

Skylight Astronomical Society

Probes to the Outer Solar System Past, Present and Future

Spotlight on: Galileo

Terry P. Riopka, President of Skylight Astronomical Society - 2018

Probes to the Outer Solar System Past and Present

Launch
Date

1972 Pioneer 10

1973 Pioneer 11

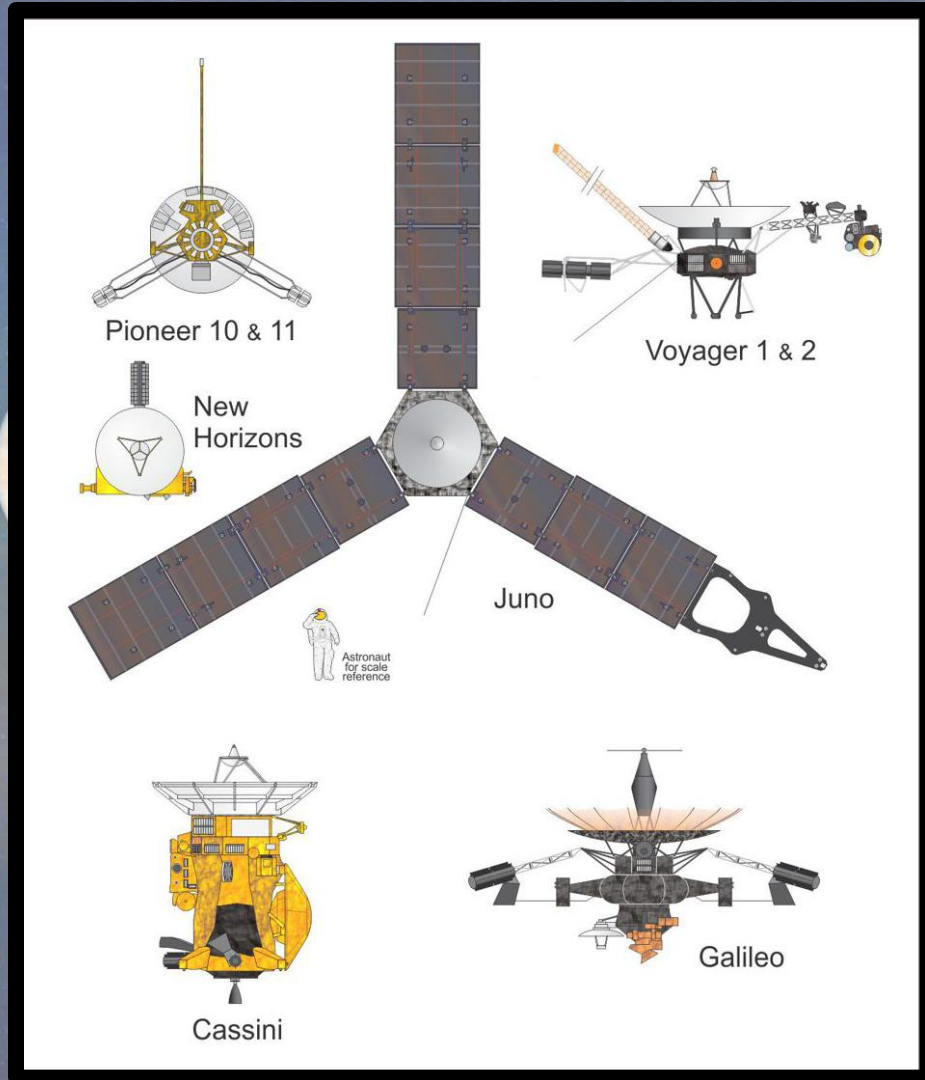
1977 Voyager 2
Voyager 1

1989 Galileo

1997 Cassini-Huygens

2006 New Horizons

2011 Juno



Galileo Orbiter and Entry Probe

Launch Date

1972 — Pioneer 10

1973 — Pioneer 11

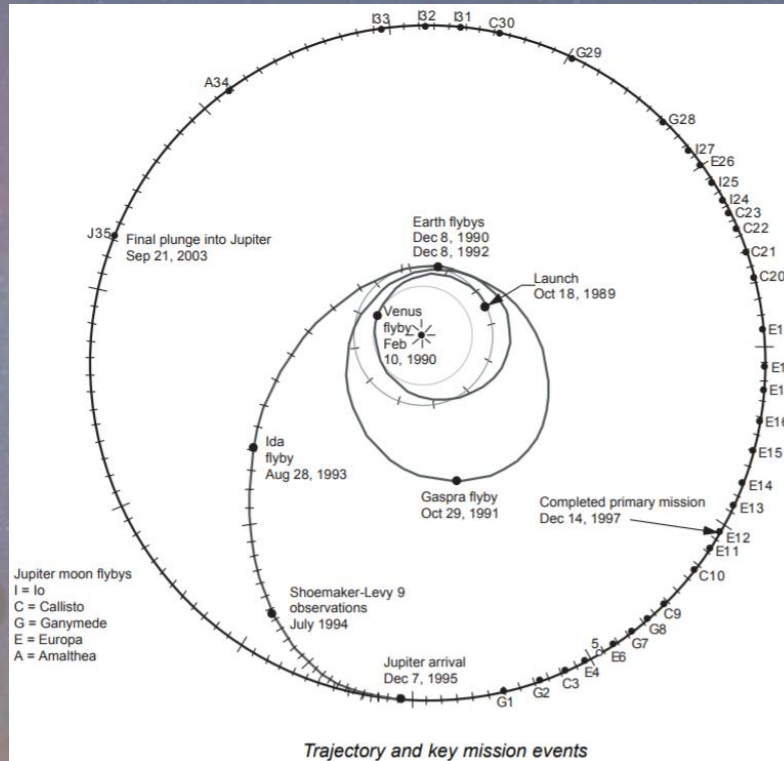
1977 — Voyager 2
Voyager 1

1989 — Galileo

1997 — Cassini-Huygens

2006 — New Horizons

2011 — Juno



- originally scheduled for 1984, launched on STS-34 in 1989 and arrived 6 years later
- first spacecraft to orbit Jupiter
- survived 8 years in orbit
- high gain antenna failed due to eroded lubricants



