

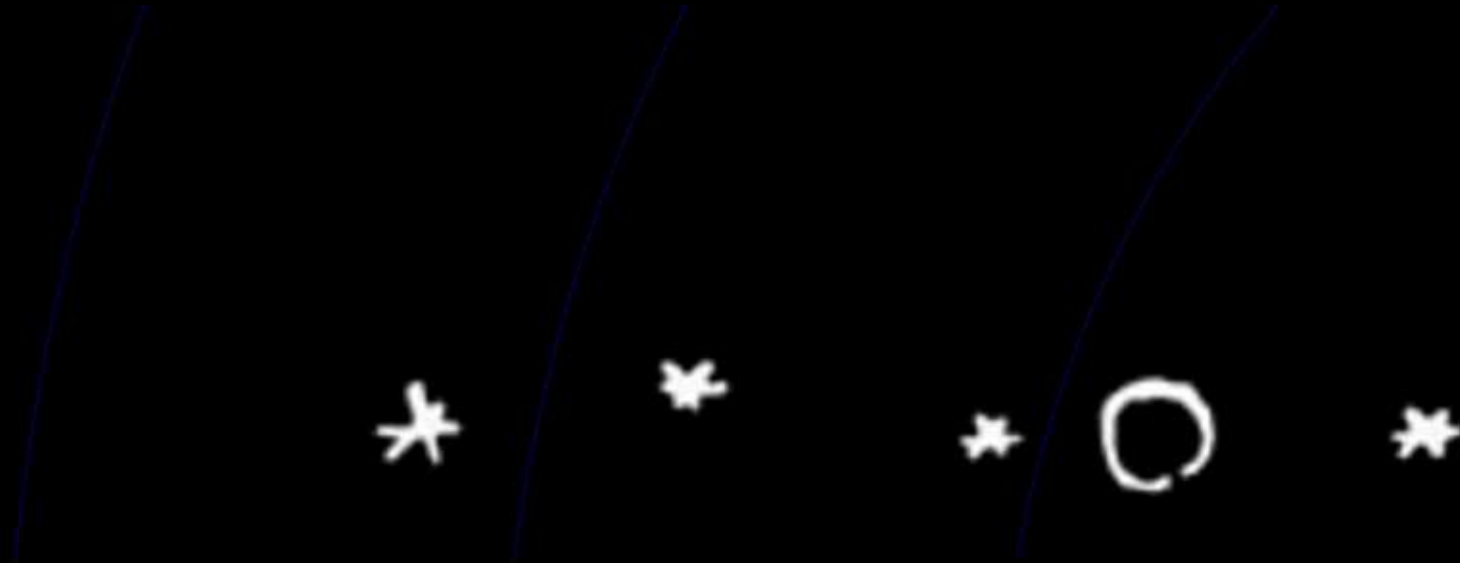


EUROPA

CLIPPER

Dave Doody

Jet Propulsion Laboratory, California Institute of Technology





THE GALILEAN SATELLITES OF JUPITER



CALLISTO
4821 KM DIA



GANYMEDE
5262 KM DIA



EUROPA
3122 KM DIA
(Earth's Moon is 3475)



IO
3643 KM DIA



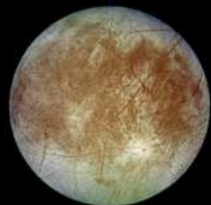
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VOYAGER SPACECRAFT
1979 MARCH & JULY



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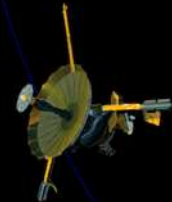
EUROPA
3122 KM DIA
(Earth's Moon is 3475)



