

Física del Sistema Solar

Solymer 1
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Facultad de Ciencias



Nuestra galaxia

300.000 millones de estrellas

Our Planet Hunting Neighborhood

Sun →



Most of the planets
found to date lie
within about 300
light-years from
our Sun.

Galaxia



Temperatura sup = 5800 C

Temperatura int = 14.000.000

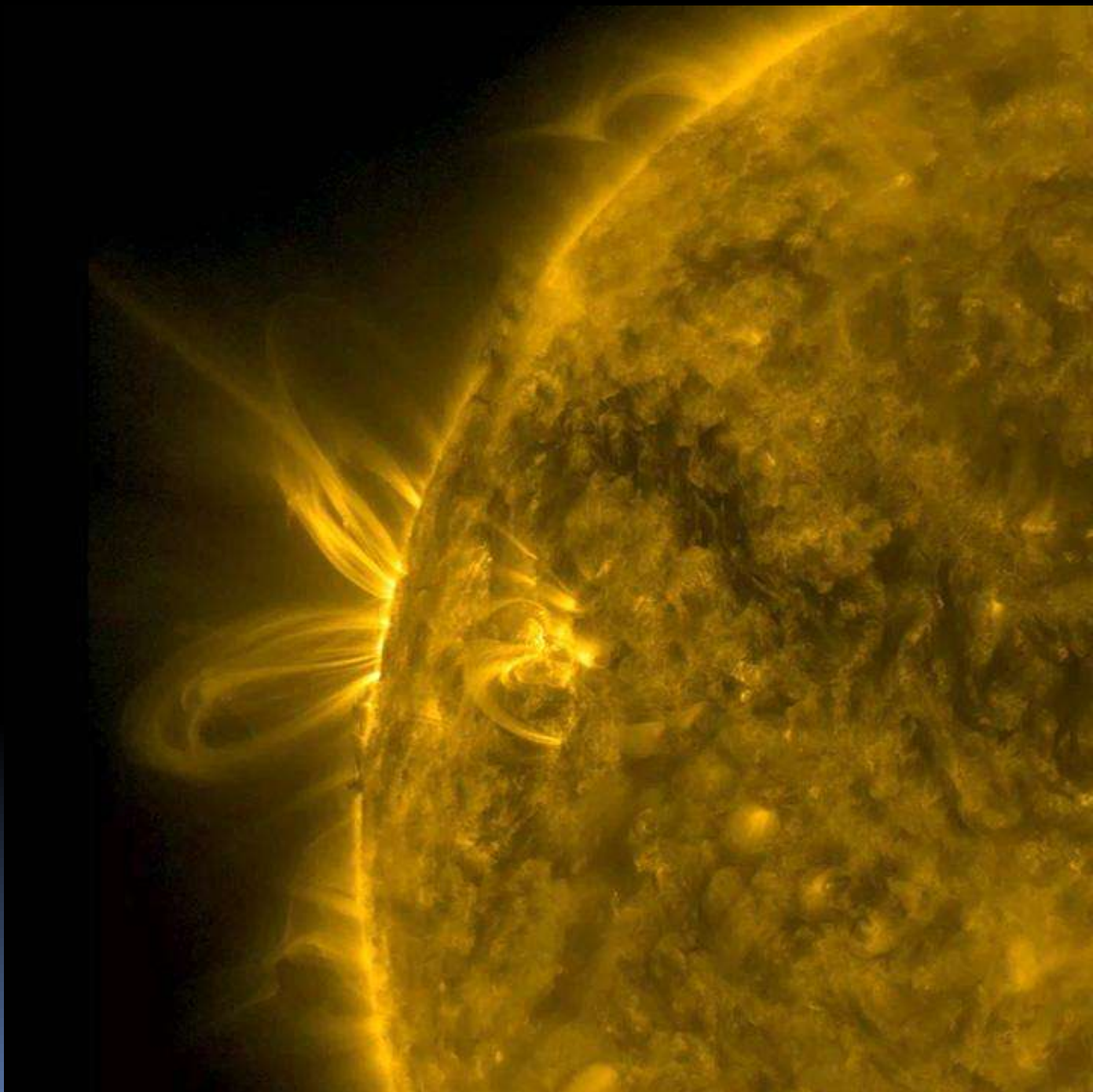
Presión = 250.000 millones de atm.

