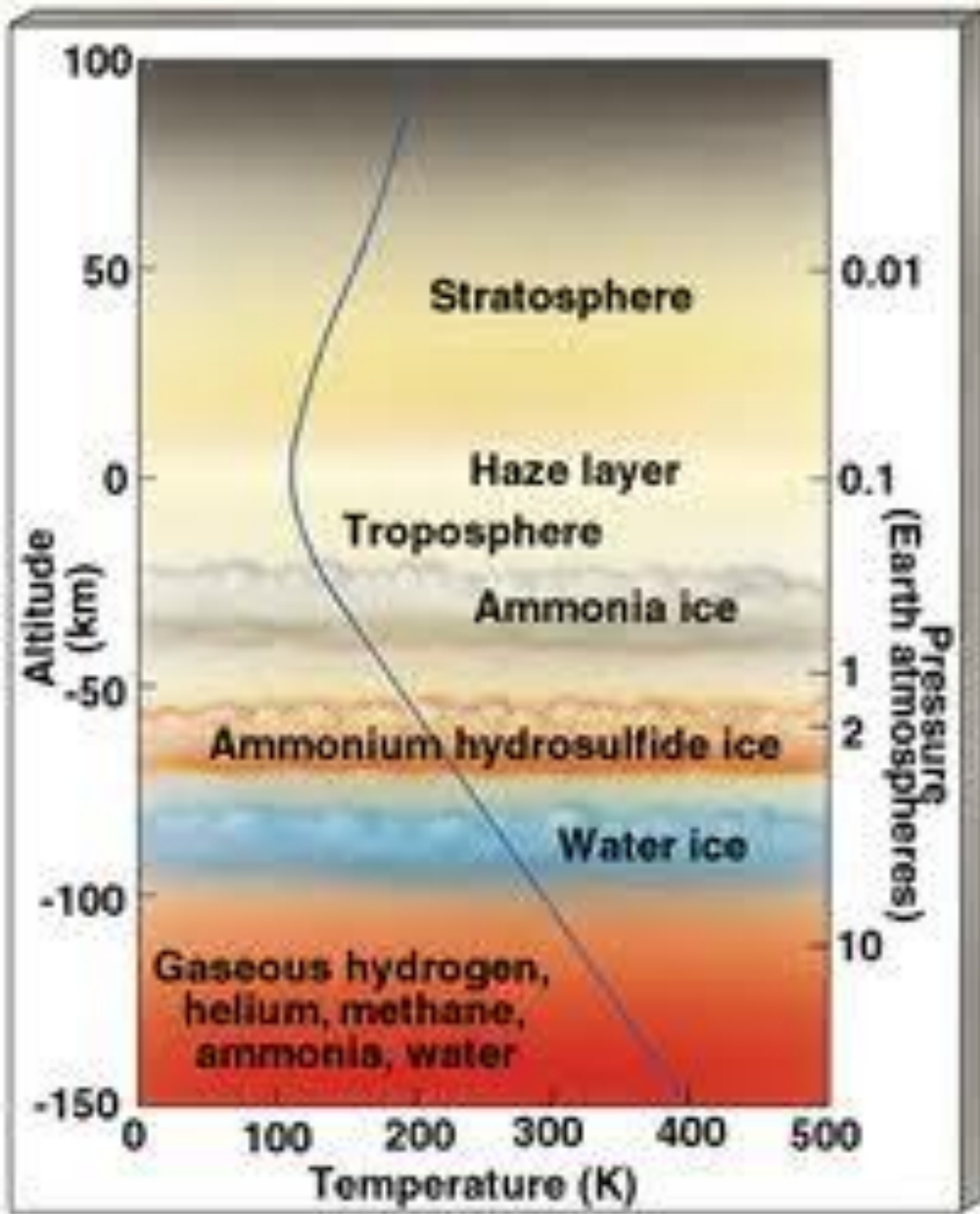
Galileo Space Probe on Dec 7  
1995 deliberately  
descended in to the Jovian  
atmosphere some several  
hundred kilometers deep



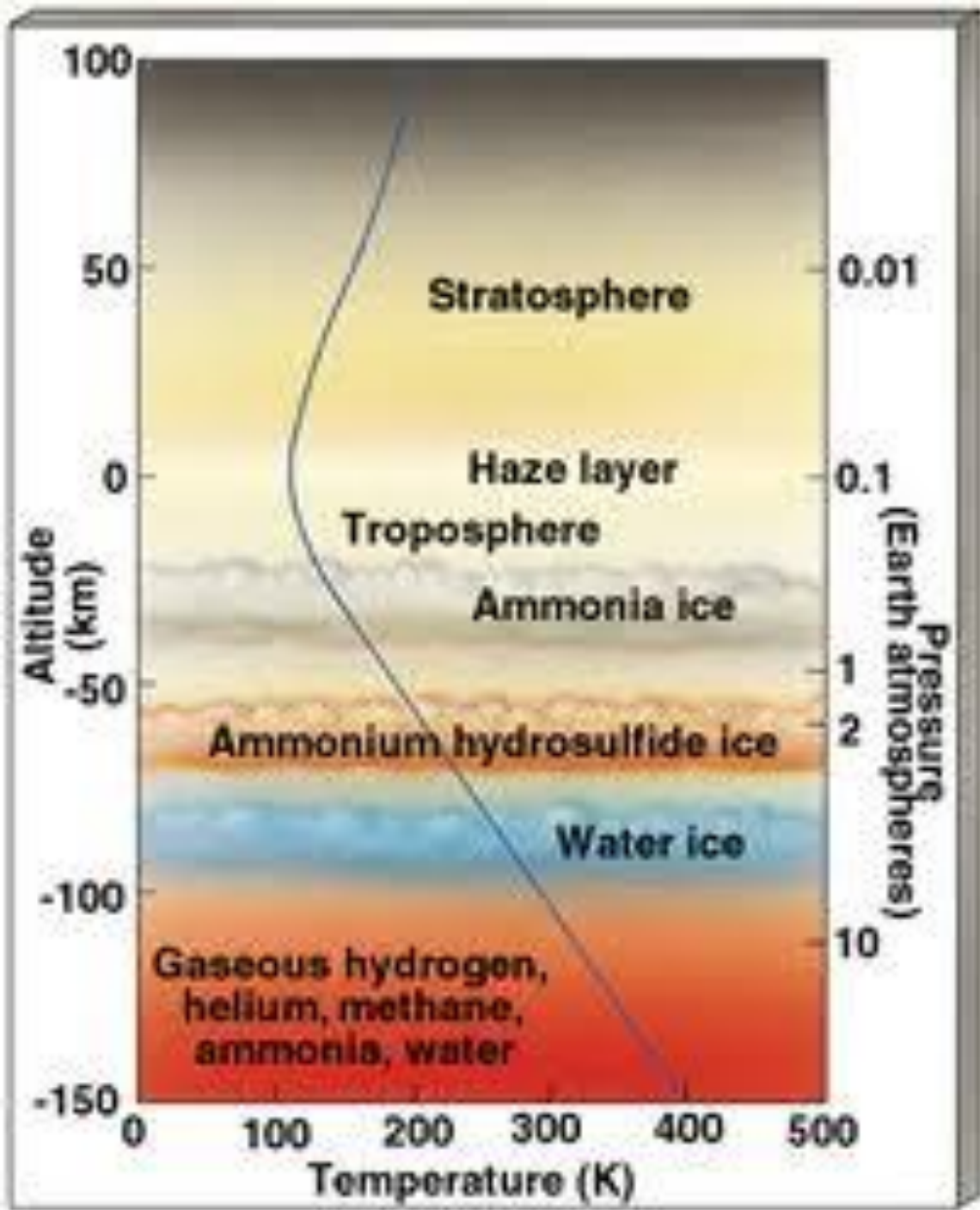


# The Appearance of Jupiter Outer Layer of the Atmosphere is

- ***NOT uniform and calm, BUT***
- ***Thick cloud cover with storms of Metallic helium with different pressures systems***







The Appearance of Jupiter  
Upper Layer of the Atmosphere has white, thin, wispy clouds of ammonia ( $\text{NH}_4$ ) ice and light rain of metallic helium.

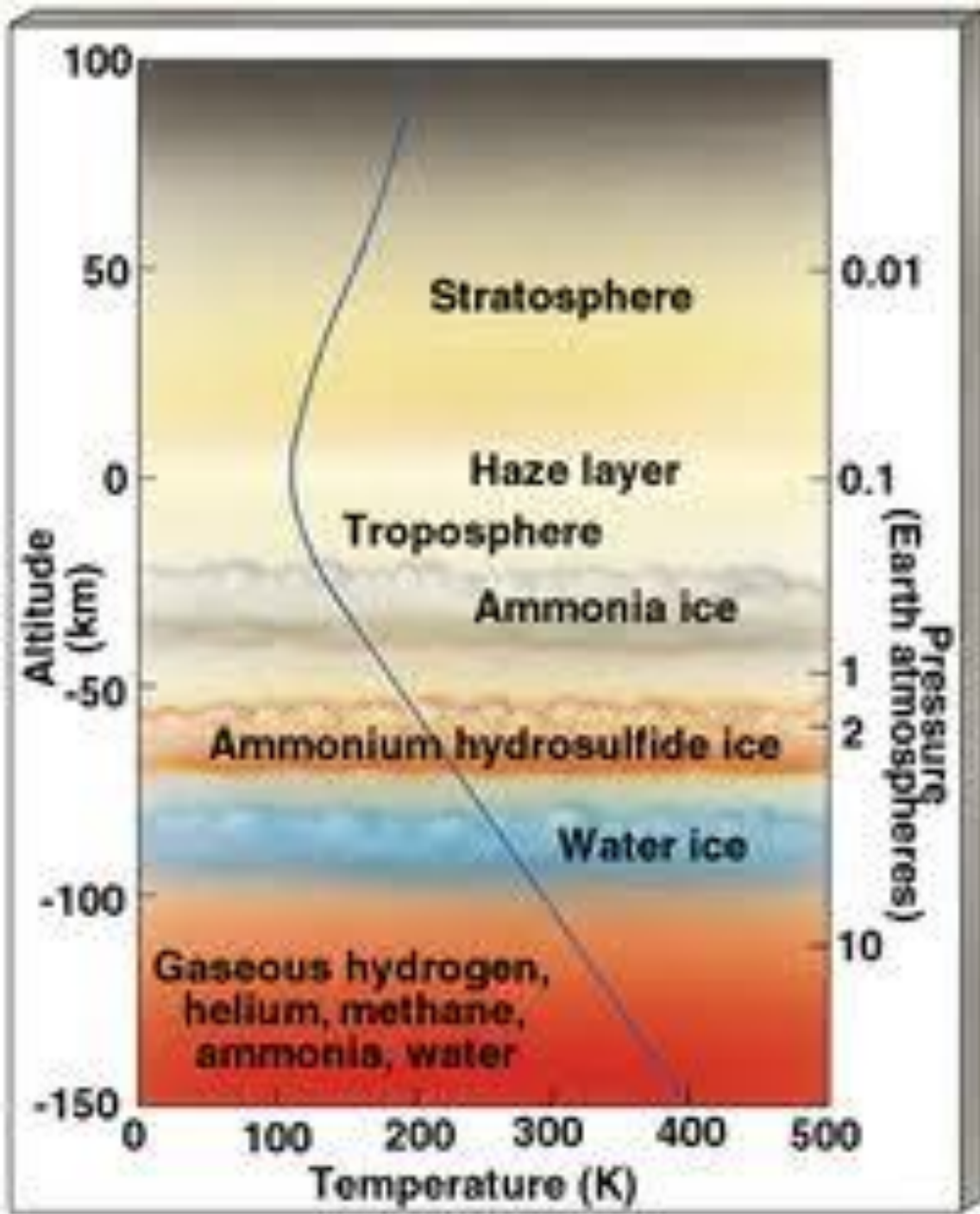
Temp:  $-189.68^\circ\text{F}$  to  $-236.47^\circ\text{F}$

Temp increases with depth

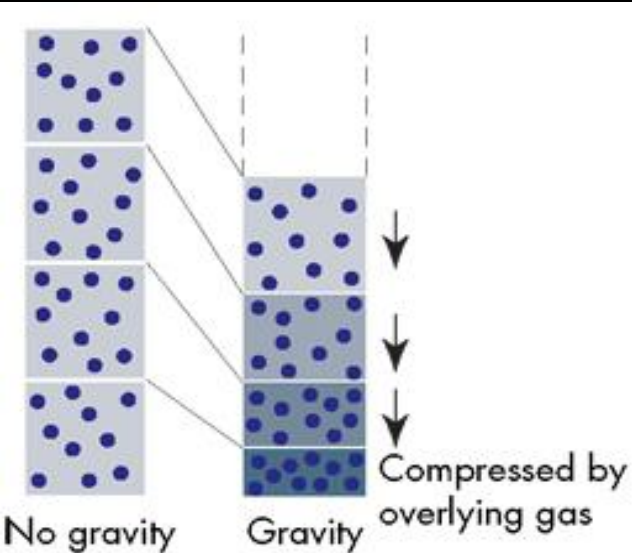
## The Appearance of Jupiter

Lower Layer of the Atmosphere has tawny color of clouds of ammonia hydrosulfide ( $\text{NH}_4\text{SH}$ ) ice and *a layer of water vapor crystals as expected.*

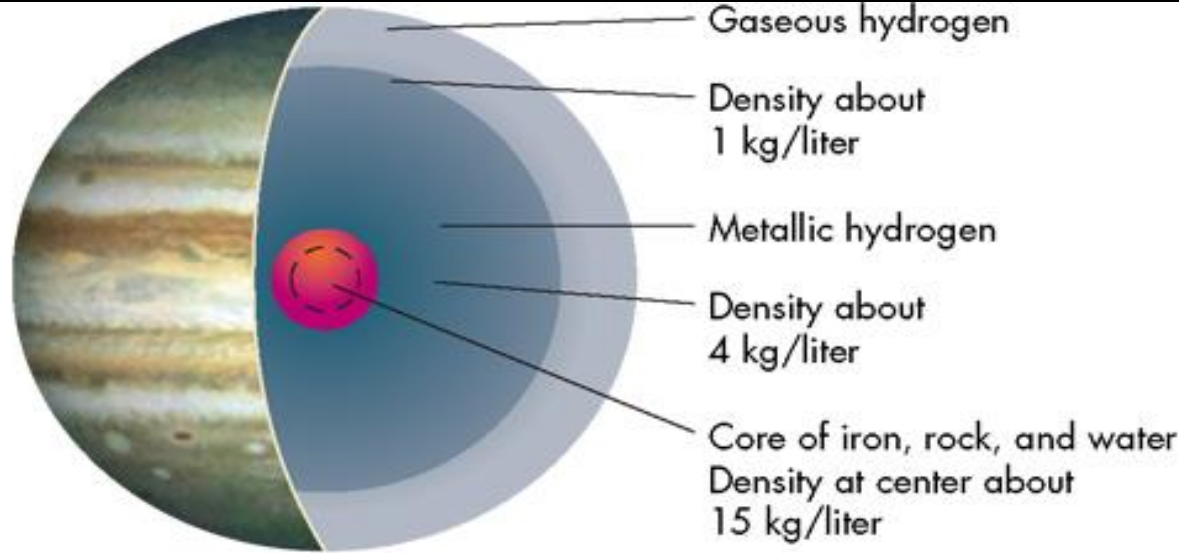
Also found was Phosphine ( $\text{PH}_3$ ) which acts like a color agent



# The Interiors of the Gas Giants

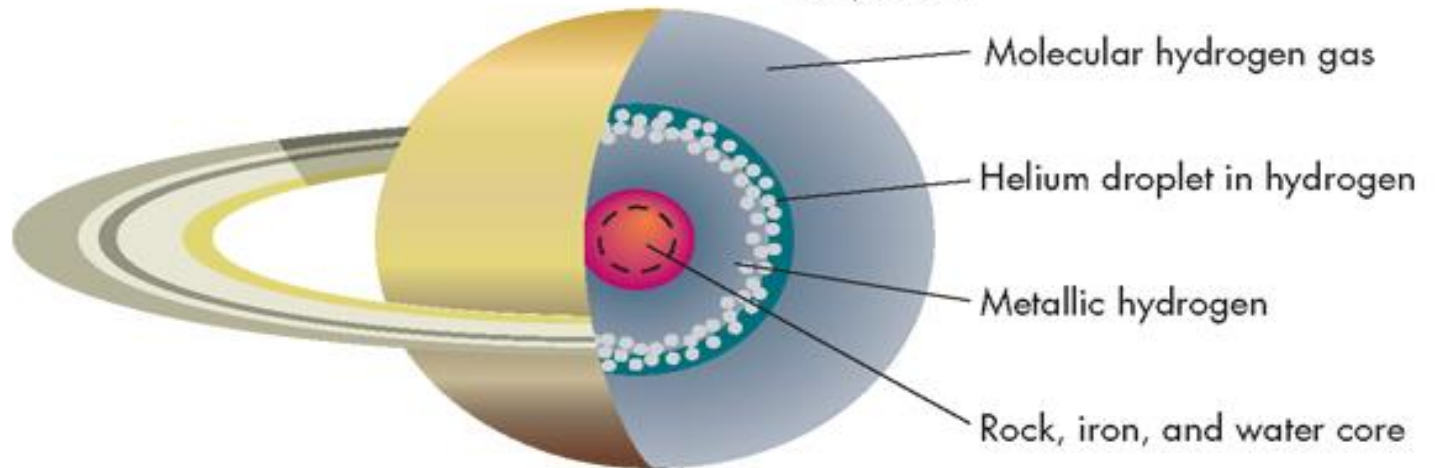


**A**



**B**

Earth for  
comparison



**C**

- **Jupiter's average density is 1.3 kg/liter**
  - Must be mostly very light elements!
- Planet is in **hydrostatic equilibrium**
  - Gravity pulls inward, interior pressure pushes outward
  - The two forces are balanced
  - Probably has a solid rocky core larger than Earth!

## The Interiors of the Gas Giants





- **No solid or liquid surface**

- Gradual transition with depth into the **huge mantle** with *Pressure is high enough to create liquid metallic hydrogen, a fluid that acts like a metal*

**Atmosphere is mostly composed of 89% H<sub>2</sub>**

## The Interiors of the Gas Giants

### Inside Gas Giant JUPITER

The largest planet in our solar system, Jupiter could hold more than 1,200 Earths. It has dozens of moons and an enormous magnetic field. The planet, mostly a giant ball of gas and liquid, also has a dark ring system composed of fine dust grains.

**TURBULENT ATMOSPHERE**  
89.8% hydrogen,  
10.2% helium,  
plus trace gases.

**GRAVITY**  
2.4 OF  
EARTH



**EARTH** 200 lbs.  
**JUPITER** 480 lbs.

**SURFACE CONDITIONS**  
**AIR PRESSURE:** 1,000x Earth  
**TEMPERATURE:** Varies by depth  
**WINDS:** Over 400 mph in the upper atmosphere.



This image of Jupiter's clouds was taken in 1979 by the Voyager 2 spacecraft.

**METAL CORE** Jupiter's core is probably made up of layers of metals and rocks, along with methane ice, ammonia ice and water ice.



Jupiter is over 11x larger than the Earth.

- **No solid or liquid surface**
- The Core of Jupiter is probably a massive core of rocky materials with some iron mixed in
- Larger than Earth!

## The Interiors of the Gas Giants

### Inside Gas Giant JUPITER

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## The Great Red Spot

- On Jupiter,  
these wind  
shears give  
rise to  
enormous  
vortices, or  
storms, seen as  
white, brown  
or red ovals in  
its clouds





- The **Great Red Spot**  
on Jupiter is one such  
vortex
  - Rises 31.2 miles above surrounding clouds
  - Wind speeds of ~220mph!
  - It is a large (cyclonic storm) **colossal of a hurricane** similar to a hurricane here on Earth.

