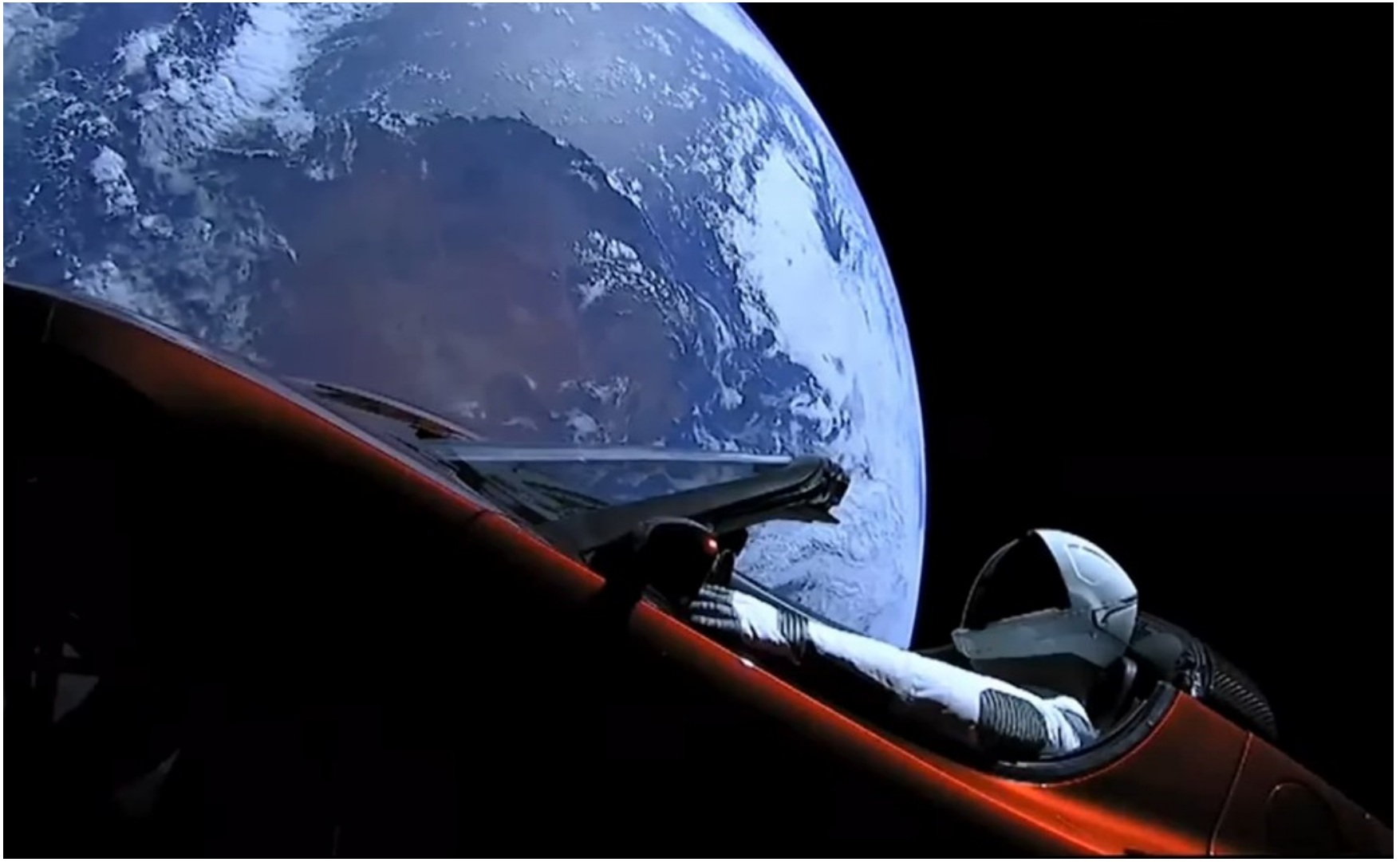
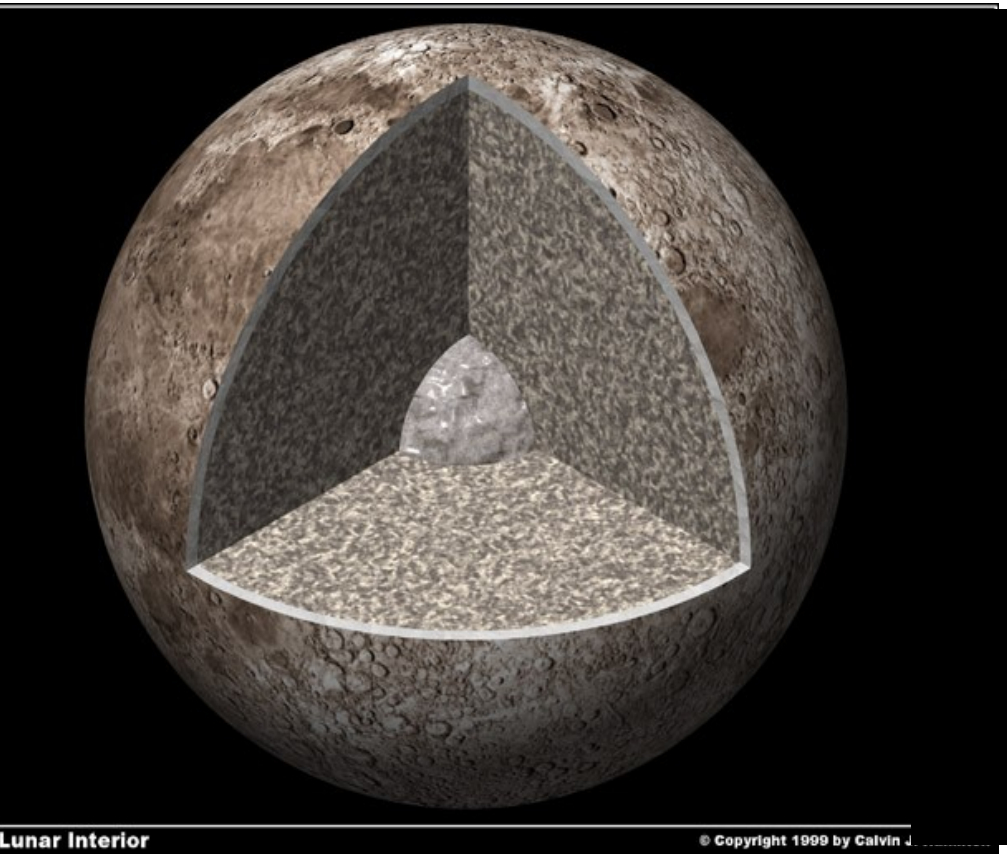
“A pupil from whom nothing is every demanded which he cannot do, never does all he can” John Stuart Mill

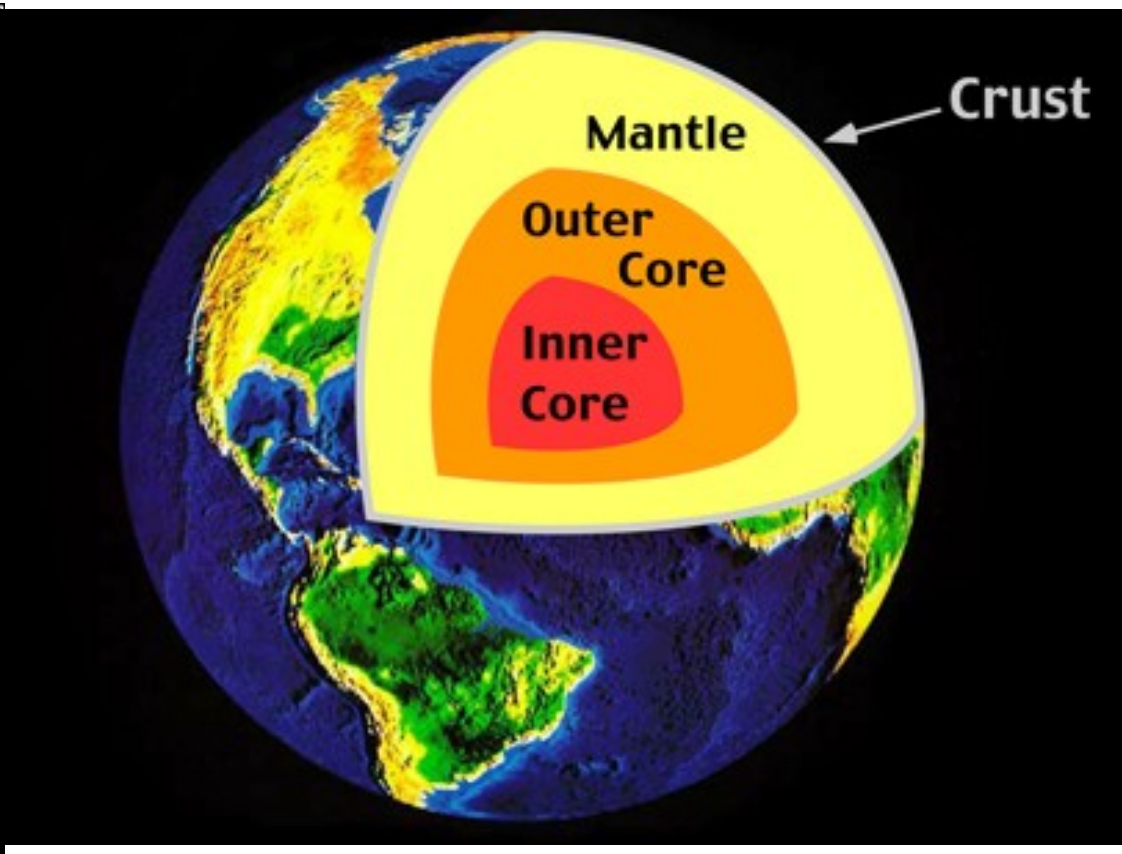
HW1 is pushed back to Wednesday at the beginning of class. 18 people w/out ‘clickers’



Structure #1(we will have 5)

Thin atmosphere over
Rocky crust over
Rocky mantle over
Rocky core.