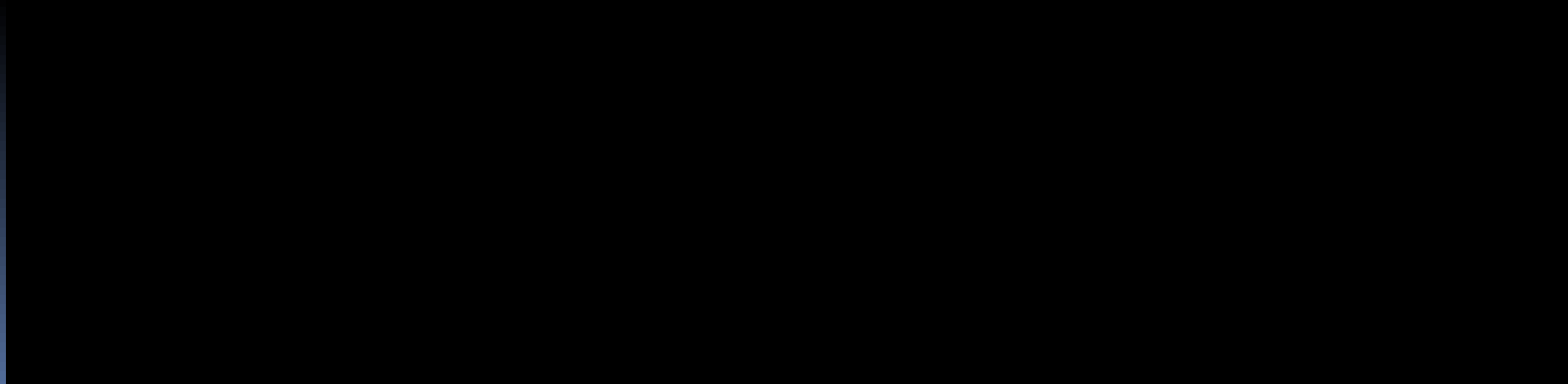
Equilibrio PESO – PRESION

Sol

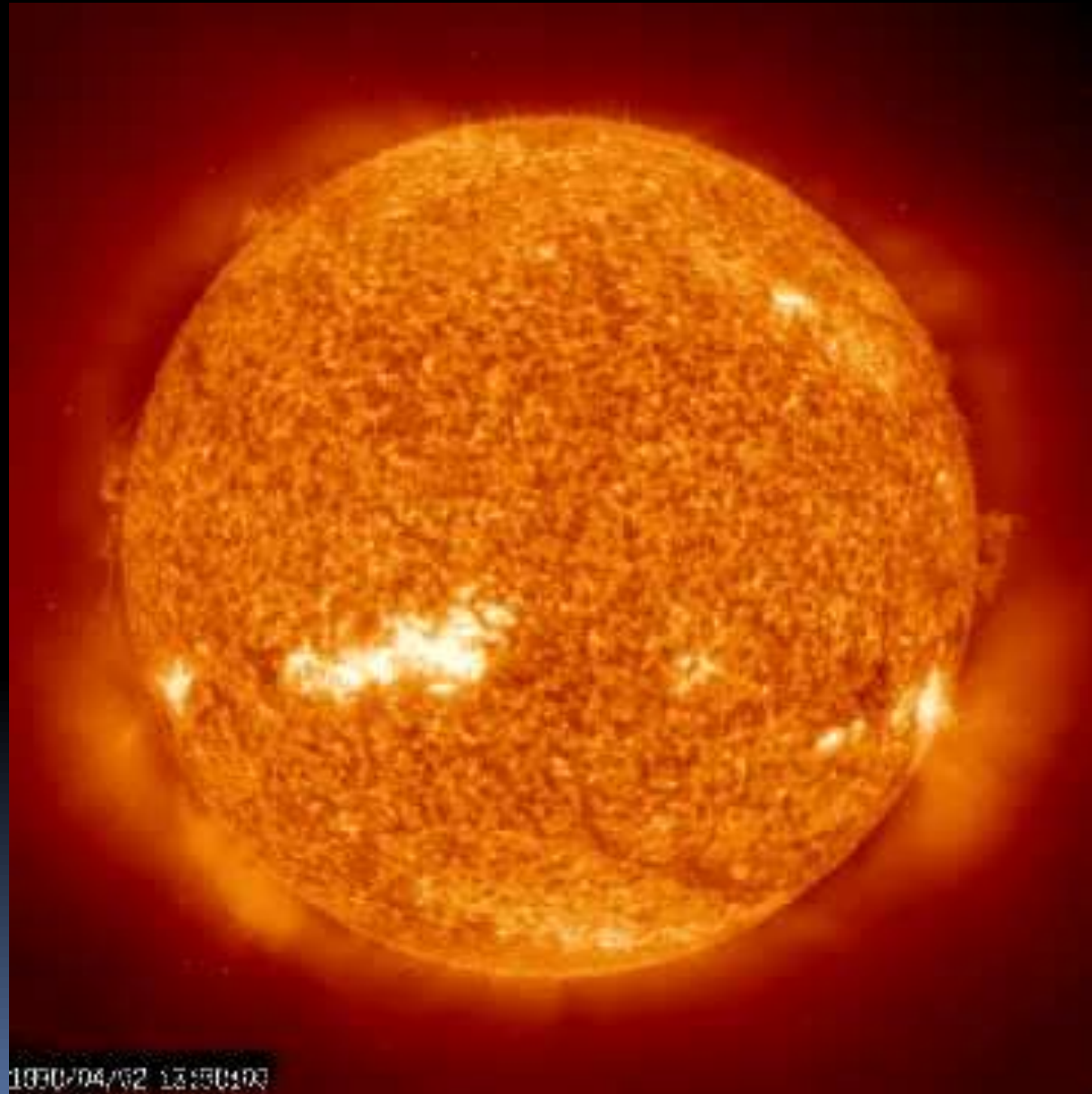
Masa = 1000 Jupiter
75% Hidrógeno







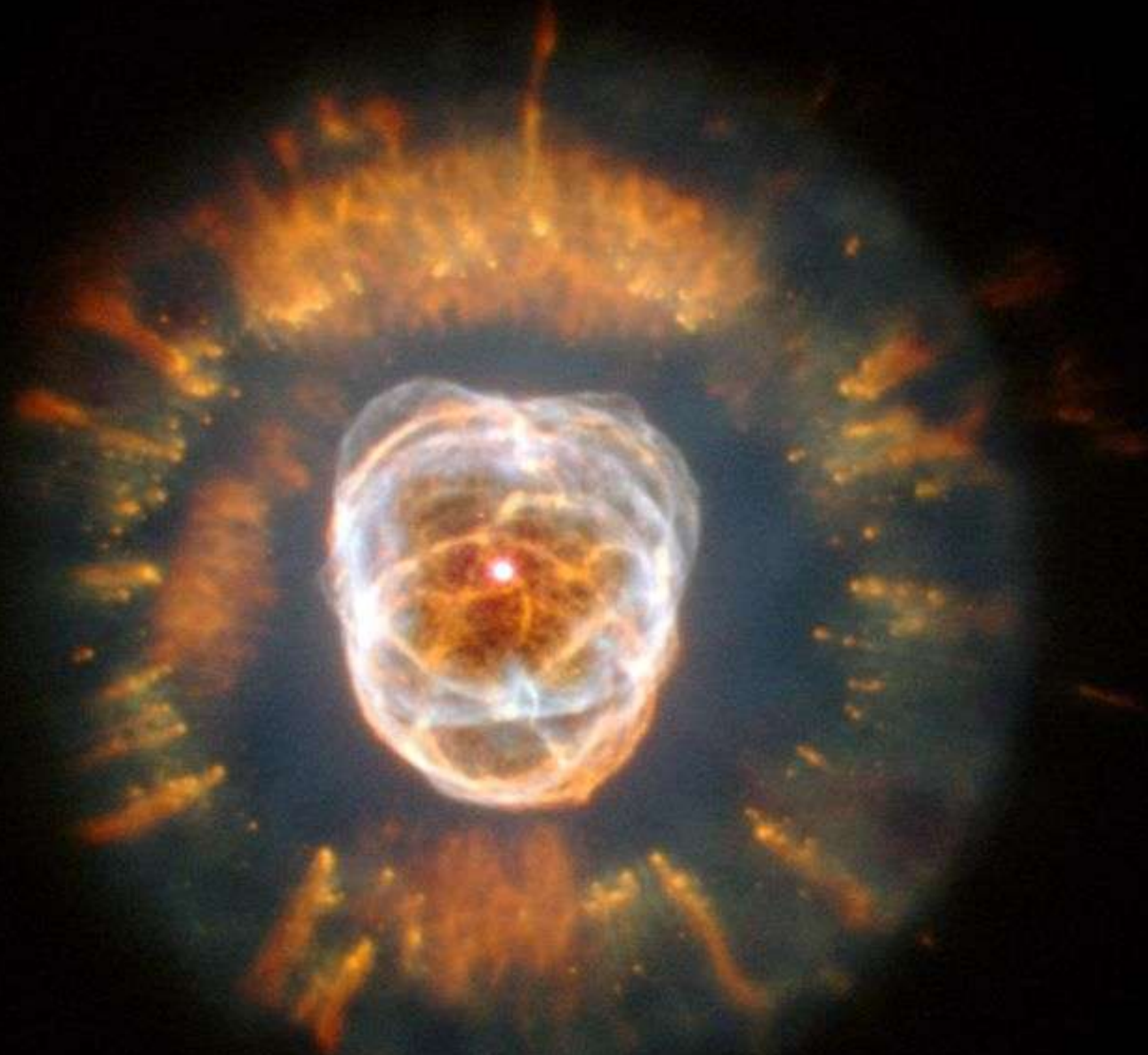
Sol: reactor de fusión nuclear



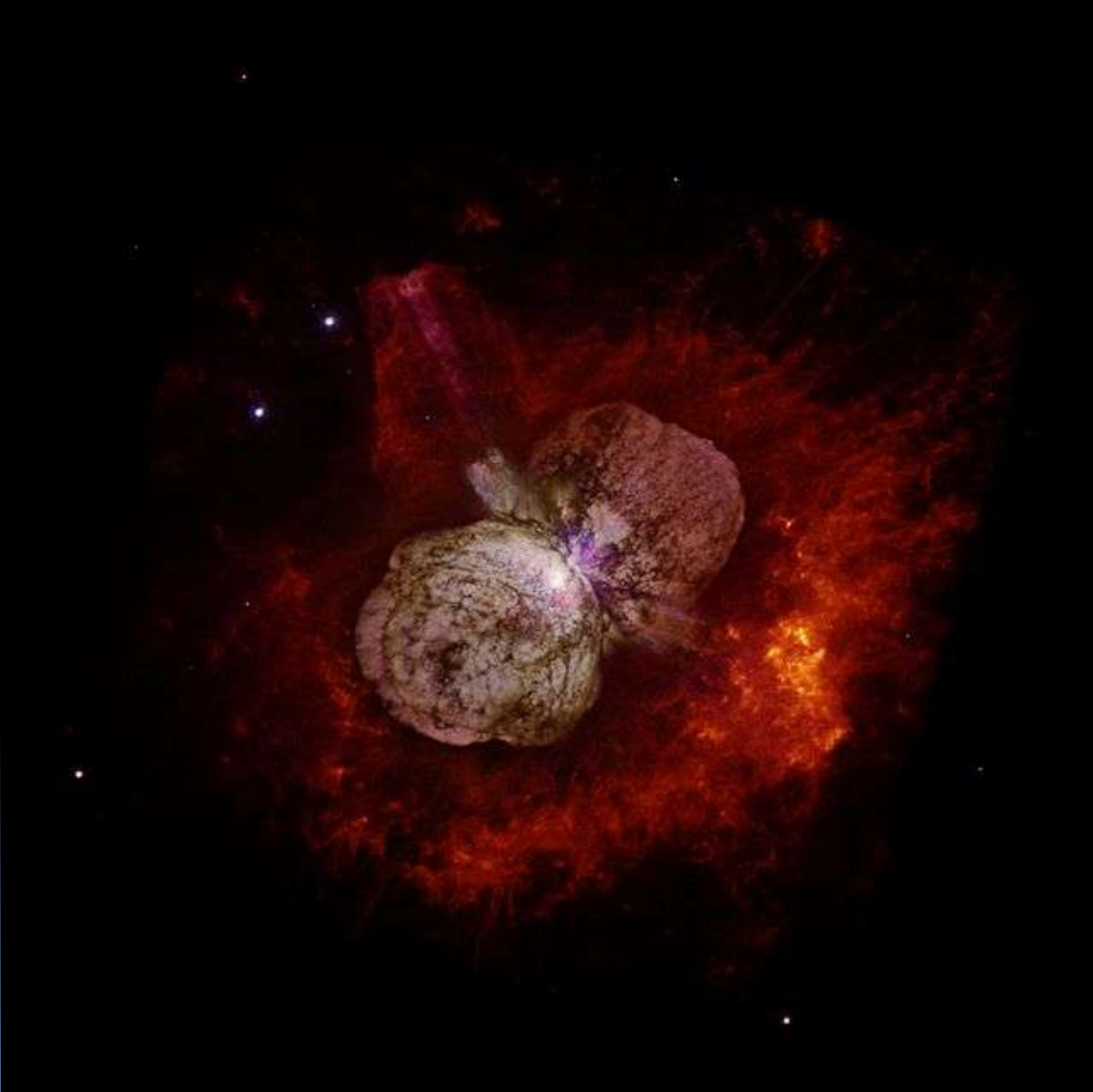
1990/04/02 13:50:03

Muerte estelar

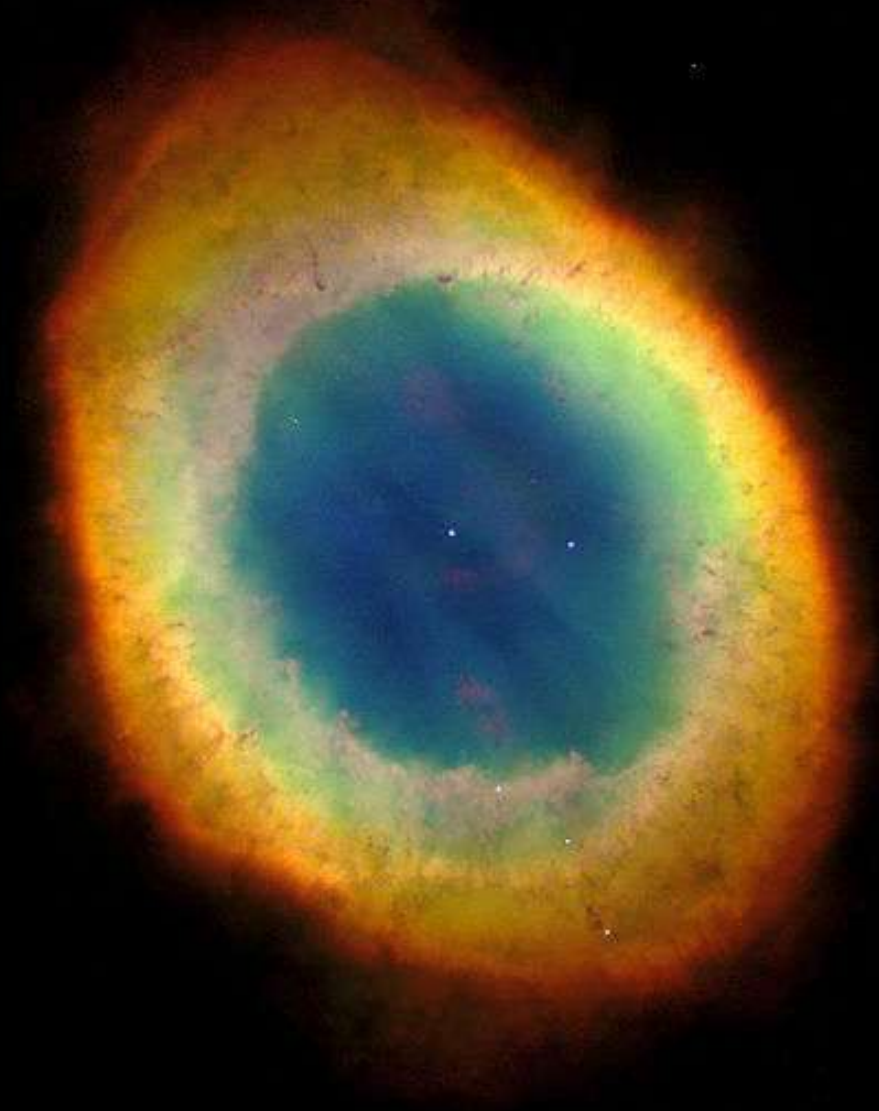




www.hubblesite.org



Medio interestelar enriquecido con “polvo” de estrellas.



Principales elementos en el polvo: CHON



Formación estelar





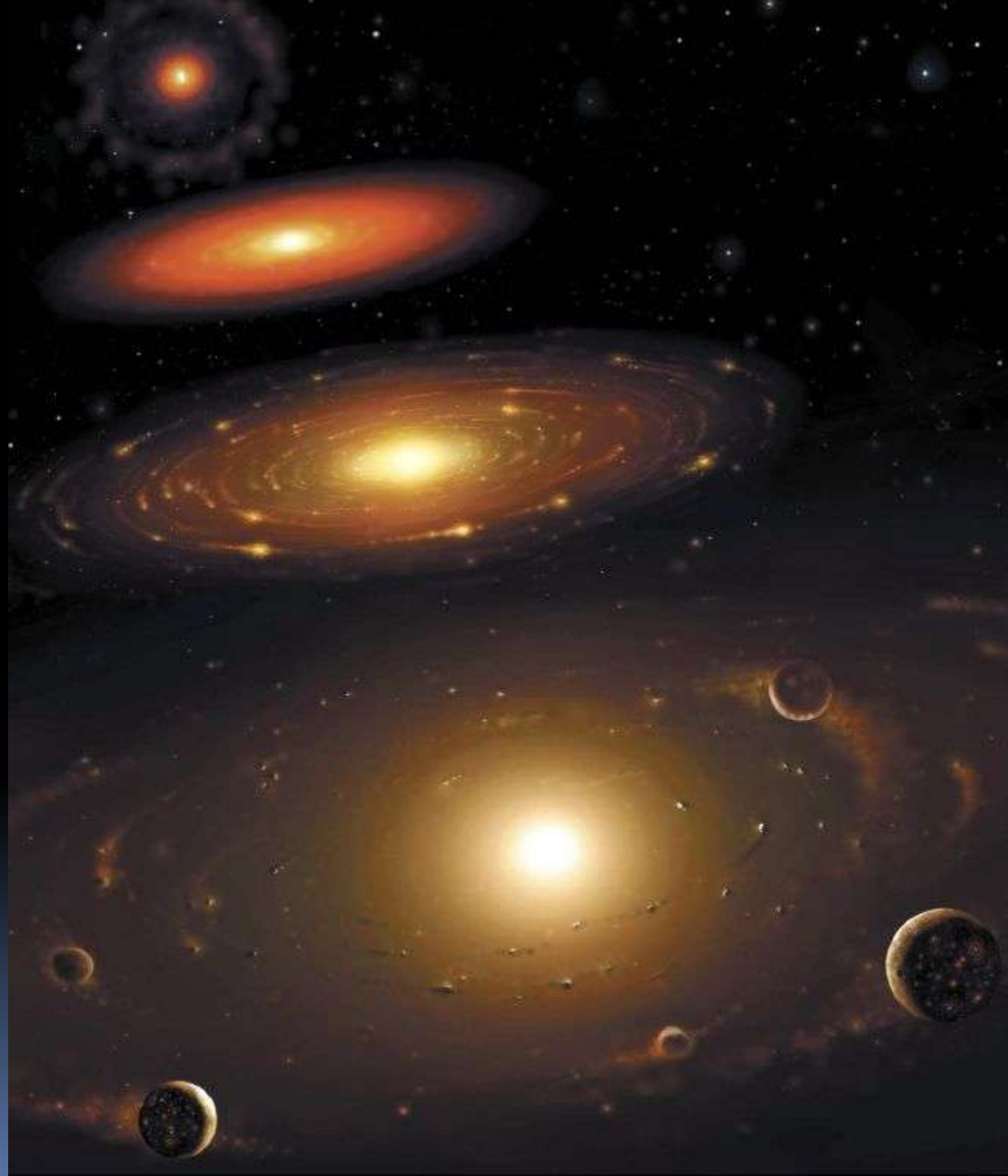
Protoplanetary Disks in the Orion Nebula HST • WFPC2

NASA, J. Bally (University of Colorado), H. Throop (SWRI),
and C.R. O'Dell (Vanderbilt University) • STScI-PRC01-13

