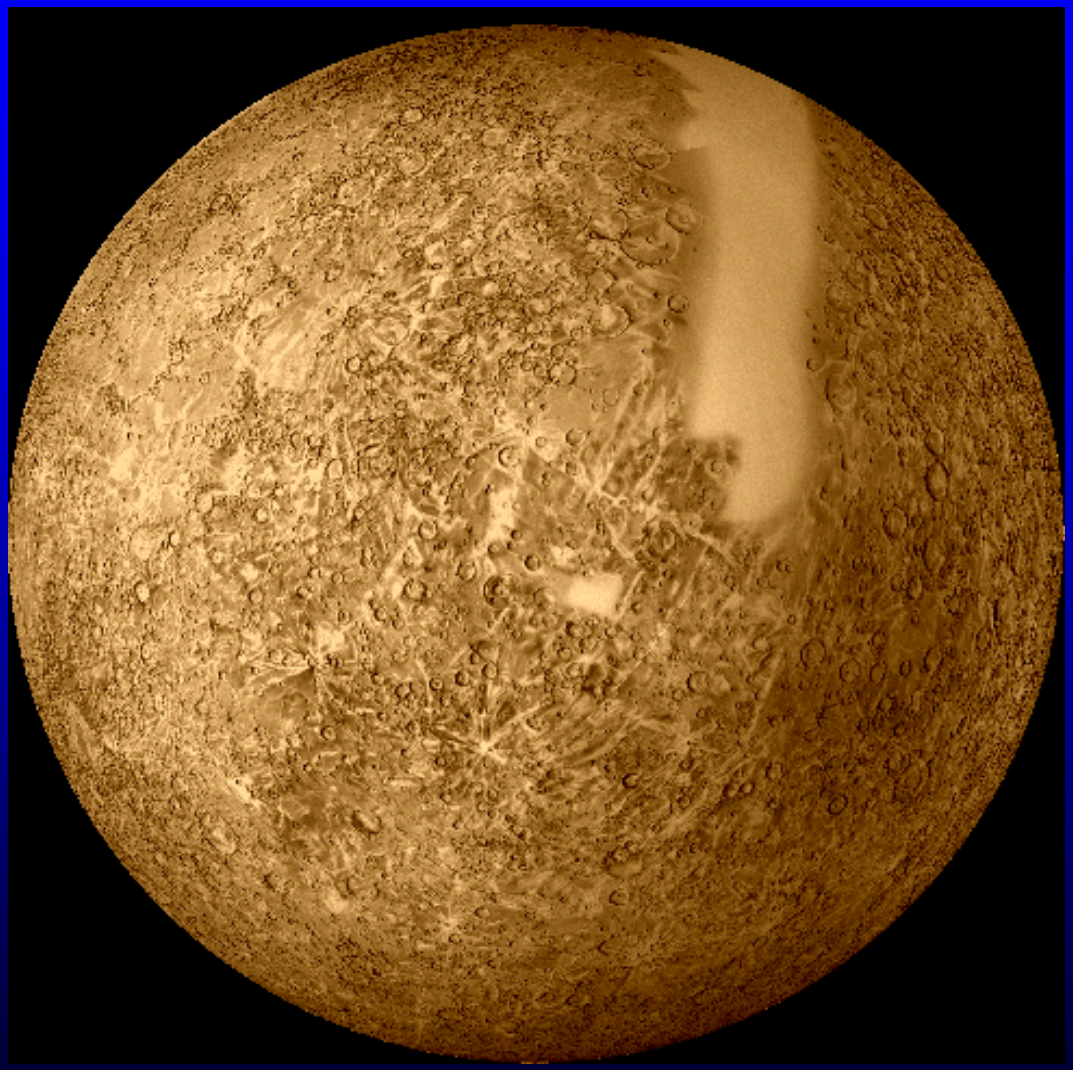
Our Solar System

Mercury

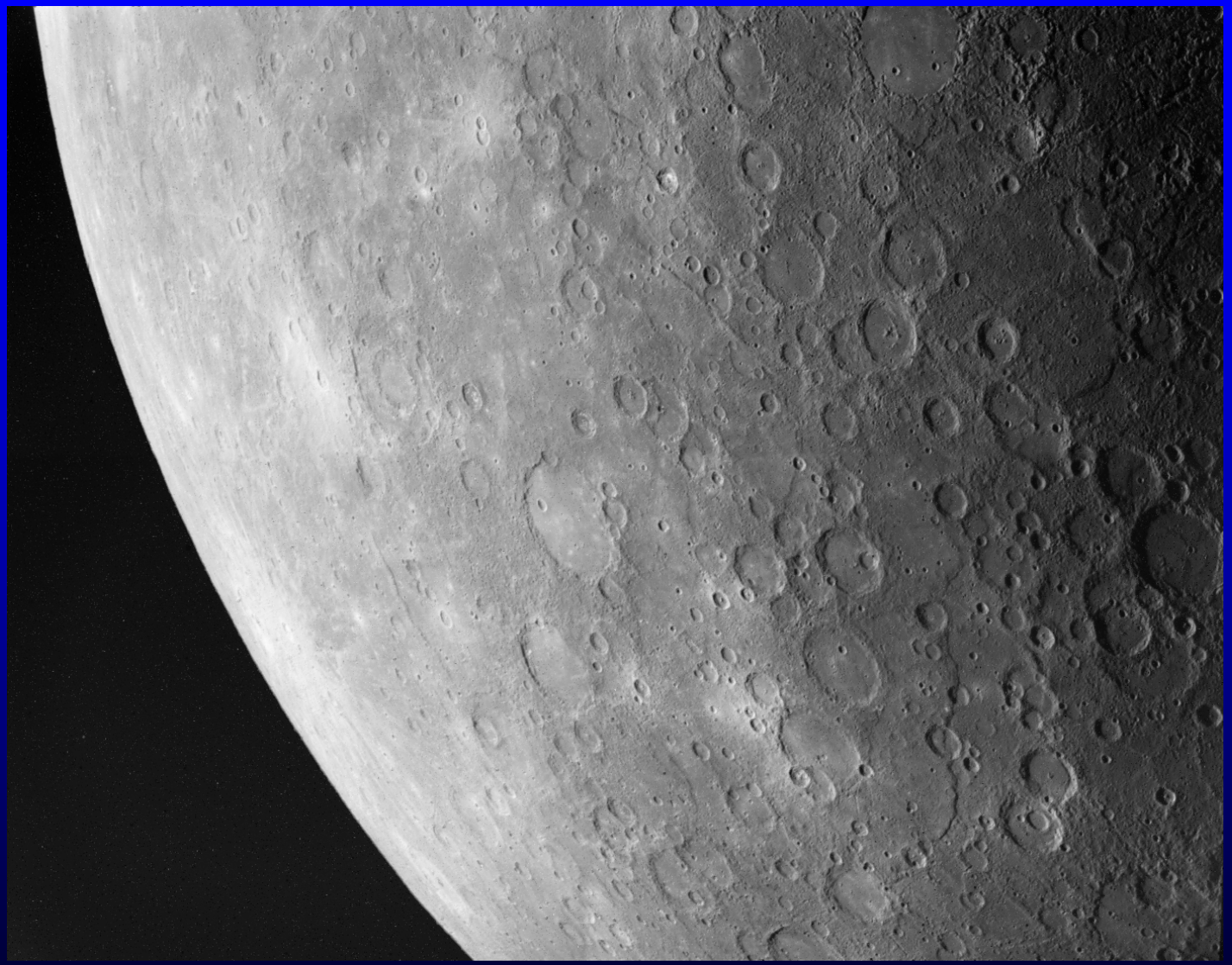


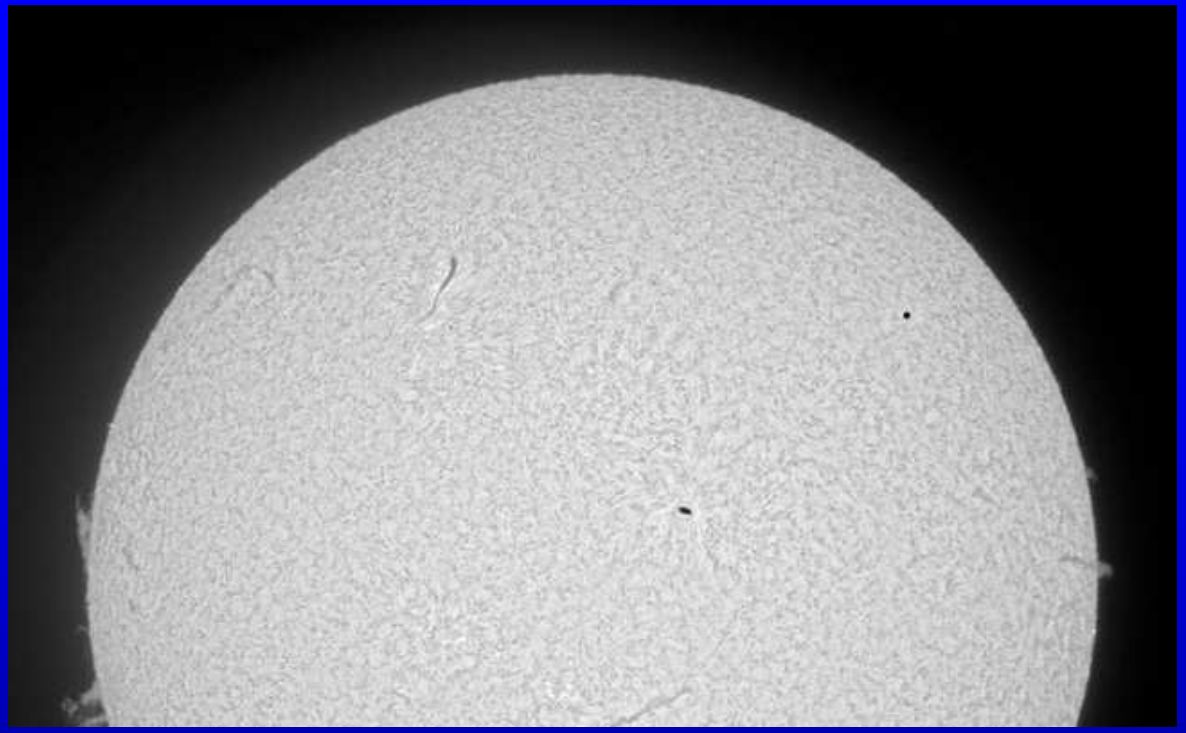
Nearest rocky planet to the Sun. Small, with no moons, it is virtually devoid of any atmosphere

Only ever visited by Mariner 10 spacecraft.

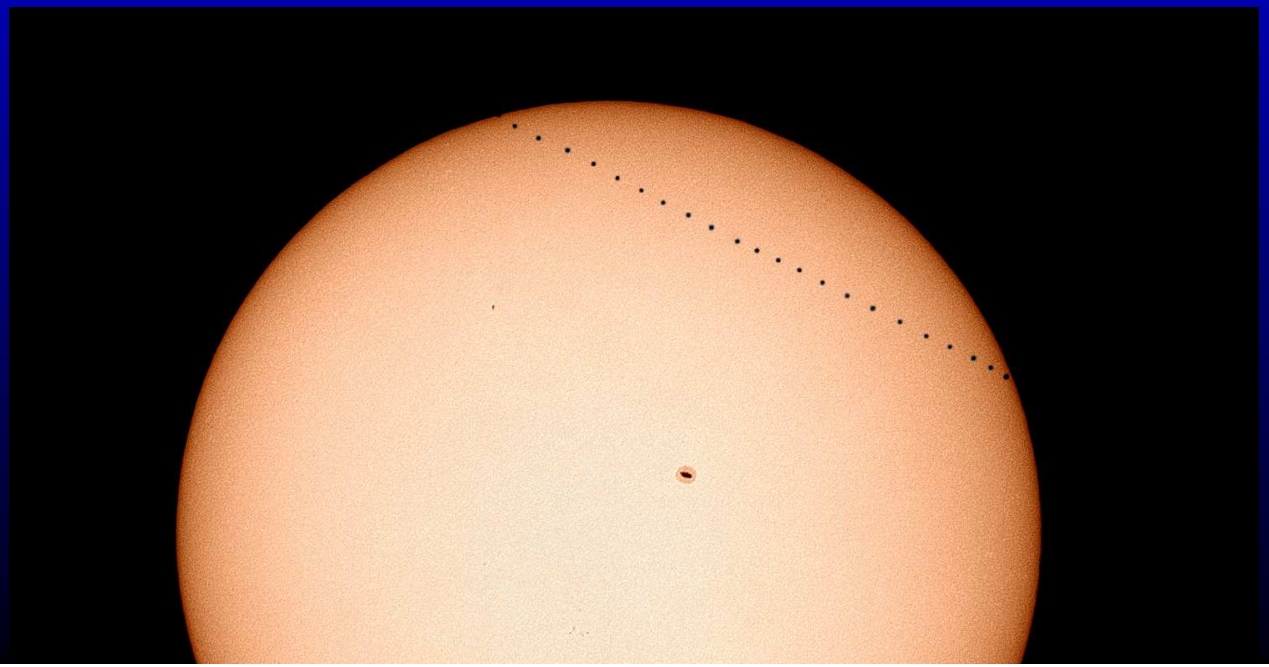
- A cratered surface very like the Moon

- Low Albedo
  - It reflects only 6% of the light falling on it





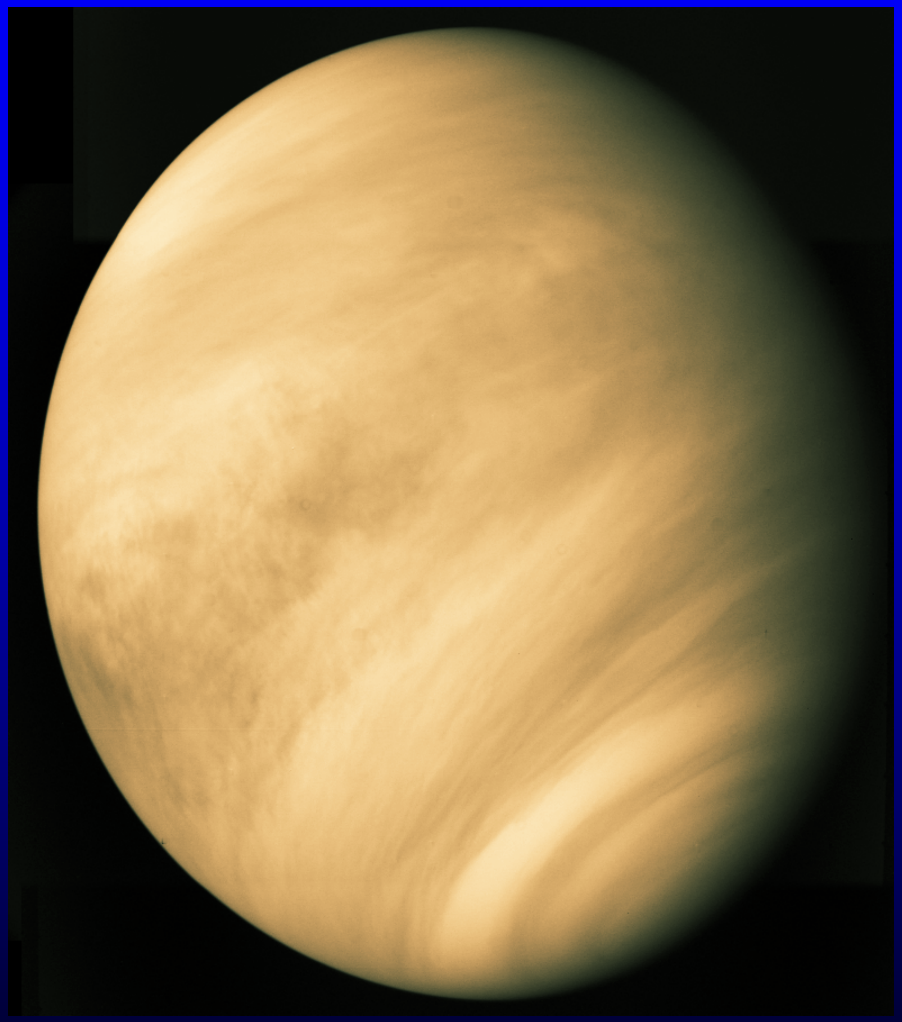
Transit of Mercury



Radar Observations

- Found that period of rotation was 58.64 Days – exactly 2/3 of the orbital period of 88 days, so it is gravitationally locked.

- Discovered ice deposits in craters near the poles where sunlight never reaches. Almost certainly deposited by the impact of comets which contain much water ice.



Venus

Atmospheric Pressure 90x that of Earth!

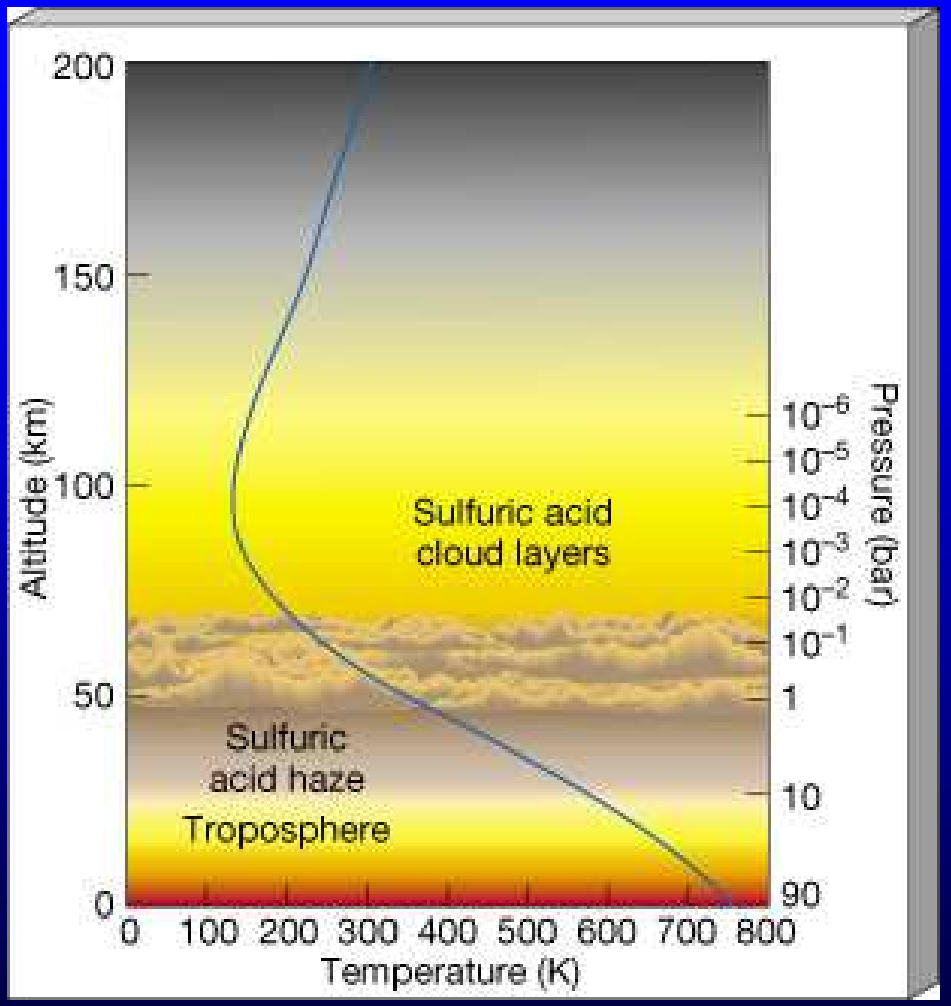
96% $C0_2$,4% N_2 ,1% O_2

Runaway greenhouse effect from CO_2

surface temperature = 500 C!

Concentrated sulphuric acid rain!

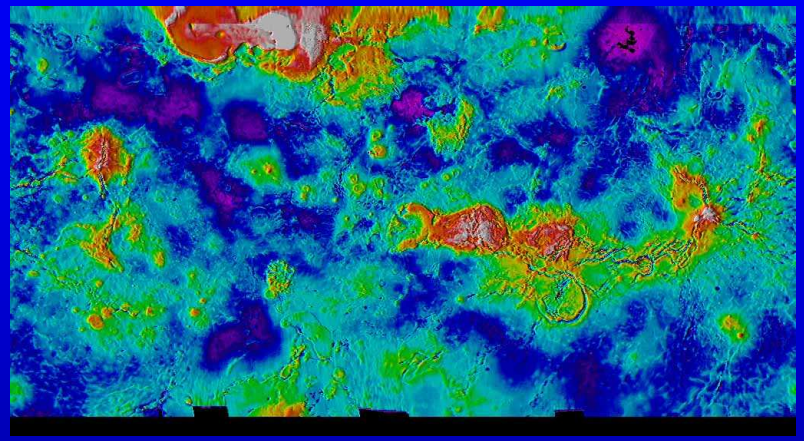
Venusian Atmosphere

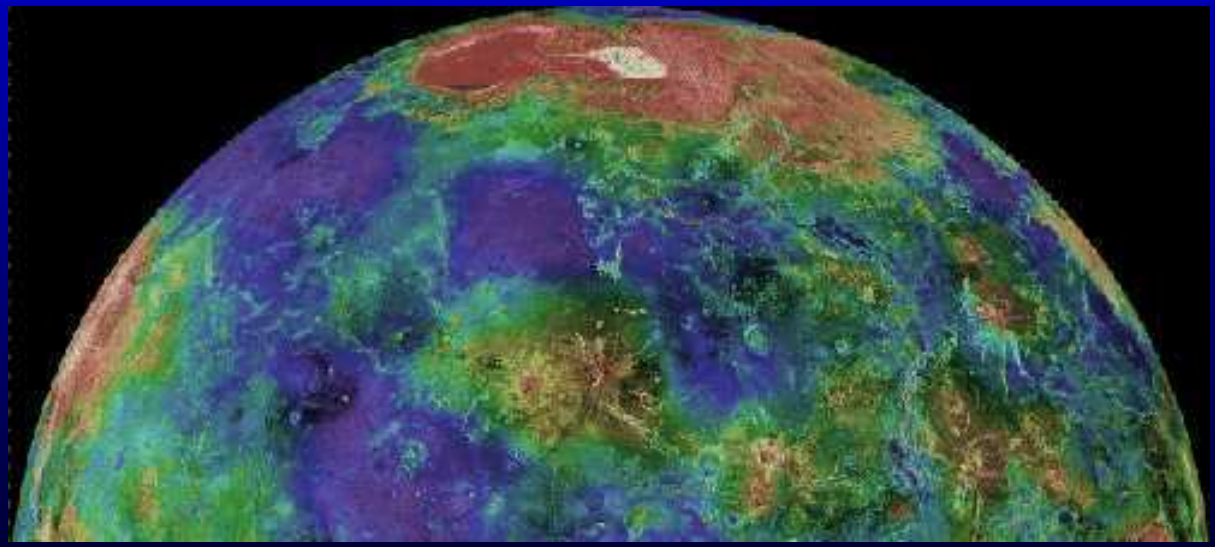


Radar Studies of Venus

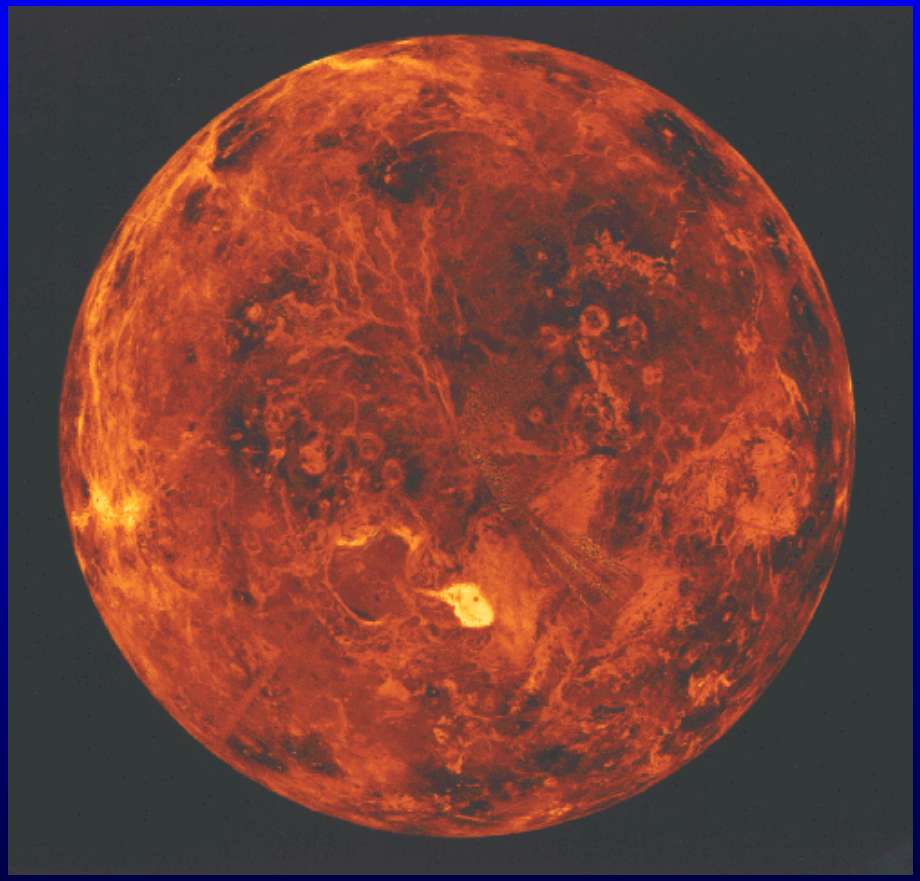
- Showed that Venus rotates once every 243 days RETROGRADE – i.e., in the opposite direction to its orbital motion.

- Radar images of the surface have been made from the Earth and orbiting satellites.

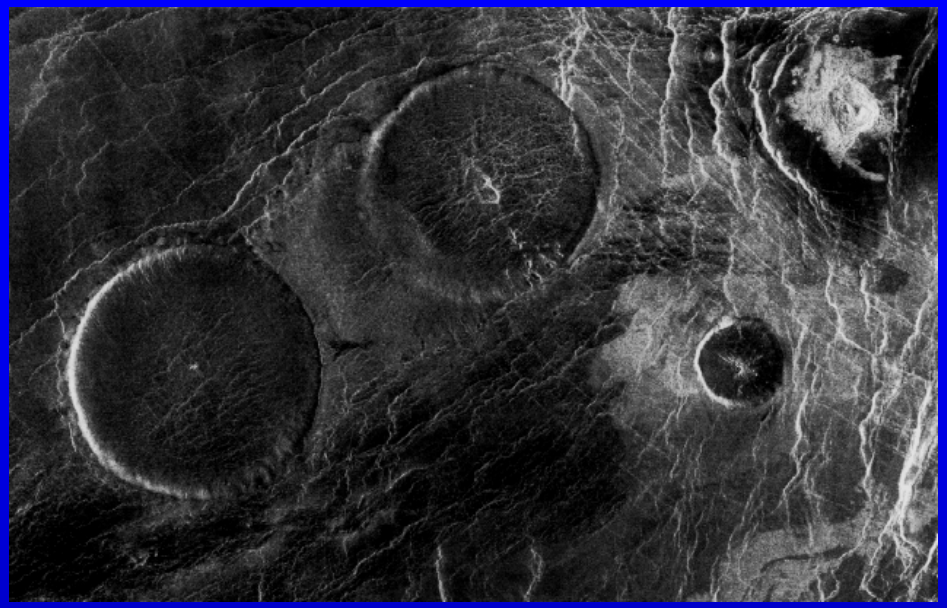


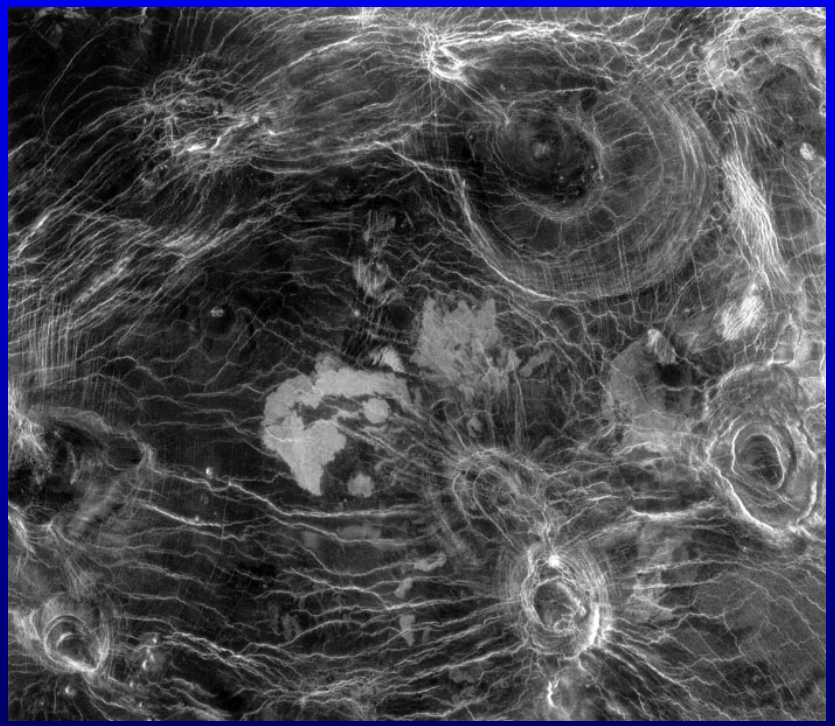


Imaged by Radar from the Magellan Spacecraft



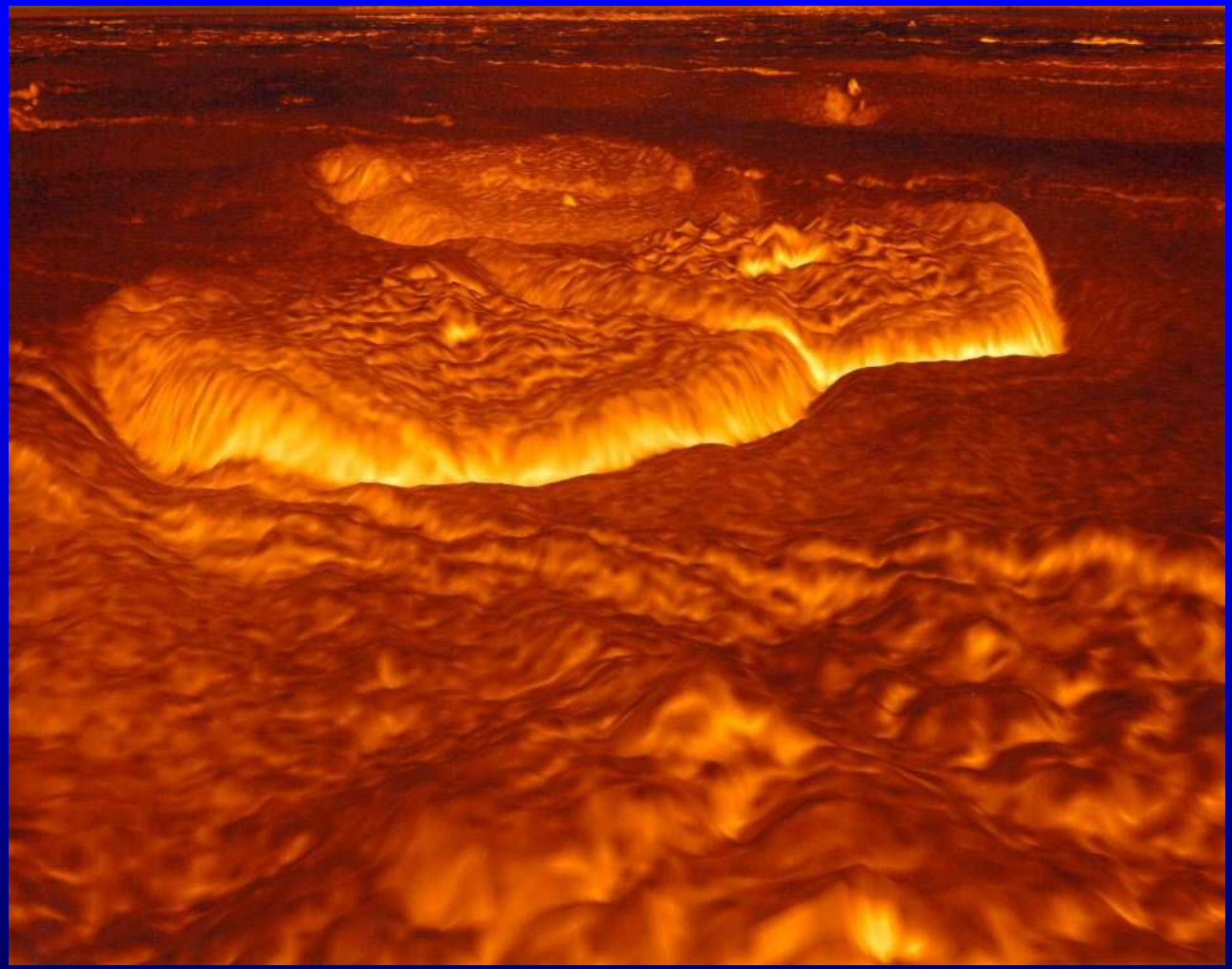
Surface



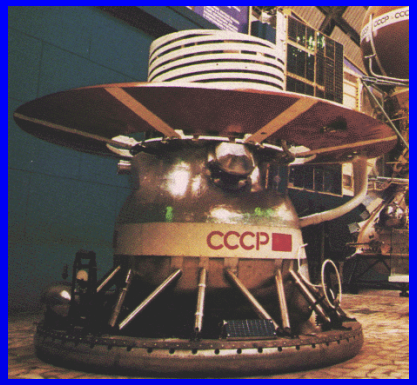


Plenty of big craters, small ones only in clusters – only large meteorites reach the surface