IO
3643 KM DIA



VOYAGER SPACECRAFT
1979 MARCH & JULY



GALILEO SPACECRAFT
1995-2003





Here on Earth / Universe

Gravitation



Here on Earth / **Universe**

Gravitation



Orbital Mechanics



Here on Earth / **Universe**

Gravitation

Orbital Mechanics

Geology



Here on Earth / **Universe**

Gravitation



Orbital Mechanics



Geology



Chemistry



Here on Earth / Universe

Gravitation



Orbital Mechanics



Geology



Chemistry



Water



Here on Earth / Universe

Gravitation



Orbital Mechanics



Geology



Chemistry



Water



Biology

Here on Earth

/

Universe

Gravitation

Orbital Mechanics

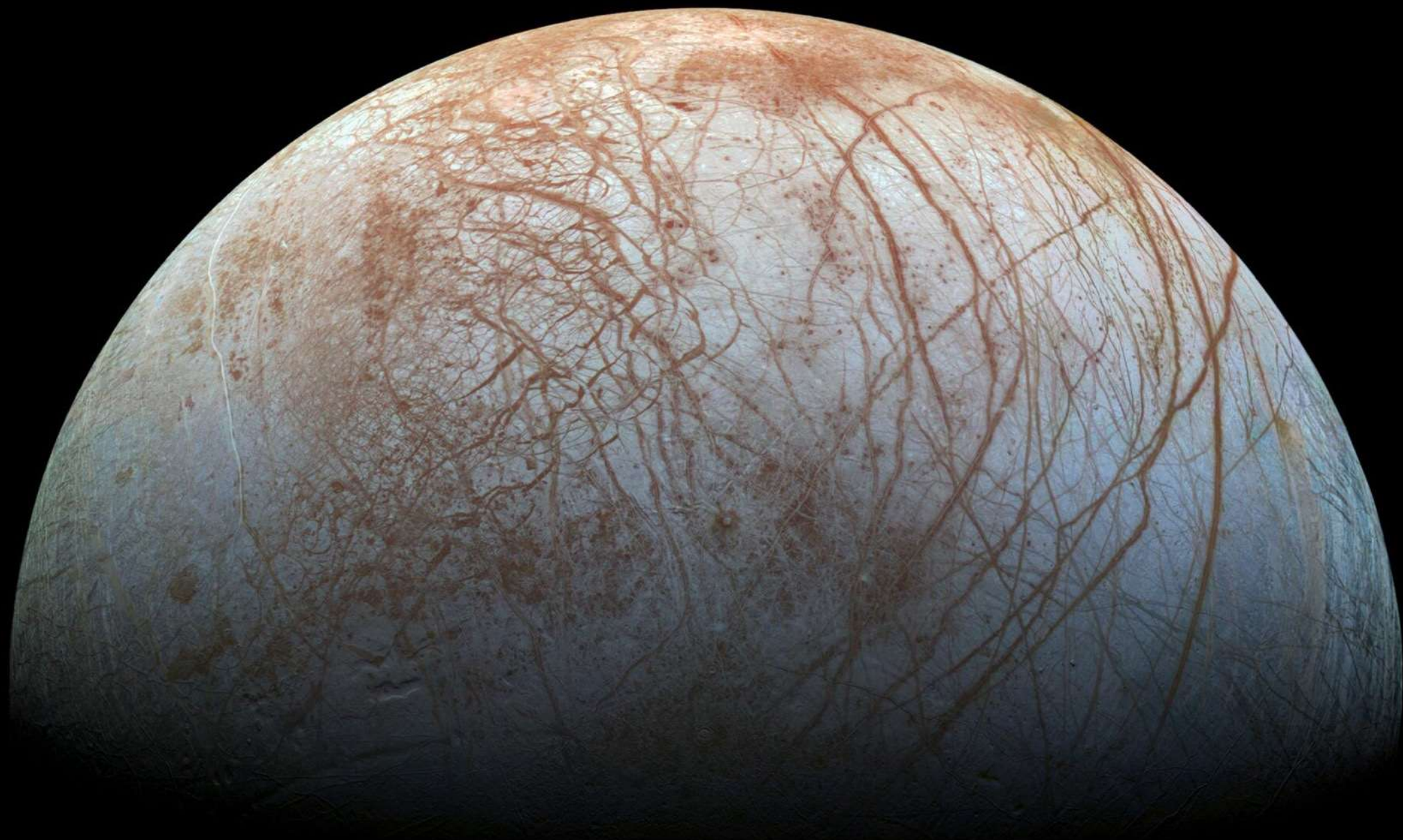
Geology

Chemistry

Water

Biology

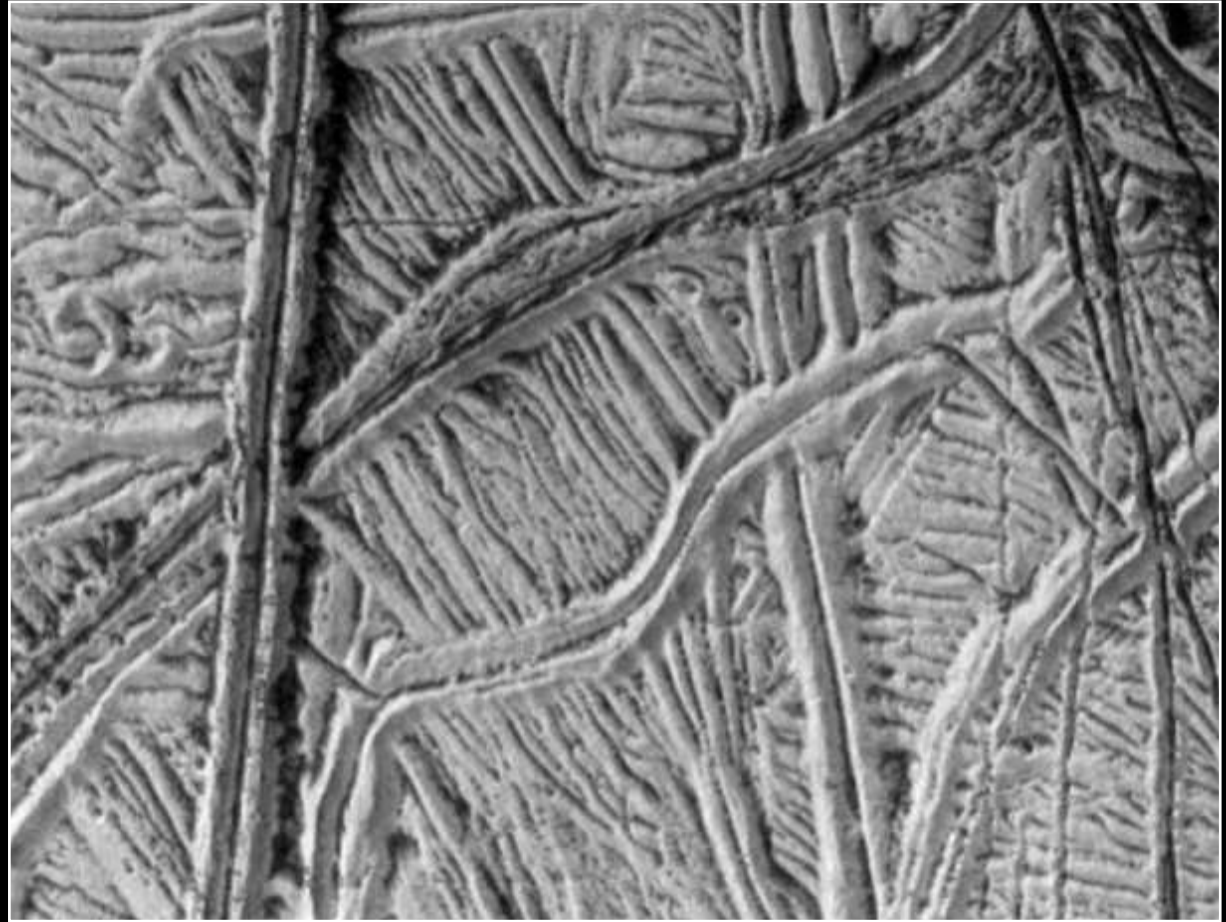
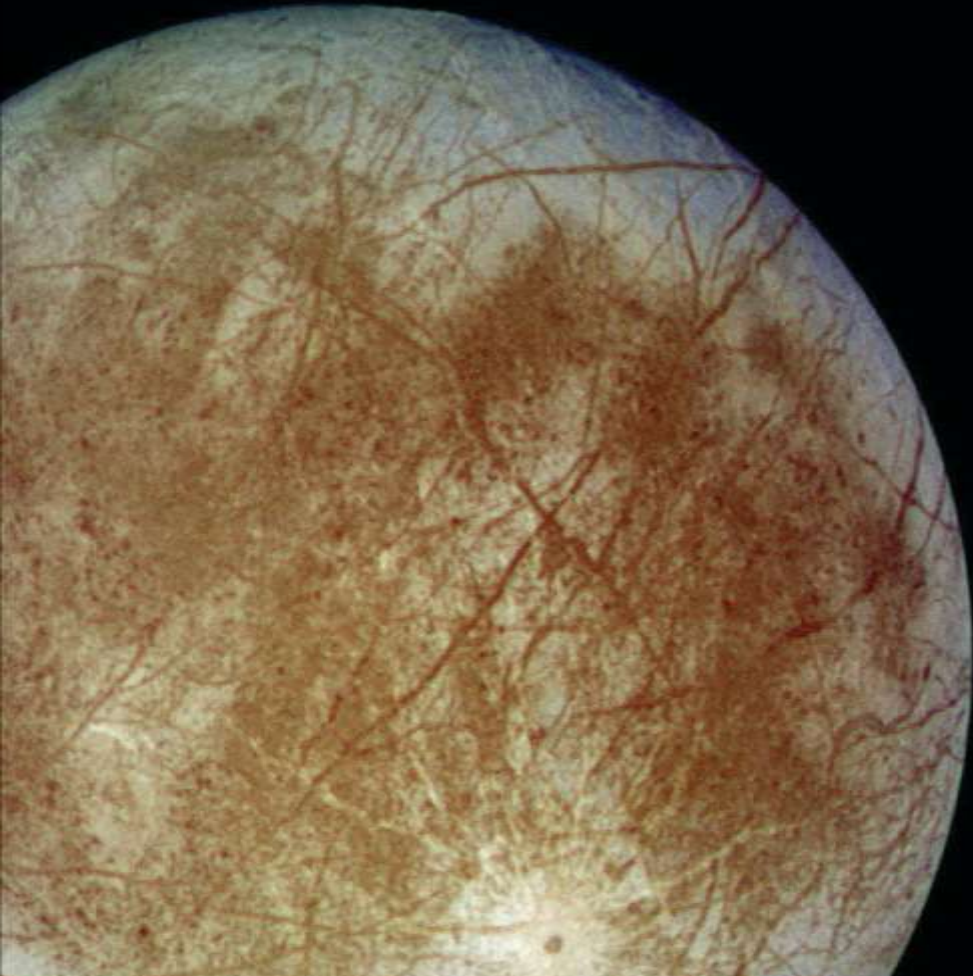