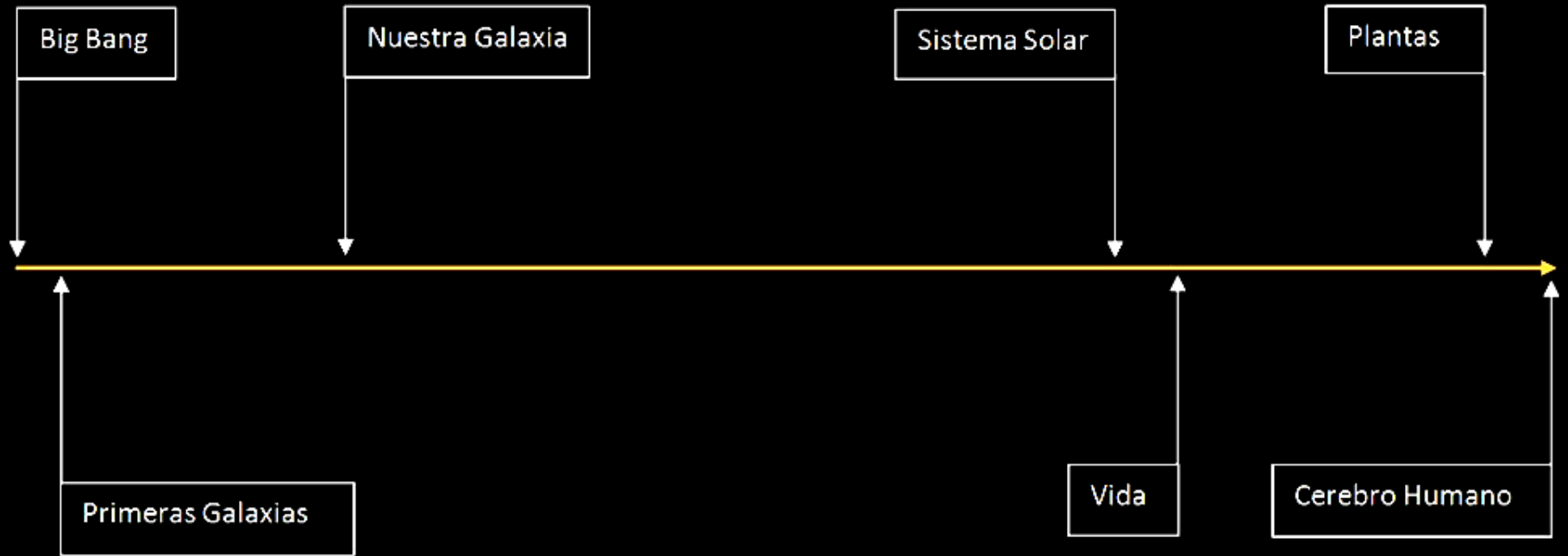
Disco protoplanetario a 450 AL de la Tierra



