Department of Physics and Astronomy

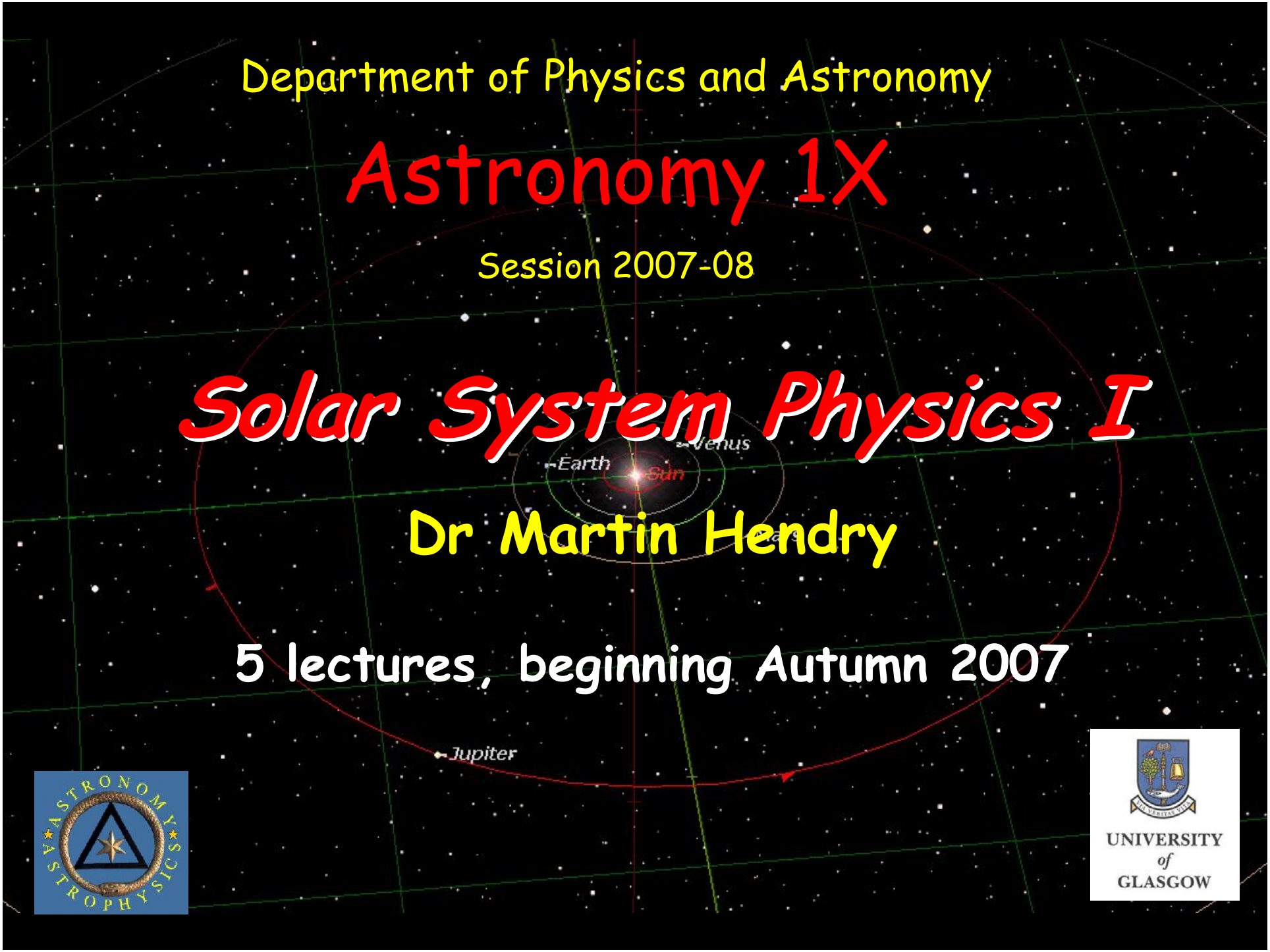
Astronomy 1X

Session 2007-08

Solar System Physics I

Dr Martin Hendry

5 lectures, beginning Autumn 2007



Dr Martin Hendry

- Room 607, Kelvin Building
- email: martin@astro.gla.ac.uk
- Tel: ext 5685
- Office hours: no formal time

Course information and handouts:
access via A1X moodle site

http://moodle.gla.ac.uk/physics/moodle/

Missed A1X enrolment on Wed 19th?...

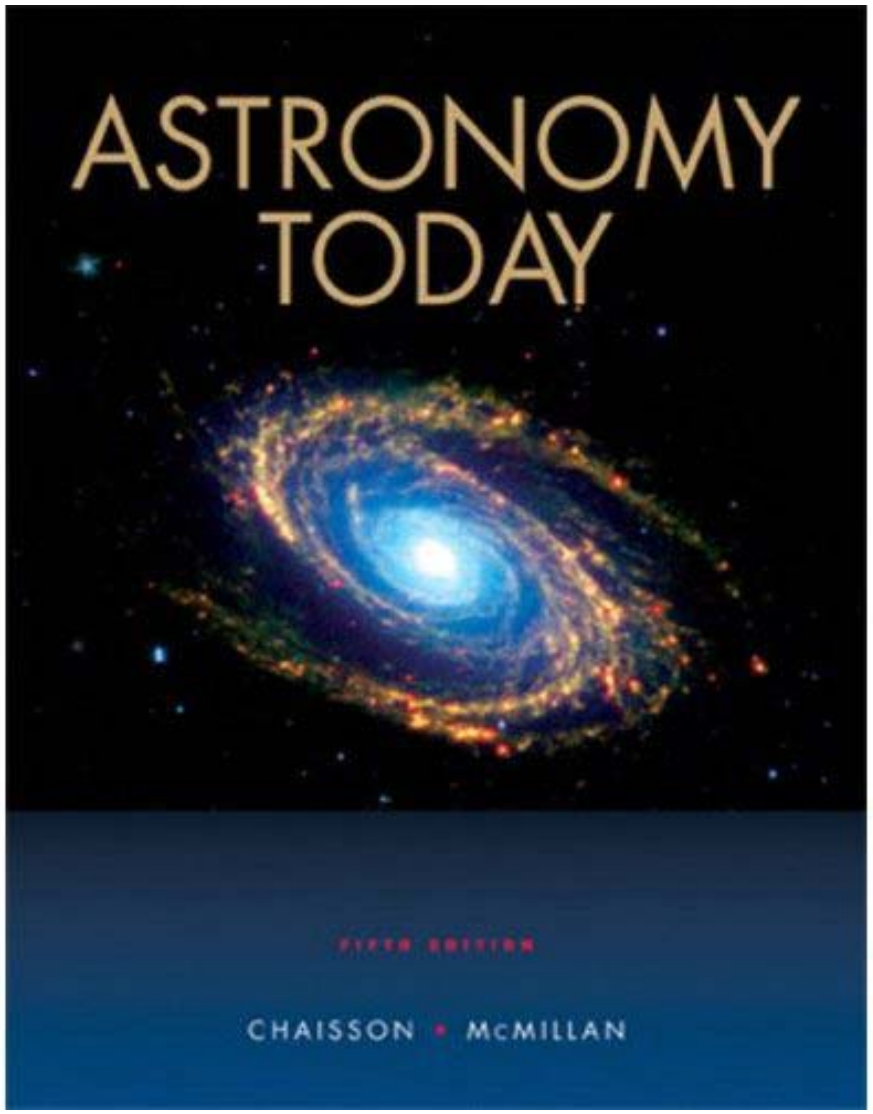
Come to see me at the end of today's lecture

Still to register on A1X moodle?...

Use your novell ID and password

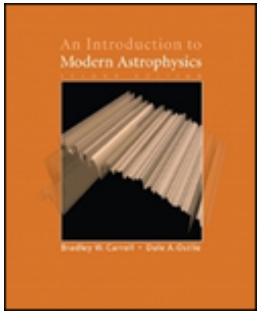
You will also need the ***A1 enrolment key***

orion



Course Textbook available as a **special package** from the University Bookshop:

Includes additional chapters from Carroll & Ostlie which are **essential** *to A1X,Y*



Cost £49.99

Includes access to online learning resources for Astronomy Today

www.coursecompass.com

course ID:

hendry35396

Astronomy A1X 2007-08
Solar System Physics I – Lecture Plan

2 lectures

Introductory Tour of the Solar System

- Qualitative description of the Sun, planets, moons and minor bodies, contrasting Jovian and terrestrial planets
- Some Solar System vital statistics
- Overview of Solar System formation

Gravitation and Solar System physics

- Newton's law of gravitation
- Surface gravity and escape speed
- Tidal forces

Links to A1X Dynamical Astronomy

Astronomy A1X 2007-08
Solar System Physics I – Lecture Plan

3 lectures

The physics of planetary atmospheres

- The ideal gas law and velocity of gases
- Hydrostatic equilibrium and atmospheric scale heights

The Jovian planets and their moons

- Internal and atmospheric structure and composition
- Ring systems and Roche stability
- Physical properties of the main satellites
- Case study: the Galilean moons

Section 1: A Tour of the Solar System

Some vital statistics:-

The Solar System consists of:-

- the Sun,
- its 8 planets,
- their moons,
- dwarf planets, asteroids and comets,
- the 'Solar wind'

- Astronomers have studied the motions of the Sun, Moon and planets for thousands of years (see A1X Positional Astronomy)

Retrograde motion

Section 1: A Tour of the Solar System

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- the Sun,
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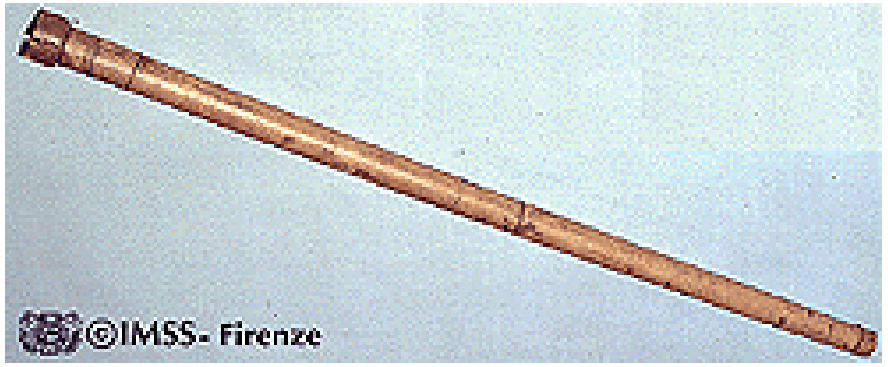
- dwarf planets, asteroids and comets,
- the 'Solar wind'

- Astronomers have studied the motions of the Sun, Moon and planets for thousands of years (see A1X Positional Astronomy)

- Before the invention of the telescope, however, we knew almost nothing about their true nature.

The Observations of Galileo

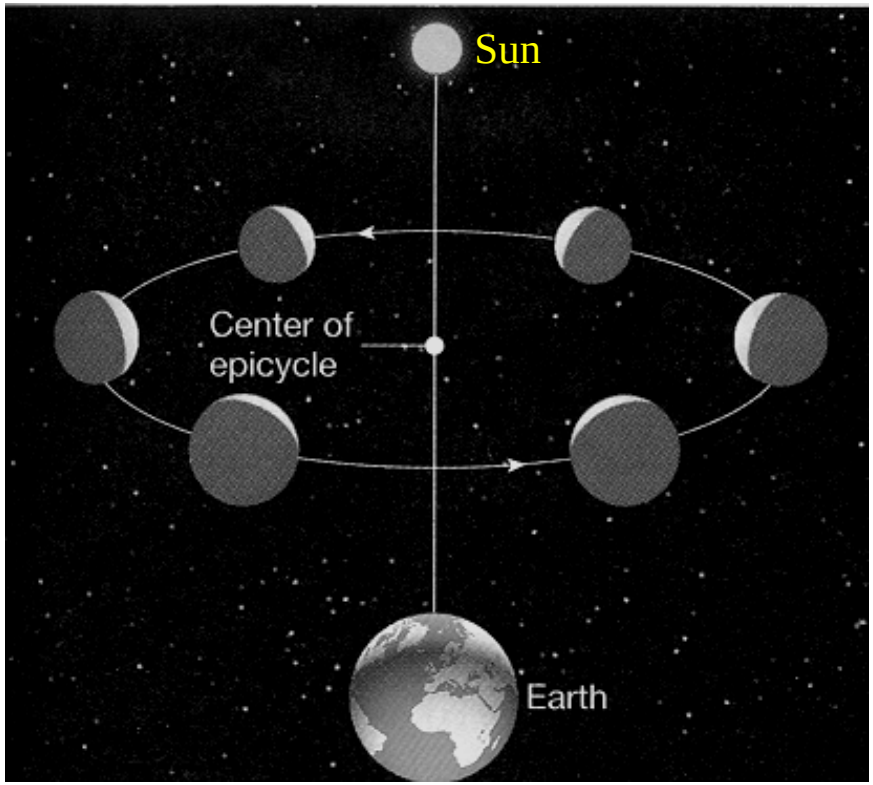
Galileo Galilei:
(1564 – 1642)



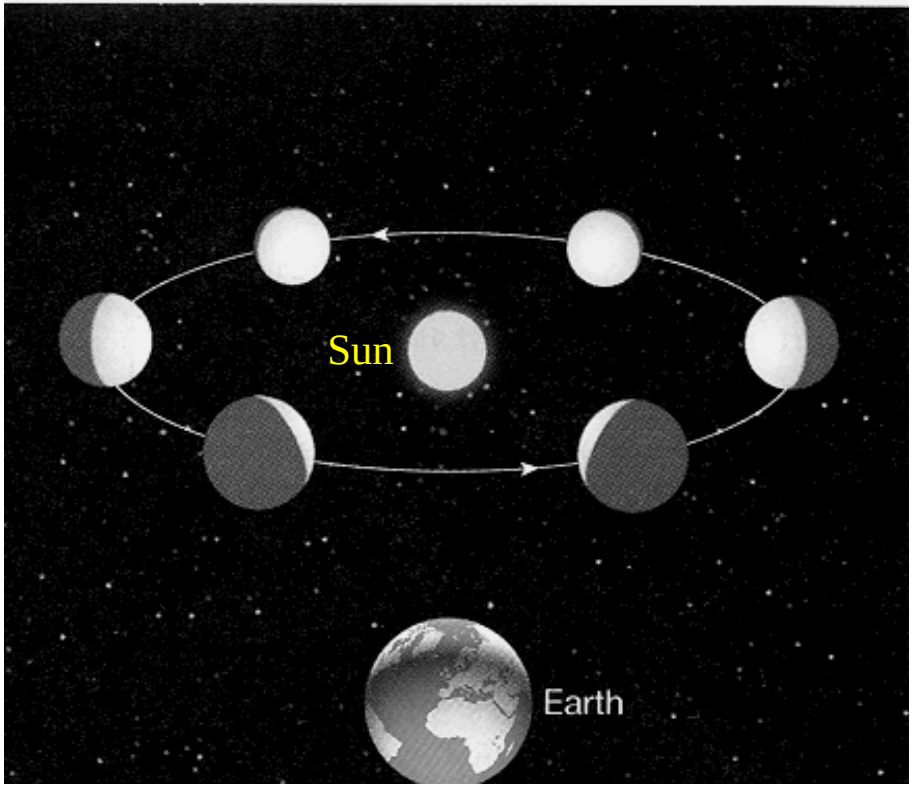
The Observations of Galileo

In 1609 Galileo observed phases of Venus

Geocentric model



Heliocentric model



The Observations of Galileo

Phases of Venus impossible to explain in geocentric model

Clear evidence that the Earth went round the Sun, and not the other way round

The Sun: some vital statistics:

The Sun is a star: a ball of (mainly) hydrogen gas,
700,000 km in radius (about 100 Earth radii)


Earth, to scale

The Sun: some vital statistics:

The Sun is a star: a ball of (mainly) hydrogen gas, 700,000 km in radius (about 100 Earth radii)

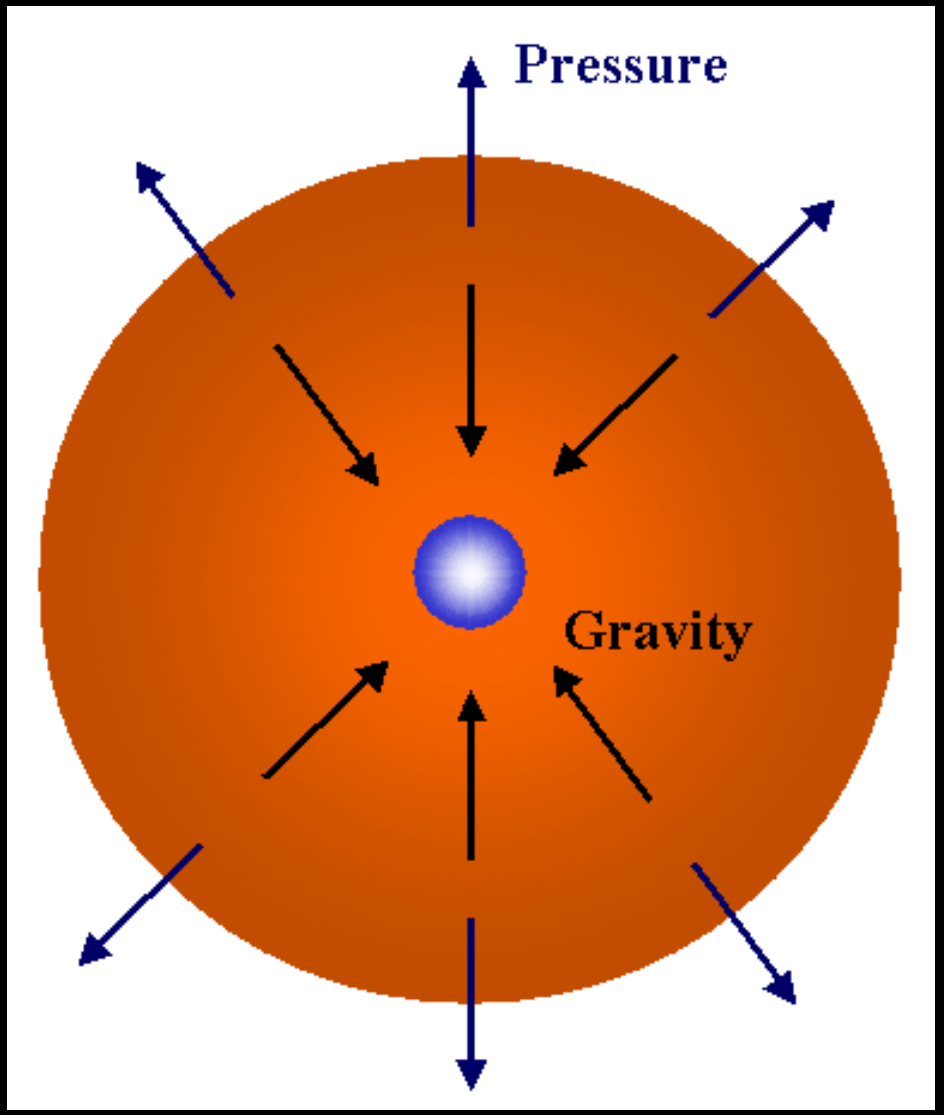
It generates heat and light through **nuclear fusion**:

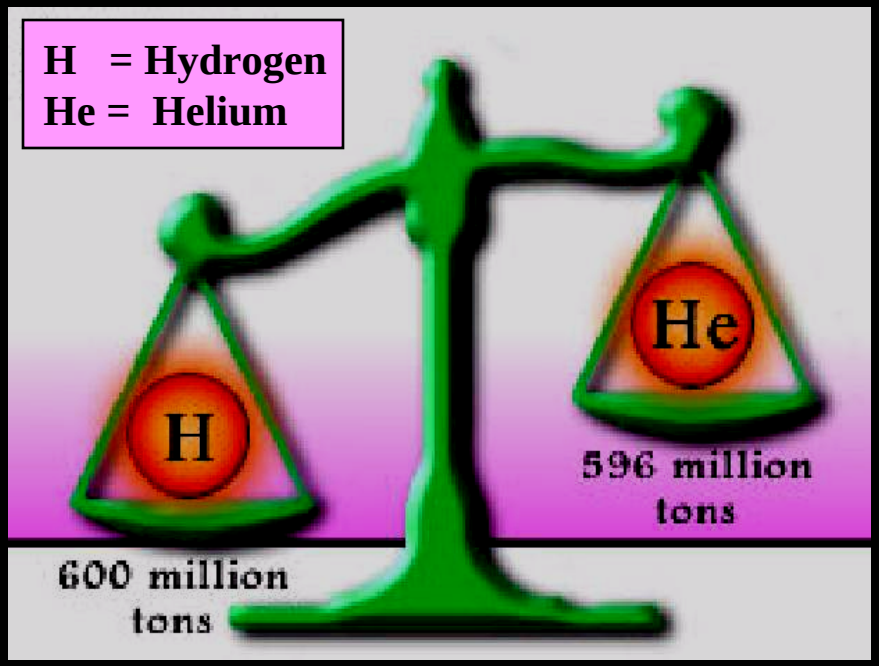
Surface temperature = 5800K

Central temperature = ~15 million K

Balance (hydrostatic equilibrium) maintained between *pressure* and *gravity*

Hydrogen fusion – fuelling a star's nuclear furnace





$E = mc^2$

The Sun: some vital statistics:

The Sun is a star: a ball of (mainly) hydrogen gas, 700,000 km in radius (about 100 Earth radii)

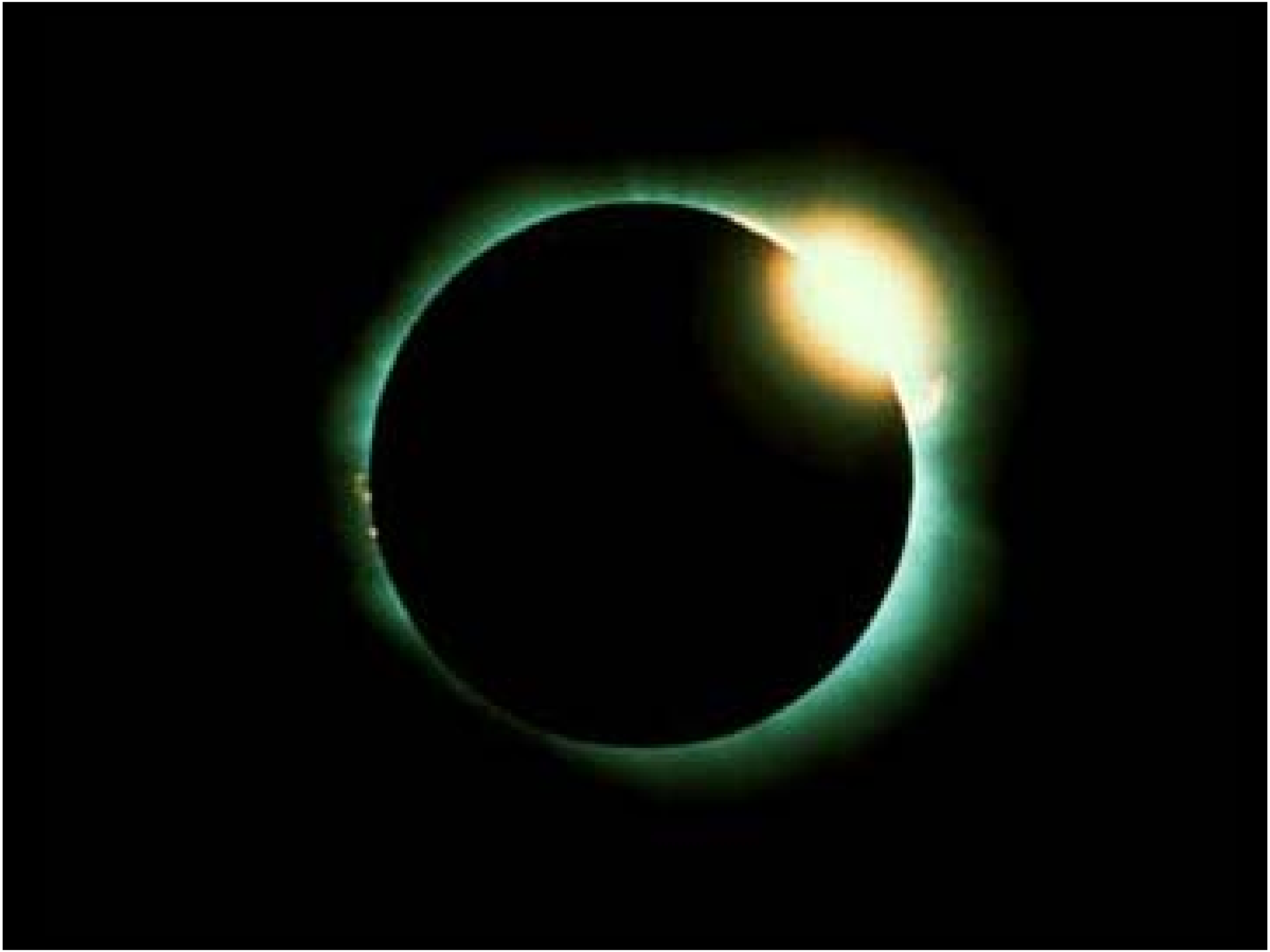
It generates heat and light through **nuclear fusion**:

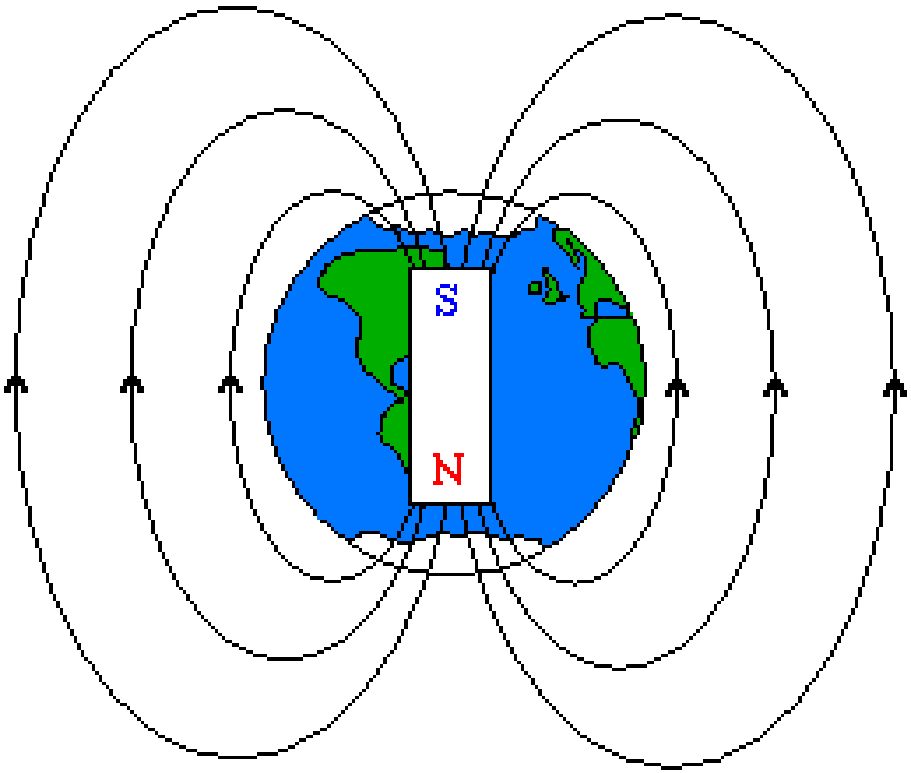
Surface temperature = 5800K

Central temperature = ~15 million K

Balance (hydrostatic equilibrium) maintained between *pressure* and *gravity*

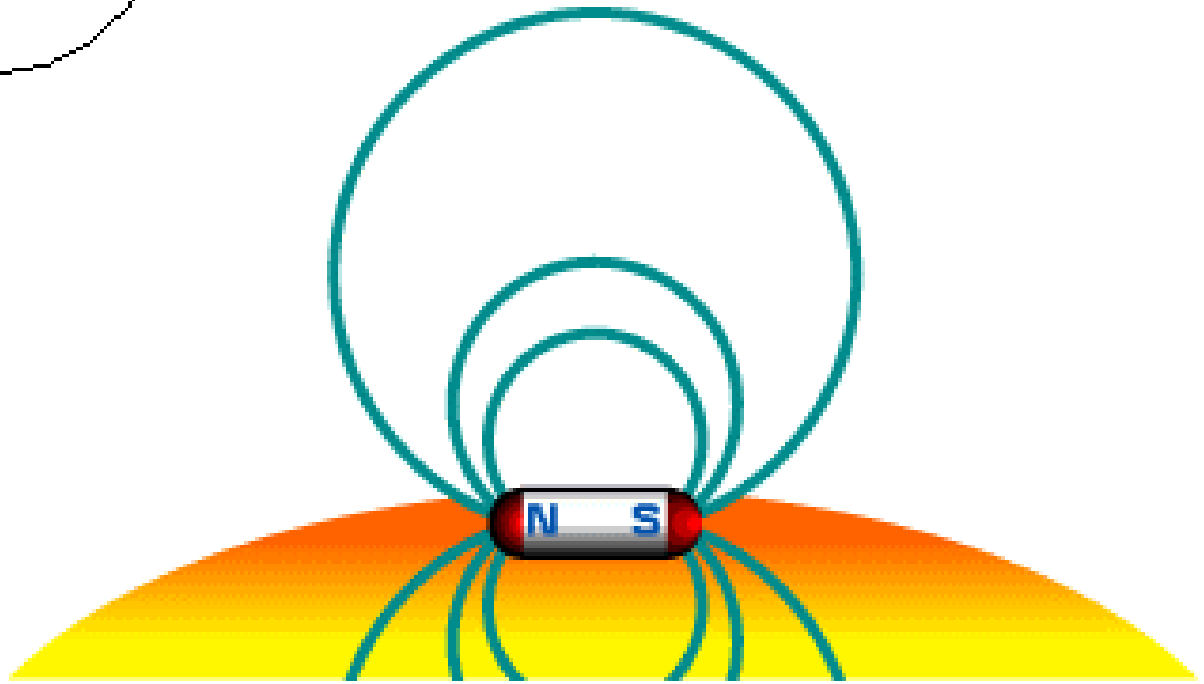
The Sun's outer atmosphere, or *corona*, is very hot (several million K) – heated by twisting of the Sun's magnetic field

