

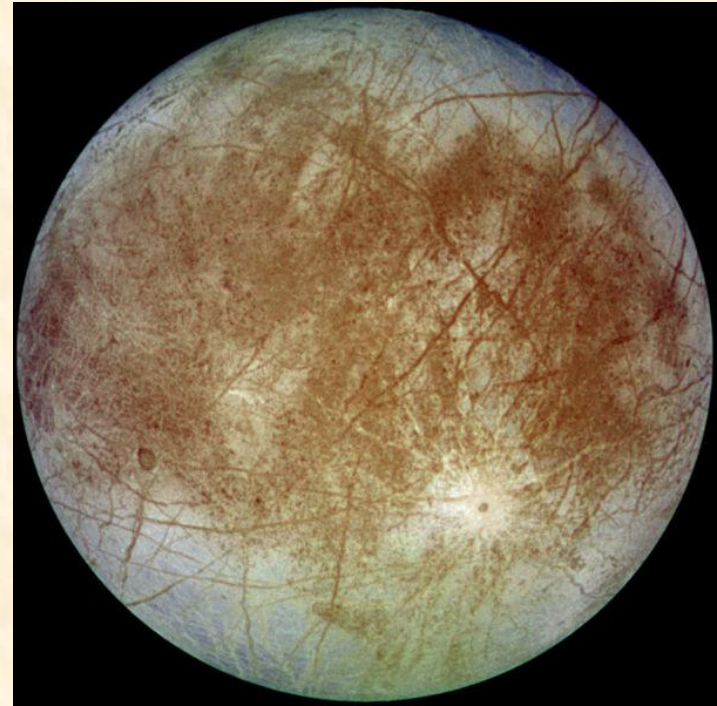


EUROPA

Joseph T. Wunderlich, Ph.D.

Talk Agenda

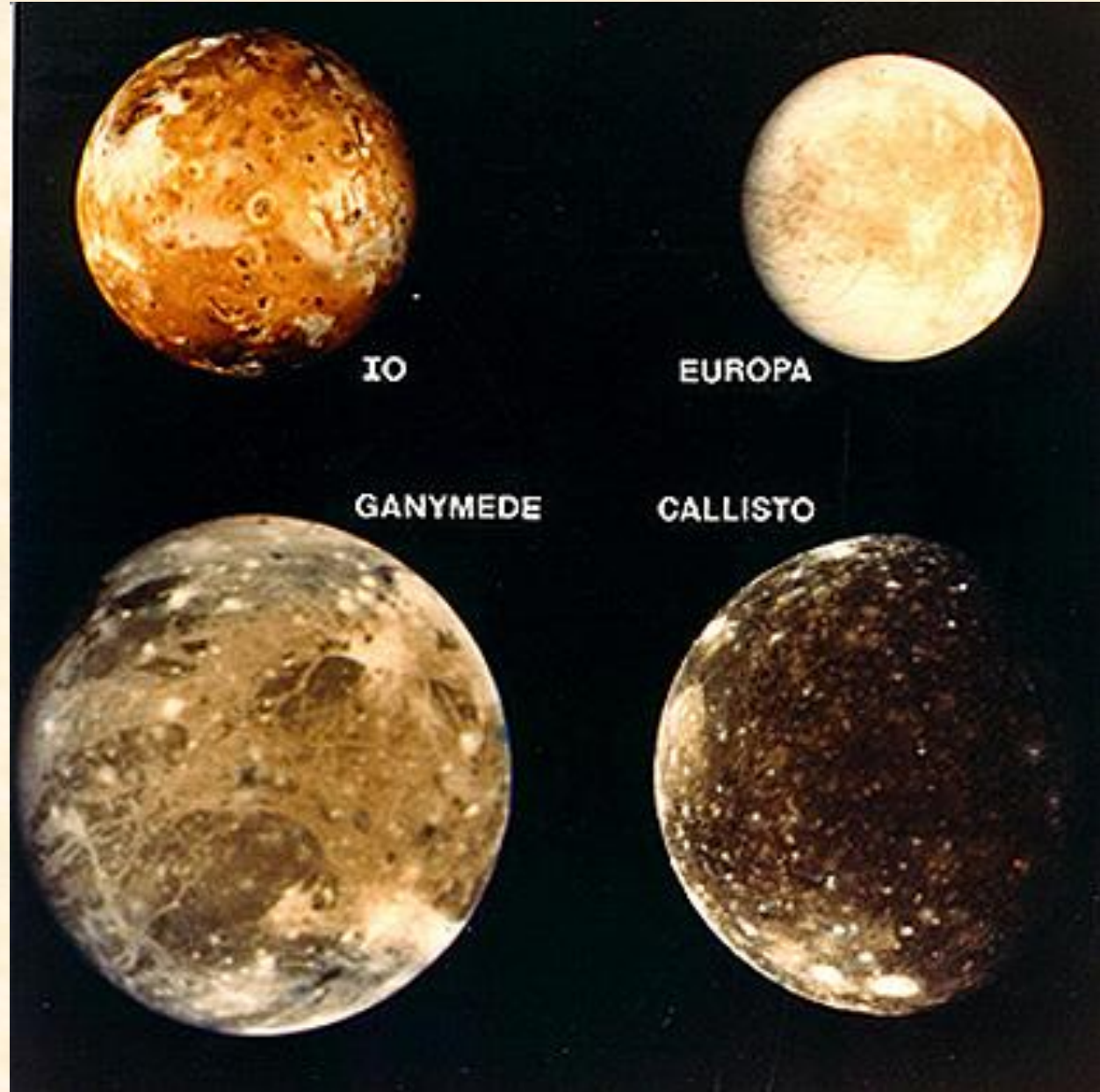
- 1977: NASA *Voyager 1*
- 1977: NASA *Voyager 2*
- 1989: NASA *Galileo*
- Future ESA/NASA “*Europa Jupiter System Mission*”(EJSM) ?