Formación del Sistema Solar

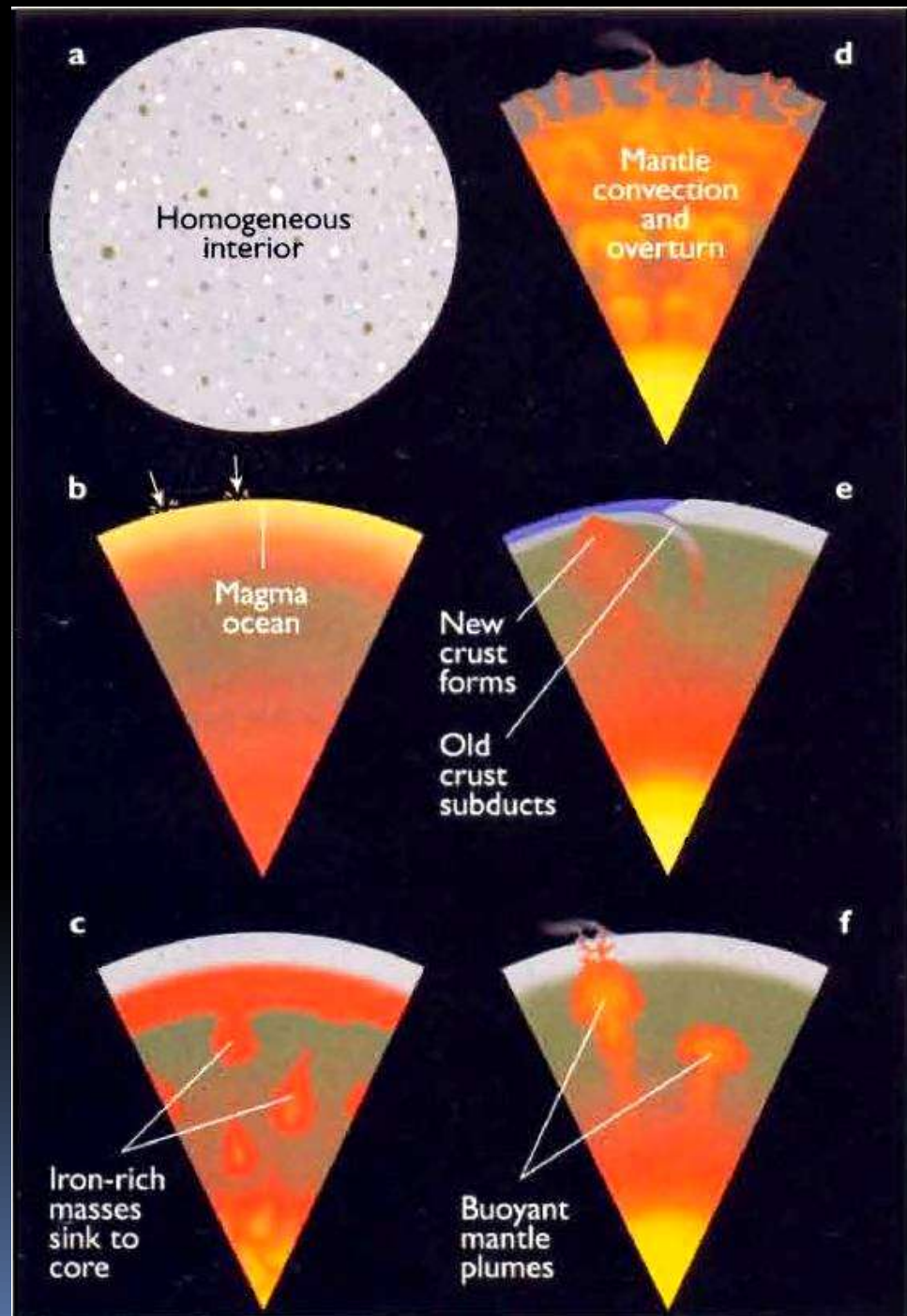


Cronología



Big Bang: hace 13.700 millones de años

Evolución planetaria

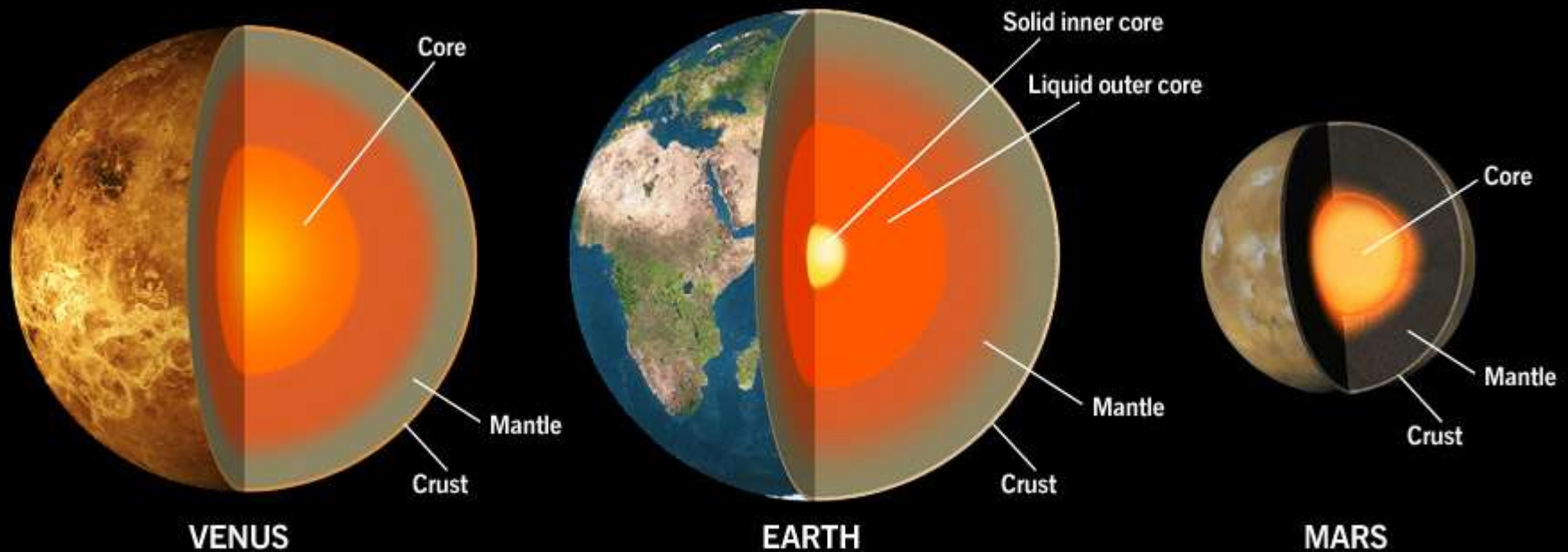


Meteorito: material primitivo

Meteorito de San Carlos



Evolución planetaria: administración del calor interno



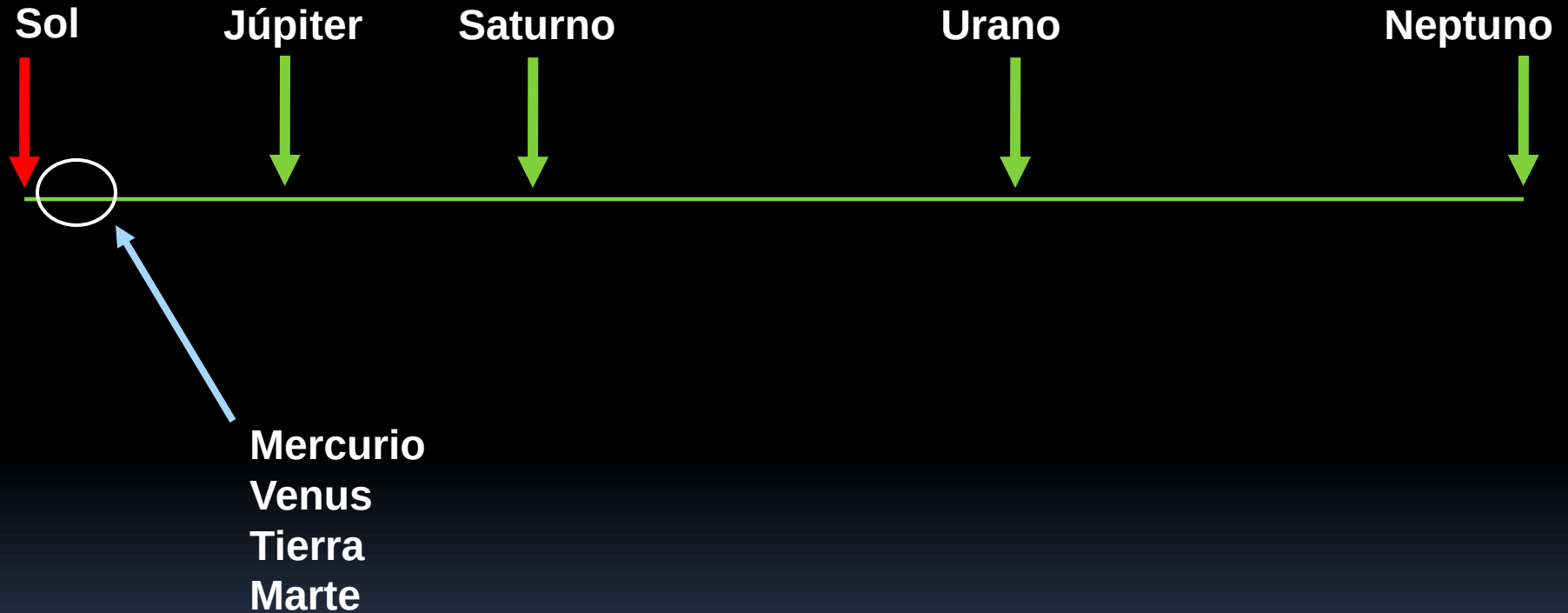
Sistema Solar

Mundos rocosos, gaseosos y helados



Sistema Solar

Distancias a escala



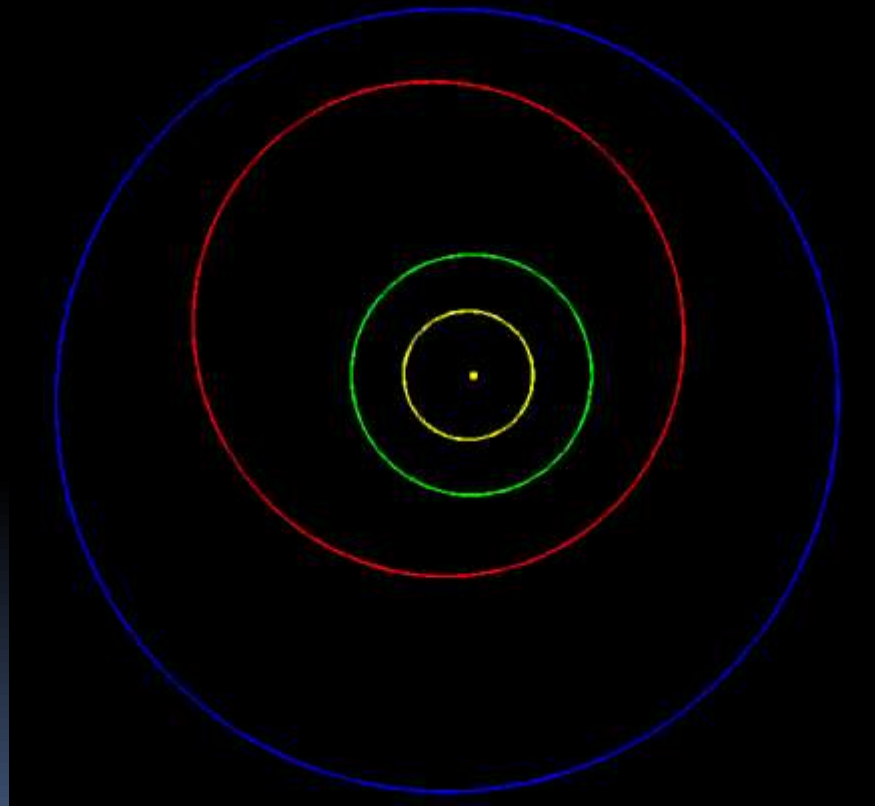
Evolución orbital

5.000.000 years of orbital evolution of
Jupiter, Saturn, Uranus and Neptune

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Experimento



MUNDOS ROCOSOS

Mercurio: fosilizado y sin atmósfera

Día = 2 años mercurianos !

Resonancia por mareas

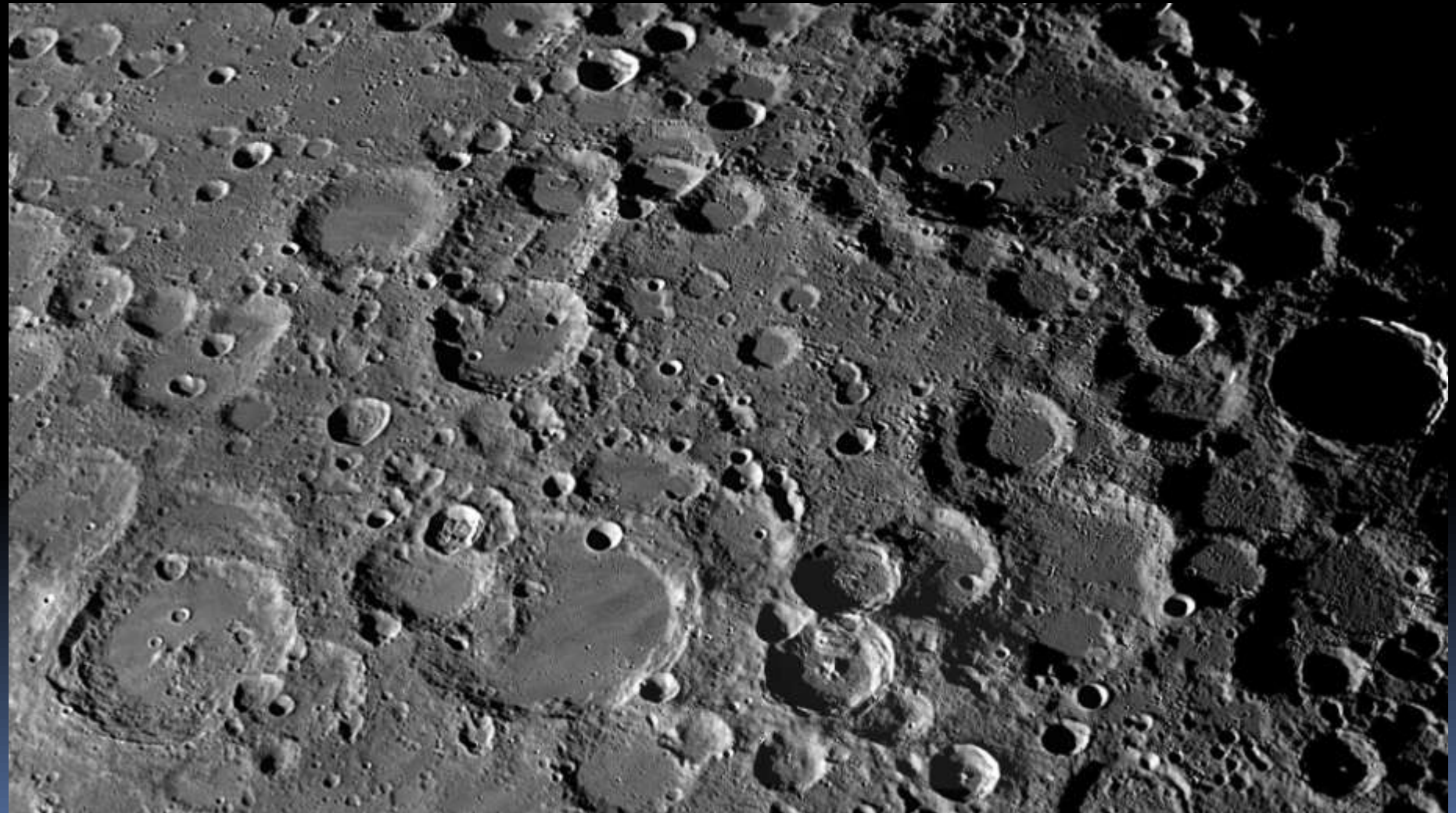
$-170\text{ C} < \text{Temperatura} < 400\text{ C}$

DIA

NOCHE



Cráteres lunares: bombardeo



Venus: atmósfera

Temperatura media = 500 C

Presión = 90 atm.

CO₂

No hay agua



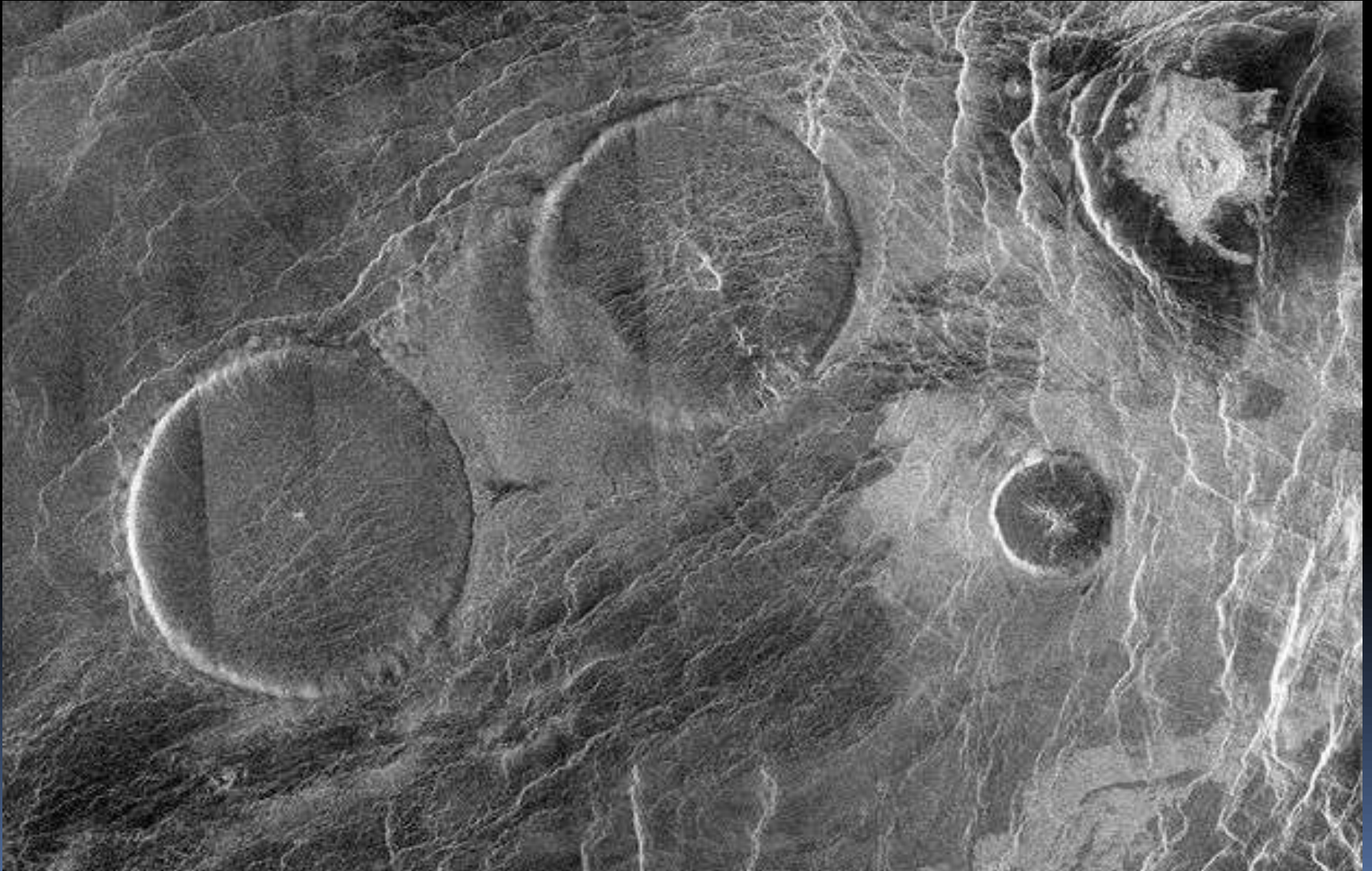
Venus: superficie

Miles de volcanes inactivos
Imágenes de radar



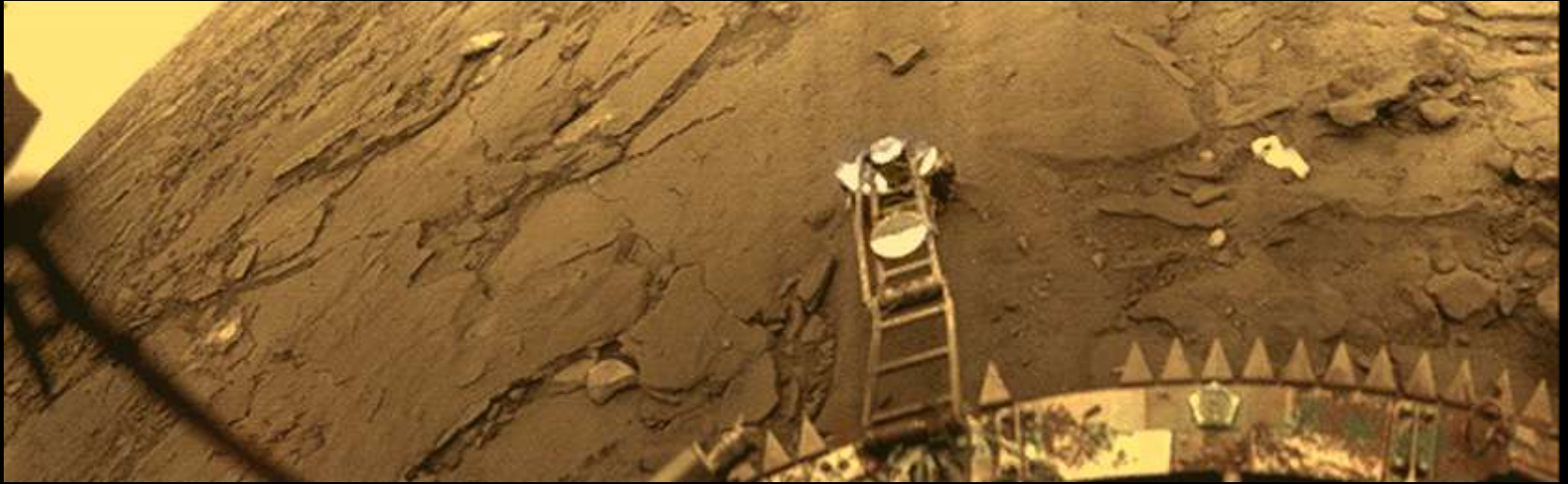
Venus

“panqueques” de lava muy viscosa



Venus

Roca sólida y seca (basaltos)