Big volcanic calderas – but no current tectonic activity



Volcanic domes



Russian Spacecraft have landed on the surface

Massive spasmodic effusive volcanic outflows replace the surface

(1982)

The Earth and Moon

The Earth-Moon System

Moon

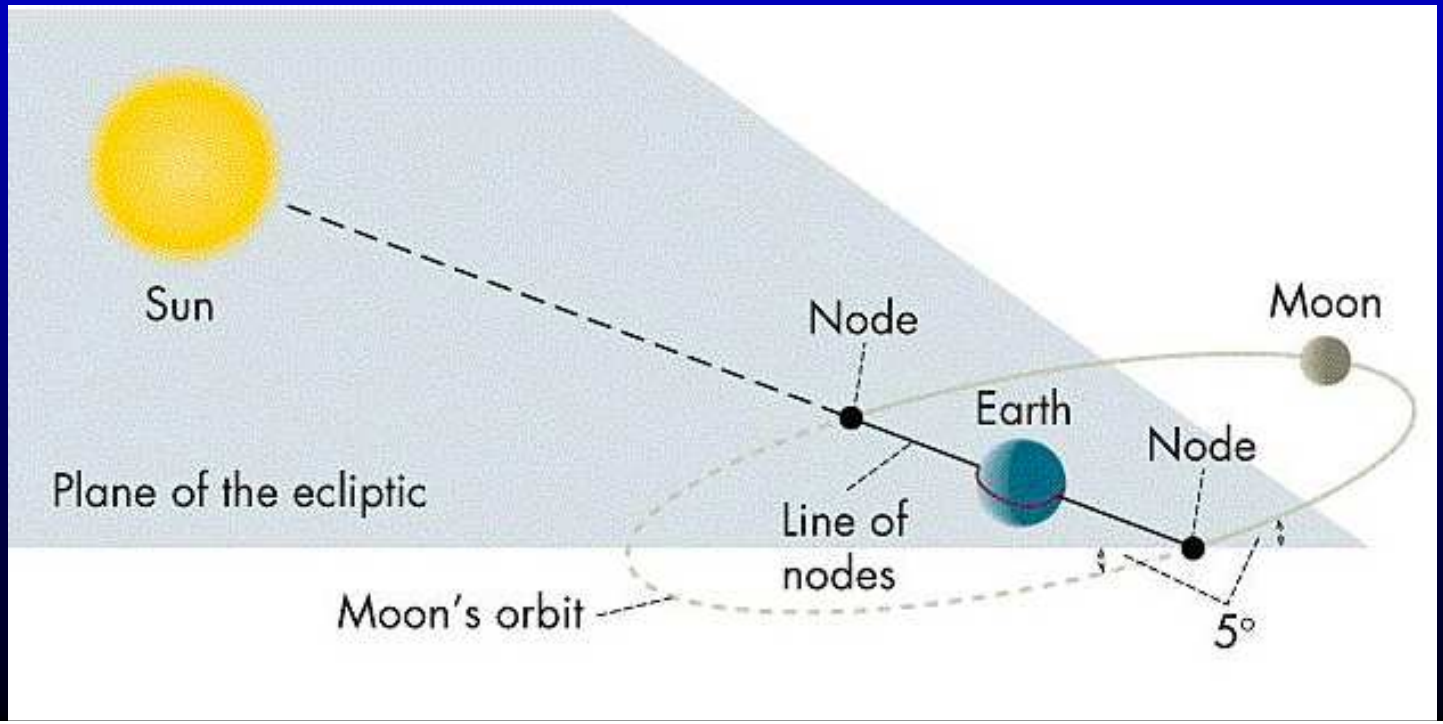
- The Moon orbits the Earth every 27 and 1/3 days. The Sidereal revolution period.
- But, as the Earth is orbiting the Sun, the same phase of the Moon repeats after 29 and ½ days. The Synodic revolution period.


Lunar Eclipse 3/4 April 1996
© Copyright 1996, Daniel Cave
Email: dancave@dial.pipex.com

Lunar Eclipse

Why not every month?

- The Moon's Orbit is inclined by 5 degrees to the plane of the Earth's orbit.
- So at Full Moon it is usually above or below the Earth's shadow.



Is The Earth-Moon System Unusual ?

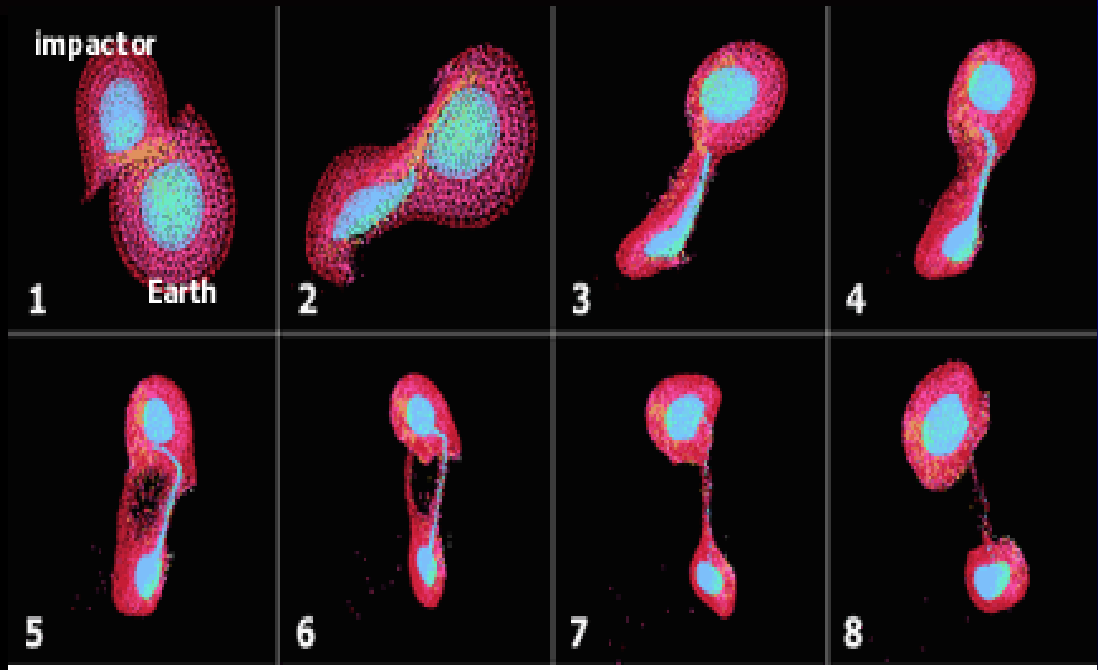
Tidal forces keep the Earth and Moon cores hot and molten

As it spirals away, the Moon comes into co-rotation and cools – same face is then locked to the Earth

Thought to originate from a giant impact

The Moon is spiralling away from the Earth (distance increasing by 4cm/year)

The Earth rotation is slowing but core is still kept hot by radio active decay and lunar tides



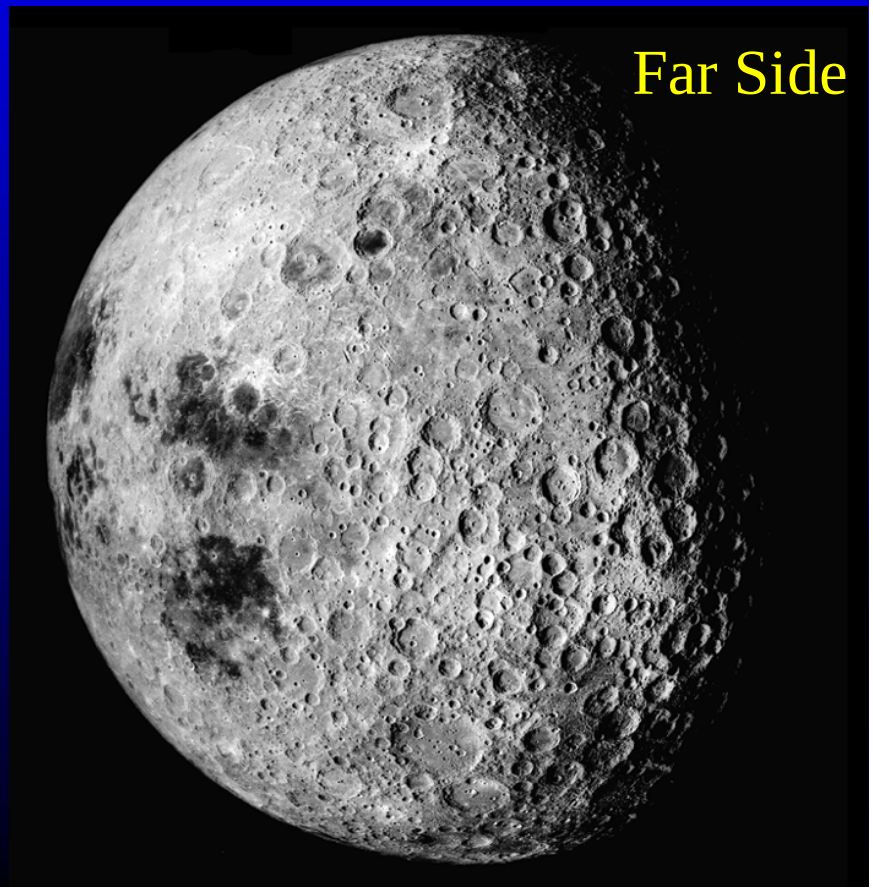
(Courtesy of A. G. W. Cameron, Harvard College Observatory.)

Near Side

The Earth-Moon System

Initial volcanic flows cover the surface of the Moon (Mare). After co-rotation the Moon cooled and the unsheltered far side was heavily bombarded completely covering the mare with impact craters. The Earth protected the near side so the mare are still visible

Far Side



The Origin of life - on Earth

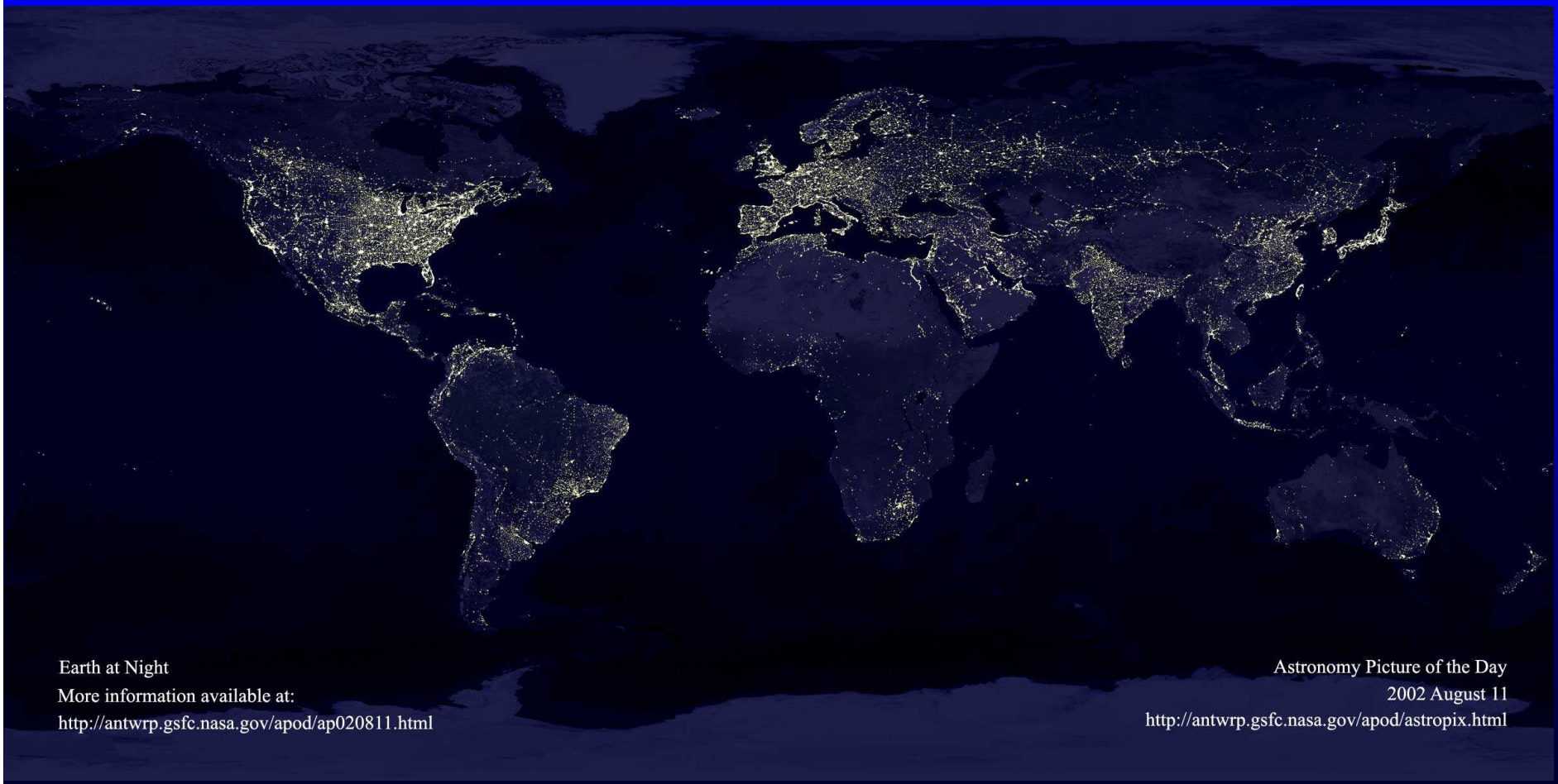
The early primordial atmosphere is swept away by the Solar wind

Life results from action of surface chemistry under the appropriate range of physical conditions

Geologically very active, volcanic emissions replace the original atmosphere

Subsequently life modifies the atmosphere to produce large quantities of reactive Oxygen – very noticeable !

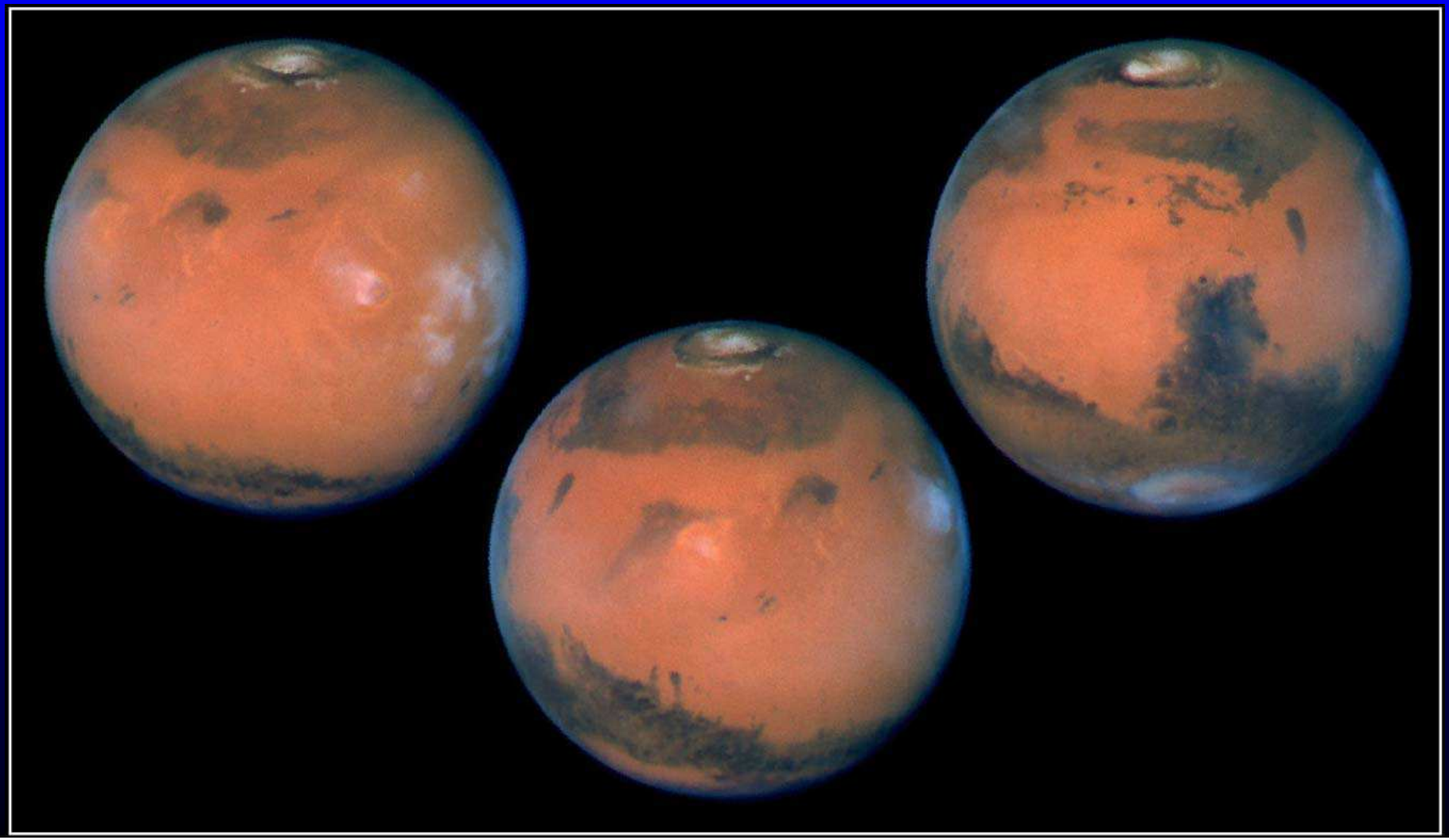
Earth at night

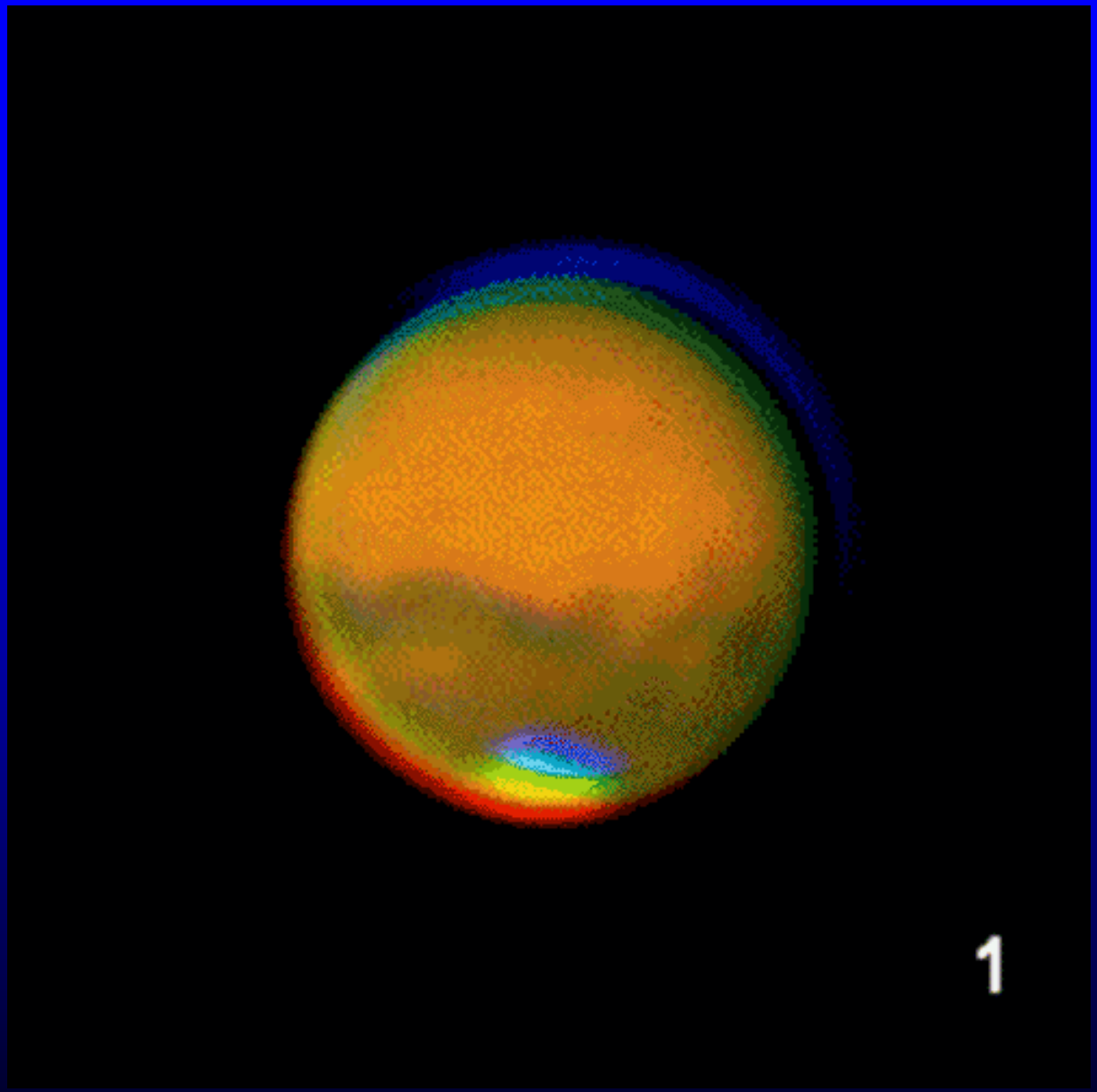


Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap020811.html

Astronomy Picture of the Day
2002 August 11
http://antwrp.gsfc.nasa.gov/apod/astropix.html

Mars

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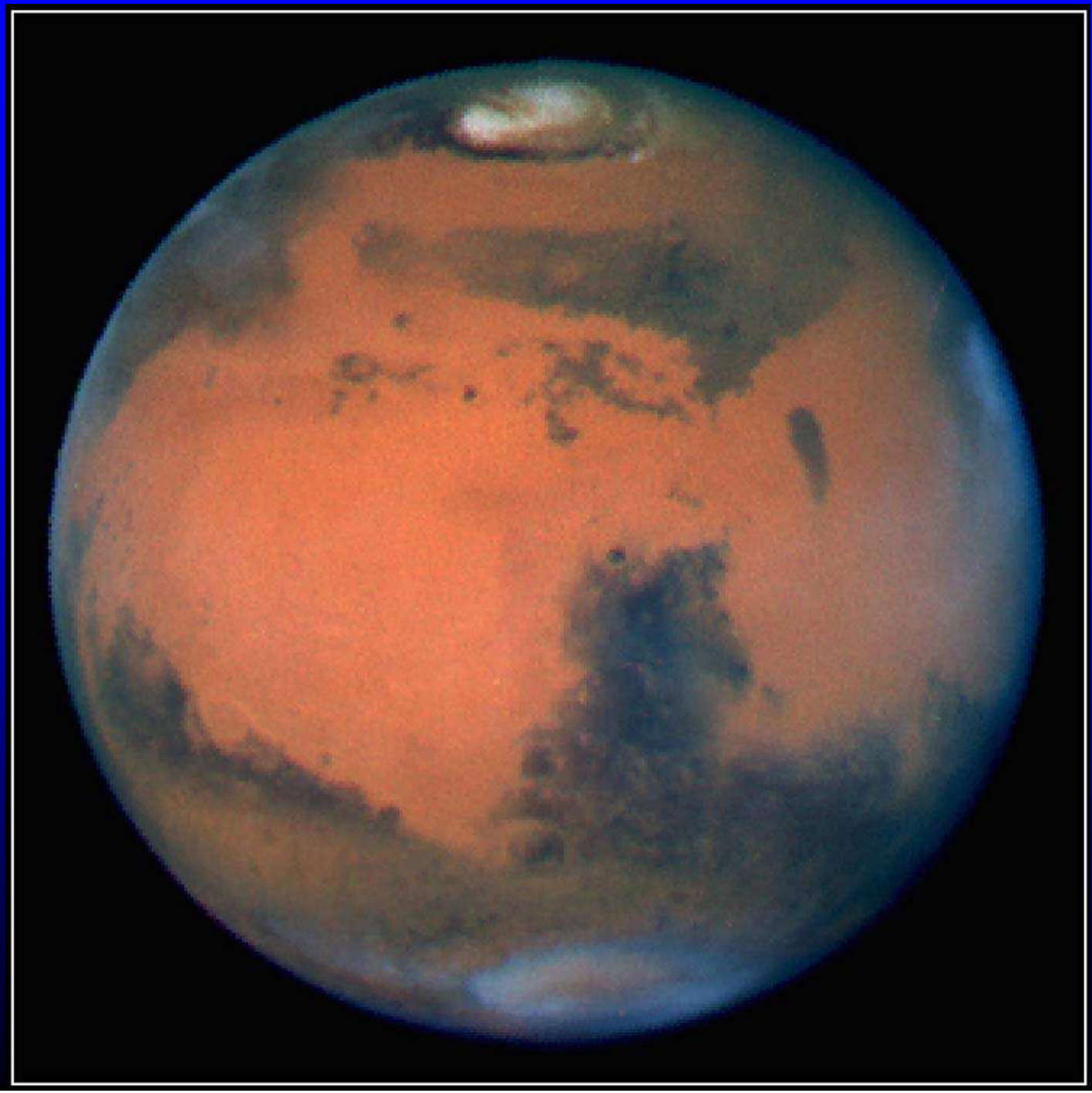
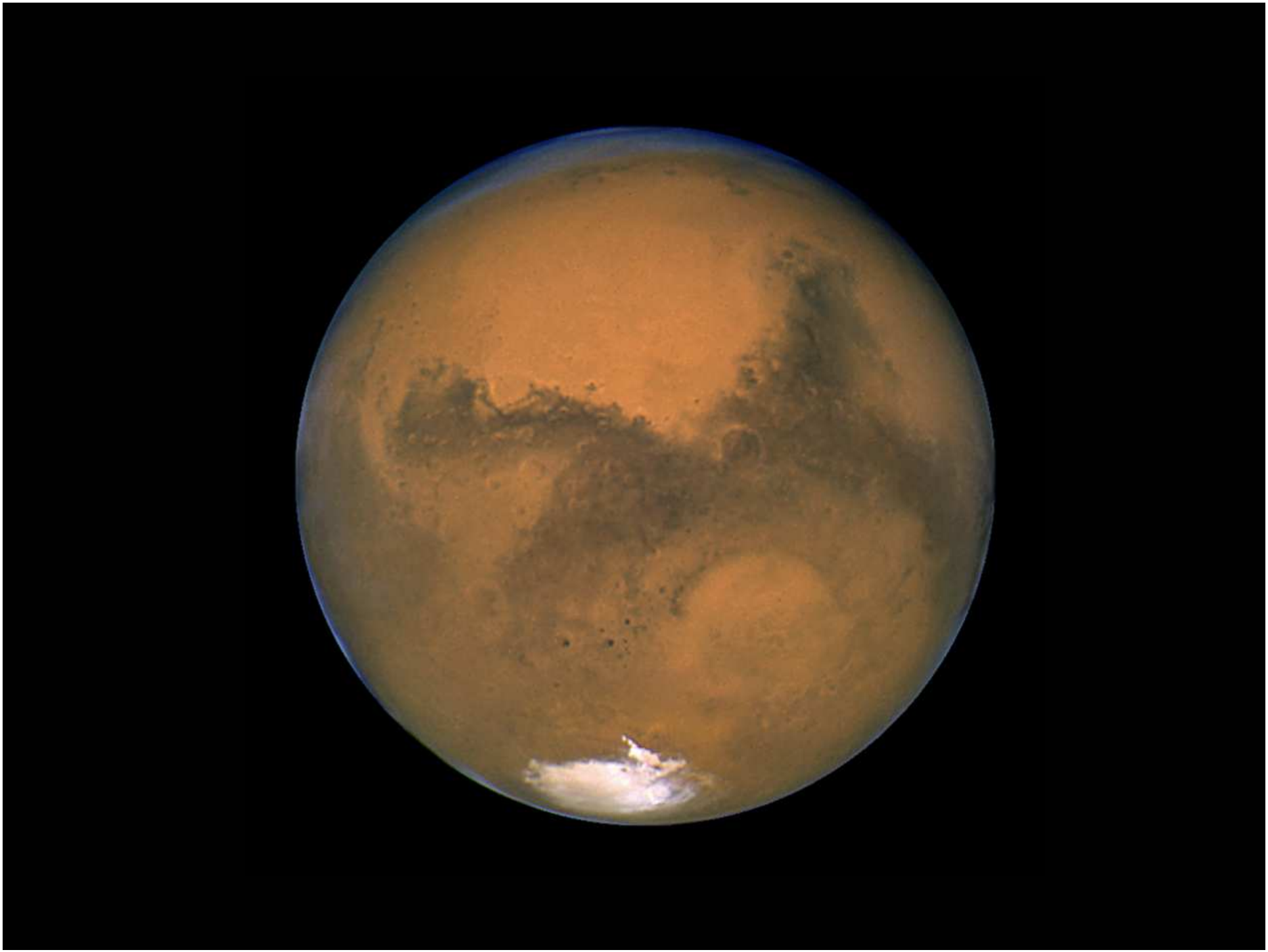
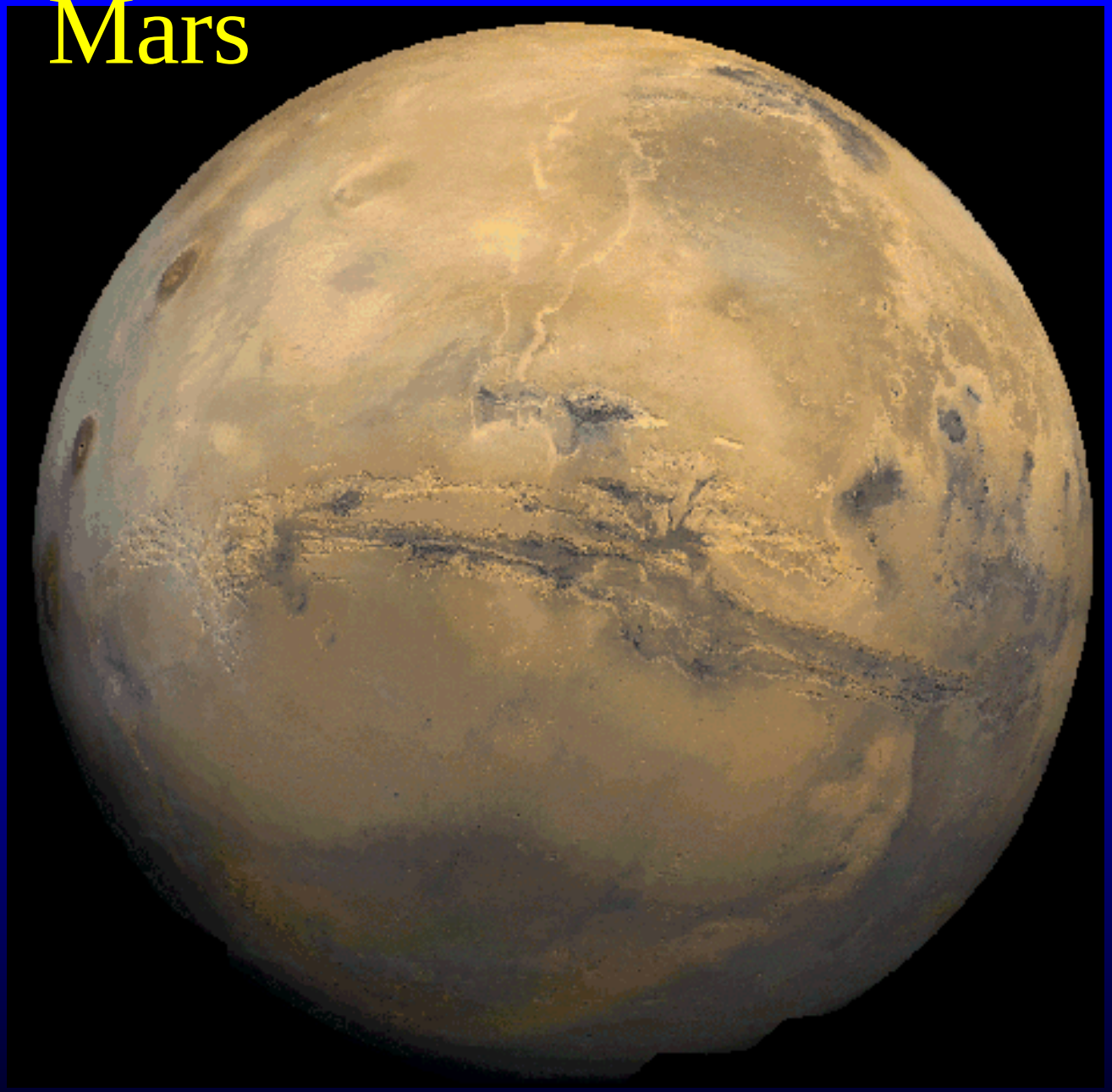