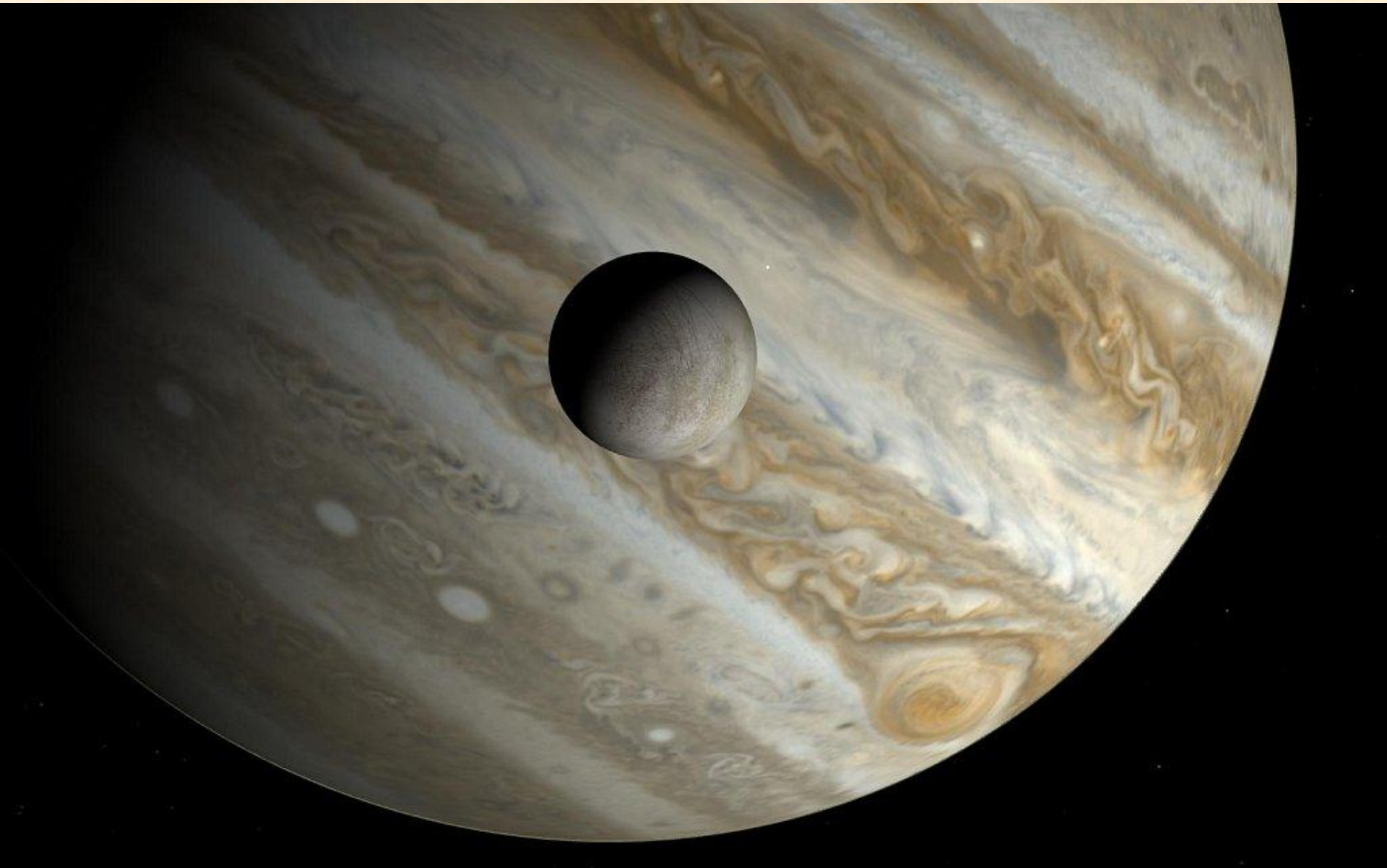
Jupiter's Galilean Moons

Of Jupiter's moons, these four are the most interesting

All others are small and irregular with likely not much to discover



Jupiter and it's moon Europa



Moon and Europa compared to Earth



1977: NASA *Voyager 1*

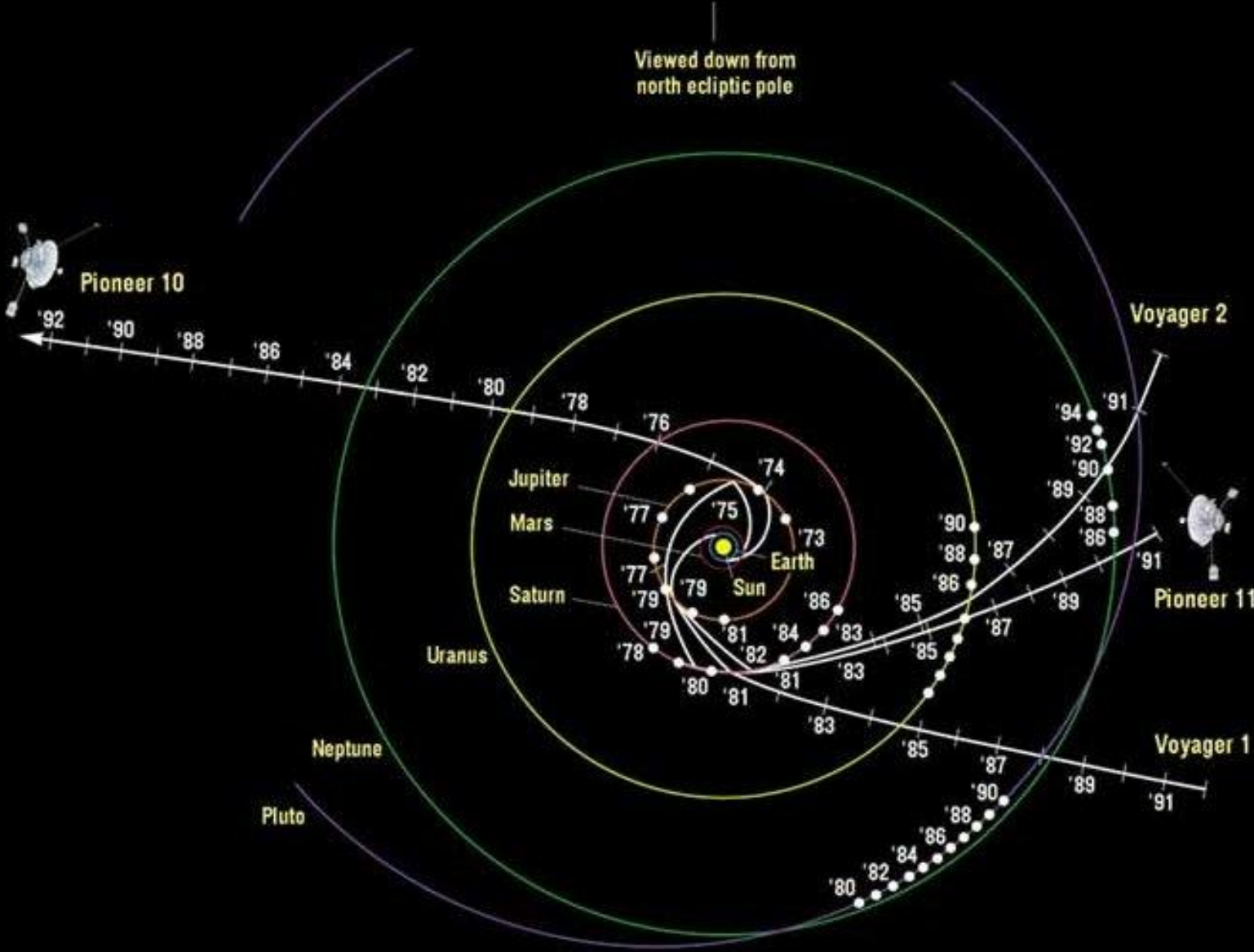