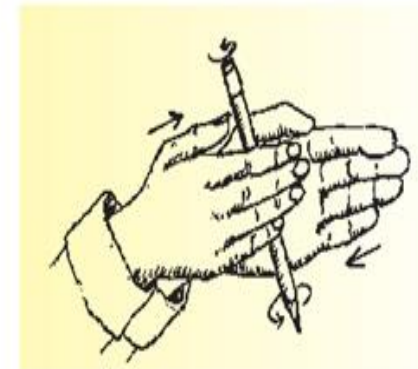
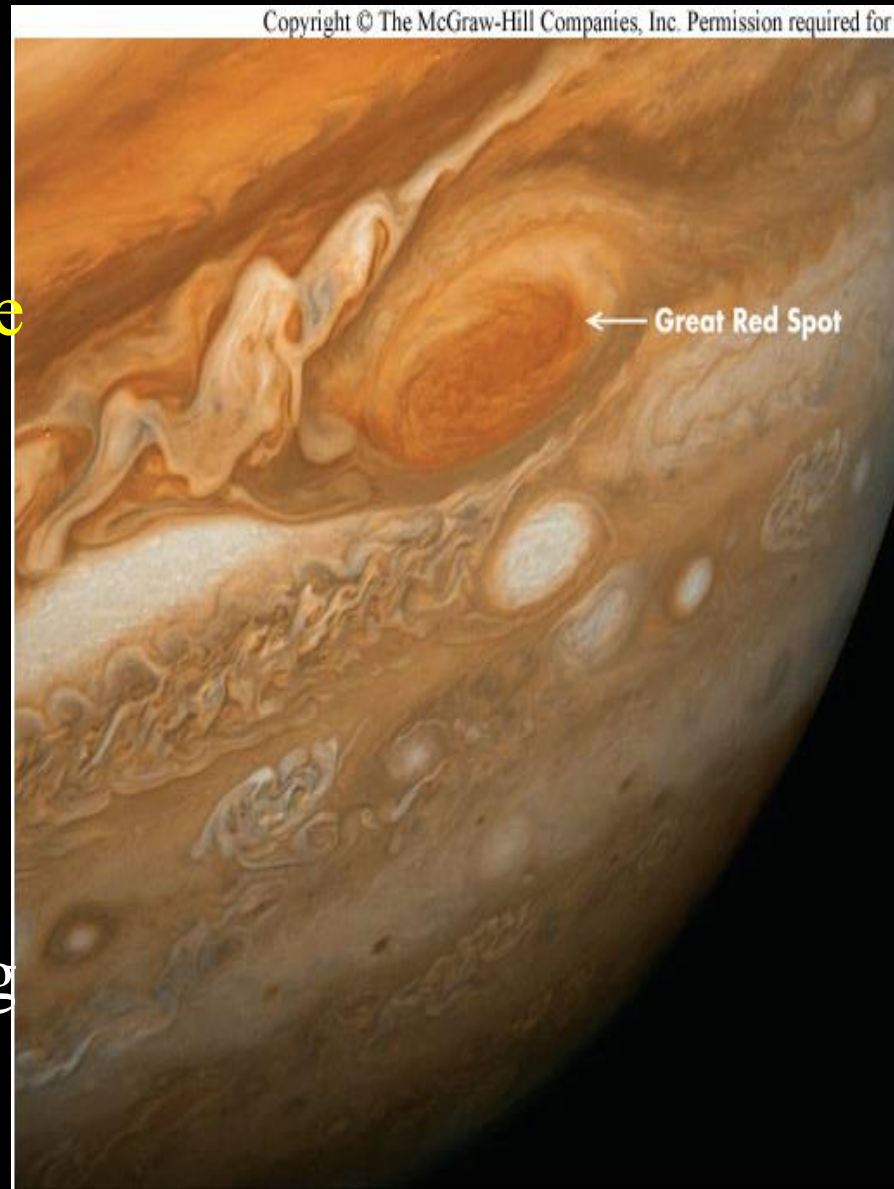


10,000 km

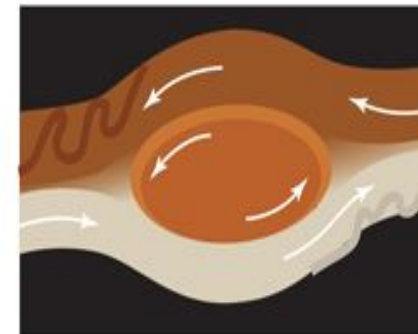


# The Great Red Spot

- The Great Red Spot is a storm that has lasted for at least 400 years (that's like 3 centuries)
  - Galileo saw it, and it hasn't changed much
  - It is changing color slowly, however.

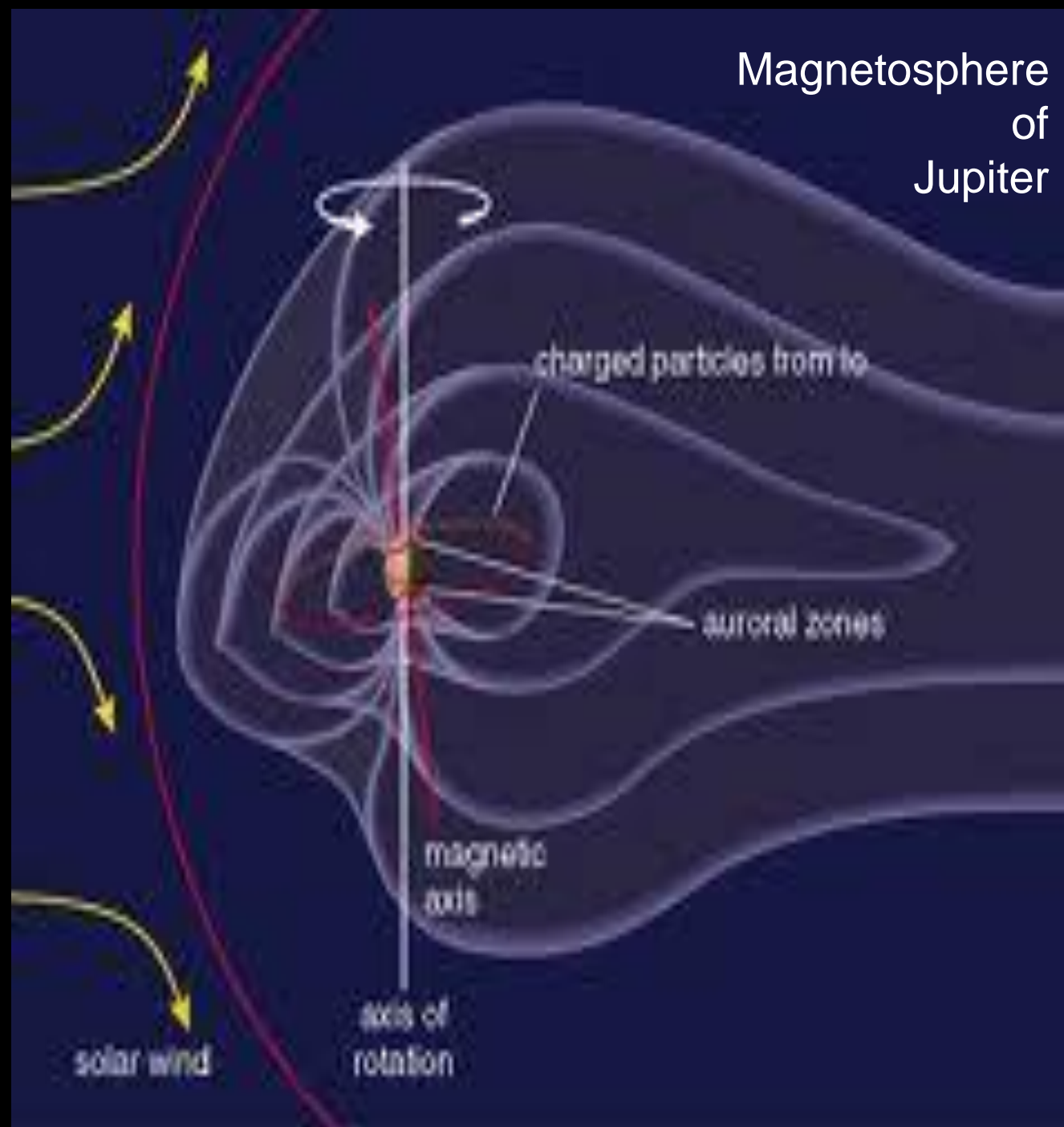


B



C

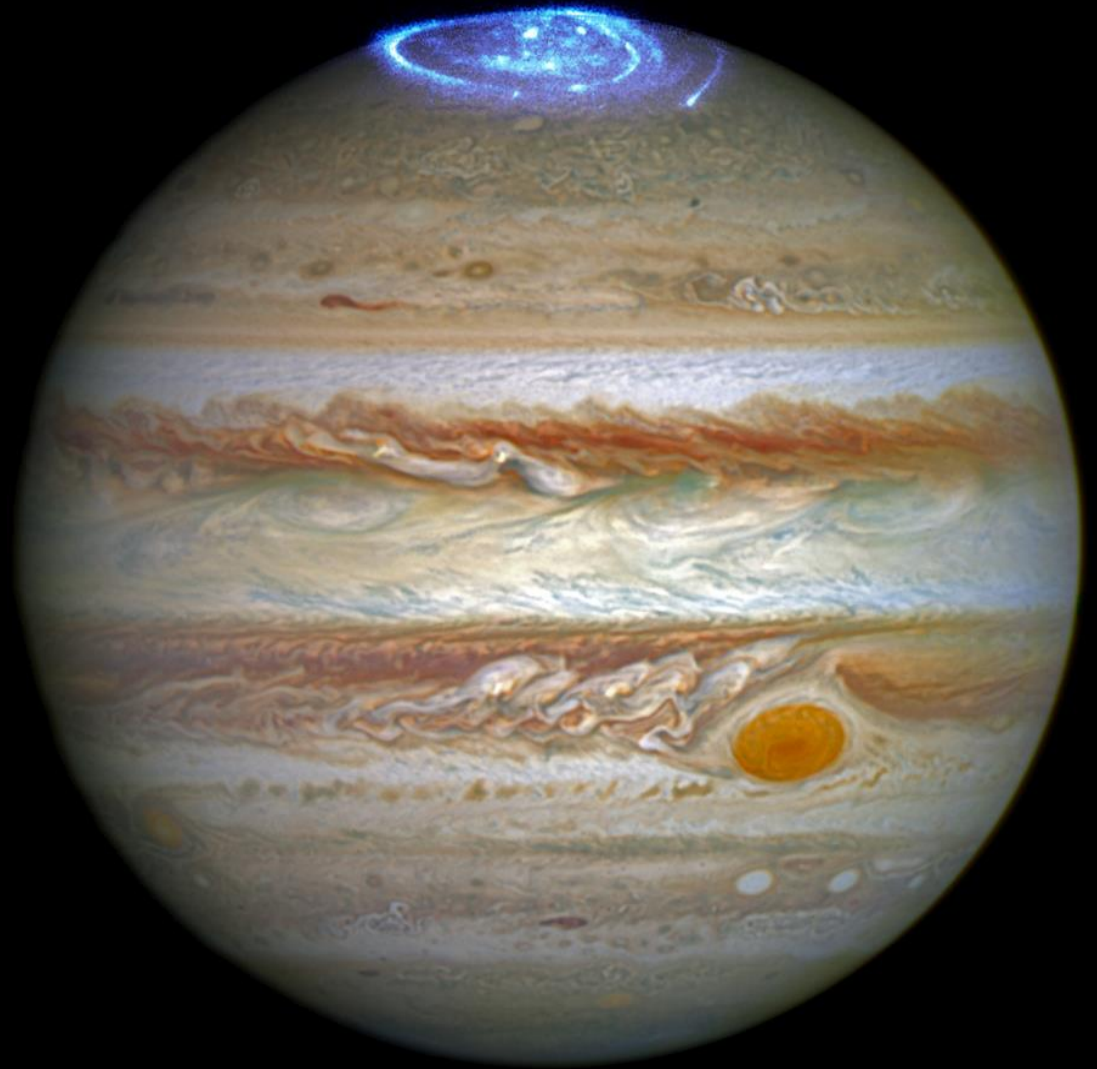
- **The liquid metallic hydrogen** in Jupiter and Saturn can carry electrical currents, **similar to the liquid core of the Earth**



- Jupiter experience auroras because of the magnetic field which

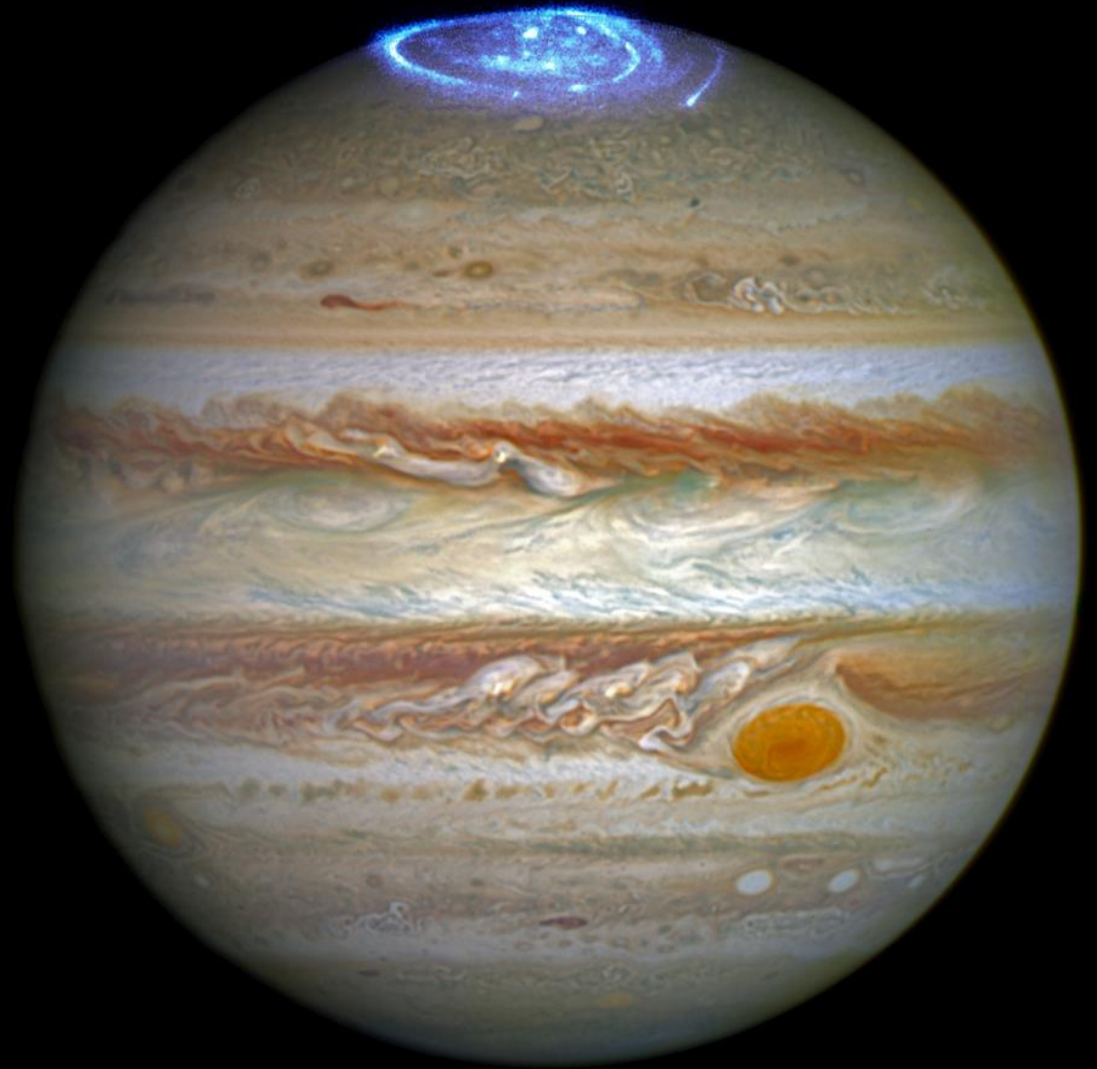


- These currents generate very large magnetic fields which allows us to measure the interior rotation rate.

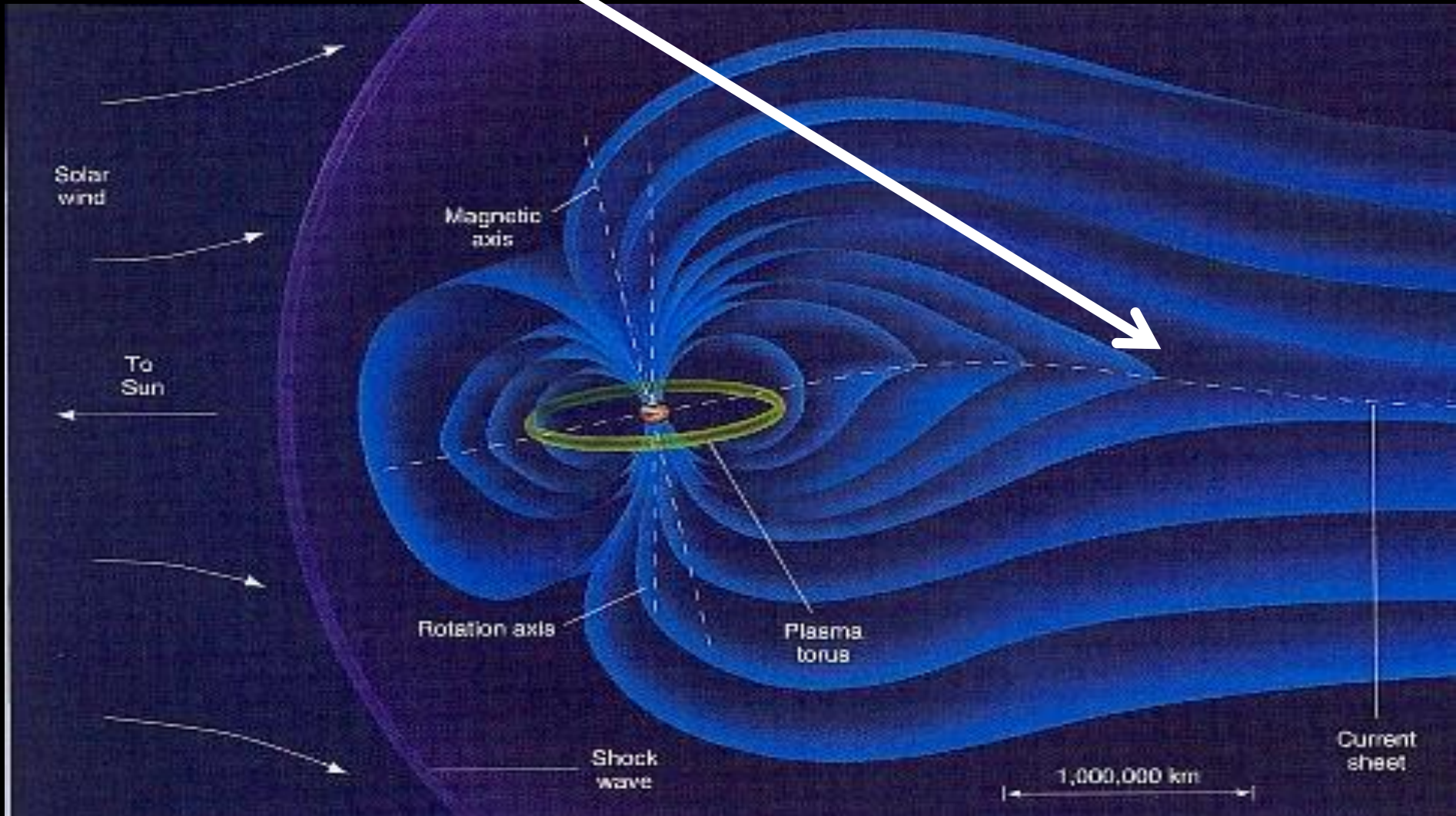




*Jupiter's  
magnetic field  
is about 20,000  
times as strong  
as Earth's, and  
if it were  
visible, would  
appear larger  
than the full  
Moon in our  
sky!*



Because Jupiter has such a strong magnetic field, its “tail” can extend beyond the orbit of Saturn






Our universe  
is not silent

<https://www.youtube.com/watch?v=e3fqE01YYWs>

Jupiter sounds (so strange!) NASA-Voyager recording

- Jupiter's magnetic field emits intense radio waves and magnetic sound because of the liquid metallic hydrogen swirling in the rapidly spinning mantle.