Mars



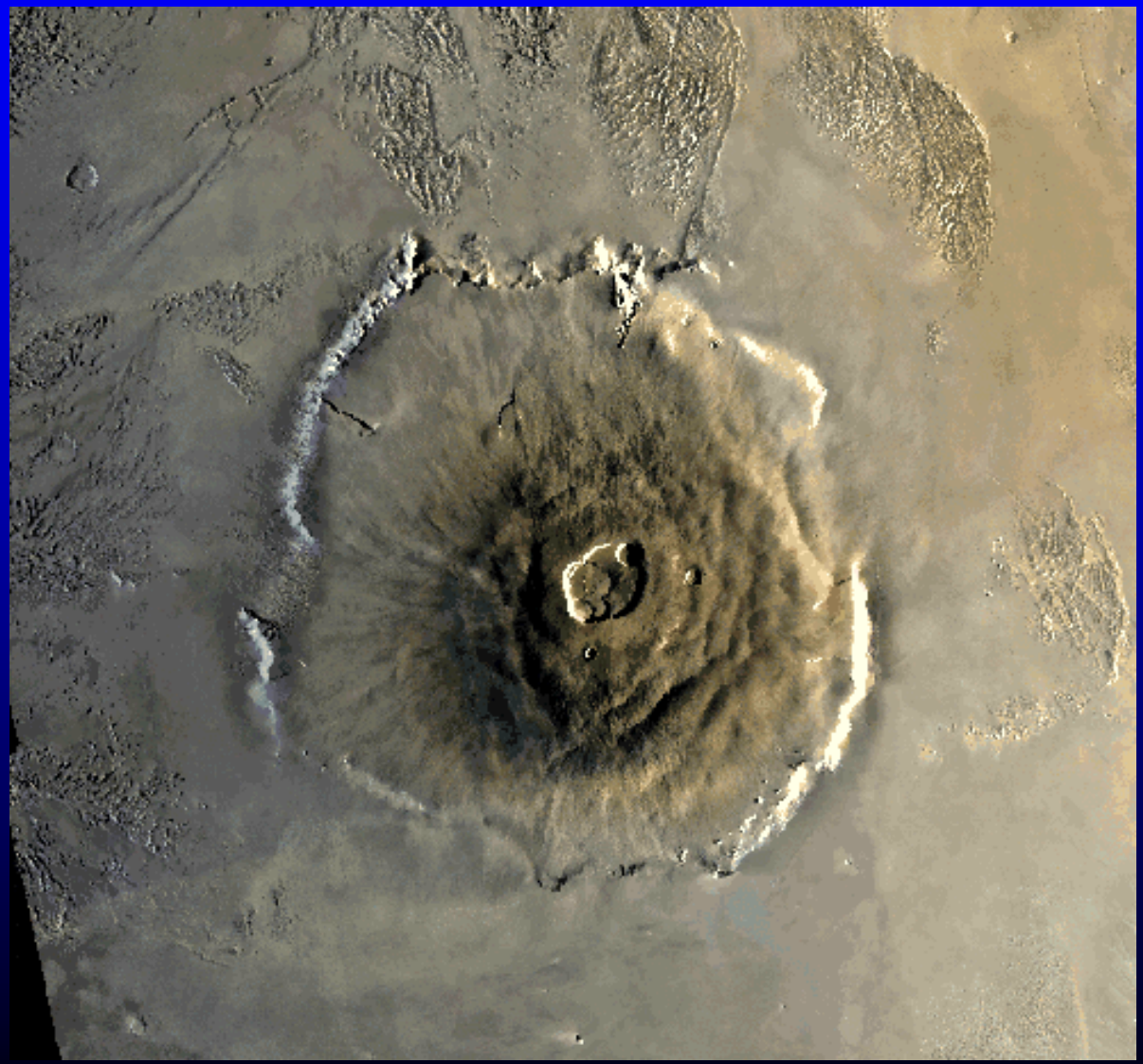
Very thin CO_2 atmosphere

Giant volcanoes, (not active)

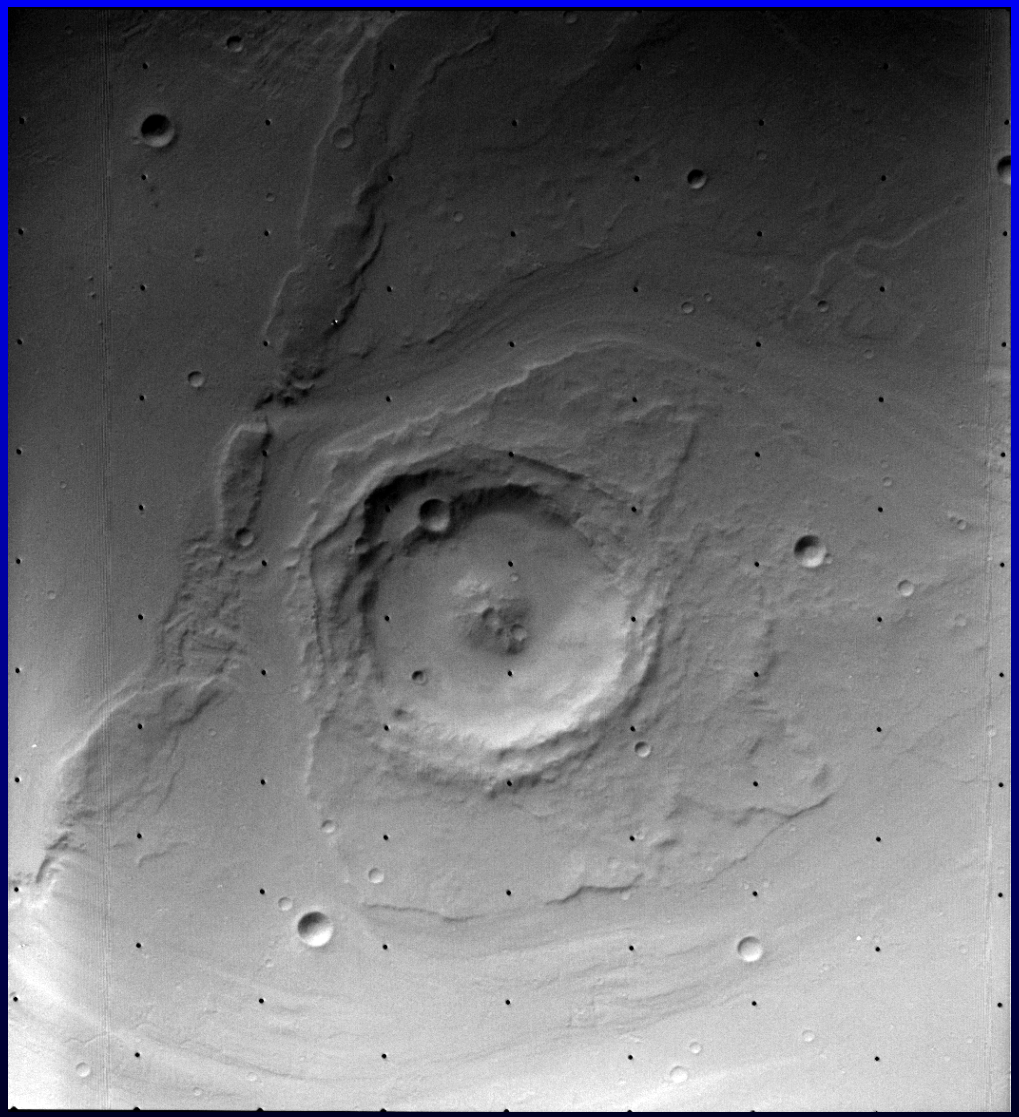
Craters

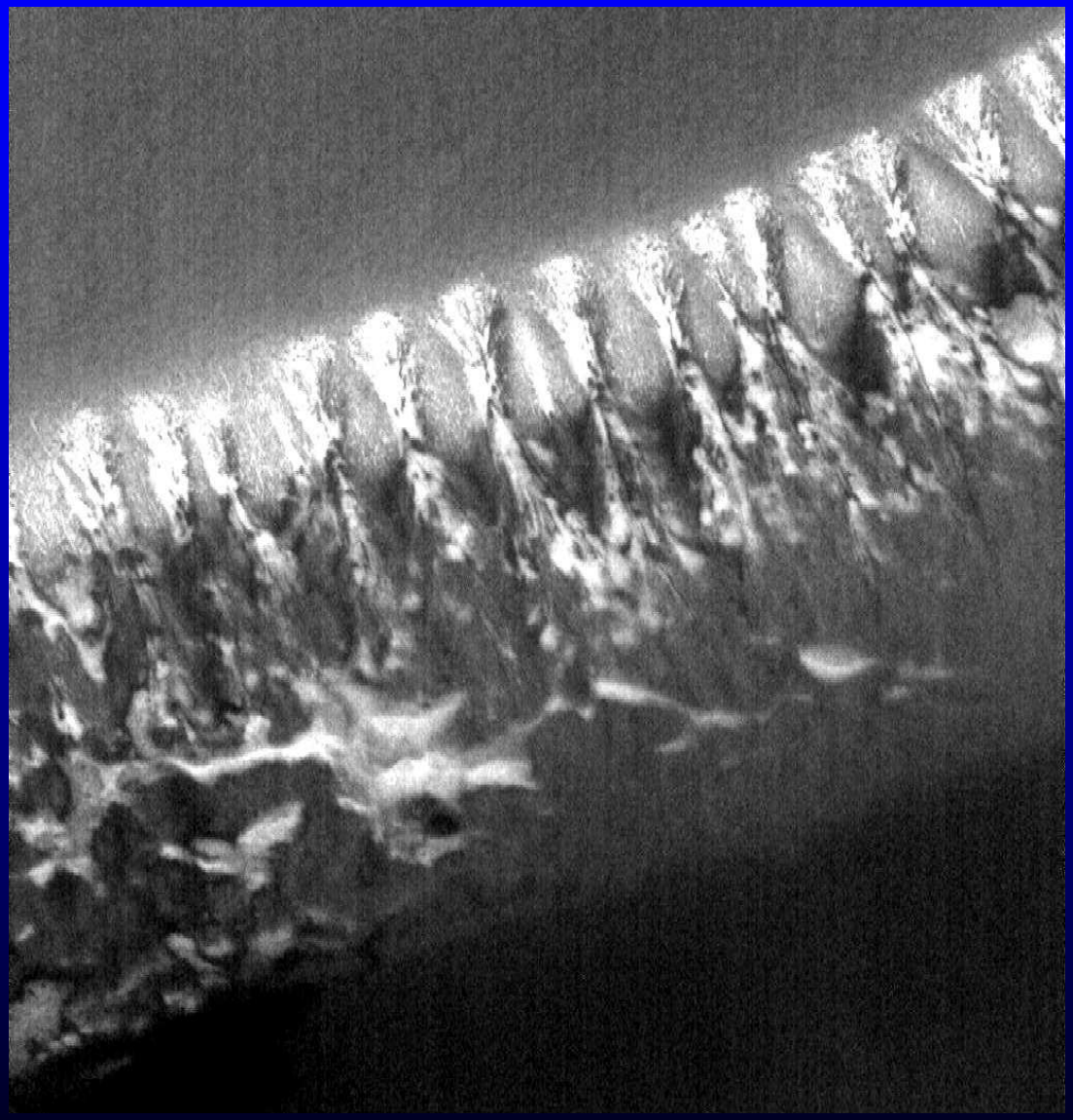
Giant Canyon – the Vallis Marineris

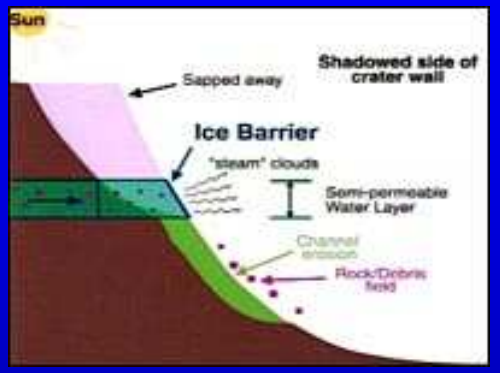
Olympus Mons

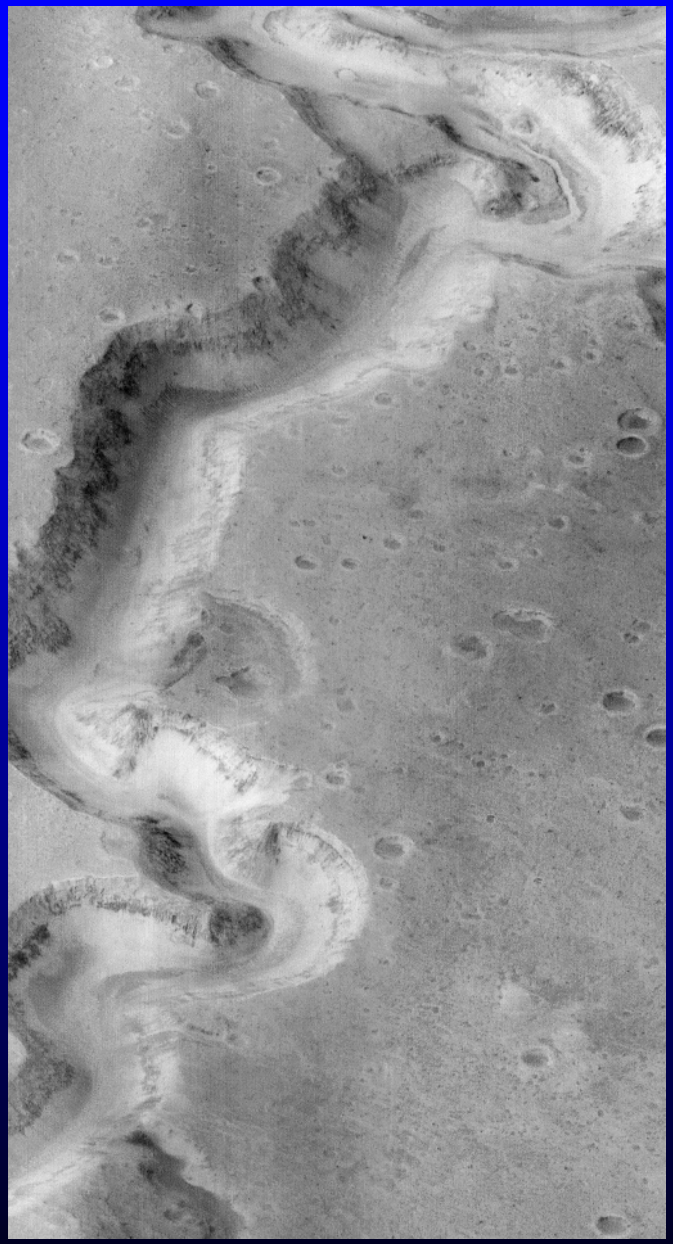


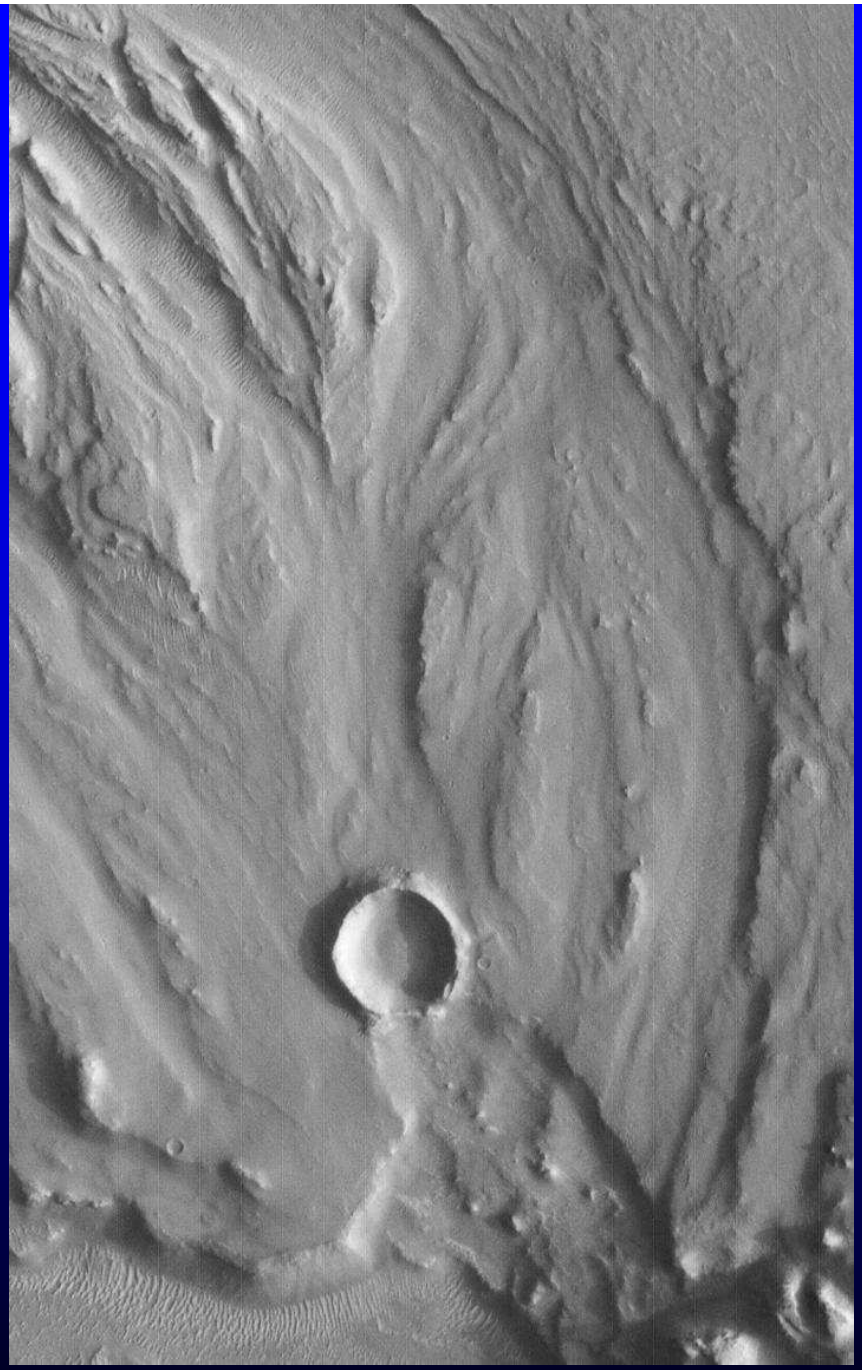
Evidence of Water Flow






Sun
Shadowed side of crater wall
Sapped away
Ice Barrier
"steam" clouds
Semi-permeable Water Layer
Channel erosion
Rock/Debris field

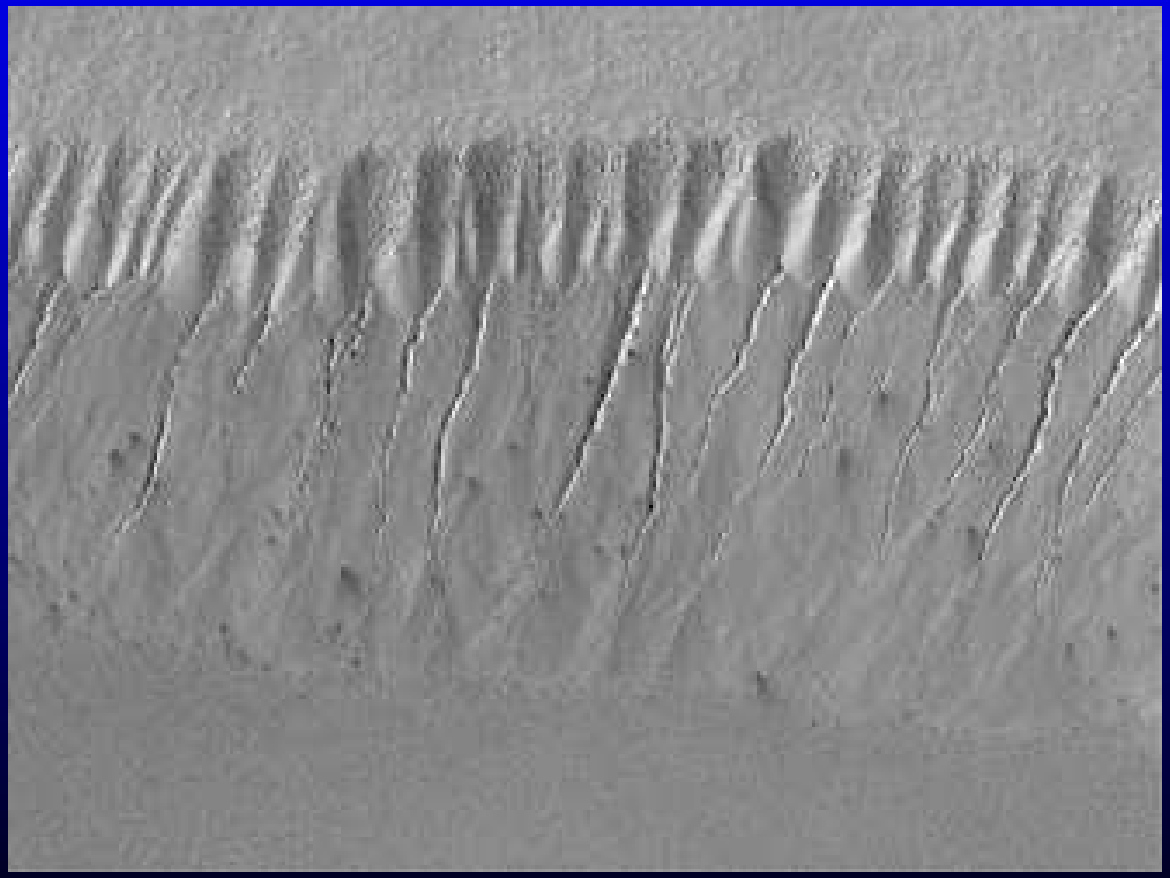




Clear evidence of plenty of liquid water on Mars in the past – implies a substantial atmosphere and seas some hundreds of millions of years ago.

Volcanic activity has ceased and atmosphere lost.

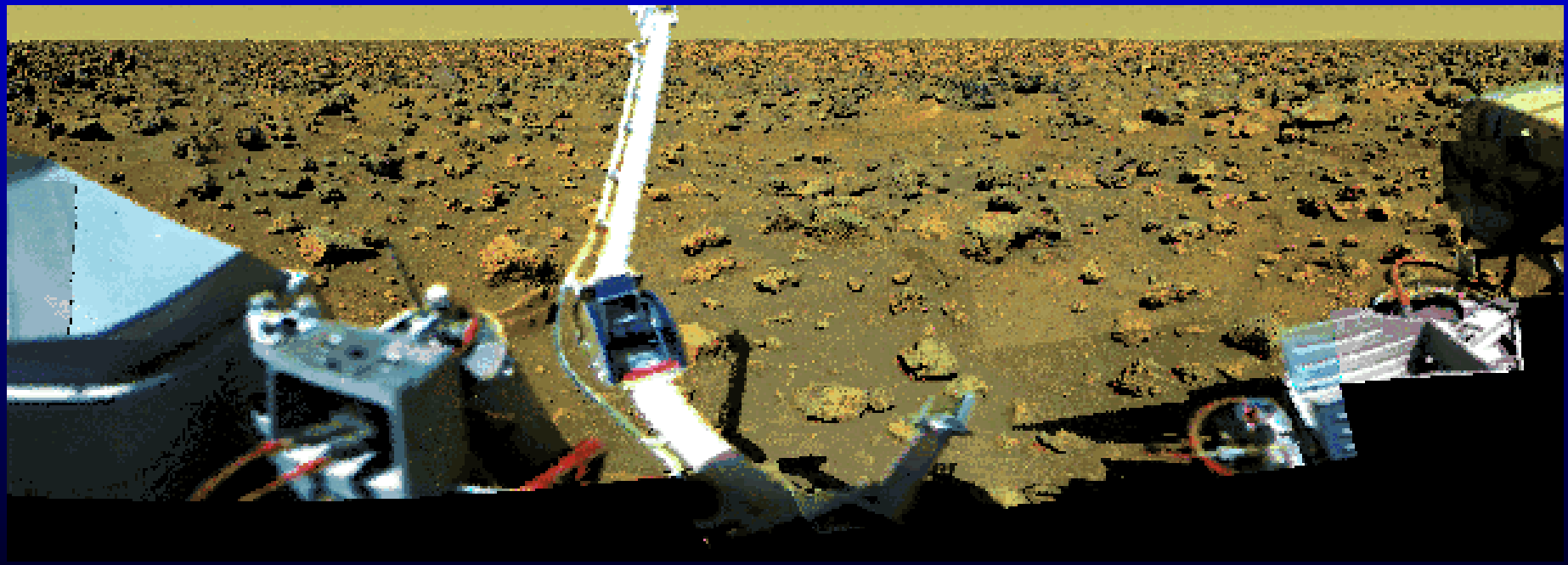
Current atmosphere contains less water than a large terrestrial lake. Water is in polar ice caps and permafrost under the surface – temporarily liberated by geological faulting or impacts.



Was there ever any life here ?

Viking on Mars

- Two Viking Spacecraft landed on Mars in 1976 to search for evidence of life.

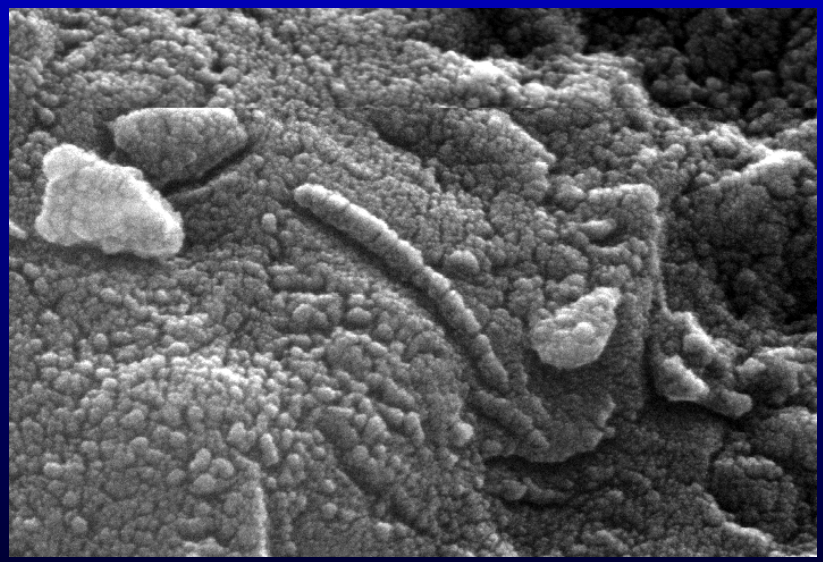


Meteorites from Mars

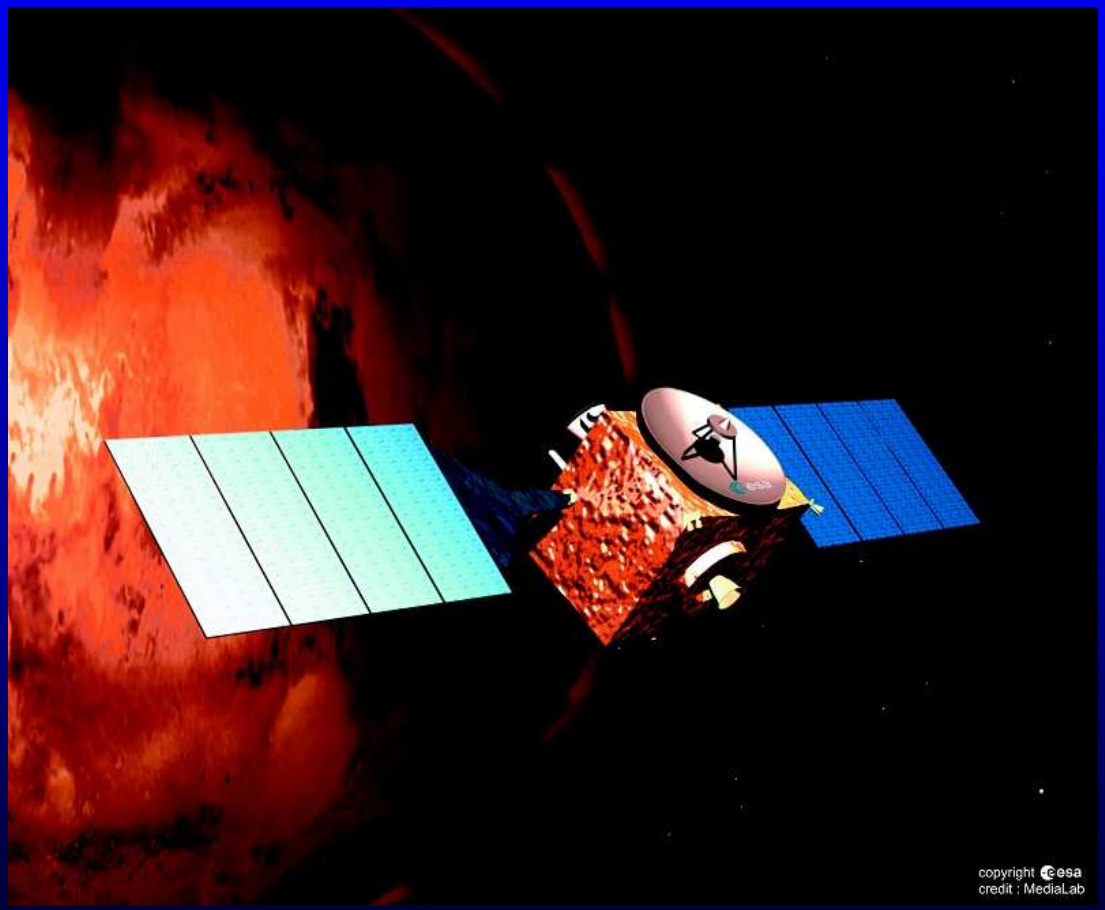
- We think that there are 13 known meteorites whose origin is Mars.
- These are now being investigated for possible signs of life.