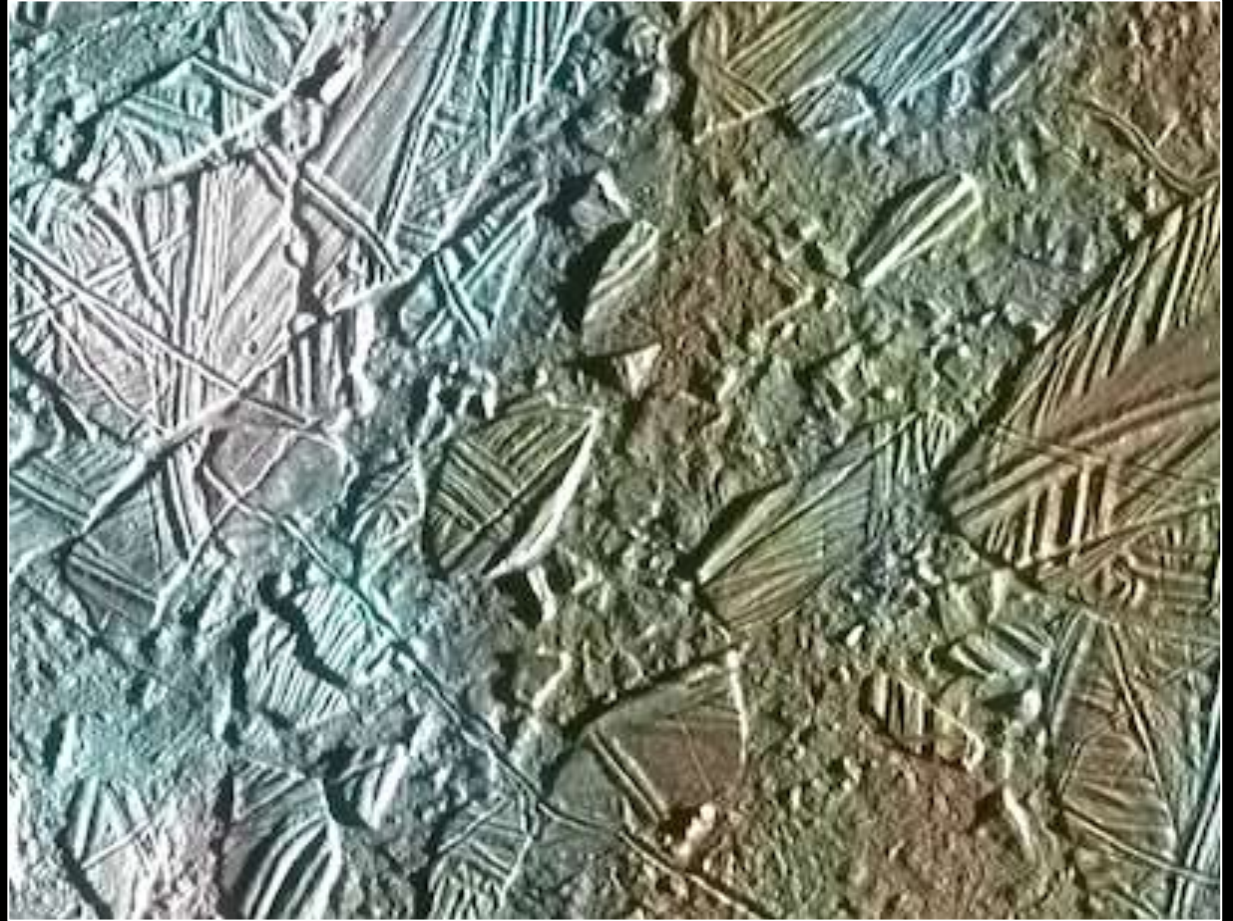
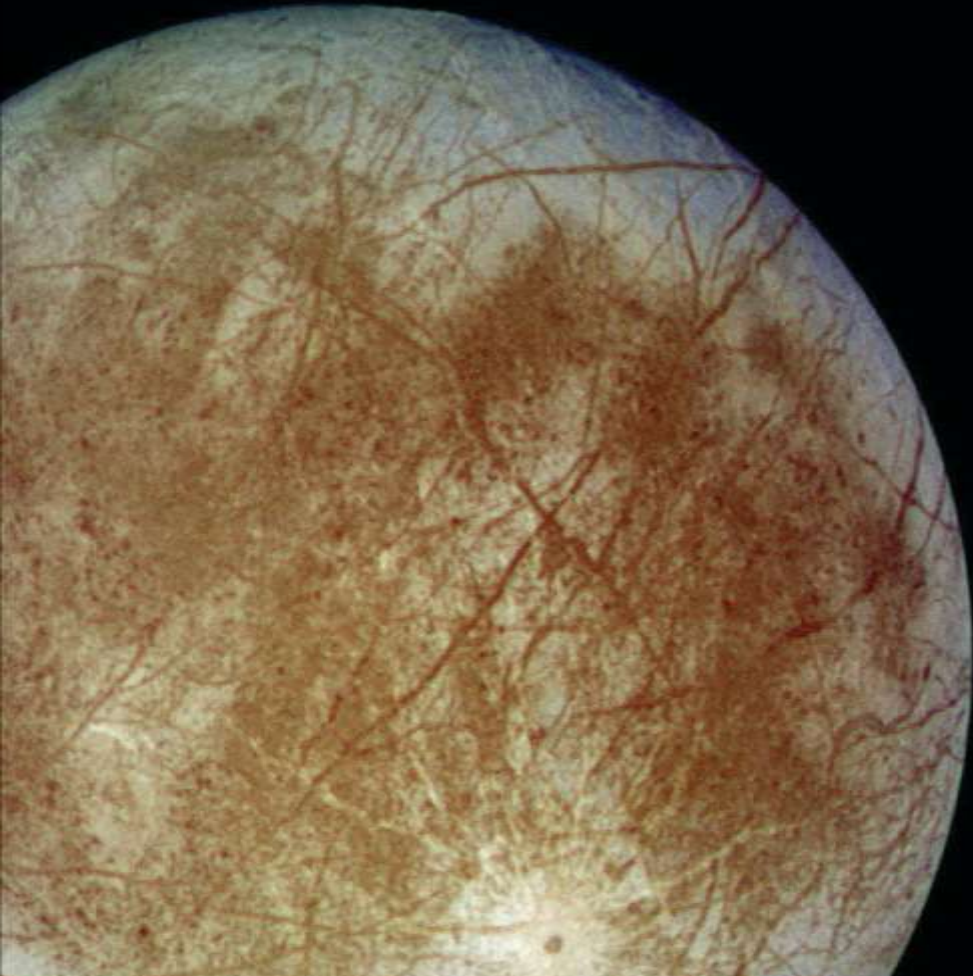
EUROPA'S SURFACE