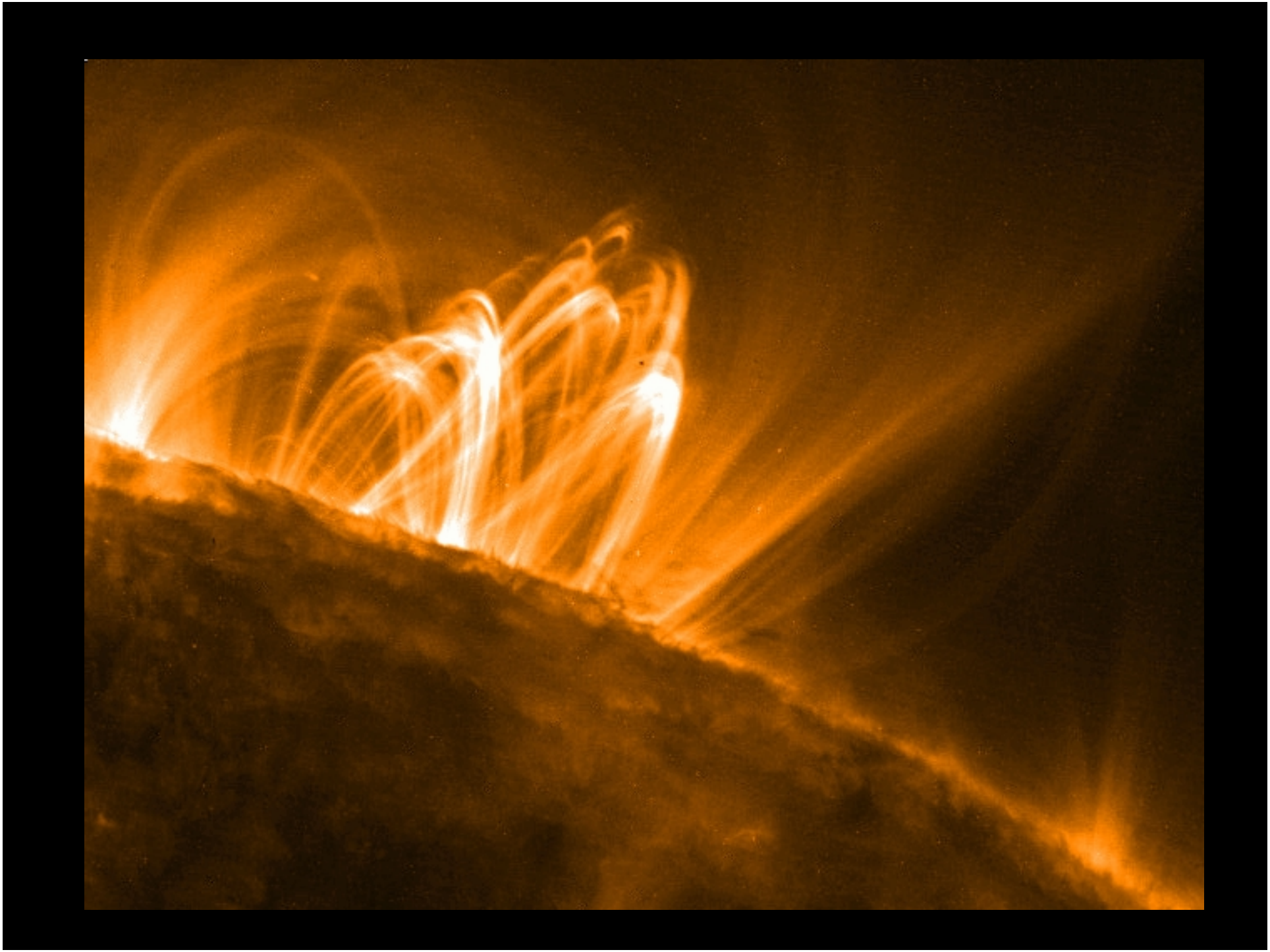


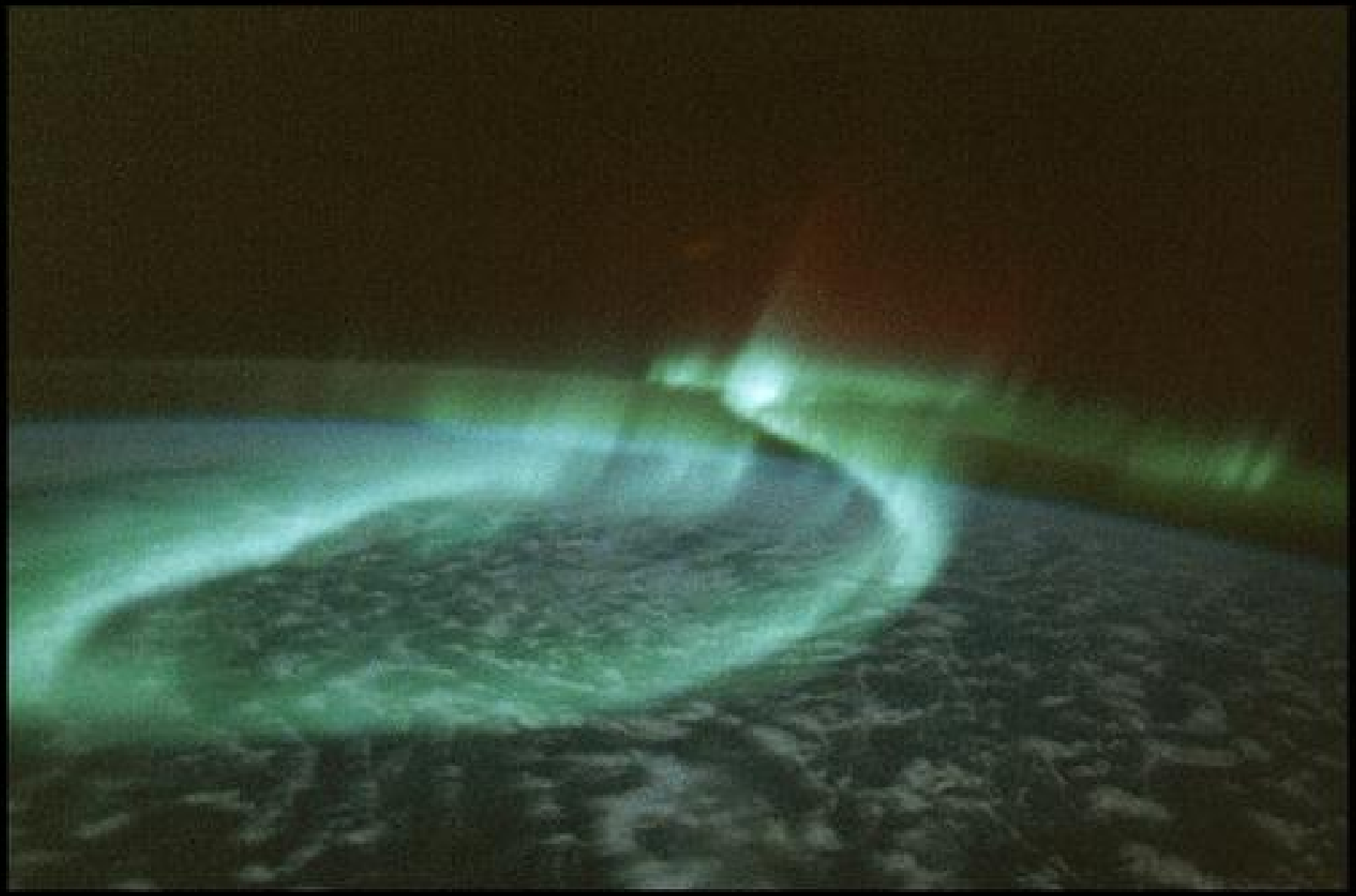


Earth’s magnetic field

Magnetic fields on the sun







Section 1: A Tour of the Solar System

The Planets: some vital statistics:-

Name	Diameter* (Earth=1)	Mass (Earth=1)	Mean distance from the Sun
Mercury	4880 km (0.383)	3.302×10^{23} kg (0.055)	5.79×10^{7} km (0.387 AU)
Venus	12104 km (0.949)	4.869×10^{24} kg (0.815)	1.082×10^{8} km (0.723 AU)
Earth	12756 km (1.000)	5.974×10^{24} kg (1.000)	1.496×10^{8} km (1.000 AU)
Mars	6794 km (0.533)	6.418×10^{23} kg (0.107)	2.279×10^{8} km (1.524 AU)
Jupiter	142984 km (11.209)	1.899×10^{27} kg (317.8)	7.783×10^{8} km (5.203 AU)
Saturn	120536 km (9.449)	5.685×10^{26} kg (95.16)	1.432×10^{9} km (9.572 AU)
Uranus	51118 km (4.007)	8.682×10^{25} kg (14.53)	2.871×10^{9} km (19.194 AU)
Neptune	49528 km (3.883)	1.024×10^{26} kg (17.15)	4.498×10^{9} km (30.066 AU)
Pluto	~2300 km (0.18)	1.3×10^{22} kg (0.0021)	5.915×10^{9} km (39.537 AU)

* Equatorial diameter

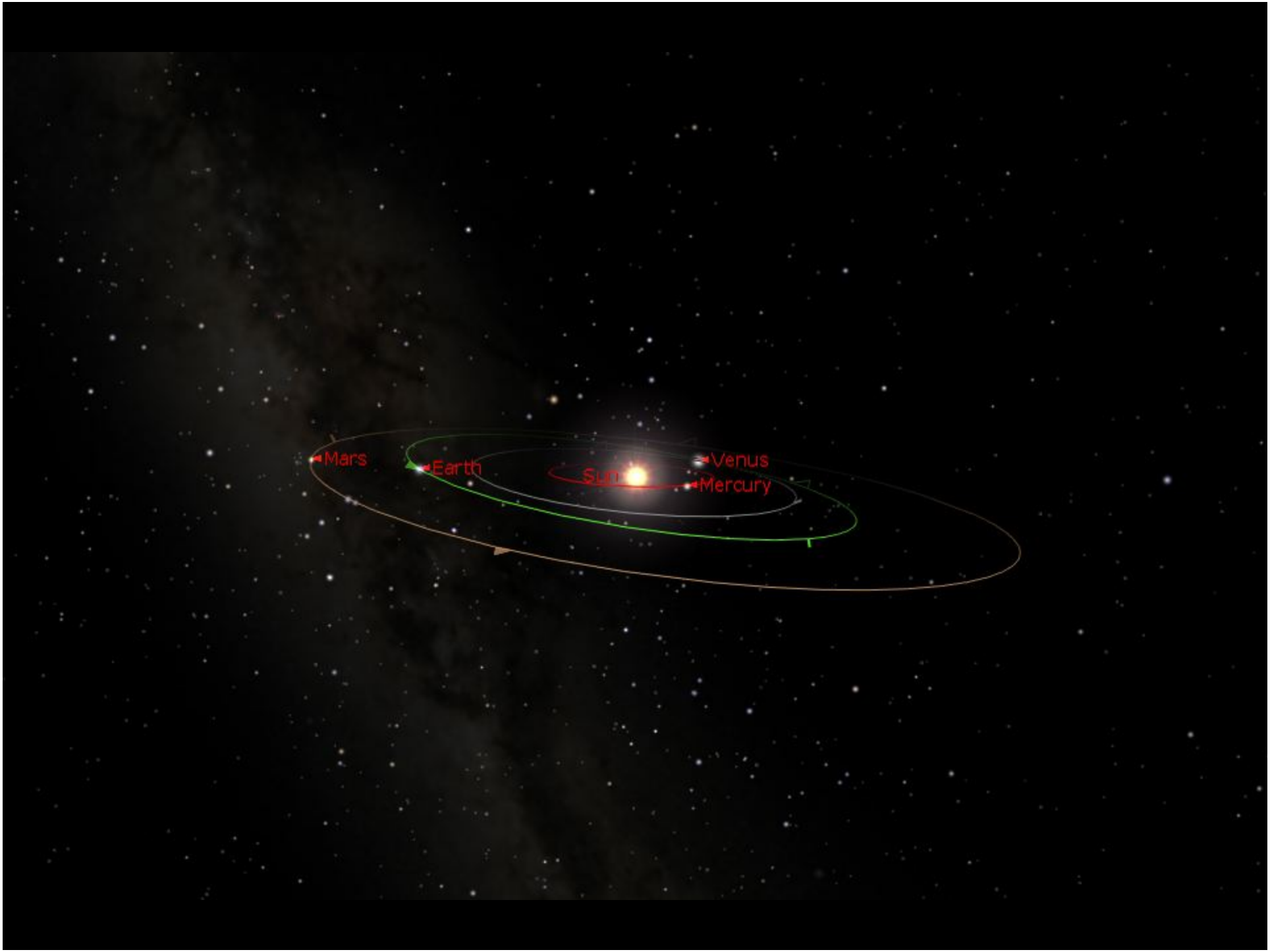
See also table 6.1 in Astronomy Today

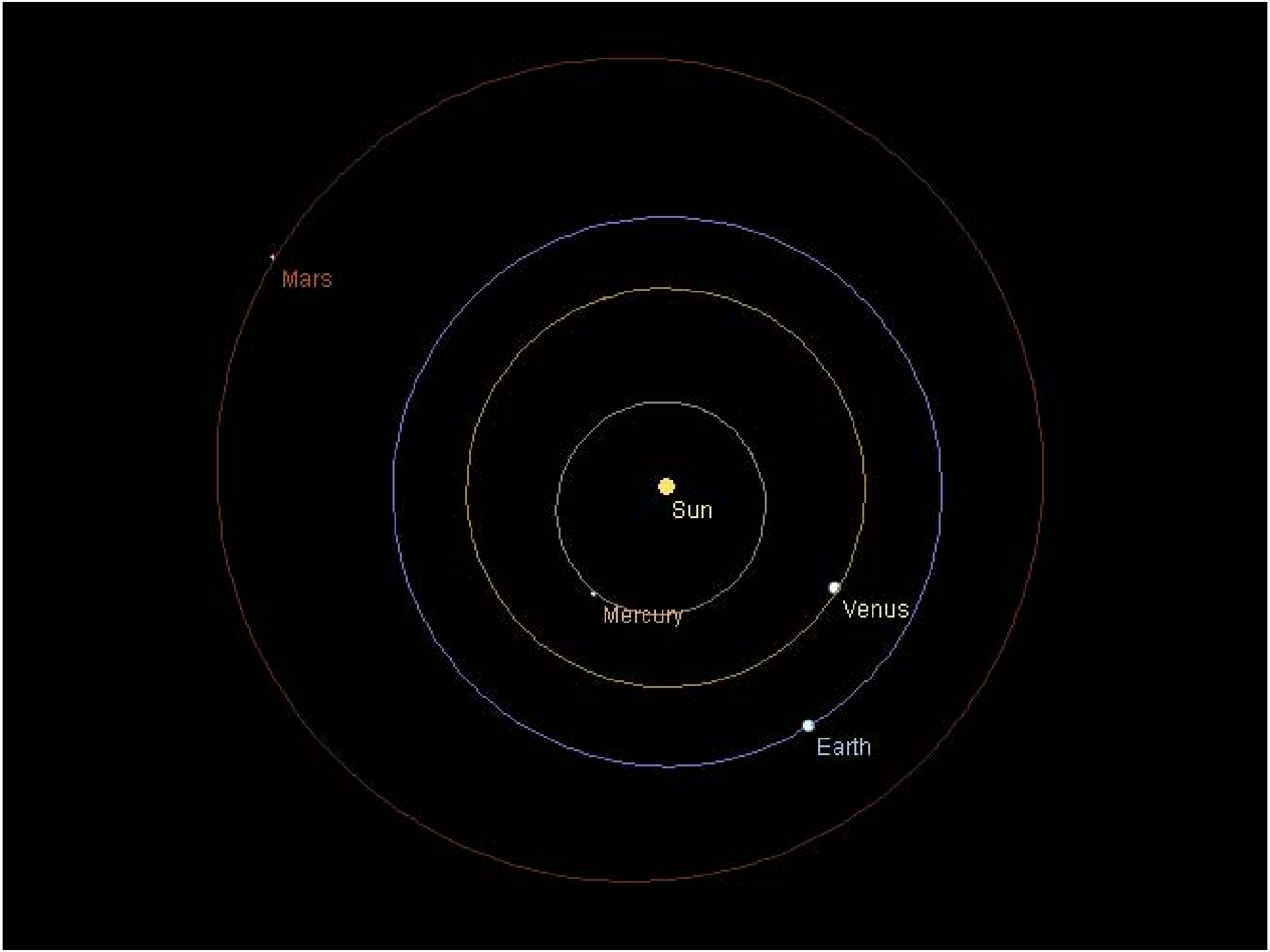
Mean Earth – Sun distance = **Astronomical Unit**

149,597,870 km

1 A.U. = 107 solar diameters

The orbits of the planets are ellipses and lie in, or close to, a plane – the ecliptic. (See A1X Dynamical Astronomy).


Mars
Earth
Sun
Venus
Mercury


Mars
Sun
Mercury
Venus
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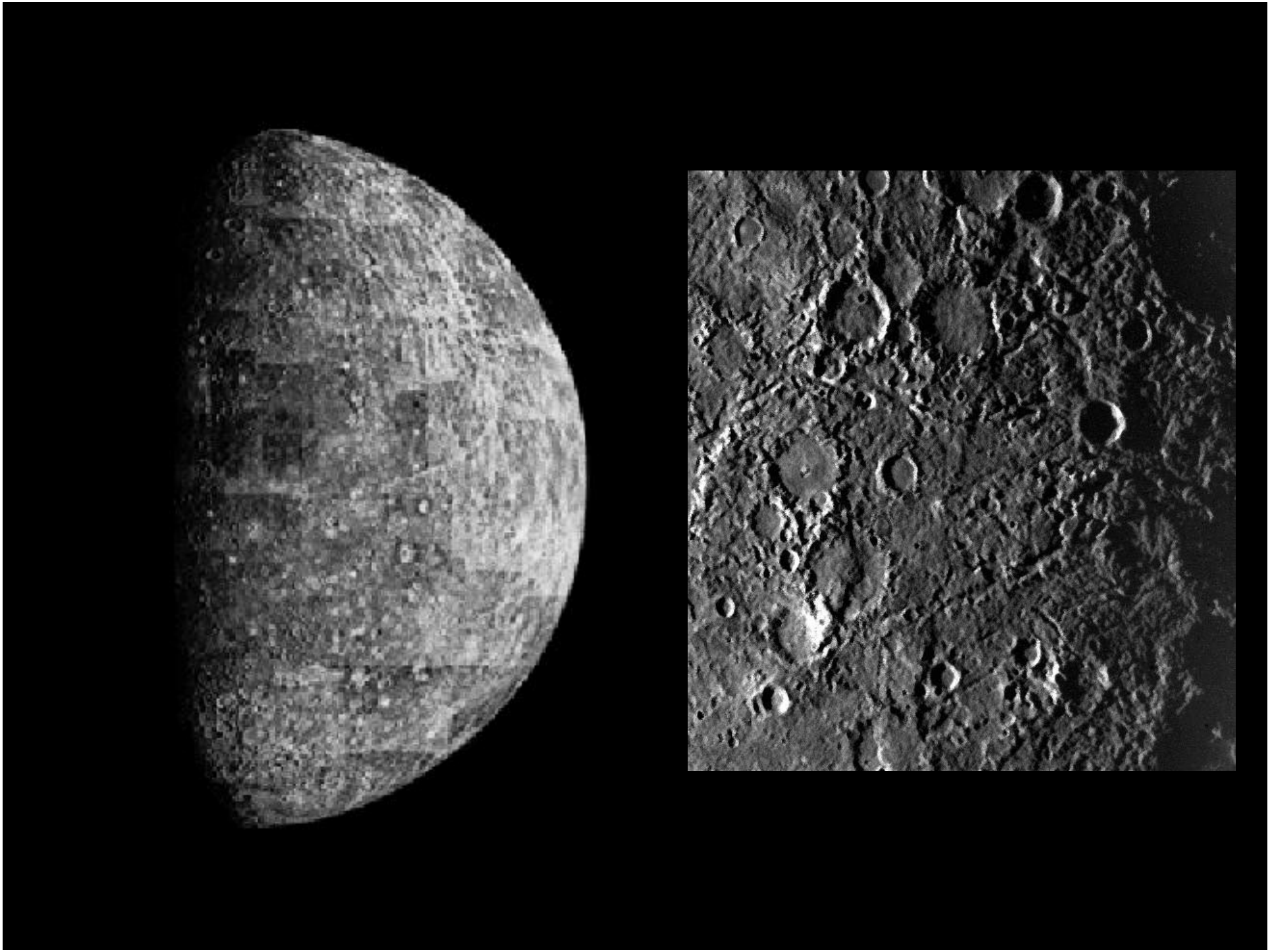
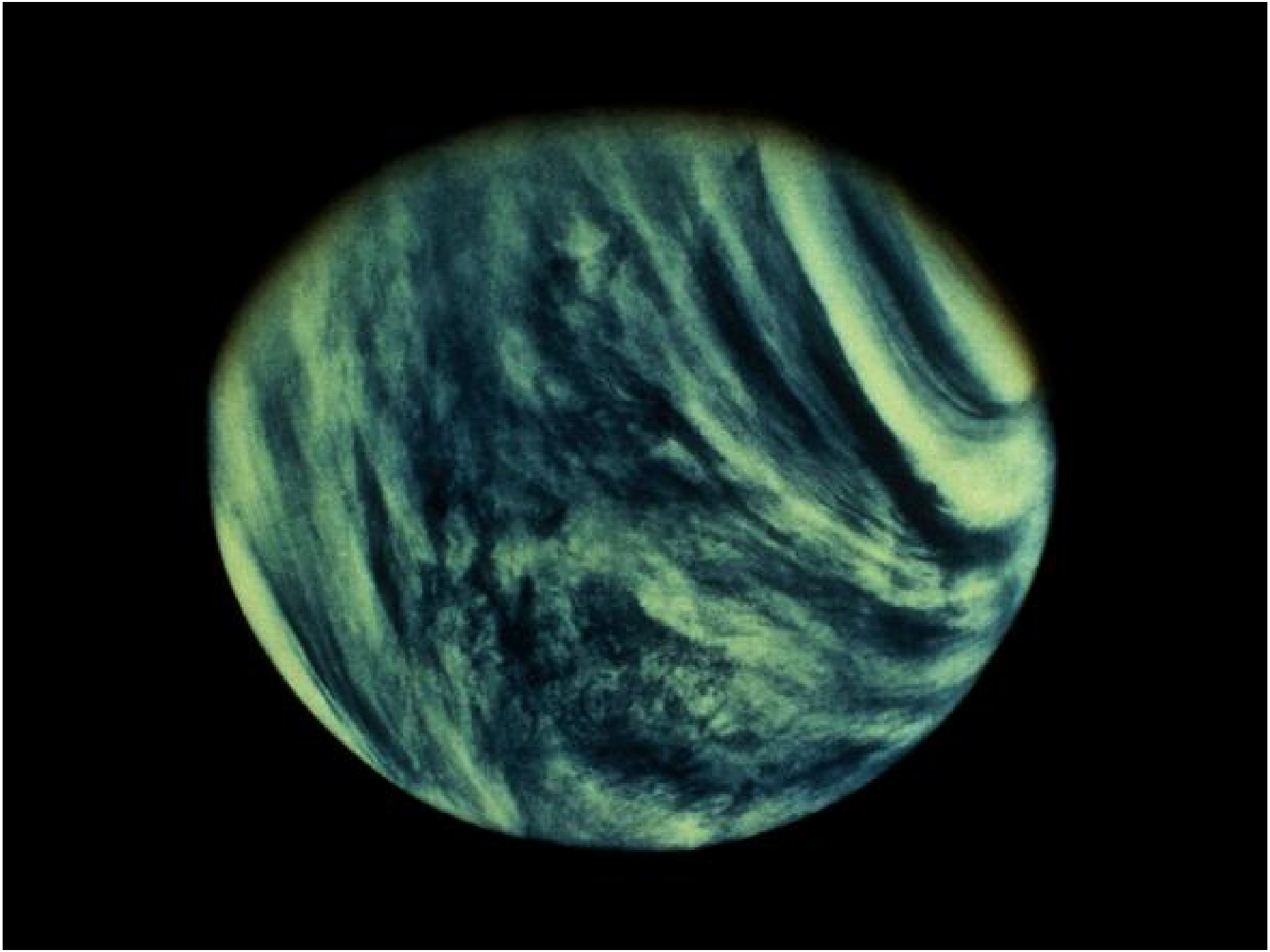
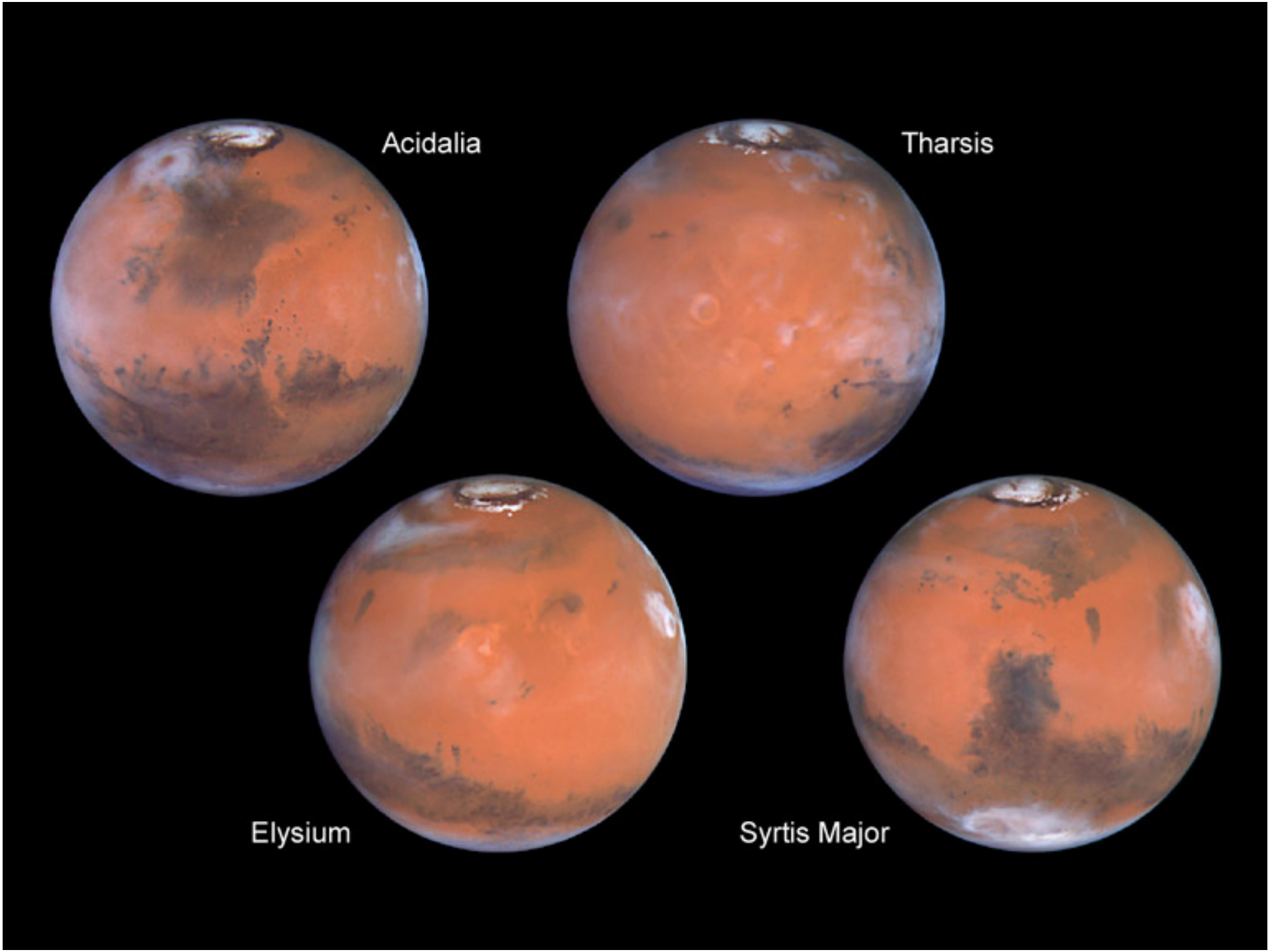
The planets divide into two groups:

Inner *Terrestrial* planets: small, rocky — **Mercury, Venus, Earth, Mars**

Outer *Jovian* planets: gas giants — **Jupiter, Saturn, Uranus, Neptune**

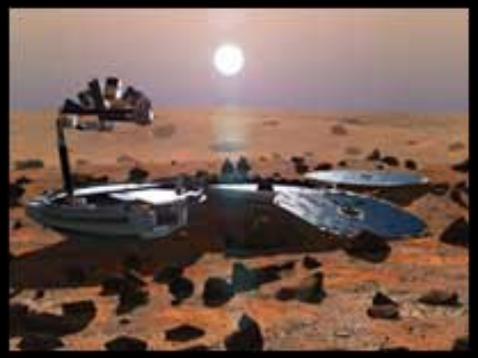


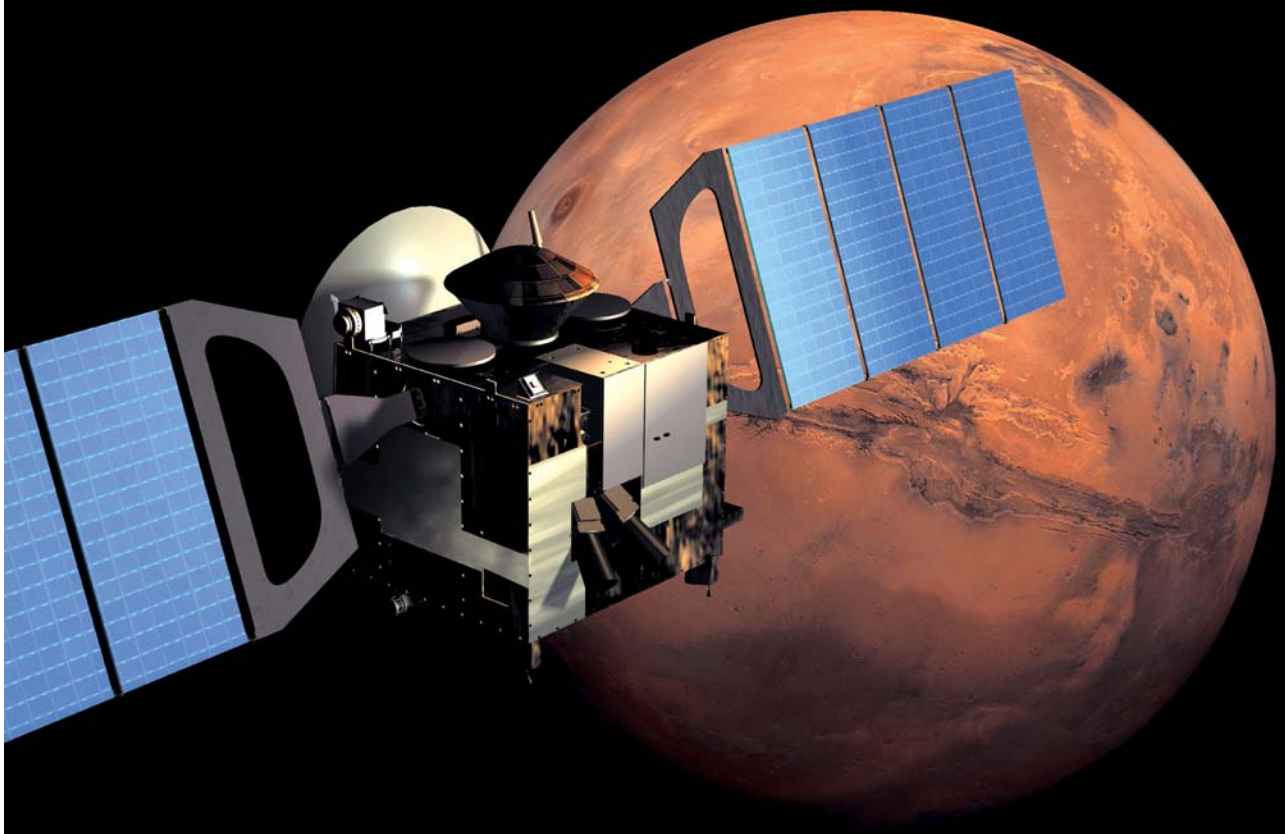


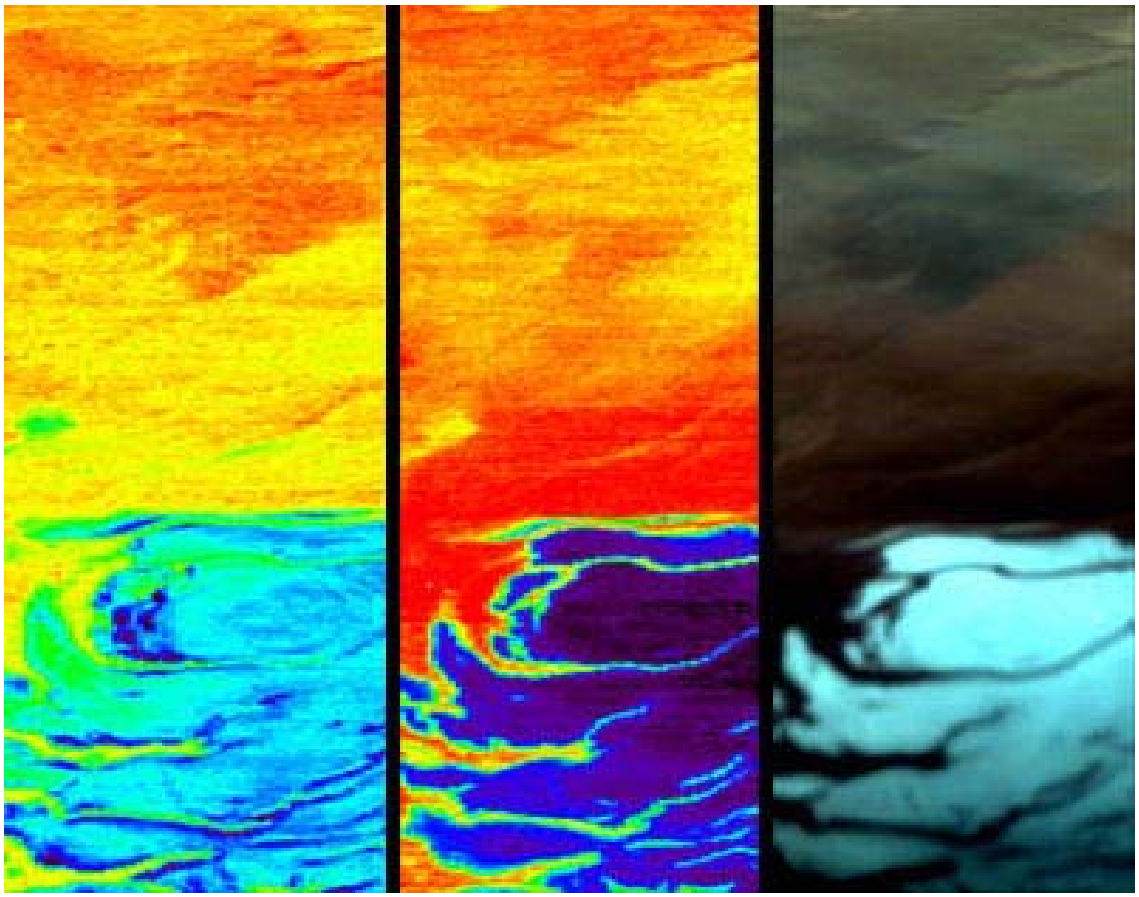

Acidalia
Tharsis
Elysium
Syrtis Major

Mars 2004:

- Mars Express (+ Beagle 2)
- Spirit + Opportunity



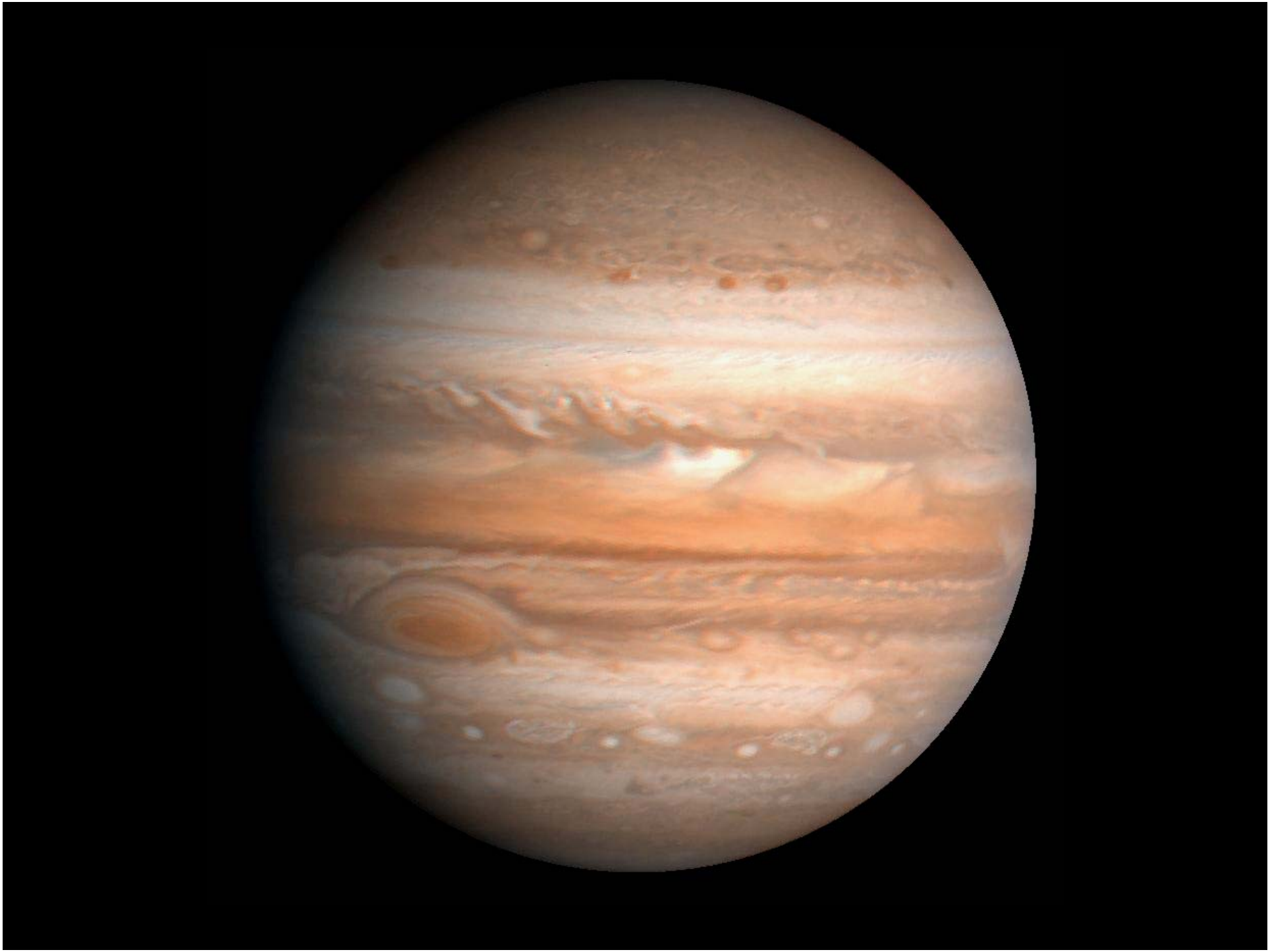


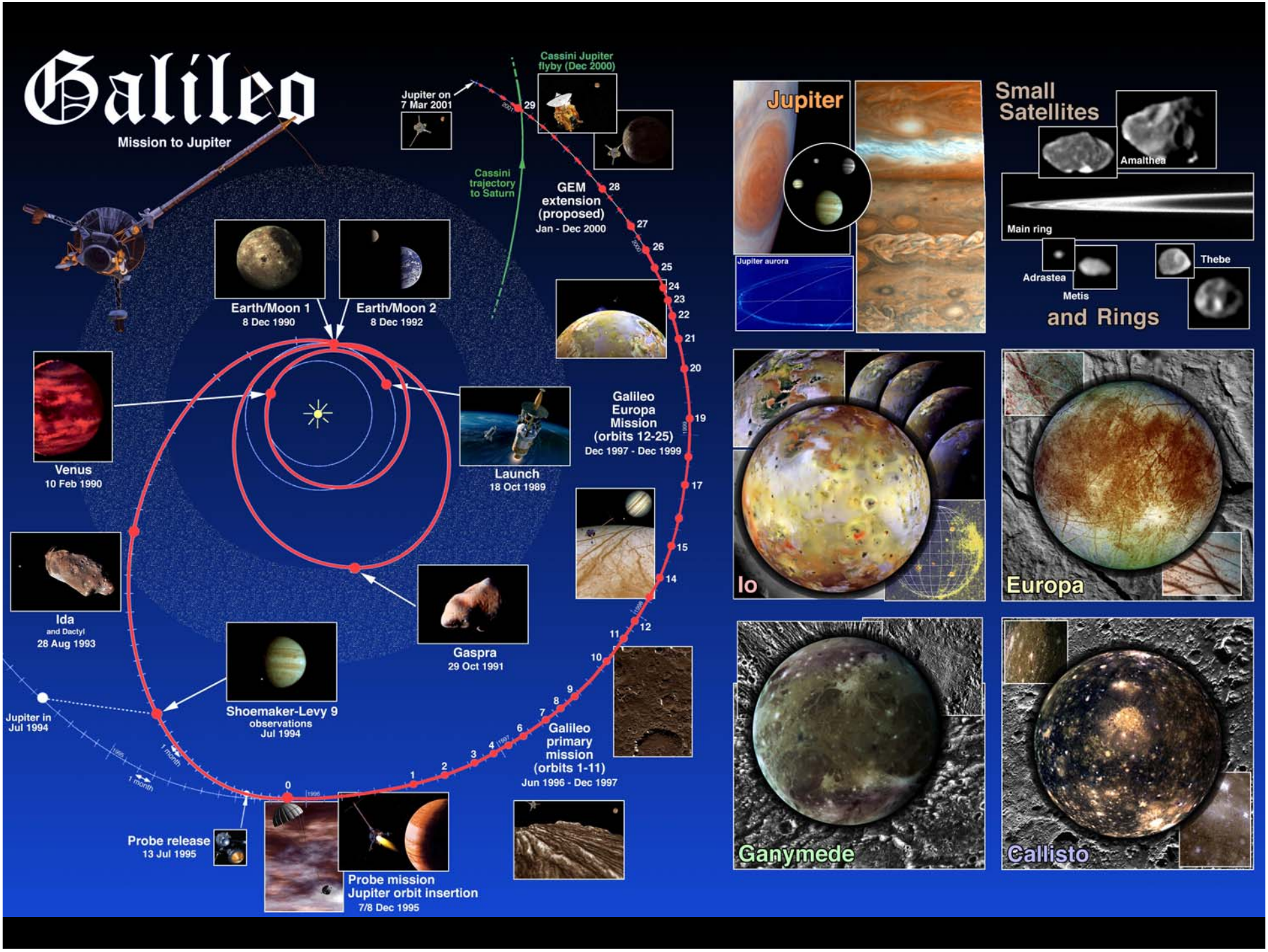


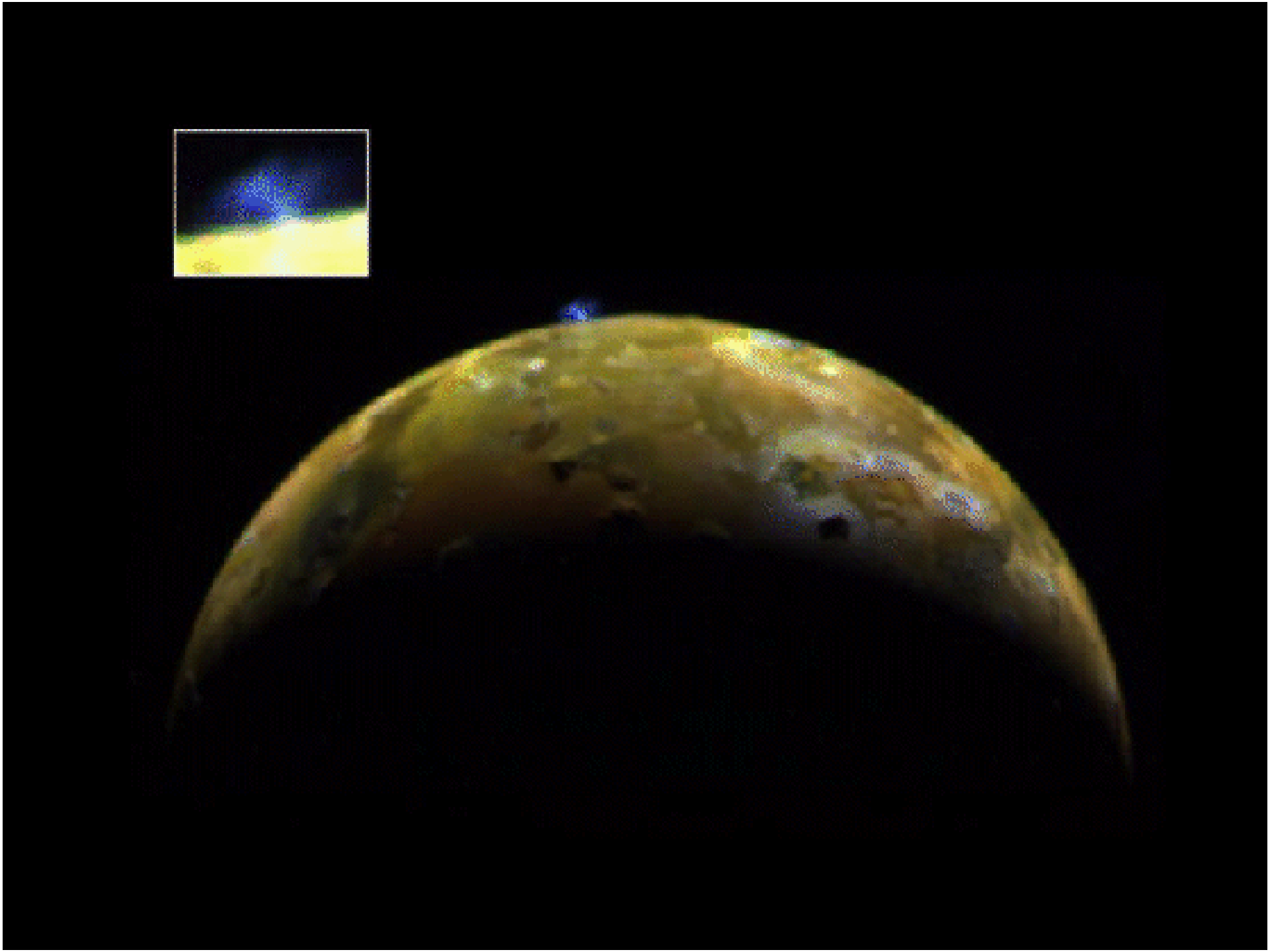
H_2O CO_2 Visible light

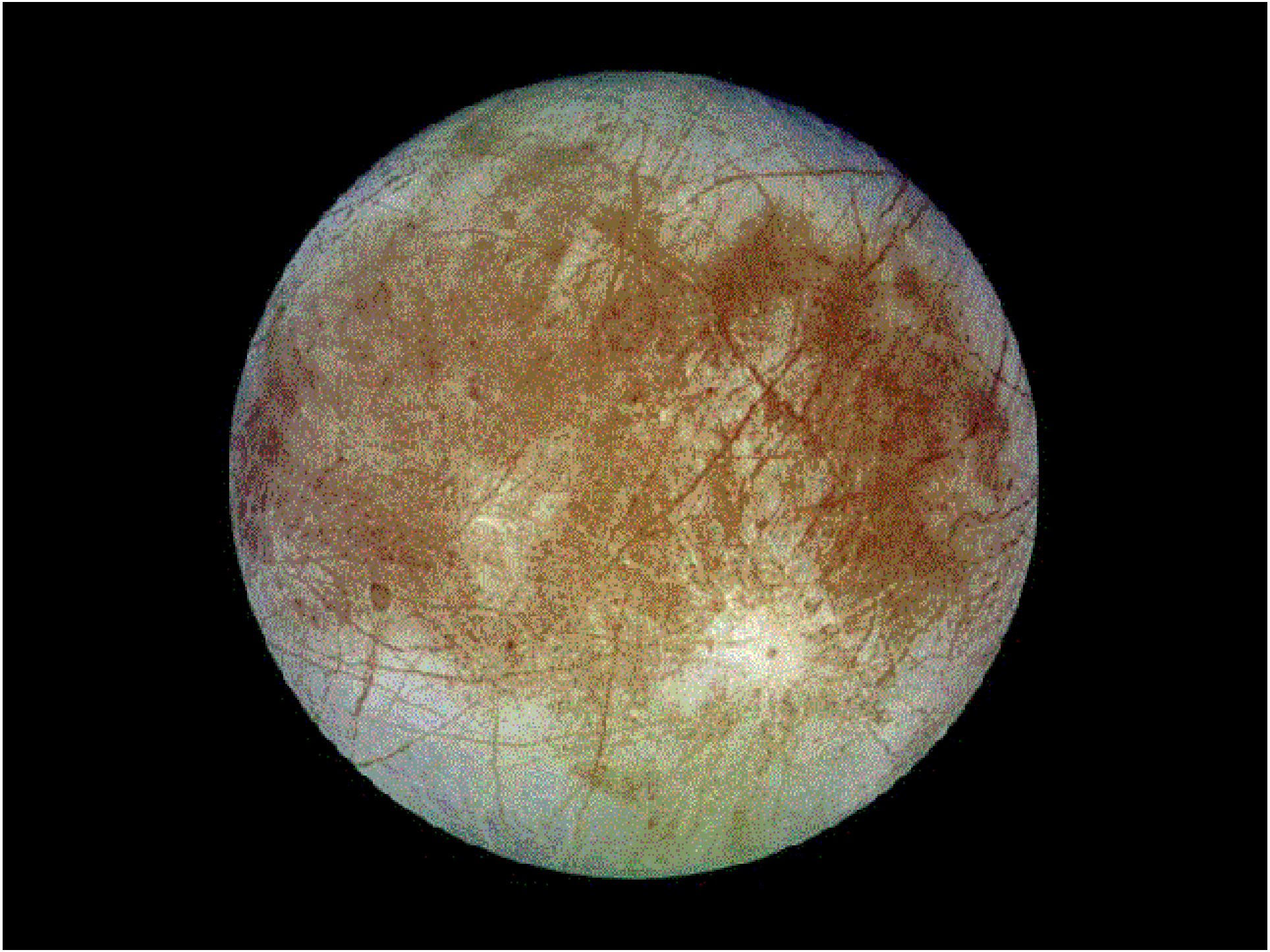
January 2004:

Mars Express Orbiter detects water ice at the South Pole of Mars.

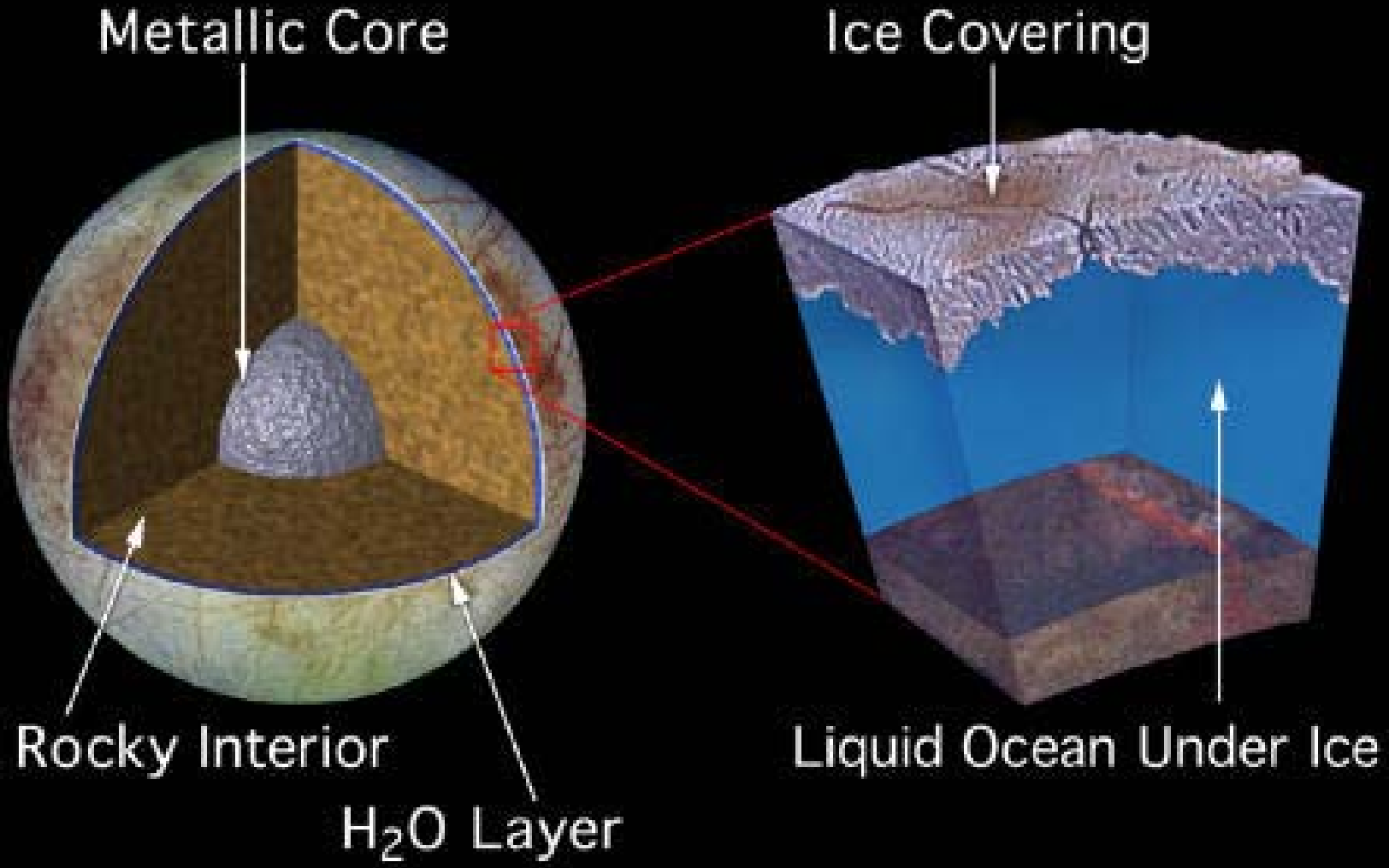



Galileo
Mission to Jupiter
Jupiter on
7 Mar 2001
Cassini Jupiter
flyby (Dec 2000)
Cassini
trajectory
to Saturn
GEM
extension
(proposed)
Jan - Dec 2000
Earth/Moon 1
8 Dec 1990
Earth/Moon 2
8 Dec 1992
Venus
10 Feb 1990
Launch
18 Oct 1989
Galileo
Europa
Mission
(orbits 12-25)
Dec 1997 - Dec 1999
Ida
and Dactyl
28 Aug 1993
Gaspra
29 Oct 1991
Shoemaker-Levy 9
observations
Jul 1994
Jupiter in
Jul 1994
Galileo
primary
mission
(orbits 1-11)
Jun 1996 - Dec 1997
Probe release
13 Jul 1995
Probe mission
Jupiter orbit insertion
7/8 Dec 1995
Jupiter
Jupiter aurora
Small
Satellites
Amalthea
Main ring
Adrastea
Metis
Thebe
and Rings
Io
Europa
Ganymede
Callisto