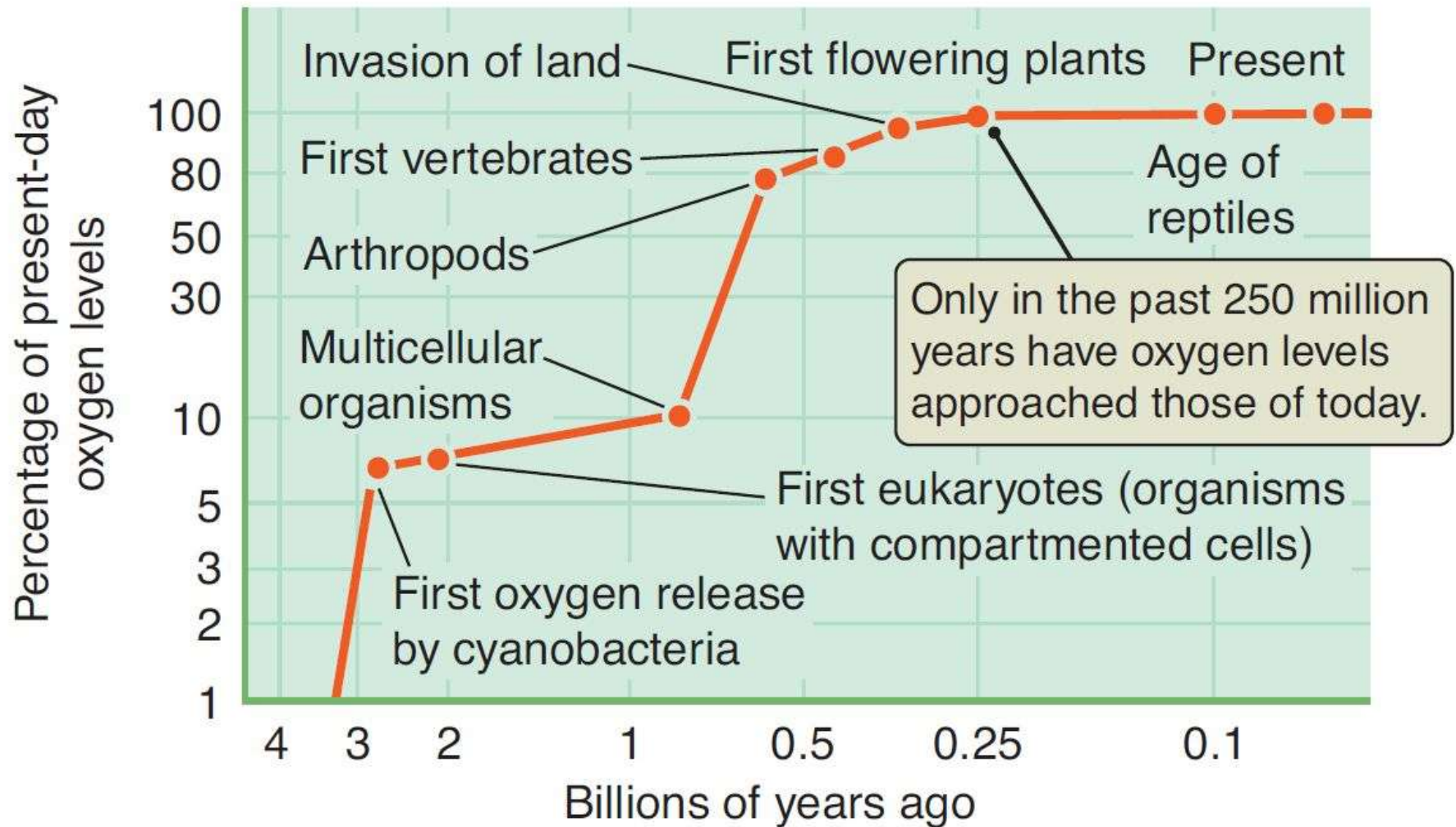


Agua sólida, líquida y gaseosa.

Única atmósfera rica en Oxígeno: energía y protección UV.

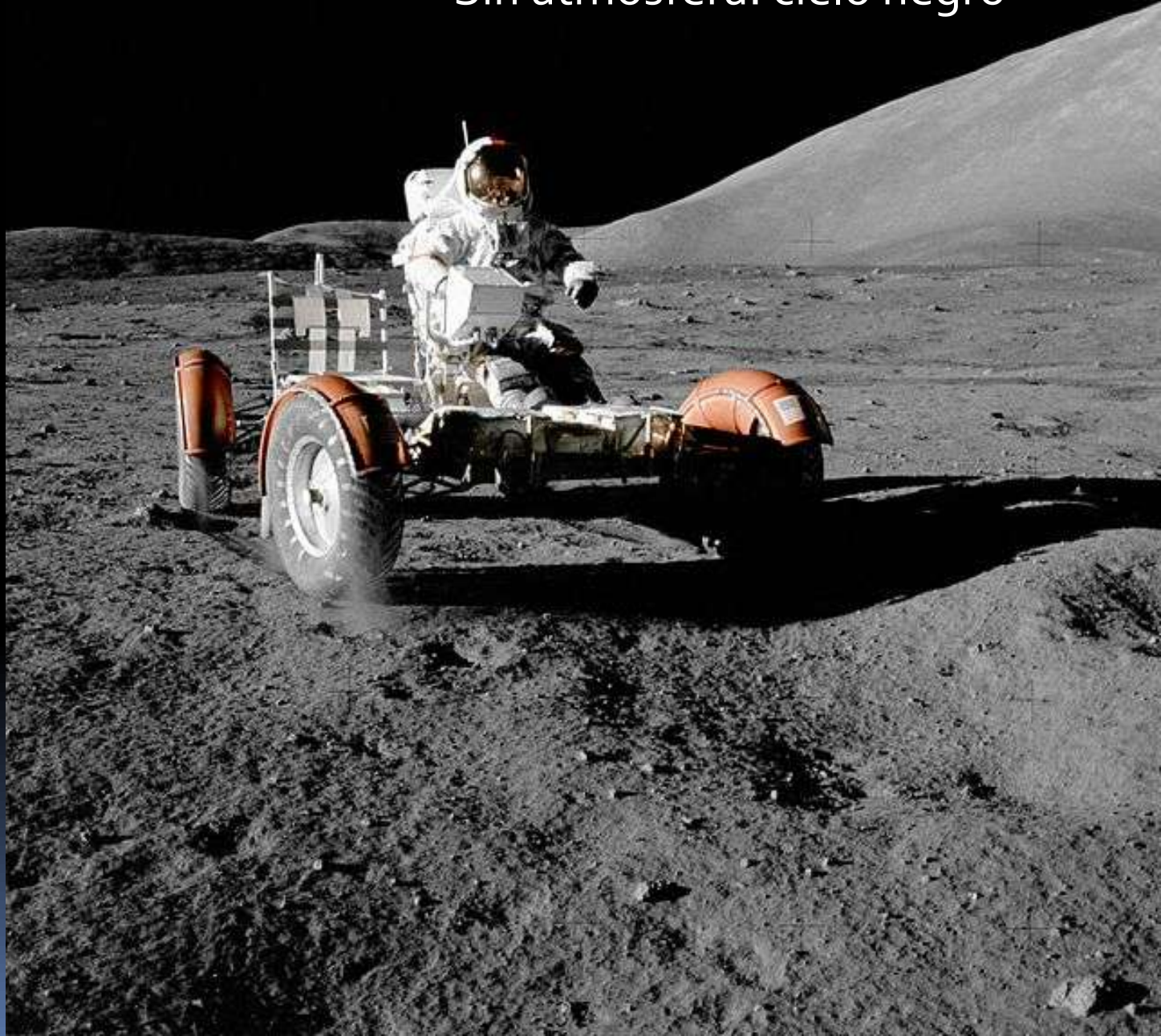


Evolución del Oxígeno



Luna

Sin atmósfera: cielo negro



Luna

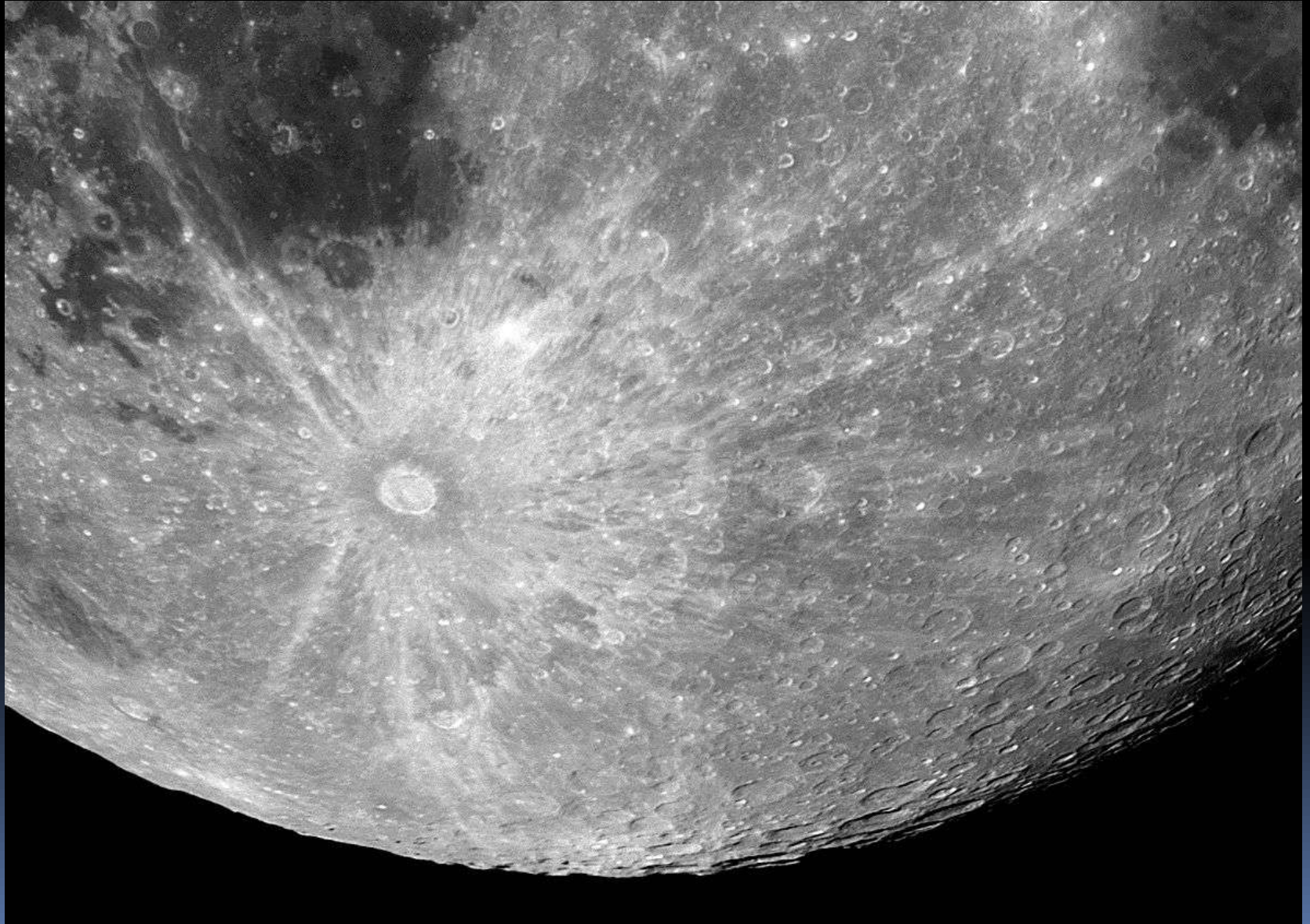
“Mares” de lava
(mas jóvenes)

Rotación sincrónica
por mareas



Cráter Tycho

"Joven" gran cráter (100 MA)