RIDGED PLAINS



EUROPA'S SURFACE

CHAOS



EUROPA'S SURFACE

CRATERS



EUROPA'S SURFACE

LENTICULAE



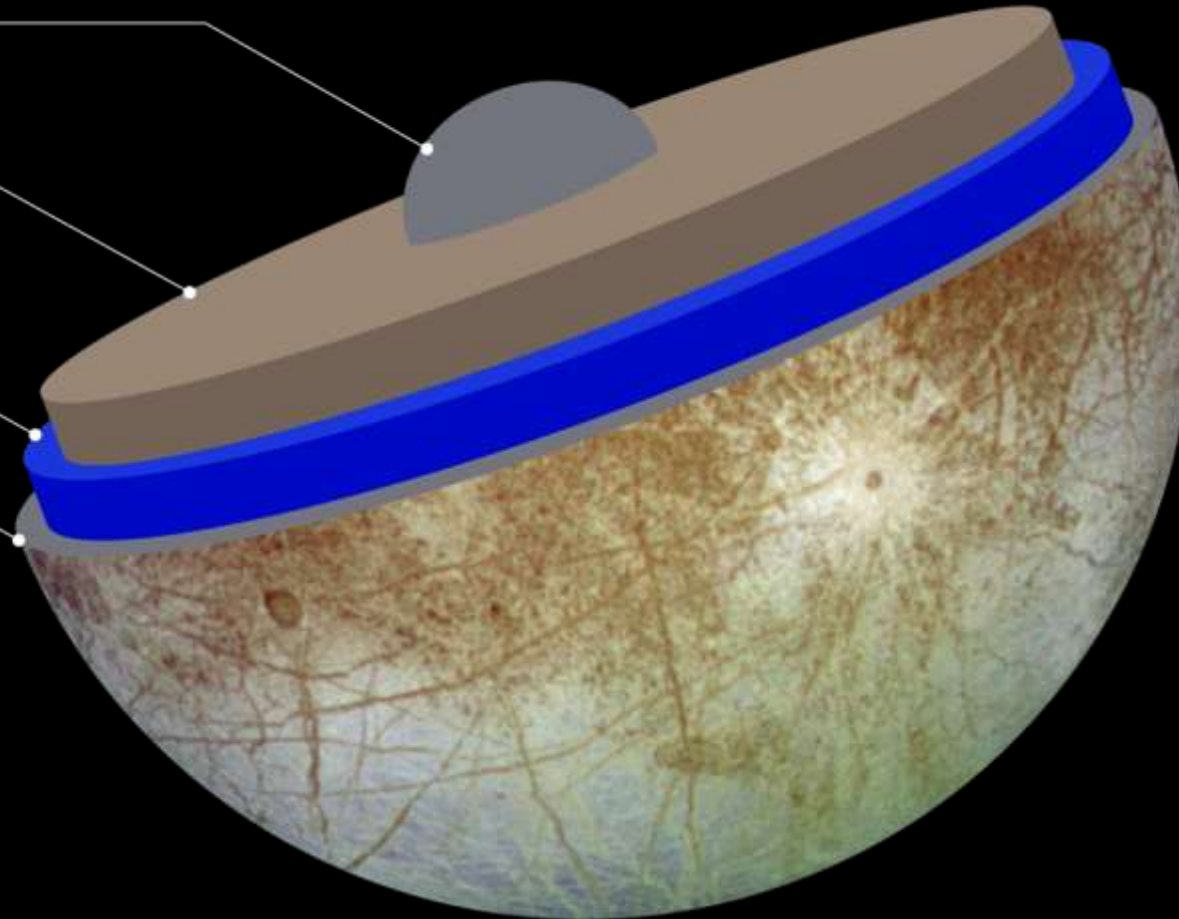
EUROPA'S INTERIOR

METALLIC CORE

ROCK

OCEAN

ICE CRUST

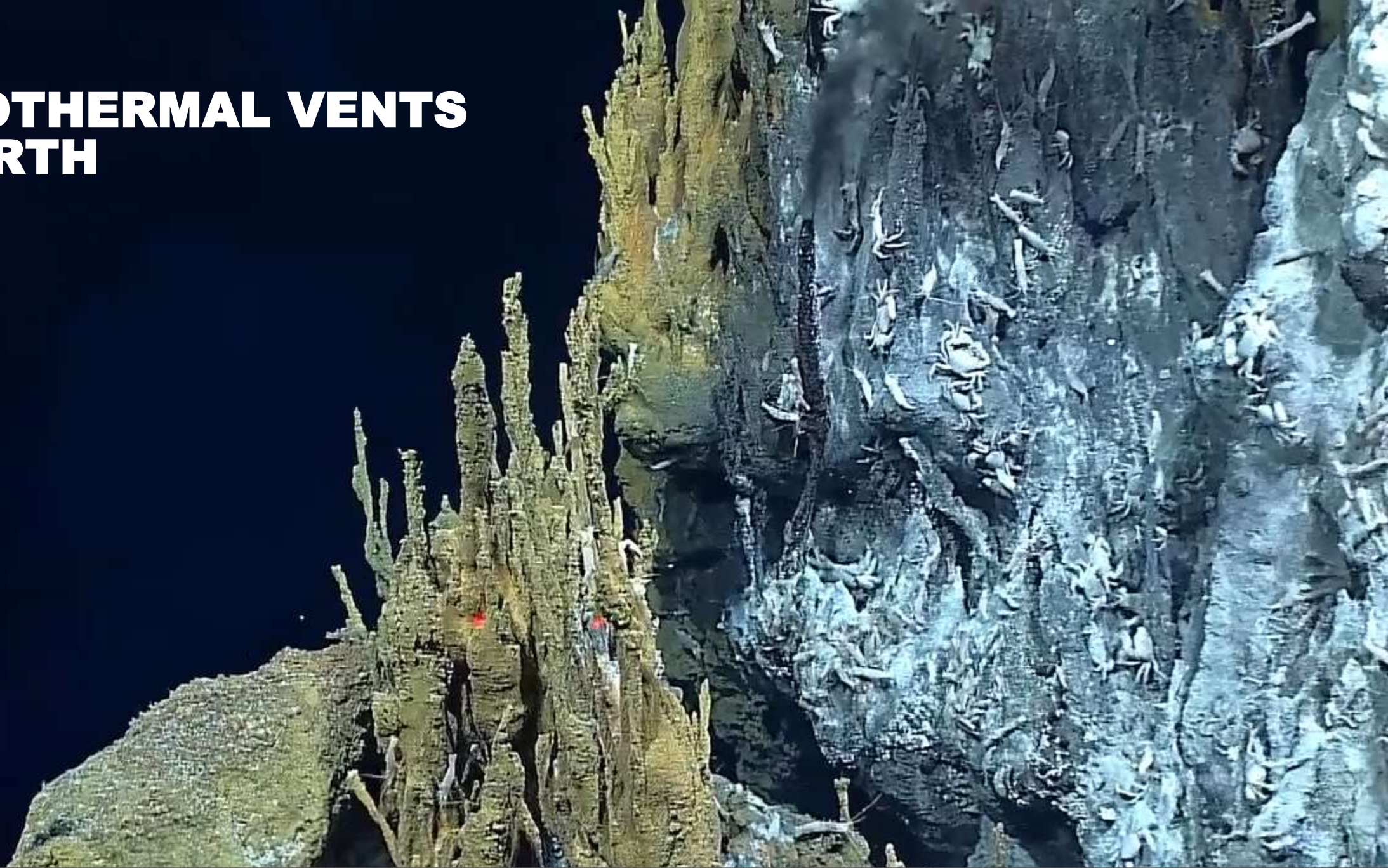


INGREDIENTS FOR LIFE?

- **WATER:**
Much more than all of Earth's oceans
- **ESSENTIAL ELEMENTS:**
From formation and impacts
- **CHEMICAL ENERGY:**
From above and below
- **STABILITY:**
“Simmering” for 4 billion years



HYDROTHERMAL VENTS ON EARTH





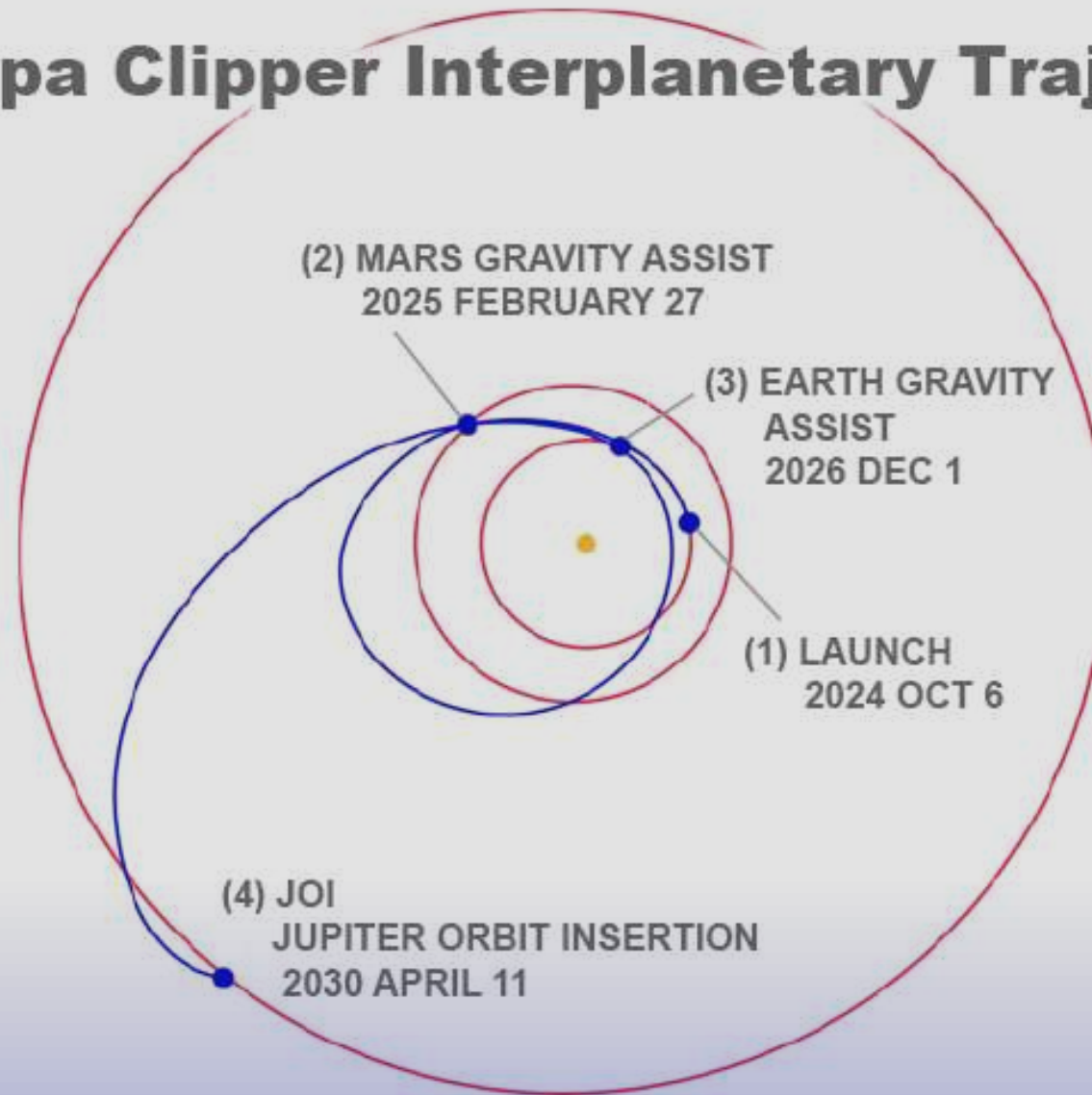
EUROPA CLIPPER SPACECRAFT



Europa Clipper Interplanetary Trajectory

VIEW LOOKING "DOWN"
FROM THE NORTH

(EVERYTHING REVOLVES
COUNTER-CLOCKWISE)