Image from: <http://www.solarviews.com/cap/craft/voyager1.htm>

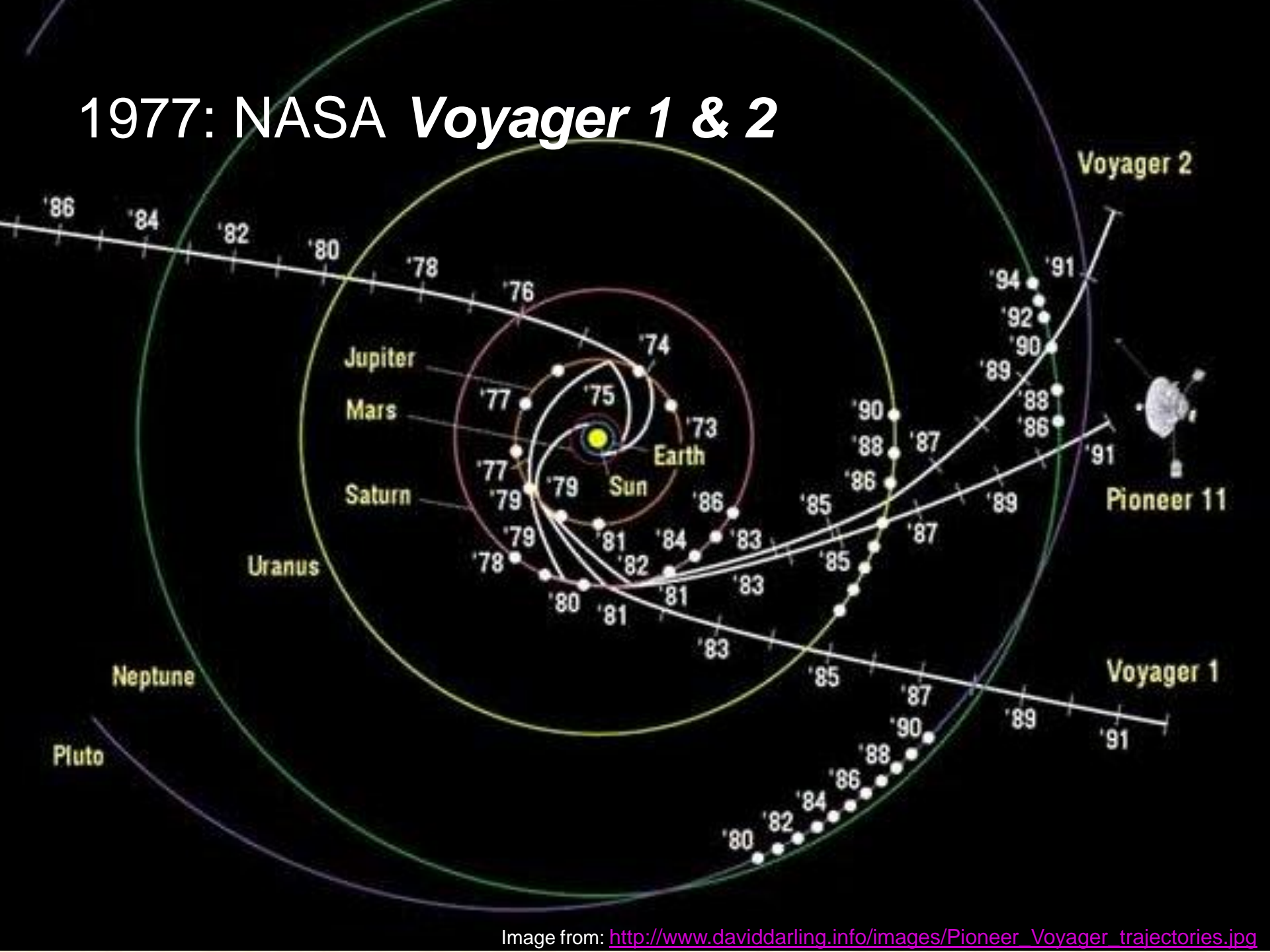
1977: NASA *Voyager 2*



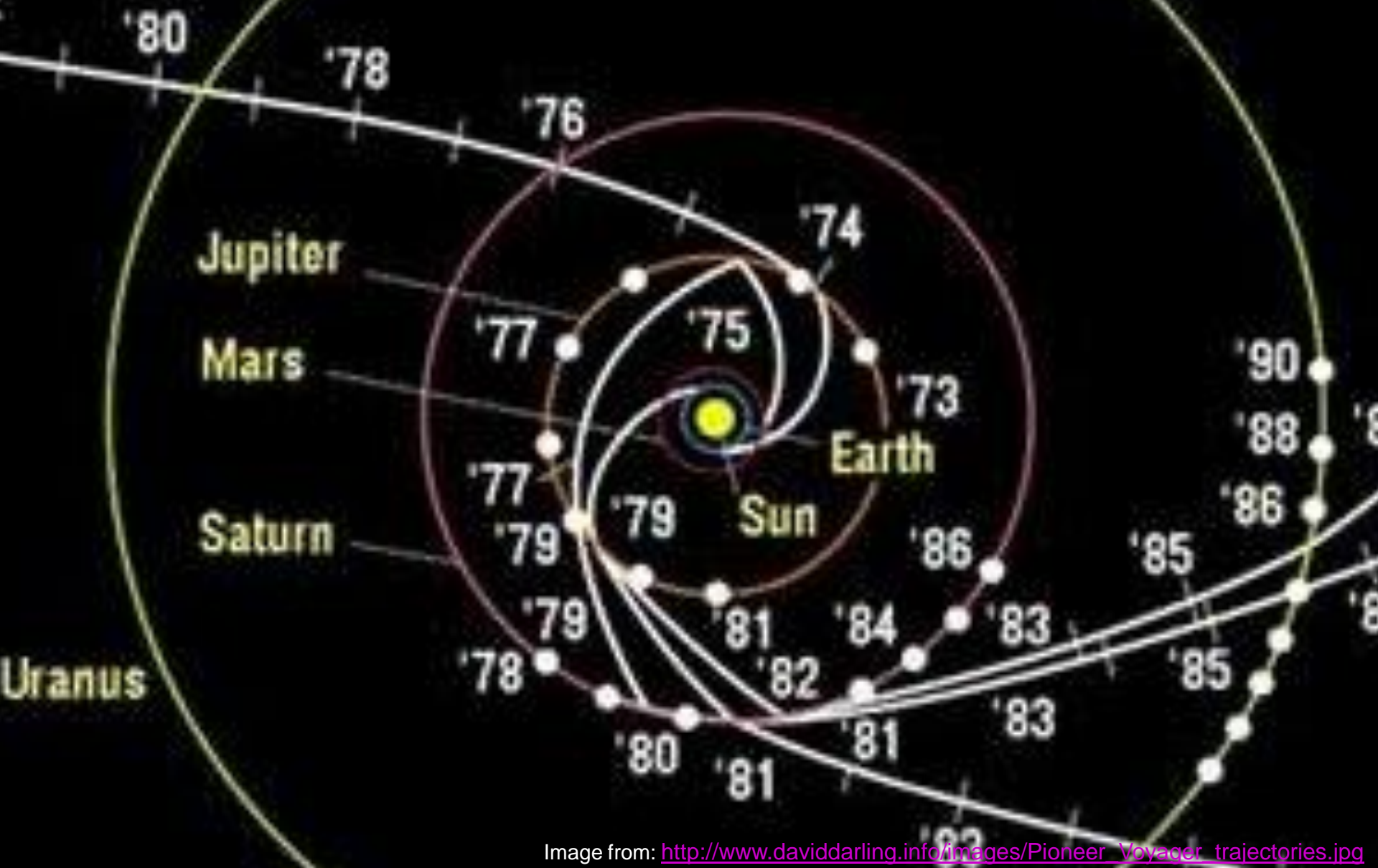
1977: NASA *Voyager 1 & 2*



1977: NASA *Voyager 1 & 2*



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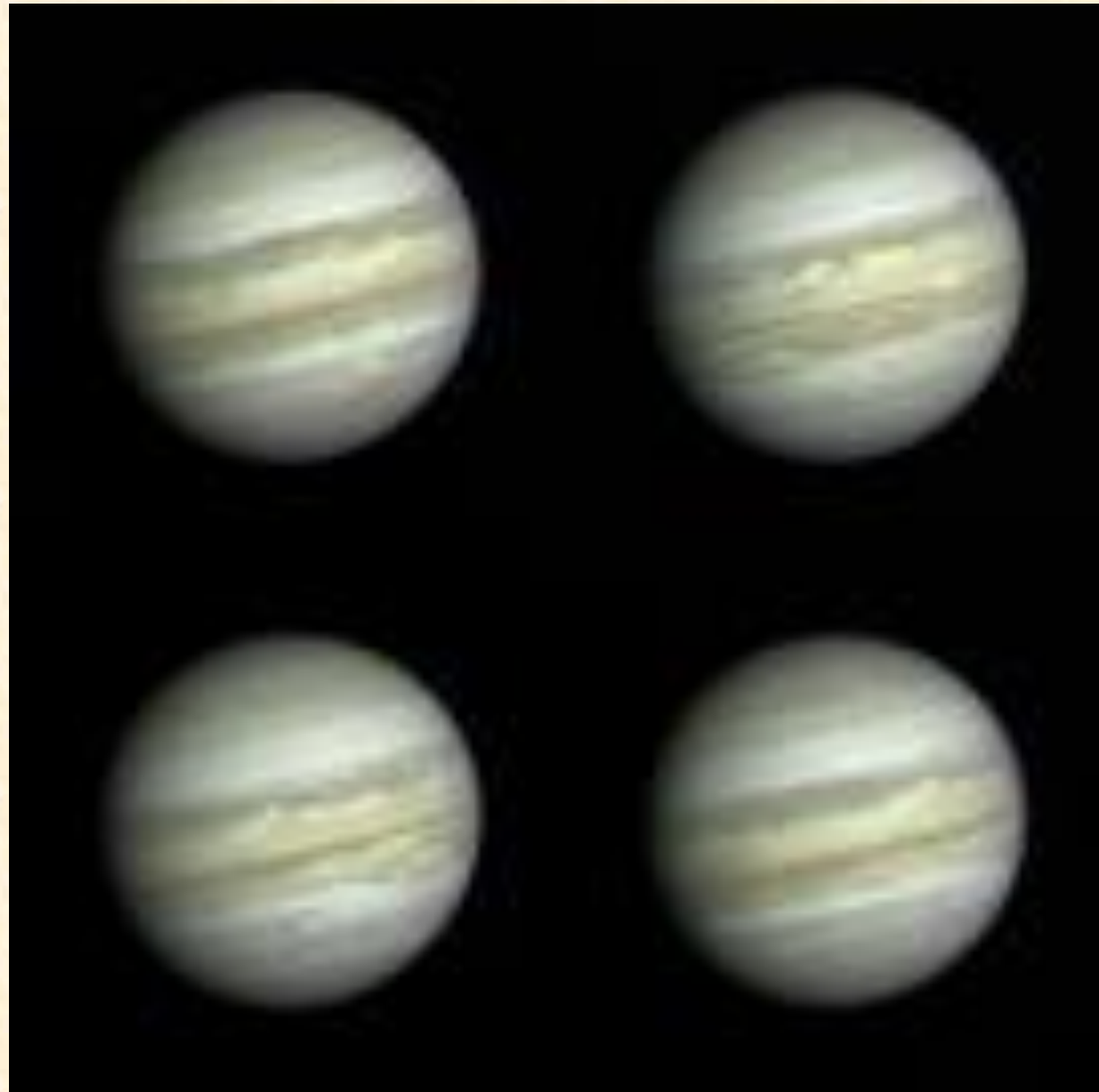