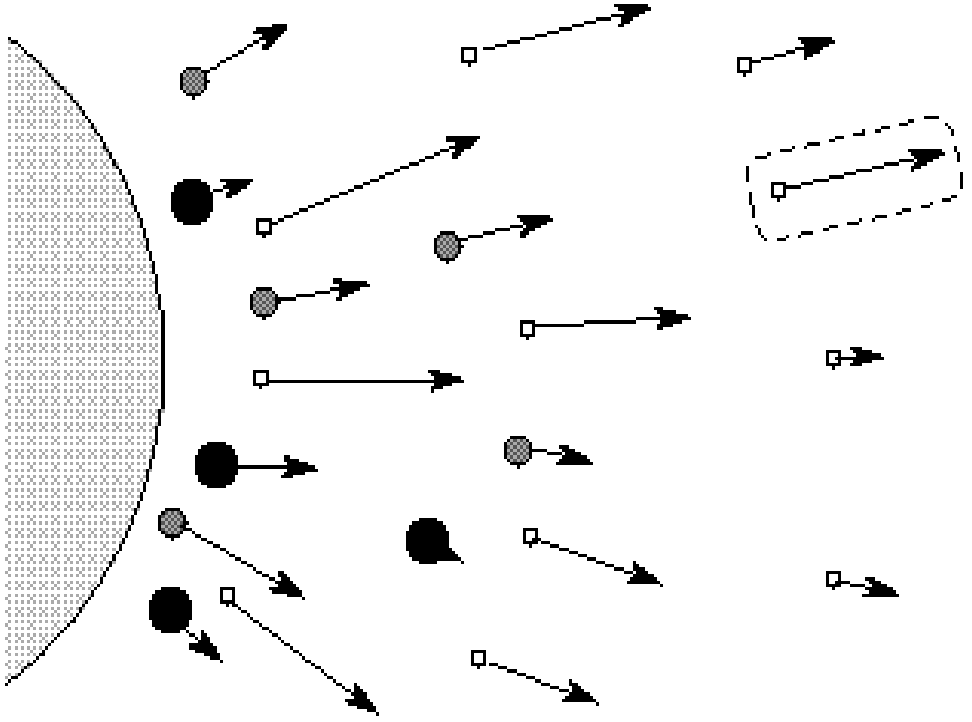


Atmosphere. This is determined by:

1) mass of planet (more massive planets have more gravity)

2) mass of gas particles (larger particles travel slower)

3) temperature (determines how fast particles move)



lighter molecules move faster on average so can get higher on average than heavier molecules. Lighter molecules high up more likely to escape planet or moon.

Review of what we've learned from the Earth-Moon system.

Surface age based on cratering

1) Smothered with craters; the surface is 4+ billion years old. (e.g. Lunar Highlands)
2) medium (-heavy?) cratered; 3.5 billion years old. (e.g. Lunar maria)
3) lightly cratered; ~200-500 million years old. (e.g. Earth's surface)
4) no craters; <few million years old.

Surface age based on cratering

If a surface is NOT 4+ Gyrs, there must be a reason for that.

Some form of erosion/resurfacing.

Color Variation

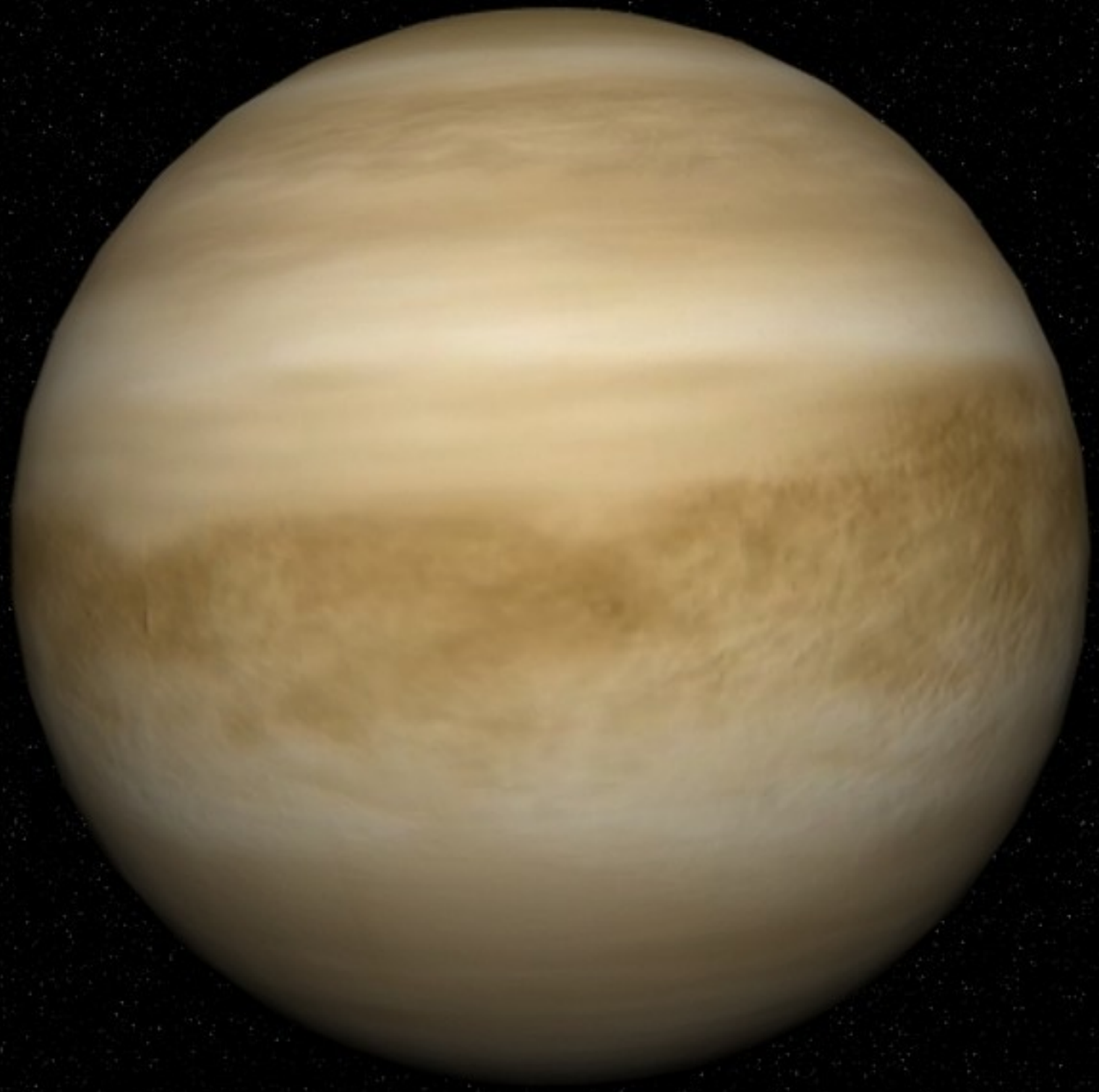
1) Composition (different colors made of different stuff)
2) Temperature (solid, liquid, or gas can change color)
3) Altitude (shading)

Well-defined features usually mean solid.
Hazy features usually mean gas.
Smooth (featureless) usually means liquid.