- 
- A bright, glowing ring of Jupiter, appearing as a thin, curved band of light against a dark background. The ring is composed of many small particles, creating a textured, slightly grainy appearance. It is oriented diagonally across the frame, from the upper left towards the lower right.
- *Jupiter has four thin rings*
    - Main ring was found by voyager I in a navigation reference frame.
    - 300,000 miles in diameter

- The rings are mainly *Dark **dusty** particles and smoky particles*
- The other rings
  - Inner ring
  - MAIN ring
  - 2 outer rings called:  
**Gossamer Rings** lies on the planet's equatorial



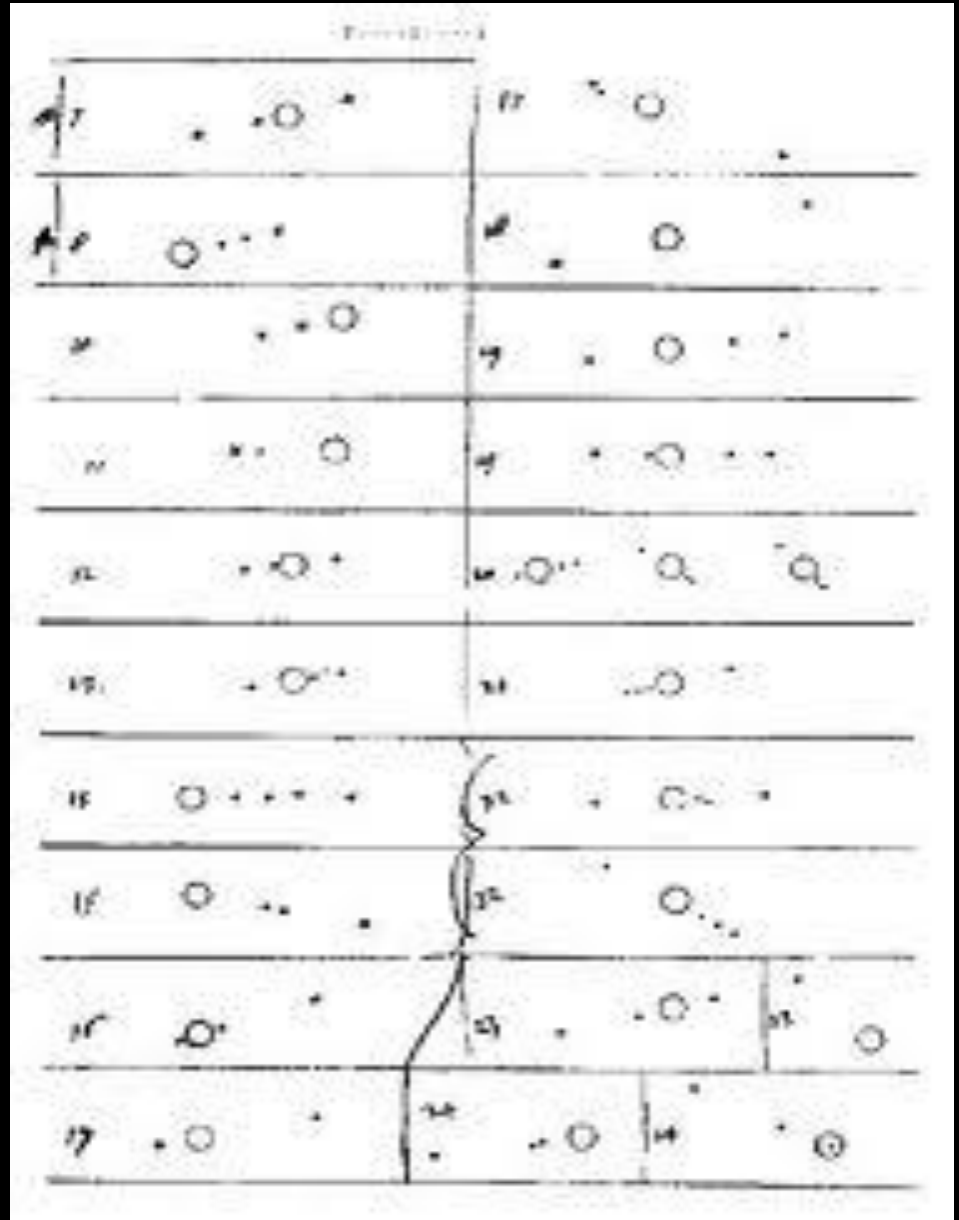
- Jupiter has a total of 67 moons
- The four largest moons of Jupiter are called the *Galilean satellites*, in honor of their discoverer in 1610
- They appear as pinpoints of light through small telescopes or binoculars





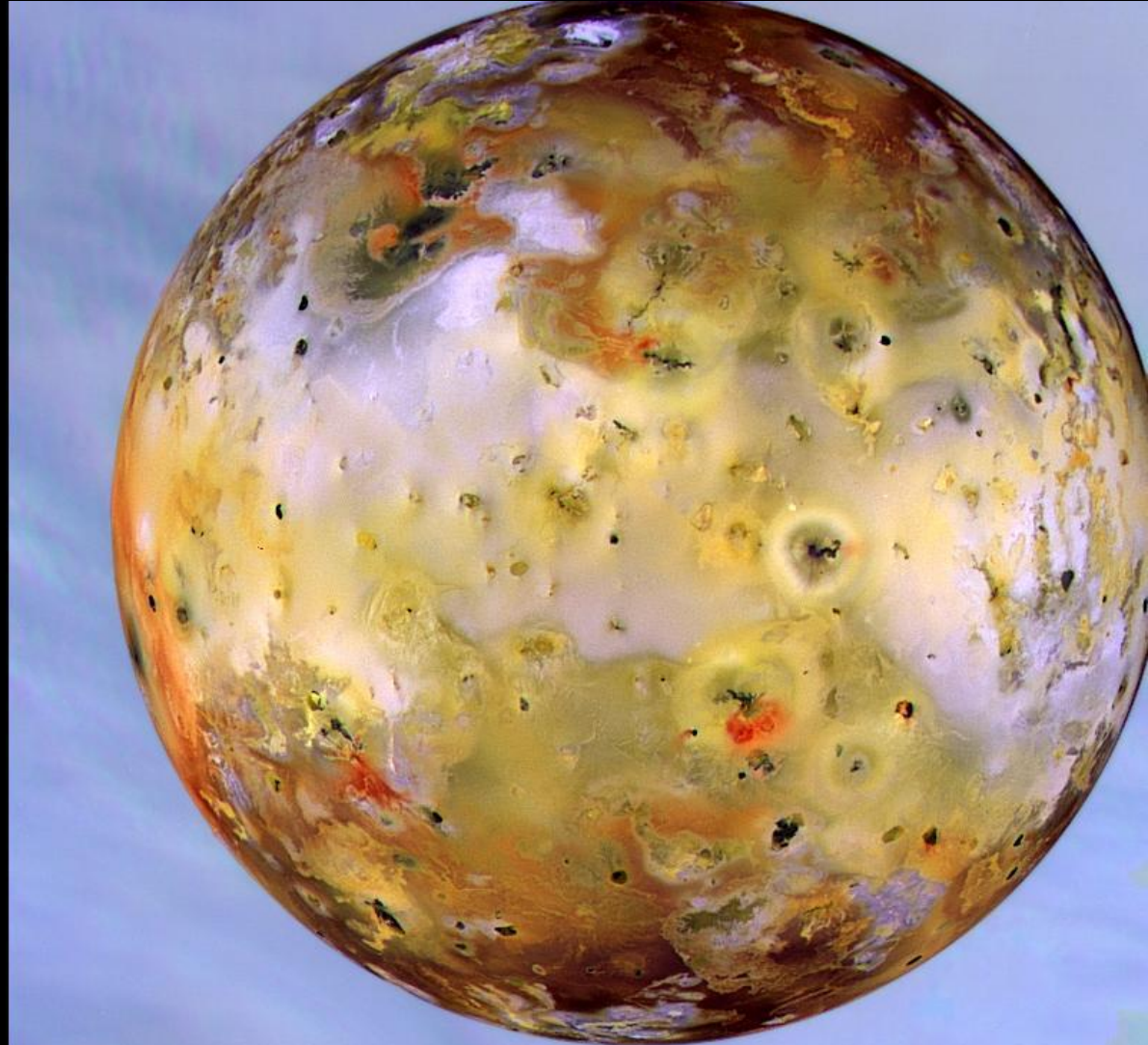
## The Galilean Satellites

- The **four largest moons where discover in 1610**
- Their positions change rapidly, with orbital periods ranging from 2 to 17 days
- **All the moons of Jupiter are tidally locked to Jupiter**
- Some moons can orbit the planet in a **RETROGRADE** orbit

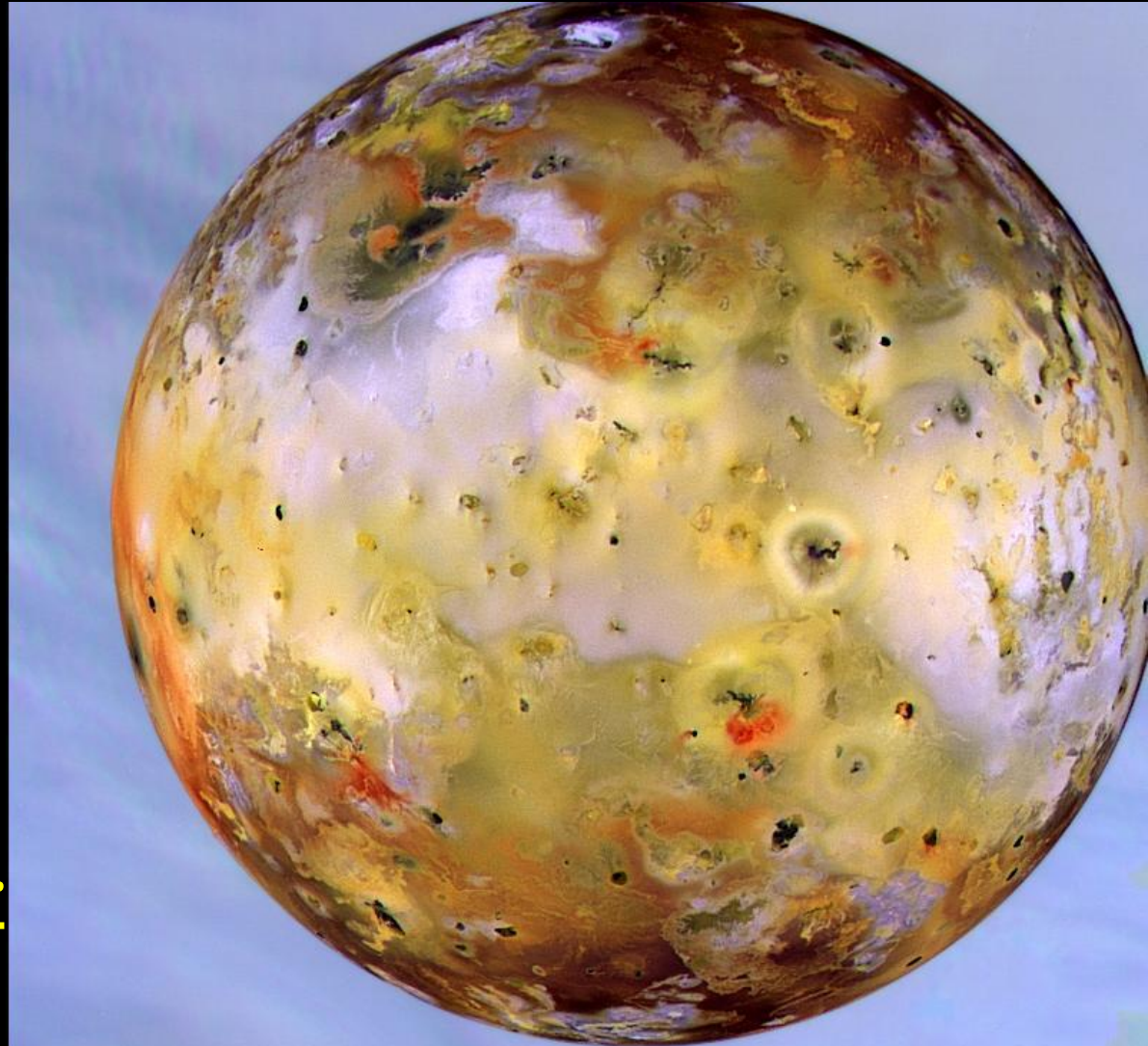


## The Galilean Satellites: Io

- Looks like a giant celestial pizza (only 262,000 miles from Jupiter)
- **HOTTEST moon in the solar system...**
- **3<sup>rd</sup> largest moon** Size of 2262 miles;

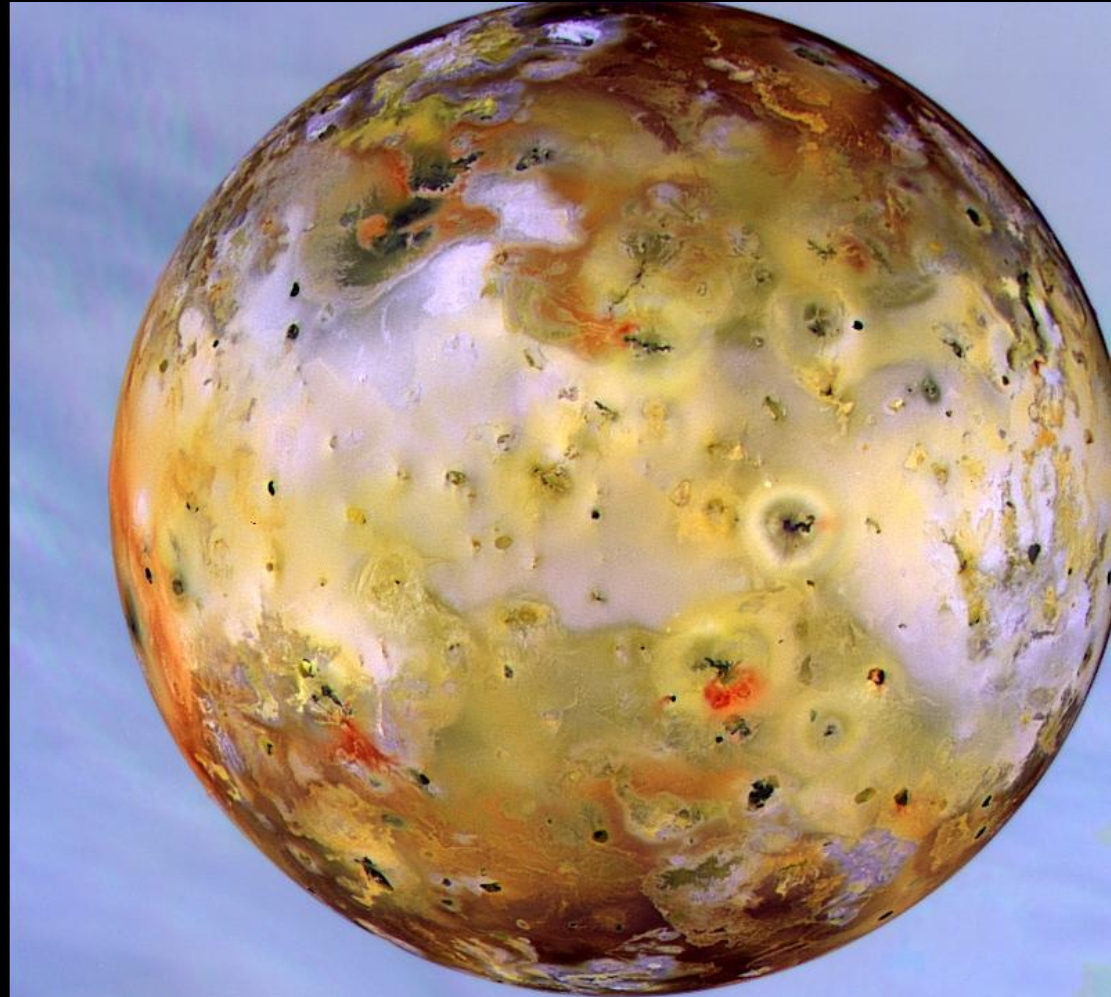


- ROTATION:
  - 1.77 earth days  
(Ioan day)
- REVOLUTION:
  - 1.76 earth years  
(Ioan years)
- *Most geological active volcanic moon that eruptions of sulfur & its compounds*



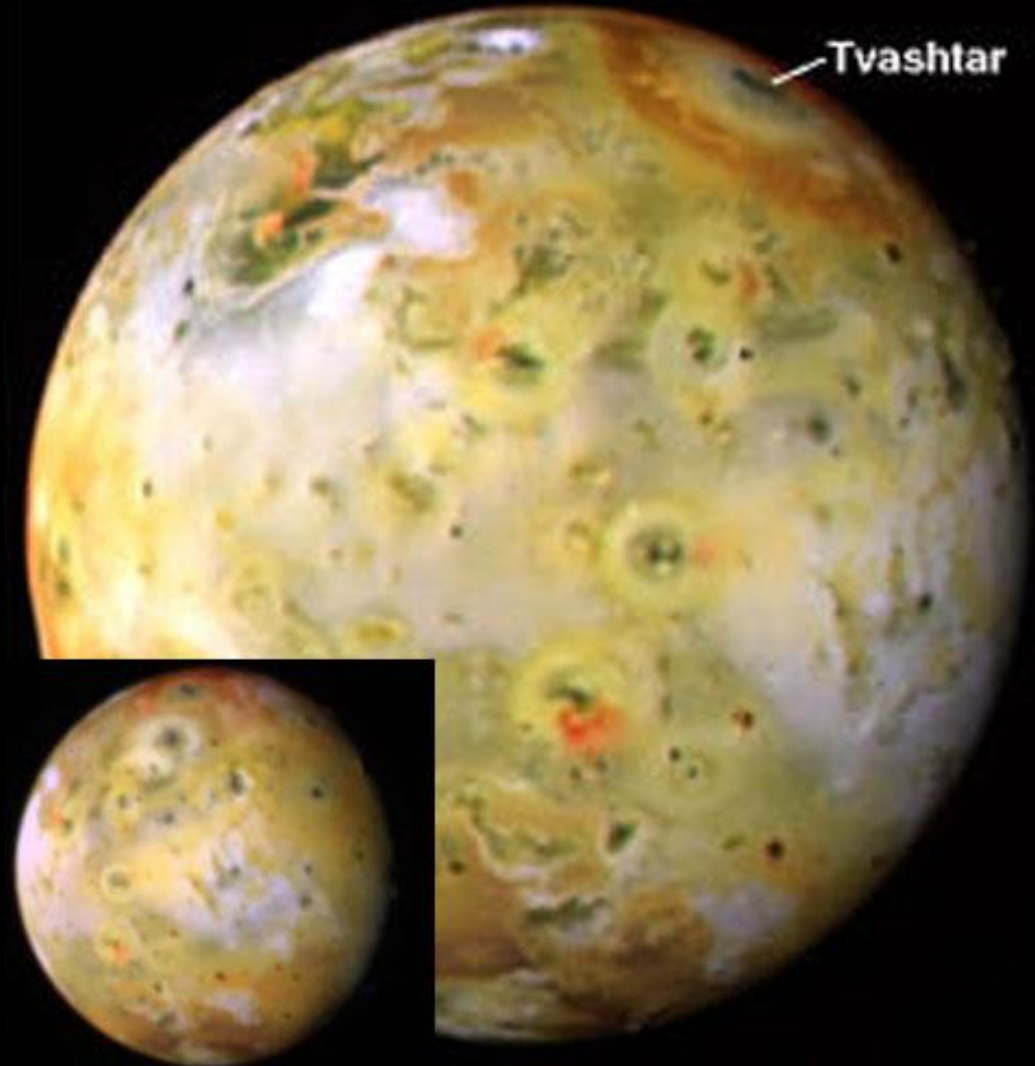


- There are more than 300 Active Volcanic Eruptions
- It erupts more than 45 thousand tons per SECOND of the hottest lava over the surface ( $\sim 2600^{\circ}\text{F}$ )
- Enough to pave the entire earth's highways each year.

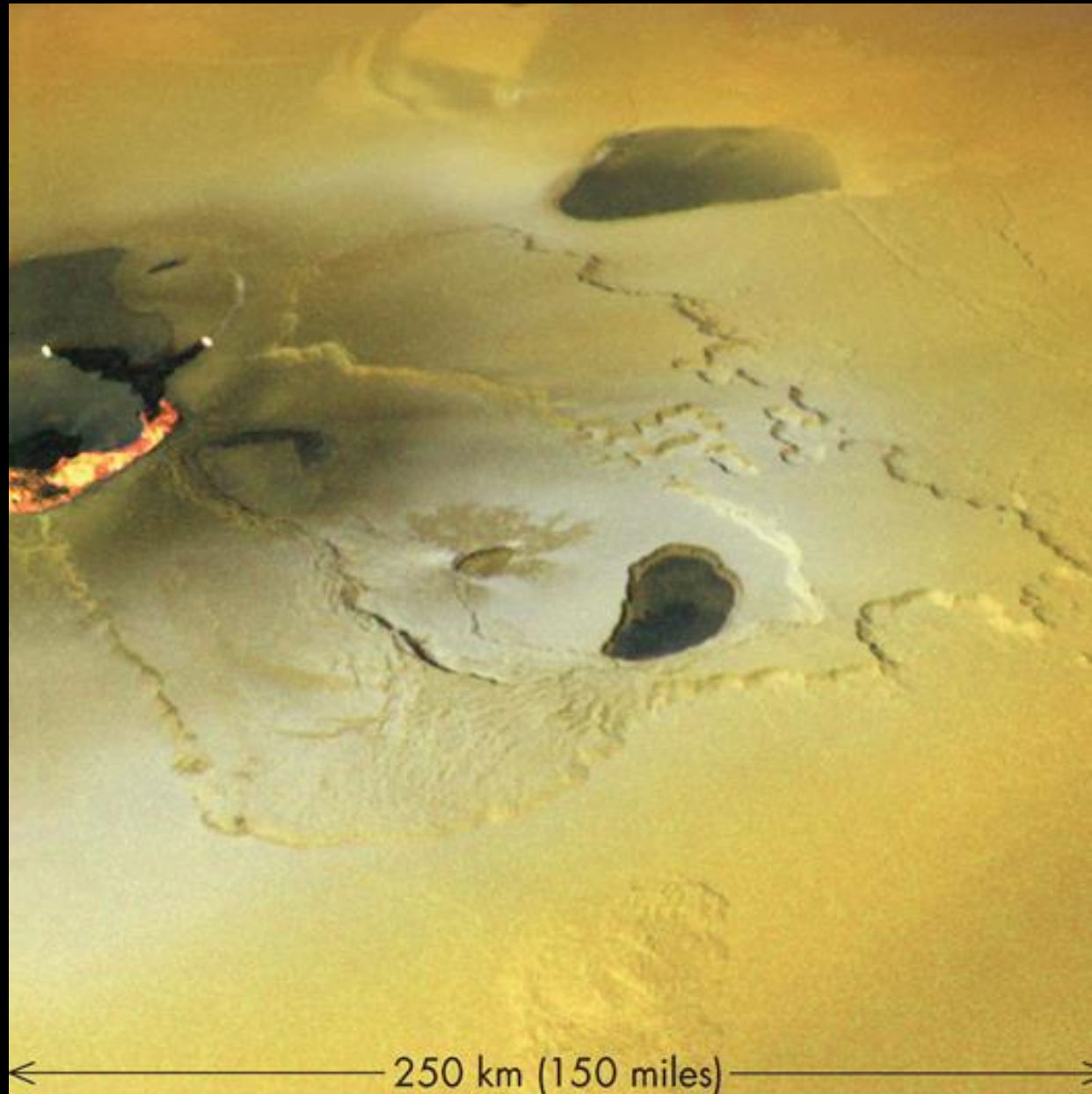


## The Galilean Satellites: Io

- Surface temp  
-243°F (-143°C)  
with Falling  
SNOW of  
Magnesium  
sulfide.
- Plume of eruption  
that reaches more  
than 250 miles up.
- Returning as snow  
of various color



- Surface of Io is a red, yellow, orange, white, color of sulfur burning at different temperatures. But some scientists believe that it might be Magnesium instead.