1977: NASA *Voyager 1*



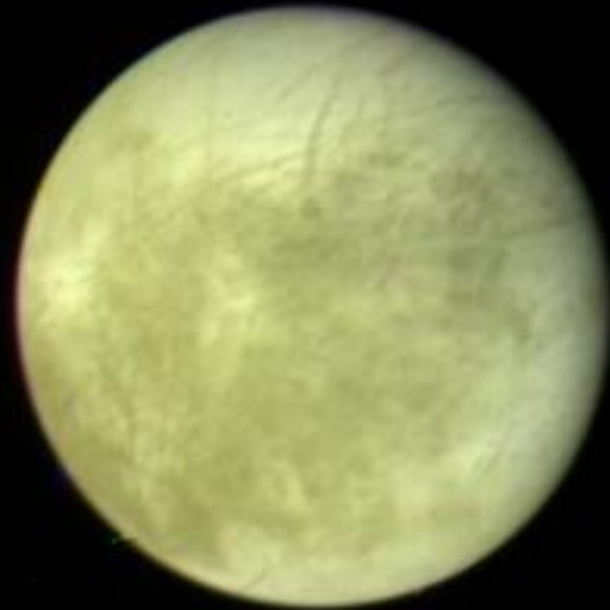
1977: NASA *Voyager 1*

Images of Jupiter



1977: NASA *Voyager 1*

Image of Europa

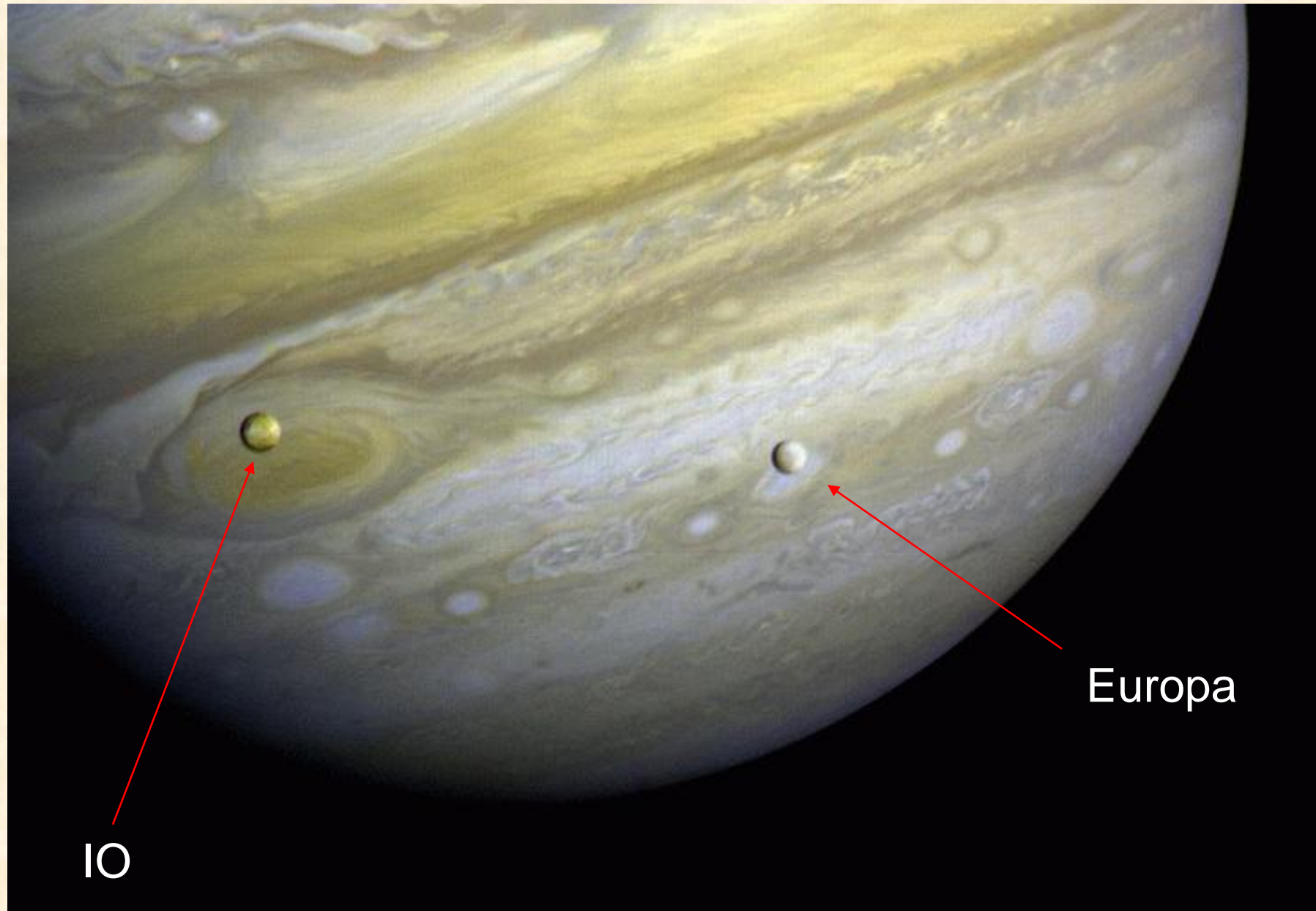


1977: NASA *Voyager 1*

Image of Europa



1977: NASA *Voyager 1*



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Europa

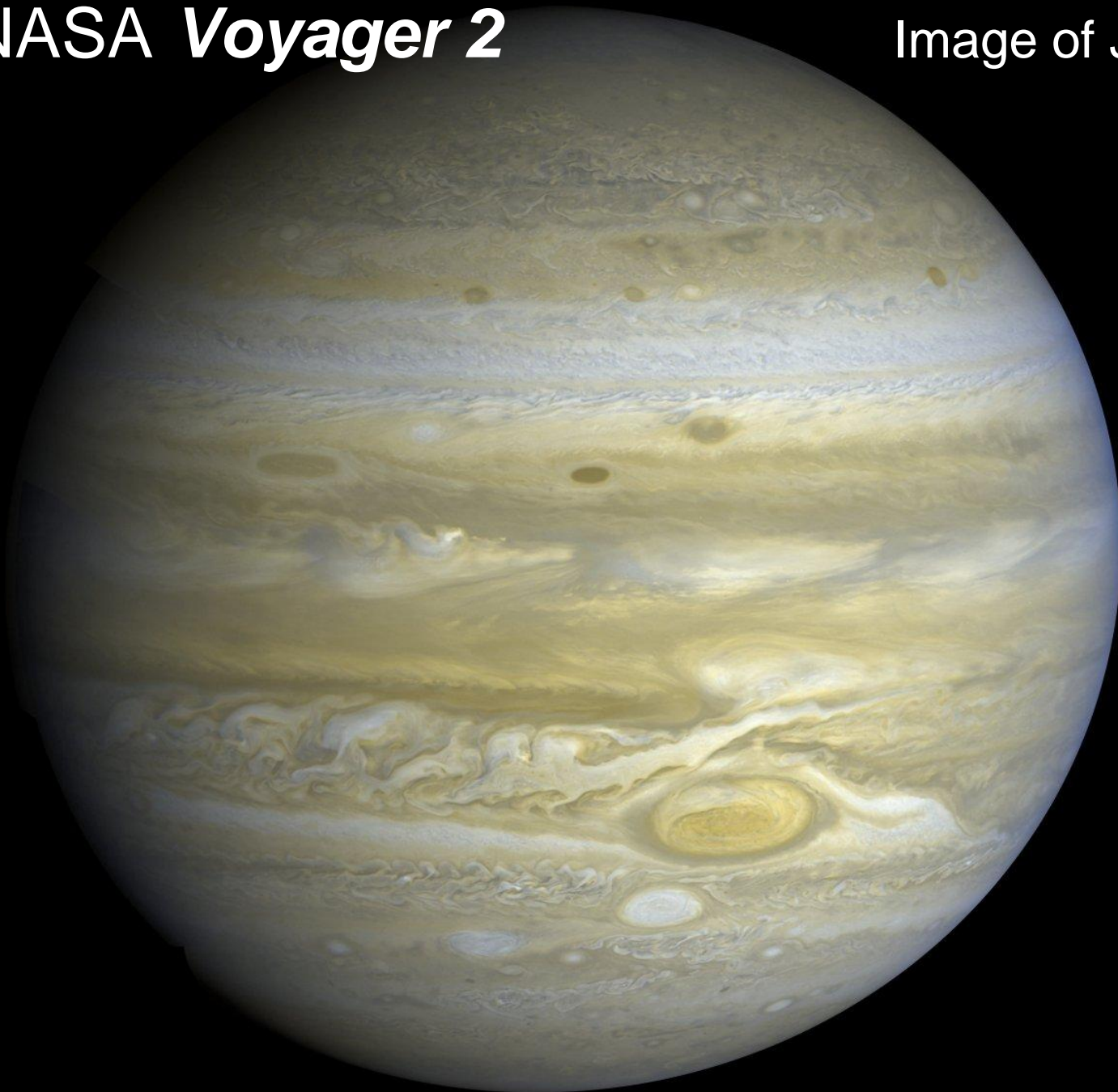
1977: NASA *Voyager 2*



Image from: <http://dustyluft.wordpress.com/2007/08/20/20th-august-1977-voyager-2-launched/>