Gravity Assist:

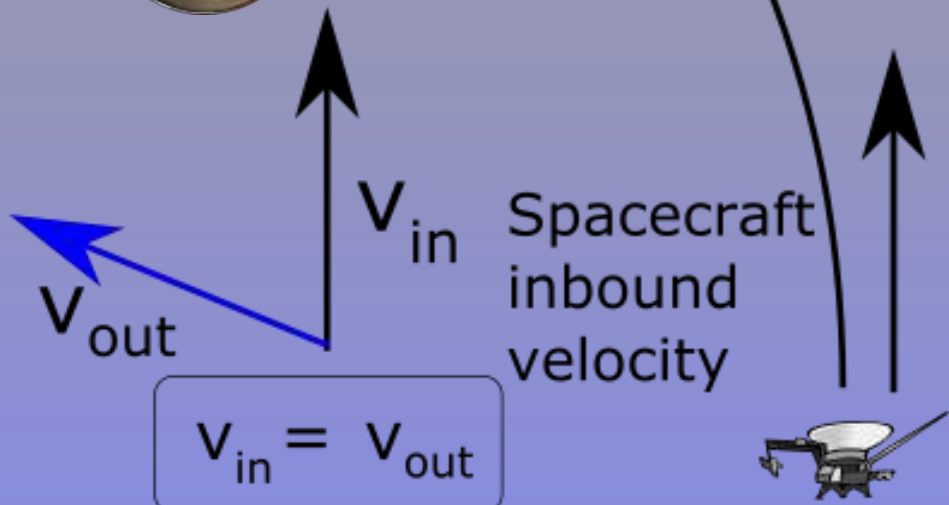
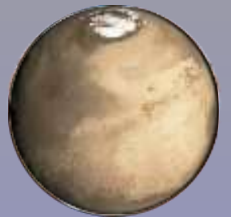
How does that work?

**Gravity temporarily connects your spacecraft
to a planet's orbital momentum.**

And steals some of that momentum.

Spacecraft outbound velocity

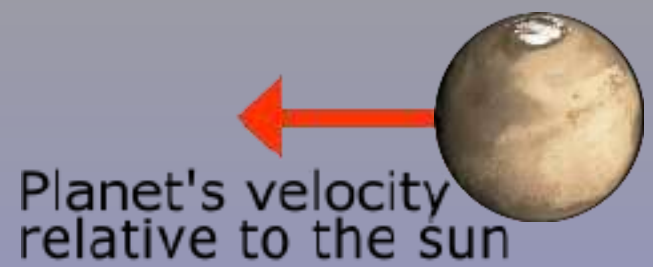
View looking down from the north on the solar system



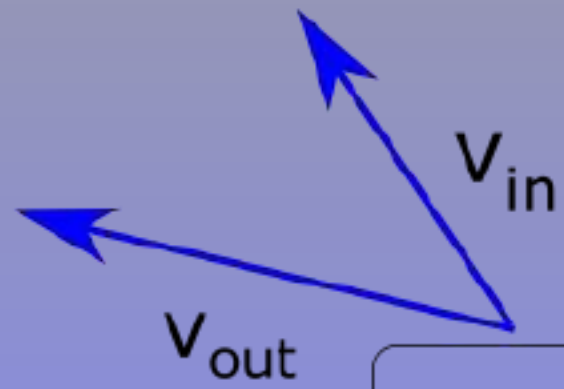
$$v_{in} = v_{out}$$

View looking down from the north on the solar system

Resultant
outbound velocity



Resultant
inbound velocity

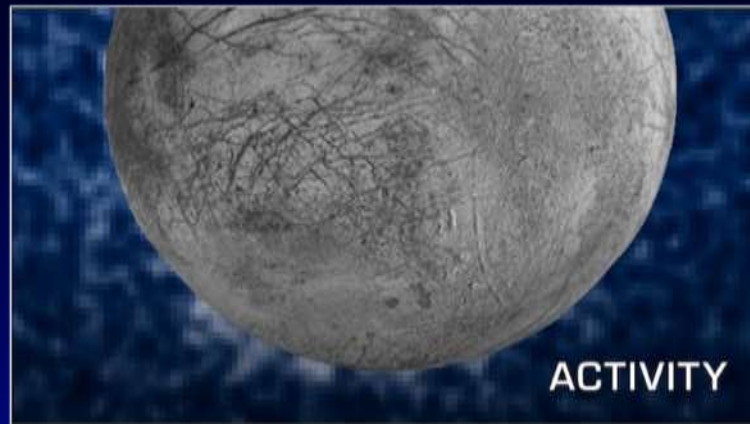
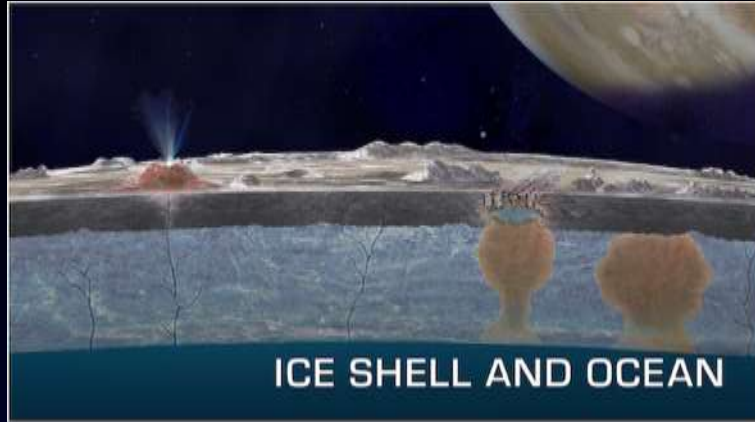


$v_{in} < v_{out}$



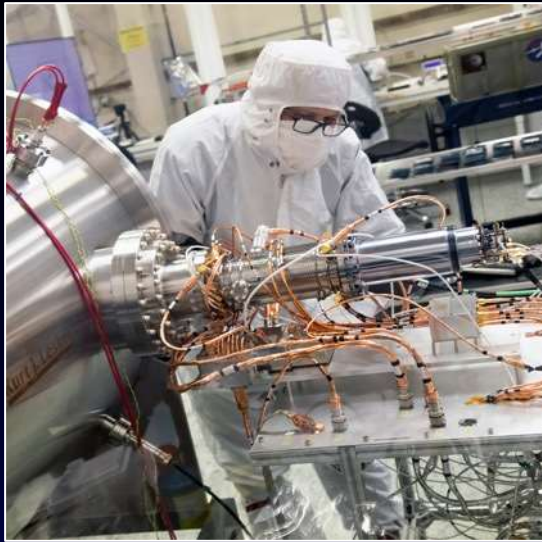
EUROPA CLIPPER MISSION SCIENCE

GOAL: TO EXPLORE EUROPA AND INVESTIGATE ITS HABITABILITY



IN SITU INSTRUMENTS

DEVELOPMENT IN PROGRESS



MASPEX

Mass Spectrometer

Source: NASA/ SwRI



SUDA

Surface Dust Analyzer

Source: NASA/ LASP-CU Boulder



ECM

Magnetometer

Source: NASA/ JPL-Caltech



PIMS

Plasma Instrument for
Magnetic Sounding

Source: NASA/ Johns Hopkins APL/ ED
Whitman

REMOTE SENSING INSTRUMENTS

DEVELOPMENT IN PROGRESS



EUROPA UVS

Ultraviolet Spectrograph

Source: NASA/ SwRI



EIS

Imaging System

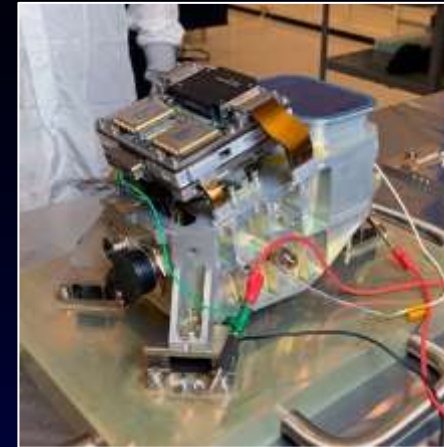
Source: NASA/ Johns Hopkins
APL/ Ed Whitman