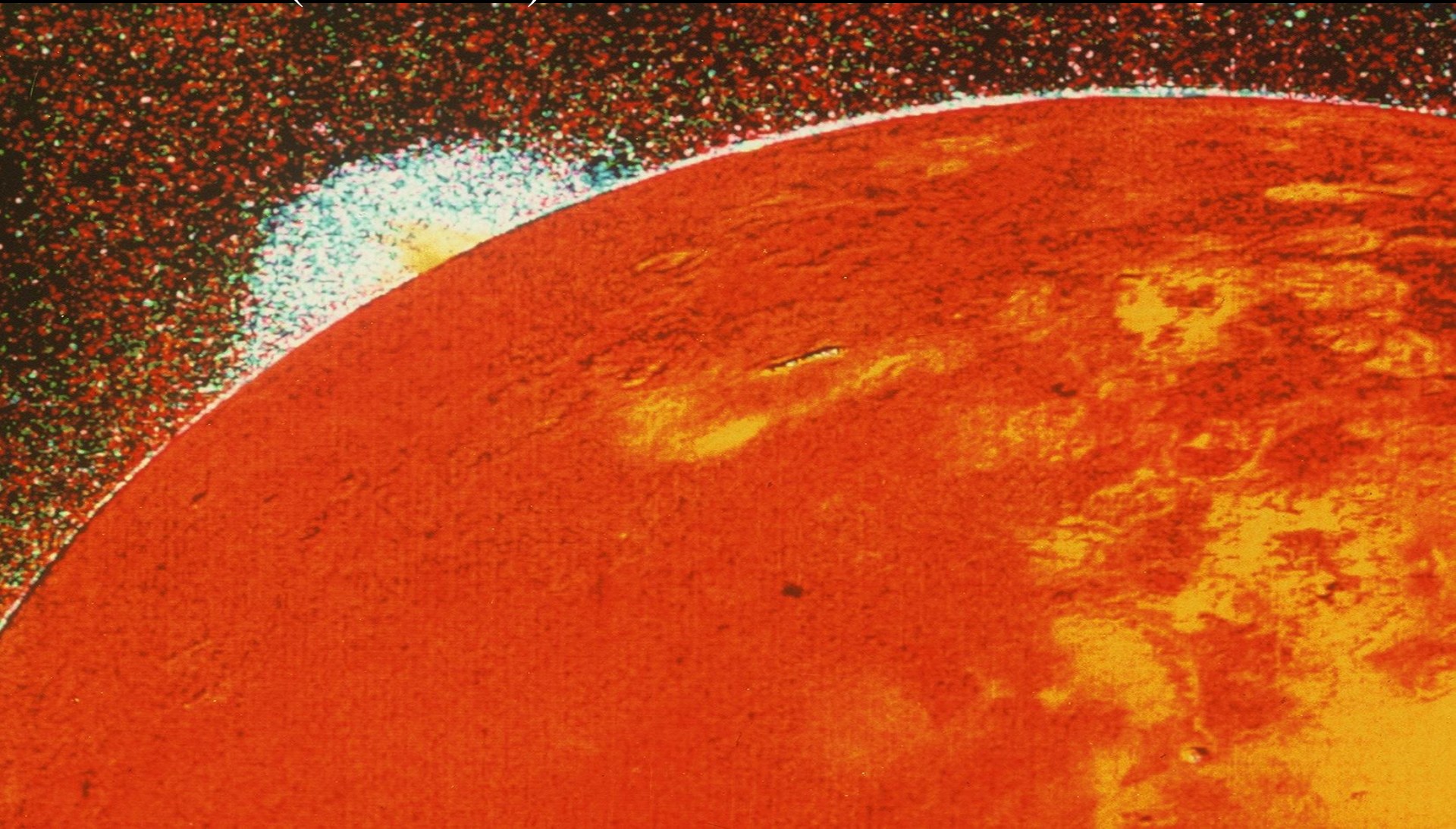


- Lava flows live olive oil
- This is caused by the Tidal Heating or Tidal Flexing (tidal stress) from Jupiter & other moons.
- Similar to bending a metal clothes hanger back and forth until it heats up!





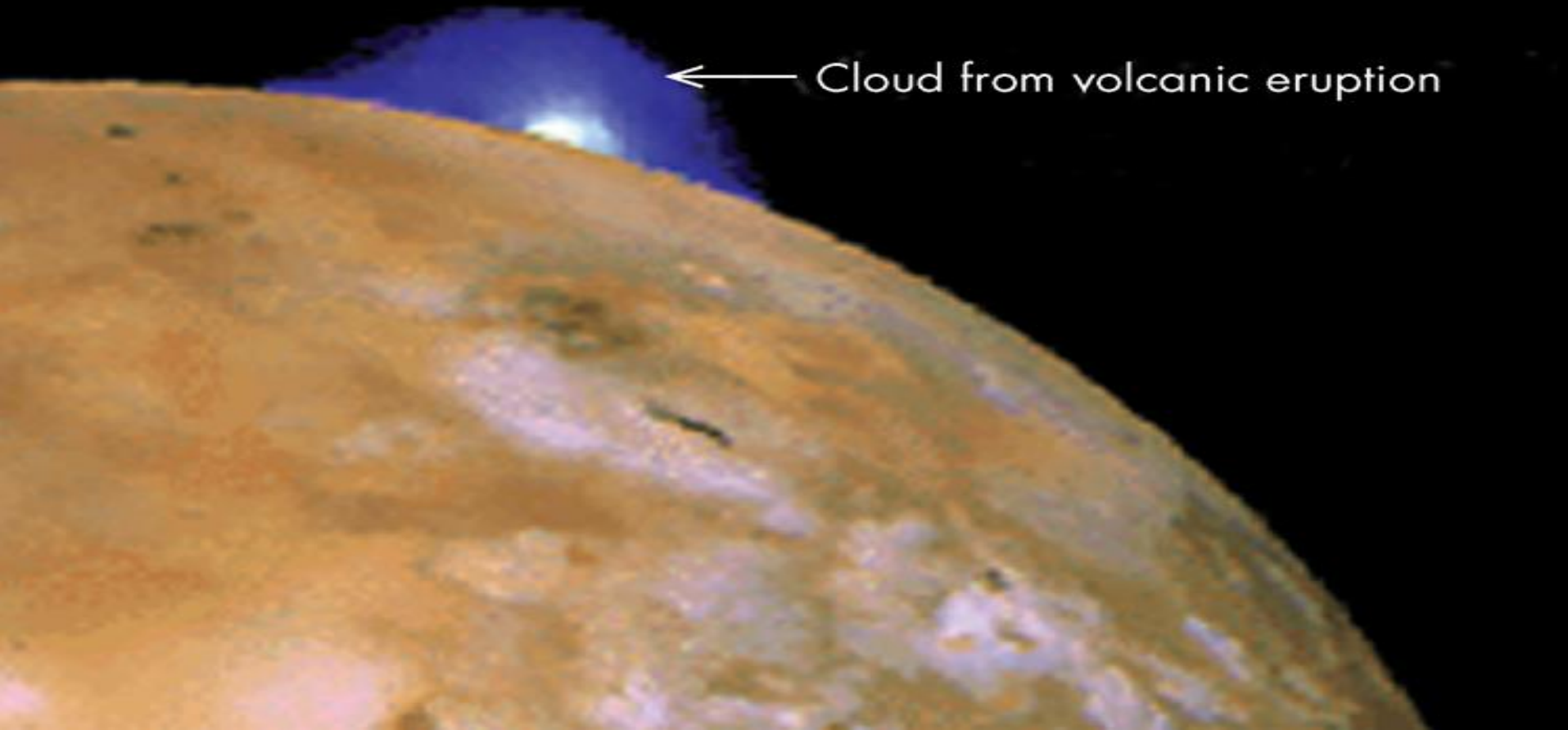
- **Largest IN THE solar system** feature volcano **LOKI**  
Patera (620 miles)



The Galilean Satellites: Io

**Prometheus** volcano most famous photo of an eruption:  
more than 50 miles high

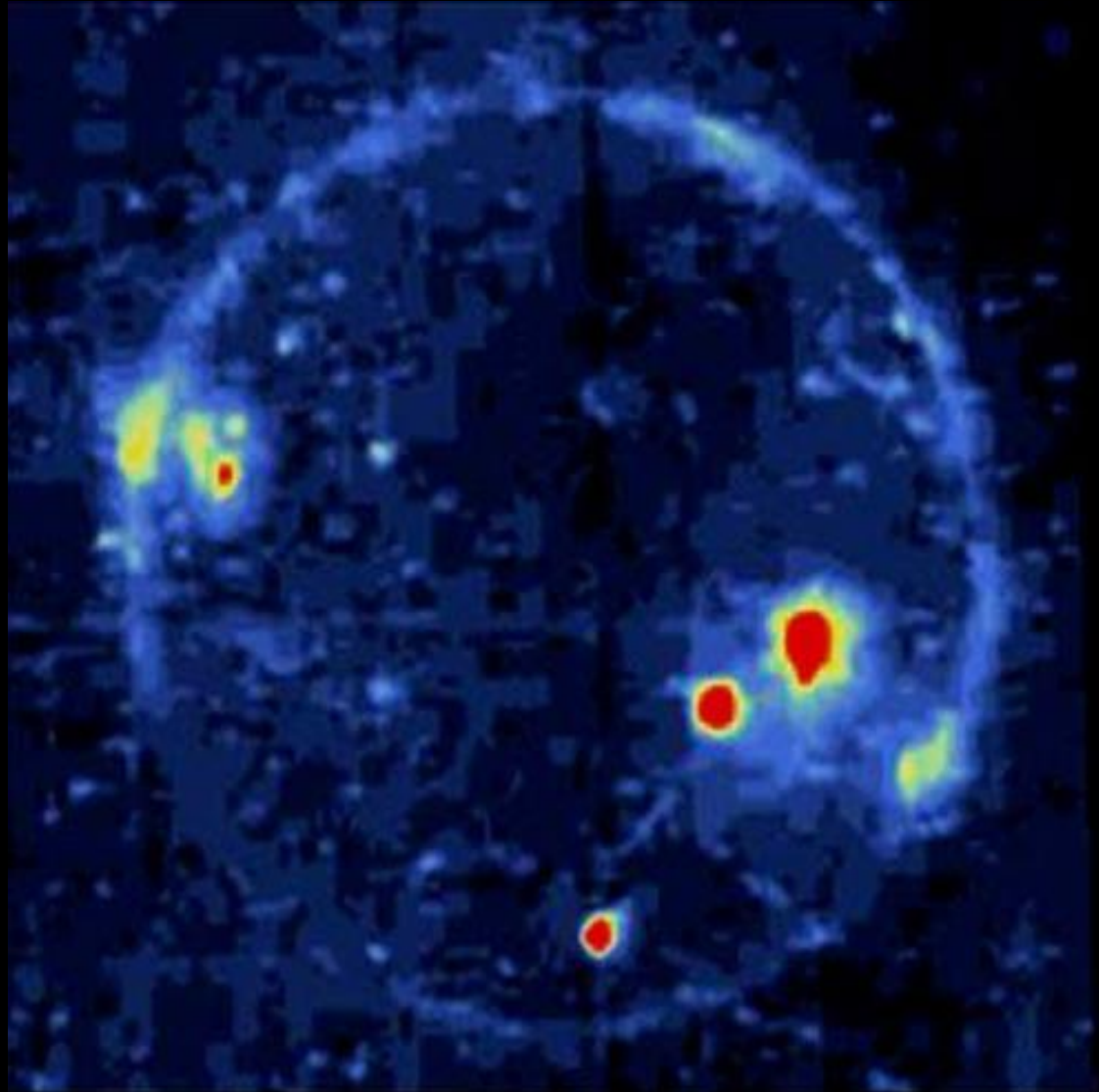
- Mountains twice as high as Mount Everest





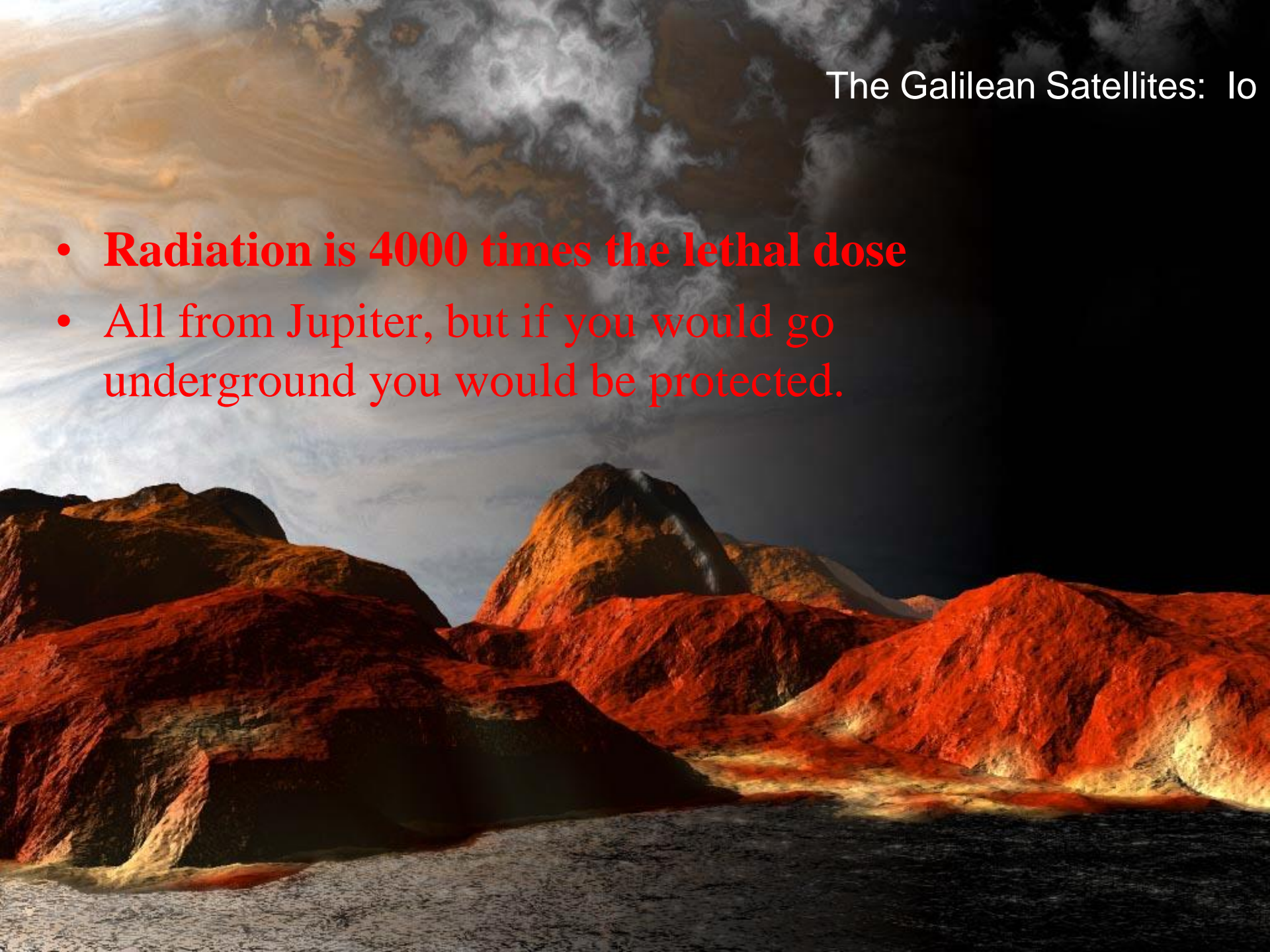
## The Galilean Satellites: Io

- North Lights covers the planet
- Gas and the ion's from Jupiter create this.
- Sodium is detected causing a SO CALLED atmosphere (nebula around moon



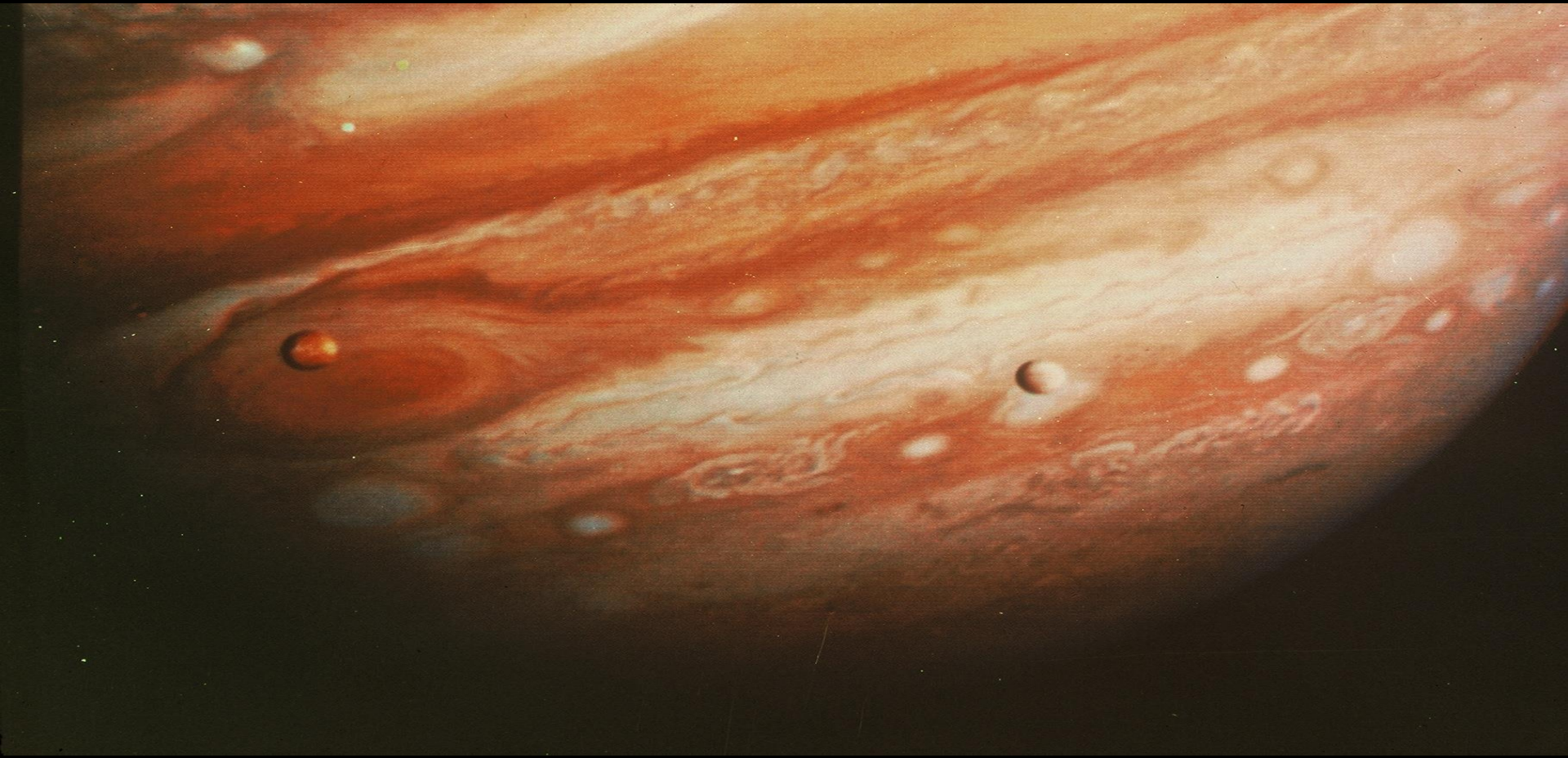
## The Galilean Satellites: Io

- **Radiation is 4000 times the lethal dose**
- All from Jupiter, but if you would go underground you would be protected.