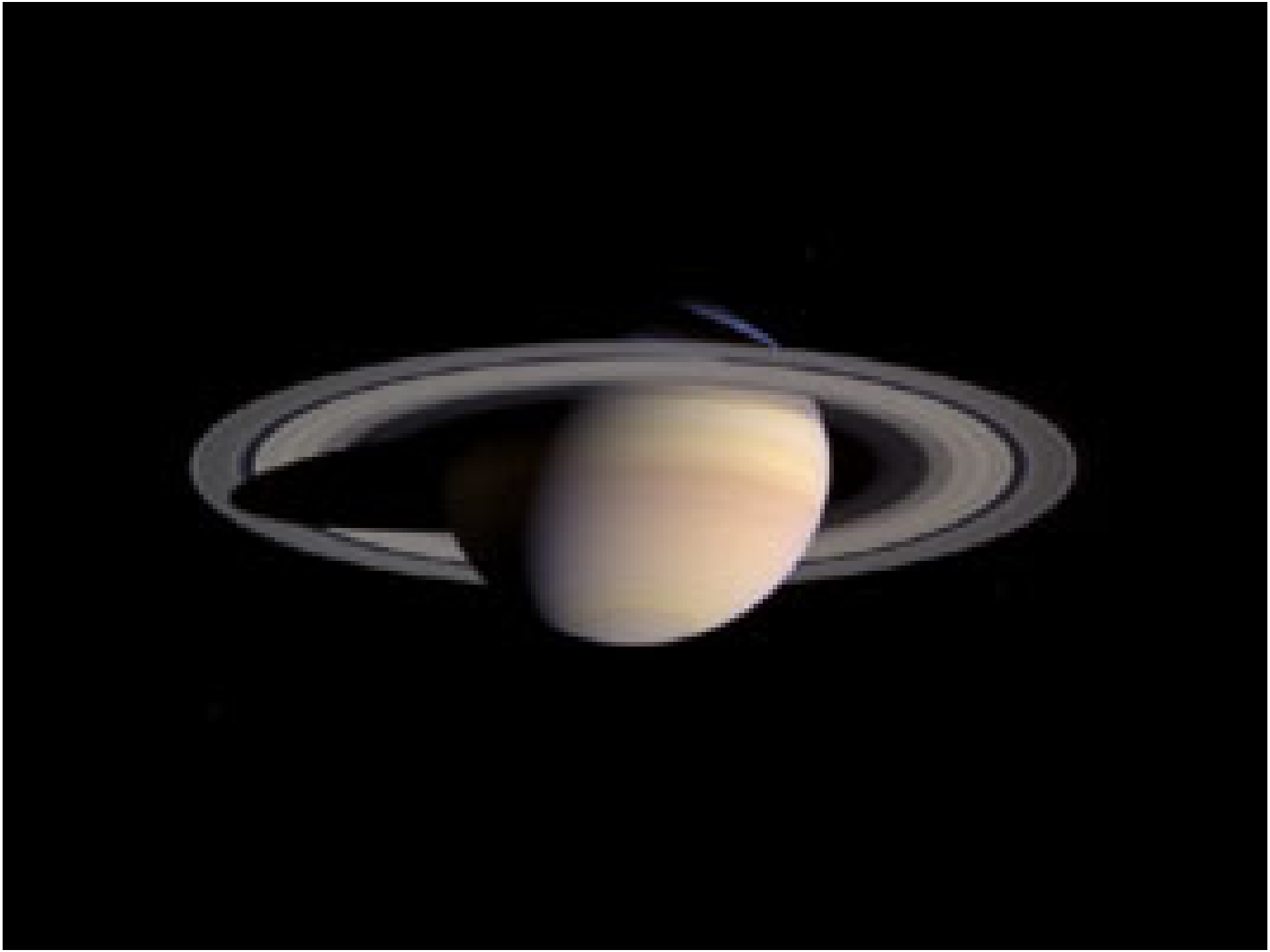


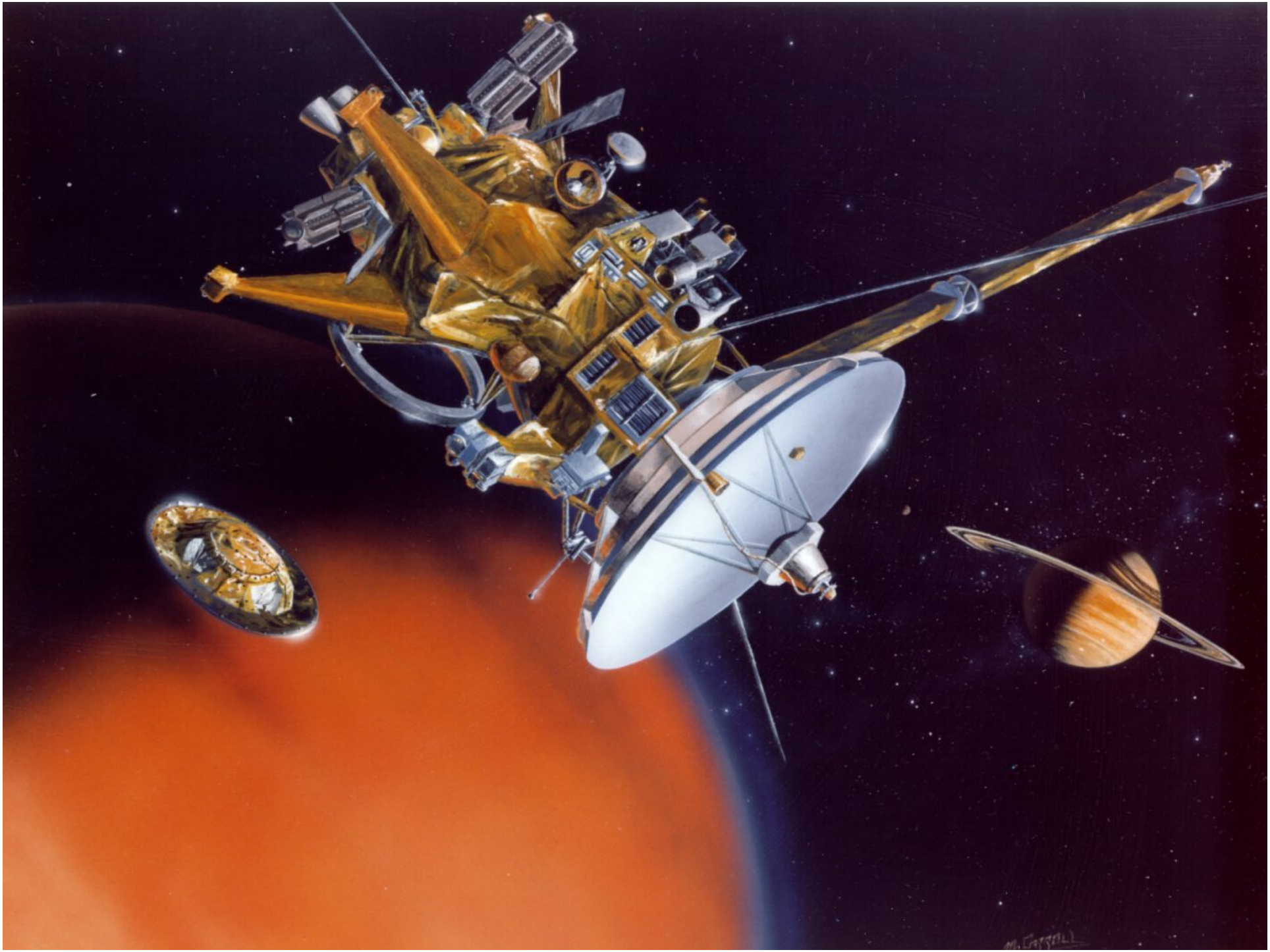


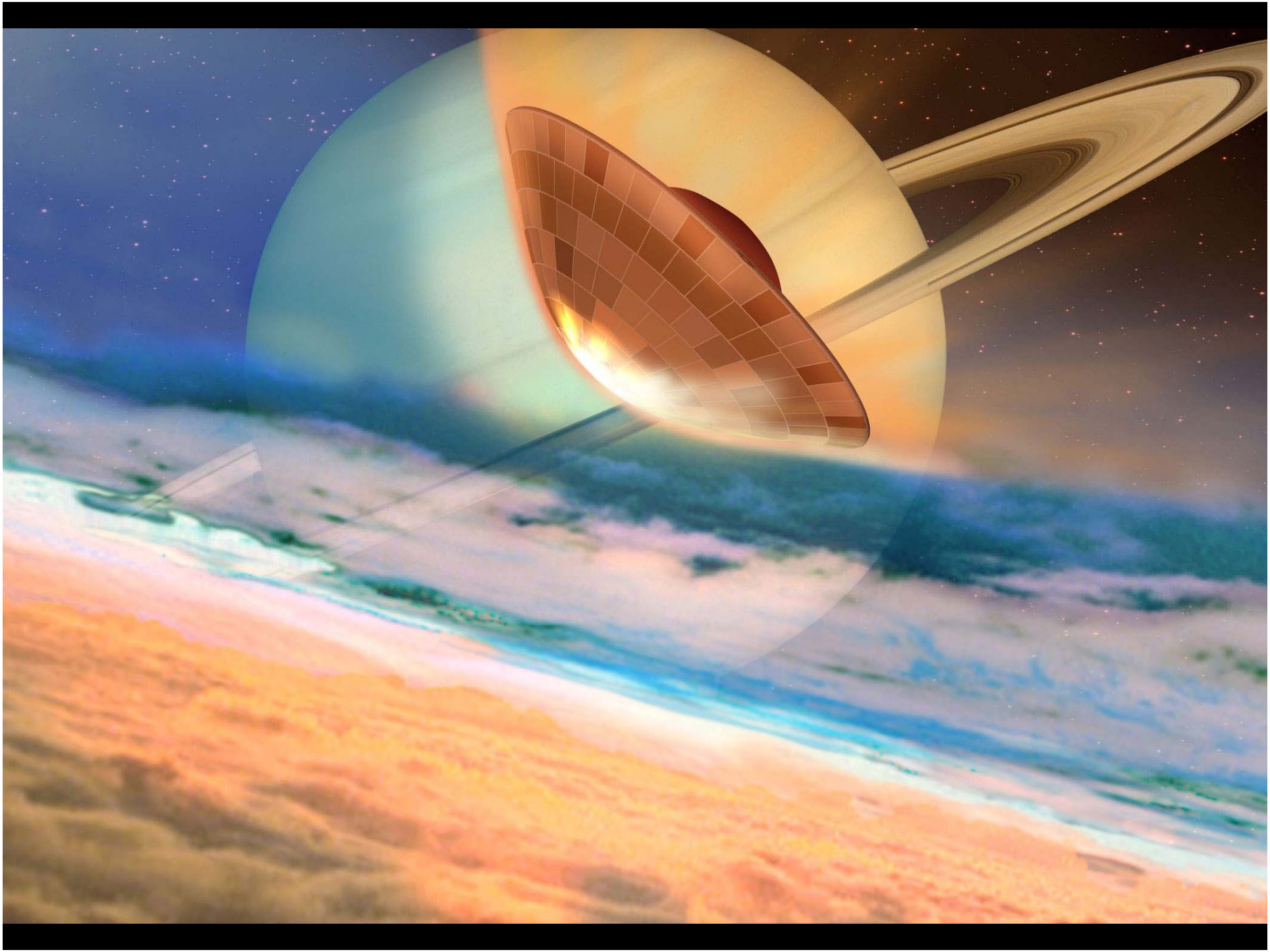
Inside Europa

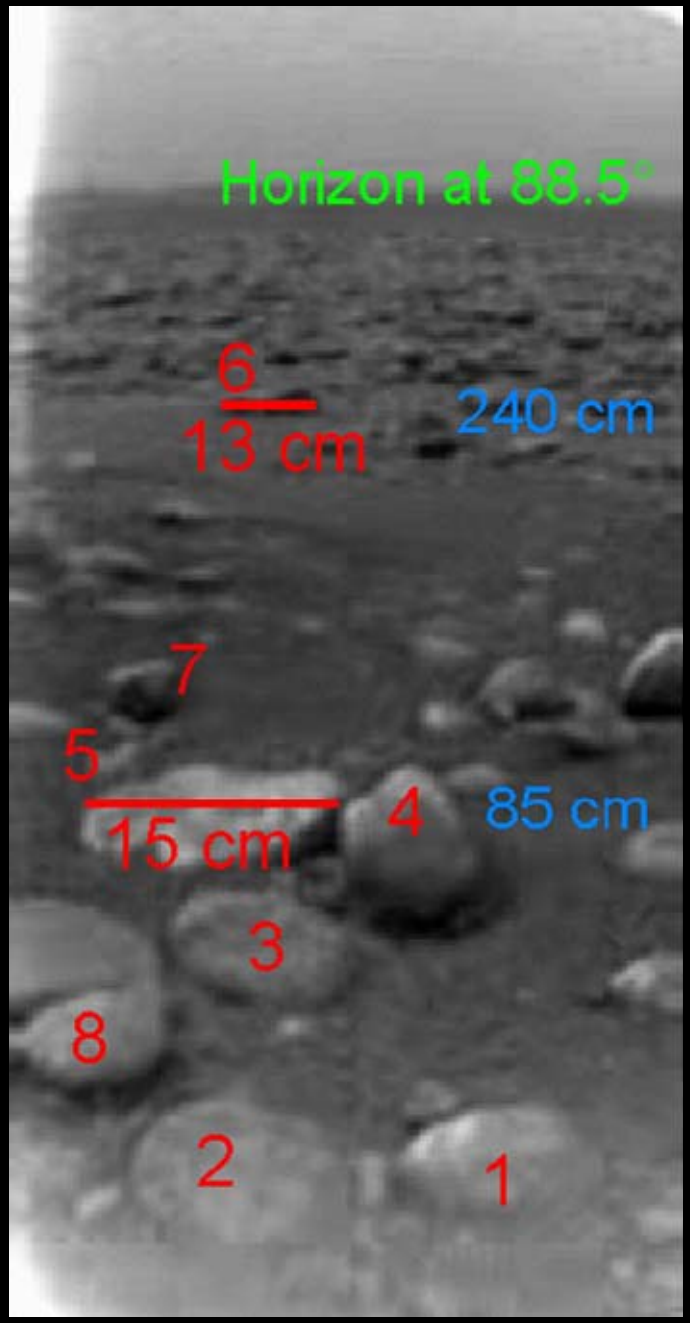


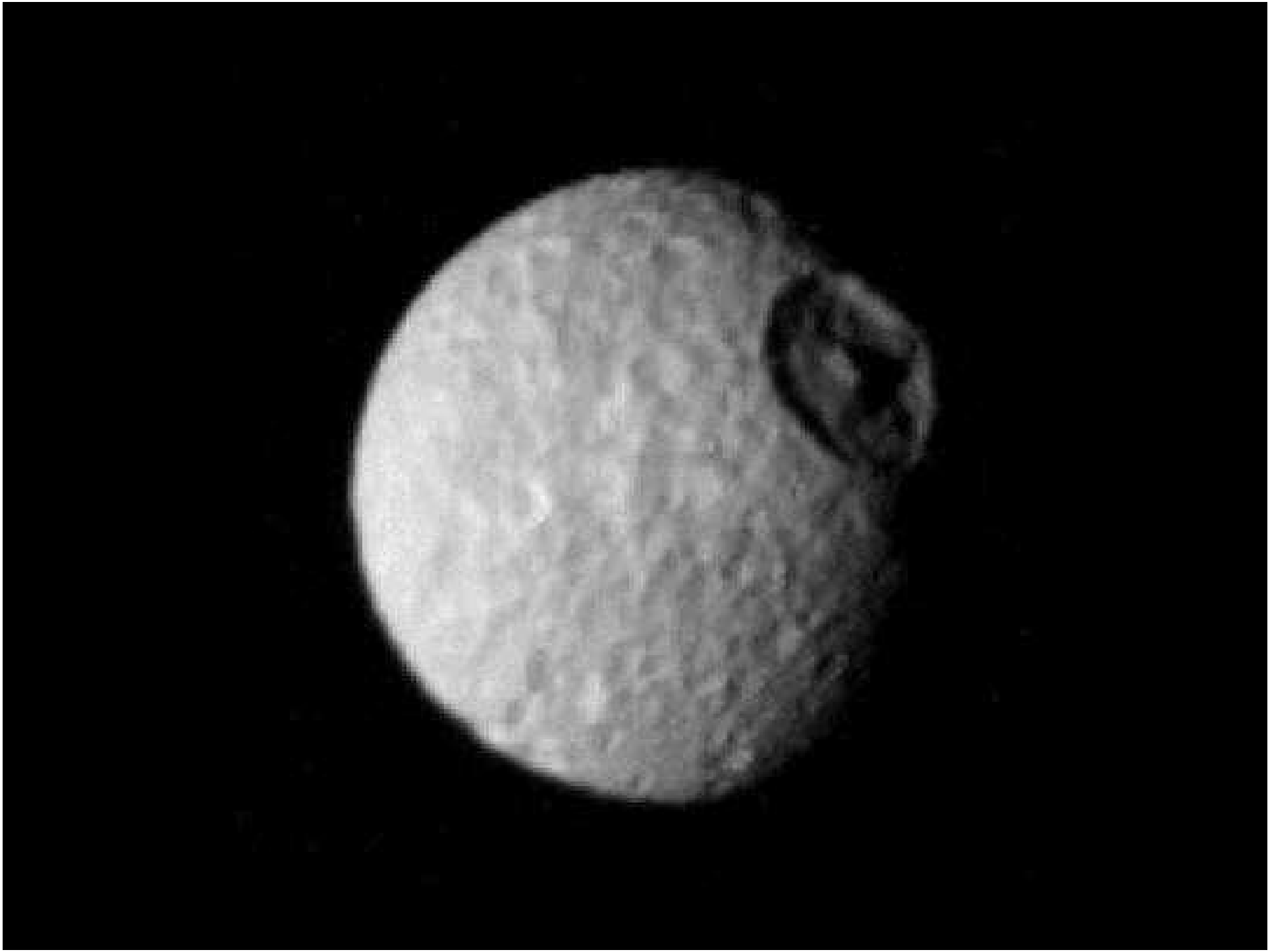
Could there be life?…..