MISE

Mapping Imaging
Spectrometer

Source: NASA/ JPL-Caltech



E-THEMIS

Thermal Emission
Imaging System

Source: NASA/ Arizona State
University

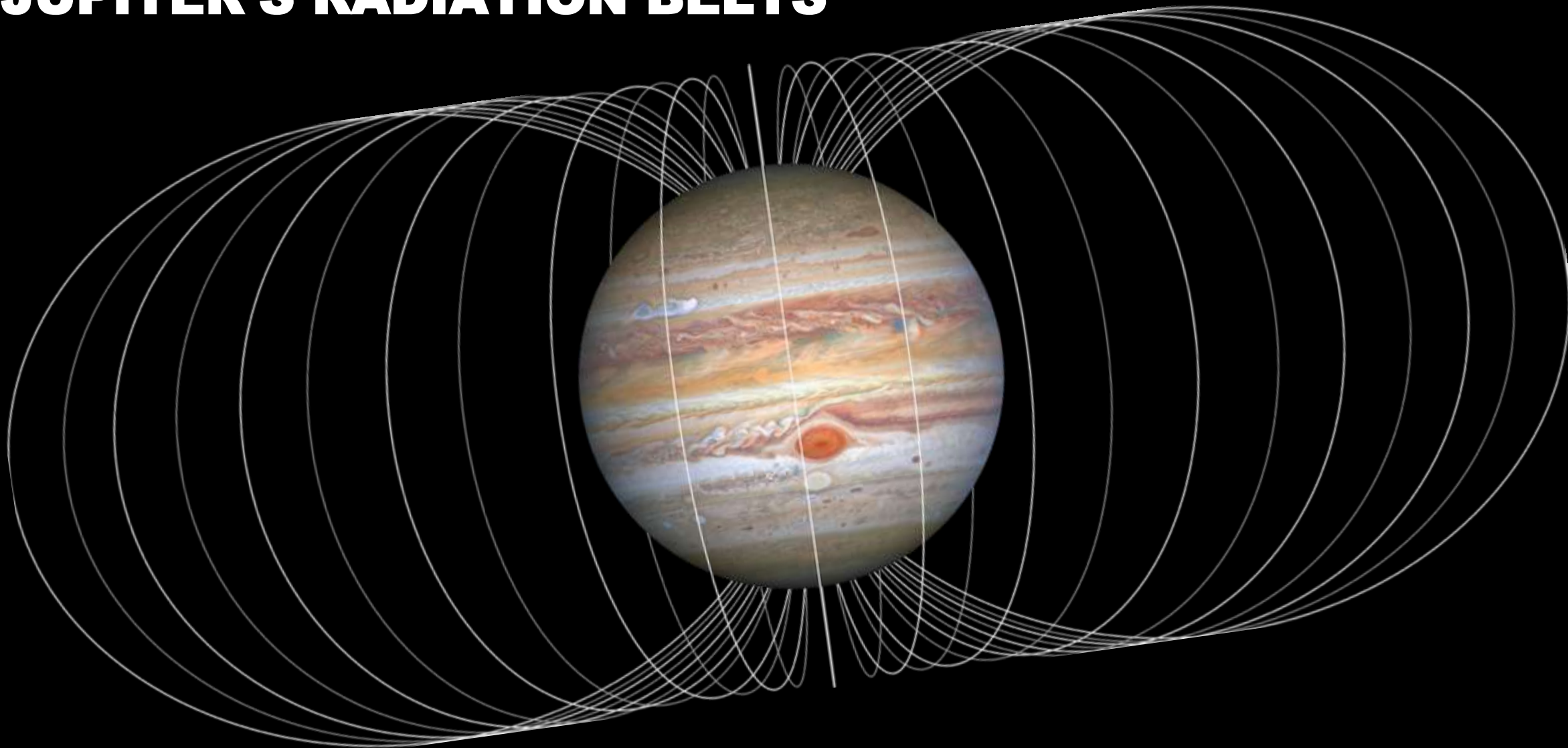


REASON

Ice-penetrating Radar

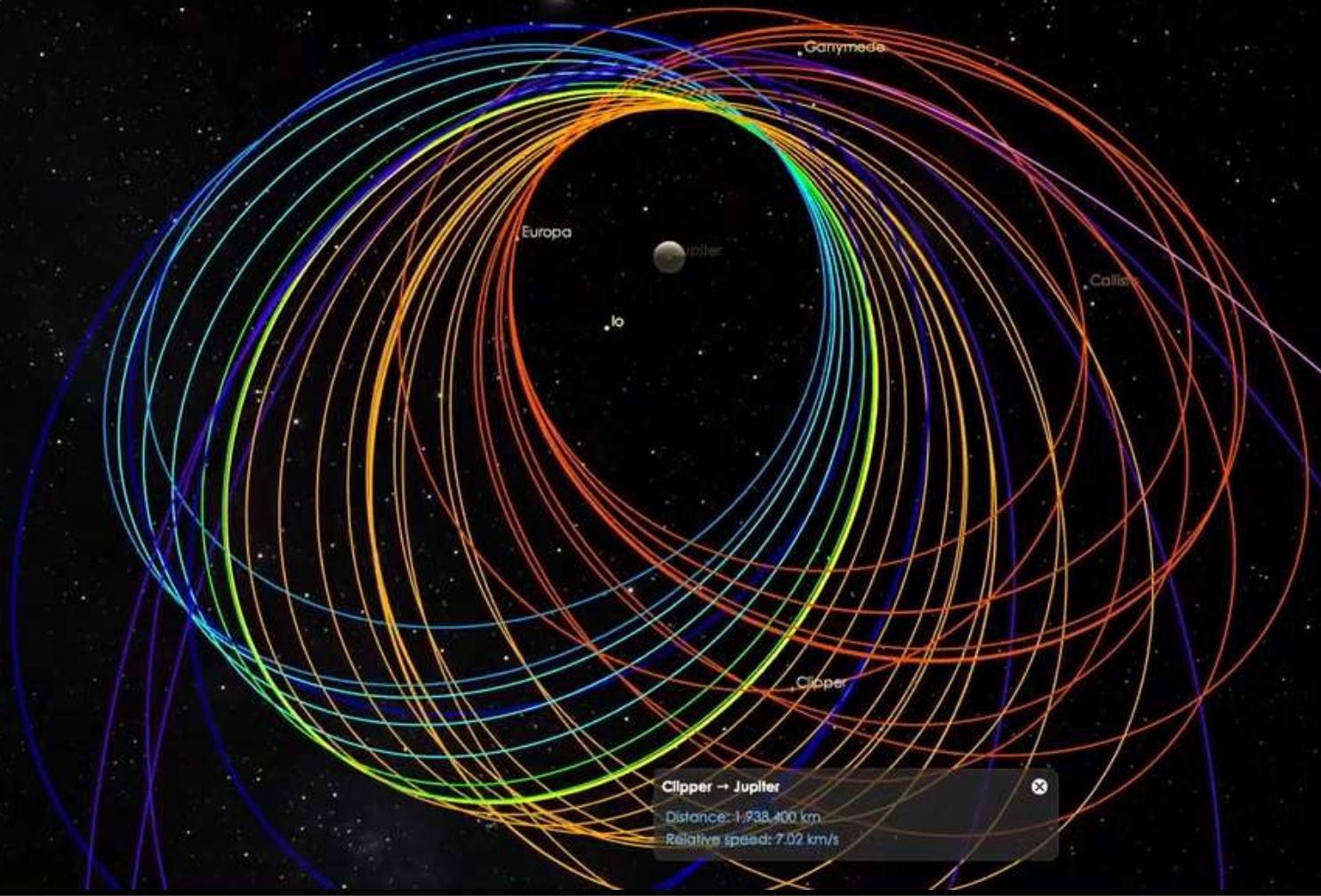
Source: NASA/ JPL-Caltech

JUPITER'S RADIATION BELTS



SPACECRAFT RADIATION DOSAGE

2030-Jul-05 09:32:39 UTC
2,000,000x time



Geiger

Instant: 0.00084 rad/s

Total: 1.452e+06 rad