Cráter Arizona: hace 10.000 años



Meteoroid

19 km/s

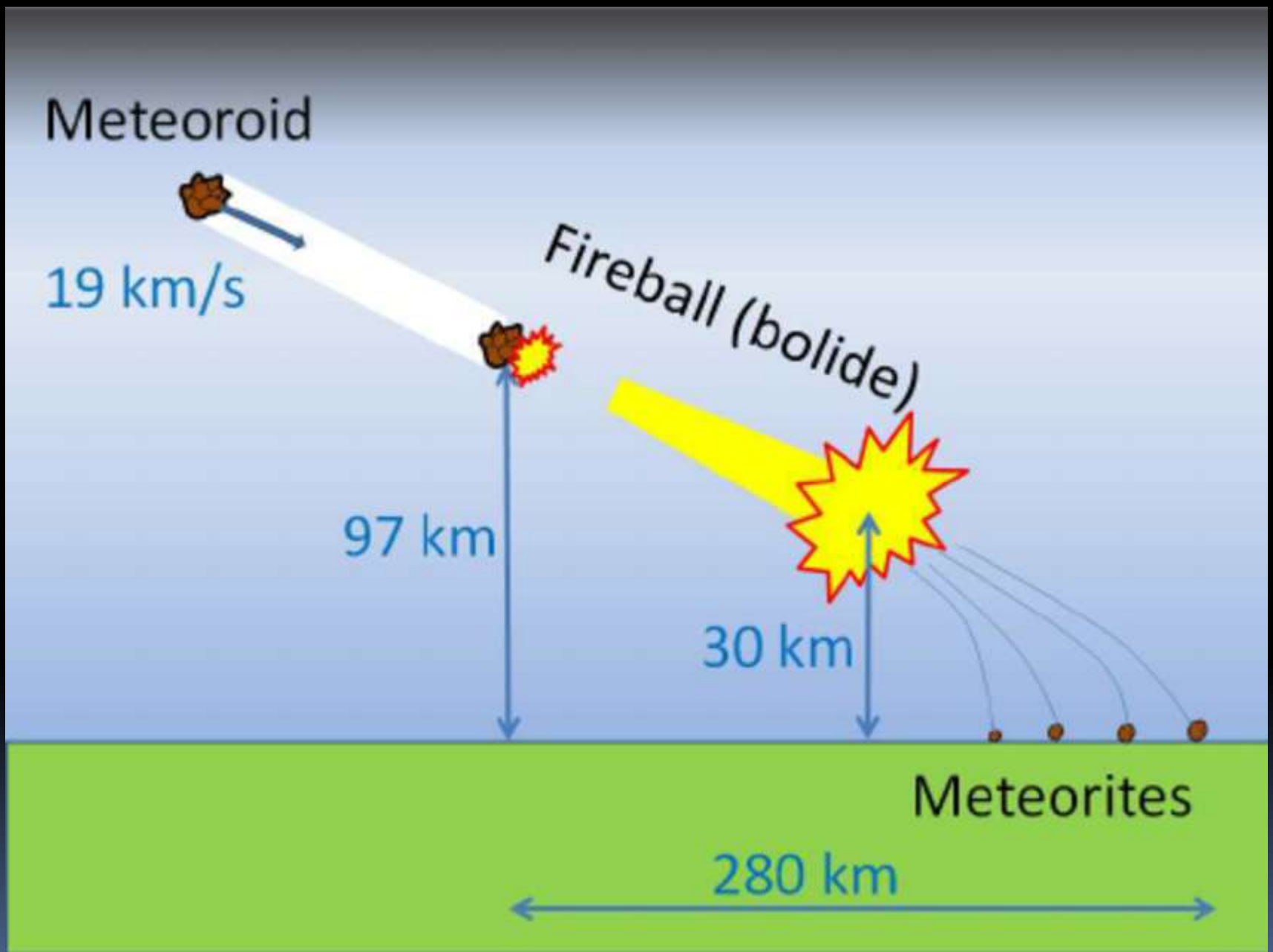
97 km

Fireball (bolide)

30 km

Meteorites

280 km



Tunguska 1908: 1000 bombas Hiroshima

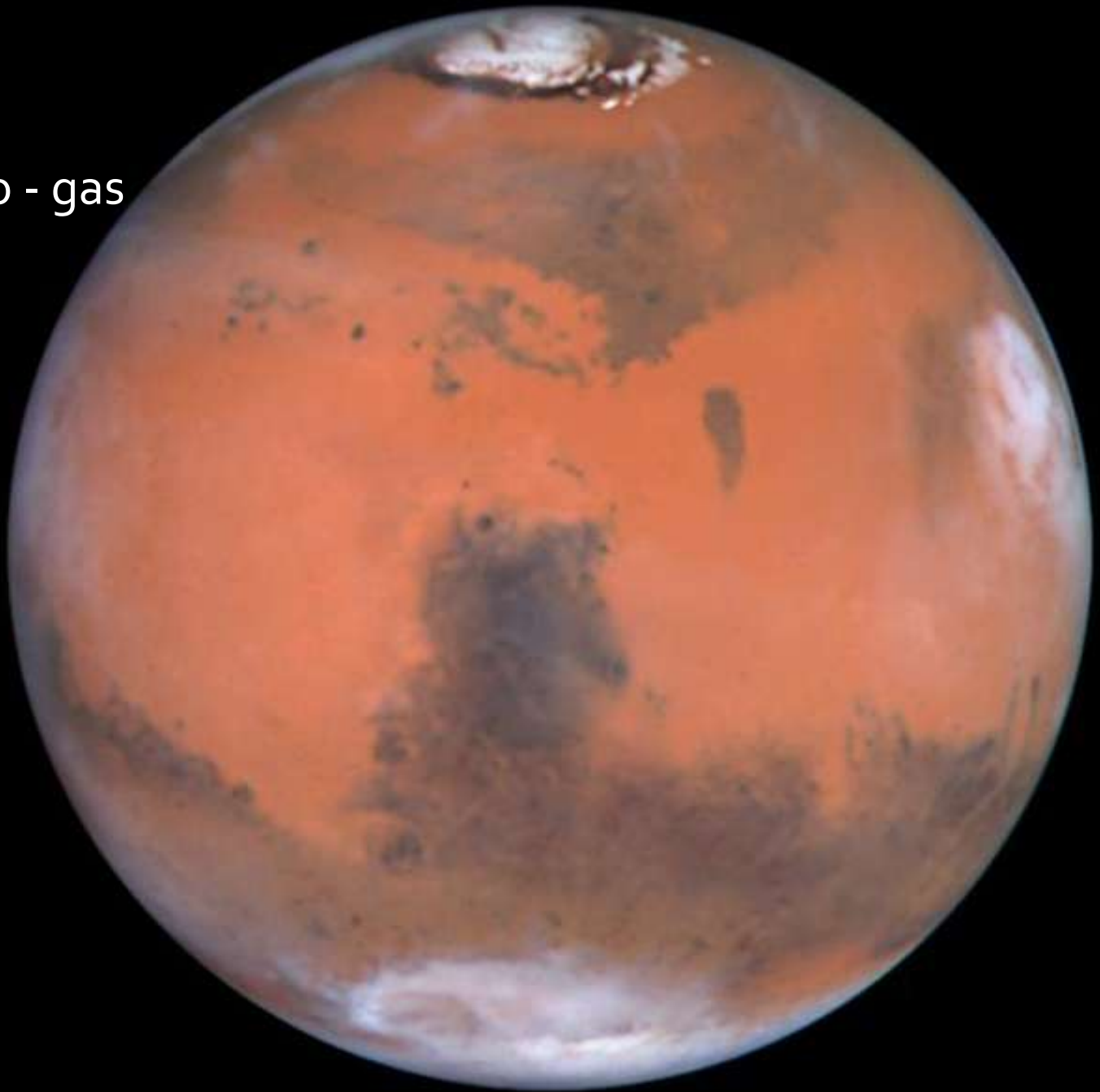


Frecuencia de impactos actual

- Asteroide de 1km cada 1 millón de años
- Catástrofe regional
- “Invierno nuclear” durante algunos meses

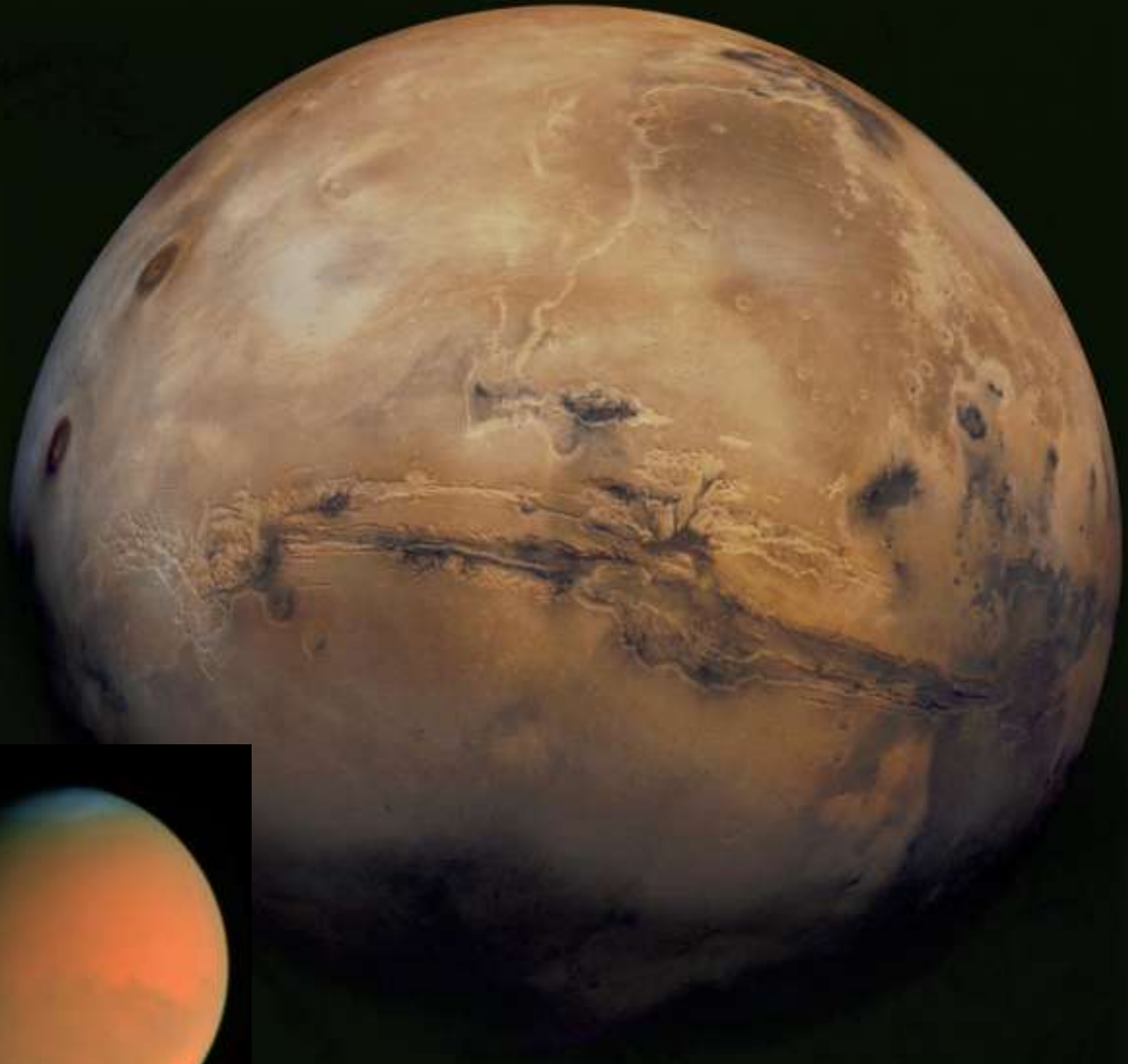
Marte

Ciclo CO₂ hielo - gas



Marte

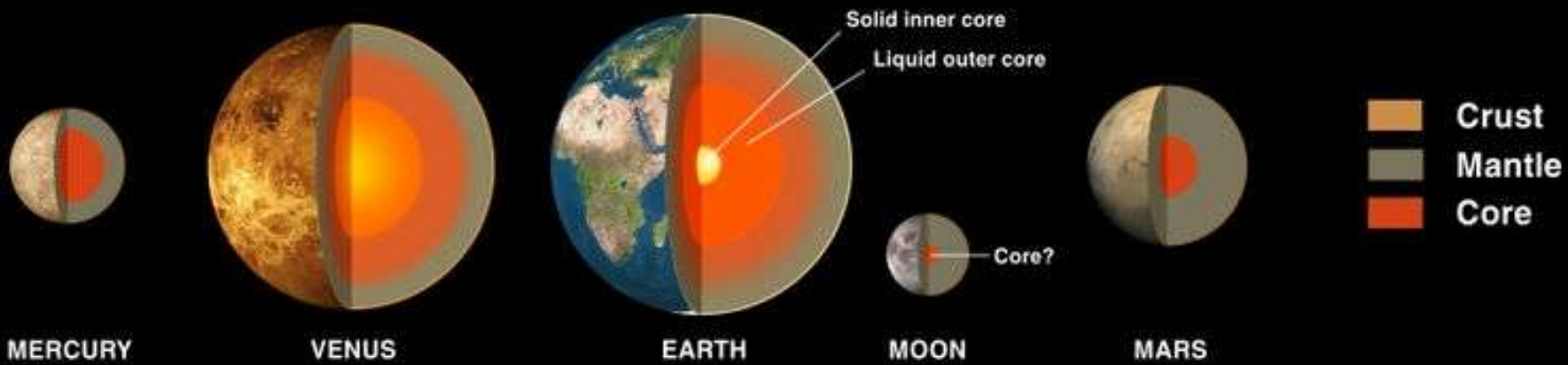
Volcanes fosilizados
Erosión por fluidos
Agua en el pasado