ALH 84001

- NASA scientists believe that they have found residues of life and possible nano-fossils in ALH 84001.

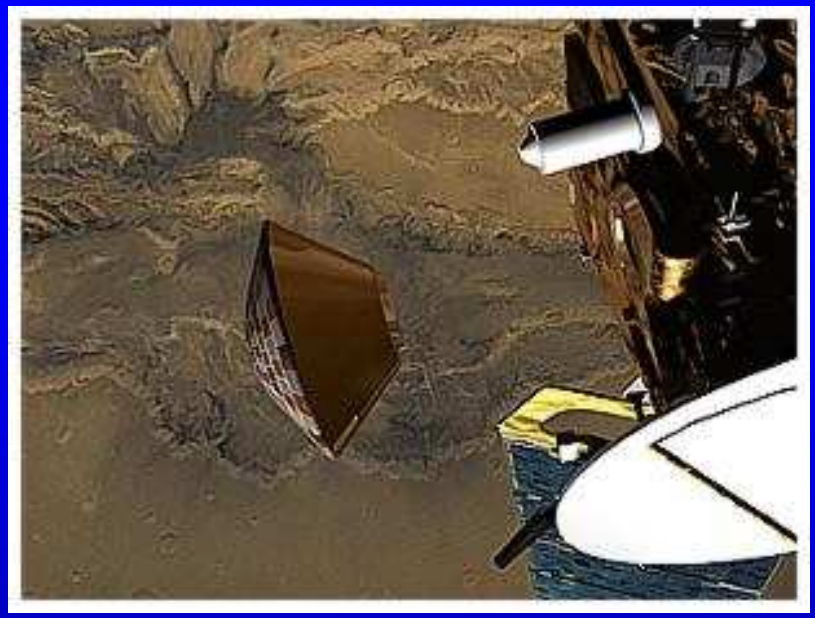


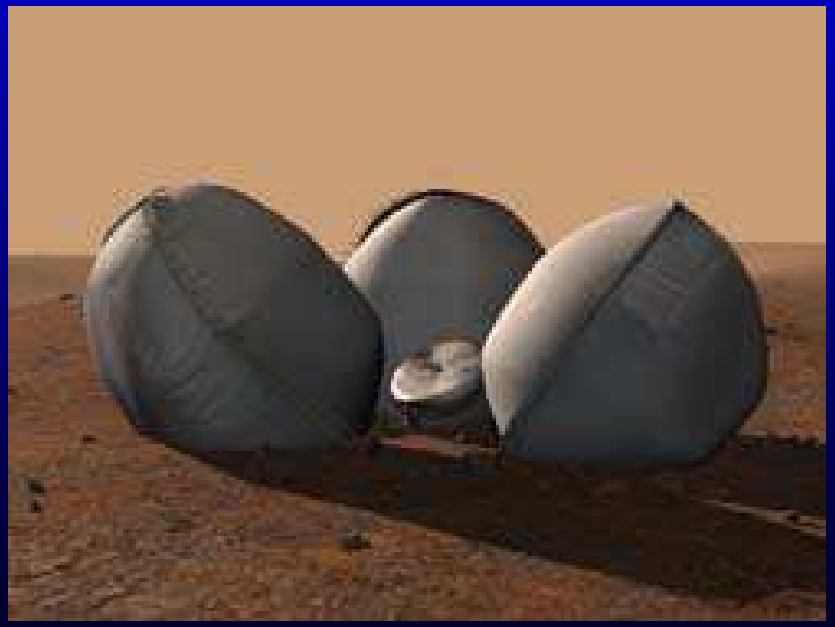
Mars Express



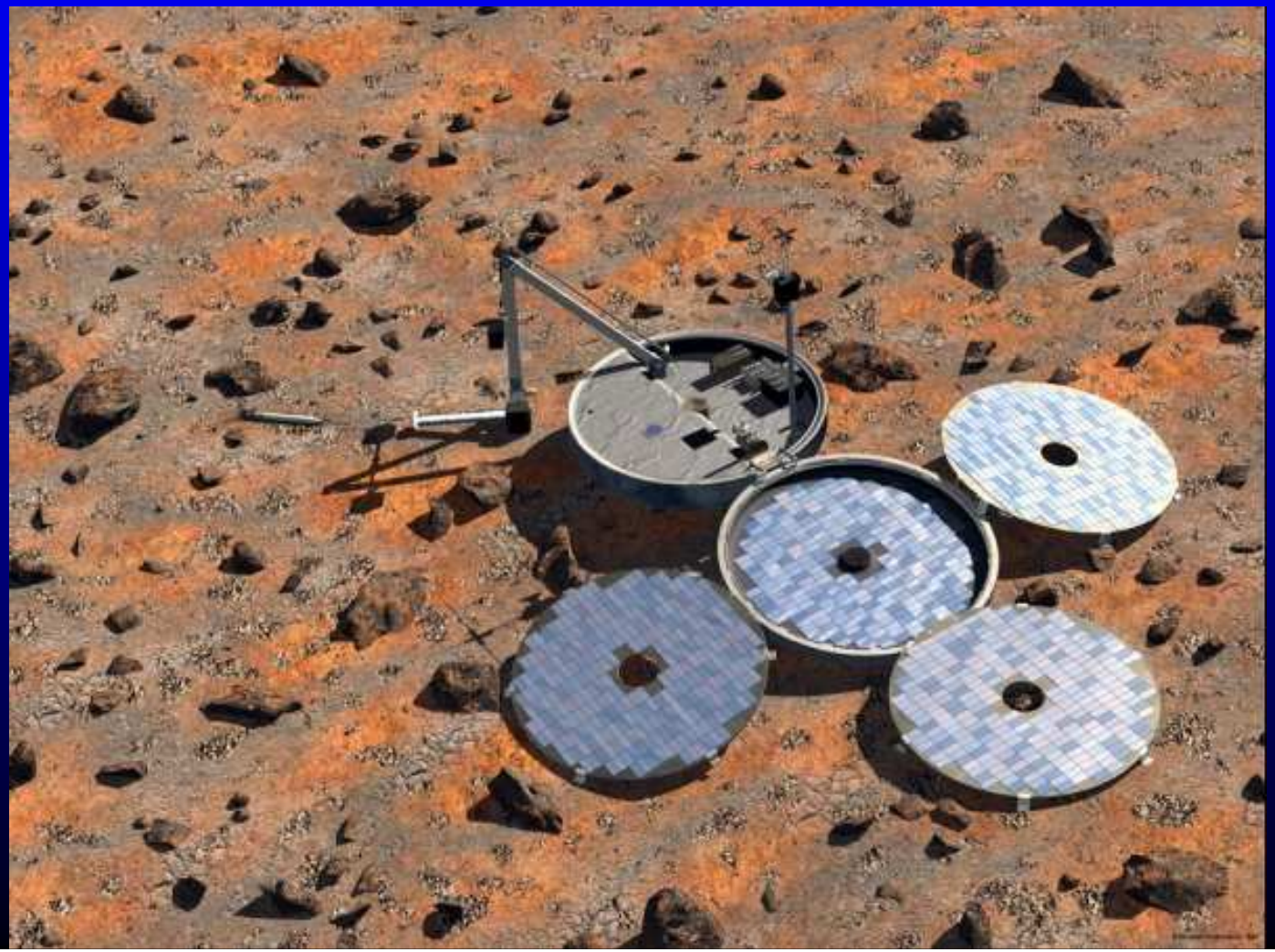
Will release a lander

- Beagle II



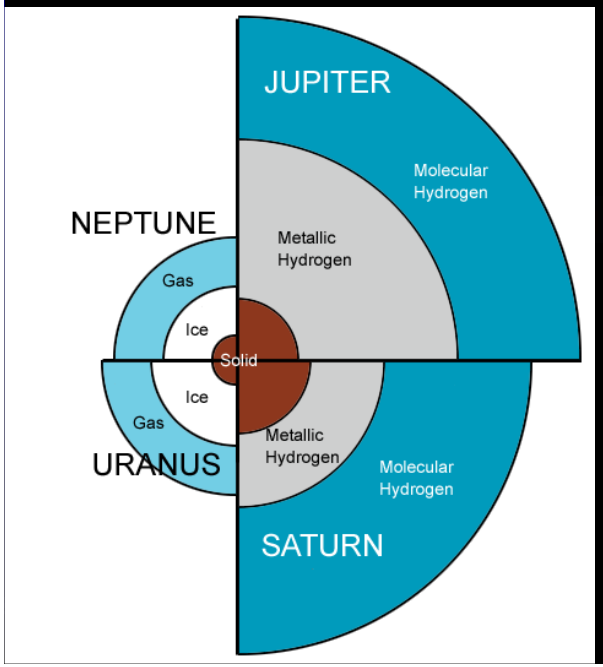


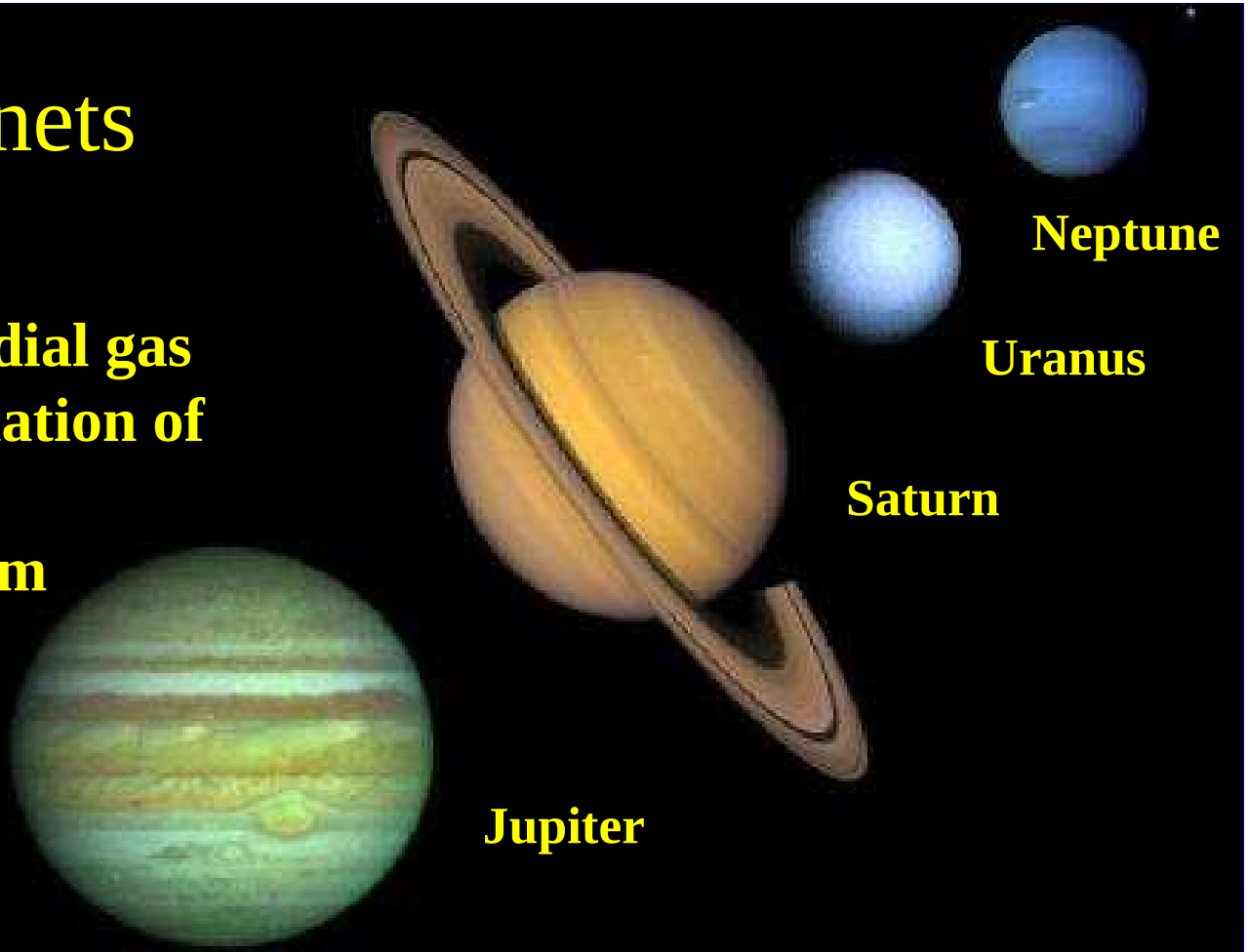
Beagle II will look for evidence of Life.



Outer Giant Planets

Solid cores deep inside surrounded by primordial gas left over from the formation of the Solar System
– Hydrogen and Helium





Neptune

Uranus

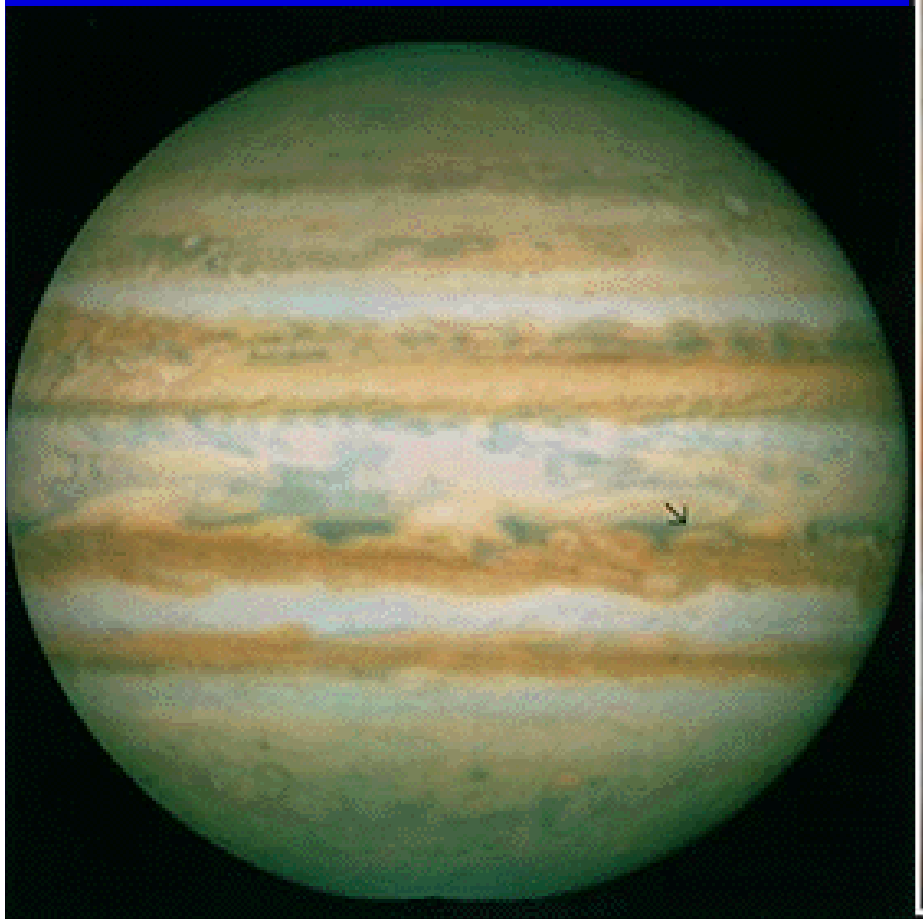
Saturn

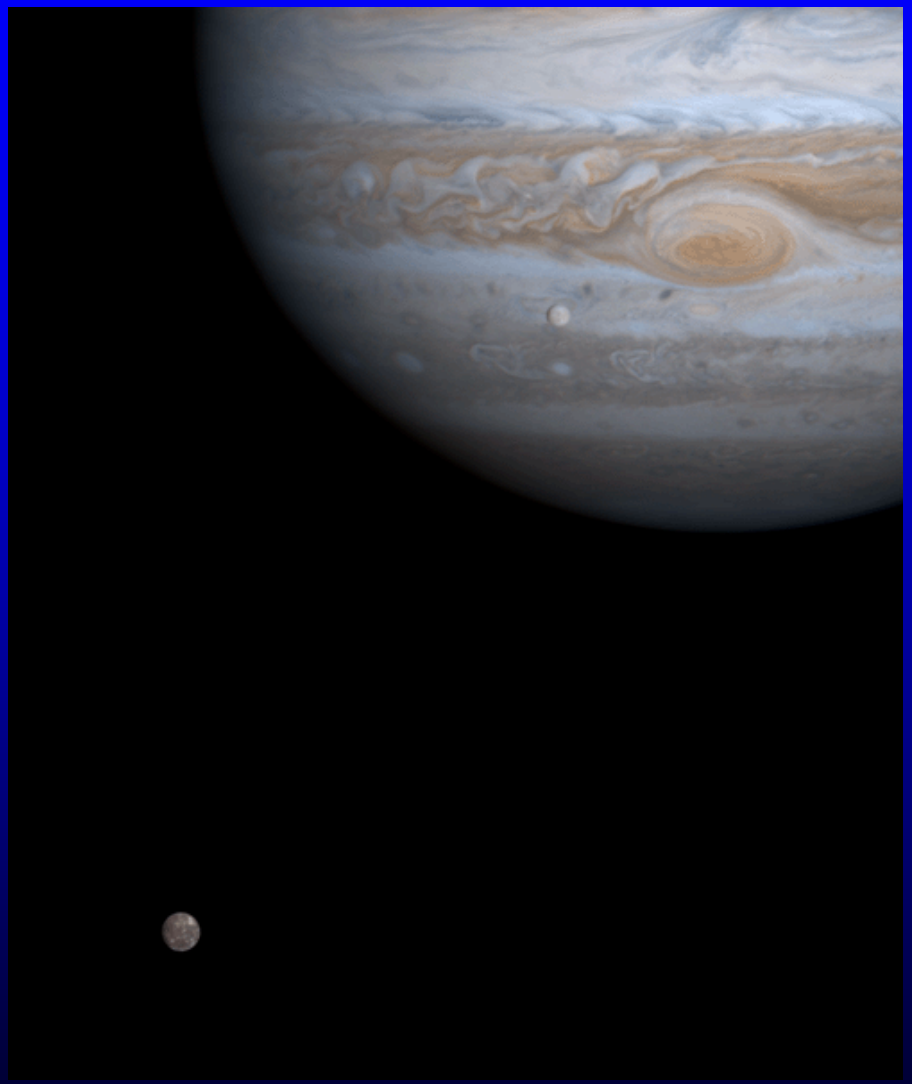
Jupiter

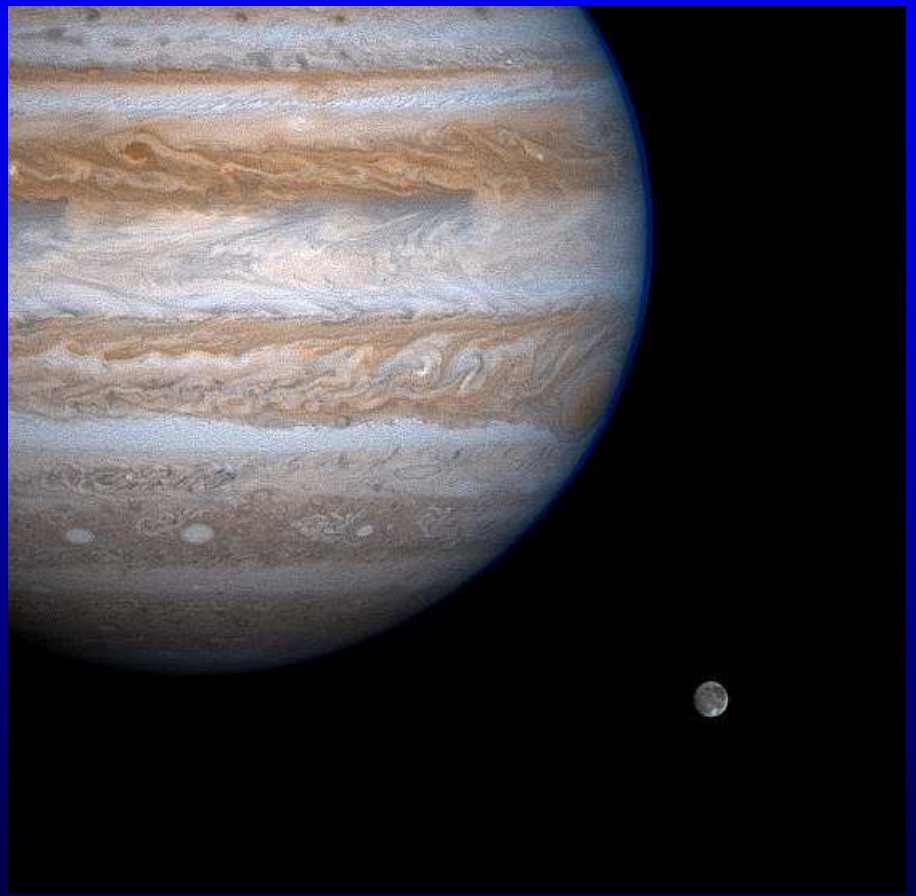
+ lots of interesting moons

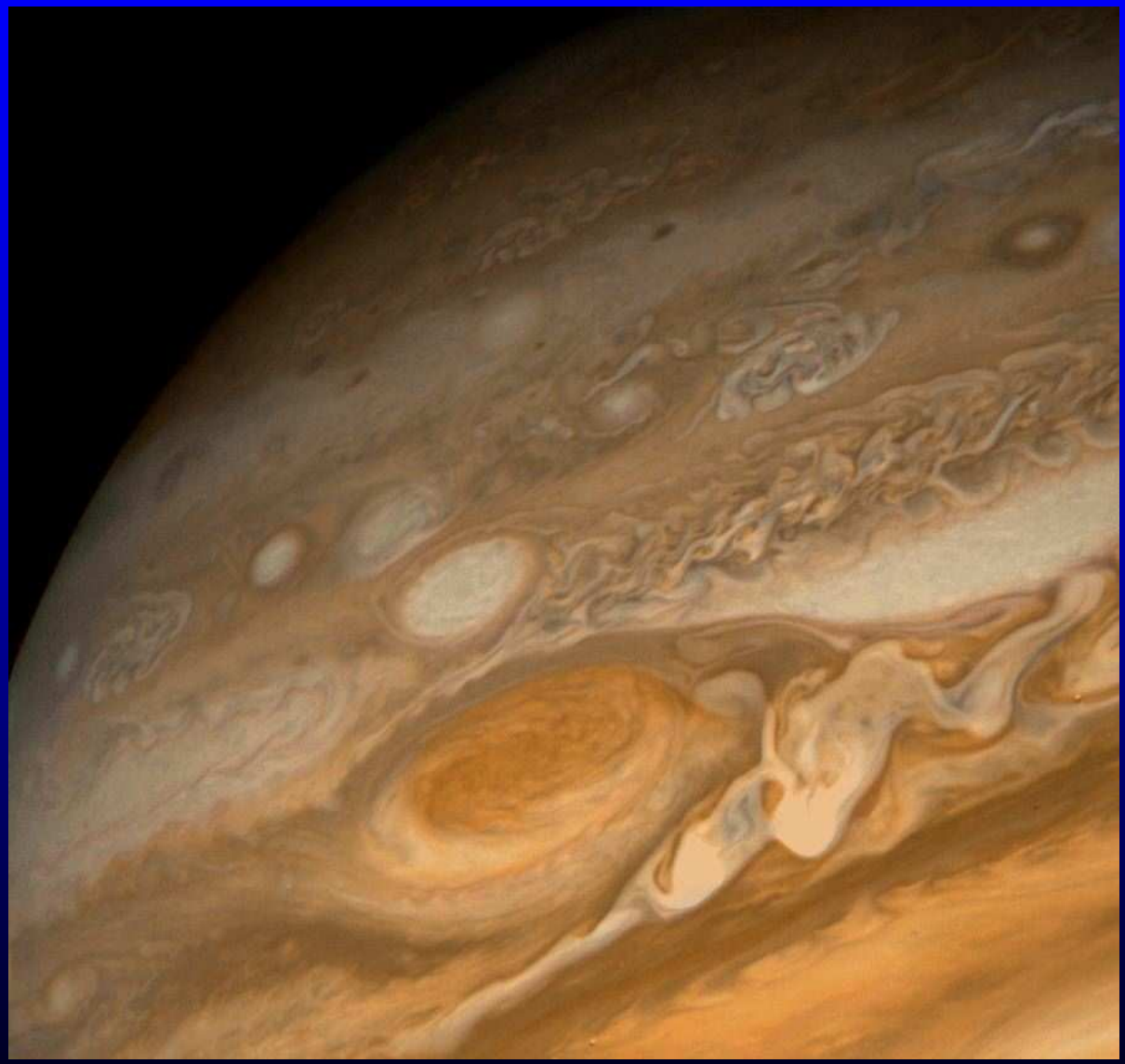
Jupiter

4 major moons – discovered by Galileo









Io – A Moon In Distress

Io orbits closer to Jupiter than the other moons.

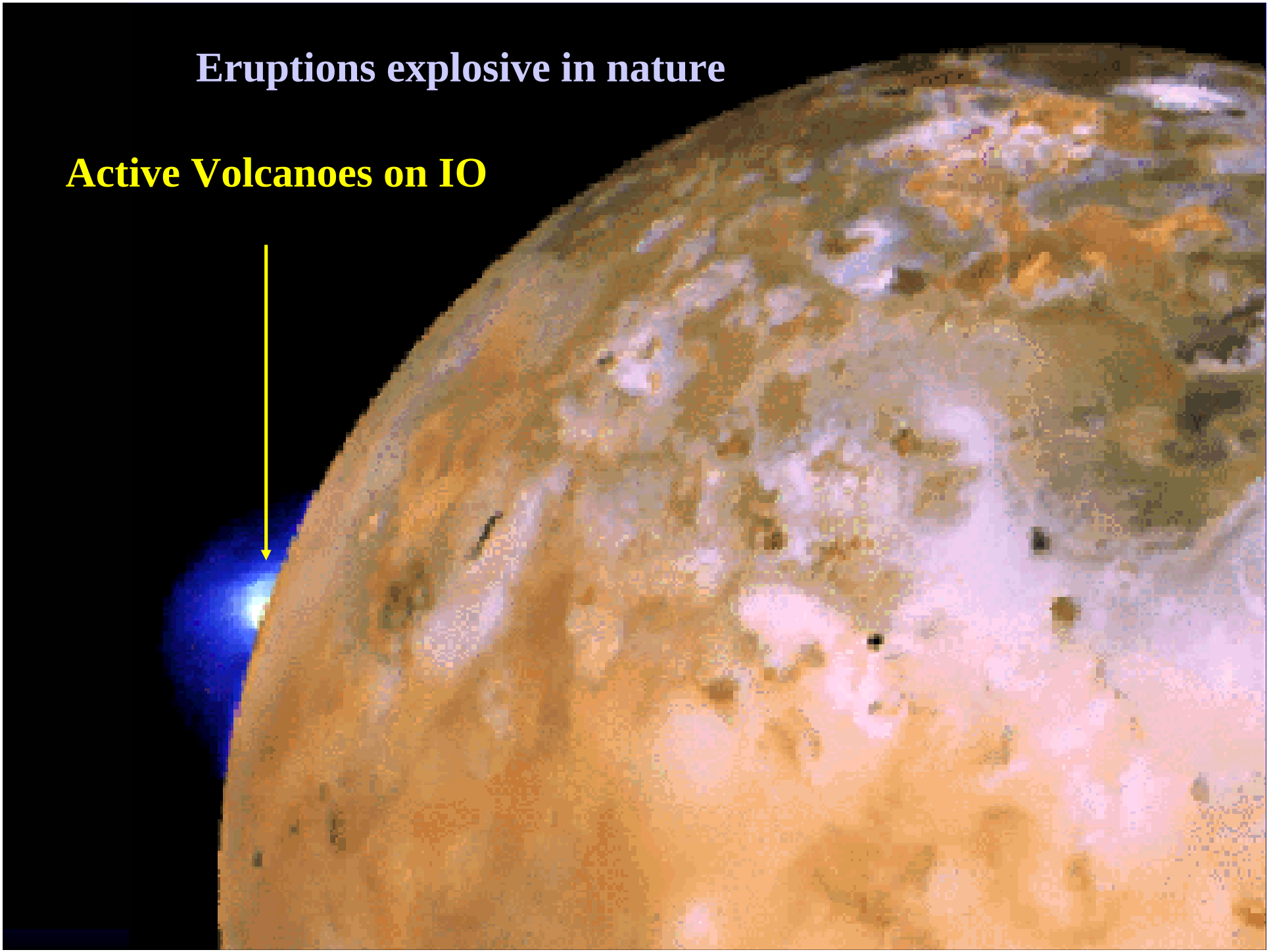
The gravitational forces torture and bend the interior of Io to produce constant volcanic flows

Surface temperature varies from +1700C (in lava lakes) to –160C.