Clipper → Jupiter

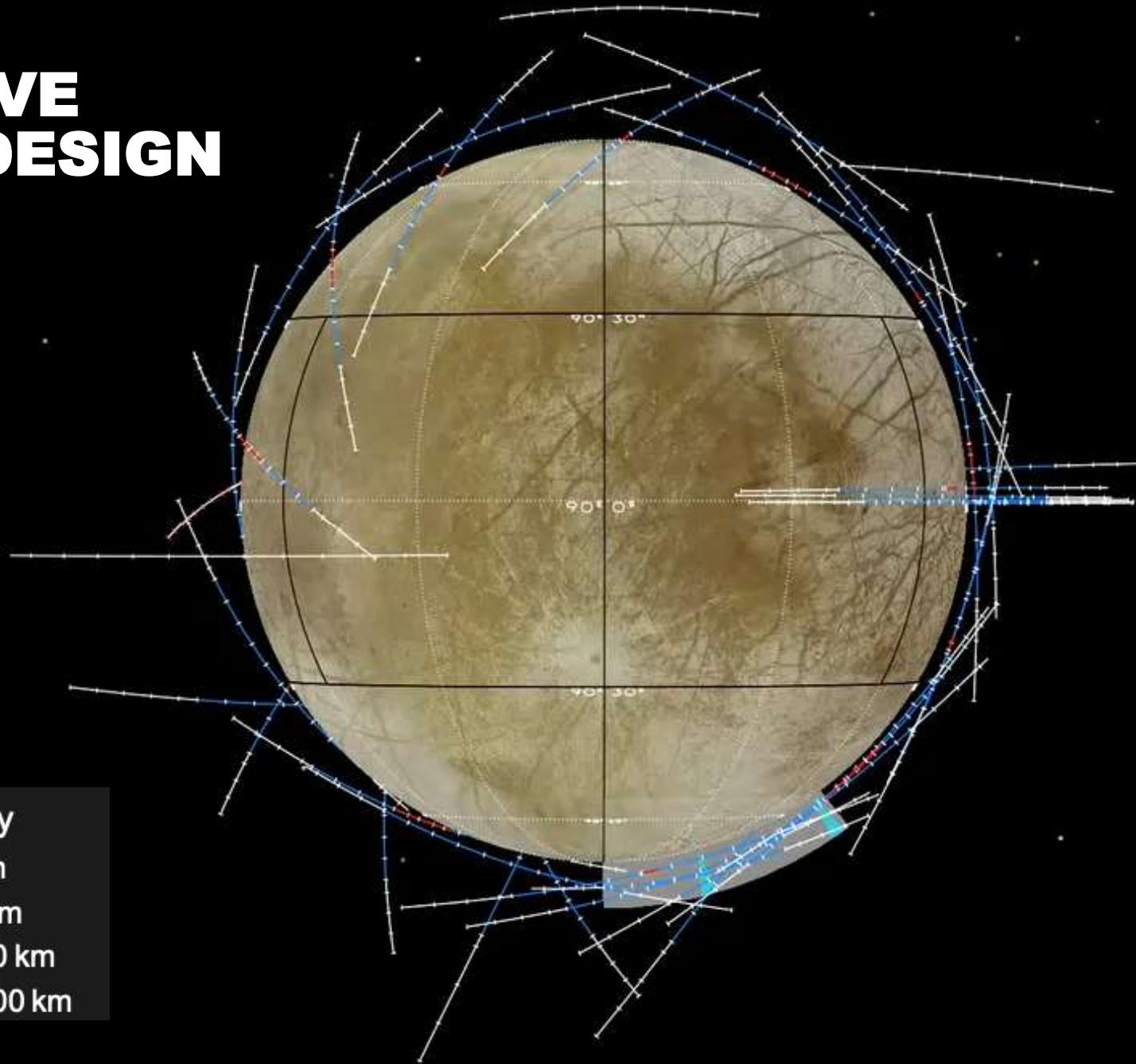
Distance: 1,238,400 km
Relative speed: 7.02 km/s

Exposure

50 rad
500 rad
5000 rad
50000 rad
100000 rad
200000 rad
300000 rad
400000 rad
500000 rad
1000000 rad
2000000 rad
3000000 rad



INNOVATIVE MISSION DESIGN



Spacecraft Trajectory

- 25 km \leq r_{alt} \leq 50 km
- 50 km $<$ r_{alt} \leq 400 km
- 400 km $<$ r_{alt} \leq 1000 km
- 1000 km $<$ r_{alt} \leq 4000 km