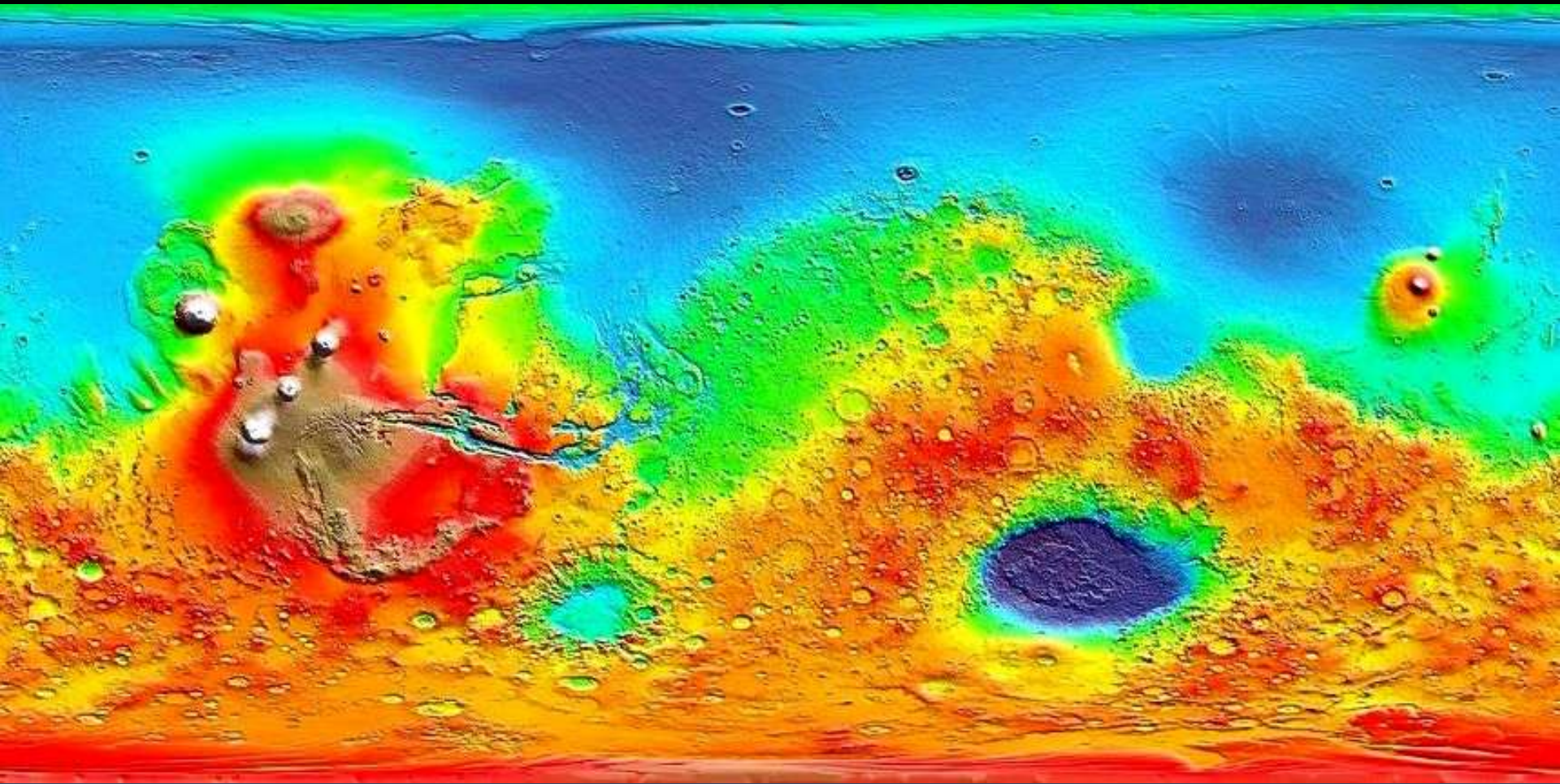
June 26, 2001



September 4, 2001

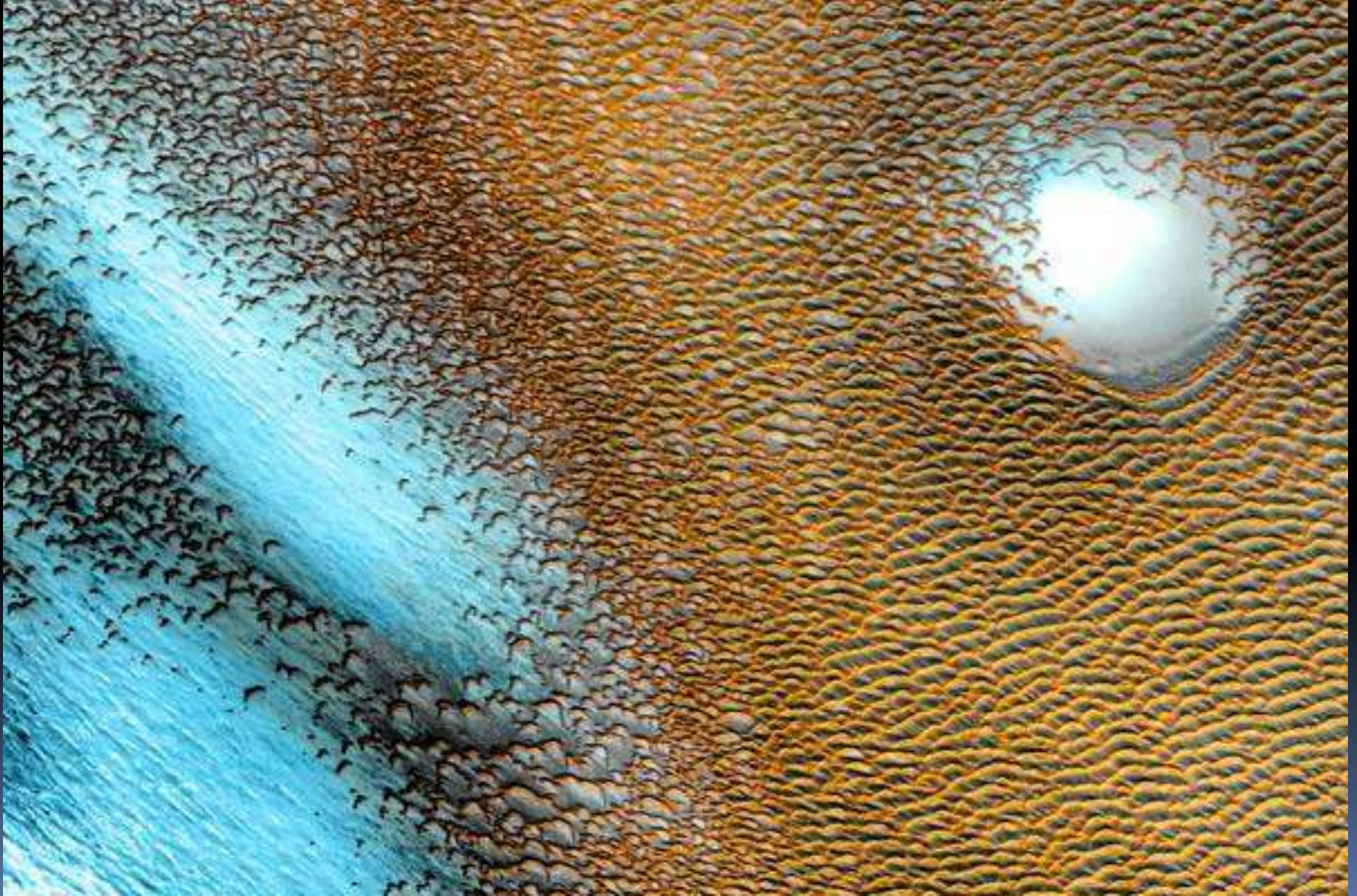


Marte



Marte

Dunas



Marte

Dunas: actividad eólica



Marte

Tornados



Tormenta de polvo



Marte

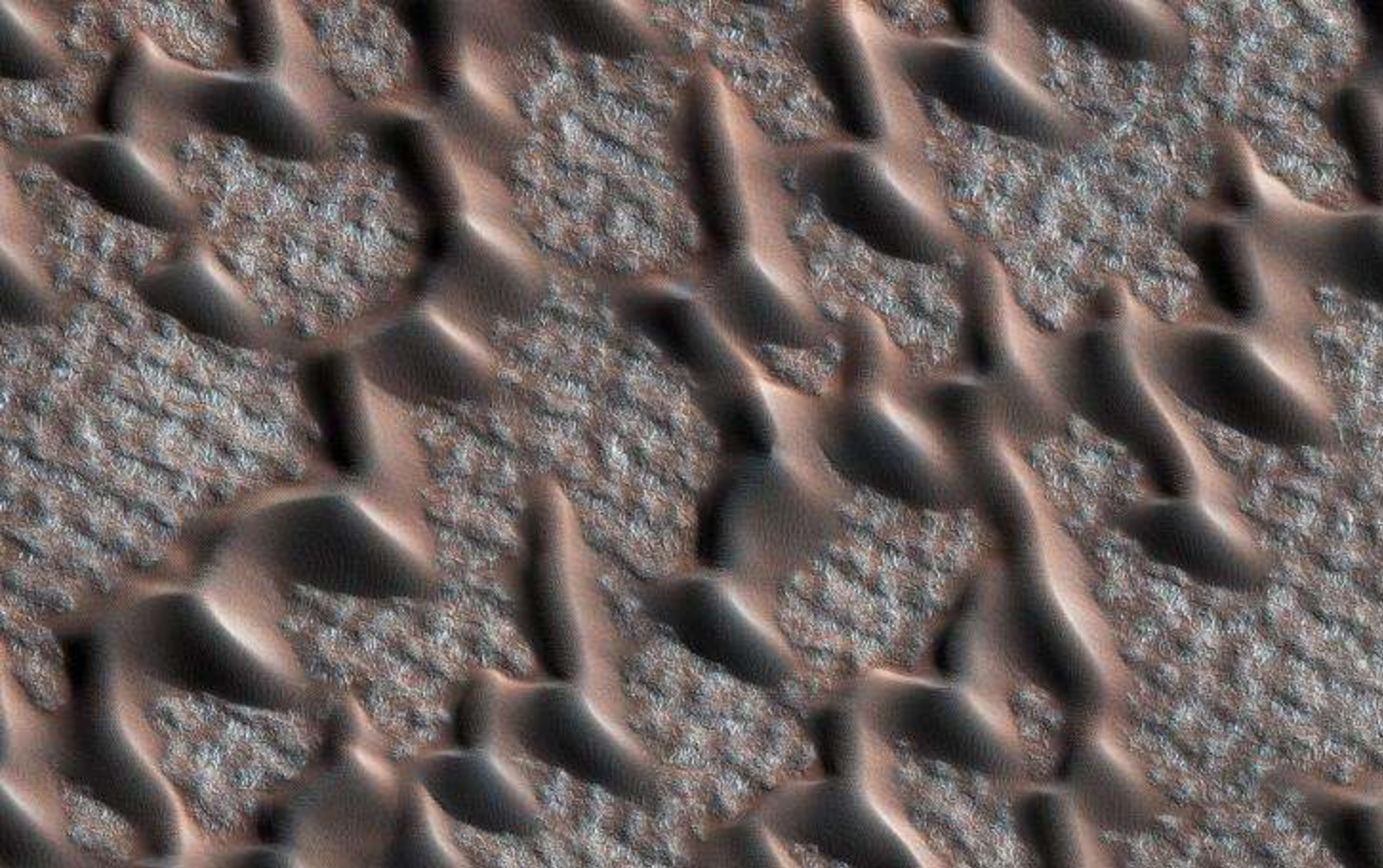
Dunas cubiertas de CO₂



Marte



Marte



Marte

Sin agua superficial.