1977: NASA *Voyager 2*

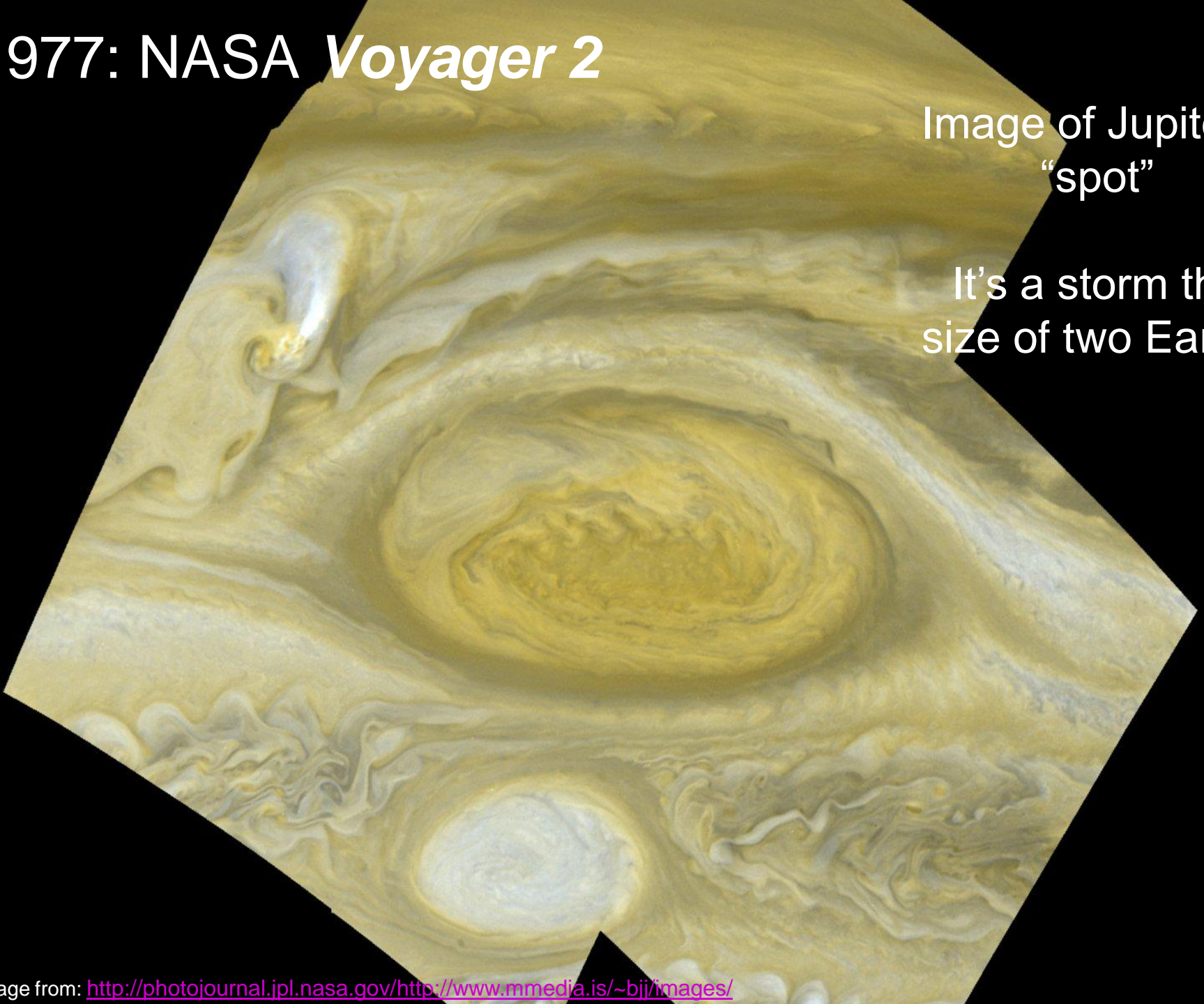
Image of Jupiter



1977: NASA *Voyager 2*

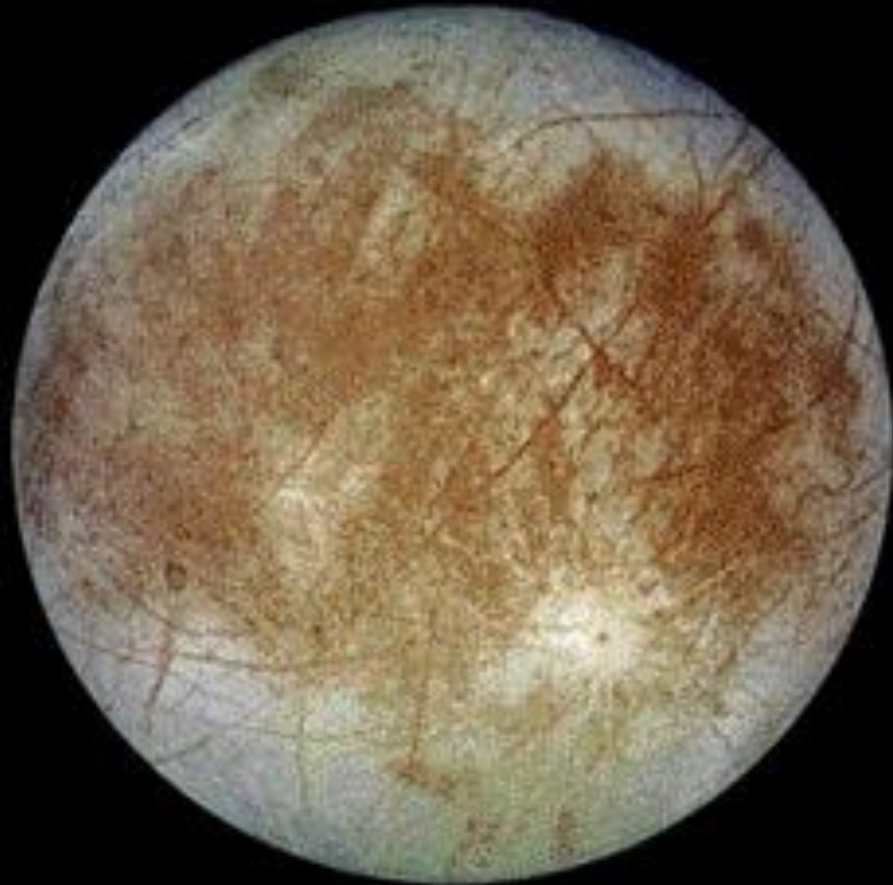
Image of Jupiter's
"spot"