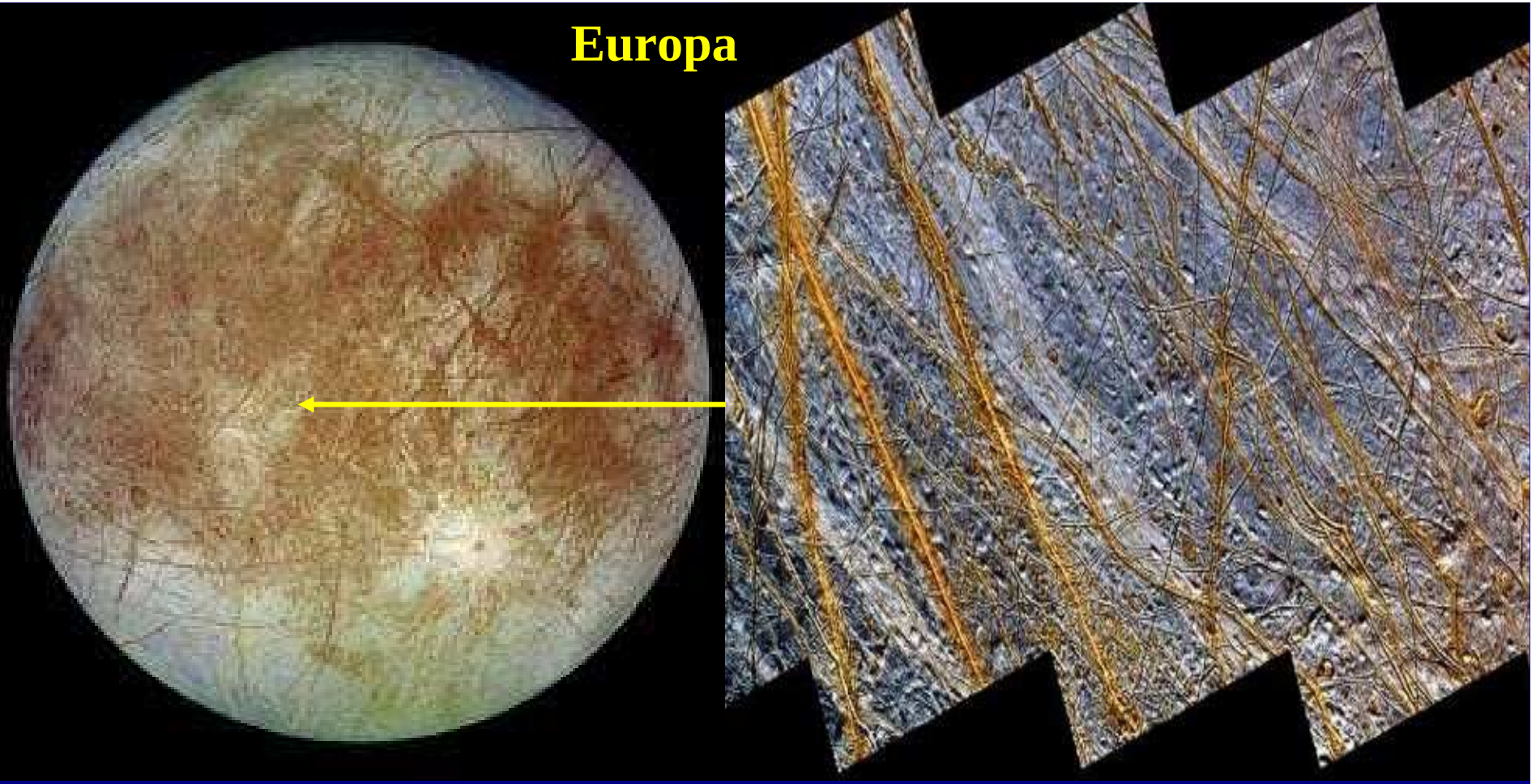
Surface shows poison gas plumes, erupting molten rock, and giant mountain ranges.

Eruptions explosive in nature

Active Volcanoes on IO



Europa



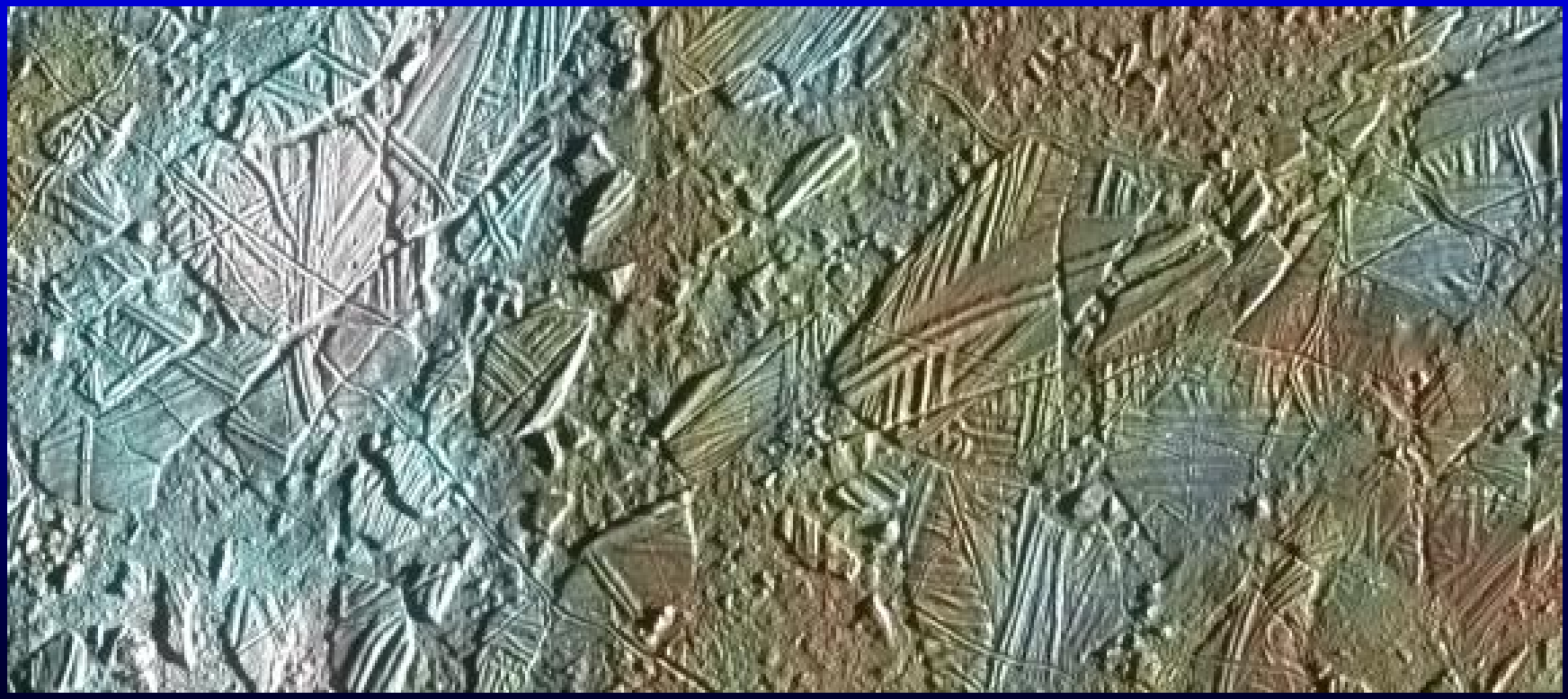
Images from the Galileo space probe show ice floes the size of cities drifting below its frozen and cracked surface

Beneath its crust lies a salty ocean containing more water than is found on Earth – It may be a liquid or more like a slurry

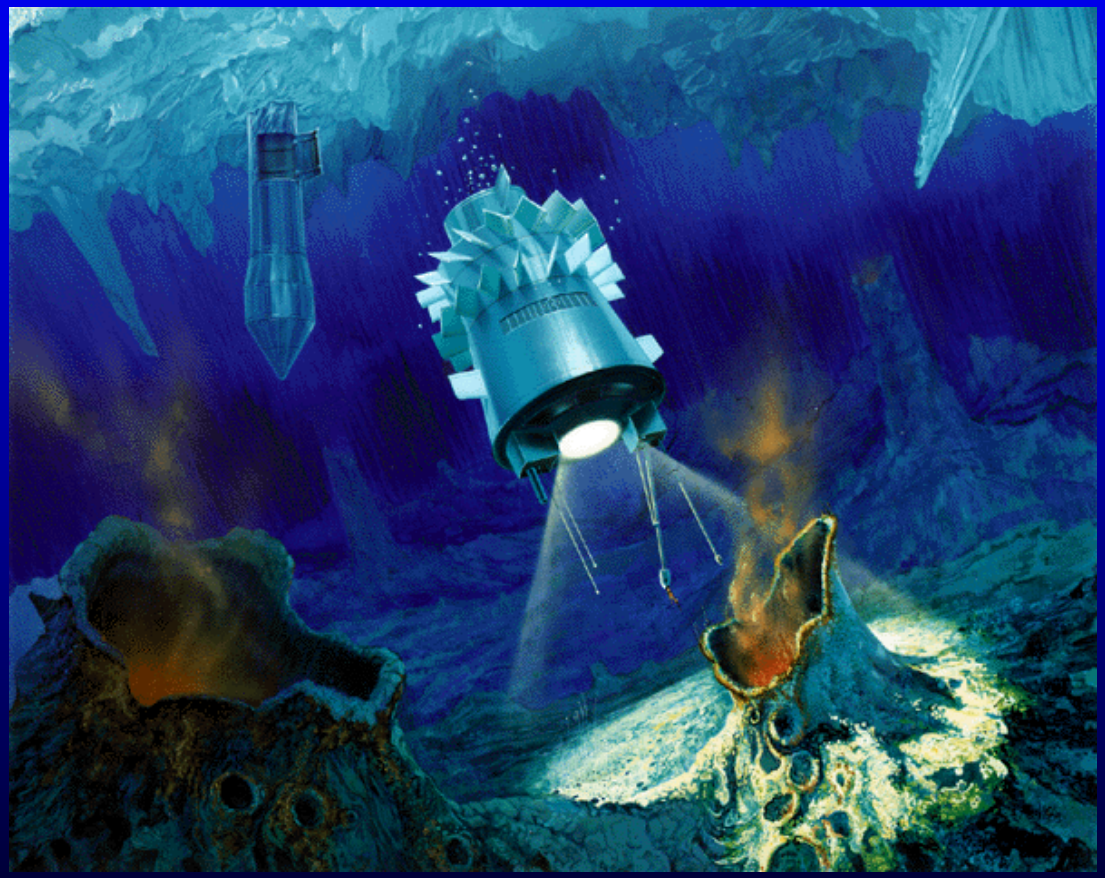
Water in abundance…….. Life ??

Breaking up of the surface

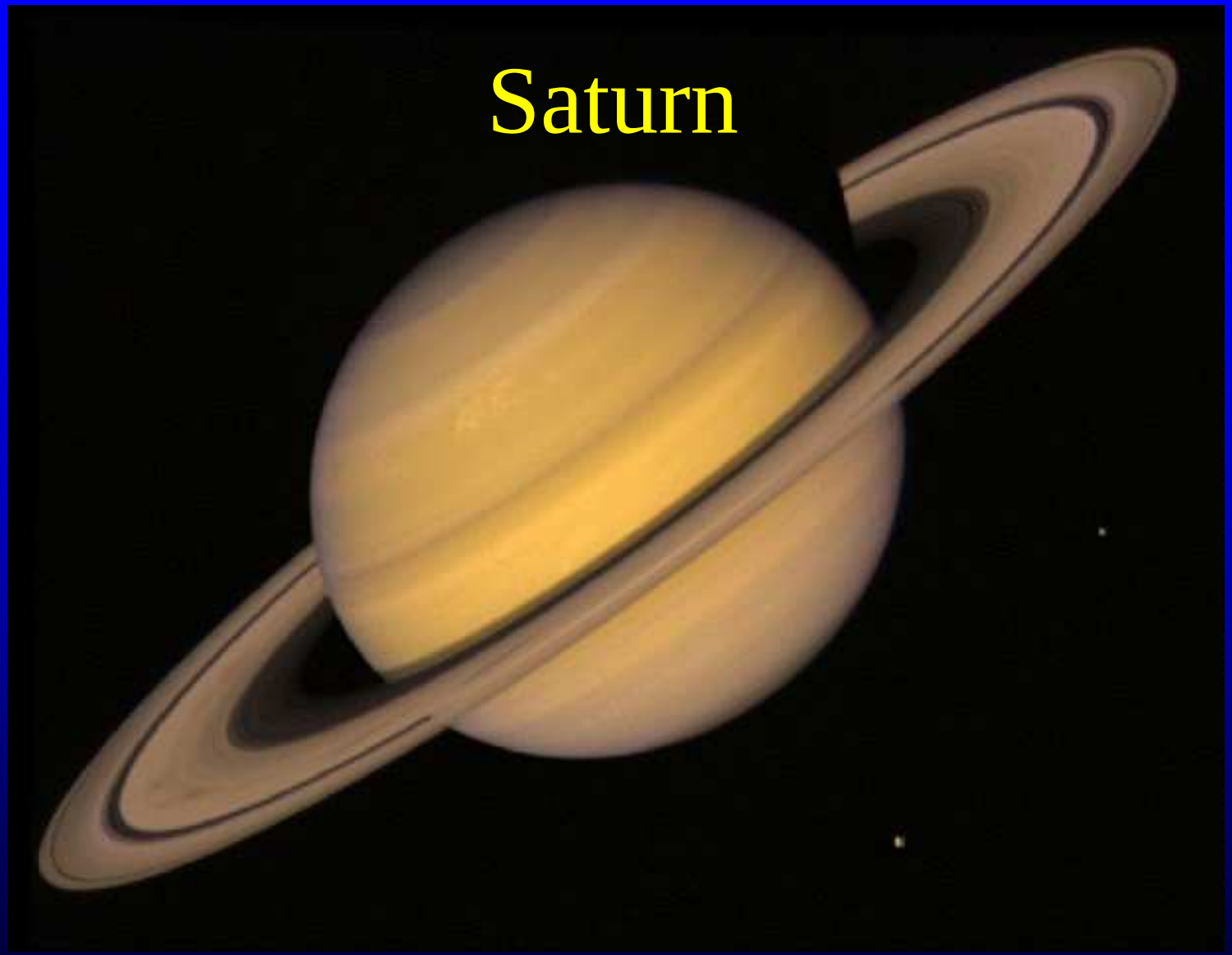
- Icebergs!

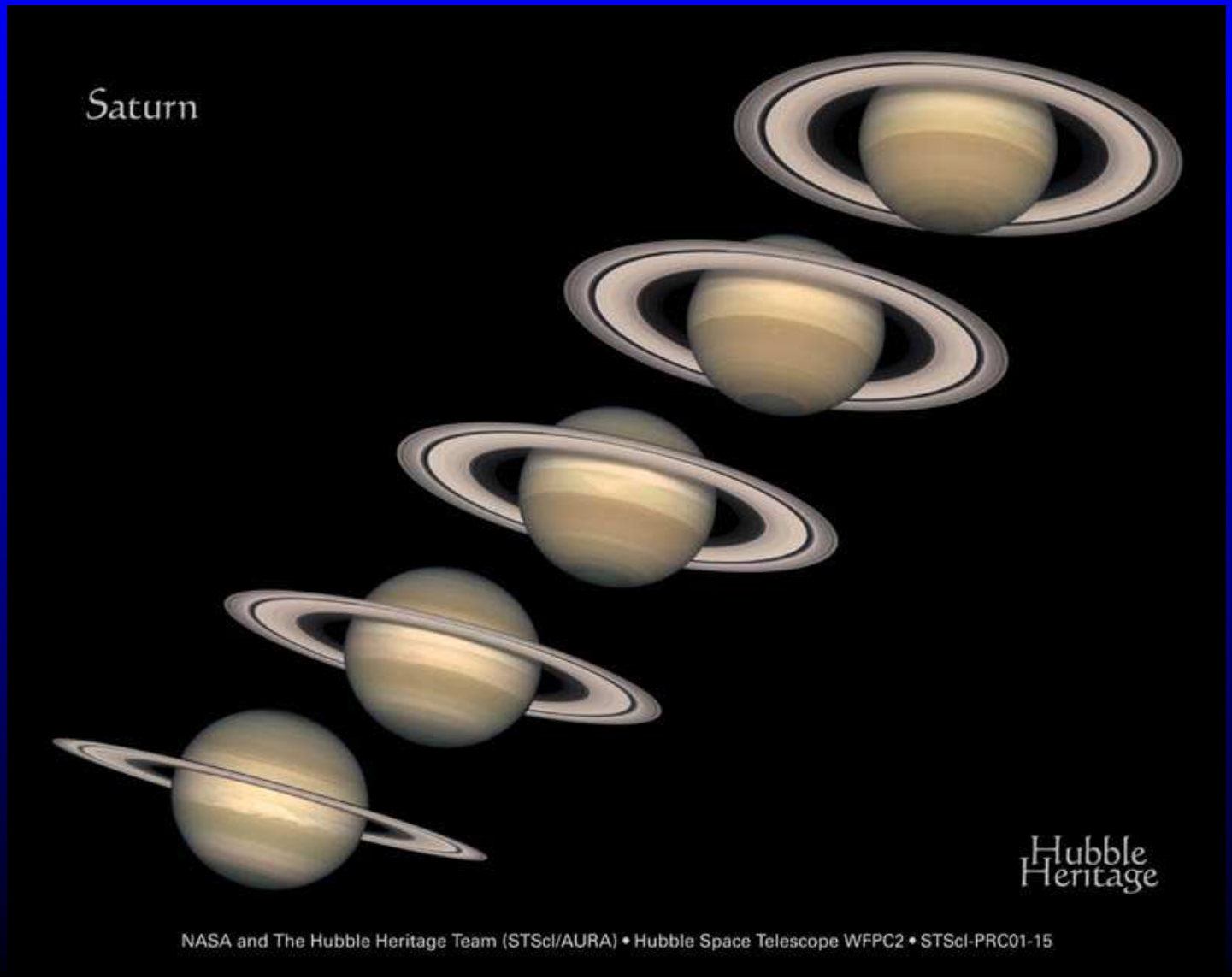


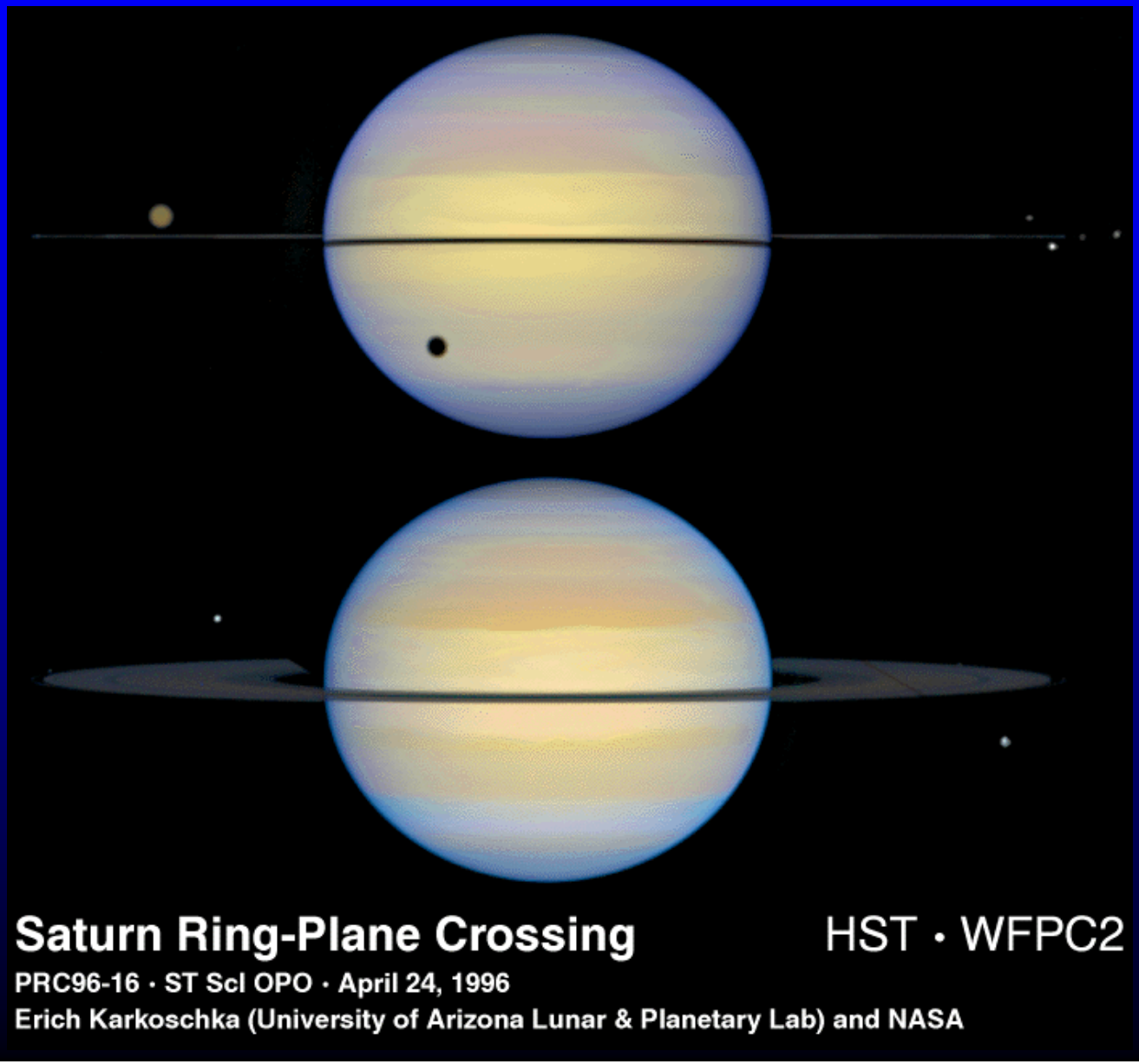
Searching for Life!

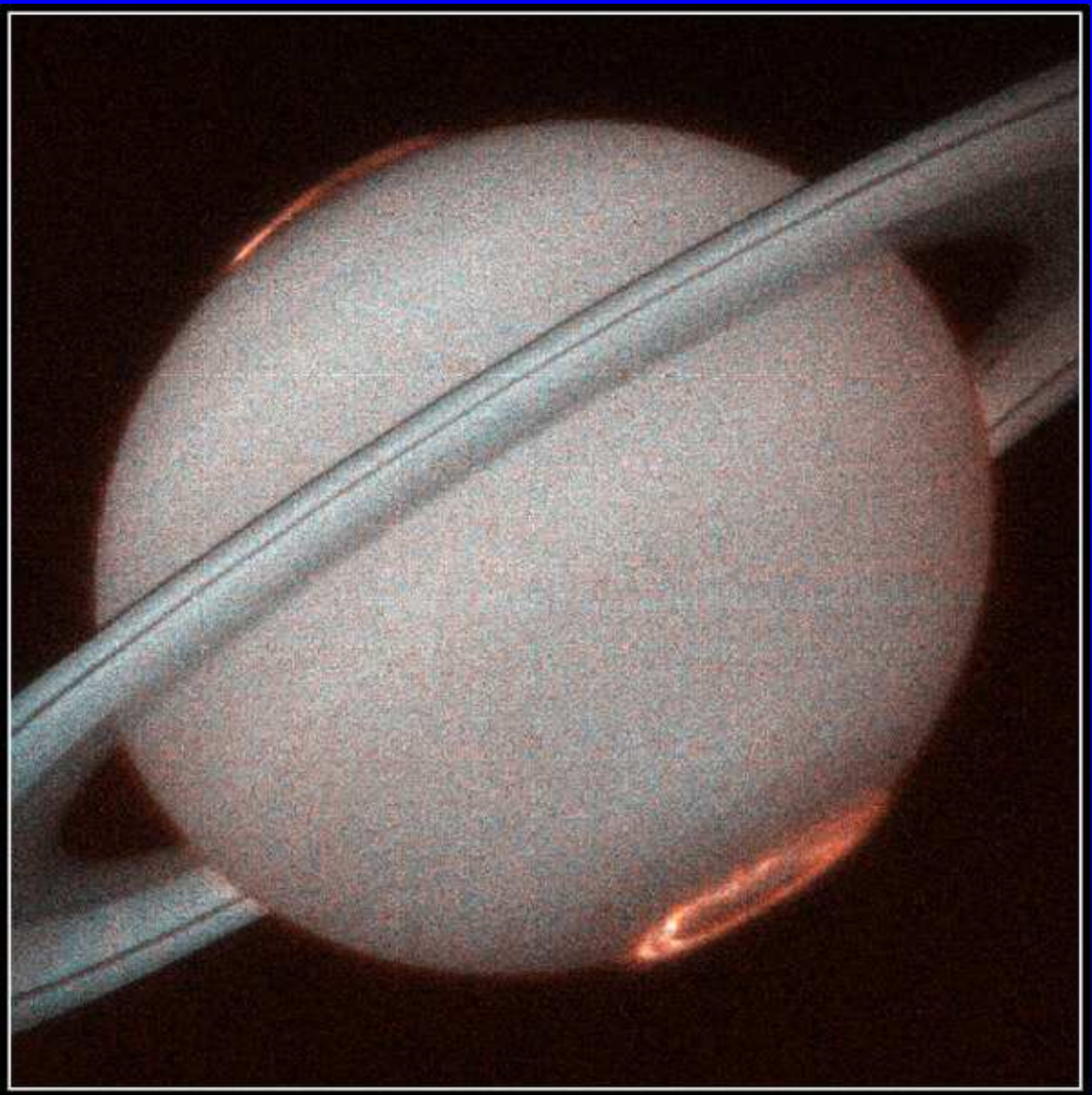


Saturn



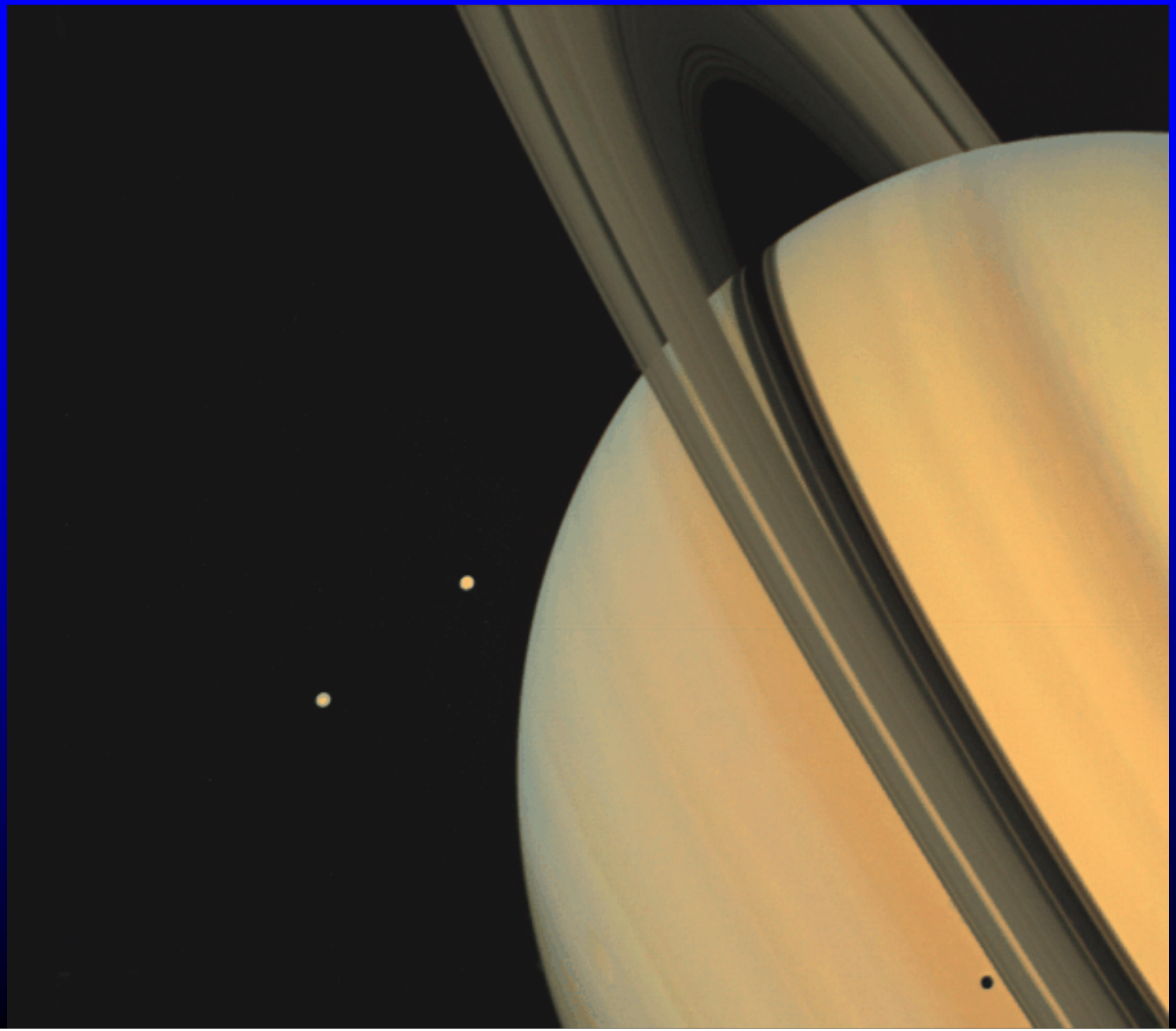

Saturn
Hubble Heritage
NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope WFPC2 • STScI-PRC01-15

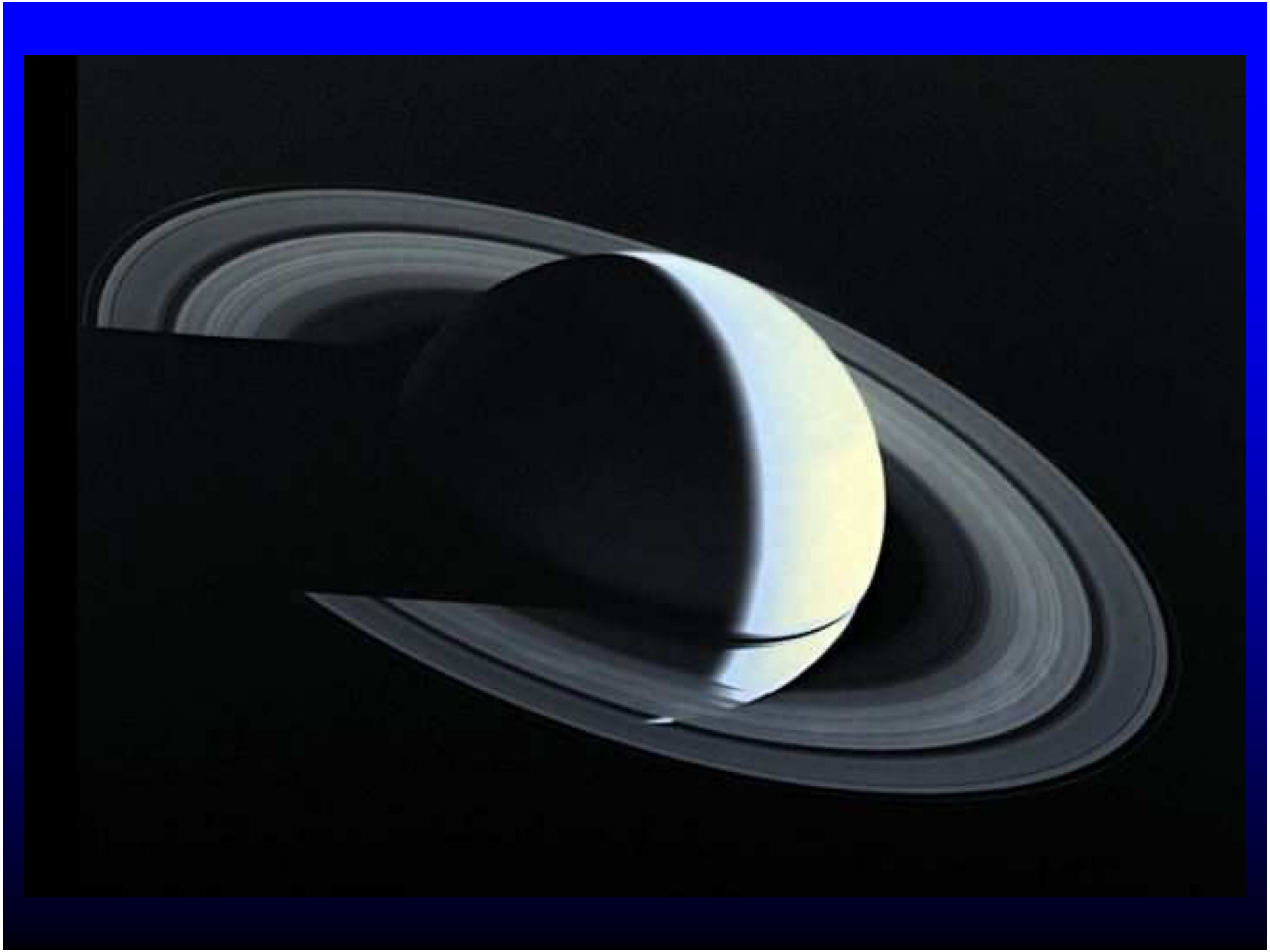

Saturn Ring-Plane Crossing
HST • WFPC2
PRC96-16 · ST ScI OPO · April 24, 1996
Erich Karkoschka (University of Arizona Lunar & Planetary Lab) and NASA