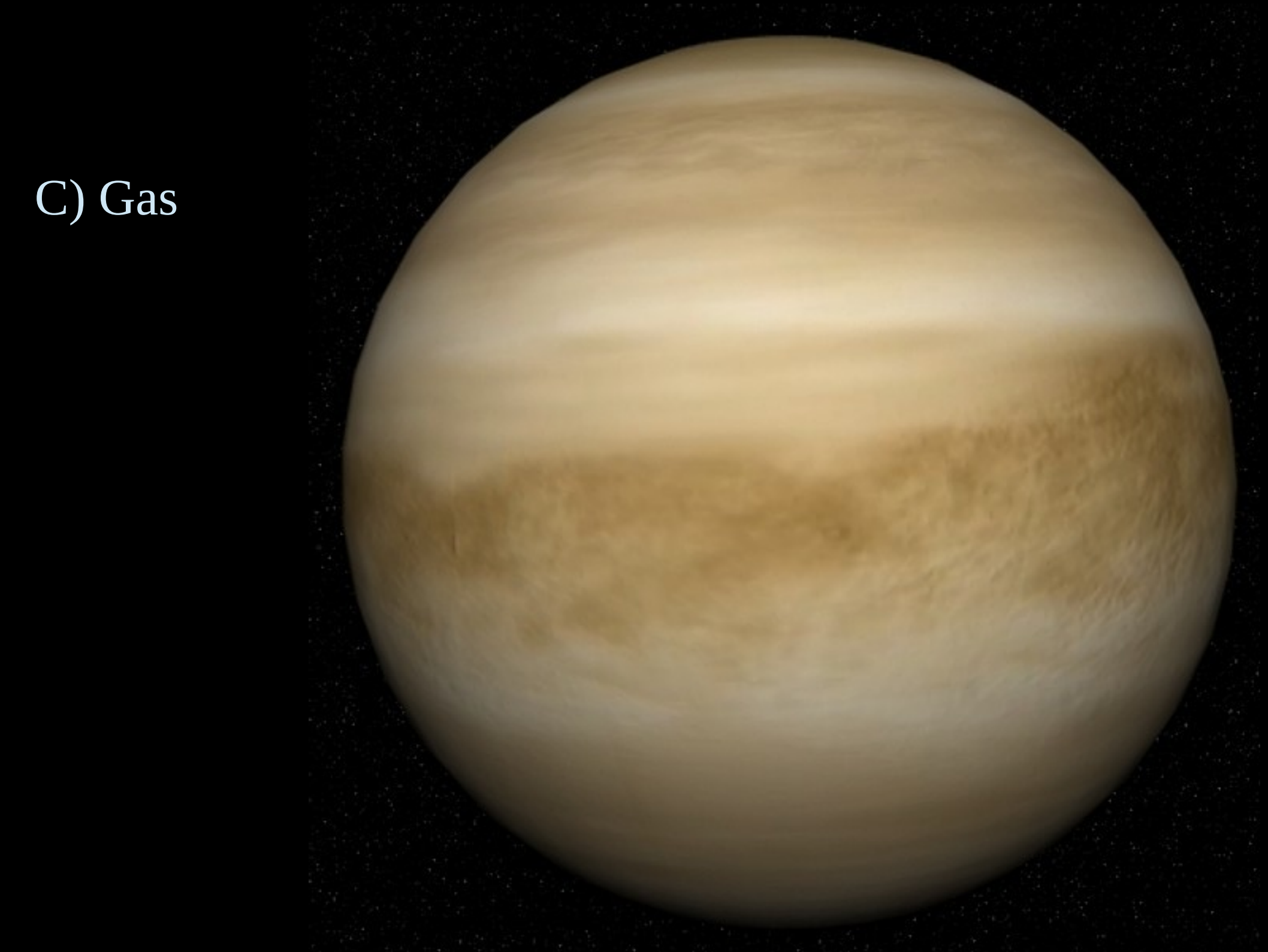
A) Solid

B) Liquid

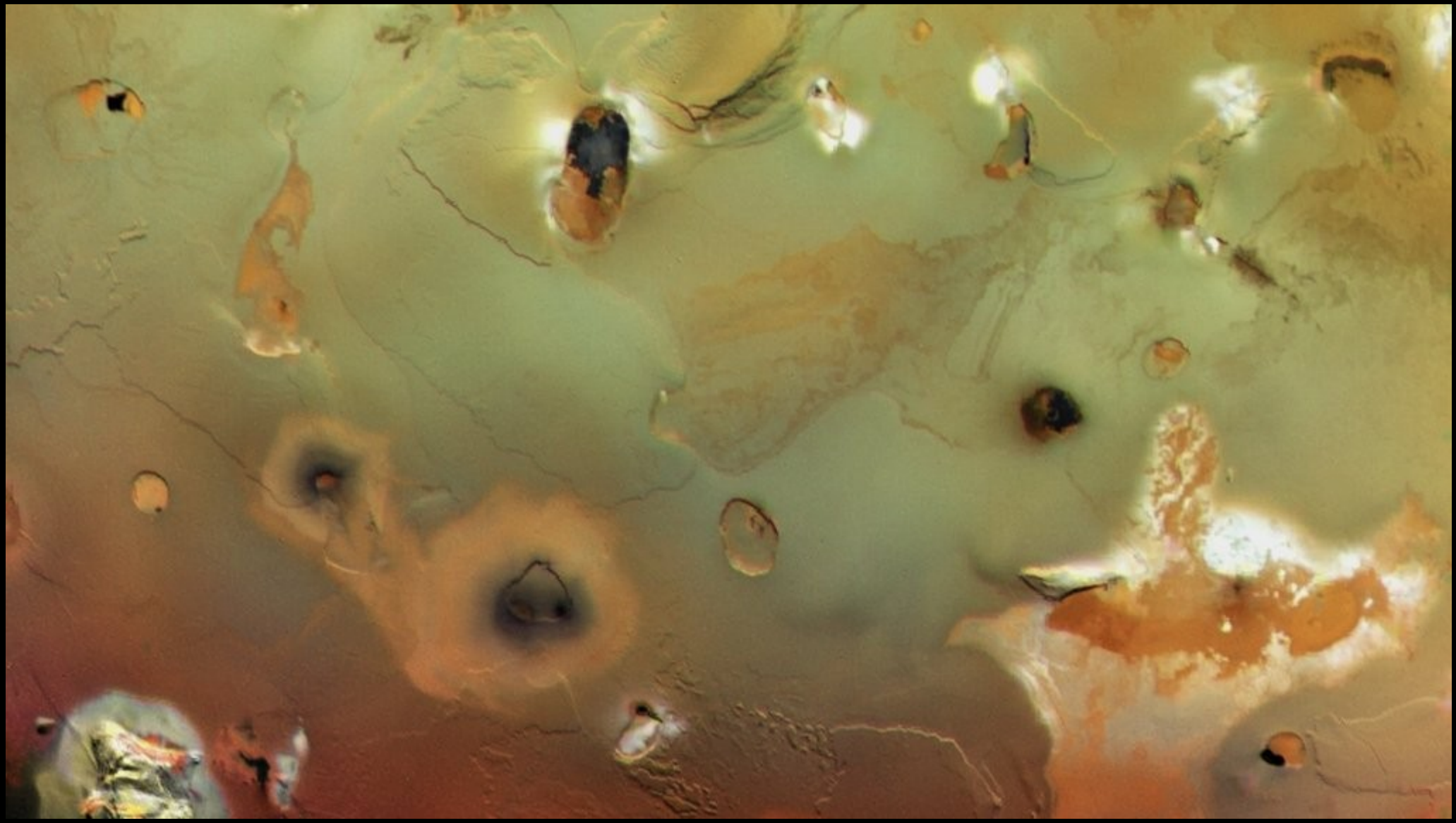
C) Gas



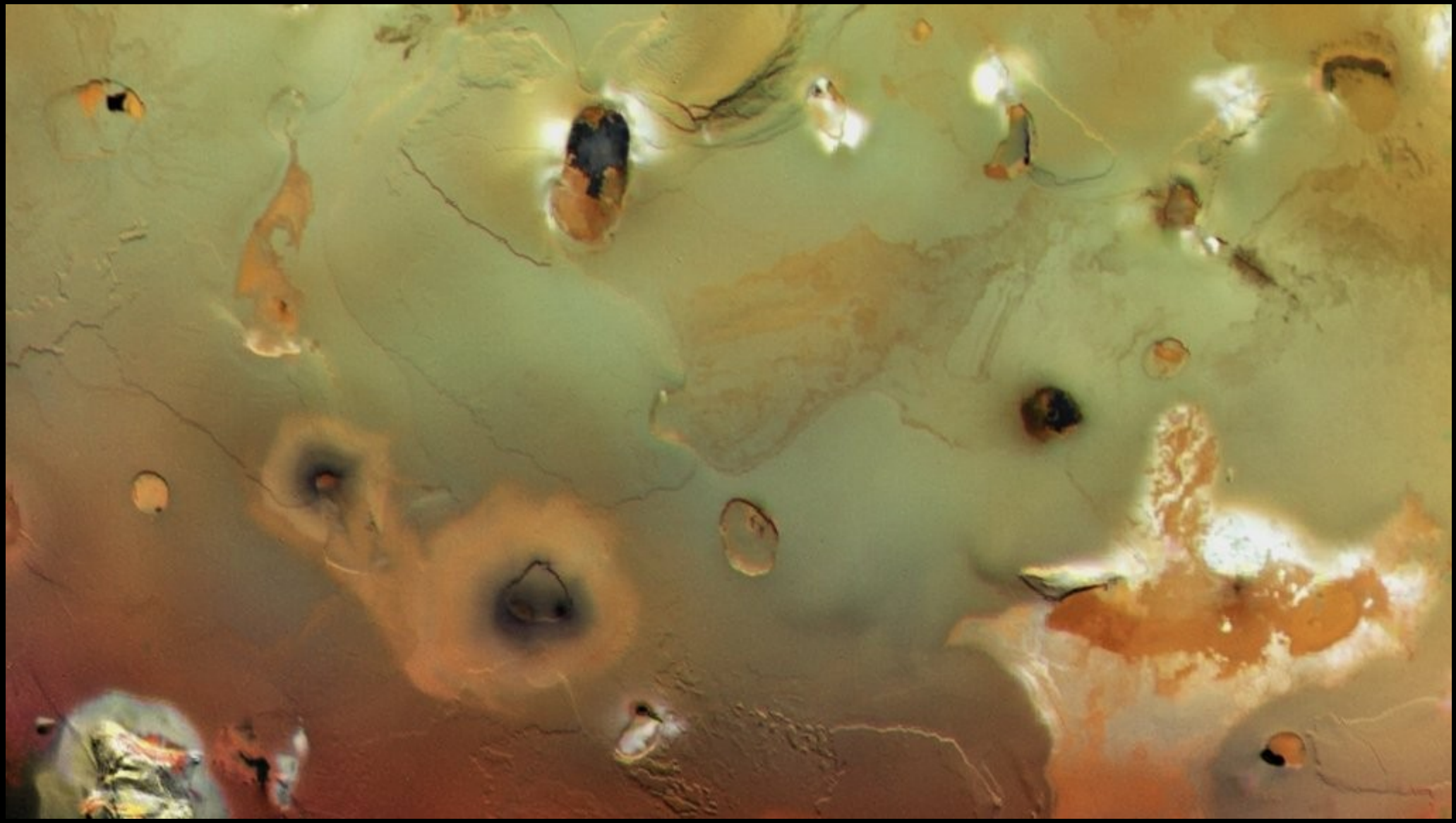
C) Gas



A) Solid B) Liquid C) Gas



A) Solid



We assume that all objects in our solar system were made at the same time.

So any younger surfaces indicate geologic processes.

Solar system Age: 4.6 billion years.

Tides:

Objects want to be tidally locked. It is the lowest energy state.

Smaller things will tidally lock to larger things.

Water: is very common in space.

Surface processes include: plate tectonics, volcanoes, wind/water erosion

The Earth: Multi-colored, round, massive, solid rocky planet with a thin blue-water ocean and white-cloud atmosphere. Green/brown land masses, white polar caps (spin axis nearly aligned with orbital axis) with water/wind weathering, plate tectonics, and volcanoes.

Bulk properties, not details.

How does a planet get a moon?

- It forms along with the planet:
- Captured:
- Split from planet:
- Formed from a ring of material that was made by a giant collision.

What are the consequences of each of these?

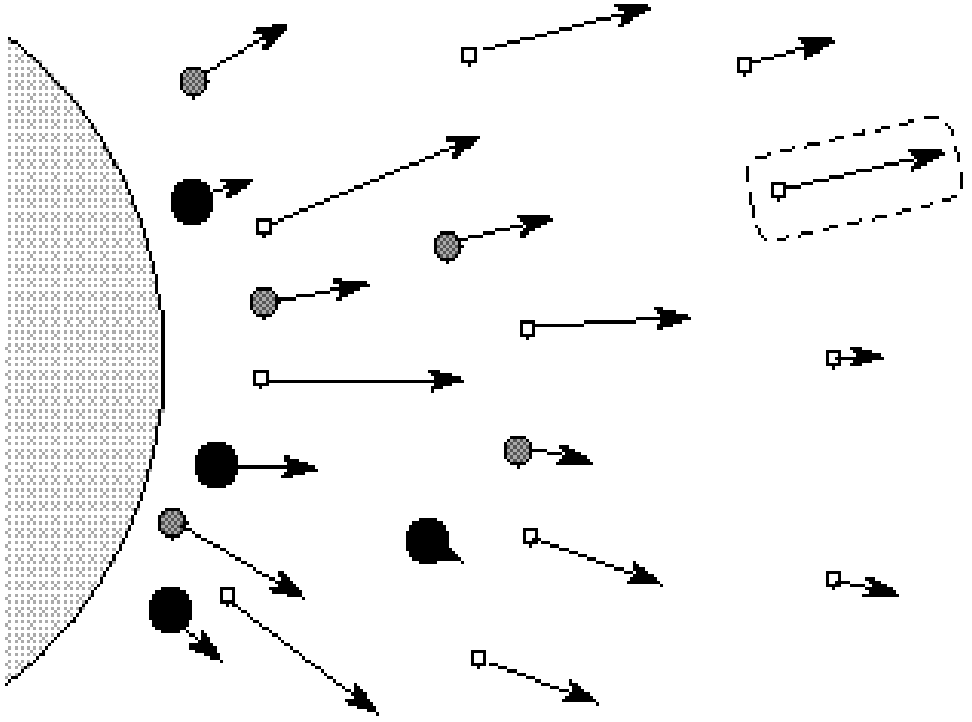
Composition and Orbit

Atmosphere. This is determined by:

1) mass of planet (more massive planets have more gravity)

2) mass of gas particles (larger particles travel slower)

3) temperature (determines how fast particles move)



lighter molecules move faster on average so can get higher on average than heavier molecules. Lighter molecules high up more likely to escape planet or moon.