- CCD (Galileo) vs. vidicon (*Voyager*)
- designed to obtain images of Jupiter's satellites at resolutions 20 to 1,000 times better than *Voyager's* best

- 134 Kbits/sec reduced to 160 bits/sec with 1 Kbit/sec after compression

Galileo Orbiter and Entry Probe

First ever asteroid flyby of 951 Gaspra

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2006 — New Horizons

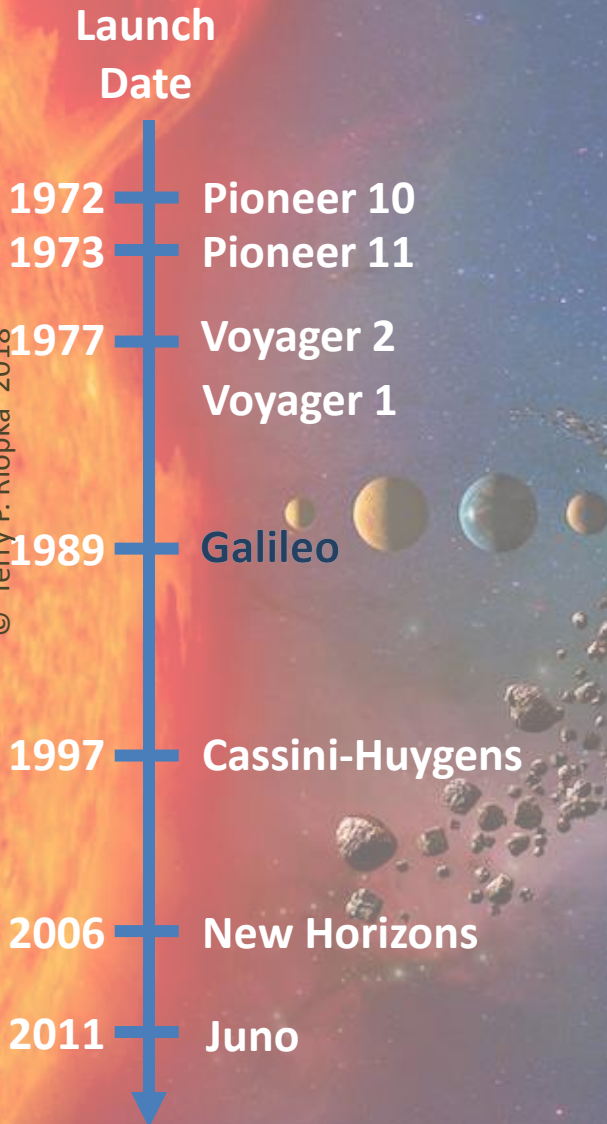
2011 — Juno



- passed within 1000 miles at a relative speed of 18,000 mph
- 57 images were returned to Earth
- best images have a resolution of about 54 meters/pixel
- about the size of Guam, or half the land area of Hong Kong

Galileo Orbiter and Entry Probe

First discovery of a moon around an asteroid



Asteroid 243 Ida and its tiny 1 mile diameter moon Dactyl

- composed of two large objects connected together
- 3 times larger than 951 Gaspra

Galileo Orbiter and Entry Probe

Launch
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Remote Detection of Life on Earth

1972 Pioneer 10
1973 Pioneer 11
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Voyager 1
1989 Galileo
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2006 New Horizons
2011 Juno



Sagan criteria for life:

- strong absorption of red light by chlorophyll in photosynthesizing plants
- absorption bands of molecular oxygen as a result of plant activity
- Infrared absorption bands caused by methane 140 orders of magnitude higher than expected
- modulated narrowband radio wave transmissions

➔ all four signs detected

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Galileo Orbiter and Entry Probe

Laser Downlink Experiment



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- 20 MW laser detected by Galileo CCD camera
- data was used to help design laser communication subsystem, that was successfully tested aboard the Lunar Atmosphere and Dust Environment Explorer mission in 2013
- planned for use on Mars 2022 orbiter mission

Galileo Entry Probe

- separated from the main spacecraft on July 10, 1995, five months before its rendezvous with the planet on December 7

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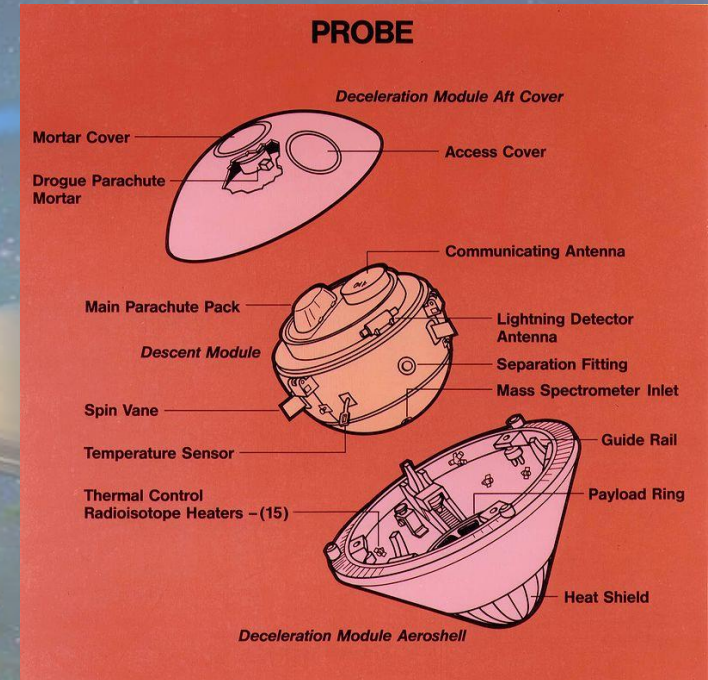
Voyager 1

1989 Galileo

1997 Cassini-Huygens

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- entered atmosphere at ~30 mi/s, slowed to < 1000 ft/s in 2 min
- shield heated to 28,000 °F, deceleration 230 g, lost half of its mass (80kg) during entry, then detached and parachute was deployed
- sent back 58 minutes of data (0.5 MB)