## The Galilean Satellites: Io

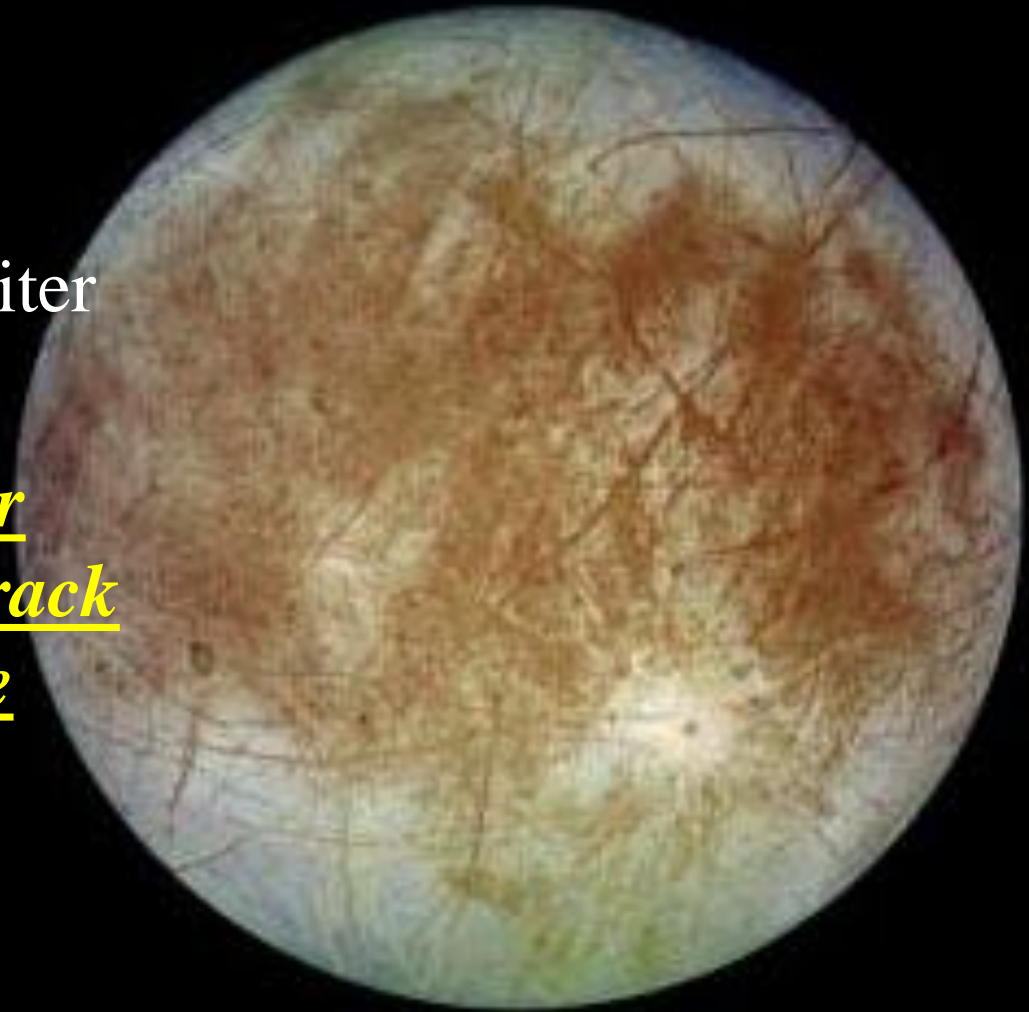


- Eccentric Orbit (oblong orbit) due to another moon pulling on it (Europa & Ganymede)



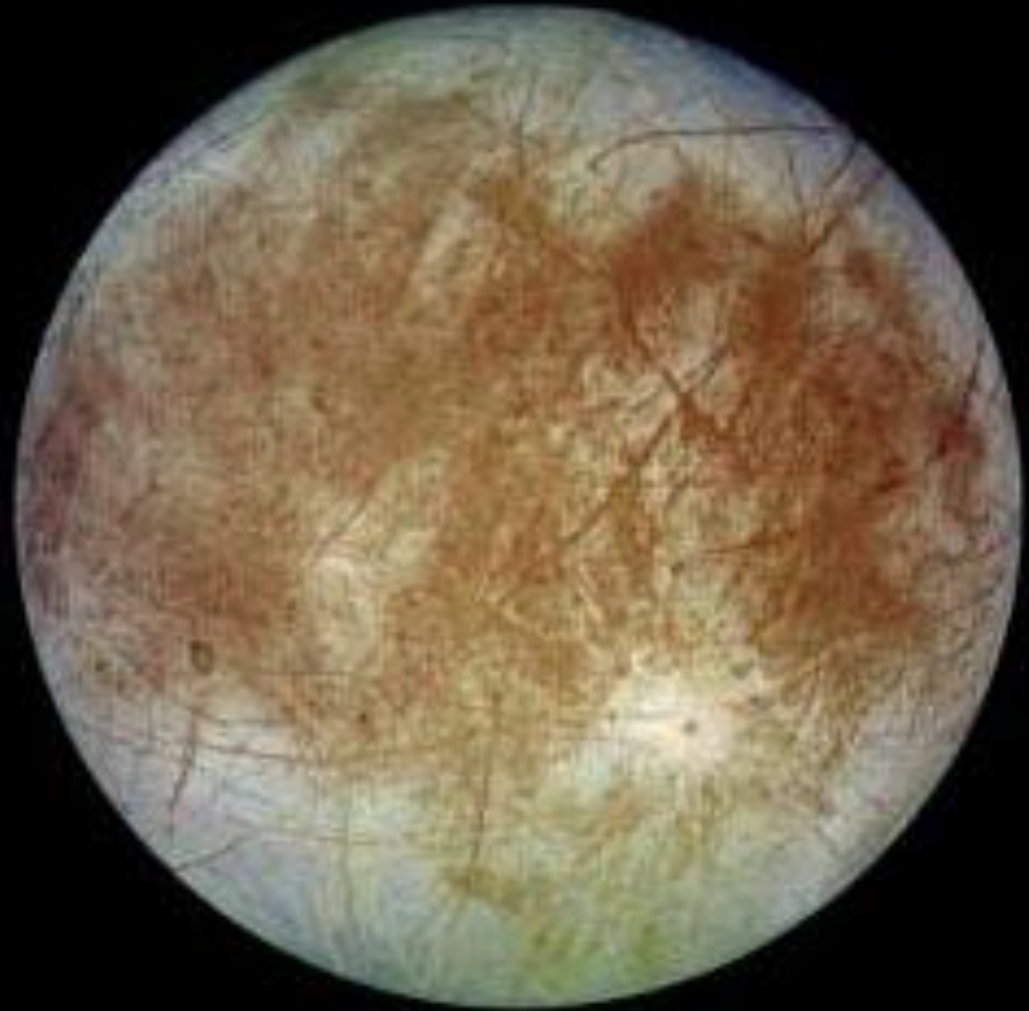
## The Galilean Satellites: **Europa**

- ROTA: 3.55 days
- REVOL: 3.55 days
- 400,000 miles from Jupiter
- ***Moon with long lines or SILVER CASING of crack egg shell on it's surface***



## The Galilean Satellites: **Europa**

- Diameter 1944 miles
- **Smallest of the Galilean moons**
- **4<sup>th</sup> largest moon but when compared to our moon Europa is much smaller**



- TEMPERETURE

- Some areas is  
-500°F
- Ave temp is  
-263°F
- Jupiter  
bombards this  
moon with high  
doses of  
radiation.

## The Galilean Satellites: **Europa**







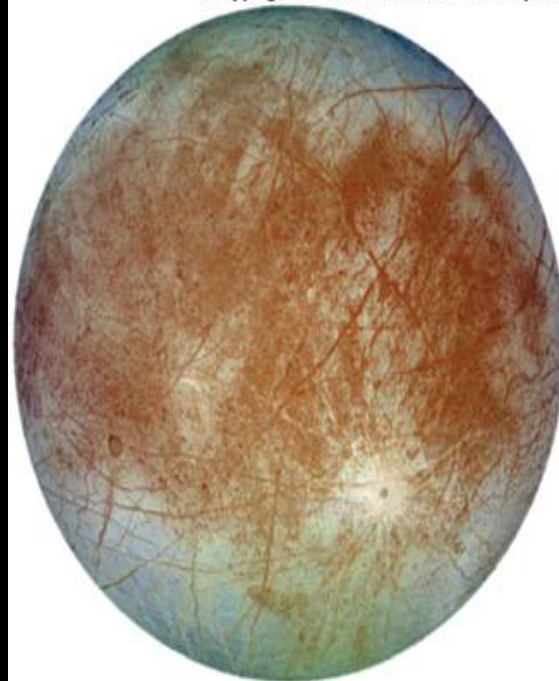
## The Galilean Satellites: **Europa**

- ***ATMOSPHERE:***
  - *In 1995, a very thin Oxygen base atmosphere was discovered before the rising and setting of the sun*

## The Galilean Satellites: **Europa**

- The lines on the **SURFACE** appear to be cracks some 300 miles long in the lighter surface
- They have **NO** depth and thus they can only be describes as 'marks' on the surface.

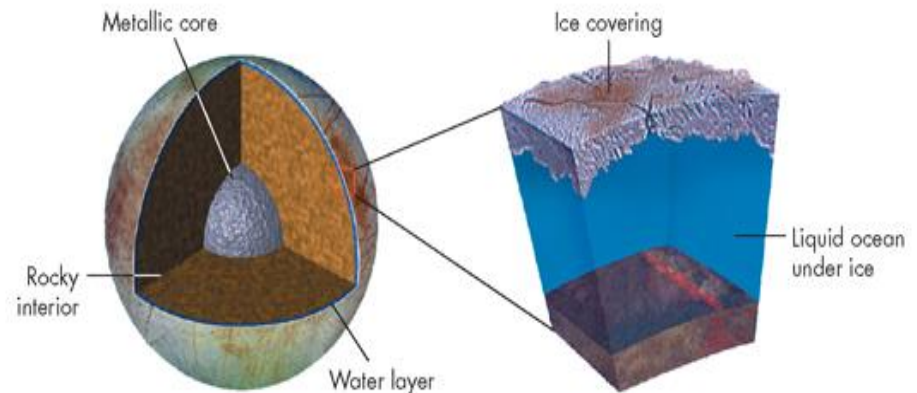
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A

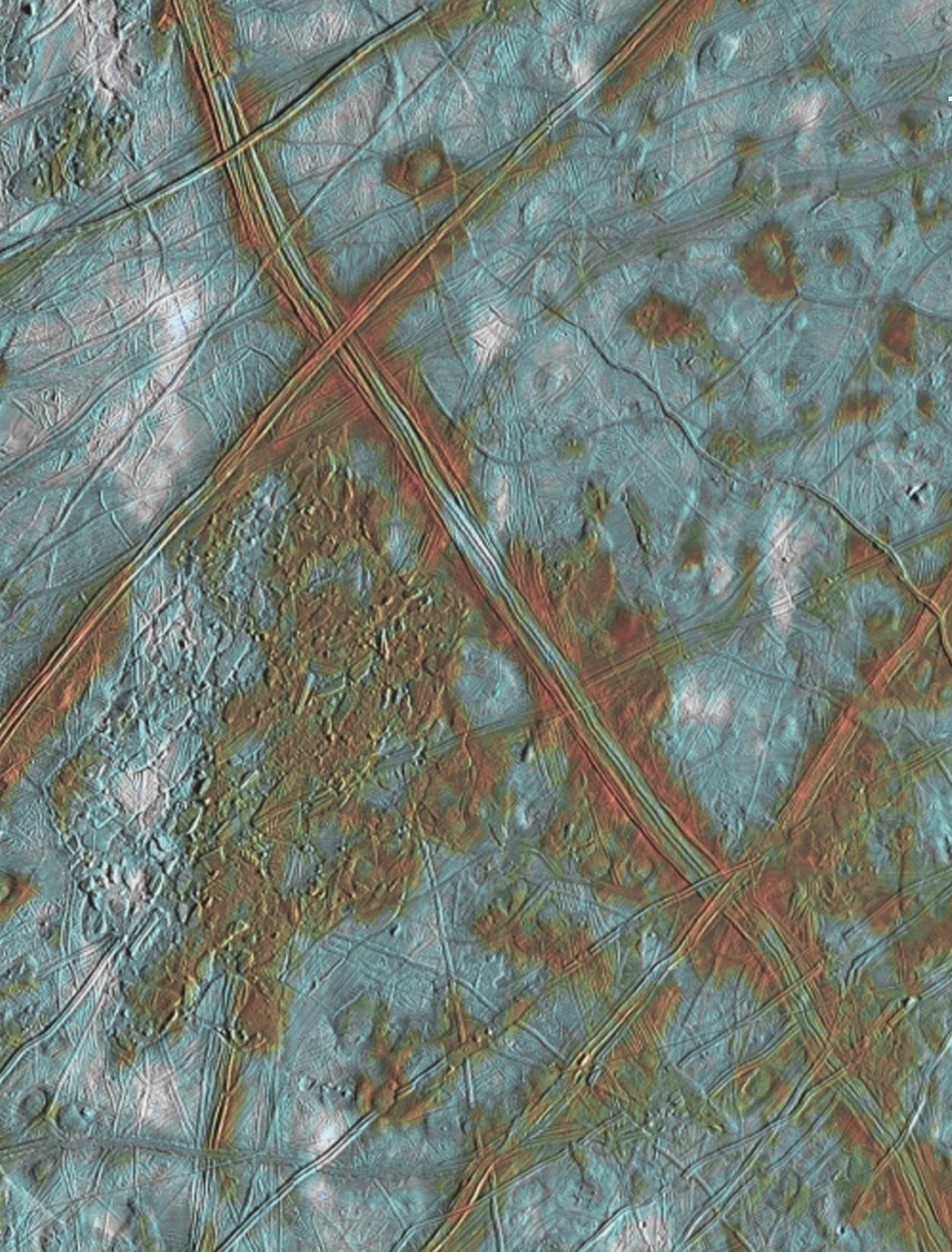


B



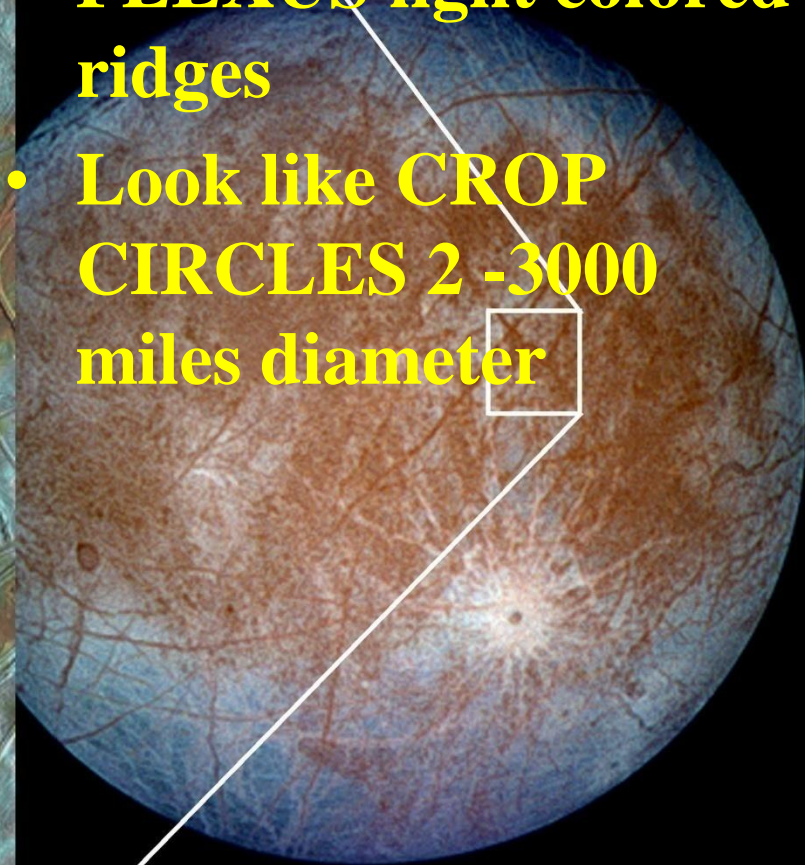
C





## The Galilean Satellites: **Europa**

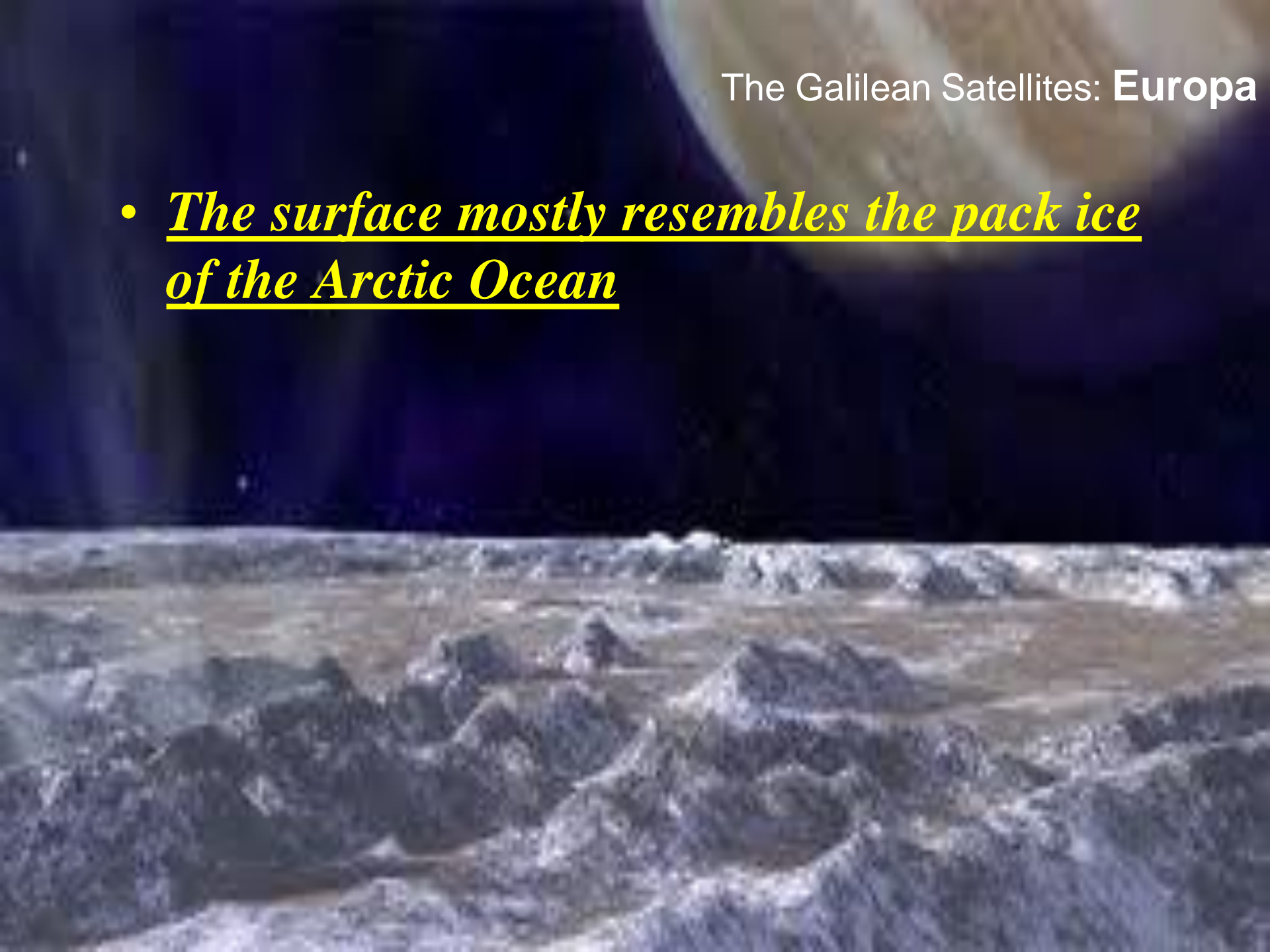
- **Numerous dark spots called MACULA**
- **FLEXUS light colored ridges**
- **Look like CROP CIRCLES 2 -3000 miles diameter**





## The Galilean Satellites: **Europa**

- *The surface mostly resembles the pack ice of the Arctic Ocean*



## The Galilean Satellites: **Europa**

Ice boulders are located everywhere, and the surface is believed to have frozen Sulfuric Acid on it.