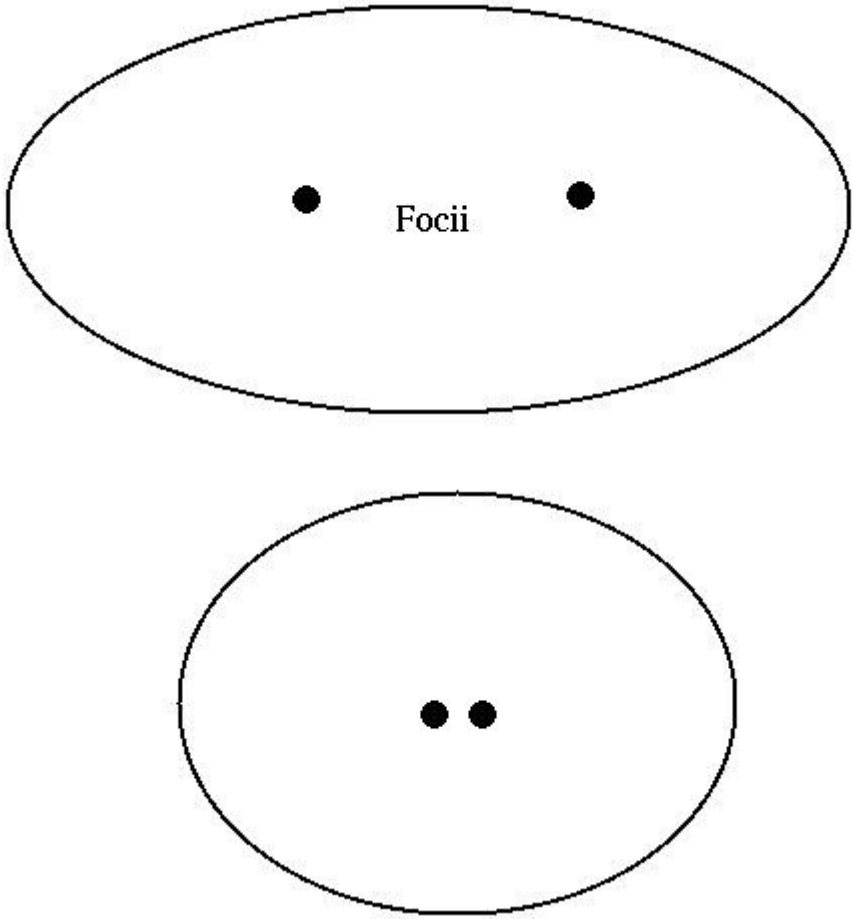
Now that we have our baseline.

It's time to explore our solar system!!

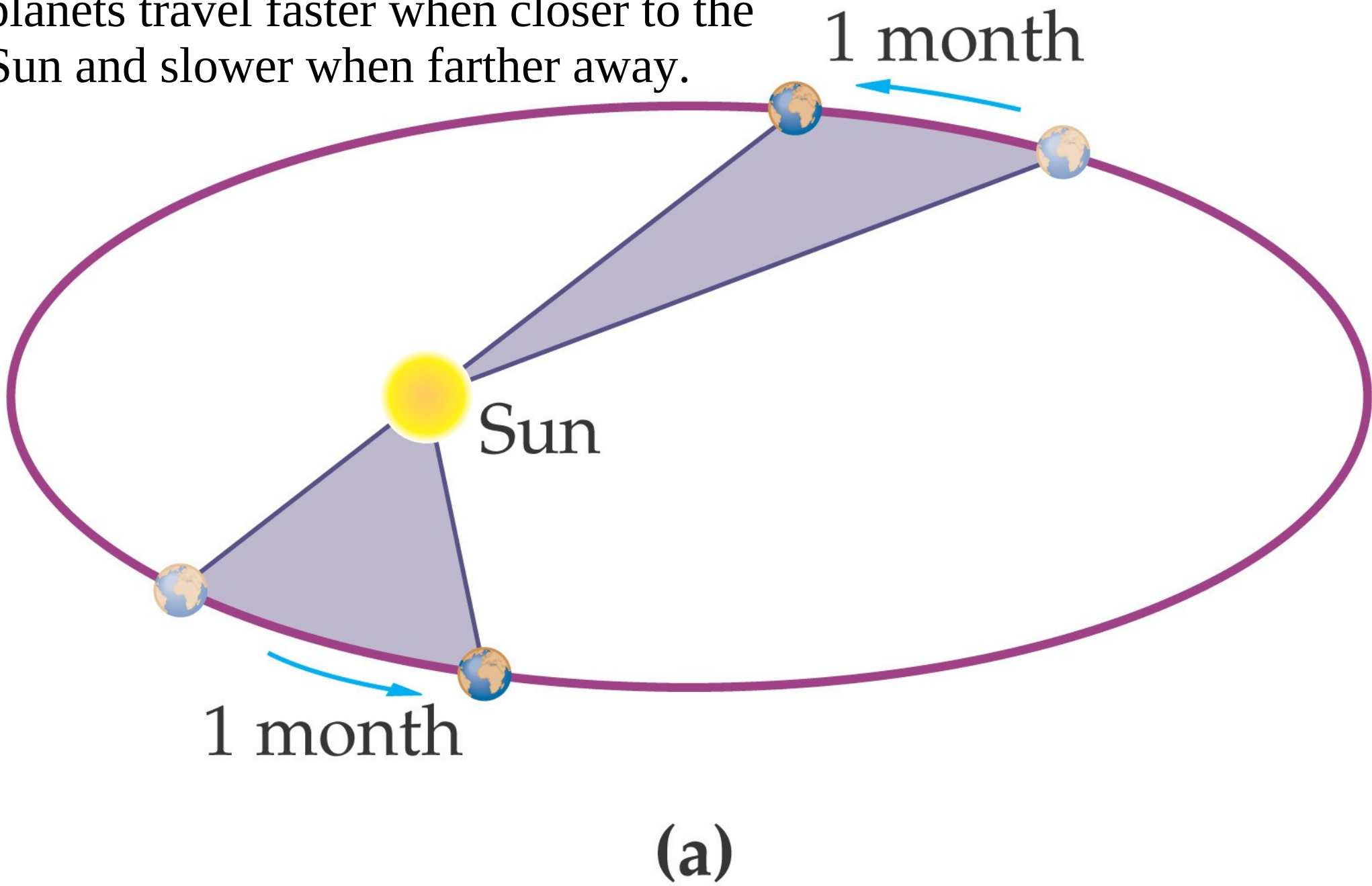
Kepler's 3 laws of planetary motion

1) Planets travel in elliptical orbits (not circles) with the Sun at one focus.
2) Planets travel faster when they are closer to the Sun, such that a line, connecting the Sun and the planet, sweeps out equal area in equal time.
3) The square of the planet's orbital period is proportional to the cube of the semimajor axis (roughly its orbital distance).

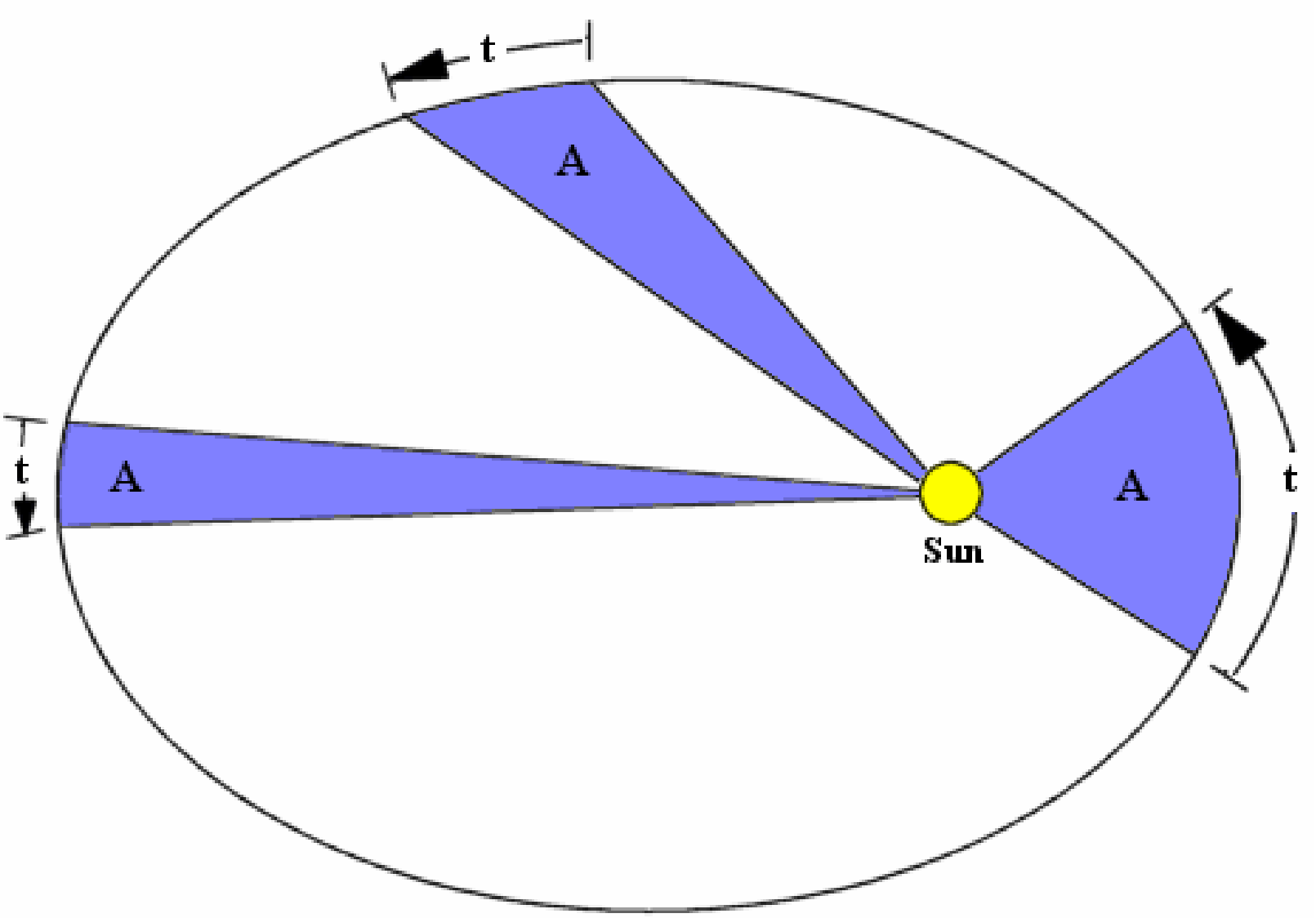
Rule 1: Elliptical Orbits.



Equal area over equal time- means planets travel faster when closer to the Sun and slower when farther away.