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Galileo Entry Probe

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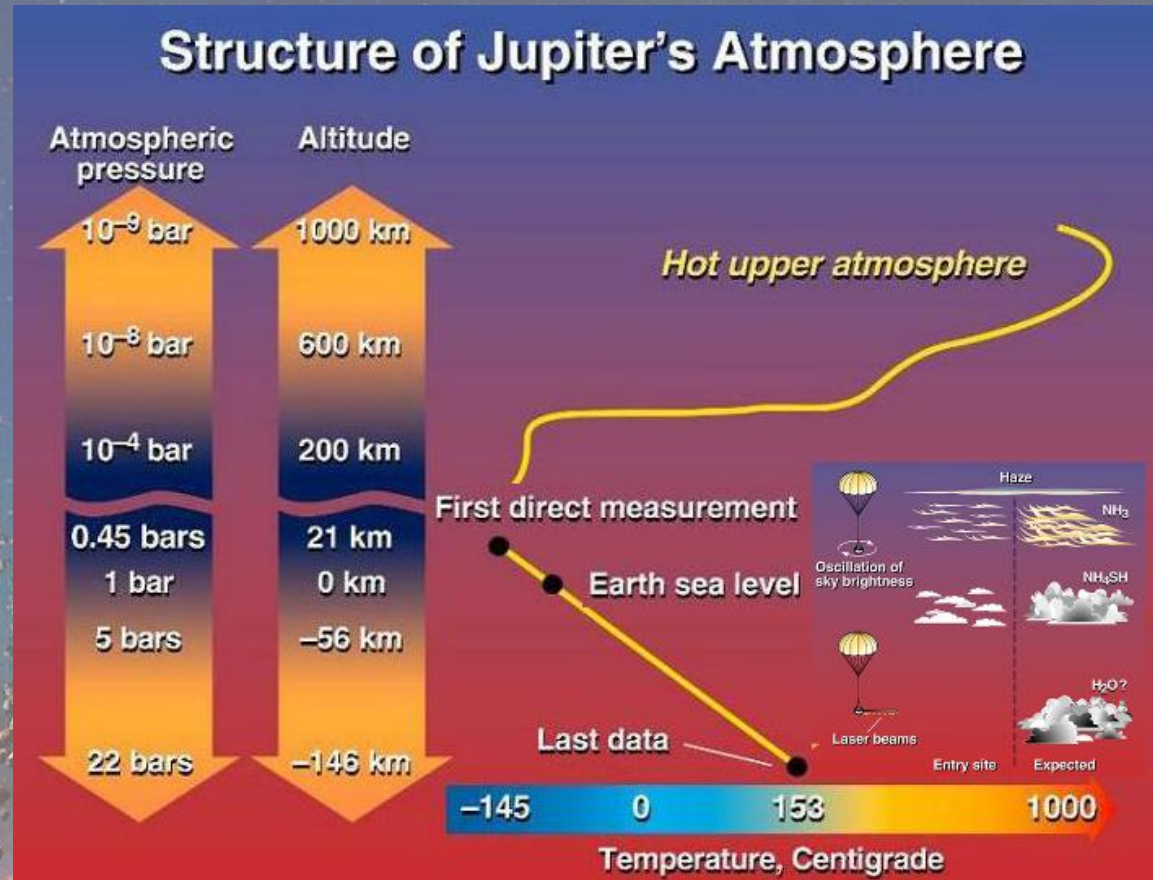
Voyager 1

1989 Galileo

1997 Cassini-Huygens

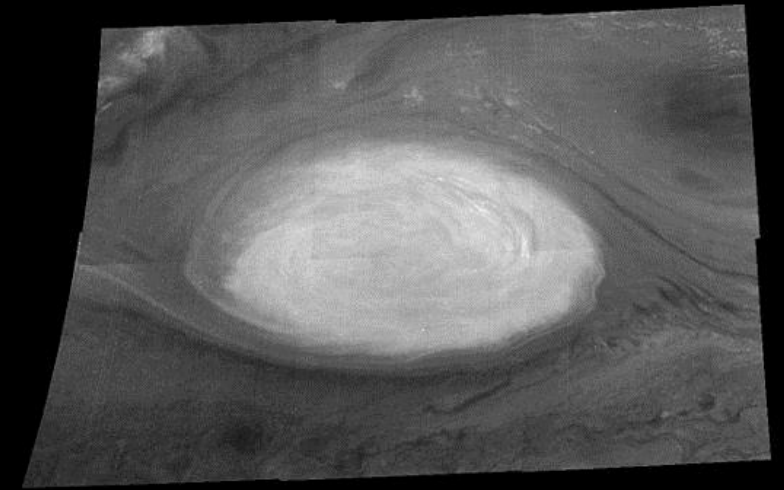
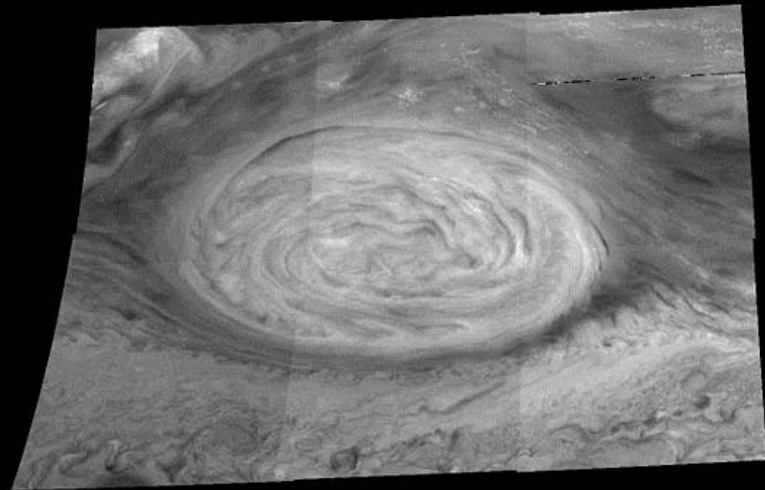
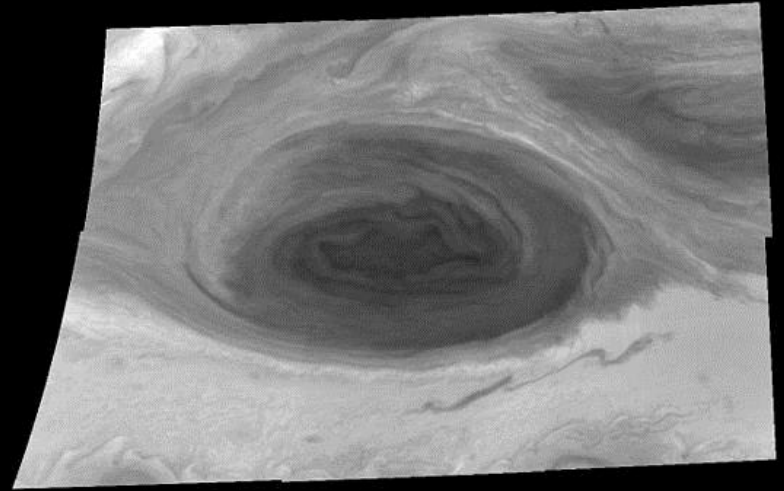
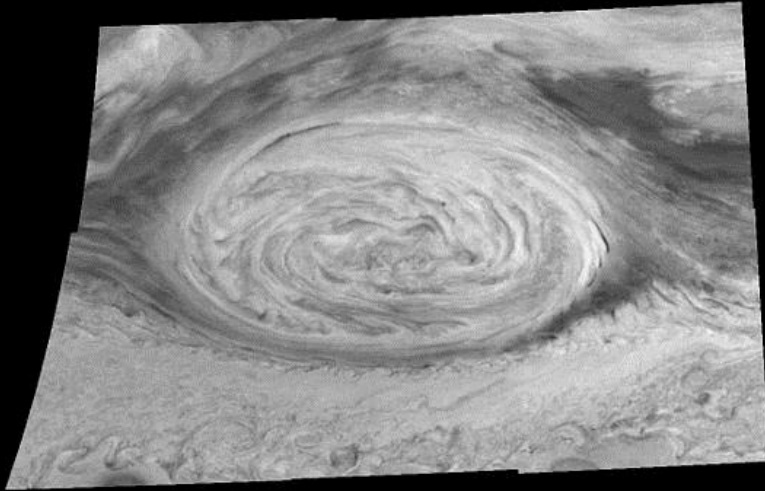
2006 New Horizons