It's a storm the
size of two Earths



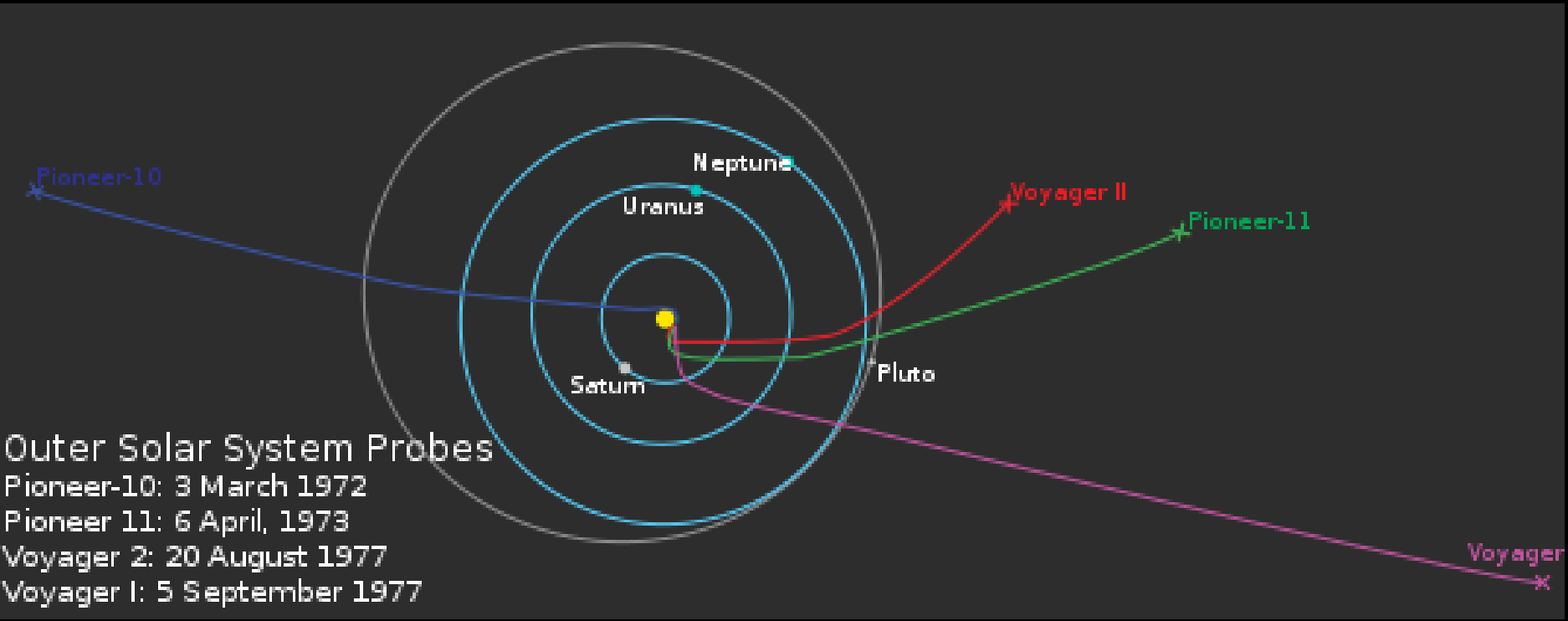
1977: NASA *Voyager 2*

Images of Europa



1977: NASA *Voyager 1 and 2*

Locations as of
May 24, 2009



1977: NASA *Voyager 2*

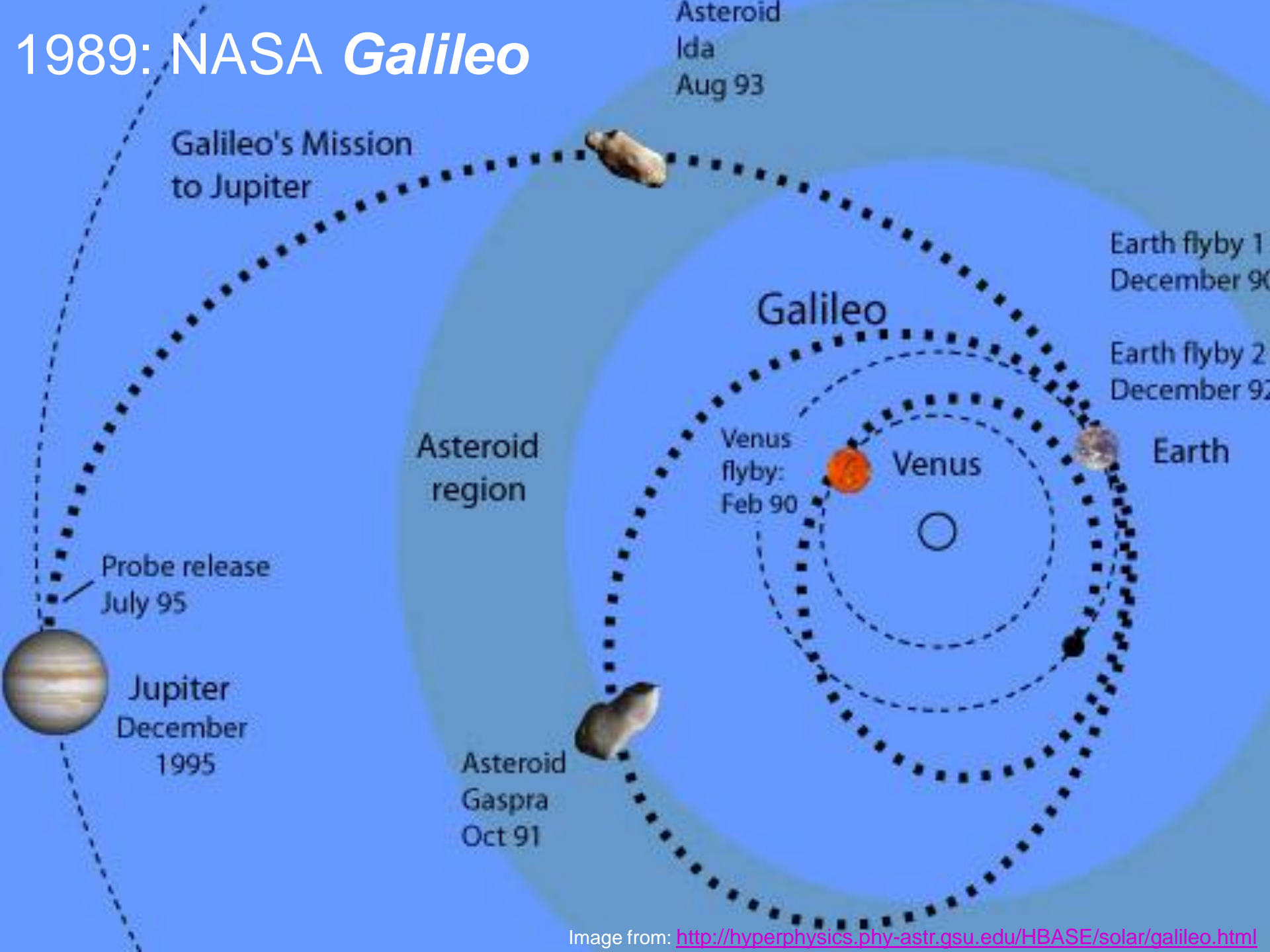
Image of Europa



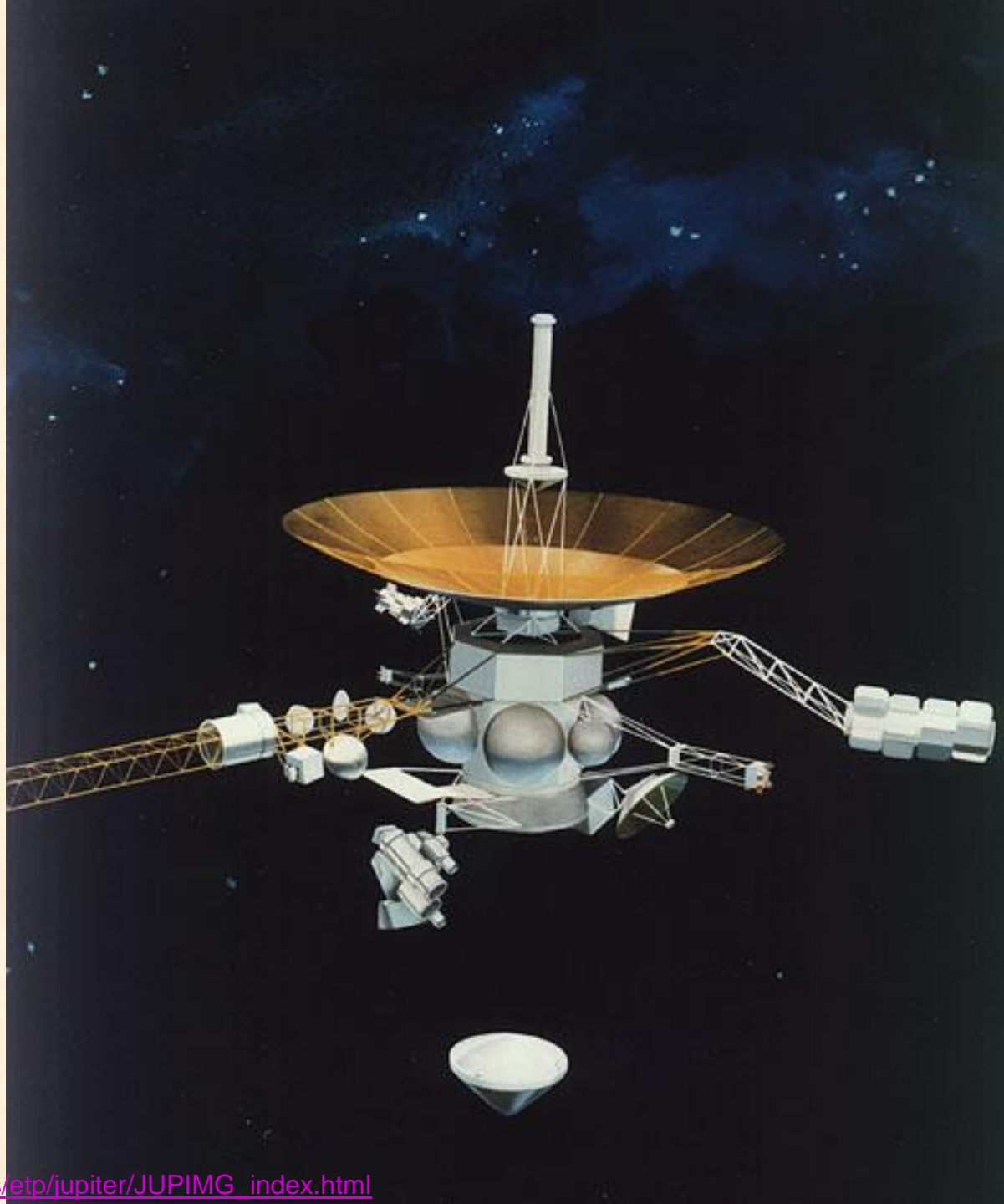
1989: NASA
Galileo



1989: NASA *Galileo*



1989: NASA *Galileo*



1989: NASA
Galileo

Image of Jupiter



1989: NASA *Galileo*

Image of Europa

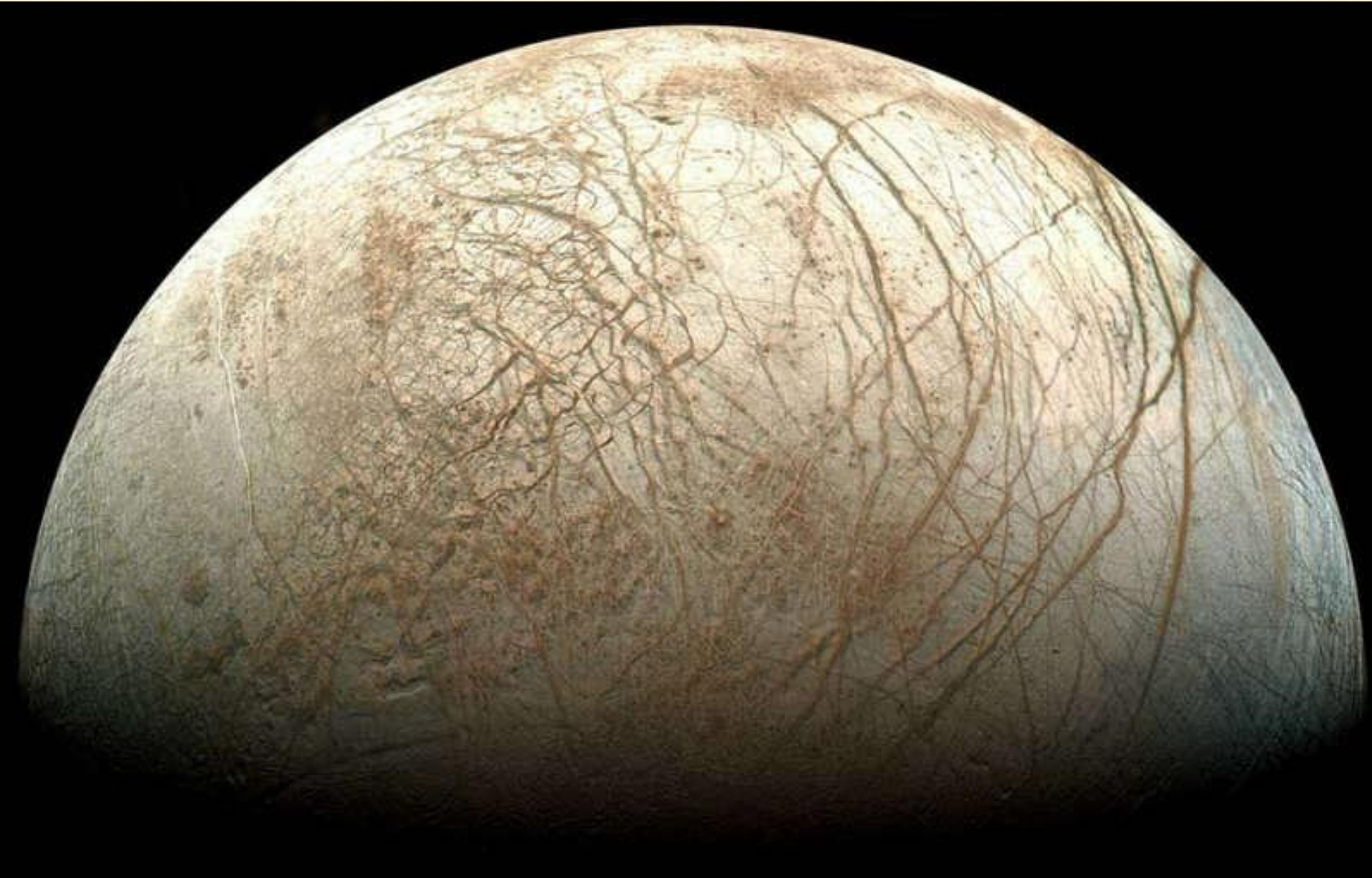
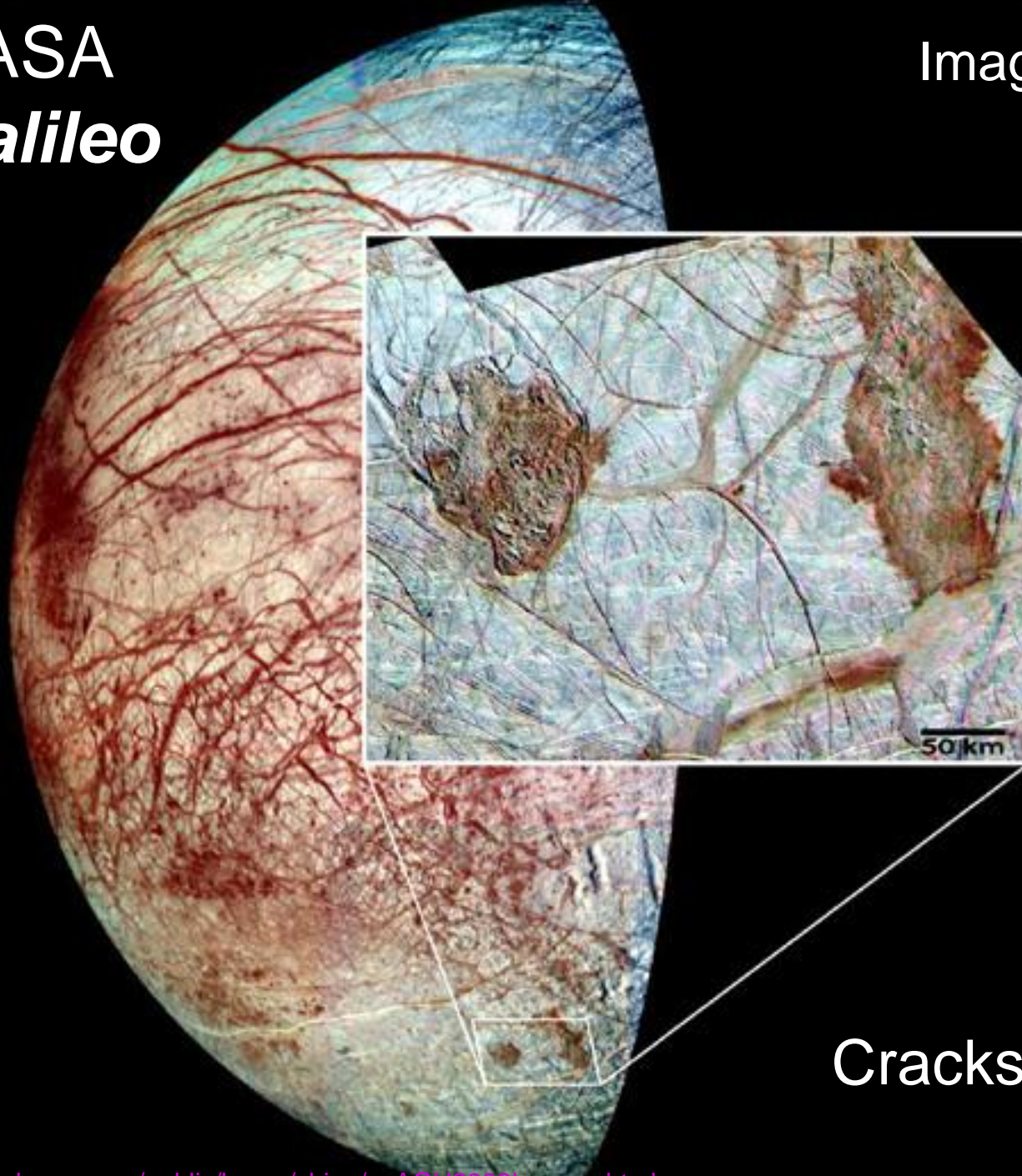