Another example

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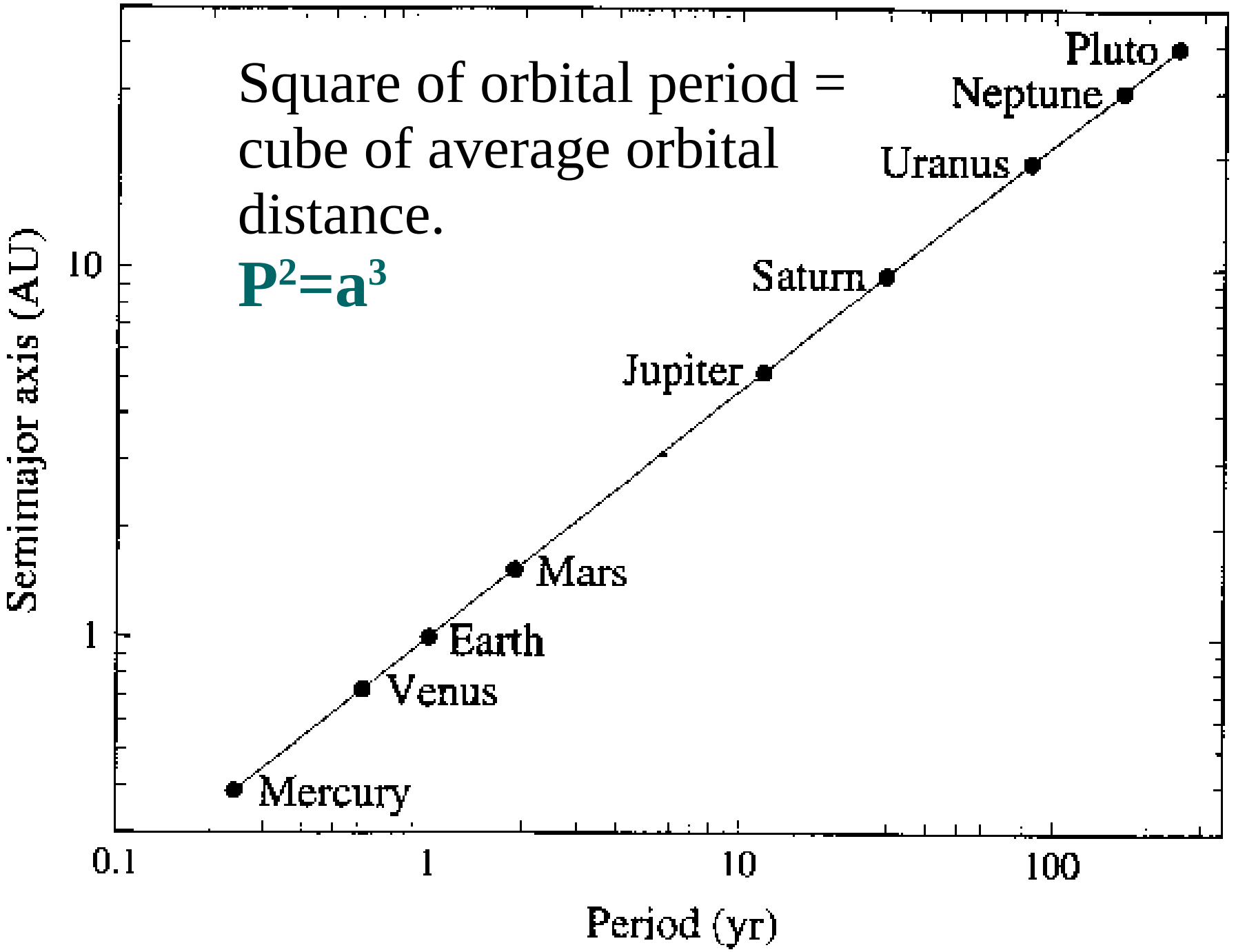

Square of orbital period = cube of average orbital distance.
$P^2=a^3$
Pluto
Neptune
Uranus
Saturn
Jupiter
Mars
Earth
Venus
Mercury
Semimajor axis (AU)
10
1
0.1
1
10
100
Period (yr)

Astronomical Unit (AU): The average distance between the Earth and the Sun.

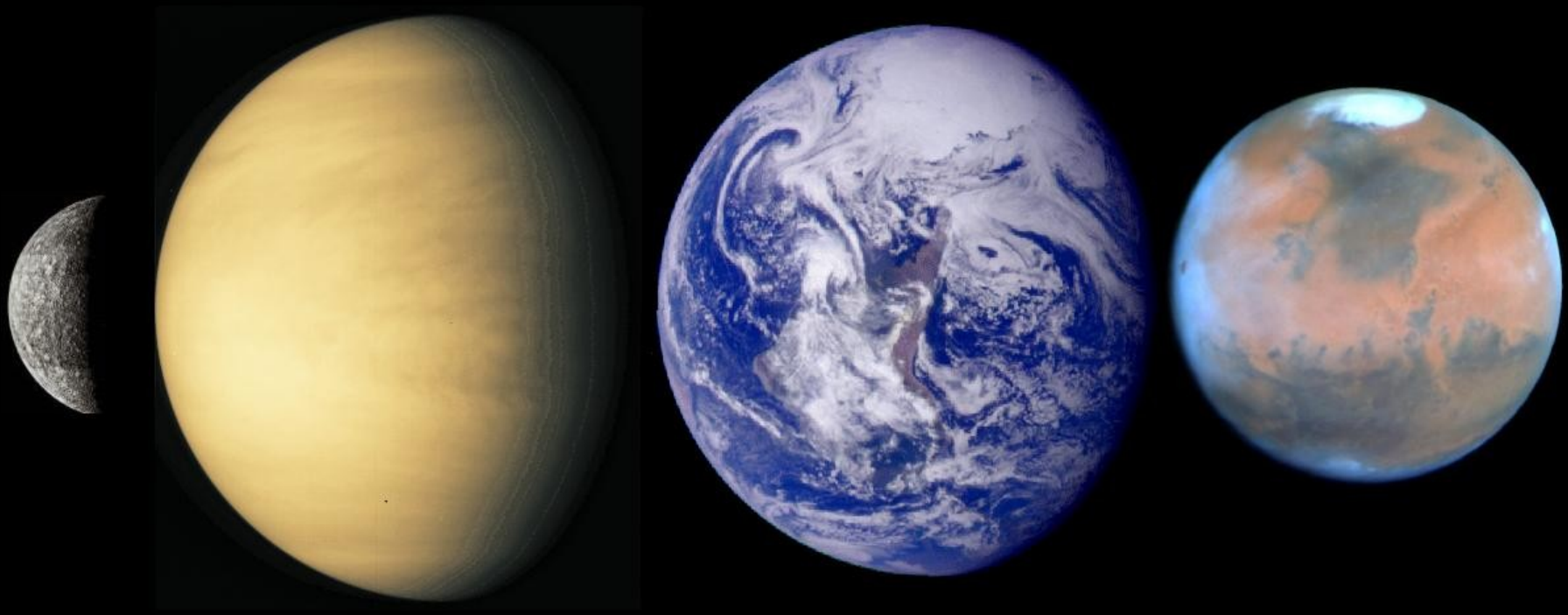
1.5×10^{11}m = 1.5 x 10^{8}km.

(1 km= 0.6 miles)

UNITS: In this class we mostly use the MKS system:

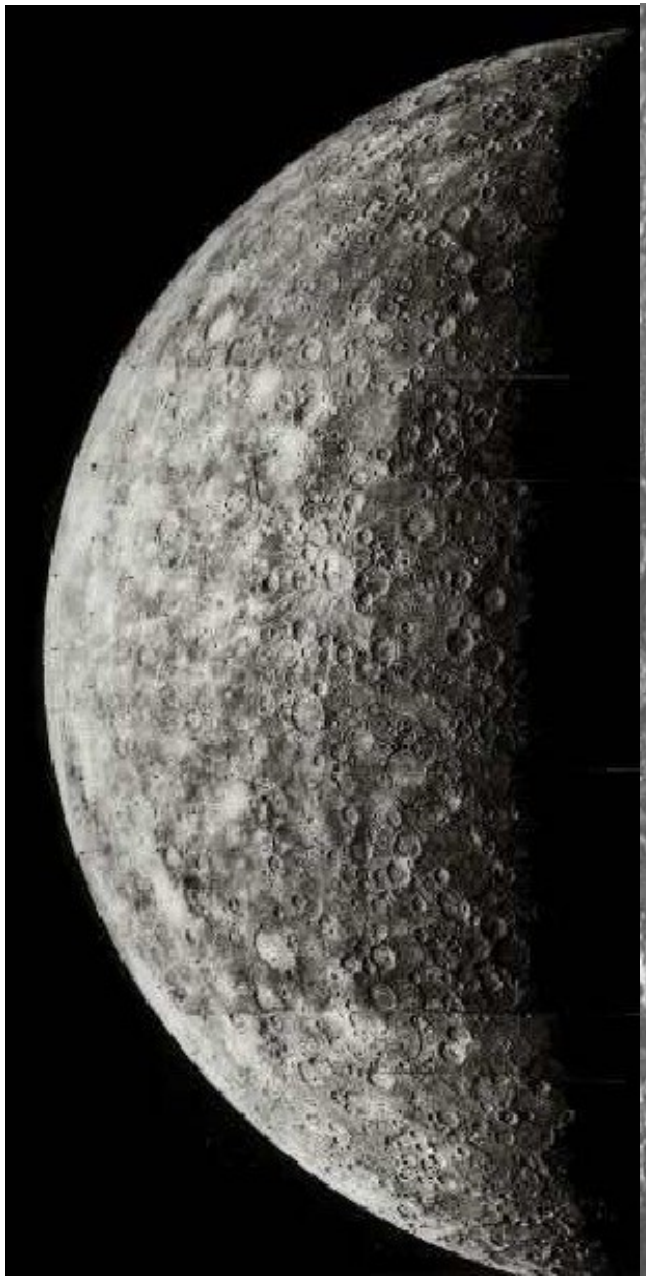
meters, kilograms, and seconds

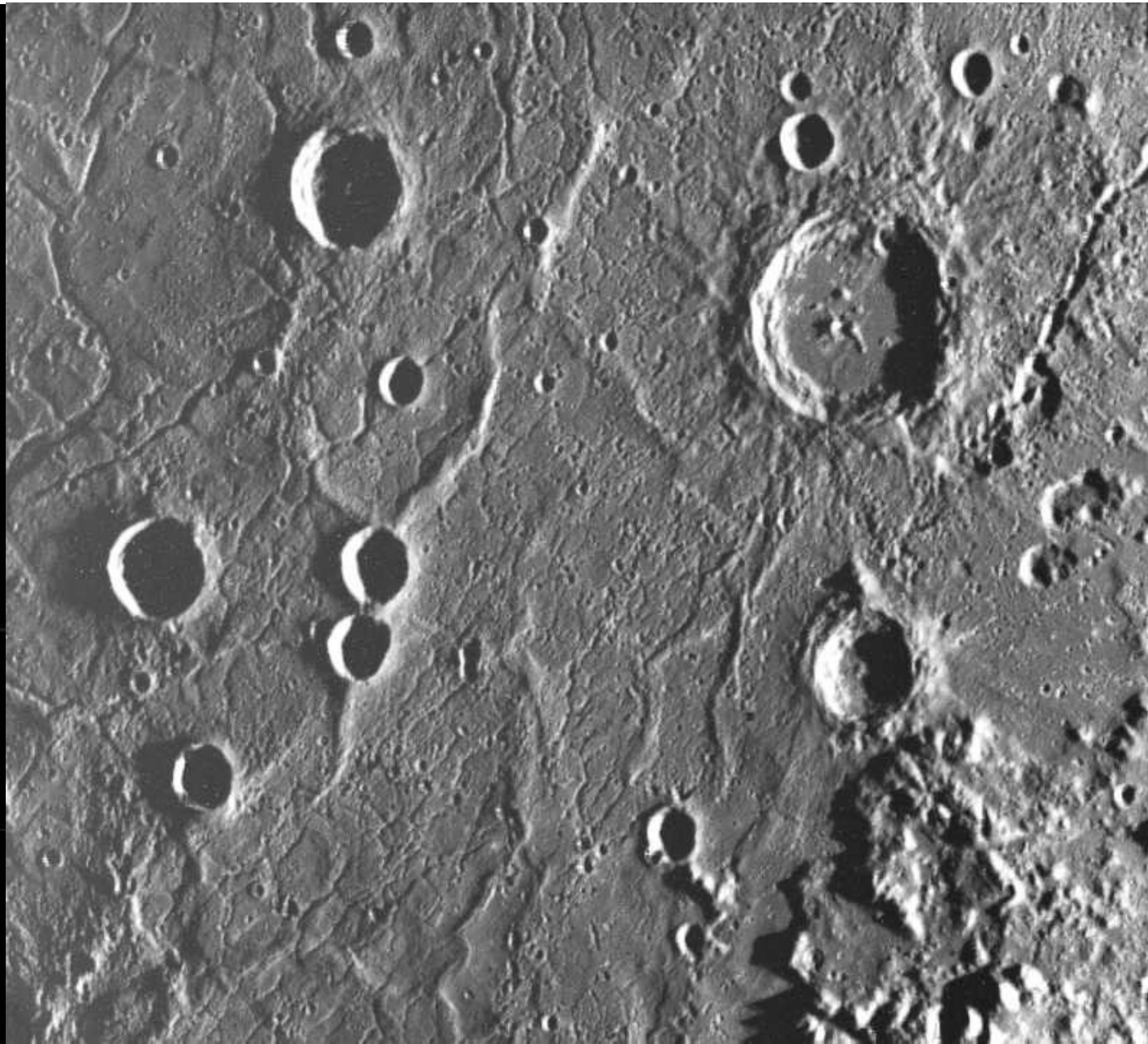
Starting with the Terrestrial planets.

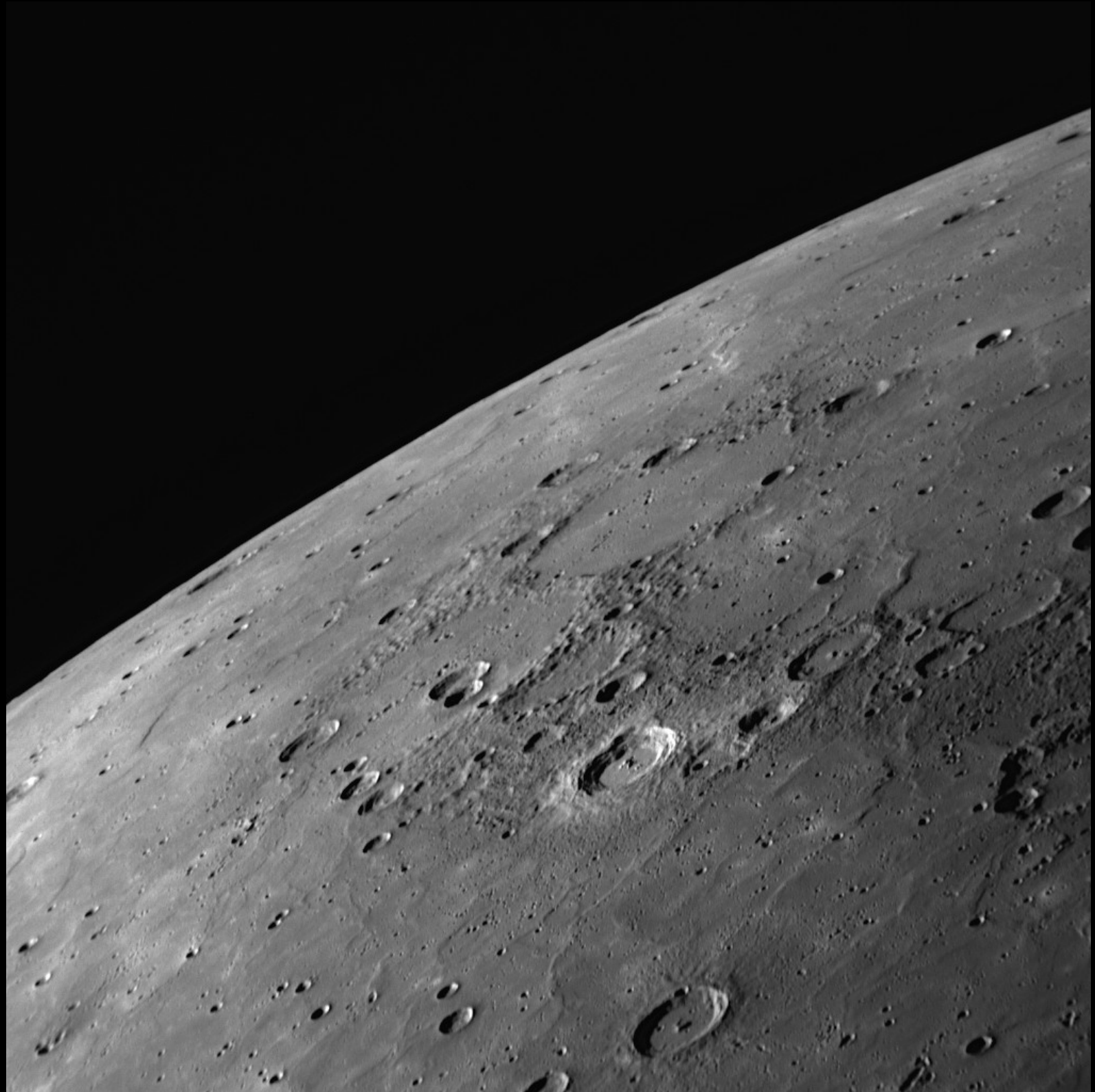


Mercury

What do you see and what does it mean?



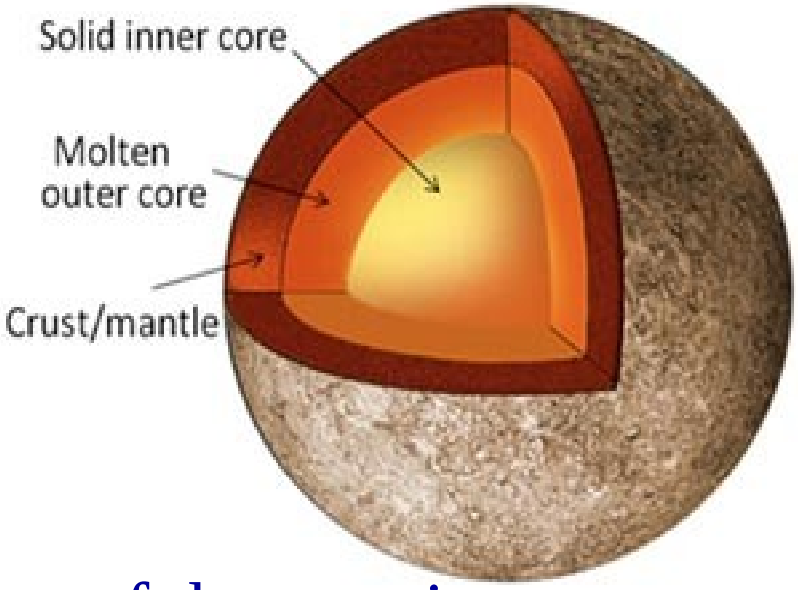




Mercury

- Old, heavily cratered surface. Probably of similar age as the highlands on the Moon: about 4 billions years old.
- Some smooth areas which may be evidence of later volcanism (lava flows, like the mare on the Moon).
- Globally cracked surface indicates that Mercury's surface solidified first (as expected) and as the mantle solidified, Mercury shrank slightly (by only 1 km in radius!), cracking the crust.

Mercury



- Density: 5.4 gm/cc
- Structure
  - Thin cracked rocky crust
  - Rocky mantle

Iron core- 75% the size of the planet. Some of the core is probably molten (liquid).

Temperature: Daytime 441F, Night -279F

Atmosphere (yes, it has one!): Thin atmosphere created by solar wind blasting the surface (made of sodium mostly). It evaporates into space.