This is an unique **HABITABLE ZONE**.

A distance where liquid water can exist on a planet's surface



- **HERE LIFE could spawn and exist beneath the surface!**
- **Microorganism were found in the Arctic ice**
- **So call in the Astrobiologists**



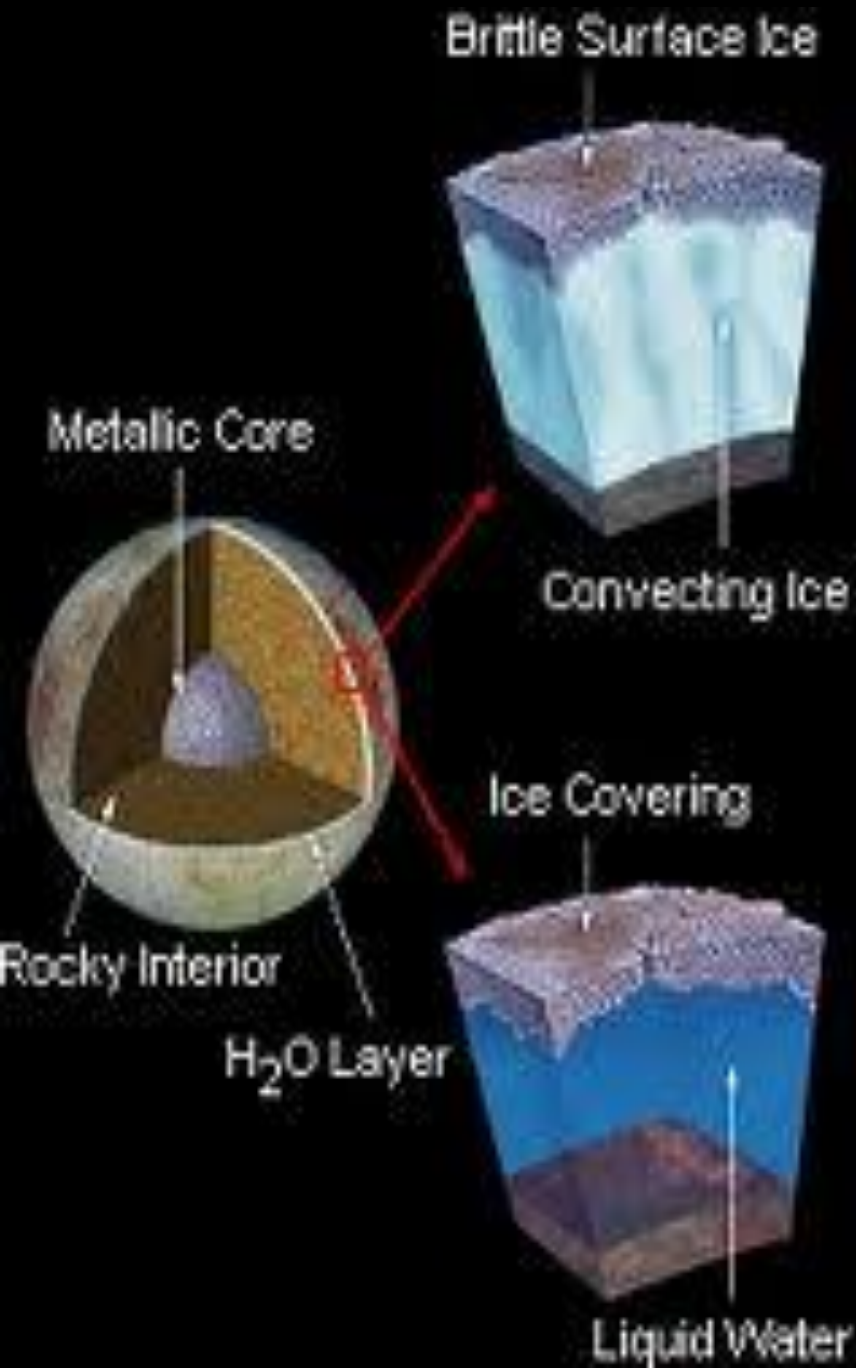


## The Galilean Satellites: **Europa**

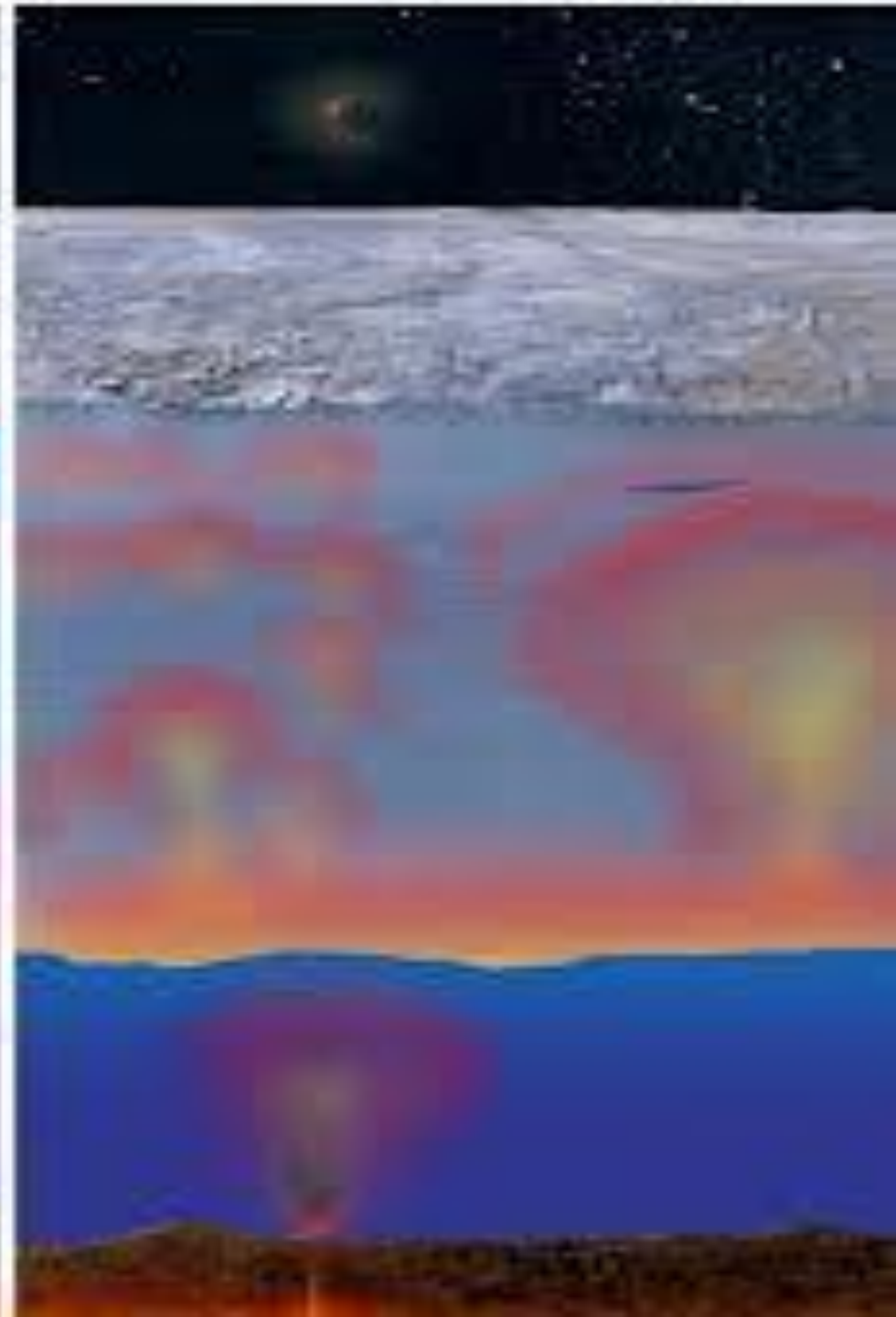
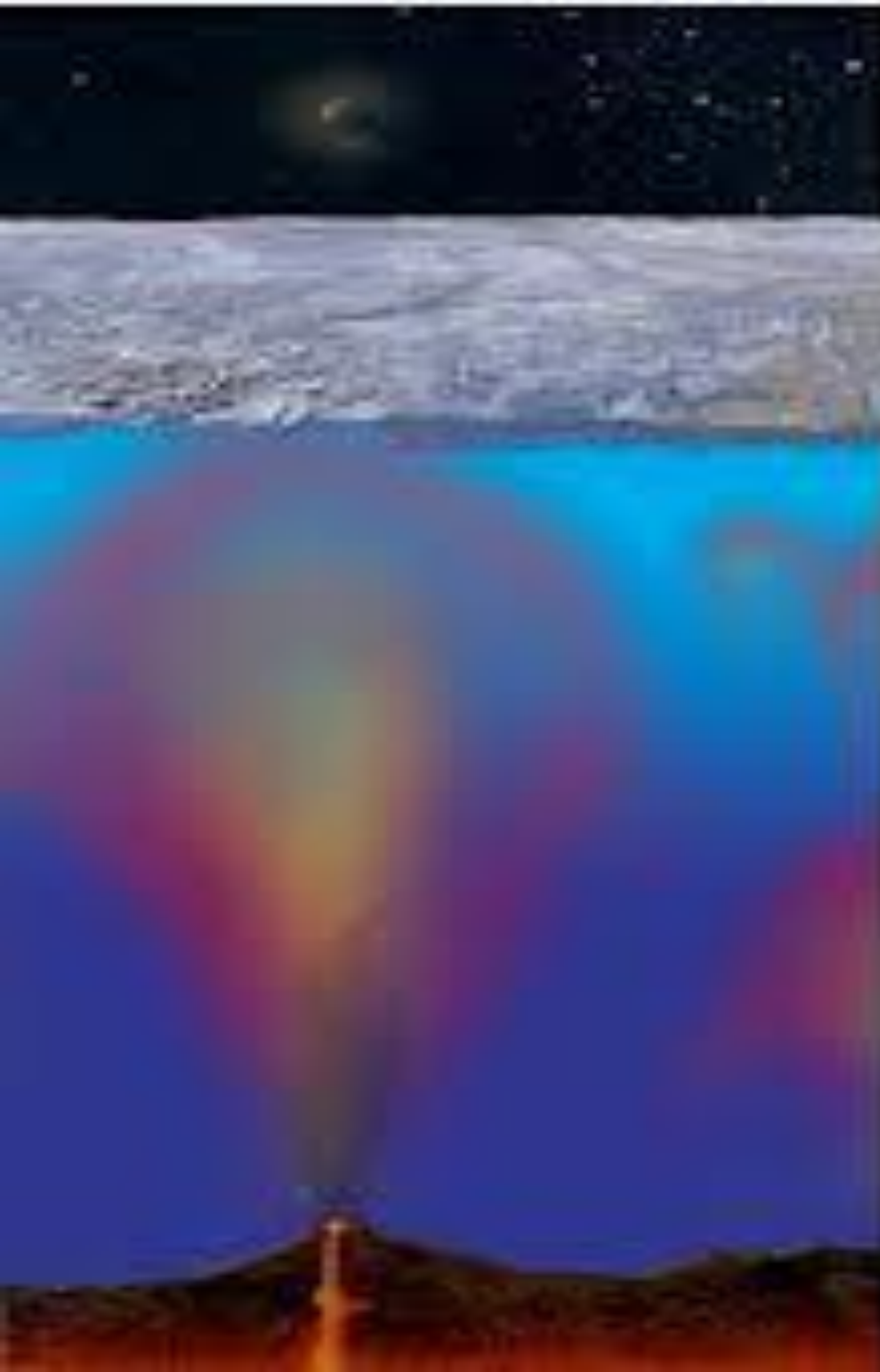
- The Surface is about 93 miles thick of solid ice with 300 feet Ice ridges.
- Some of these cracks are deeper than the empire state building.
- *Beneath the surface is believed to be 62 miles thick on liquid water*

## The Galilean Satellites: **Europa**

- Heat from the interior is likely enough to keep a liquid ocean of water beneath its icy crust



This heat is caused by the **Tidal Heating** or **Tidal Flexing** (tidal stress)





## The Galilean Satellites: **Europa**

- NASA is sending the KRYOBOT

Europa Lander Mission (ELM) Separation, Entry and Landing Sequence



Separated from OEV and Entry Vehicle (OEV)



Braking Burn (Star 1)



Separation from Propulsion Module



Descent



Deployment



Start 30 day Surface Mission



## The Galilean Satellites: **Europa**

- Drilling 75 miles per day make take several months to get to the ocean

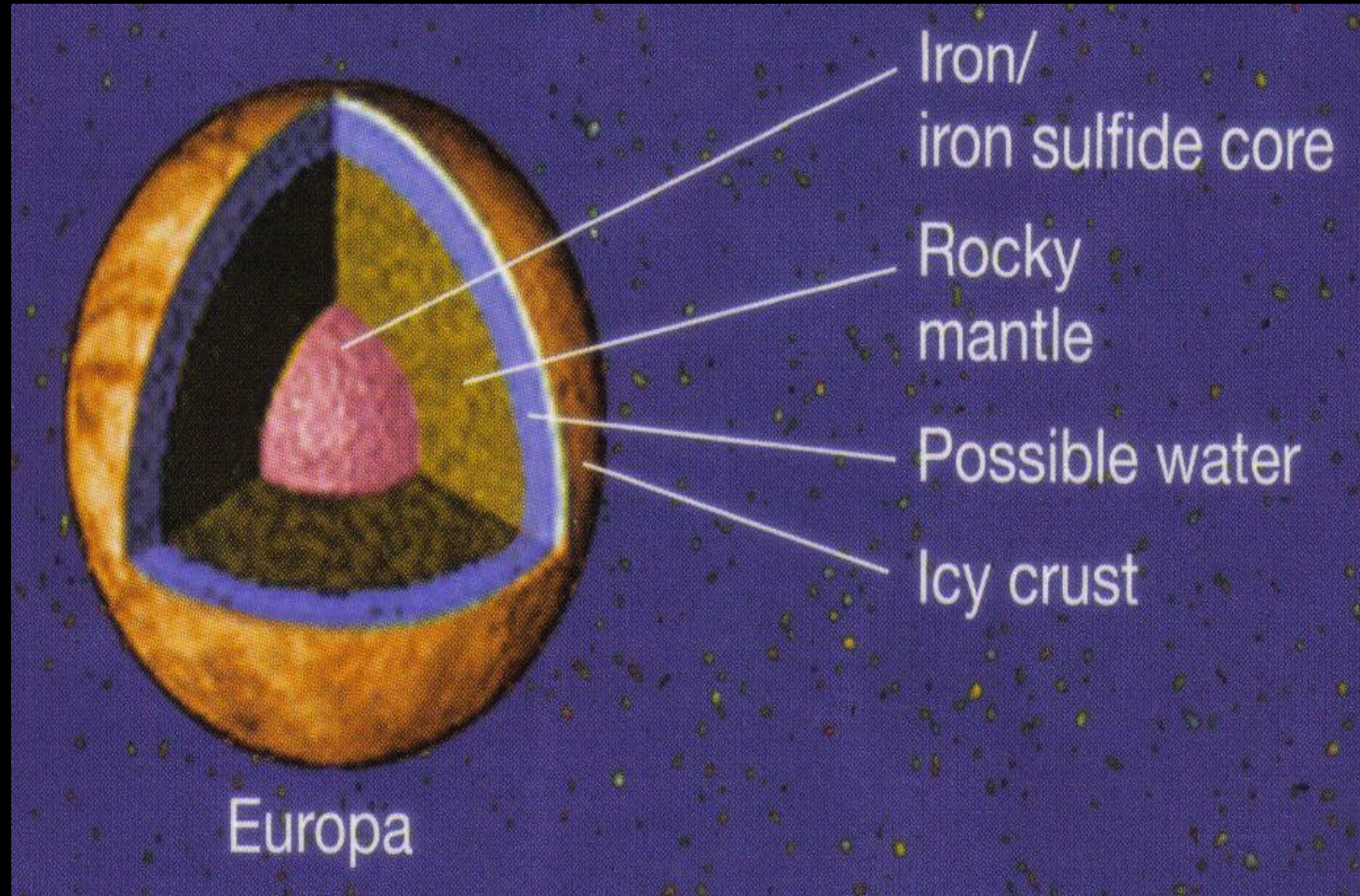
## The Galilean Satellites: **Europa**

- Then open up and let a Submersible out to explore the ocean.





## The Galilean Satellites: **Europa**



- Mantle is believed to be active this warming the water above it like Earth.
- Solid ice core

- *Largest moon in the solar system.*
- Larger than Mercury and Pluto
- It has the STRANGEST surface whose gravity is close to Earth.

The Galilean Satellites: **Ganymede**



## The Galilean Satellites: **Ganymede**

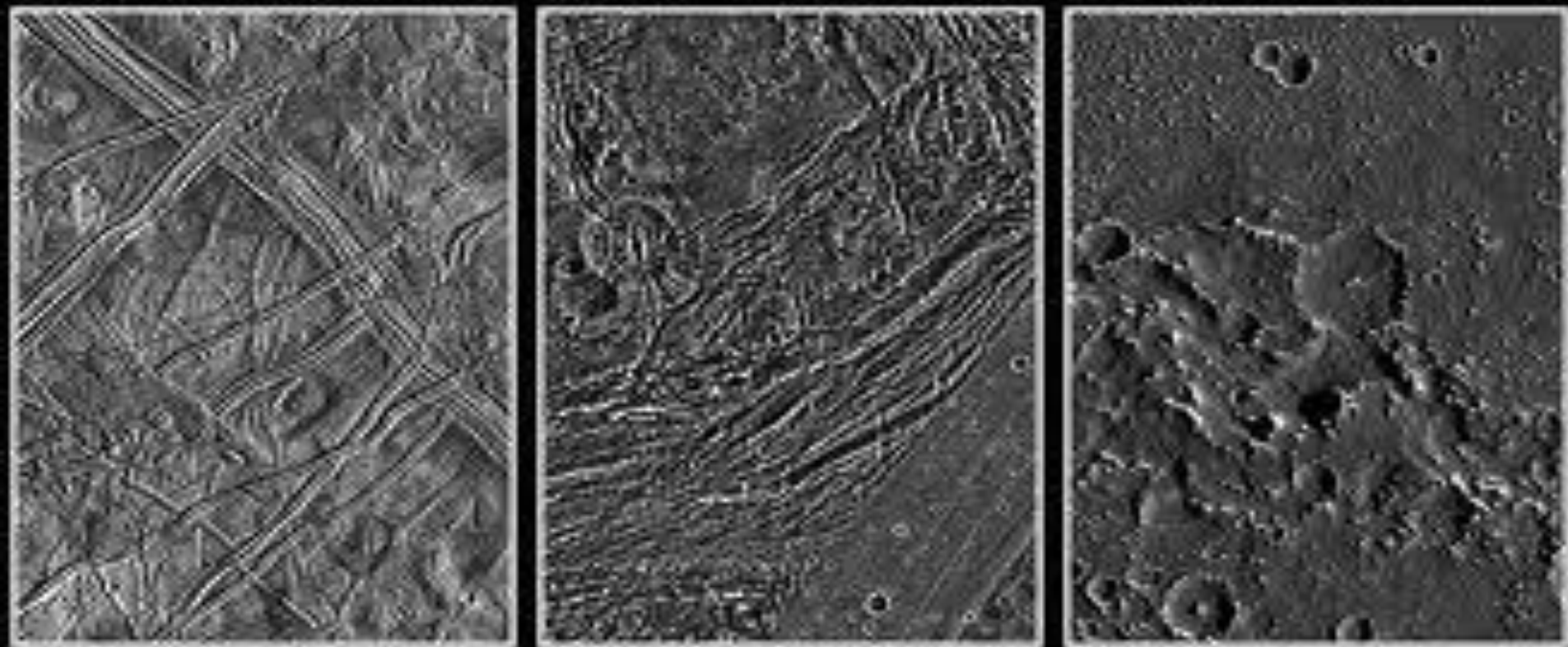
- Diameter:  
3274 miles
- Rotation:  
7.15 days
- Revolution:  
7.16 days
- "dirty  
snowball"  
looking planet





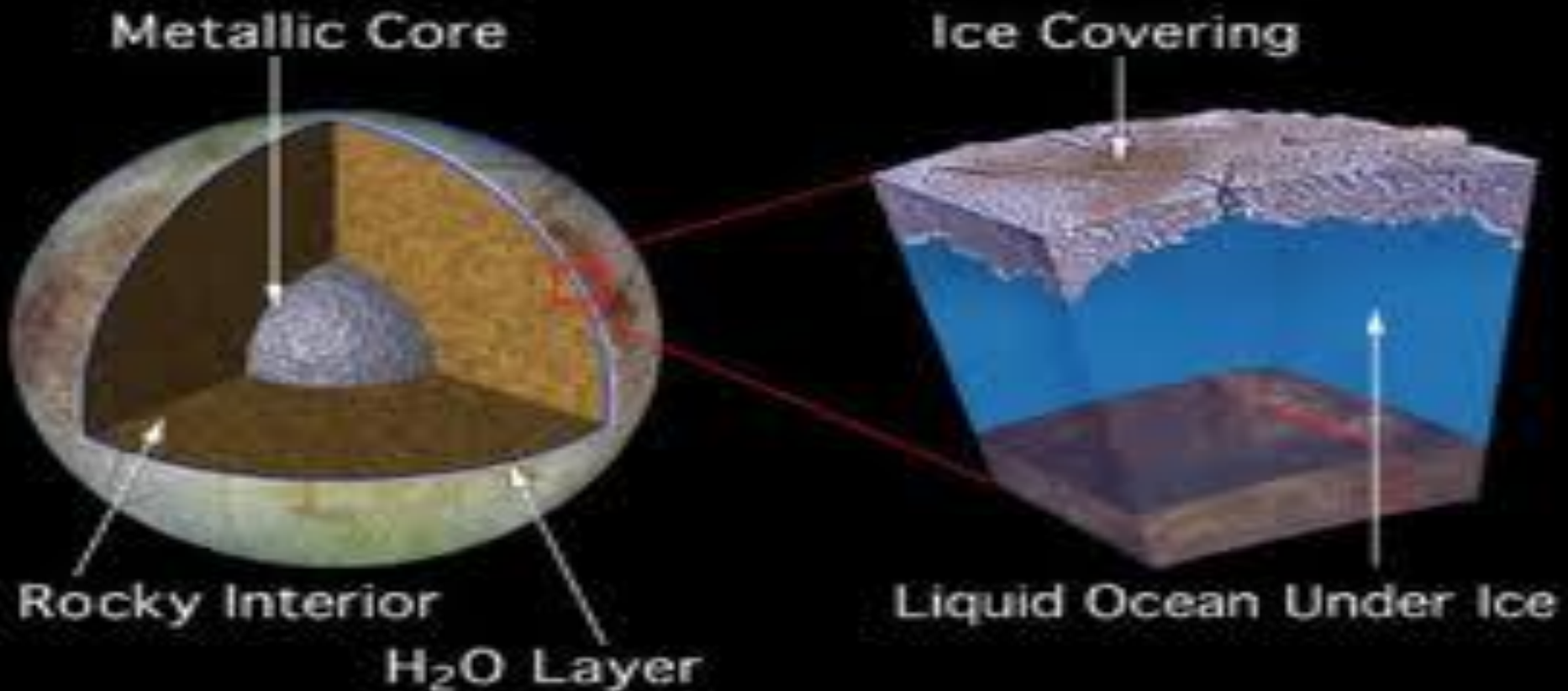
## The Galilean Satellites: **Ganymede**

- **Striking grooved terrain that sometime crisscross** & has an icy tectonic features
- Has a 60-mile thick icy crust, floating on a 400 miles of slushy mantle of water.