2011 Juno



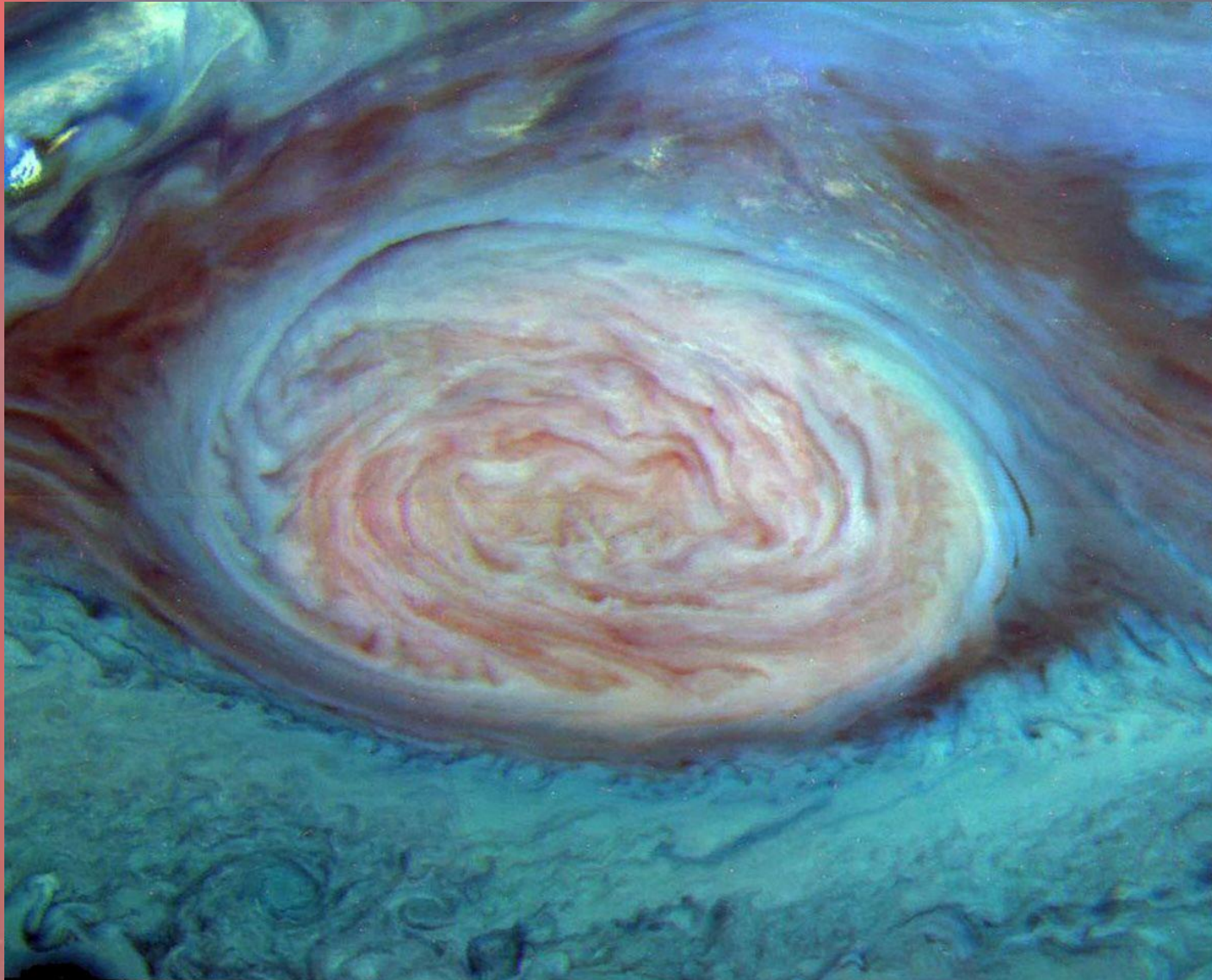
- atmosphere much denser and hotter with periods of intense heat and cold
- lack of water clouds, single vs. three tier cloud structure
- half the helium, less water, less heavy elements
- less lightning, much stronger winds – constant at half the speed of sound from 4-22 bars

Galileo Orbiter



Jupiter's Red Spot in Near-Infrared Wavelengths

Galileo Orbiter



Jupiter's Red Spot in Near-Infrared Wavelengths

Galileo Orbiter

Size Comparison



Daily Radiation Dose: 36 Sv

5.4 Sv

0.080 Sv

0.0001 Sv

Average daily radiation:

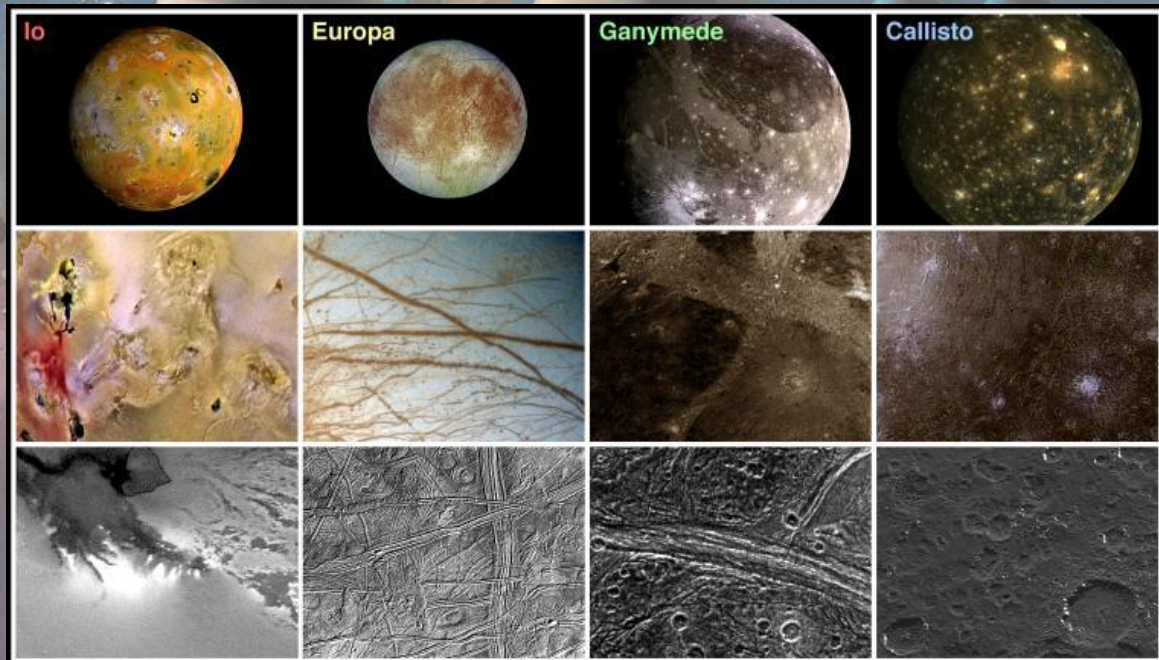
Earth: 0.00001 Sv

Moon: 0.001 Sv

Safer on Callisto than on the Moon!

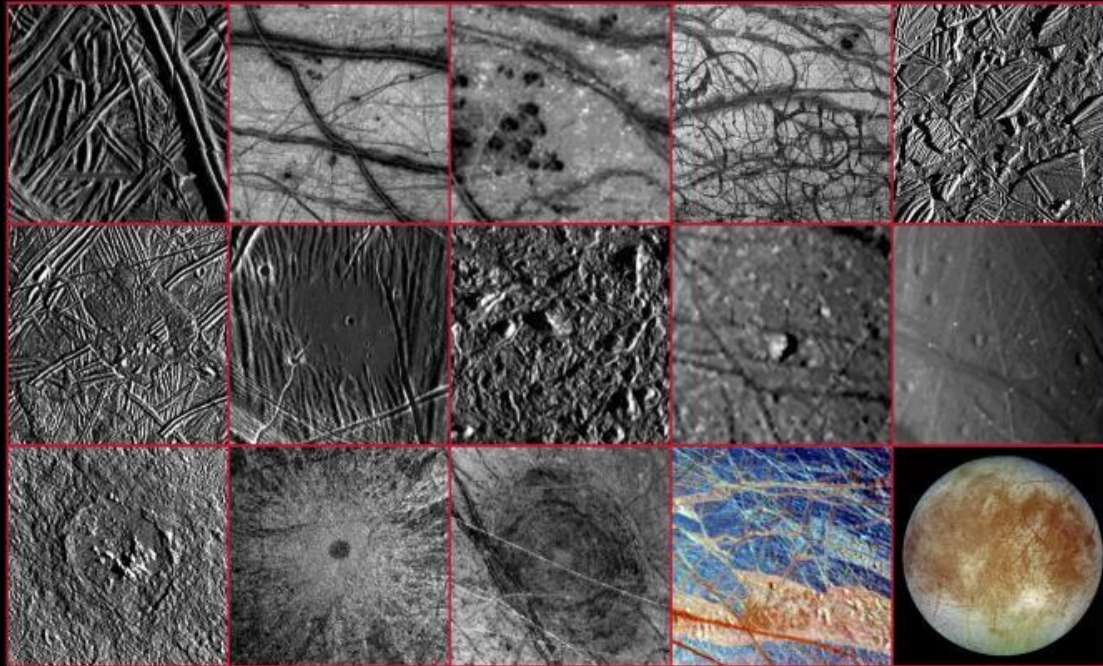
- outside of Jupiter's radiation belt but protected by its magnetic field

Surface Detail Comparison



Galileo Orbiter - Europa

EUROPA — Surface-feature examples



- smoothest object in the solar system
- Hard outer layer of ice 6-20 miles thick, with outer layer of water about 62 miles thick
- induced magnetic field suggests salty liquid water ocean
- one three moons known to have thin oxygen atmosphere