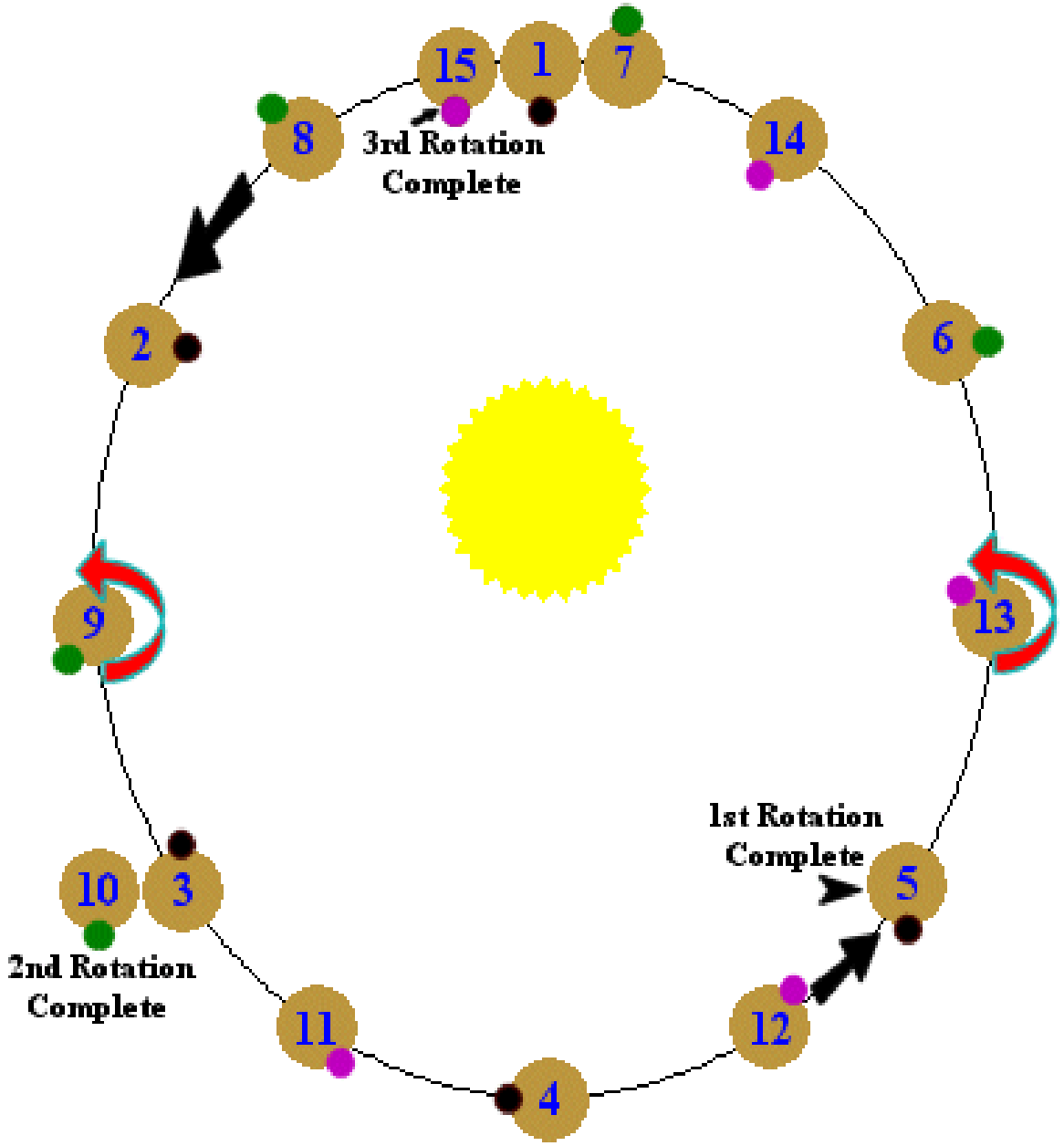
1 trillionth of Earth's pressure

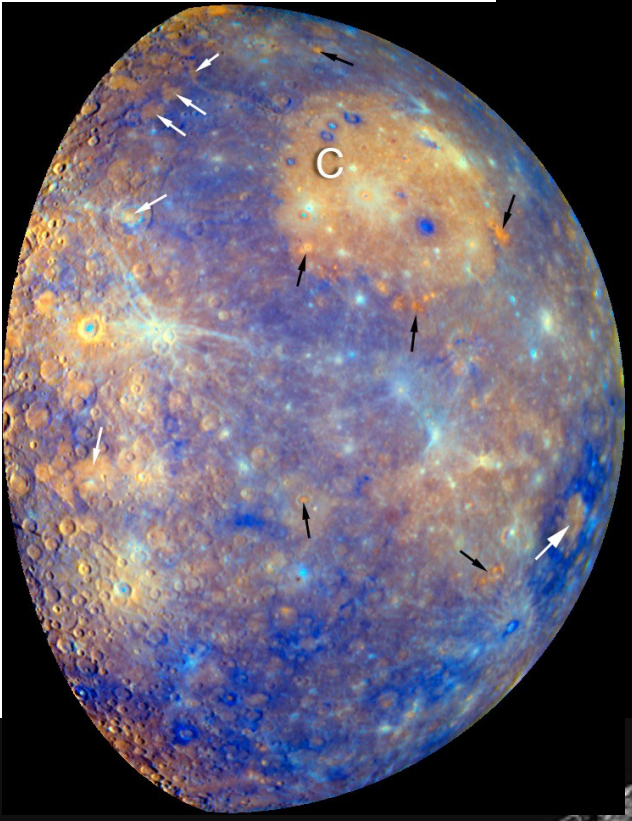
No moons.

Mercury, Unusual Spin/Orbit 3:2 Spin/Orbit resonance.

- One sidereal day is 59 Earth days.
- One solar day is 176 Earth days.
- One orbital period is 88 Earth days.

This is a form of tidal locking!





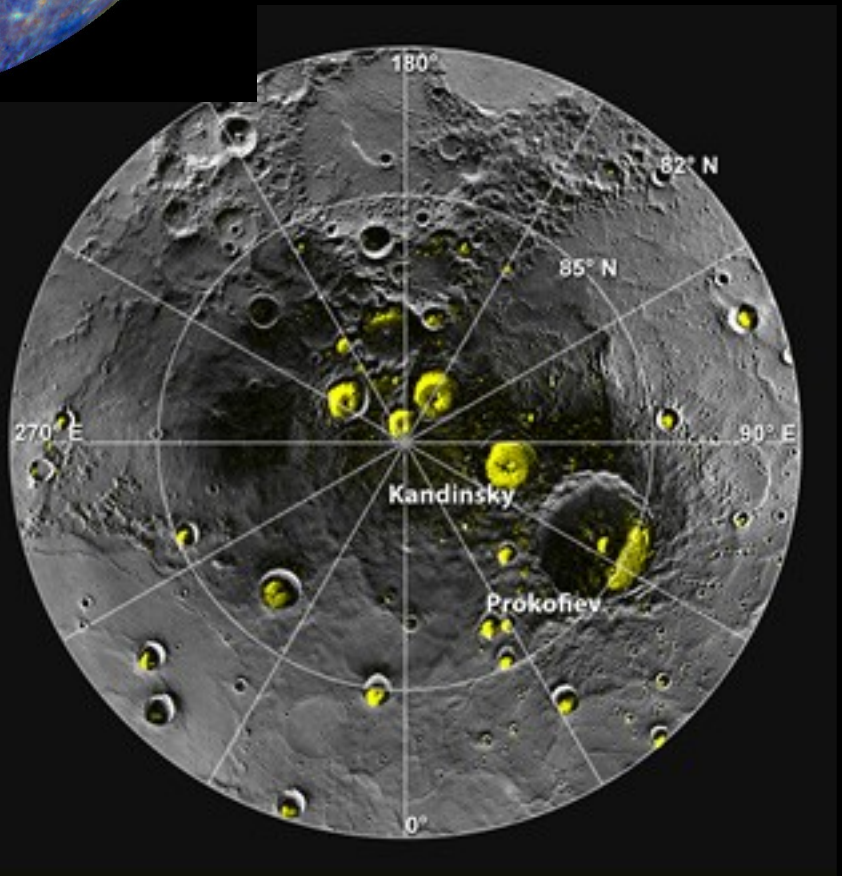
Messenger results: Ice in craters (0.1-1 trillion tons of water ice).