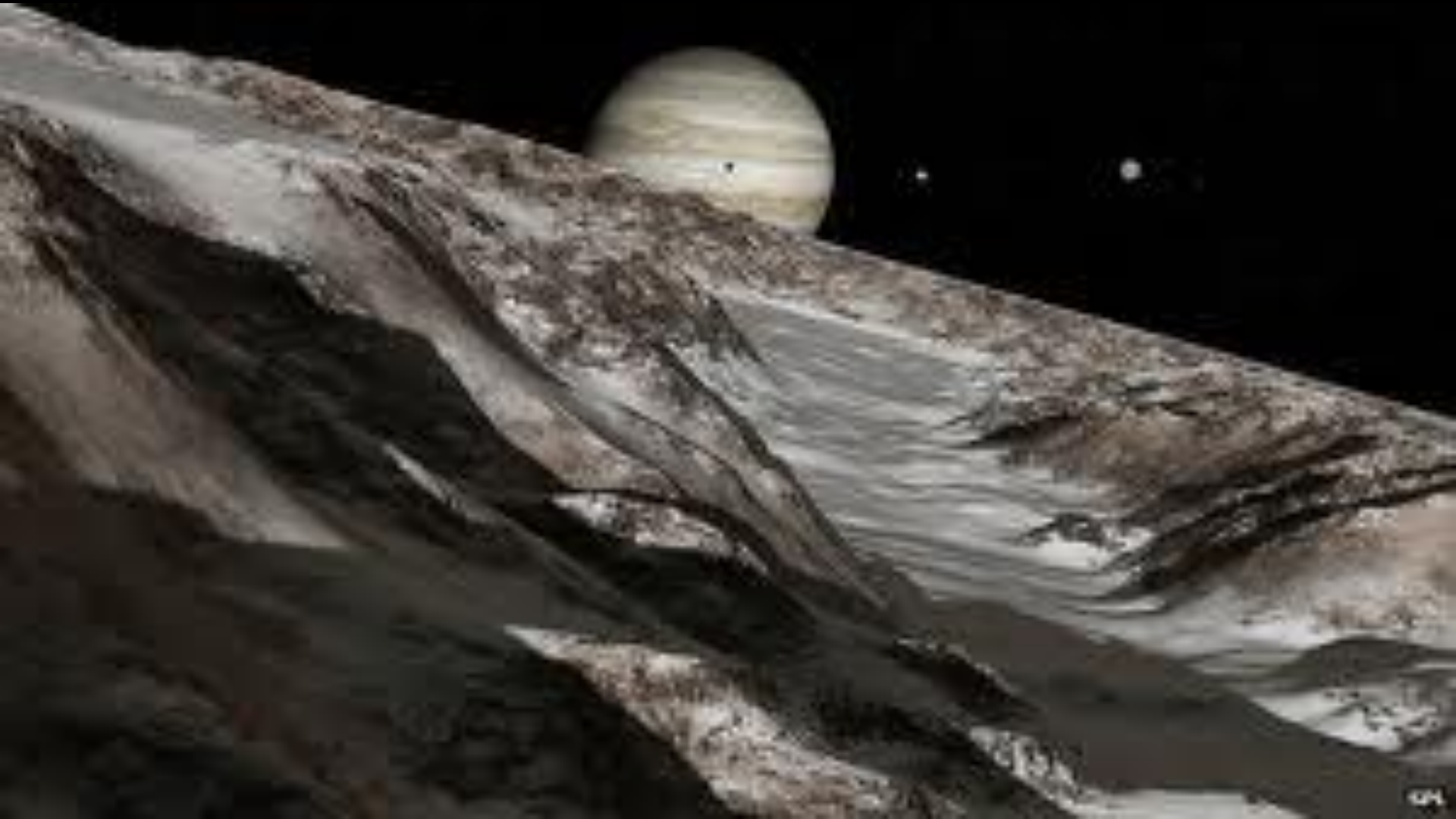
## The Galilean Satellites: **Ganymede**

- Recent photos (1997) reveals an iceberg floating
- Meaning that water should exist beneath the surface.
- **HOWEVER**; today the “maria” is too thick to reach the surface.



- Crust does consist of  
Ozone layer on it, but  
NO actual atmosphere.

The Galilean Satellites: **Ganymede**





- Cracks are caused by crustal tectonic stress from Jupiter's gravity
  - And the heat is caused by the Tidal Heating or Tidal Flexing (tidal stress)
- The Galilean Satellites: **Ganymede**



- Plate activity stopped about 3 billion years ago when the cooling crust became too thick

The Galilean Satellites: **Ganymede**



- A special feature on the moon is the Galileo Region...
- This is a large circular feature.
- Dark area because of micrometeorite dust settling onto it over several billion years.

## The Galilean Satellites: **Ganymede**

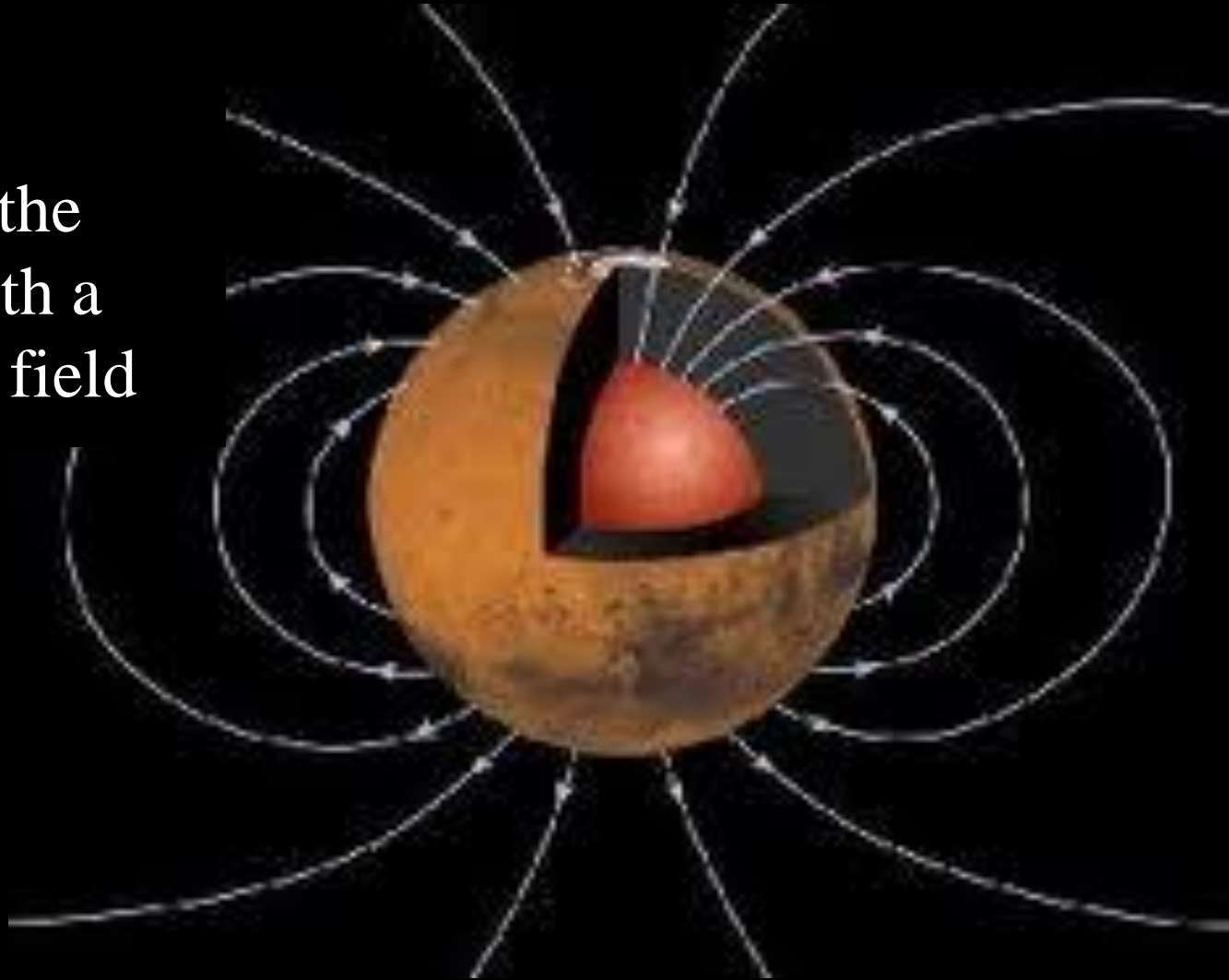




- The first moon found  
with a  
MAGNETOSPHERE  
surrounding it.

The Galilean Satellites: **Ganymede**

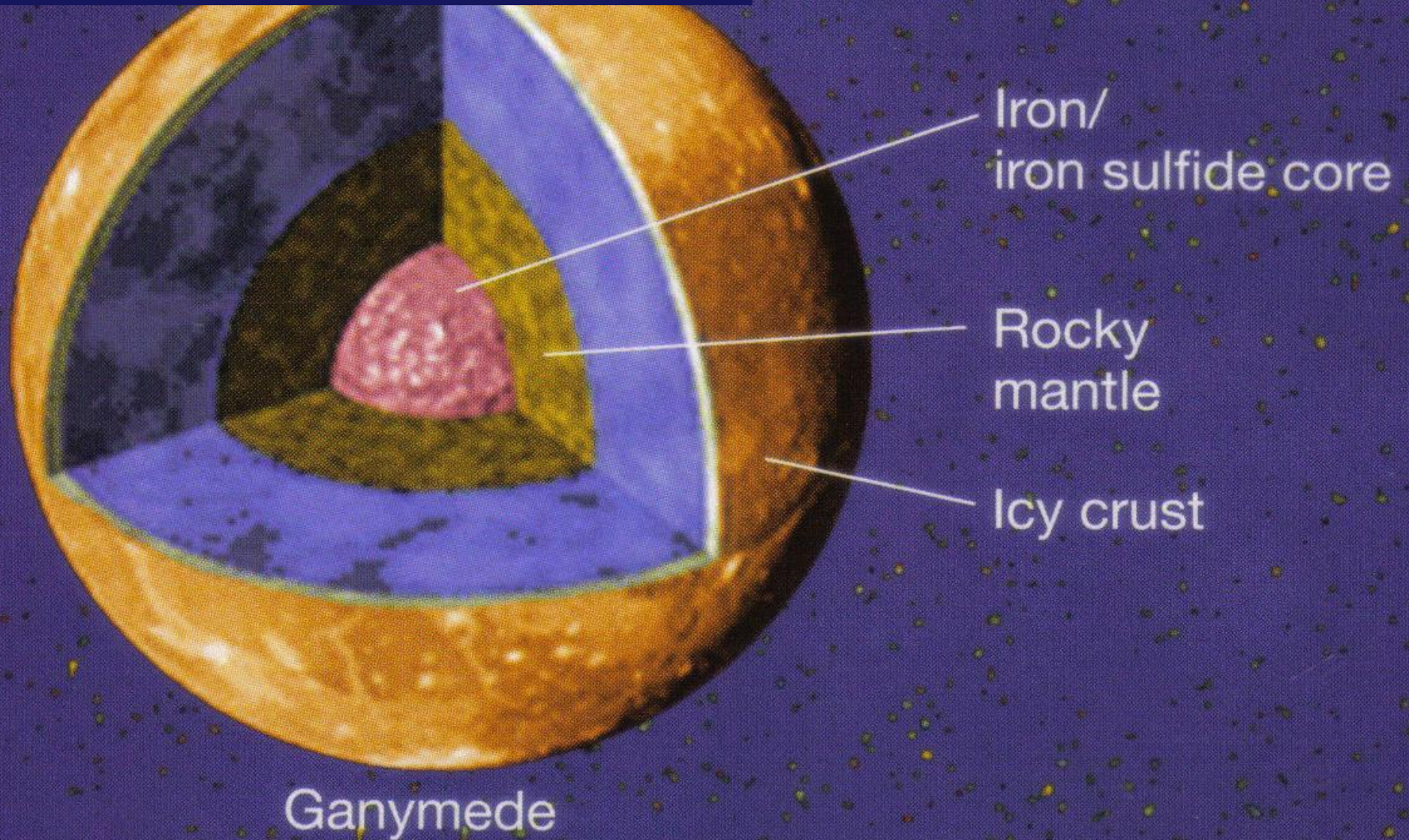
- ONLY moon in the  
Solar system with a  
TRUE magnetic field





- Thus the **moon has a iron core** and the mantle that rotates around it

## The Galilean Satellites: **Ganymede**





## The Galilean Satellites: Callisto

- *Most heaved crated object in the solar system*
- *And the 2<sup>nd</sup> Largest moon in the solar system*
- Rash of Craters make scientist
- *Believed to be the oldest moon*





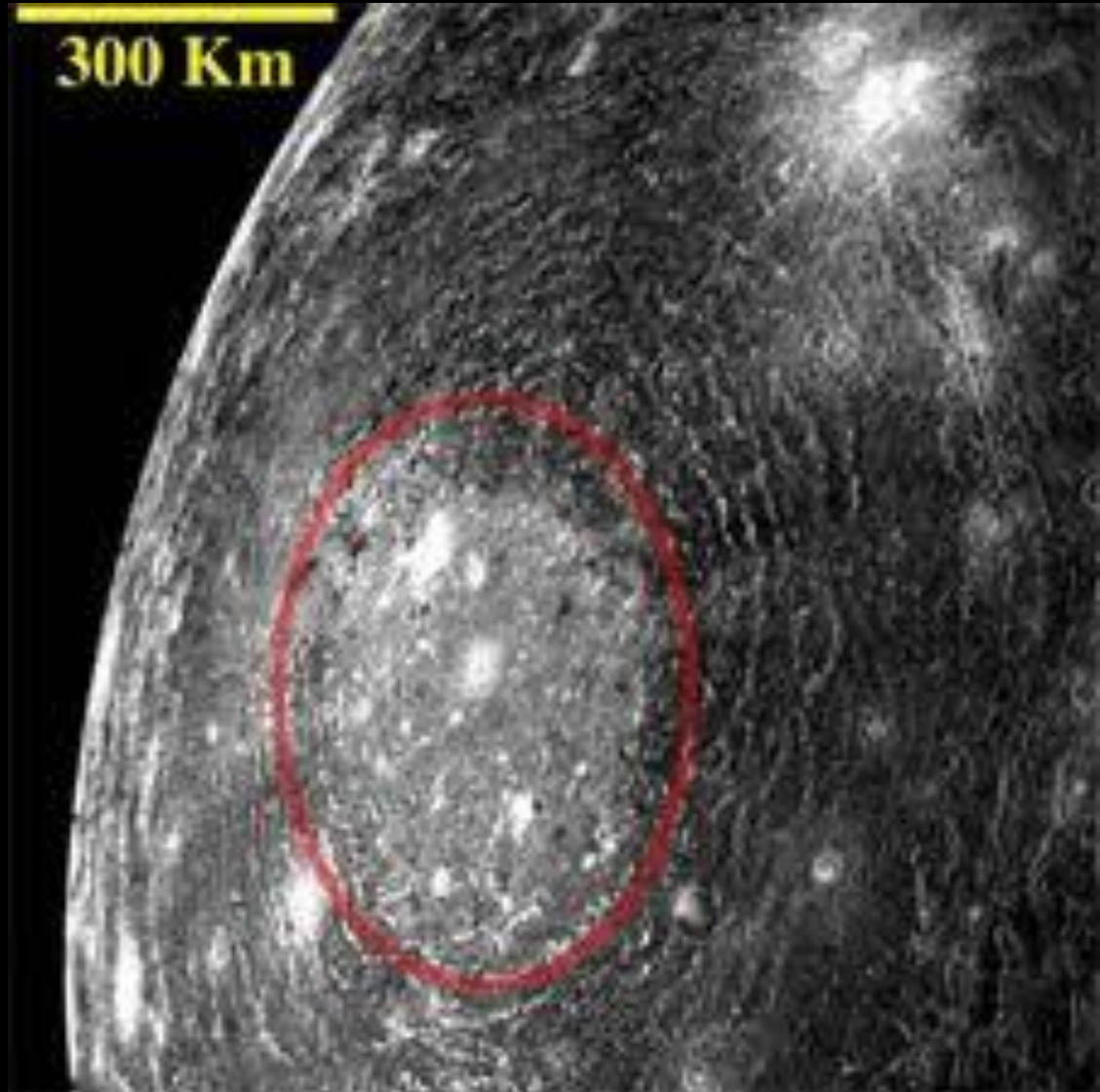
## The Galilean Satellites: **Callisto**

- Diameter of 2962 miles
- Rotation:
  - 16.689 day
- Revolution:
  - 16.689 days
- Ave Temperature:
  - $-279^{\circ}\text{F}$