Saturn Aurora HST • STIS

PRC98-05 • ST ScI OPO • January 7, 1998 • J. Trauger (JPL) and NASA





Saturn's Moon Titan

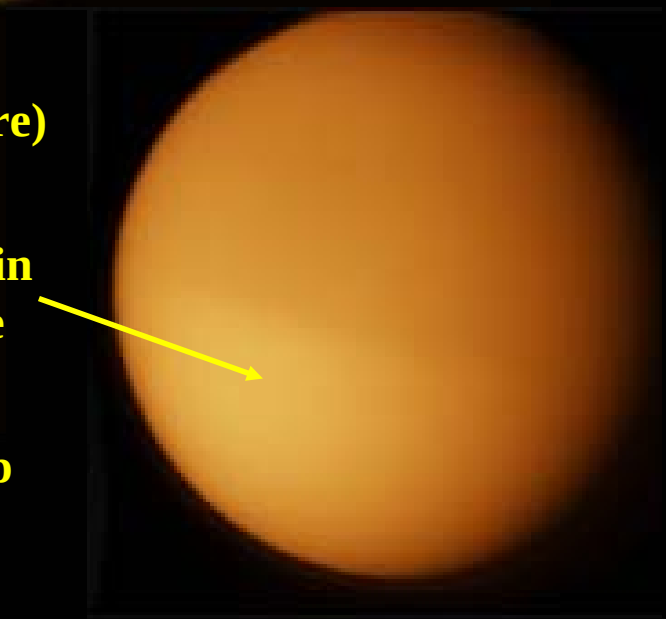
A cold world – but it contains all the right chemistry for possible life

Voyager 1 - 1980

Thick atmosphere (1.5 x density of Earth's atmosphere) composed of Nitrogen and hydrocarbons

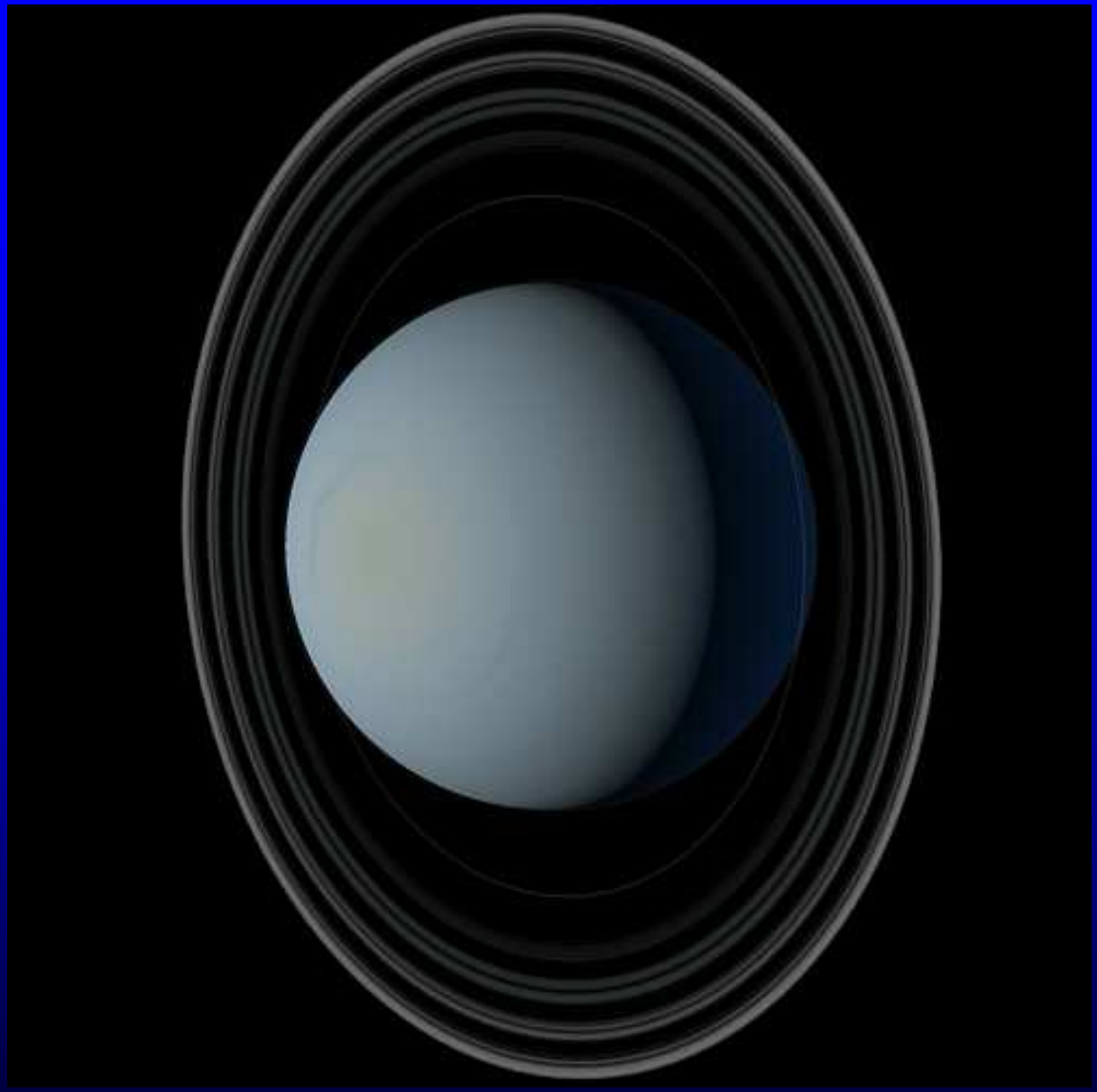
'Shiny' spot – a continent of frozen methane drifting in a methane ocean ? - or a mountain range of water ice eroding under methane rain ?

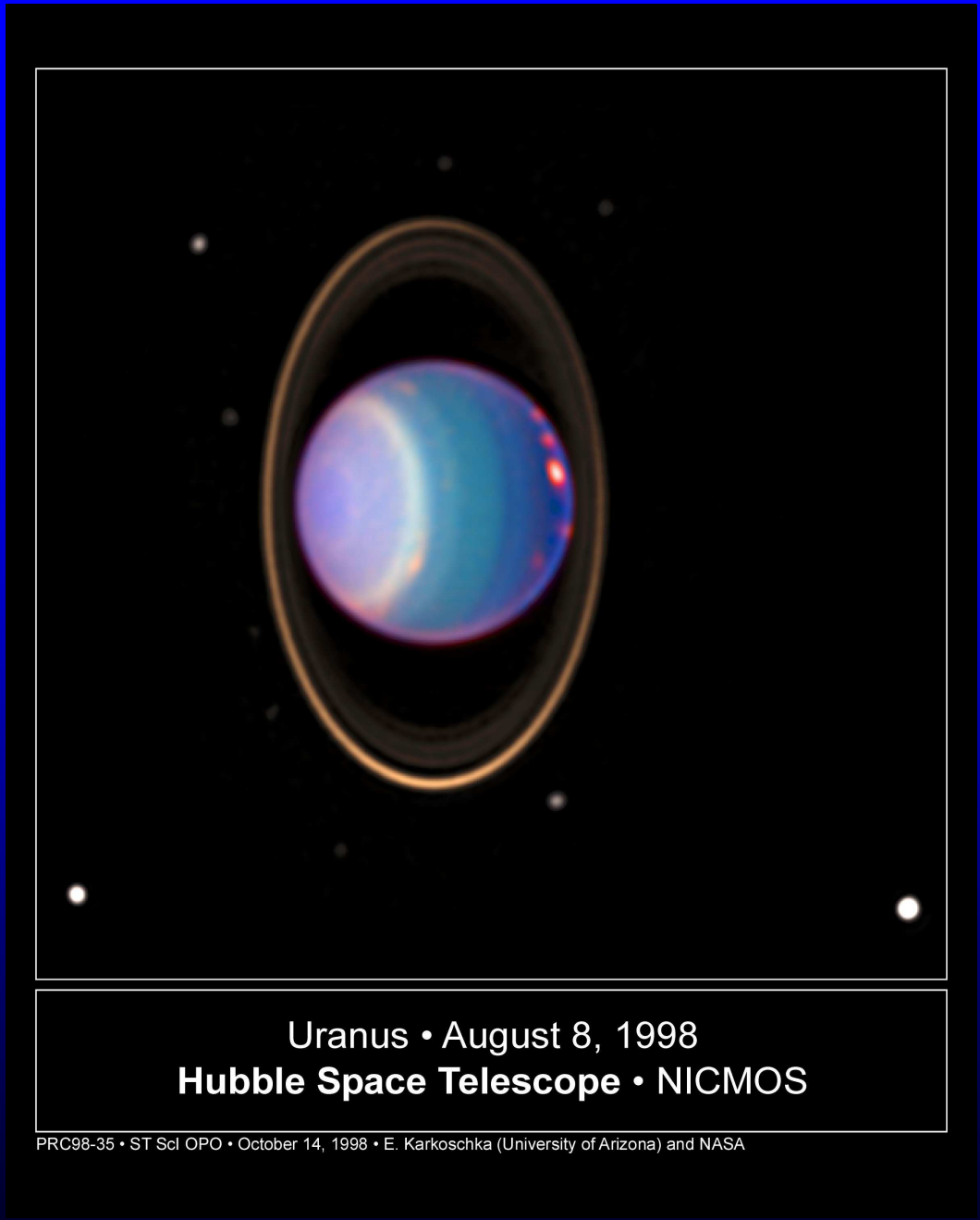
Cassini spacecraft set for rendezvous in 2004 will map the surface with radar and send the Huygens probe down to the surface – properties unknown !!




Hugens Probe at Titan 2004

William Herschel and his Telescope



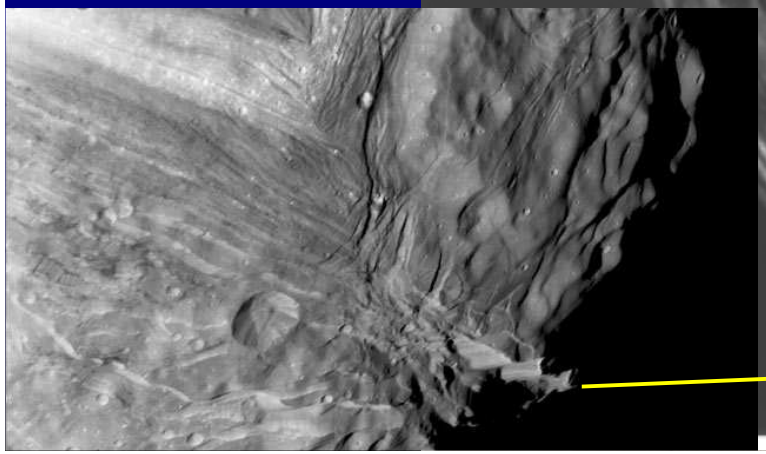


Uranus • August 8, 1998
Hubble Space Telescope • NICMOS

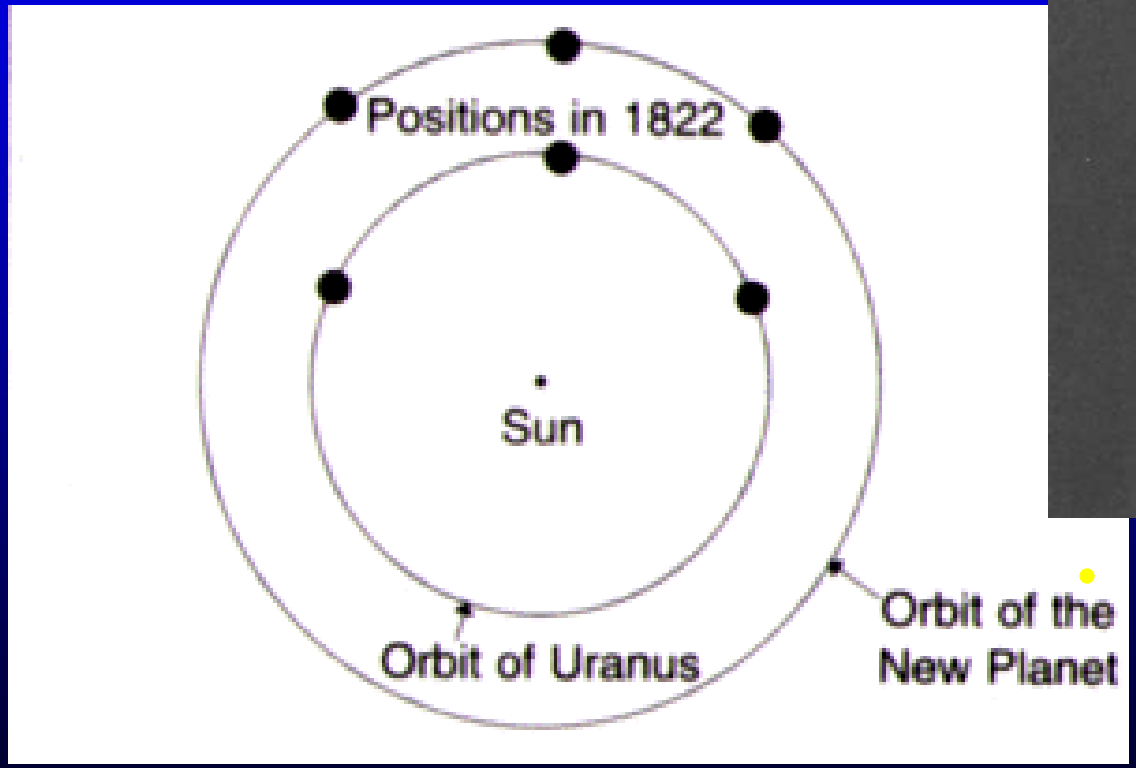
PRC98-35 • ST ScI OPO • October 14, 1998 • E. Karkoschka (University of Arizona) and NASA

Miranda – a moon of Uranus

Only 450 km in diameter this moon is only just held together by self gravity and has recombined following a giant impact (hetereogenius accretion)

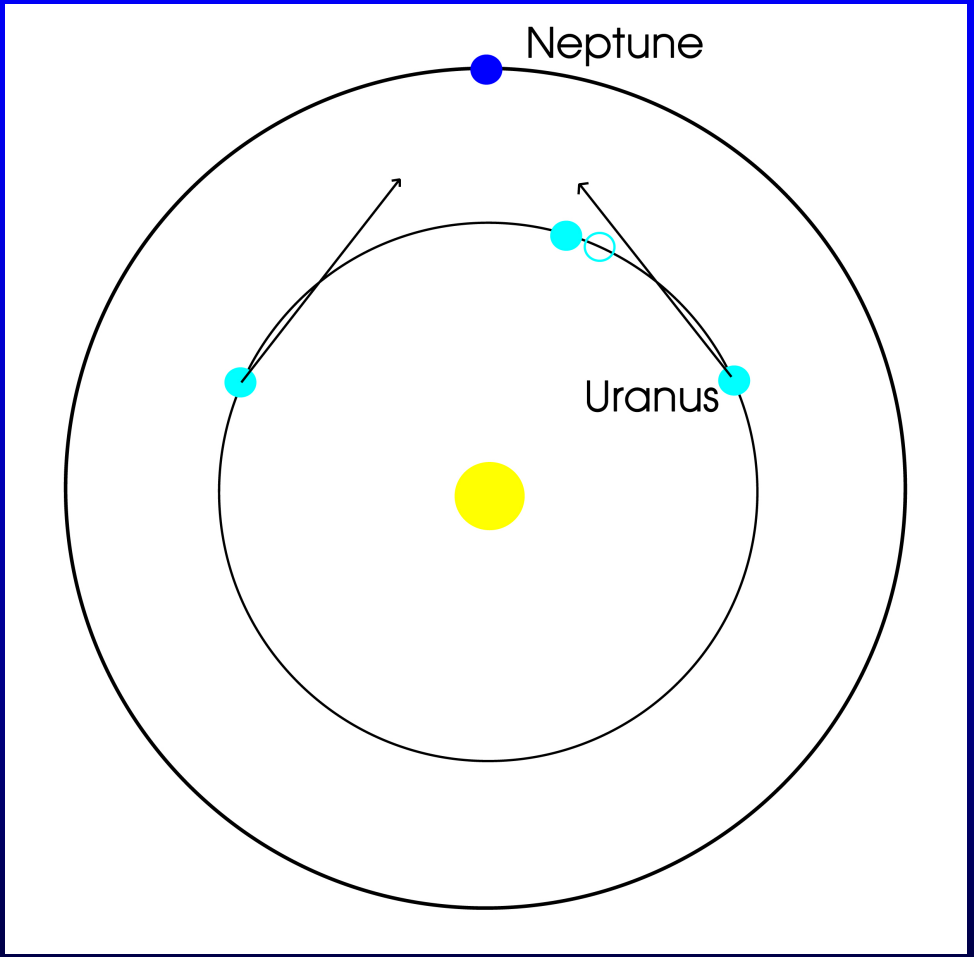


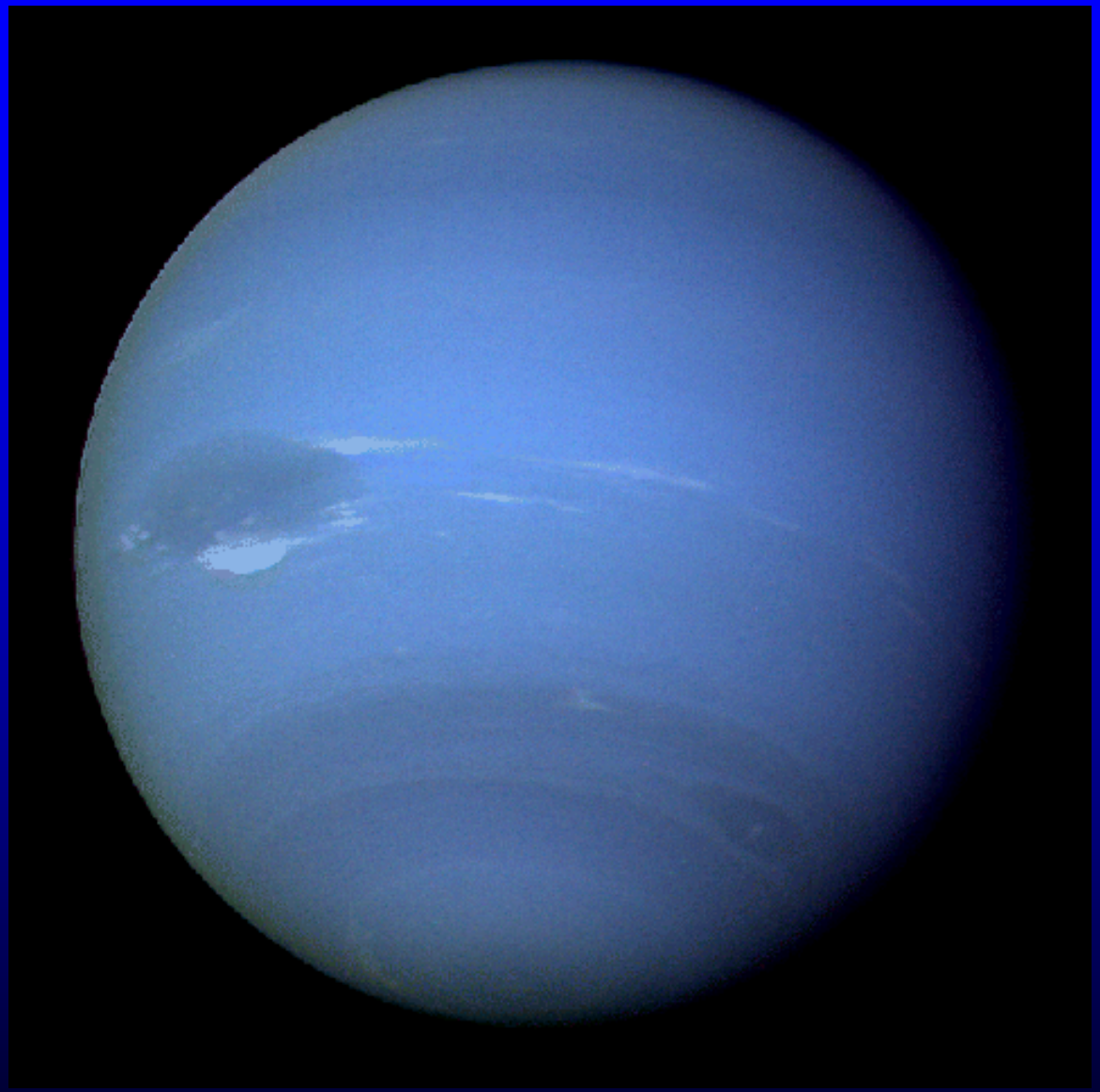
The discovery of Neptune

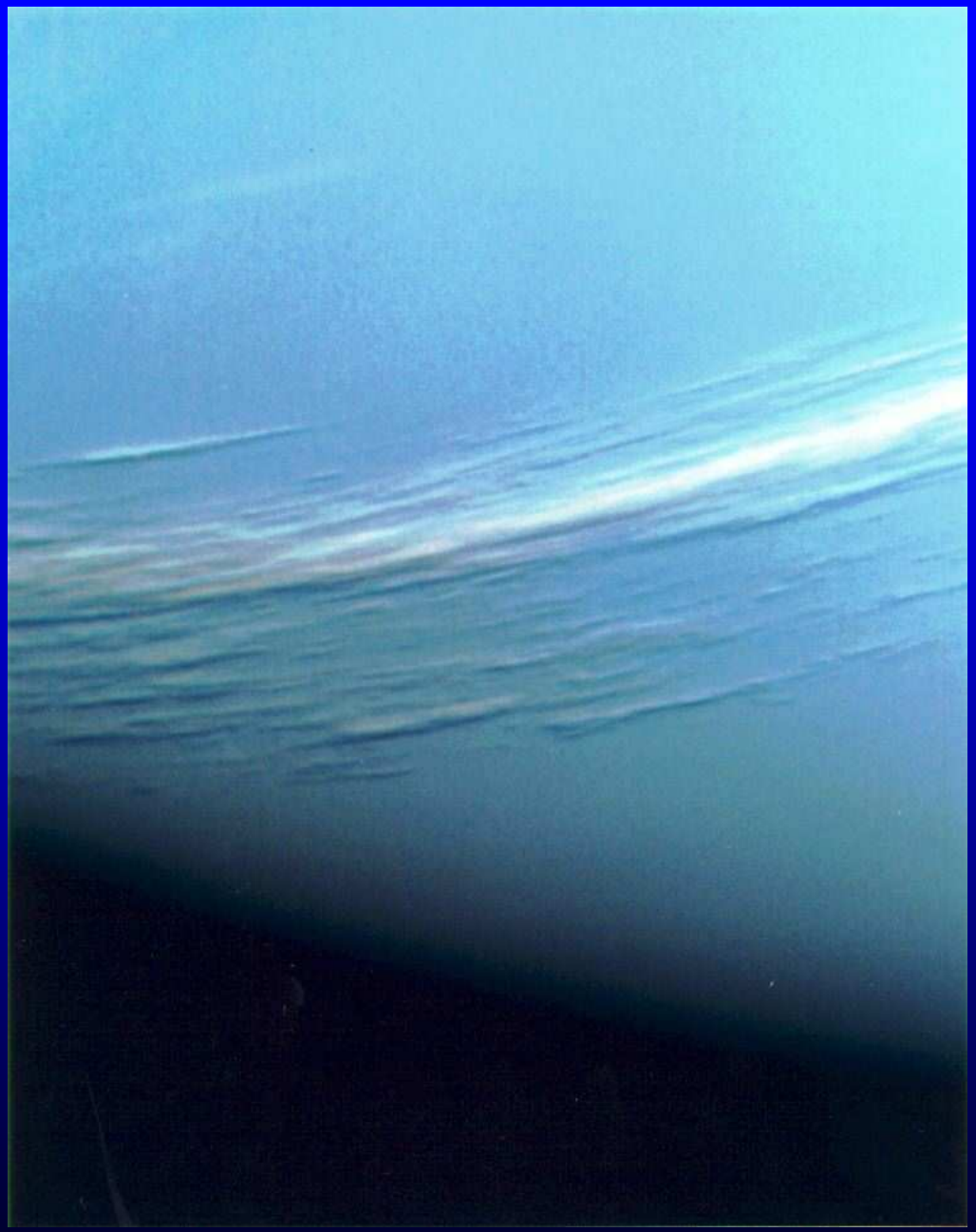


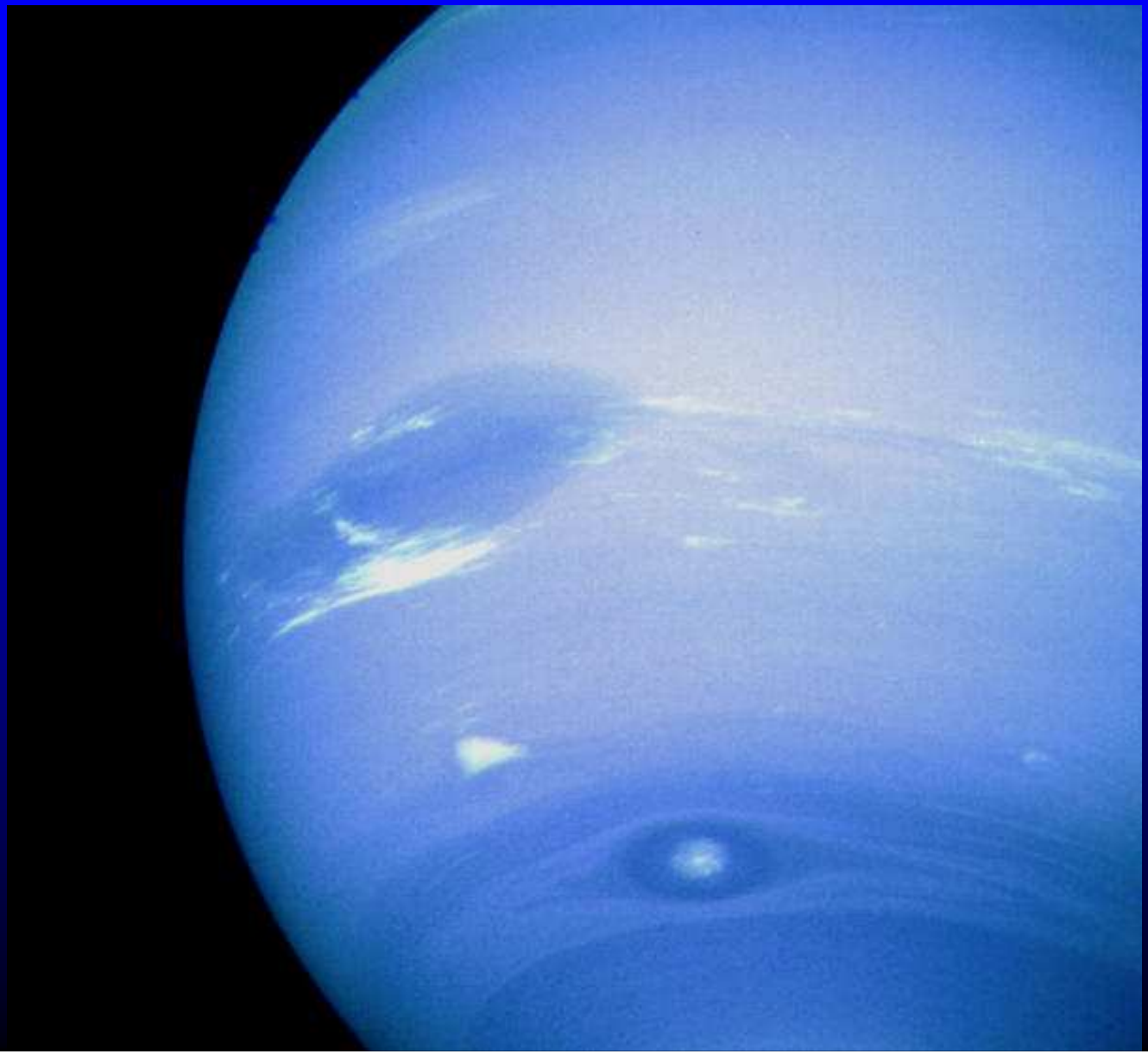
John Couch Adams

- As Uranus approached Neptune, their joint attraction ADVANCED the position of Uranus in its orbit.
- As it receded from Neptune, their joint attraction RETARDED the position of Uranus in its orbit until it was back where it would have been without the presence of Neptune.
- Neptune lay beyond the point where where Uranus was most ahead of its predicted track.