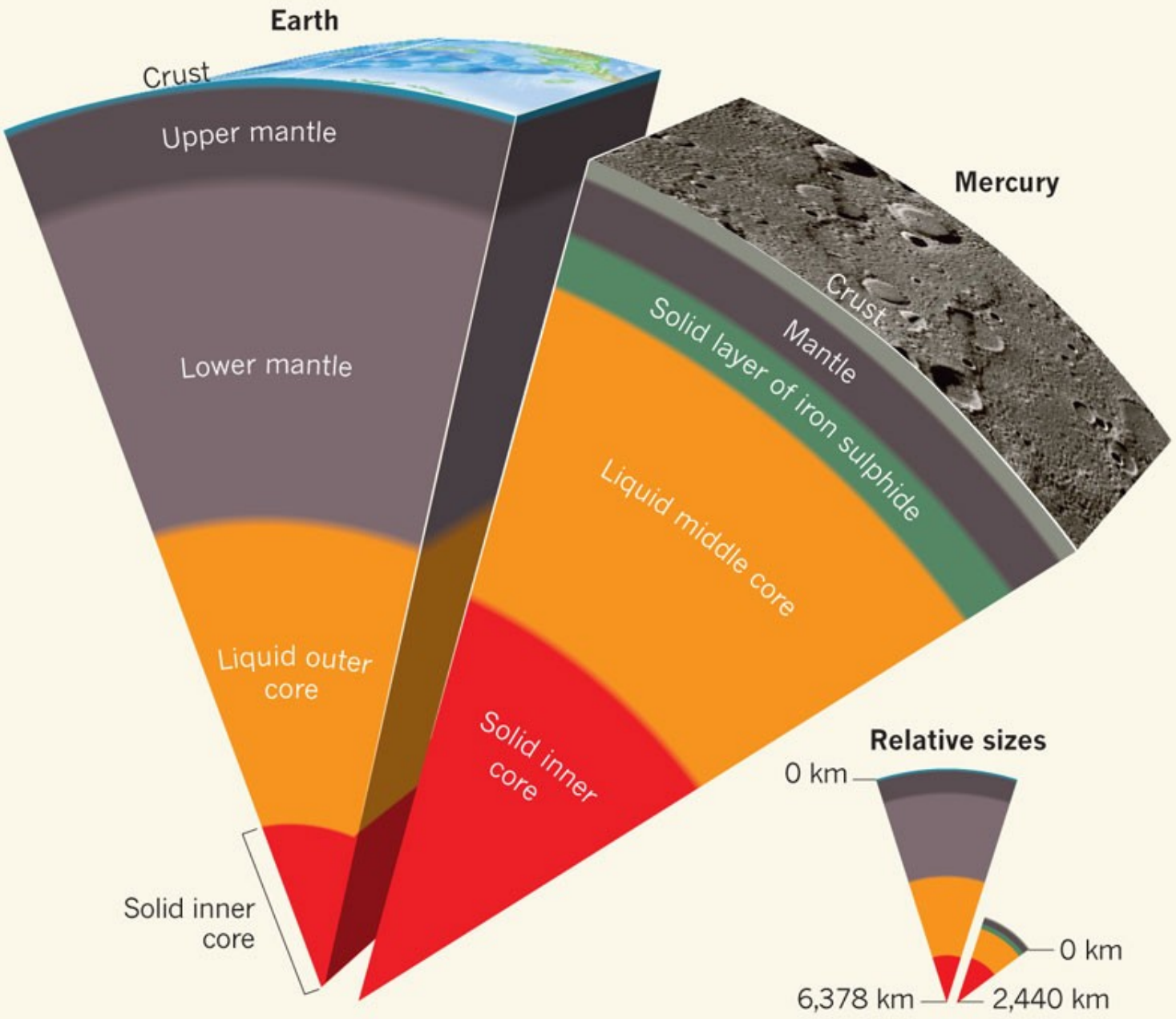
Larger Fe core and partially liquid

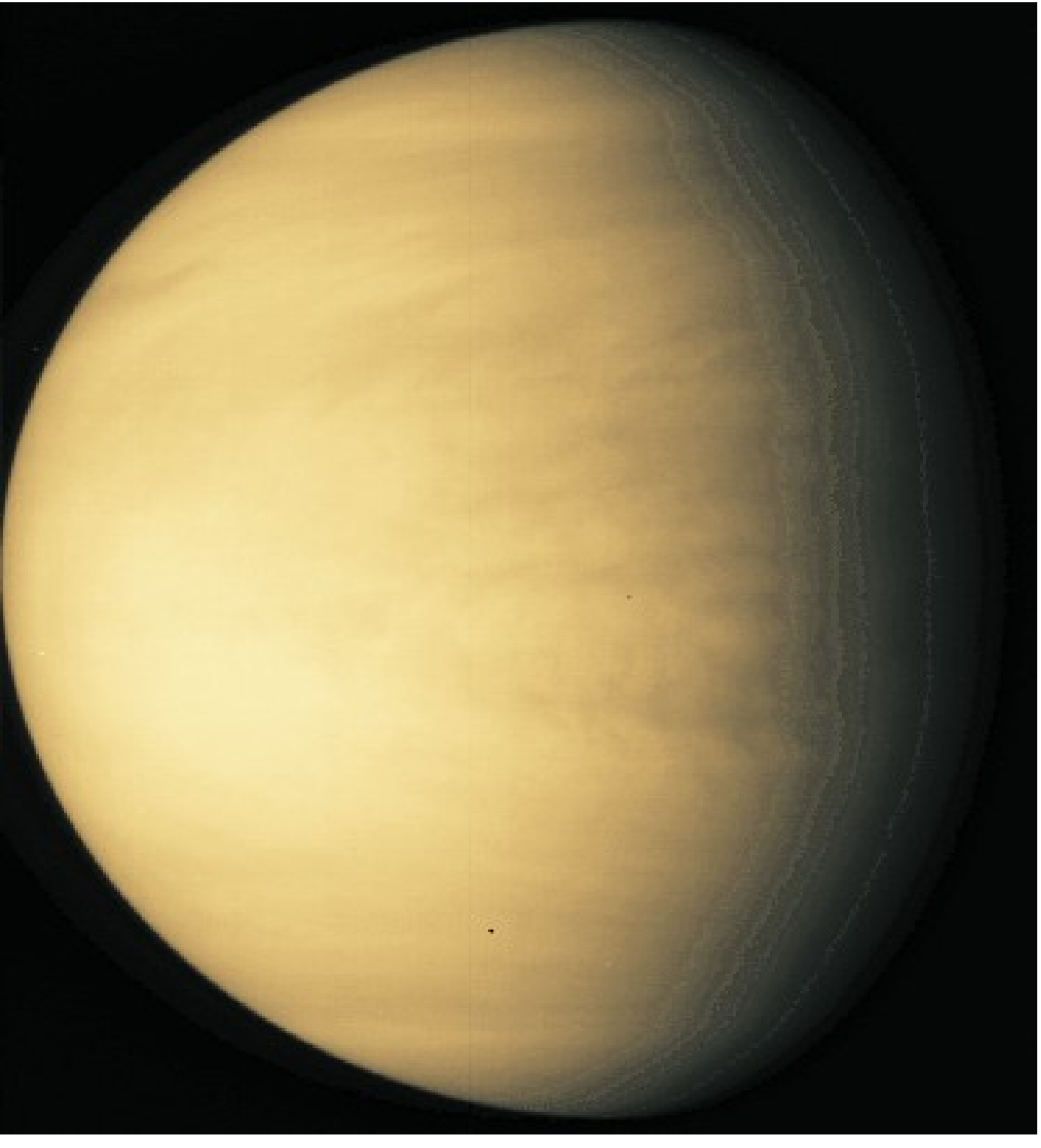
Magnetic field is uneven (South pole is weaker)

Atmosphere changes with distance.

Surface is sulfur-rich. 10X Earth's



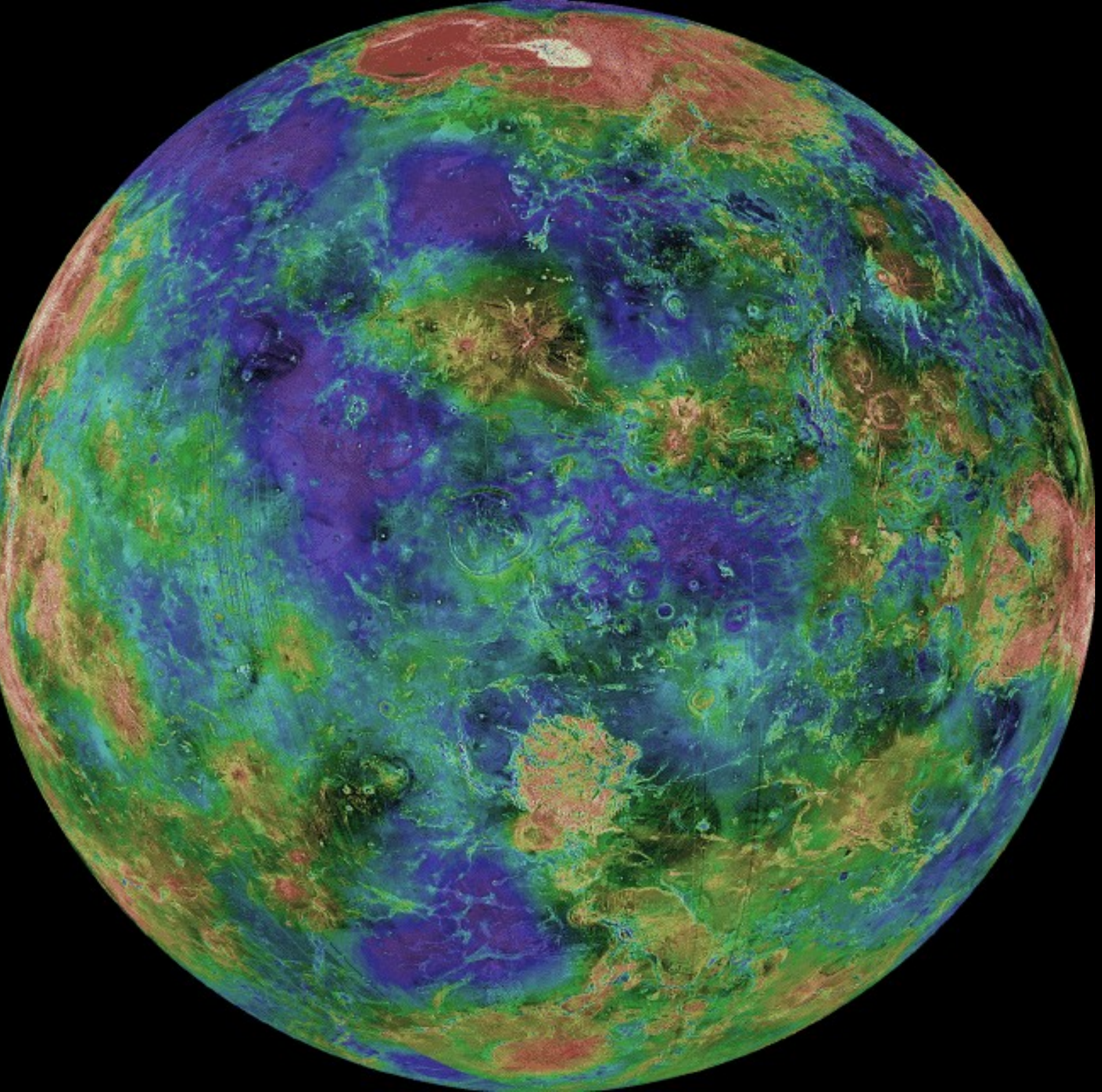

Earth
Crust
Upper mantle
Lower mantle
Liquid outer core
Solid inner core
Mercury
Crust
Mantle
Solid layer of iron sulphide
Liquid middle core
Solid inner core
Relative sizes
0 km
0 km
6,378 km
2,440 km



Describe Venus based on the next 3 images.

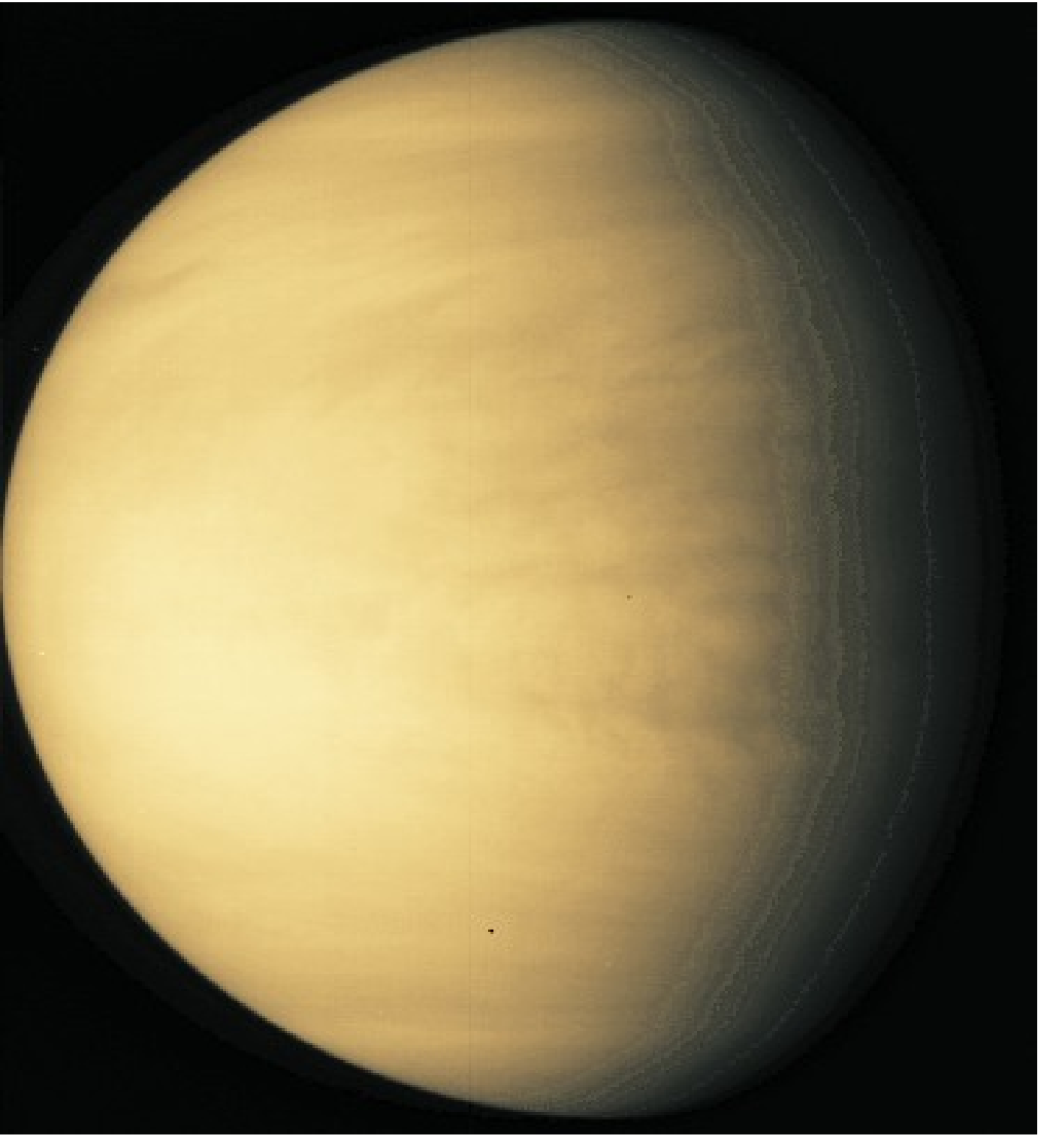
Through the clouds!

This is a reflectivity map: smoother parts are lighter



Relief Map:

Low areas are dark blue while high areas are red (the highest being white).



Venus is a rocky planet, like Earth, but it’s always covered with clouds.

4,000 miles of rock,
200 miles of clouds.