Ridges and
Lineaments
27
meters/pixel

Triple Bands
1.6
kilometers/pixel

Dark Spots
1.6
kilometers/pixel

"Pull-apart"
Terrain
1.6
kilometers/pixel

"Raft" Terrain
250
meters/pixel

Flows
225
meters/pixel

"Puddle"
27
meters/pixel

Mottled Terrain
35
meters/pixel

Knobs
1.6
kilometers/pixel

Pits
1.6
kilometers/pixel

Crater
300
meters/pixel

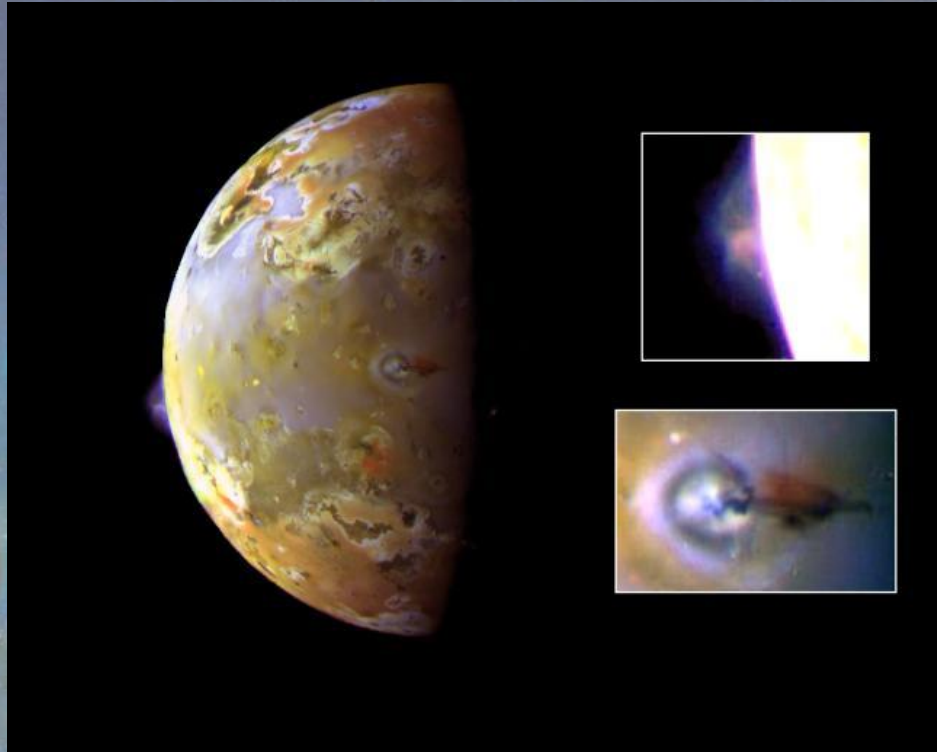
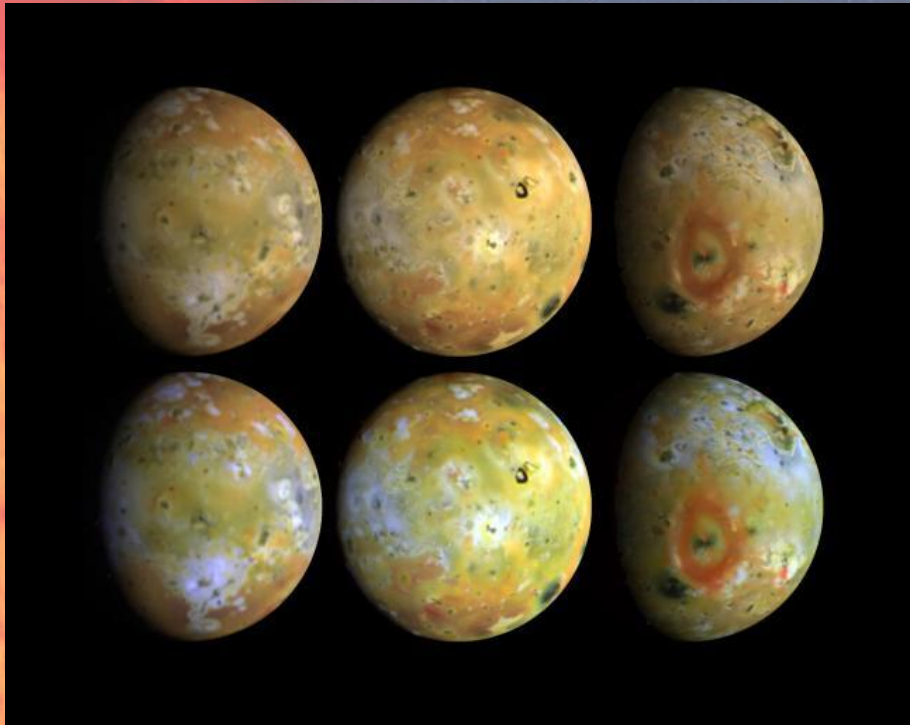
Crater Ejecta
1.4
kilometers/pixel