Image from: <http://www.solarviews.com/http://http://www.astronet.ru/db/xware/msg/apod/2007-12-02>

1989: NASA
Galileo

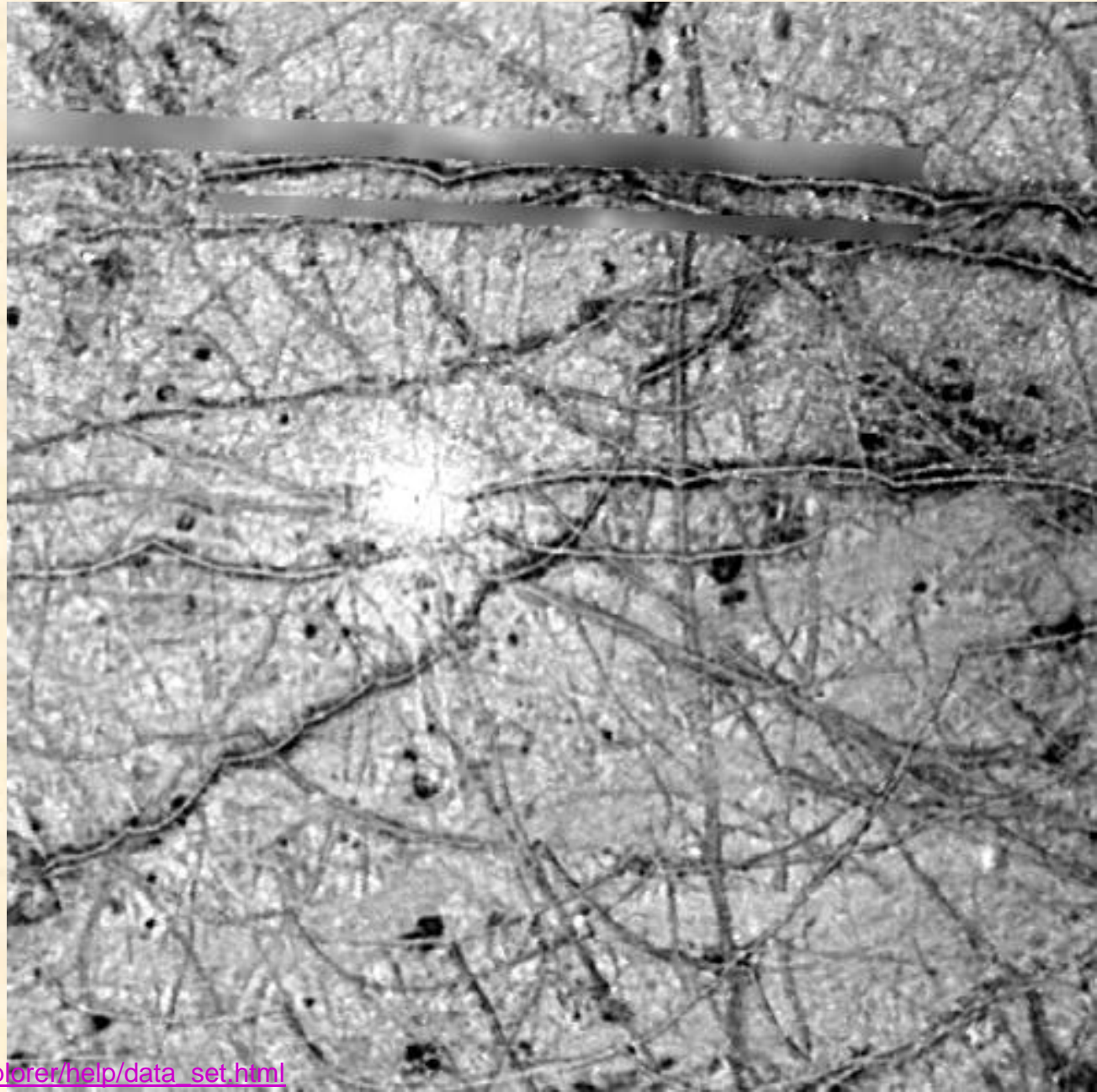
Image of Europa



Cracks in the ice

1989: NASA *Galileo*

Using images from Galileo and Voyager 1 and 2, this mosaic was prepared by the USGS Astrogeology Research Program using the an image processing and cartographic system.



1989: NASA *Galileo*



These spots
could be from
relatively
warmer ocean
below
interacting with
icy surface

Spots are
approximately
10km across

See many related talks at:

The *International Workshop on “**Europa Lander: Science Goals and Experiments**”*

February 9-13, 2009, Moscow, Russia

<http://www.iki.rssi.ru/conf/2009elw/>

Europa Rover

An possible course project Design

The mission objective is to explore an ocean confirmed in 2025 to be under the ice of Europa. Assume your launch is scheduled for 2040

Also assume one of the following:

- *A Europa Jupiter System Mission* discovers some very thin patches of ice (less than 200 meters thick) created by localized sub-surface thermal anomalies.

OR

- A mission concurrent to yours (but designed by others) has created craters on Europa's surface that have frozen over with approximately 200 meters of ice; but assume the ice will quickly freeze much thicker -- and therefore a rapid execution of all mission operations is critical.

Europa Rover

Your rover must be able to:

- Maneuver on icy surface
- Drill through 200 meters of ice
- When liquid water reached, either:
 - (1) Act as a UUV, or
 - (2) Deploy 100 small (10 cm.) networked UUV's
- Communicate with UUV's if option (2) chosen
- Communicate with base station that is communicating with several orbiters, and earth; and is also running a concurrent simulation building an environmental map of the region of Europa being explored. Simulation information should also be communicated back to the rover, and then to UUV's if option (2) chosen; this is to help with exploration, and preservation of the rover.
- Optionally, control a hyper-redundant manipulator attached to the rover to aid with exploration, digging, and/or deployment of small UUV's
- Withstand extremely cold temperatures (-143C, -225F max)
- Power itself by energy source other than sun since incident solar radiation reaching Europa is minimal; propose a means of powering the rover.