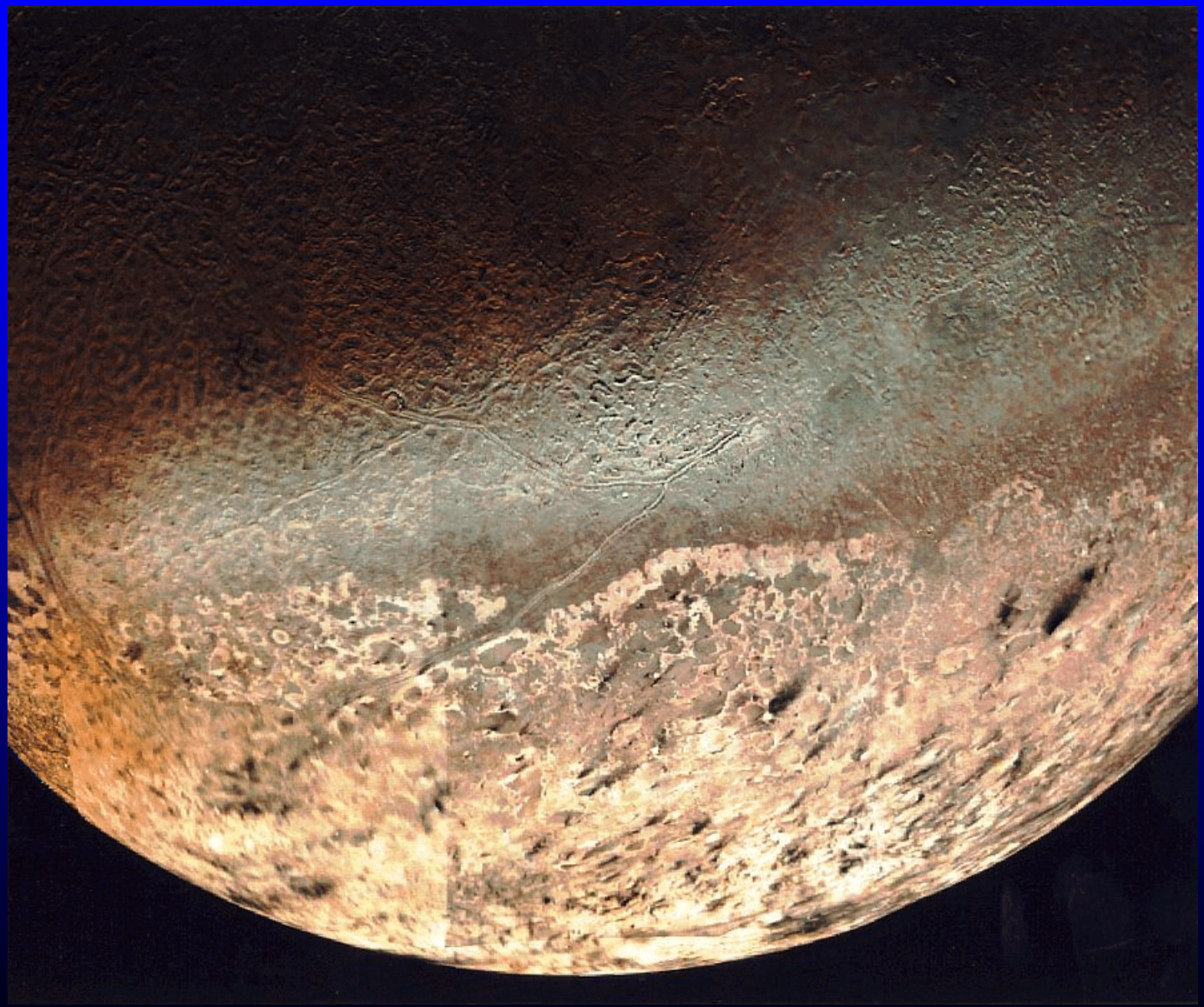


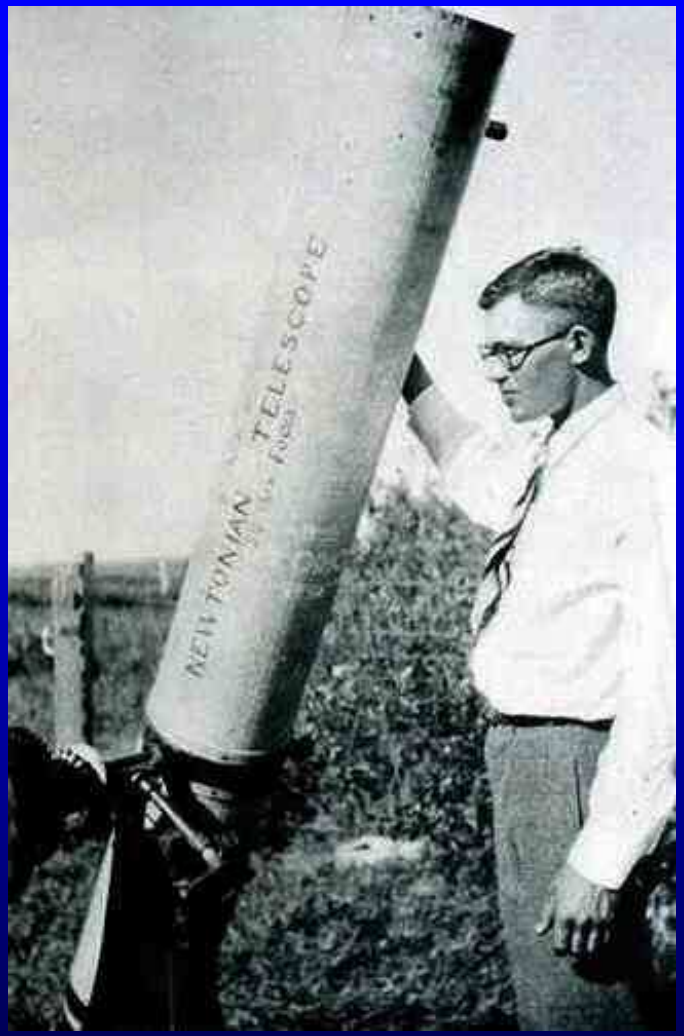




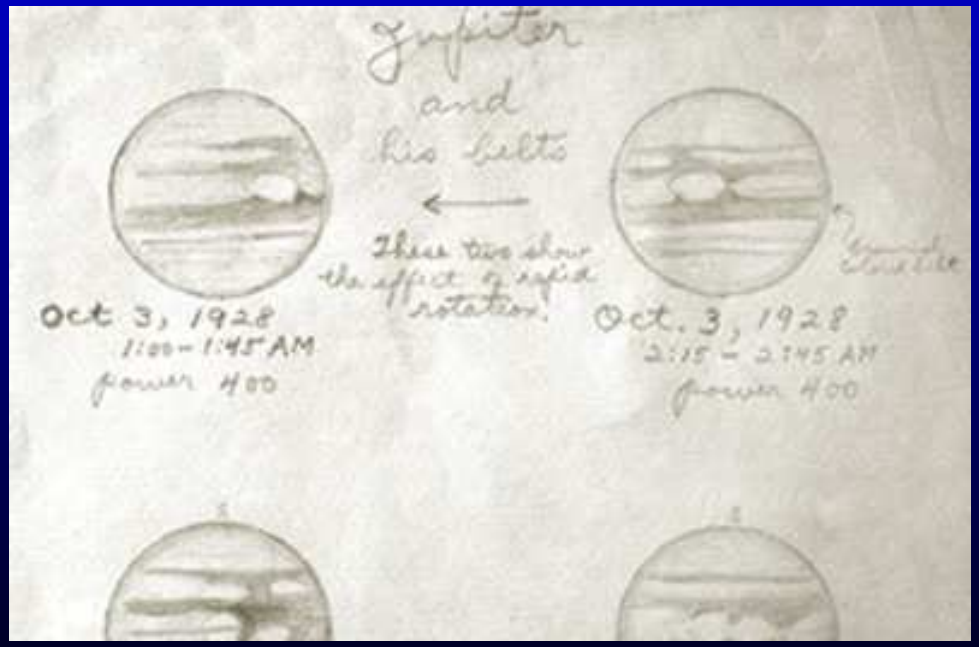


Neptune with Triton

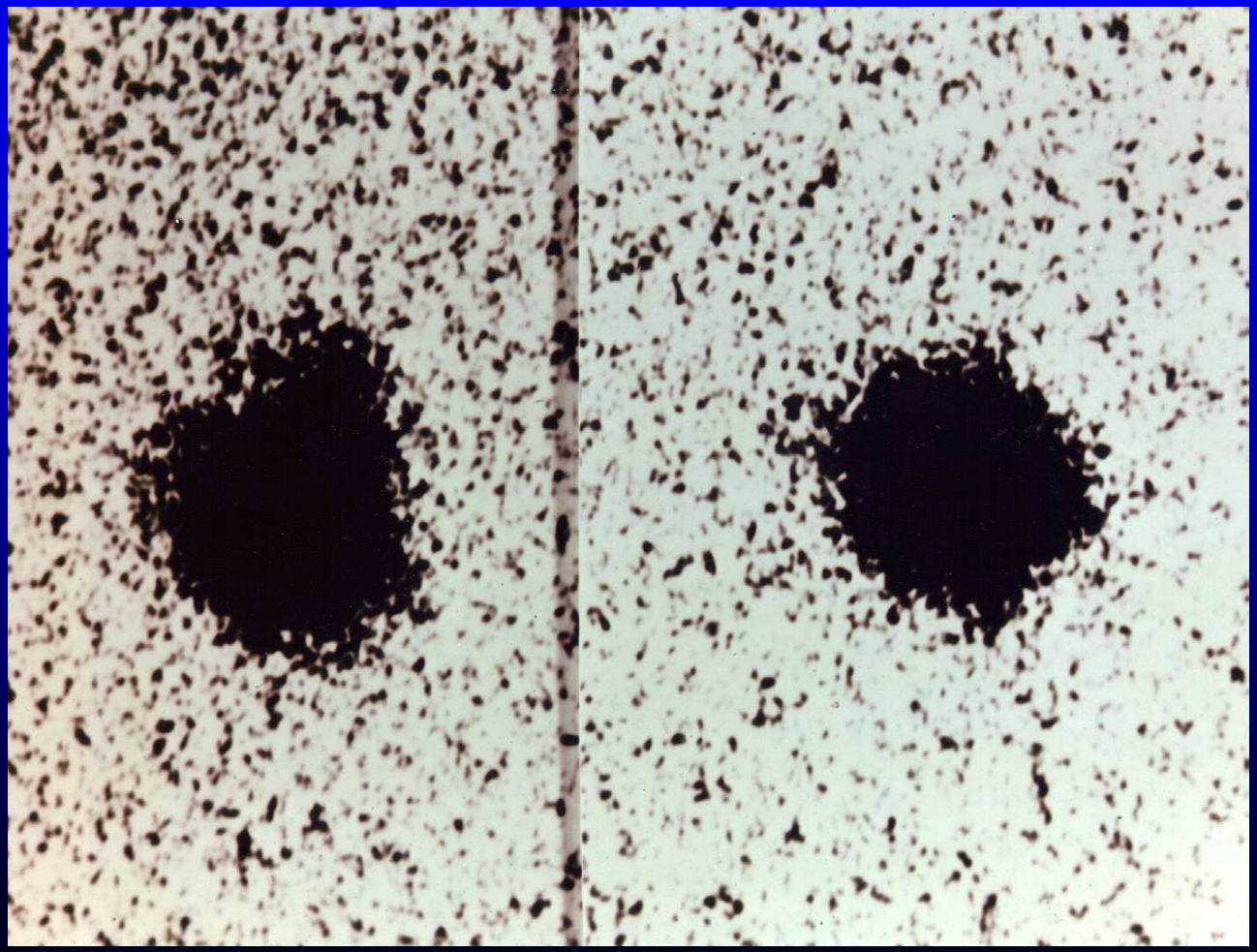




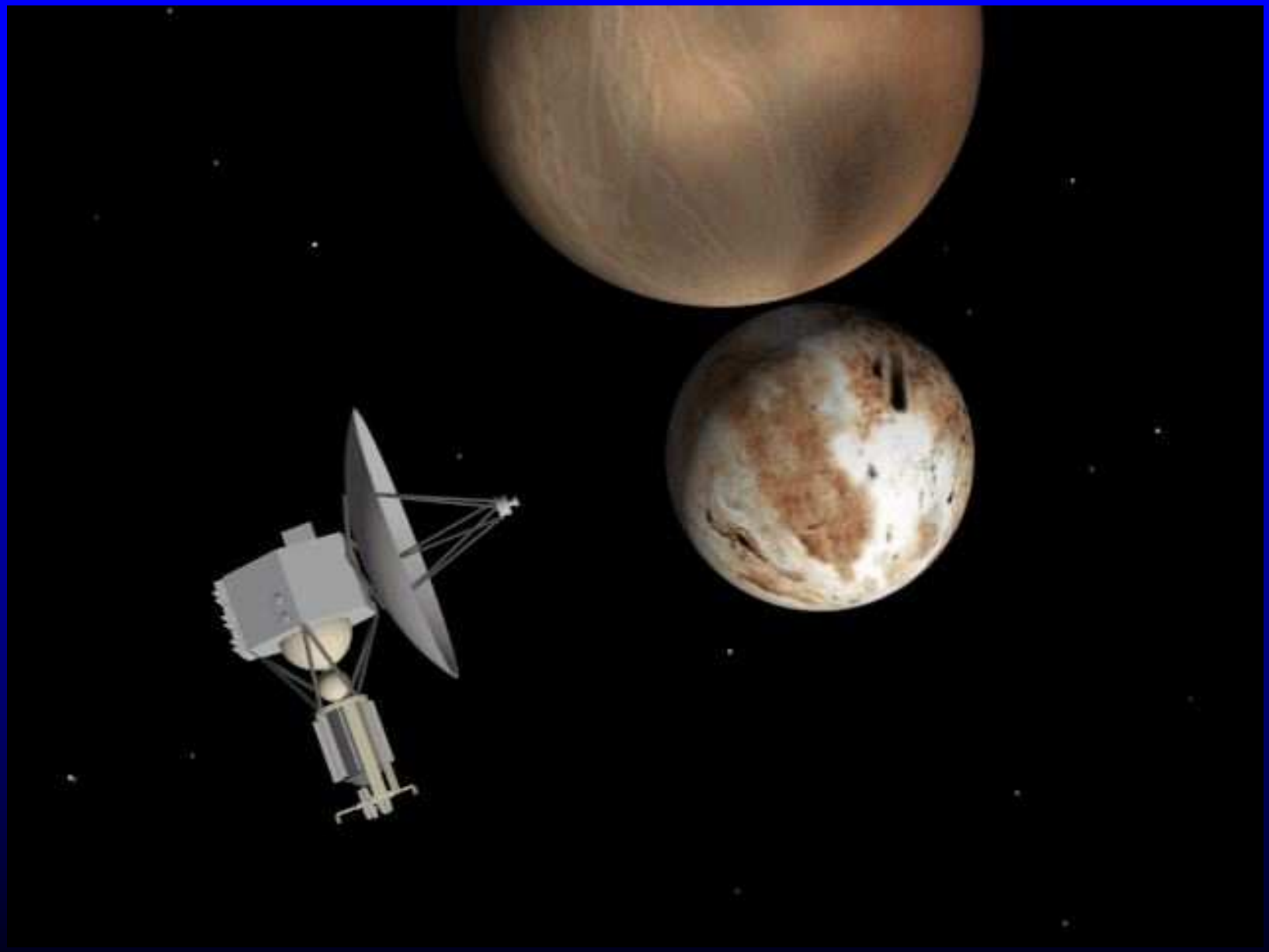
Clyde Tombaugh



The discovery of Charon



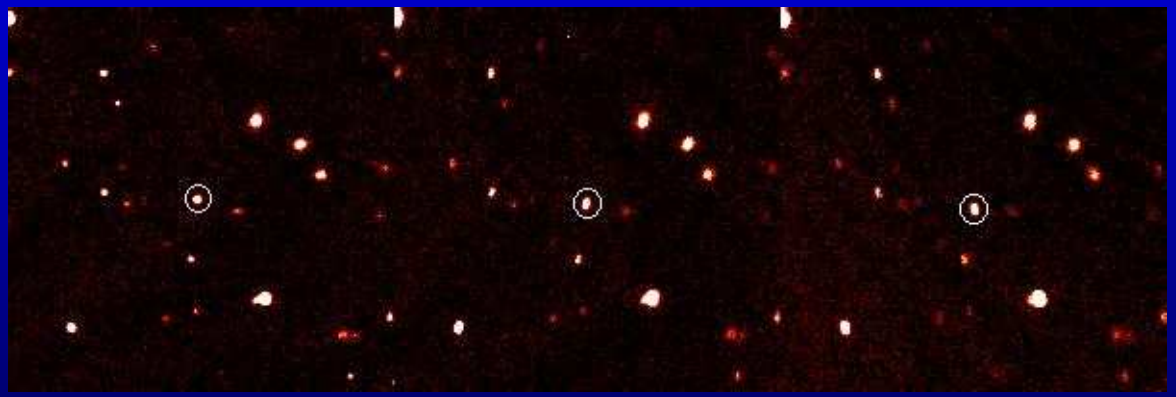
Pluto (now demoted to a dwarf planet) and Charon

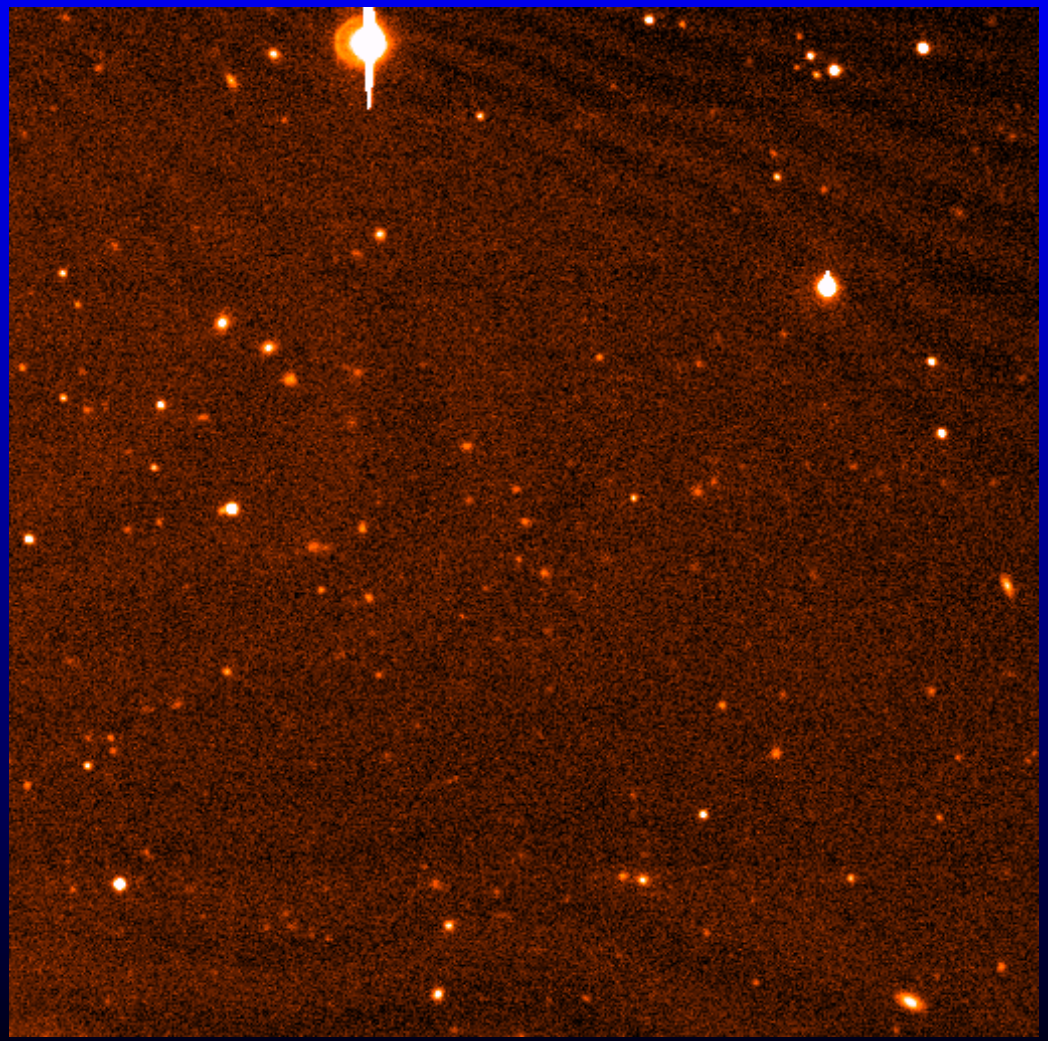


The 10th Planet Discovered?

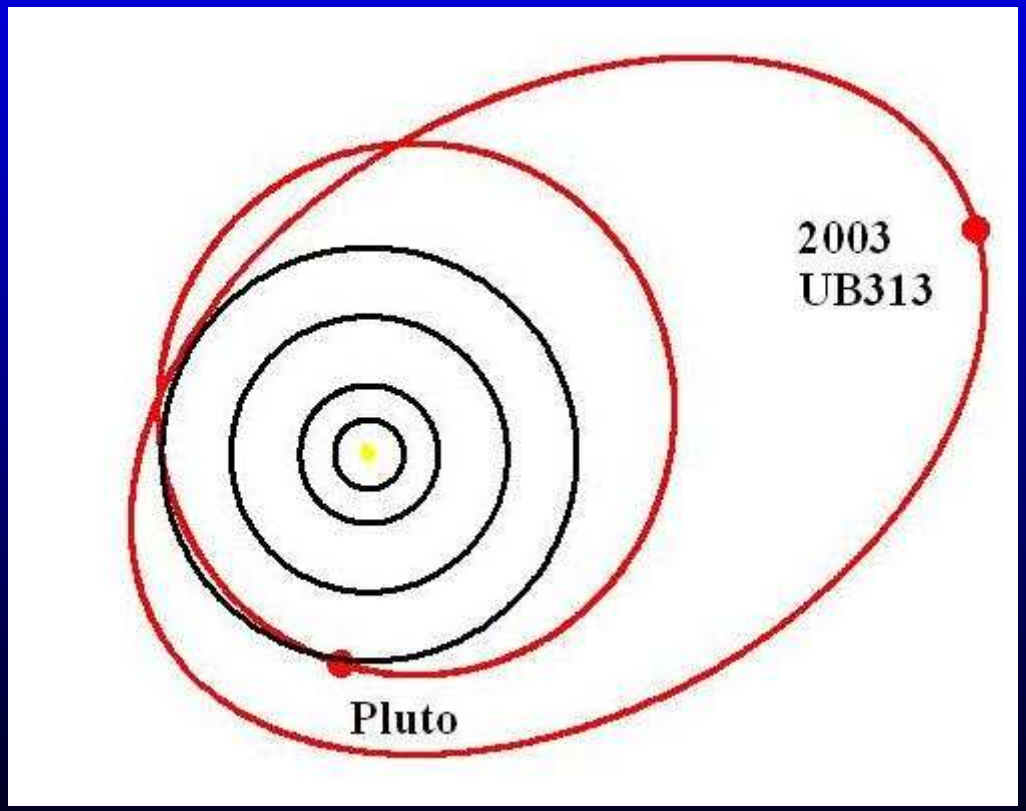
2003 UB313

Discovery Images

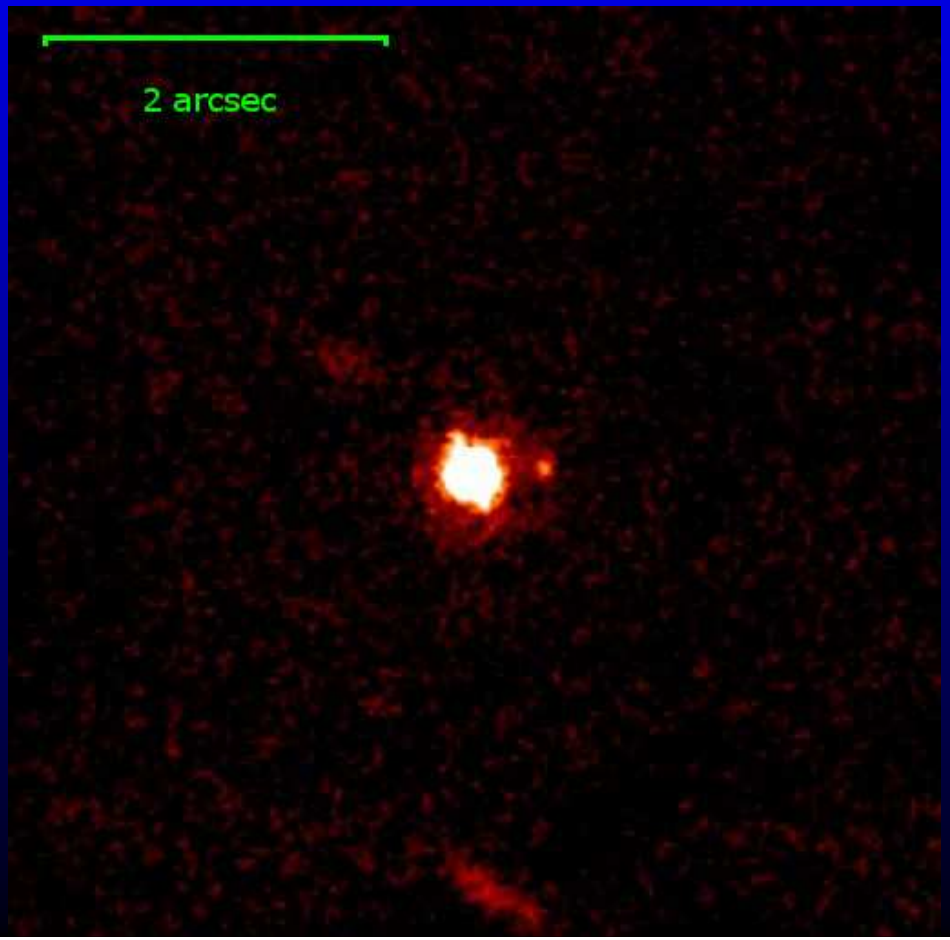




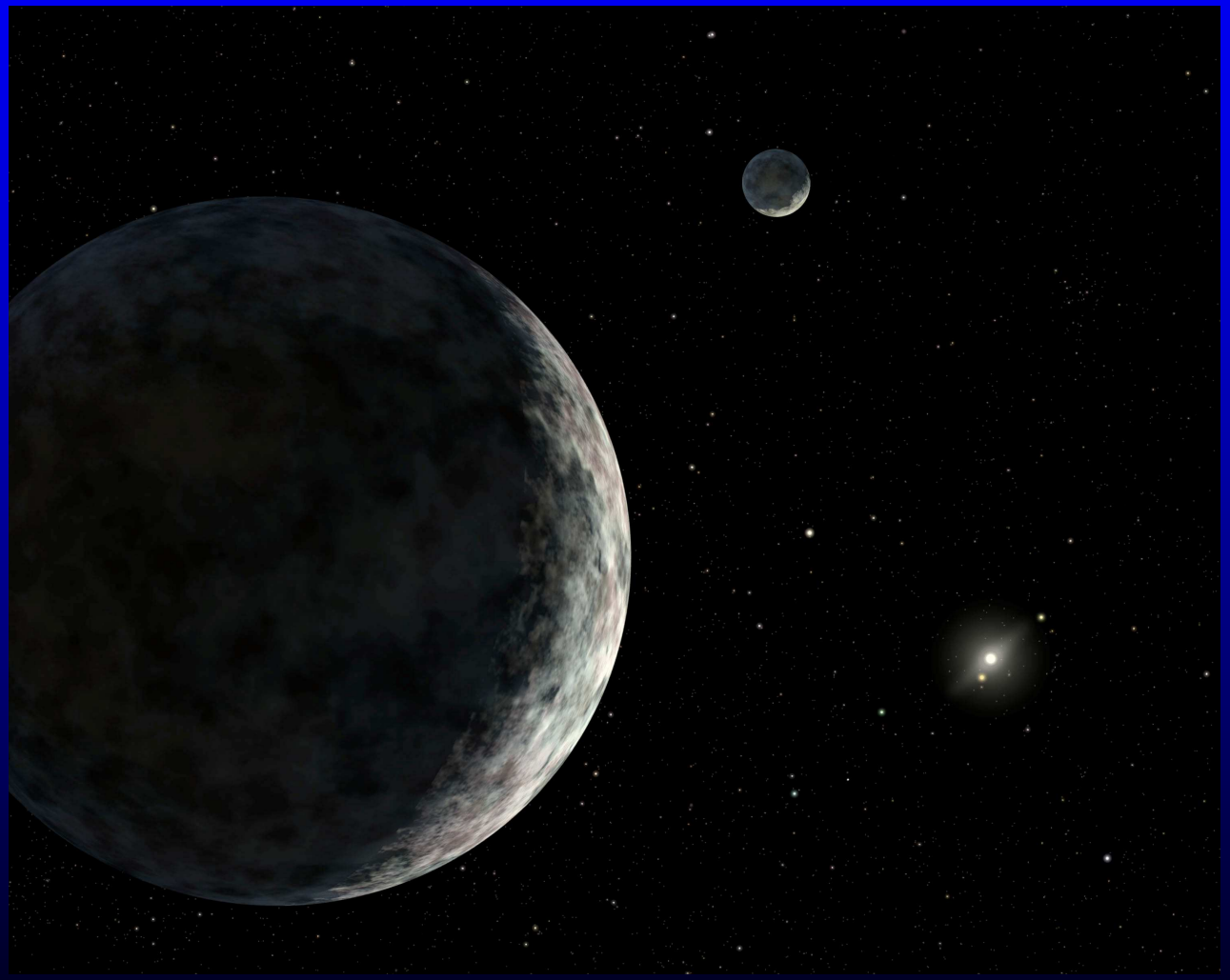
Now classified as a “Dwarf Planet” :ERIS



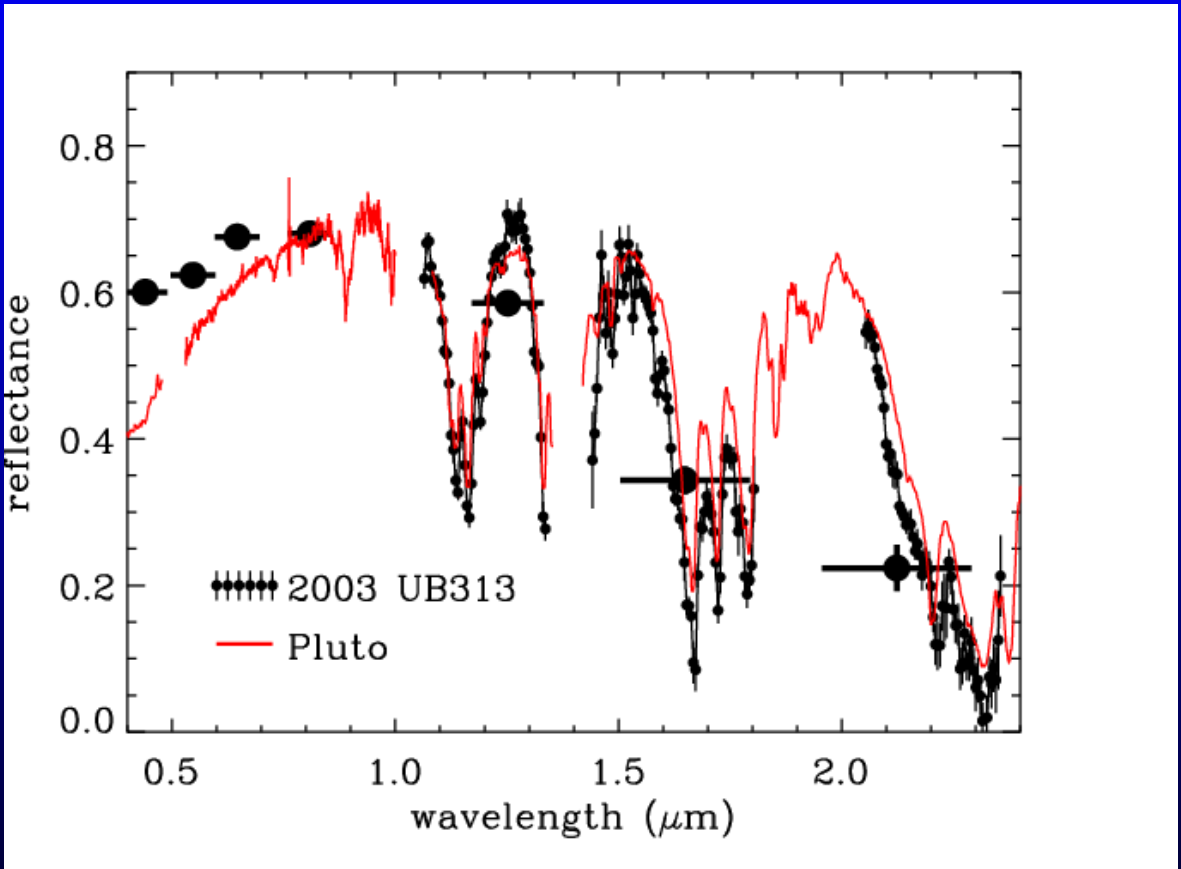
Eris has a moon calledDysnomia



Artists Impresion



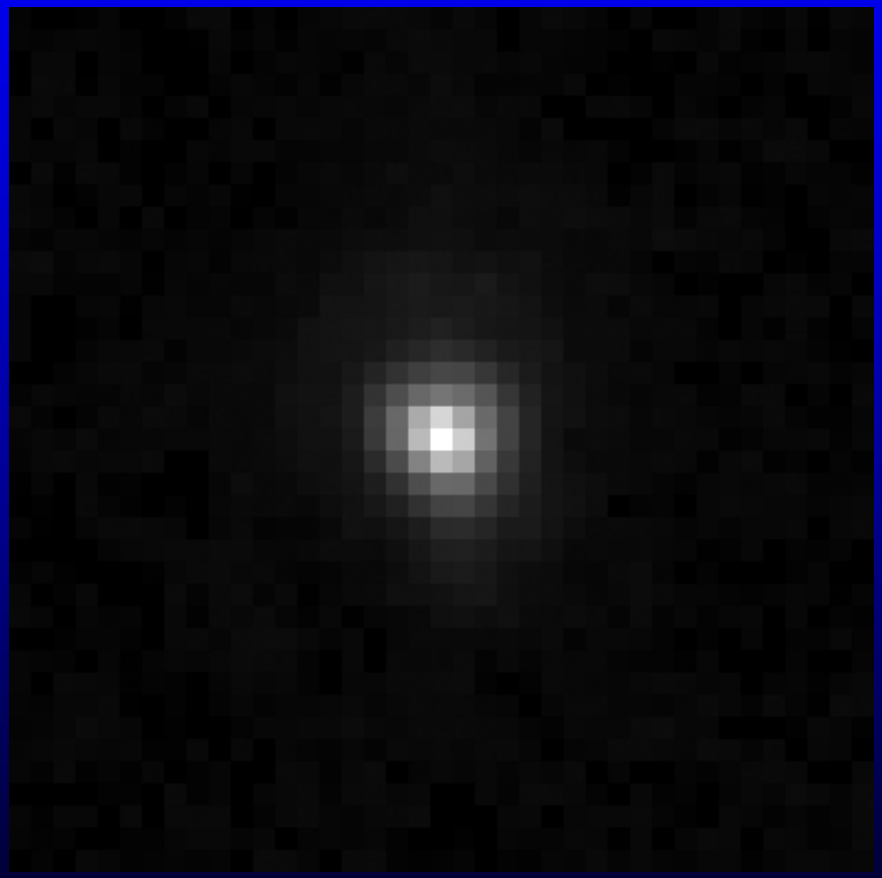
Spectrum similar to Pluto.