"Macula"
600
meters/pixel

IR-Bright/Dark
Terrain
1.6
kilometers/pixel

Global View
7
kilometers/pixel

Galileo Orbiter – Io

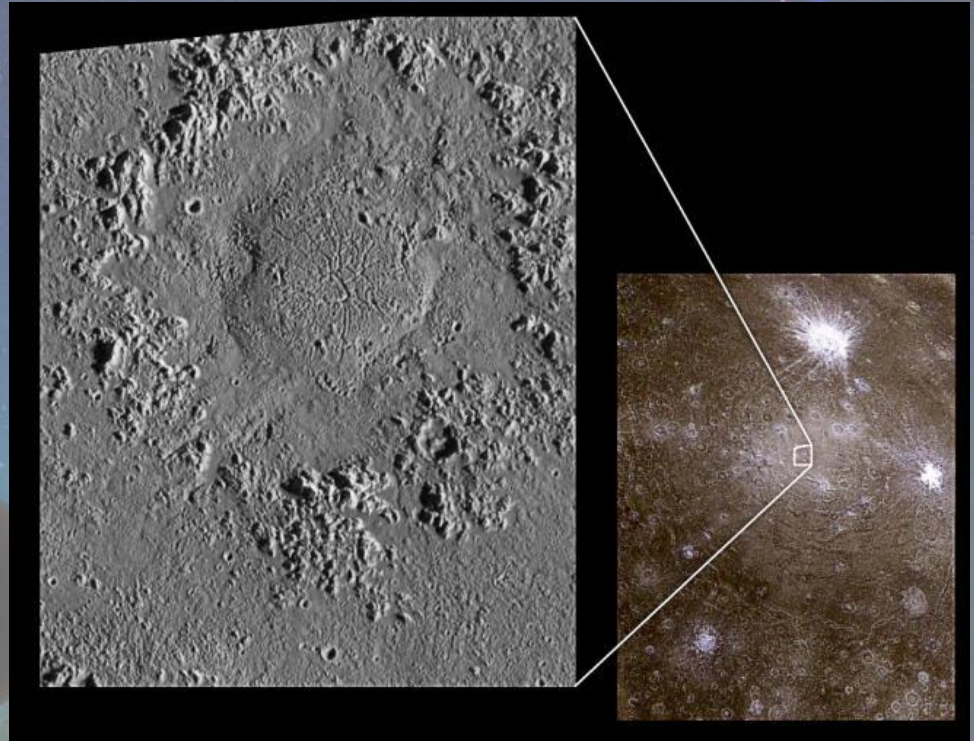
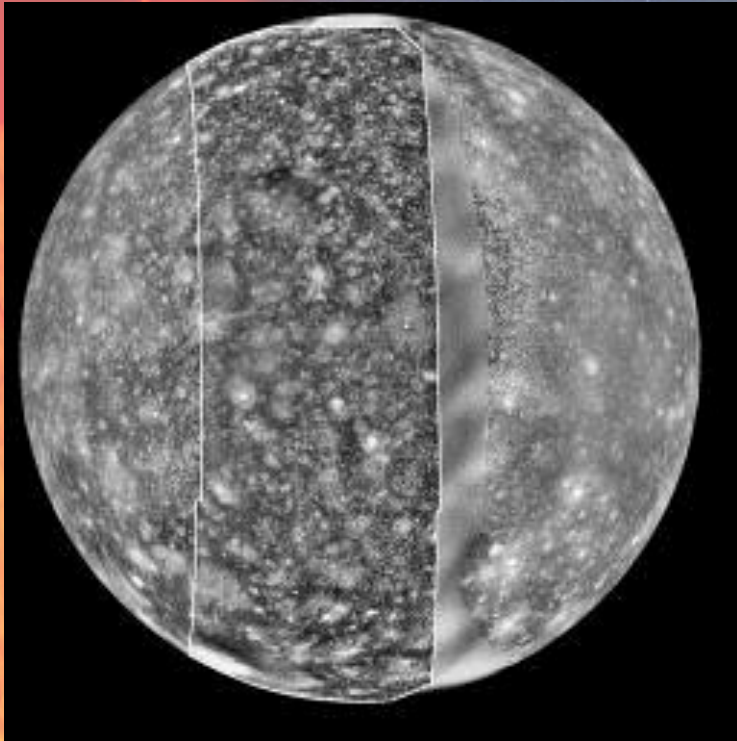


Global View of Io

Volcanic Plume above Pillan Patera
(with closeup)

- Highest density moon in solar system
- Over 400 volcanoes – most geologically active body in solar system
- Thin atmosphere of sulfur dioxide

Galileo Orbiter – Callisto

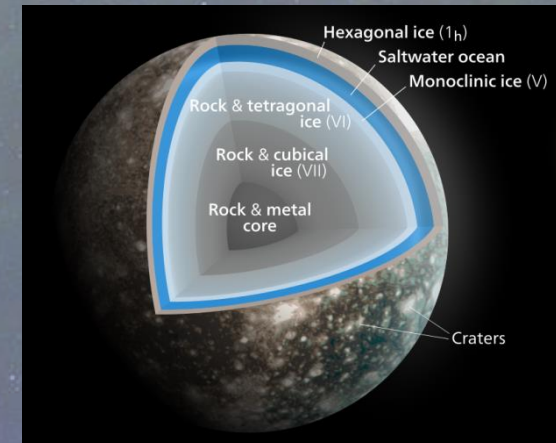


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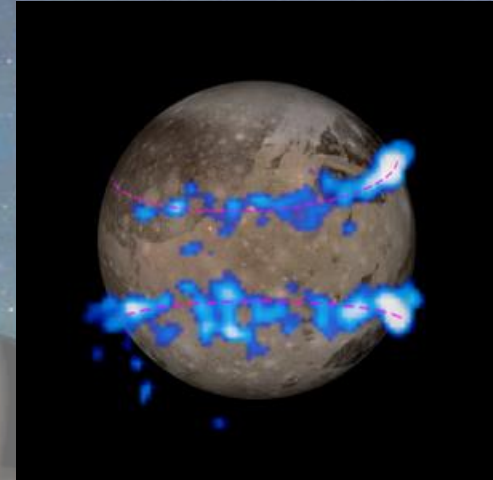
Voyager 1 (left) / Galileo (middle) / Voyager 2 (right)

• dome crater called “Doh” in the Asgard region on Callisto

- only Galilean satellite not in resonance with others
- oldest and most heavily cratered surface in solar system
- thin atmosphere of carbon dioxide, constantly replenished
- low radiation – most suitable human base for future explorers