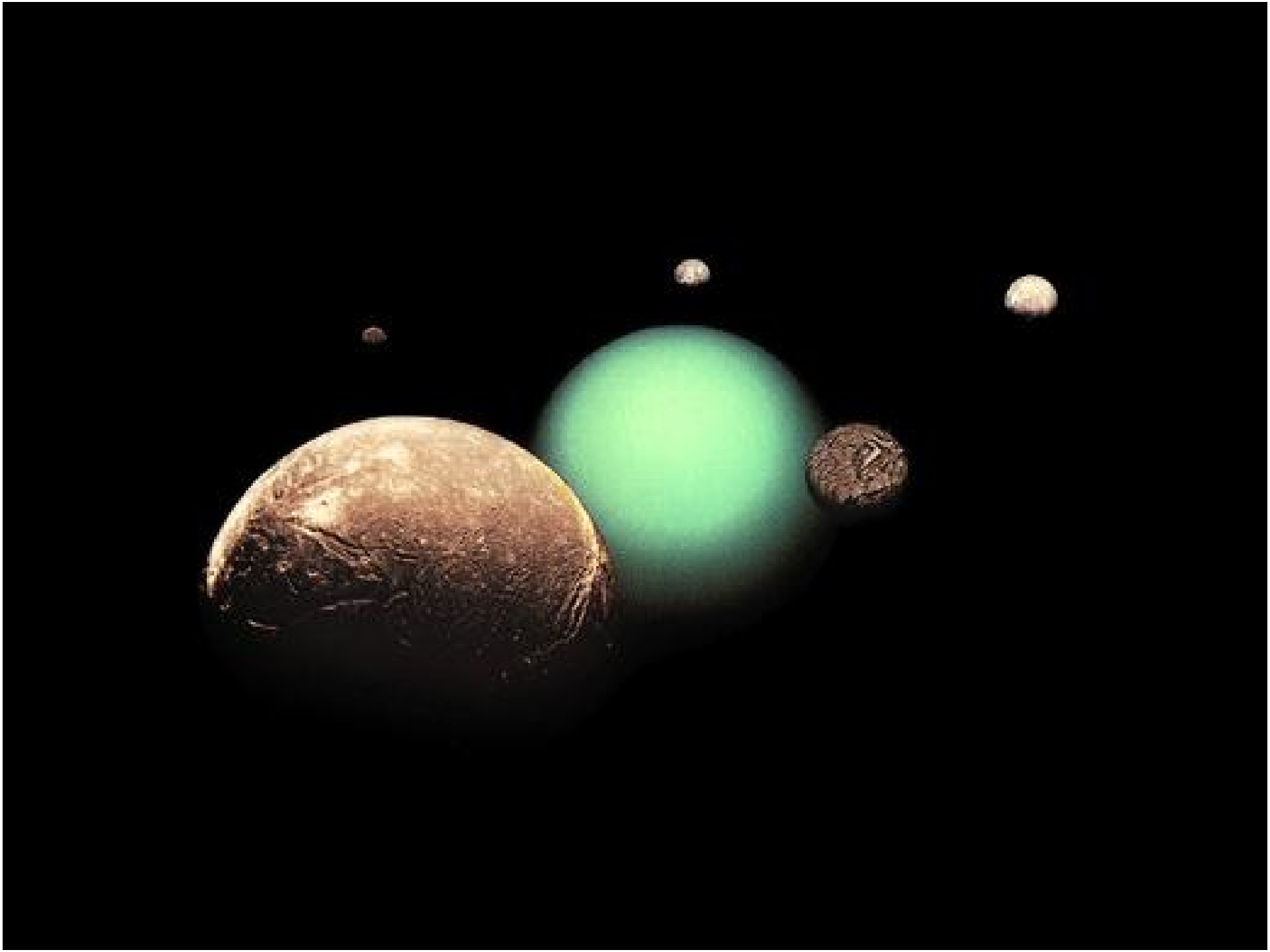


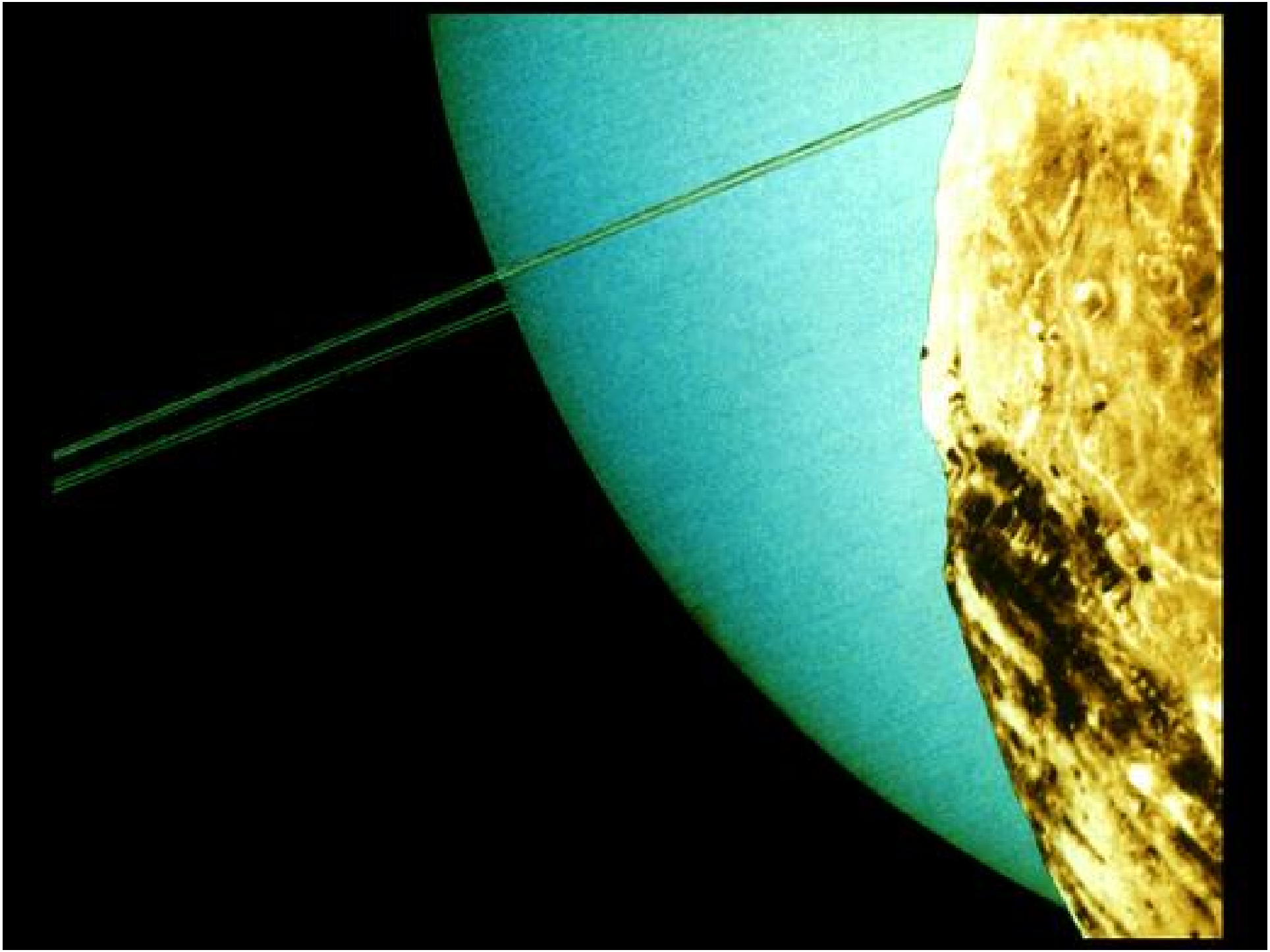


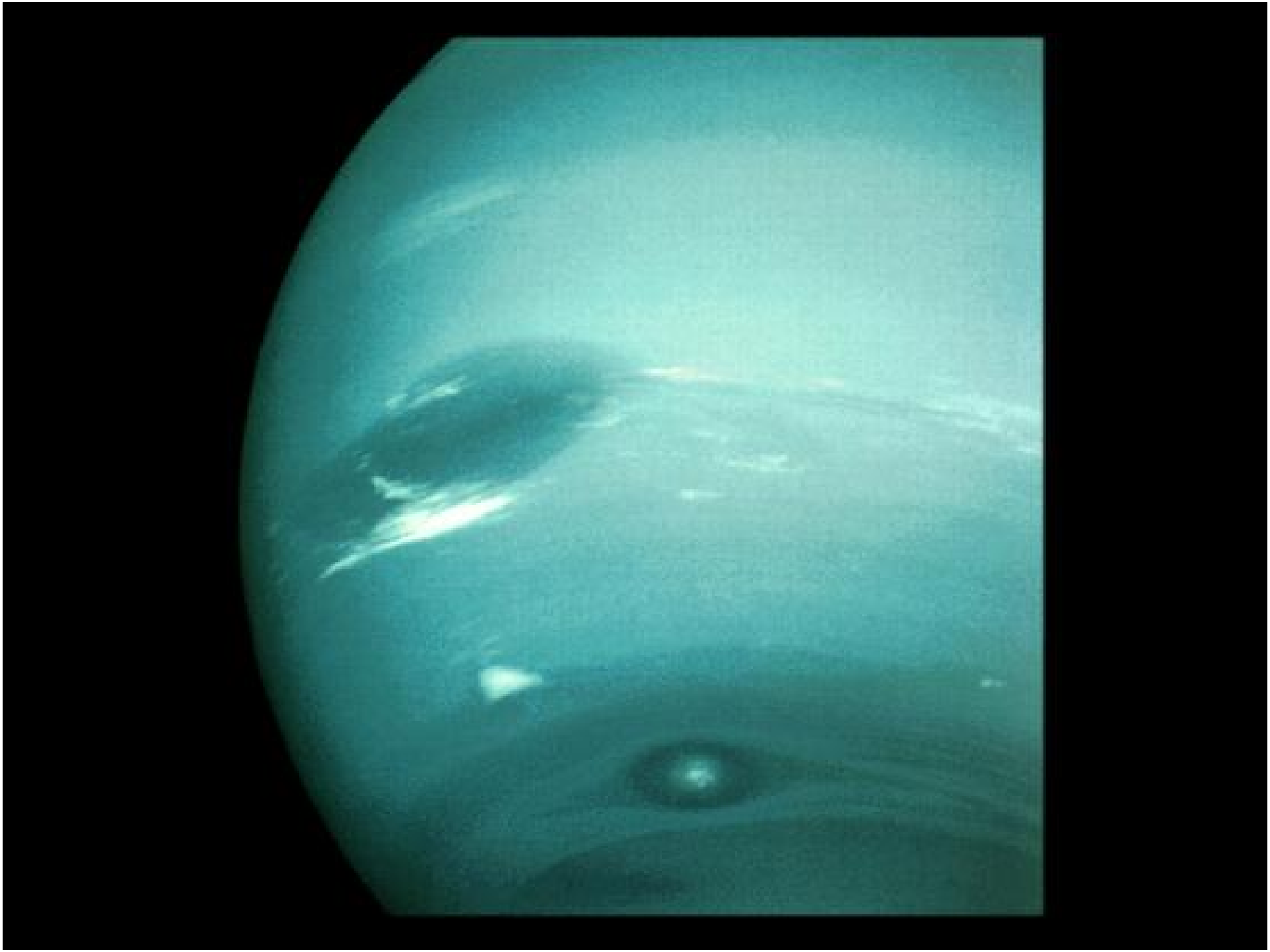


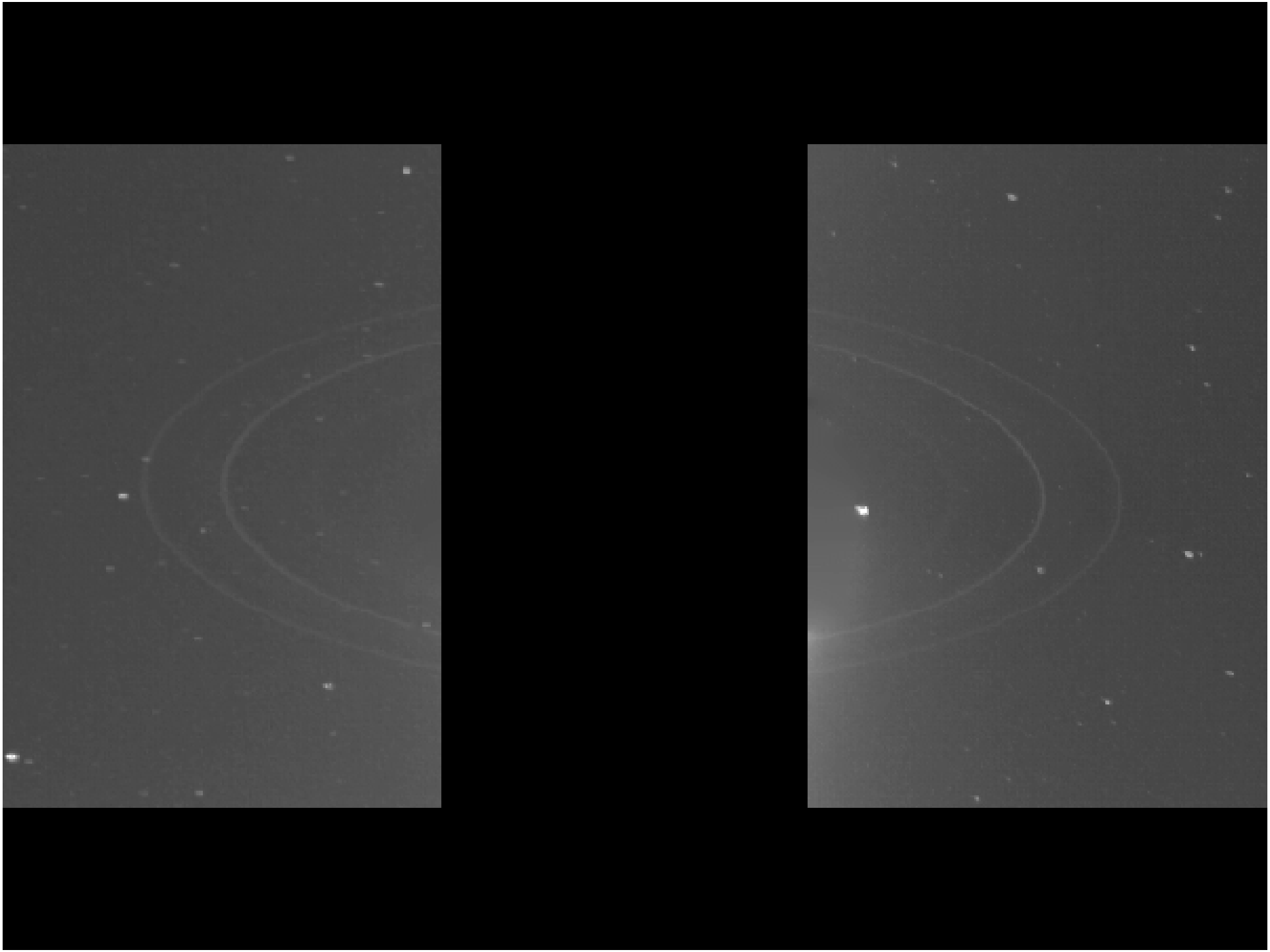

Horizon at 88.5°
6
13 cm
240 cm
7
5
15 cm
4
85 cm
3
8
2
1











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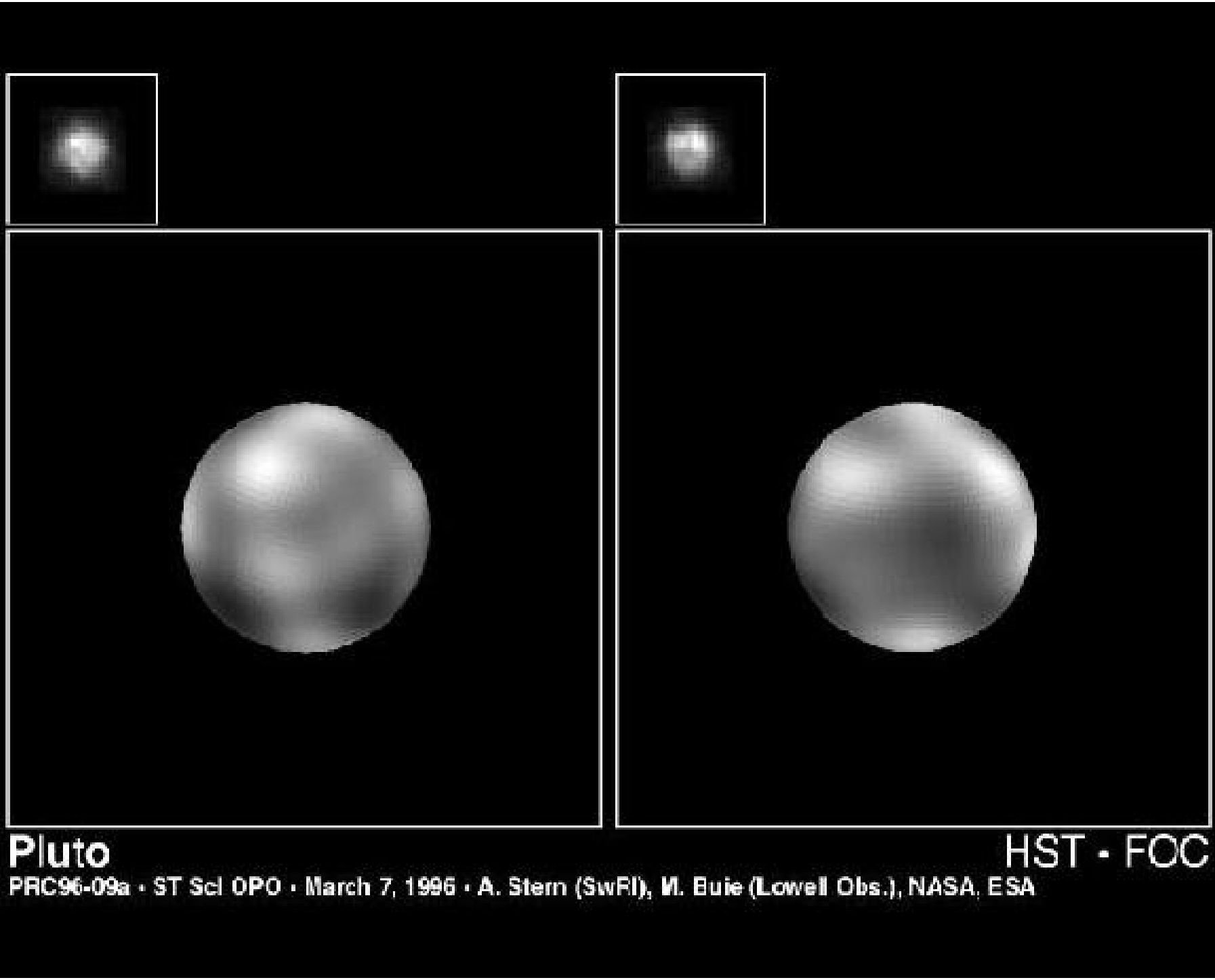
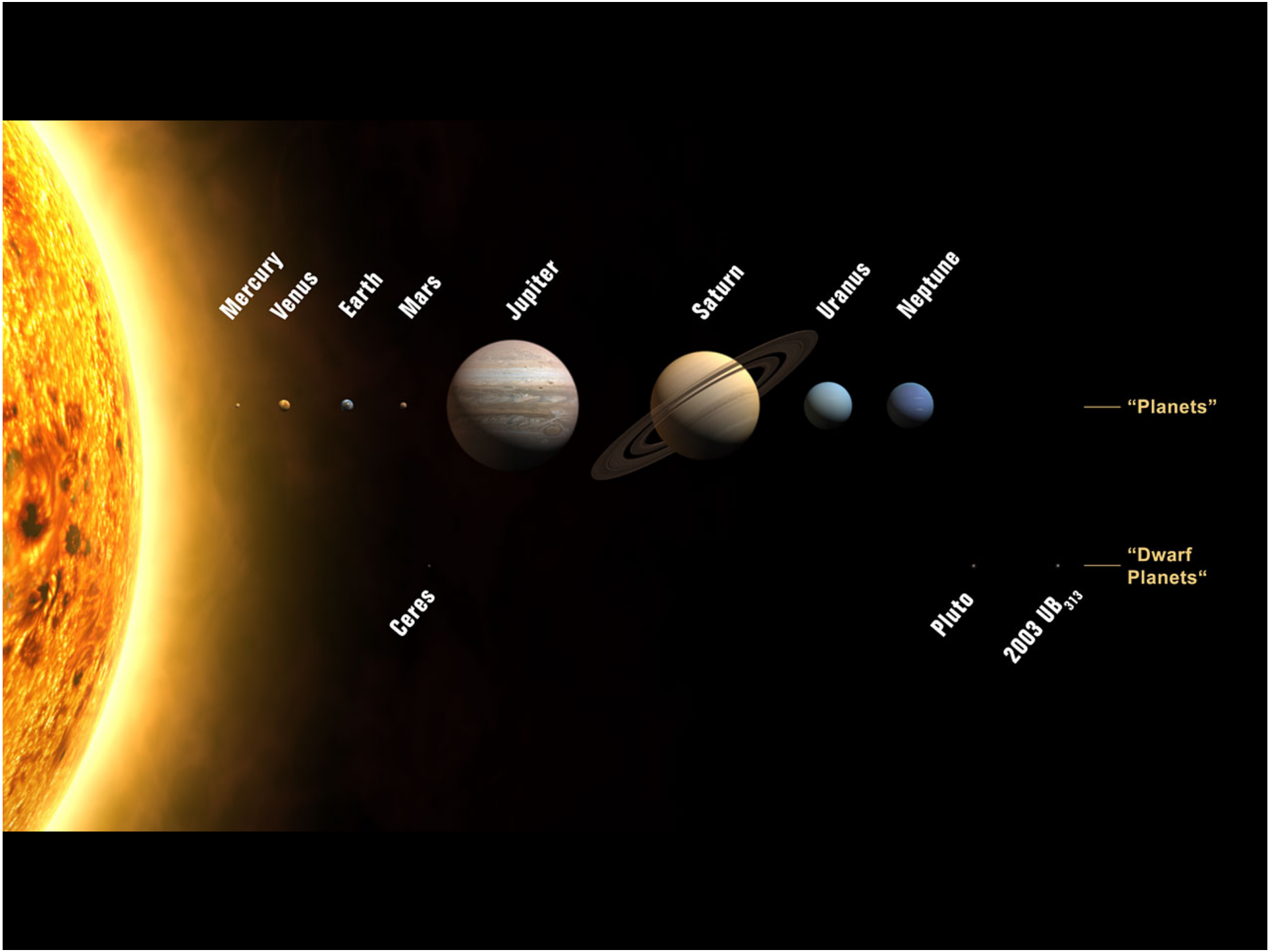
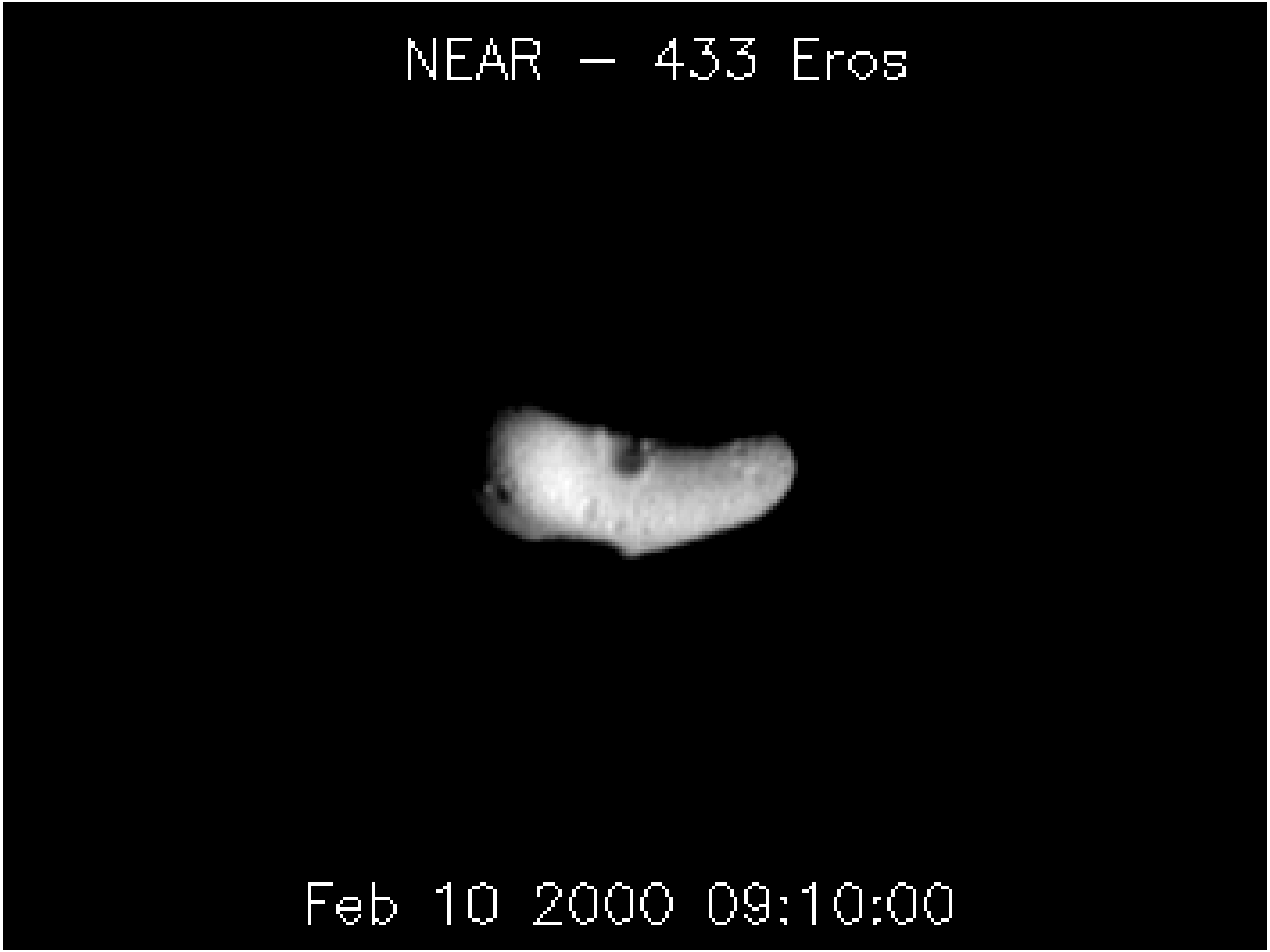
Pluto is a 'misfit' – Kuiper Belt object; along with asteroids and comets, 'debris' from formation of the Solar System.