Size?

- Estimate from Reflectivity – assume to equivalent to that of Pluto.
  - Gives 2860 km. (Pluto = 2274 km)
- Assume Fresh Snow on Earth.
  - Gives 2330 km.
- Assume Antarctica
  - Gives 2475 km.
- Assume 100% reflectivity
  - Gives 2210 km. (97% size of Pluto)

HST Image



- New Diameter = 2400 +/- 100 km
  - cf Pluto 2288 km
- This implies a reflectivity of 86 +/- 7 %
- The second most reflective body in the Solar System after Enceladus – Saturn's Moon
- Frozen Methane and Nitrogen likely cause.
  - Surface Temperature now -243C as furthest from Sun. No atmosphere!
  - Temperature is -217C when closest. Thin atmosphere.

Other Solar System bodies

Now all classed within

“small solar system bodies”

Comets

- Come into the inner solar system from the Oort Cloud when their circular orbit is peturbed.
- Remnants of the Early Solar syatem

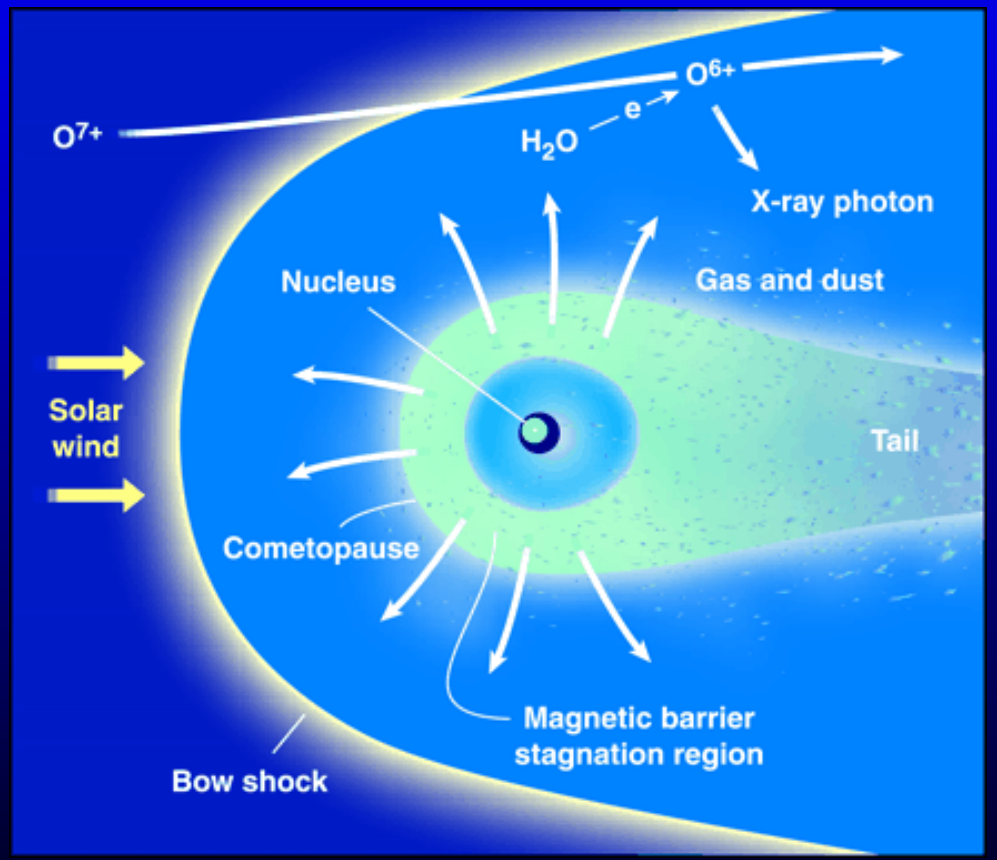
A Dirty Snowball

- As the comet closes on the Sun, the Sun's heat ablates the ice and this releases the dirt as dust particles.
- The comet forms two tails
  - 1) the dust tail, yellowish, which is seen by light reflected from the dust which spreads out along the orbit – can be curved.
  - 2) the ion or gas tail, ionised gas, which is bluish – a line from Cyanogen CN. Tends to be straight.

Two Tails

The Coma

- As the nucleus of the comet nears the Sun, the gas driven off forms a spherical COMA from which comes the tail.
  - The Coma may be ~ 300,000 miles across.
  - The tail may be up to 100,000,000 miles long!



Short Period comets

Giotto's Adoration of the Magi

Some comets get "trapped" in the inner solar system if they pass close to Jupiter or Saturn and then orbit the Sun in the inner solar system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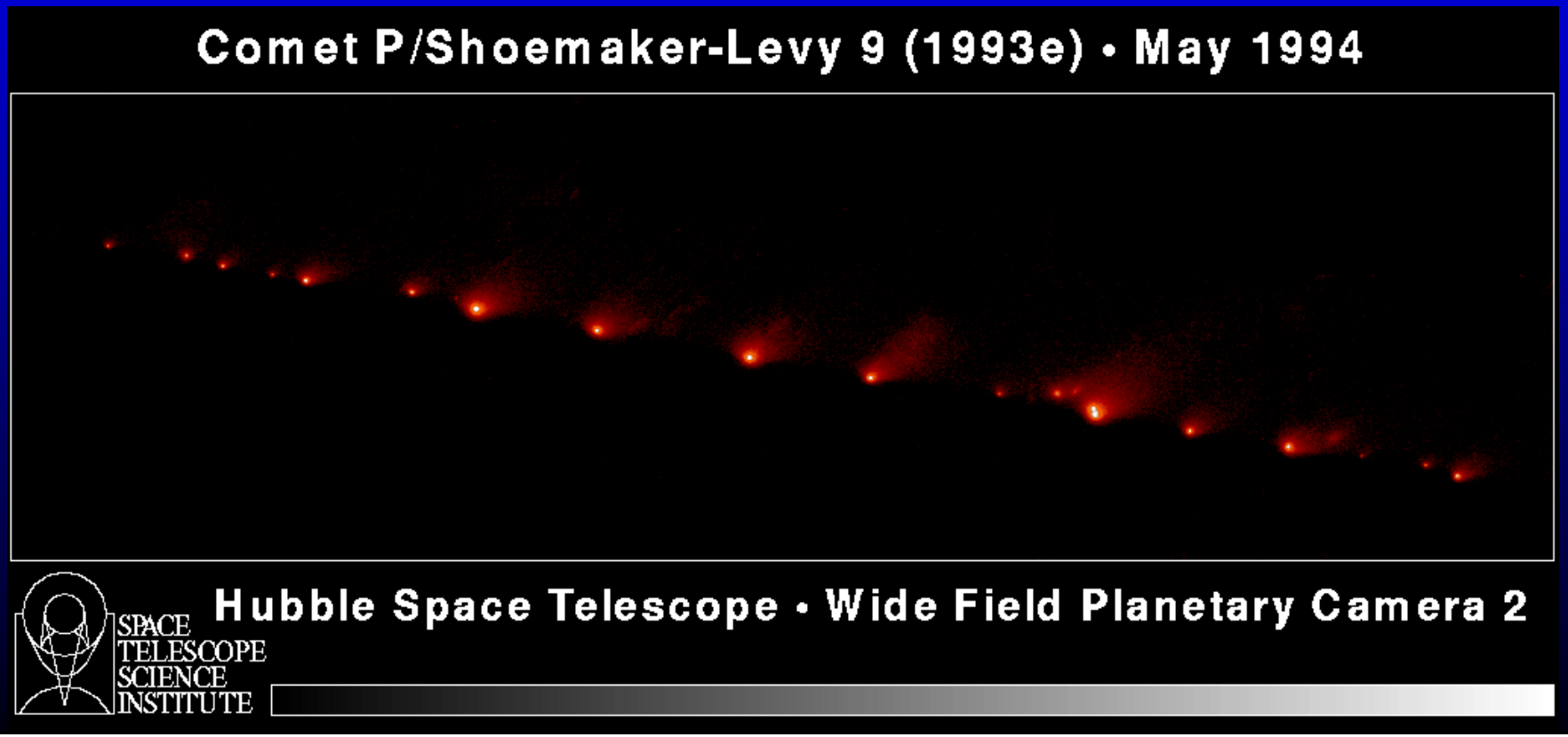
www.WilliamJosephGallery.com

Meteor Showers

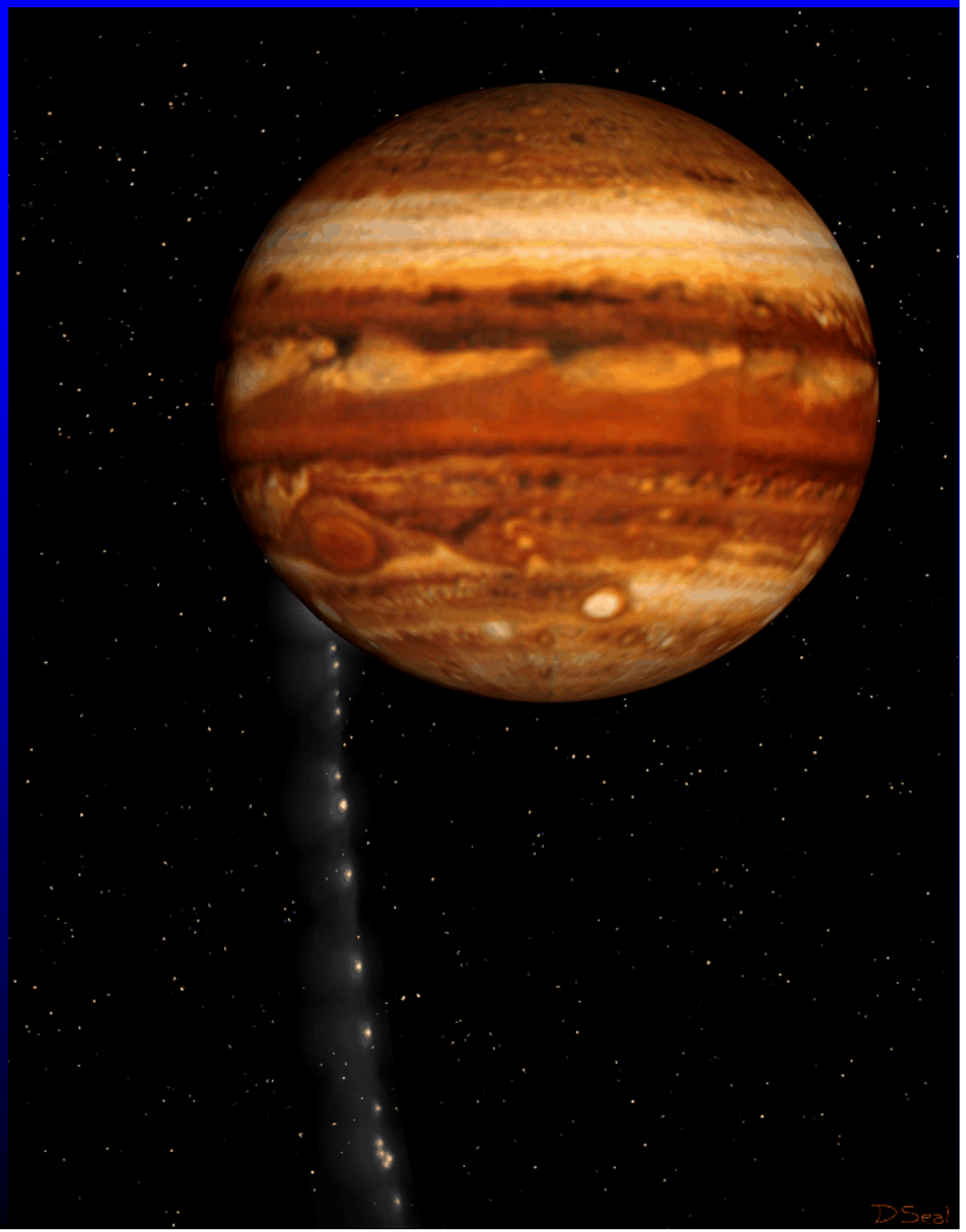
- When the Earth crosses the orbit of a short period comet we may observe a Meteor Shower
  - The Perseids
  - The Leonids

Shoemaker-Levy 9

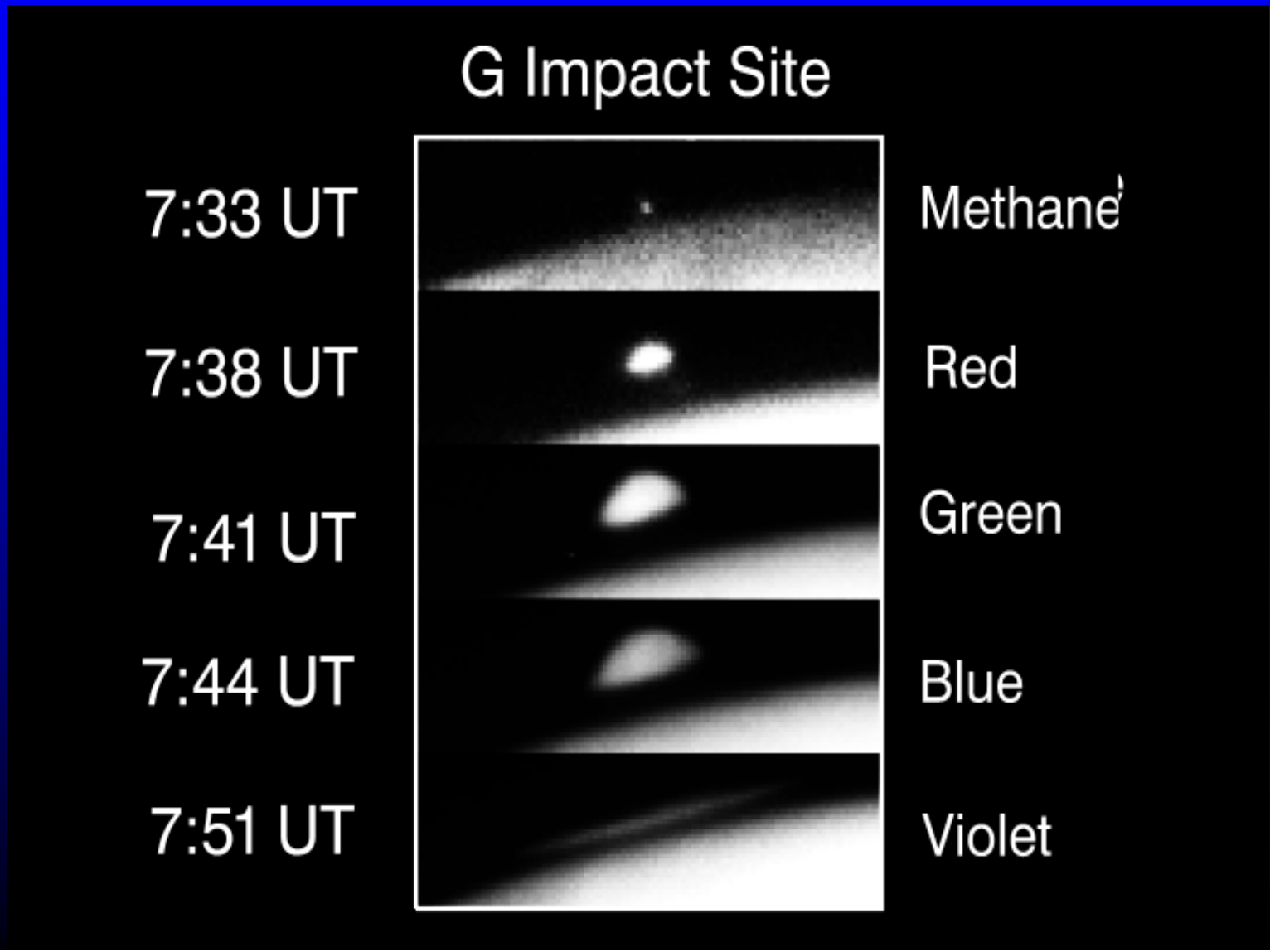
- The comet had been captured by Jupiter, whose tidal forces had broken it up into ~22 pieces.

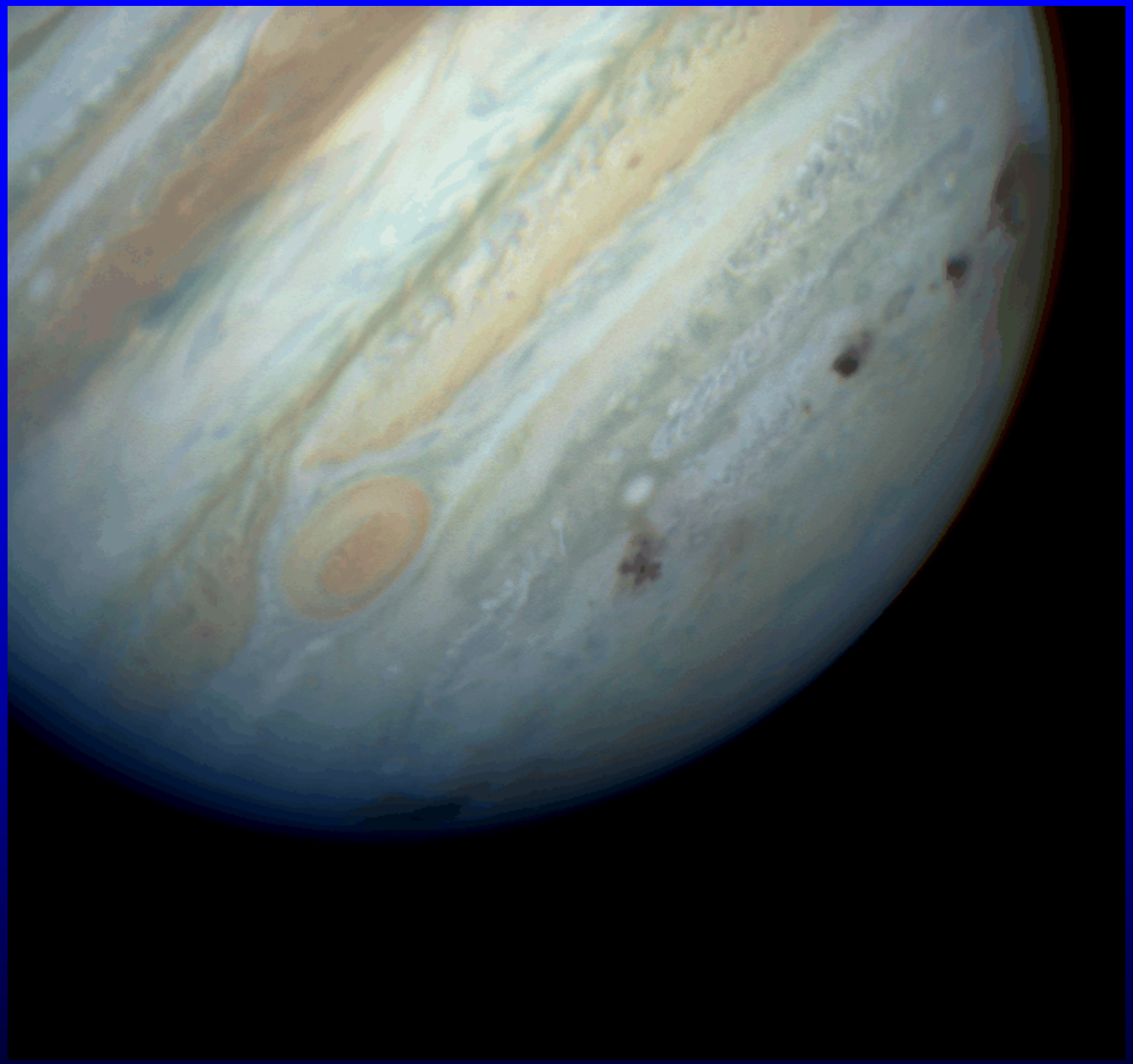


Impact with Jupiter!

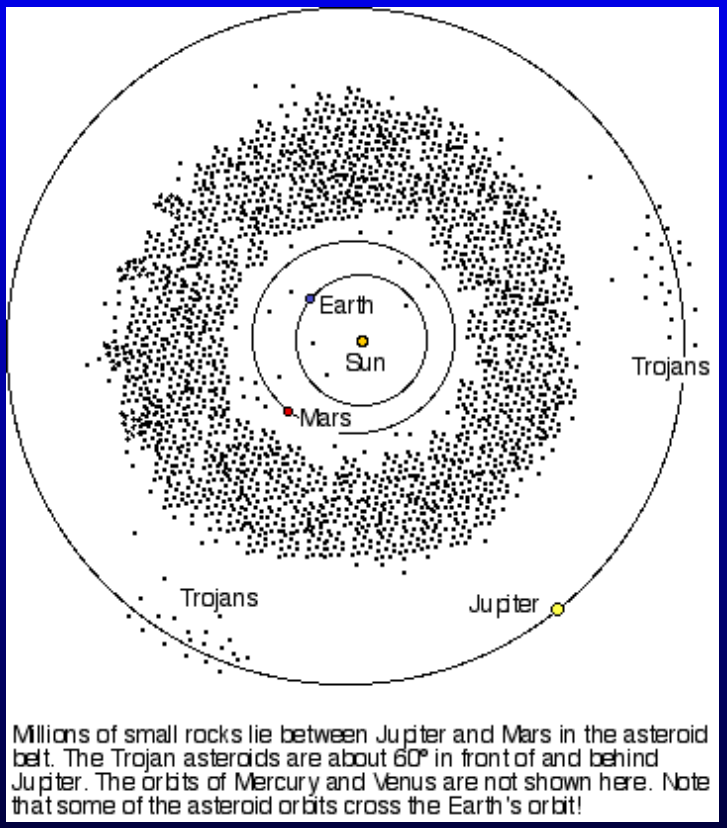


Seen by the Hubble Space Telescope

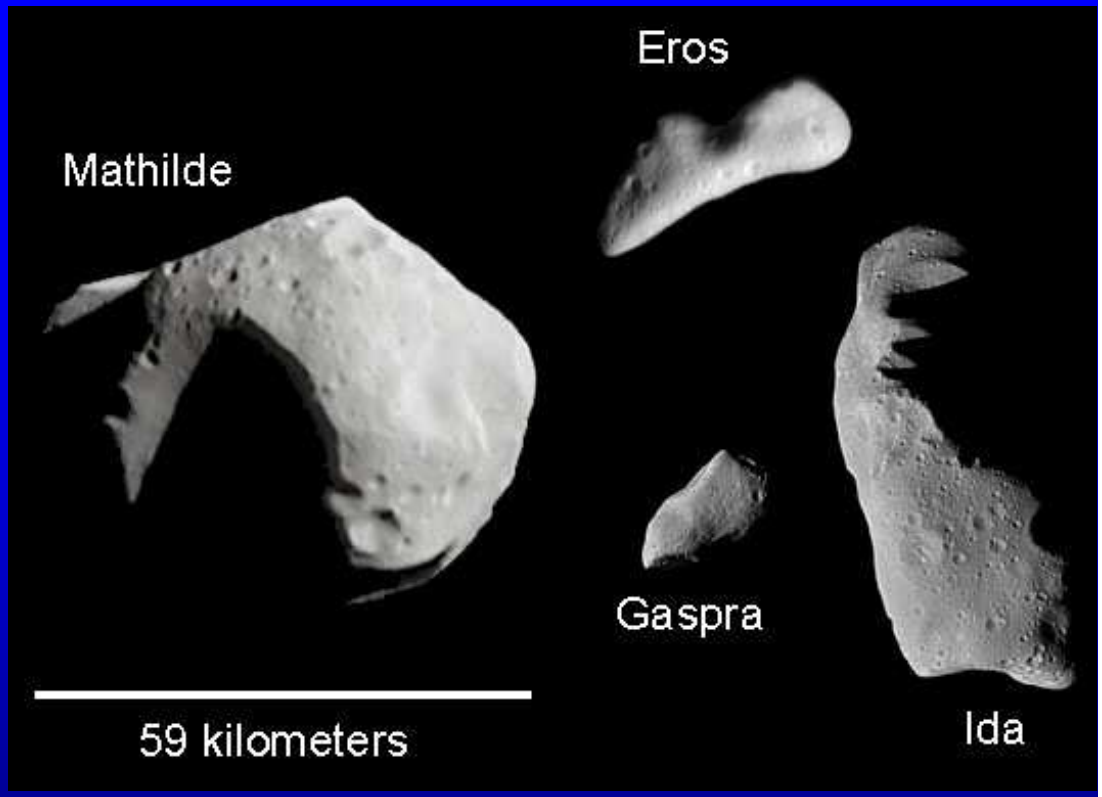




Asteroids



Millions of small rocks lie between Jupiter and Mars in the asteroid belt. The Trojan asteroids are about 60° in front of and behind Jupiter. The orbits of Mercury and Venus are not shown here. Note that some of the asteroid orbits cross the Earth's orbit!



- Lie between Mars and Jupiter
  - Main Belt

Ceres – first to be discovered
Now classed as a “Dwarf Planet”

- 6 greater than 300km across.
- 200 greater than 100km.
- 0.1% Mass of Earth
- 1/3 in Ceres

Impacts on Earth

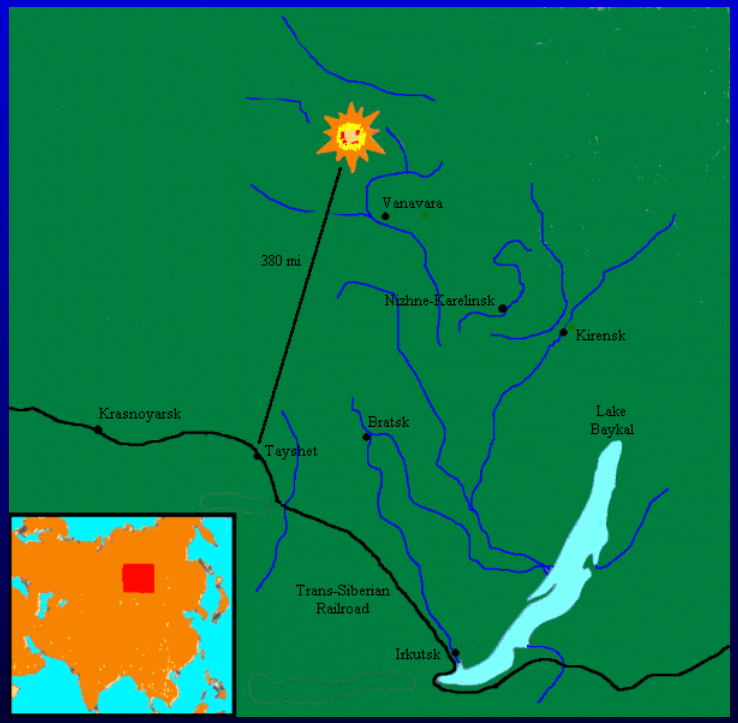
- The Arizona Crater

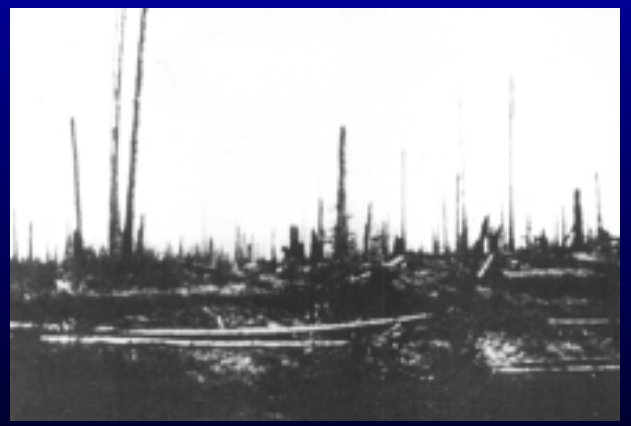
The end of the Dinosaurs

A Fatal Blow for the Dinosaurs!

Tunguska

- Tunguska June 1908





Comet Swift-Tuttle

- It was thought for a time that it could possibly impact with the Earth in 2126. We now believe that it will miss by 15 million miles – no problem.
- BUT keeps your heads down in 4497 – it could pass closer than 1 million miles!