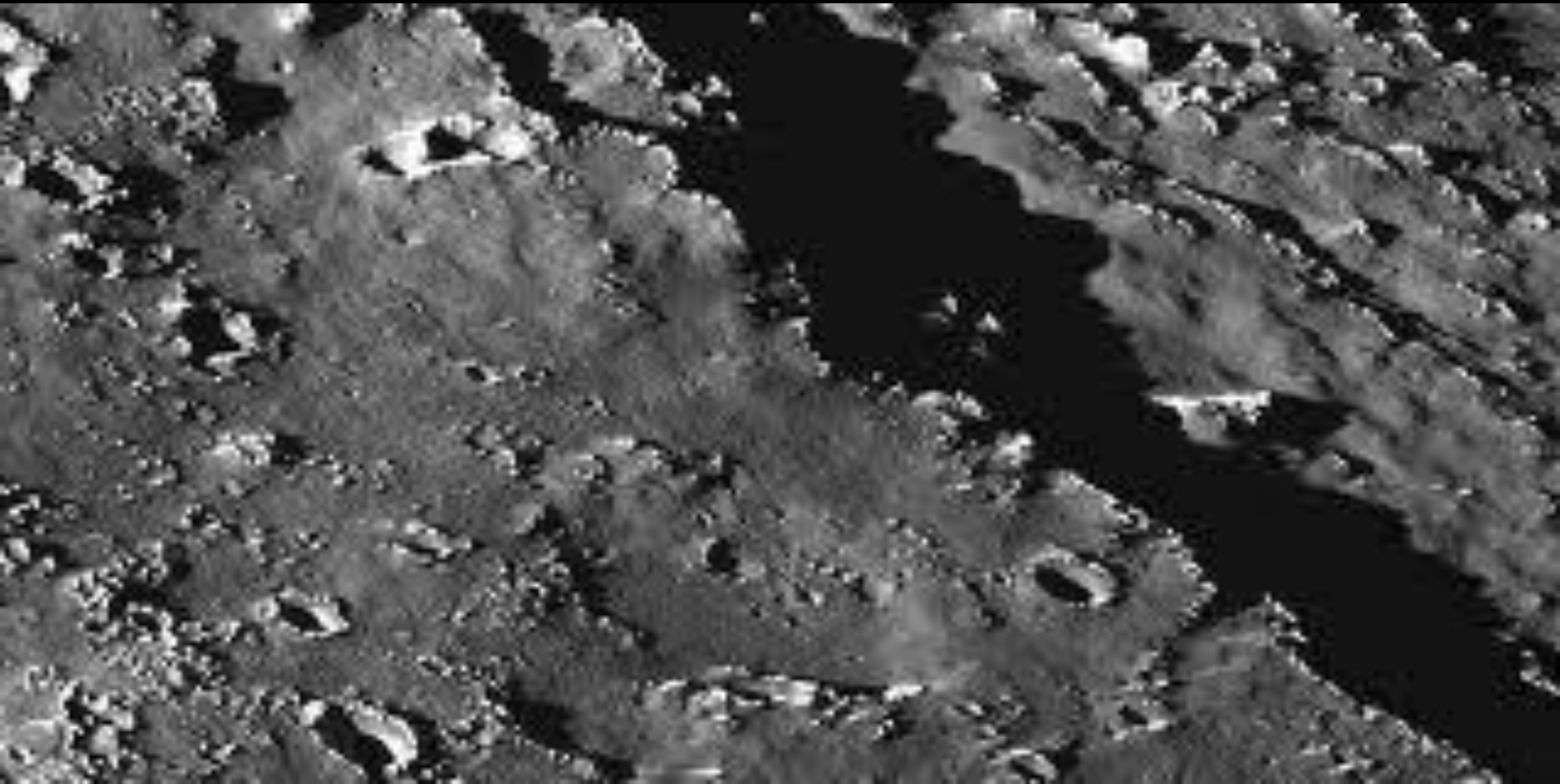
## The Galilean Satellites: **Callisto**

- Has a huge series of concentric ridges surrounding each of 2 large basins
- The larger of the two, on Callisto's Jupiter-facing side, is called **Valhalla**



## The Galilean Satellites: Callisto

- **Valhalla** measures some 1864 miles across.
- The ridges resemble the ripples made as a stone hits the water



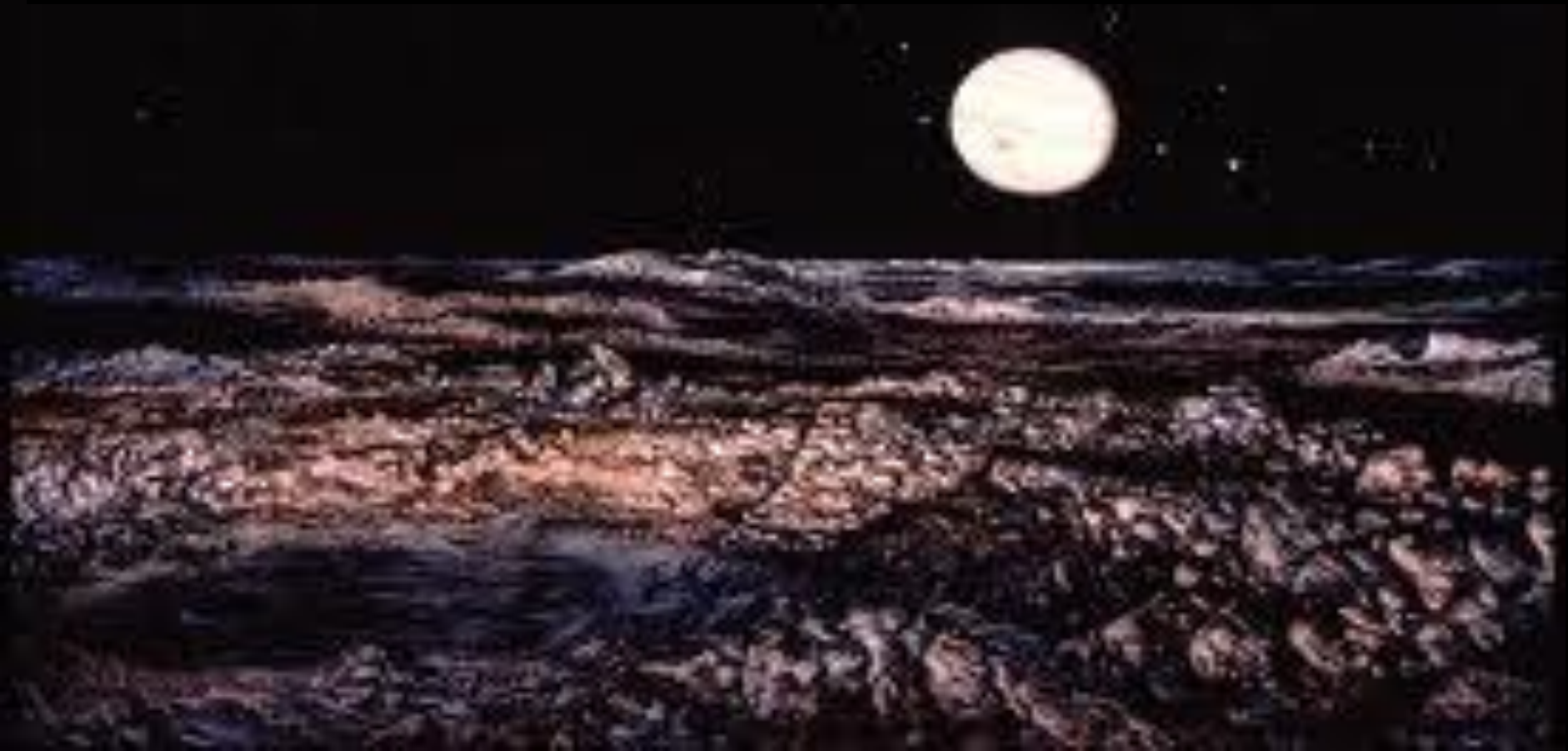


## The Galilean Satellites: Callisto



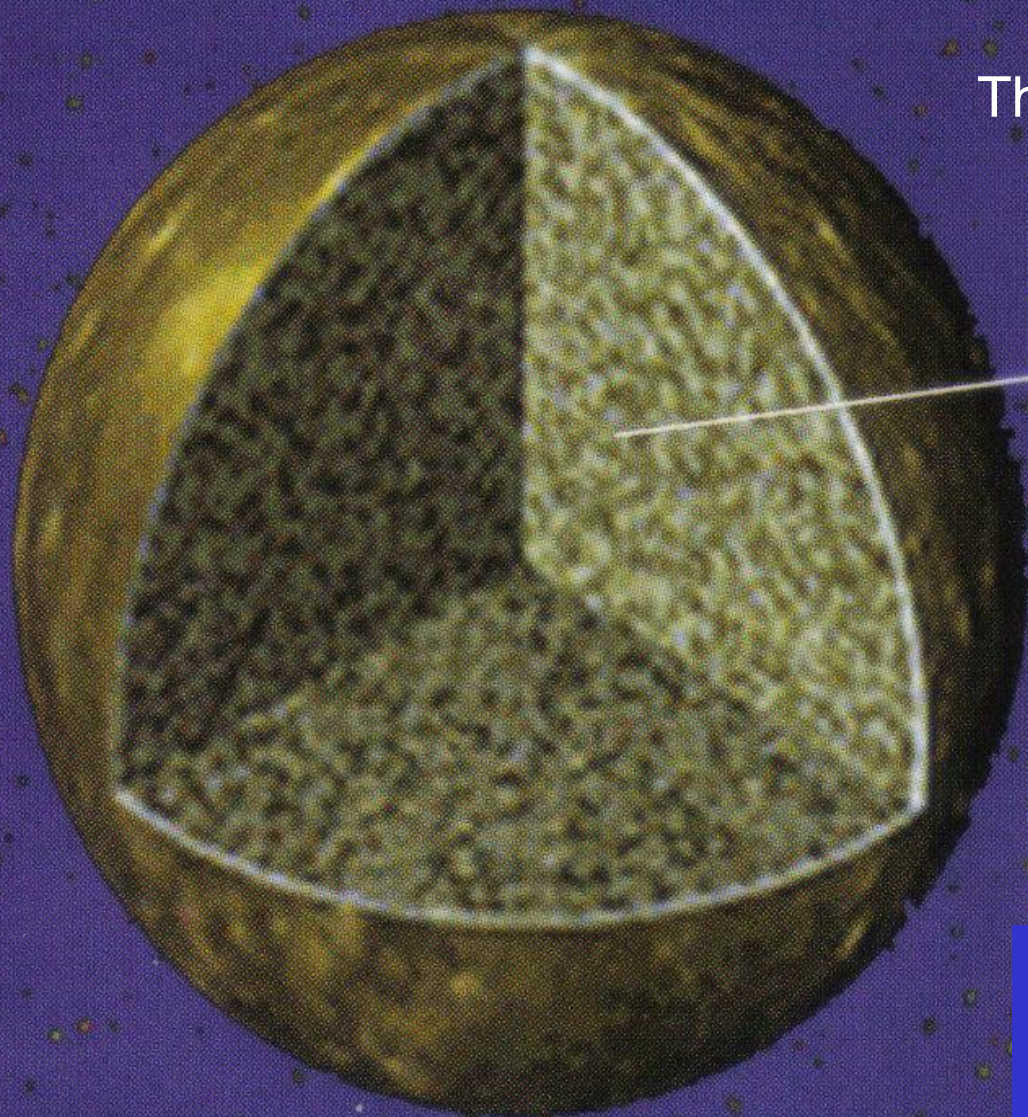
- Most likely caused by a cataclysmic impact with an asteroid or comet
- The ridges solidified before they could settle back causing spike mountains.

- The Spikes in the **craters** is an indication of an **ICY surface**
- Craters remain on this planet because there is **no sign of geologic activity**





## The Galilean Satellites: Callisto



Ice/rock  
mixture

Callisto

- Has a weak magnetic field
- Not sure of a core



## *ROLE of the PLANET:*

Is to acts like a big brother for us, by either deflecting objects or destroying objects that come to close to the planet.

The Great Impact



It was discovered  
that after 5  
billions years it  
orbit in the  
Kieper belt  
that *Comet  
Shoemaker-  
Levy* got to  
close to  
Jupiter.

The Great Impact



**The Comet Shoemaker-Levy was ripped apart due to the tidal forces from the planet.**







The comet fragmented into 9 large pieces,  
(Labeled “A” to “I”) that would bring it into  
a collision course with Jupiter.

*This was the first time we have ever seen a  
comet strike a planet and this was NOT the  
last. There has been two more strikes*

- **On July 16, 1994 Comet Shoemaker-Levy 9 fragments a.k.a. the “string of pearls” collided into Jupiter with a series of spectacular explosions.**





**Information  
from this  
impact gave  
us clues  
about what  
might  
happen if  
such an  
impact  
occurred on  
earth**



- This information made thousands of people realize just how “lucky” are planet really is.
- The largest impact came from Fragment "G" which was about 8 miles across.



- **Earth probably could with stand a 3-mile wide comet impact but not without major devastation.**





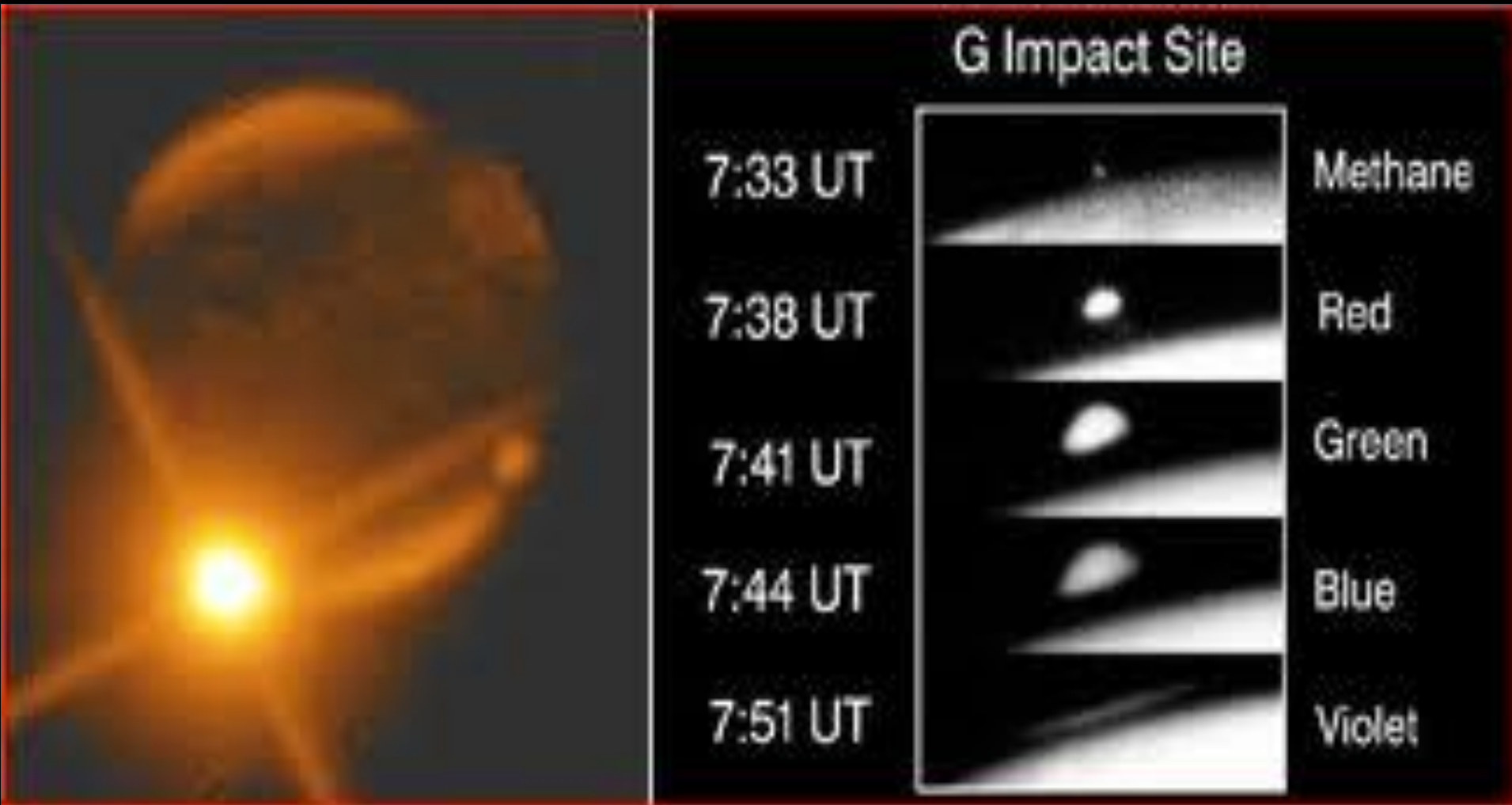
- **BUT any larger and Earth might not survive?**



Such an impact would cause an explosion that would equal 150 hydrogen bombs going off at once



Fragment “G” created a plume that arose some 2000 miles into space.



**One such asteroid that Big Brother missed is Apophis. It will approach Earth at a distance of 37,000-38,000 kilometers on April 13, 2029.**





**Earth's gravitational attraction will either cause this space rock to fly off into space or...**



**Likely send it on a collision path with Earth,  
that may occur on April 13, 2036.**



**Most space agencies say collision, but NASA said that it will not happen.**

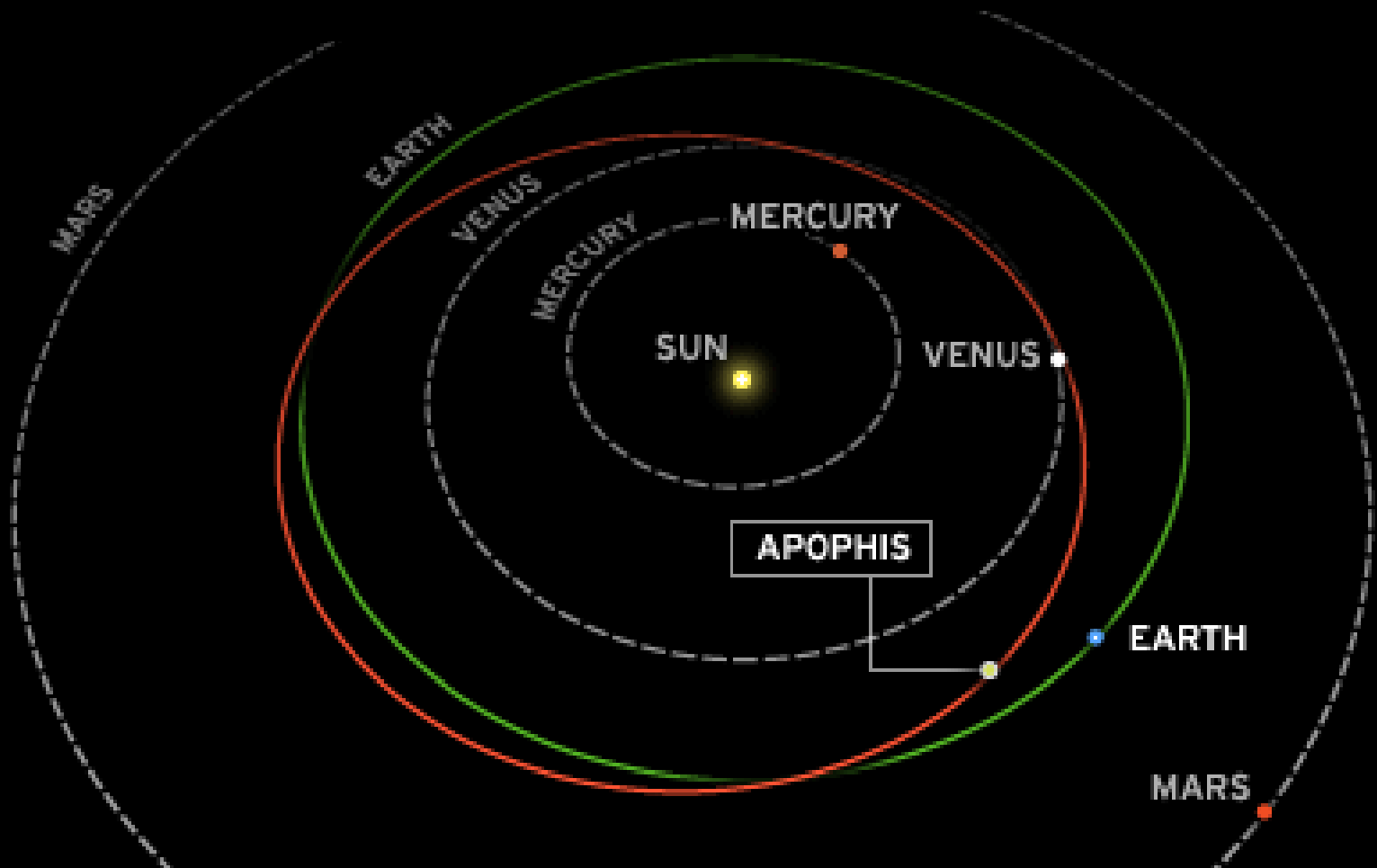
**We are just going to have to wait and see**





## The Great Impact

**in this chart, we can follow Apophis as it chases earth from Oct. 8, 2012 until Jan. 23, 2013, while Apophis is close enough to deflect.**



- **Asteroid Apophis**



- **Asteroid Apophis (2004 MN4)**
- diameter of 1,300 feet (400 meters)

- Fortunately, more precise plotting ruled out a collision in 2029. However, Apophis will still make an extremely close pass — missing Earth by mere tens of thousands of miles.



- At that distance, Earth's gravitational pull could perturb Apophis' orbit enough to put it on a track to hit during another pass in 2036.
- Experts say that could happen if, during the 2029 close encounter, the asteroid passes through an outer-space "keyhole" that measures about 2,000 feet (600 meters) across.



- **At this current time Asteroid Apophis is on a collision course with Earth on April 13, 2036**

The Great Impact



The End



**Where are  
Big  
Brother ?**