Pluto
HST • FOC
PRC96-09a • ST ScI OPO • March 7, 1996 • A. Stern (SwRI), M. Buie (Lowell Obs.), NASA, ESA

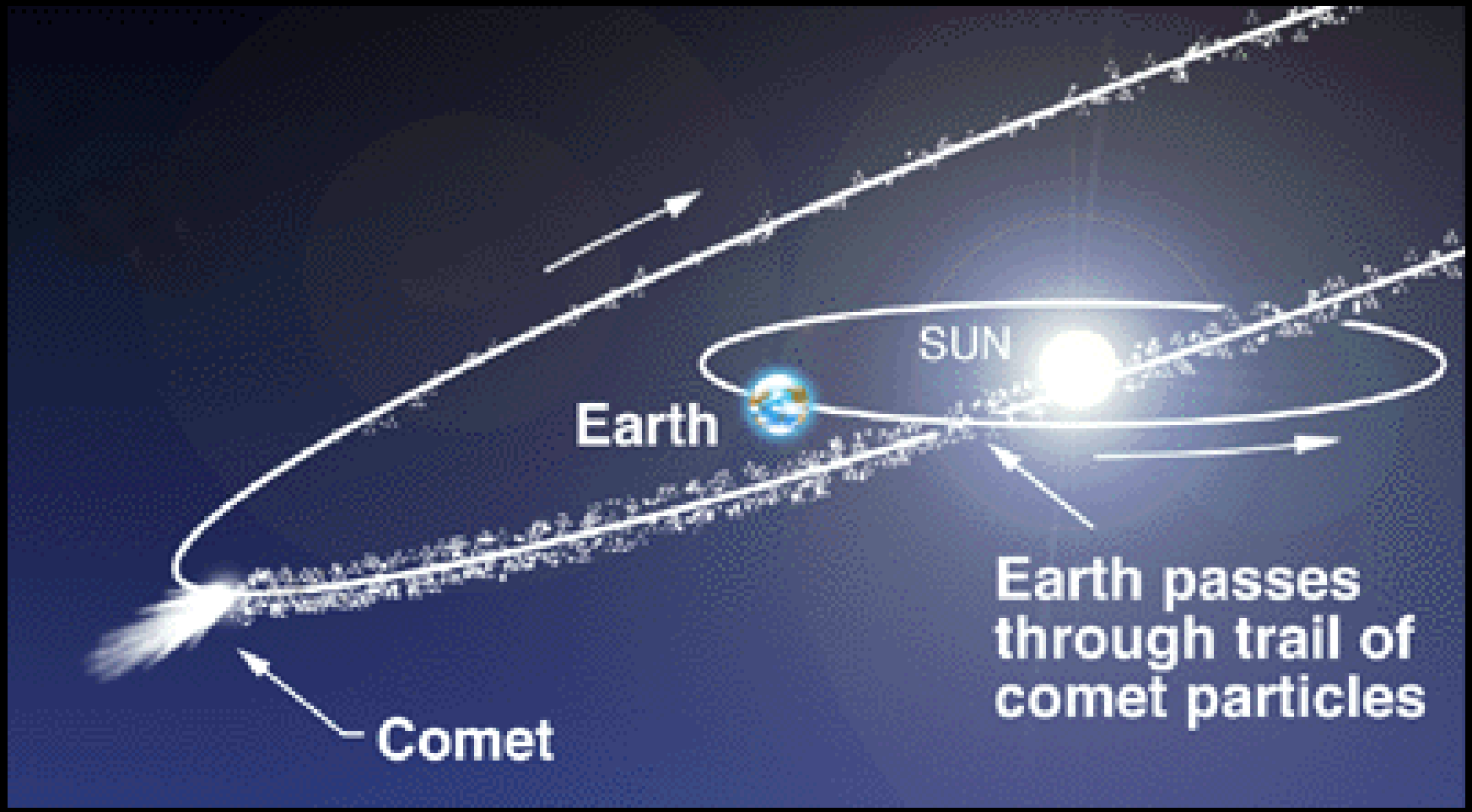

Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
"Planets"
Ceres
Pluto
2003 UB313
"Dwarf Planets"

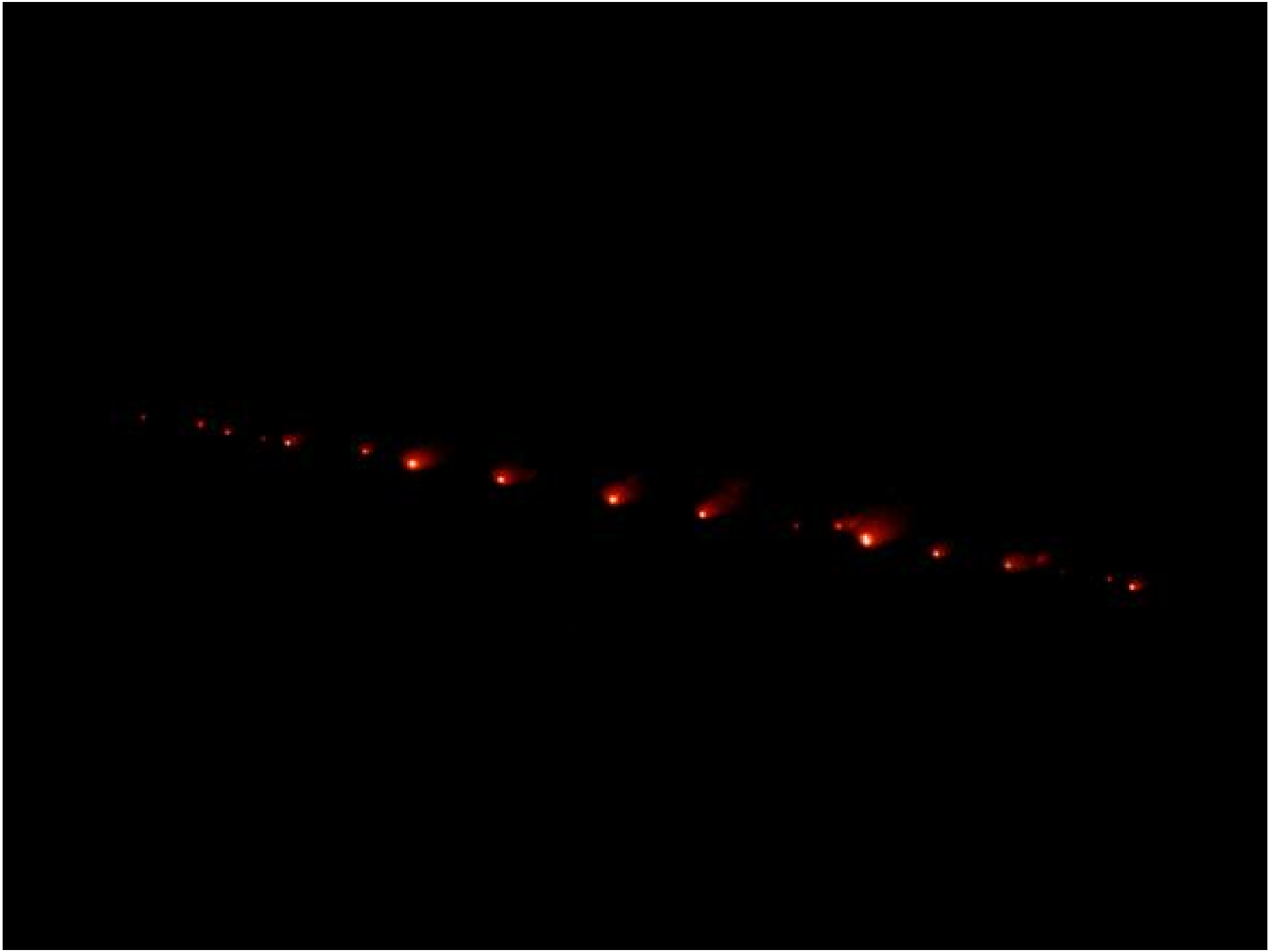
Invention of telescope led to discovery of Minor Planets or *asteroids*. Most orbit between Mars and Jupiter – ***Asteroid Belt***

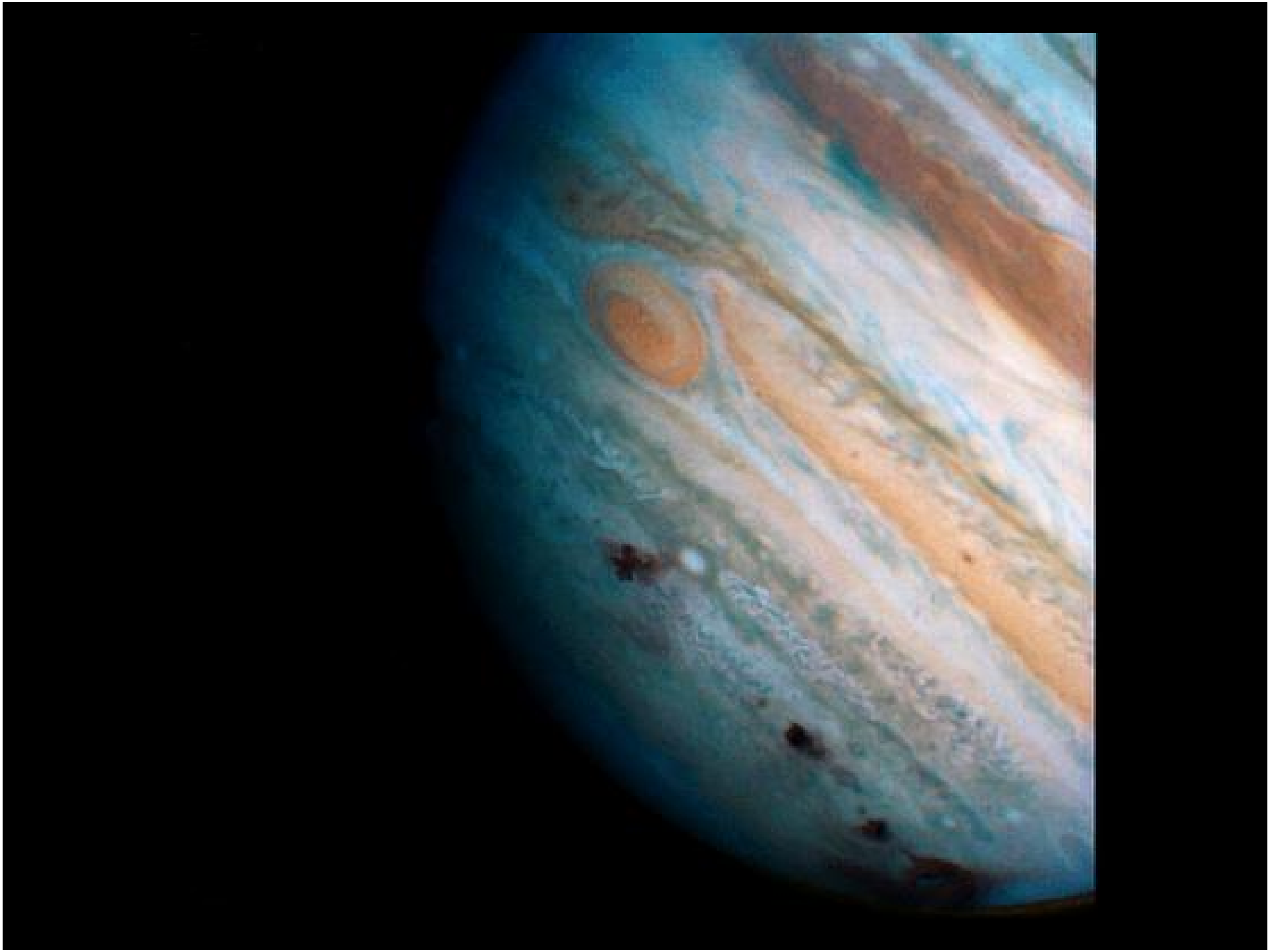
'Lumps' of rock (up to 1000km across), reflecting sunlight. Only visible through a telescope


NEAR – 433 Eros
Feb 10 2000 09:10:00

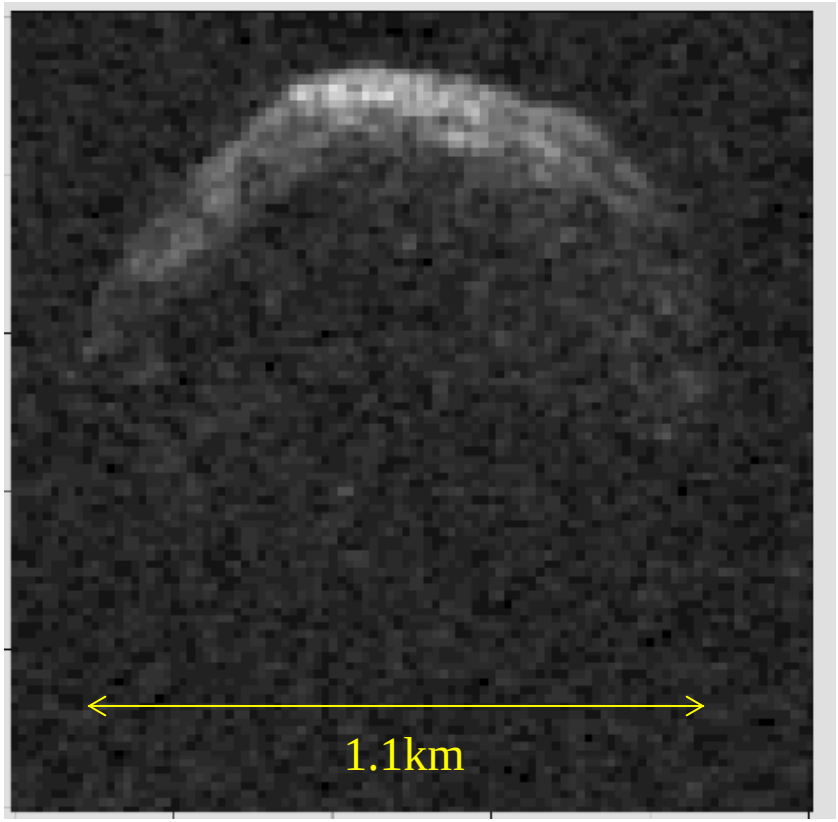
Leonid Meteor Shower: Nov 17th – 18th







873 years till Doomsday?…



Credit: Arecibo Observatory

Asteroid 1950DA: 1 in 300 chance of collision with Earth on March 16th 2880

(Science, Apr 5th 2002)

Need to determine the orbit of the asteroid…

…all about *gravity*