Europa Data [1]:

Europa Rover

Mass (Earth = 1) :	0.0083021
Surface Gravity (Earth = 1) :	0.135
Mean Distance from Sun (AU) :	5.203
Orbital period (days) :	3.551181
Rotational period (days) :	3.551181
Orbit Inclination (degrees) :	0.470

Surface Composition:

The smoothest object in the solar system.

Nothing exceeding 1 km in height.

Two types of terrains:

- 1) Mottled, brown or gray small hills
- 2) Large smooth plains criss-crossed with a large number of cracks (Some curved and some straight, some extend for thousands of kilometers)

Europa Atmosphere [2]: *“NASA's Hubble Space Telescope (HST) has identified the presence of an extremely tenuous atmosphere of molecular oxygen ... its surface pressure is barely one hundred billionth that of the Earth”*

[1] <http://www2.jpl.nasa.gov/galileo/europa/>

[2]: <http://www2.jpl.nasa.gov/galileo/europa/hst.html>

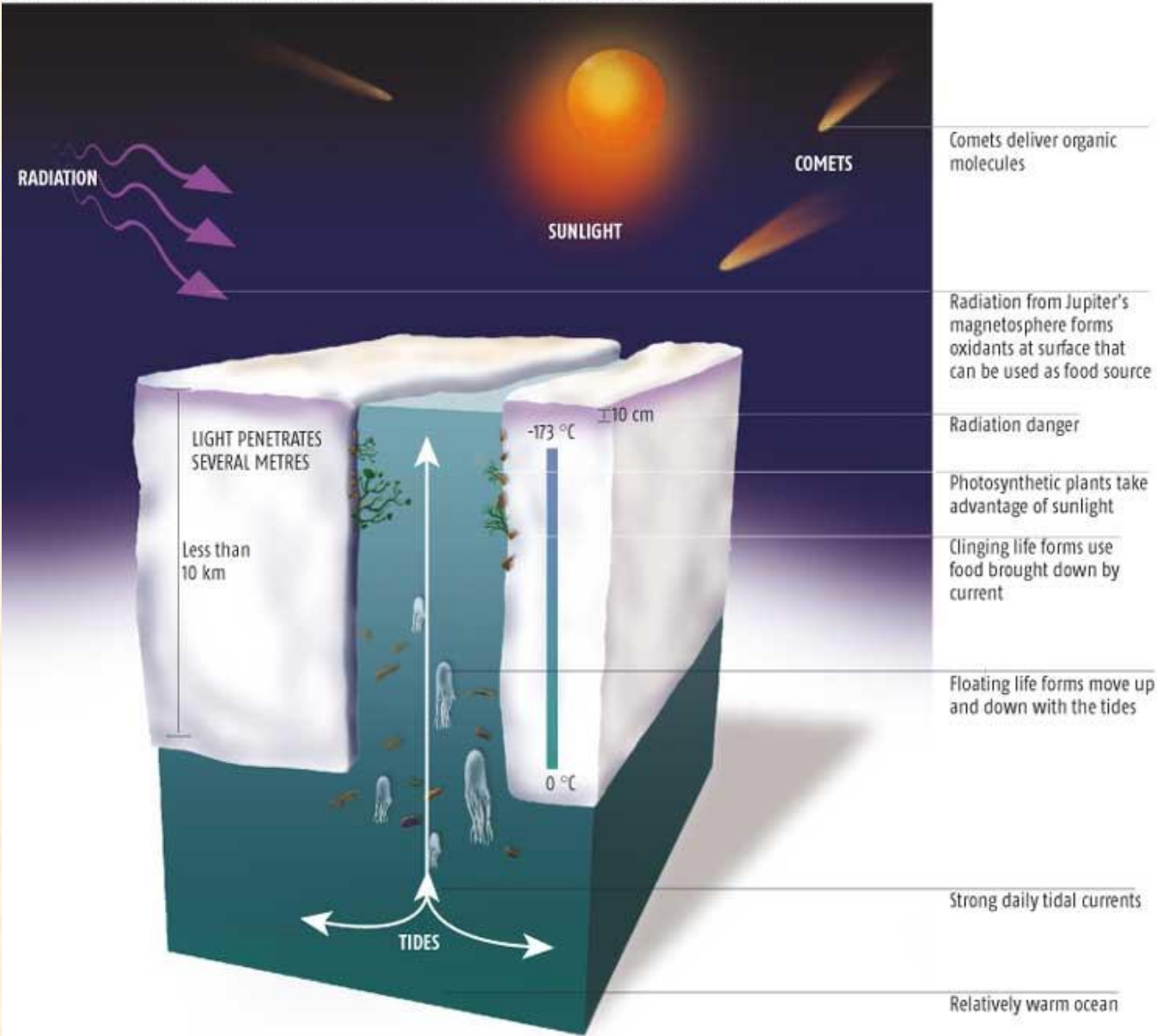
Europa Rover

Many believe there could be life in Europa's relatively warm sub-surface ocean

Mainly due to effects of very strong tidal forces caused by Jupiter's very large mass, plus the pull of other moons

IS THERE LIFE ON EUROPA?

If Europa's icy crust is thin enough, cracks would provide a habitat where life could thrive



Europa Rover

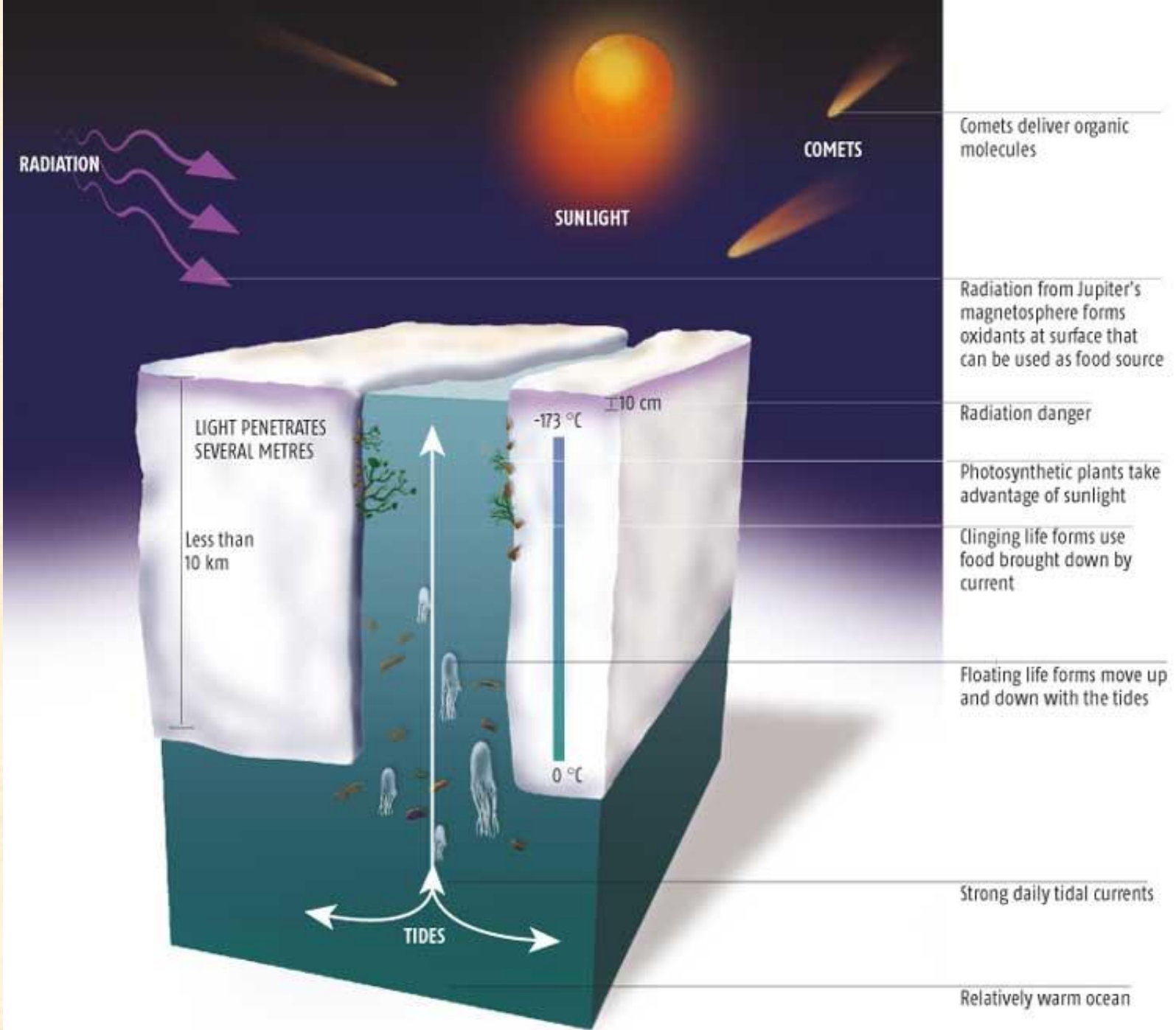


Image from <http://www.newscientist.com/article/dn2929-thin-ice-opens-lead-for-life-on-europa.html>



Spots are
approximately
10km across

See:
[VIDEO](#)