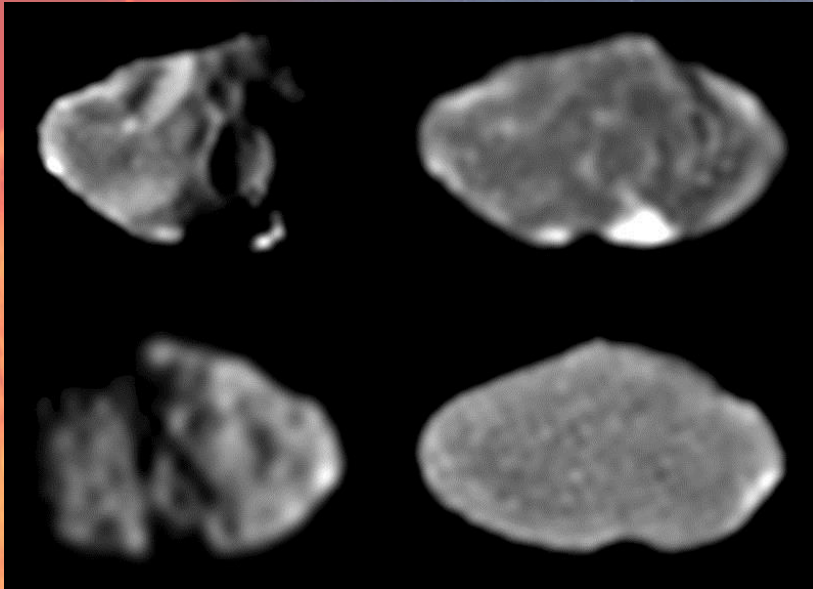
Galileo Orbiter – Ganymede



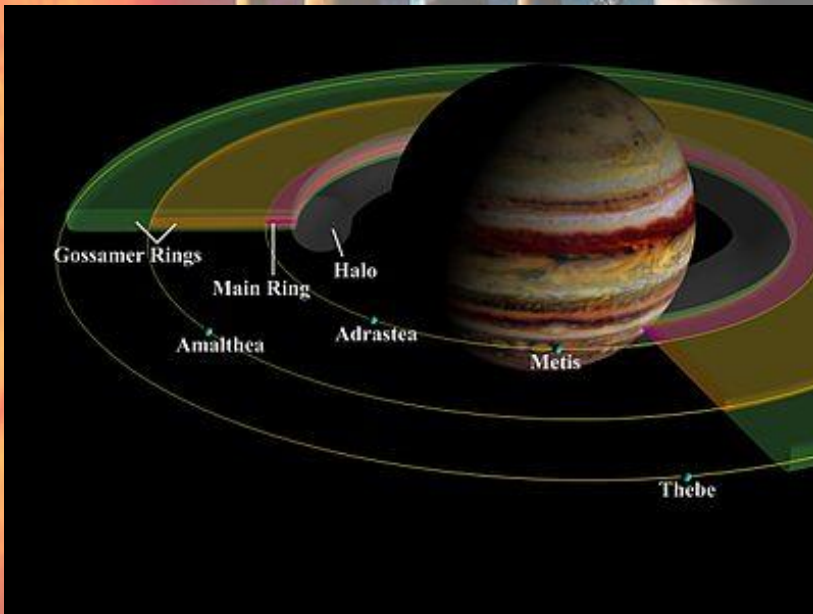
Shifting of aurora suggests subsurface salt ocean

- Largest and most massive moon in the Solar System
- Only moon known to have its own magnetosphere
- One of three moons known to have thin oxygen atmosphere

Galileo Orbiter – Amalthea/Rings

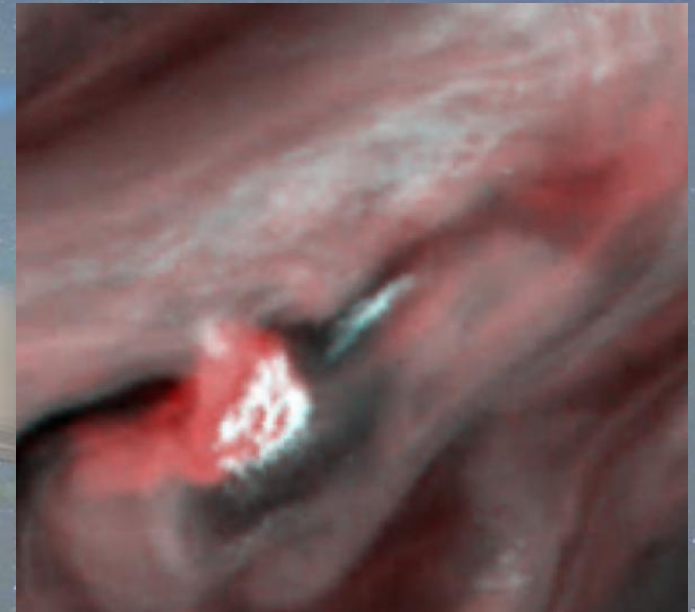
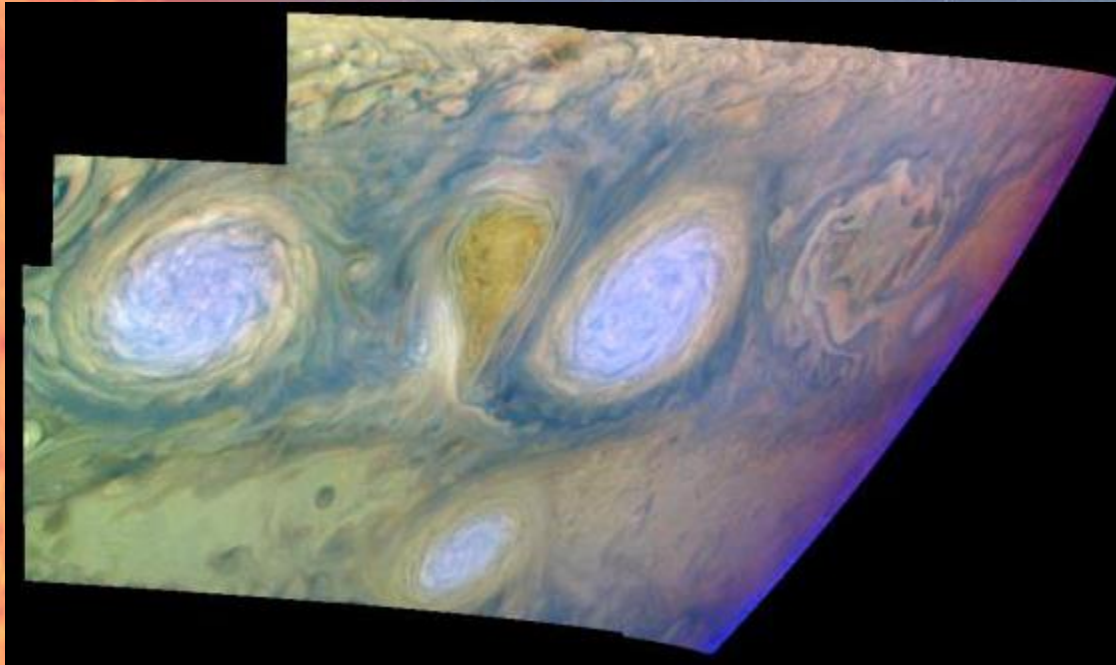


- obtained most detailed images of Amalthea – largest of three inner satellites
- ejected dust responsible for Amalthea Gossamer Ring



- thoroughly investigated and imaged Jupiter ring system
- determined particle size $< 15 \mu\text{m}$

Galileo Orbiter



Observed first merging of cyclones on Jupiter

First images of water clouds

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- *Galileo* had not been sterilized prior to launch
- impacted Jupiter in darkness just south of the equator on September 21, 2003,
- impact speed was approximately 108,000 mph

Probes to the Outer Solar System

End

Thank you!