The Deep Space Network

Tracking for navigation



The Deep Space Network

Tracking for navigation

Telemetry for science data
and spacecraft data



The Deep Space Network

Tracking for navigation

Telemetry for science data
and spacecraft data

Commanding



The Deep Space Network

Tracking for navigation

Telemetry for science data
and spacecraft data

Commanding

Radio Science



The Deep Space Network



Tracking for navigation

Telemetry for science data
and spacecraft data

Commanding

Radio Science

VLBI

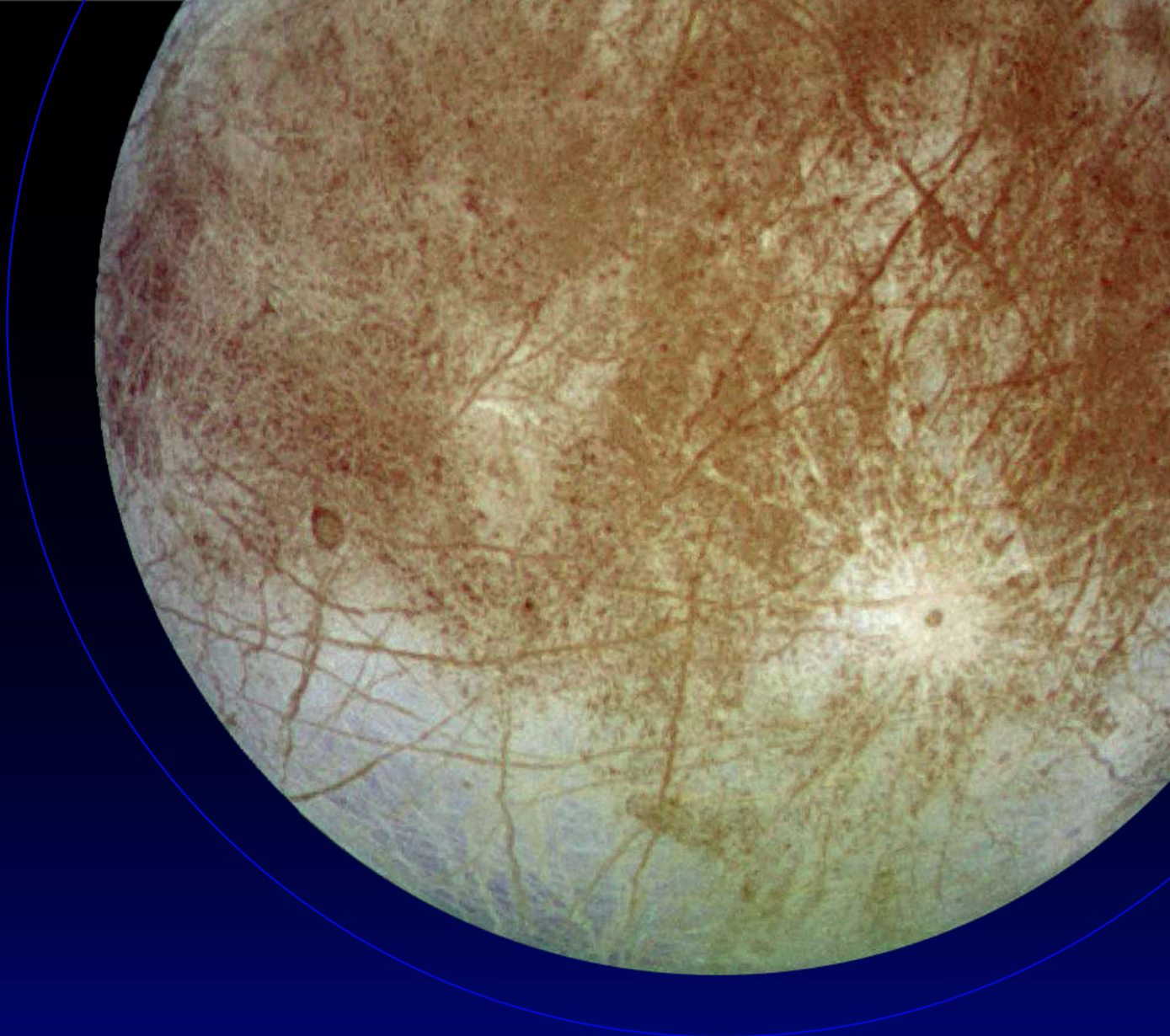
GET INVOLVED

 europa.nasa.gov

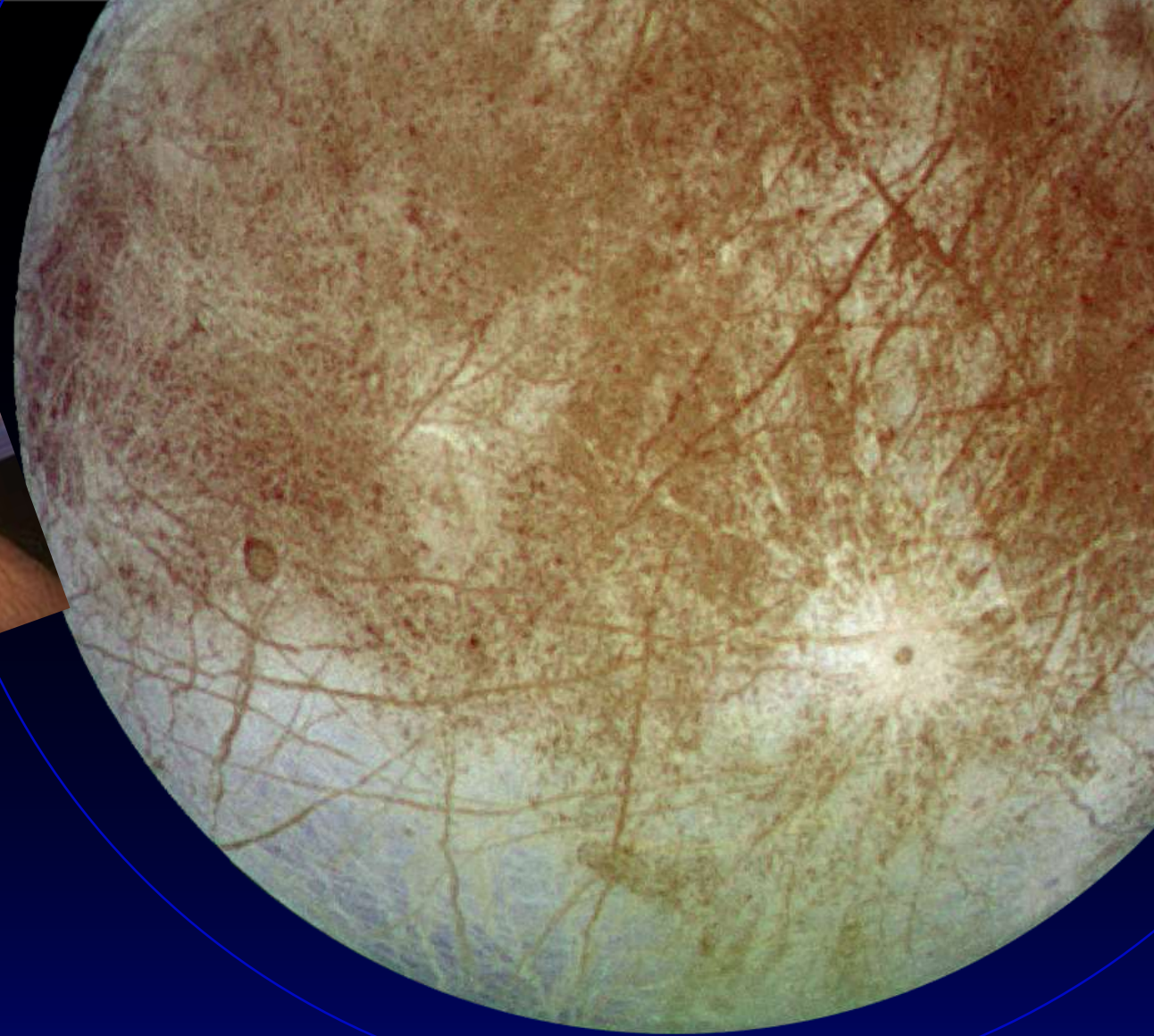
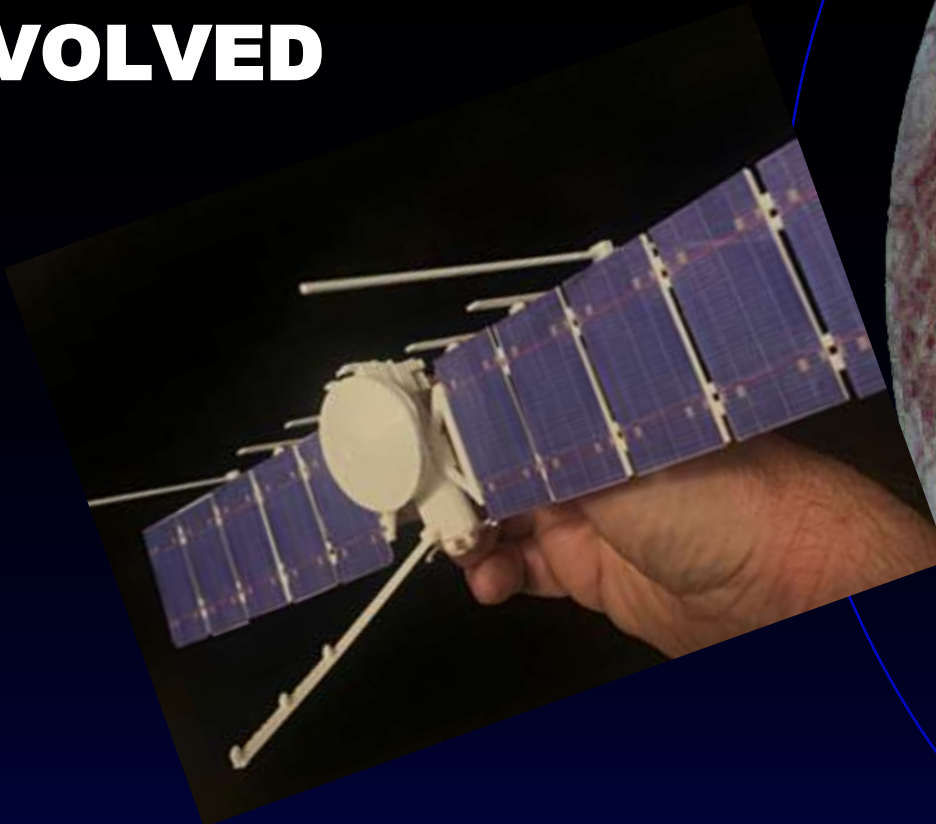
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