Hielo subsuperficial (permafrost)



Deimos (satélite de Marte)



2 km

Fobos (satélite de Marte)



Astroide Eros



Itokawa

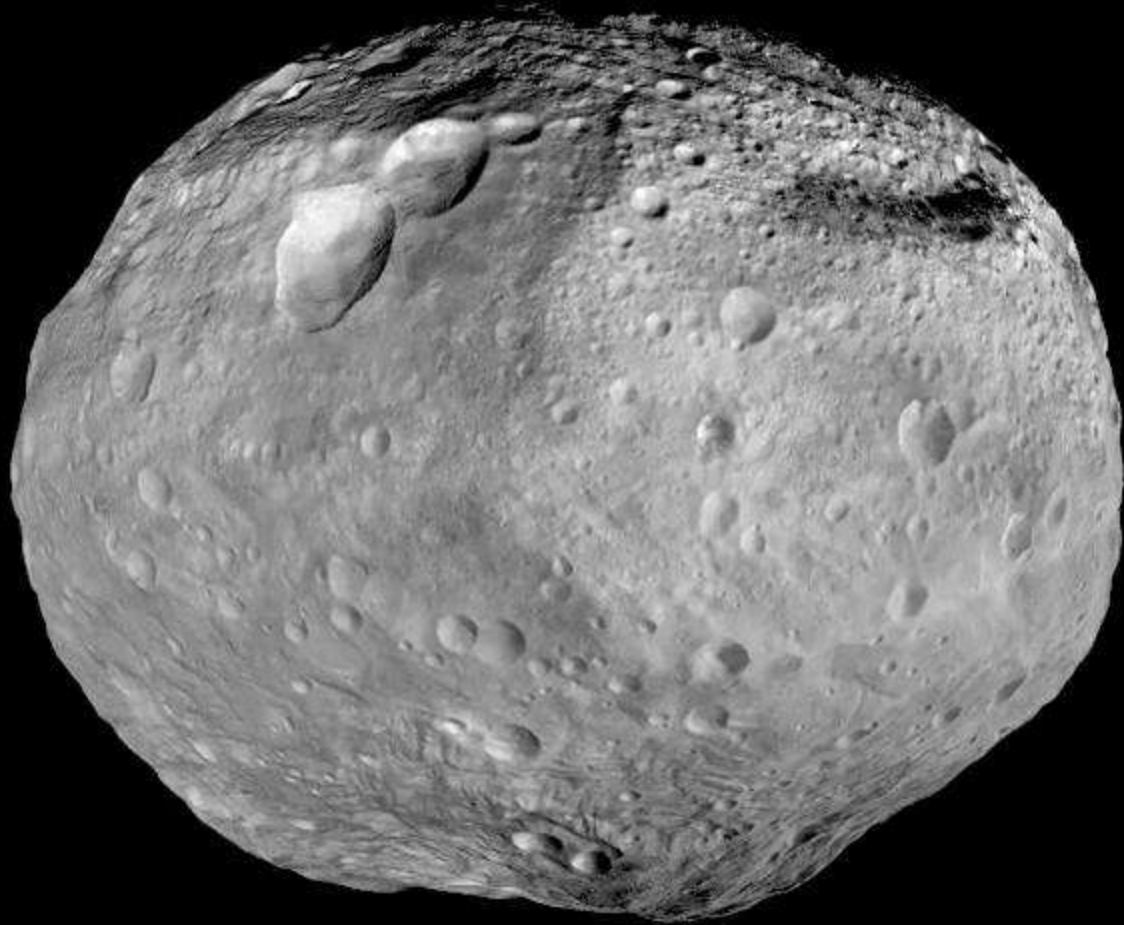
“Pila de escombros”



Ceres(planeta enano)



Vesta





243 Ida - $58.8 \times 25.4 \times 18.6$ km
Galileo, 1993

Dactyl
[[243] Ida I]
 1.6×1.2 km
Galileo, 1993



9969 Braille
 $2.1 \times 1 \times 1$ km
Deep Space 1, 1999



5535 Annefrank
 $6.6 \times 5.0 \times 3.4$ km
Stardust, 2002



2867 Steins
 5.9×4.0 km
Rosetta, 2006



433 Eros - 33×13 km
NEAR, 2000

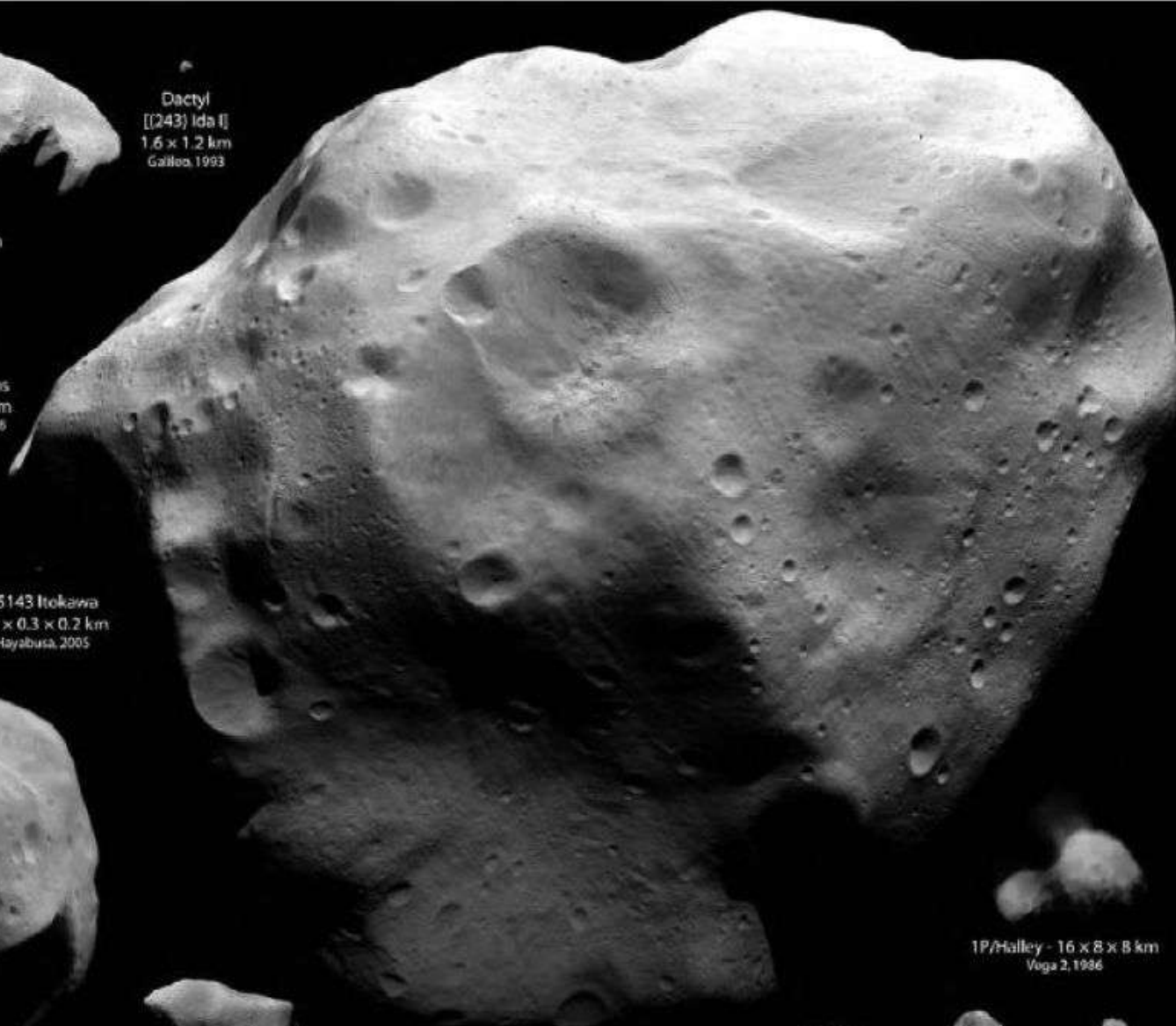
25143 Itokawa
 $0.5 \times 0.3 \times 0.2$ km
Hayabusa, 2005



253 Mathilde - $66 \times 48 \times 44$ km
NEAR, 1997



951 Gaspra - $18.2 \times 10.5 \times 8.9$ km
Galileo, 1991



21 Lutetia - $132 \times 101 \times 76$ km
Rosetta, 2010



1P/Halley - $16 \times 8 \times 8$ km
Vega 2, 1986



19P/Borrelly
 8×4 km
Deep Space 1, 2001

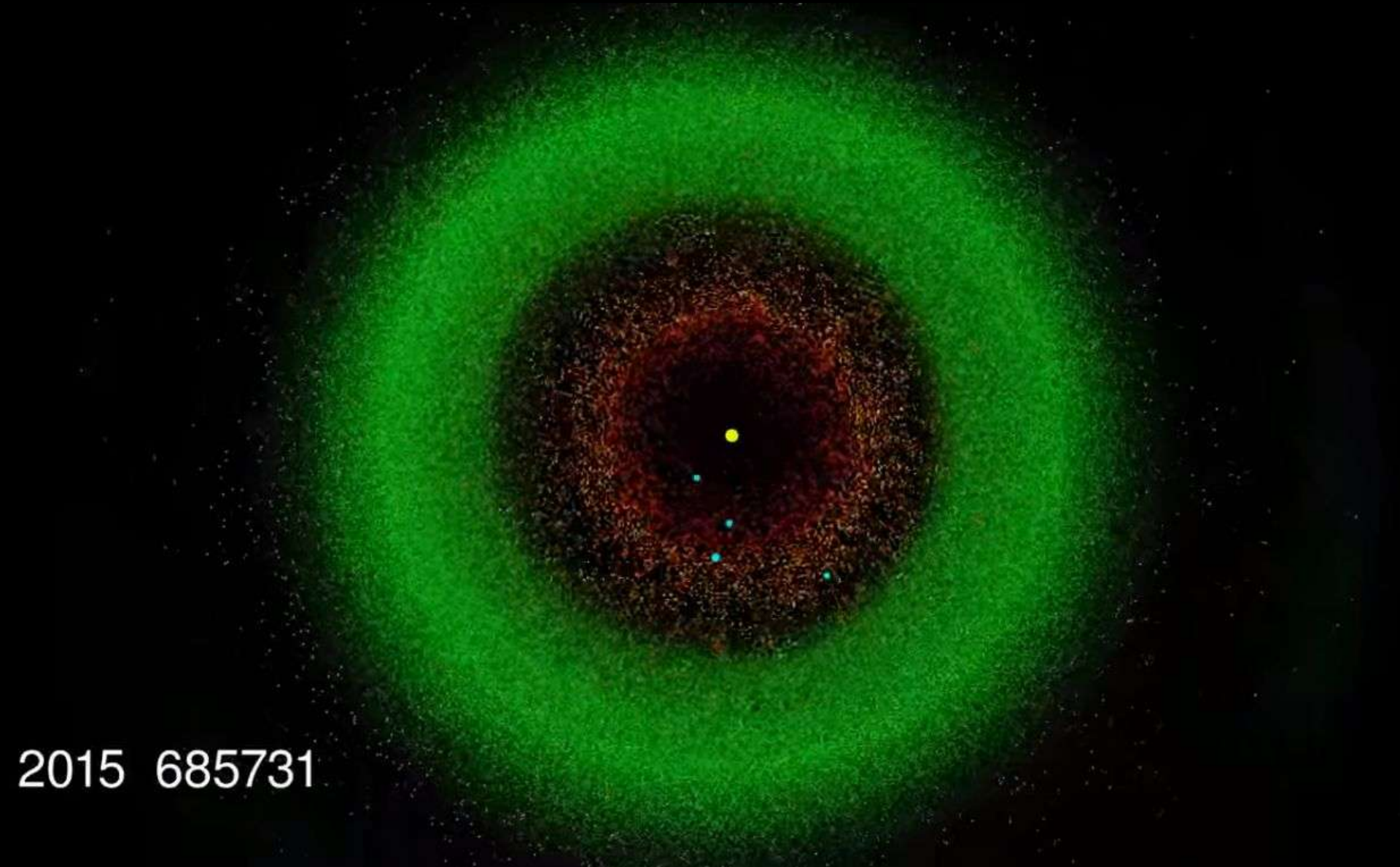


9P/Tempel 1
 7.6×4.9 km
Deep Impact, 2005



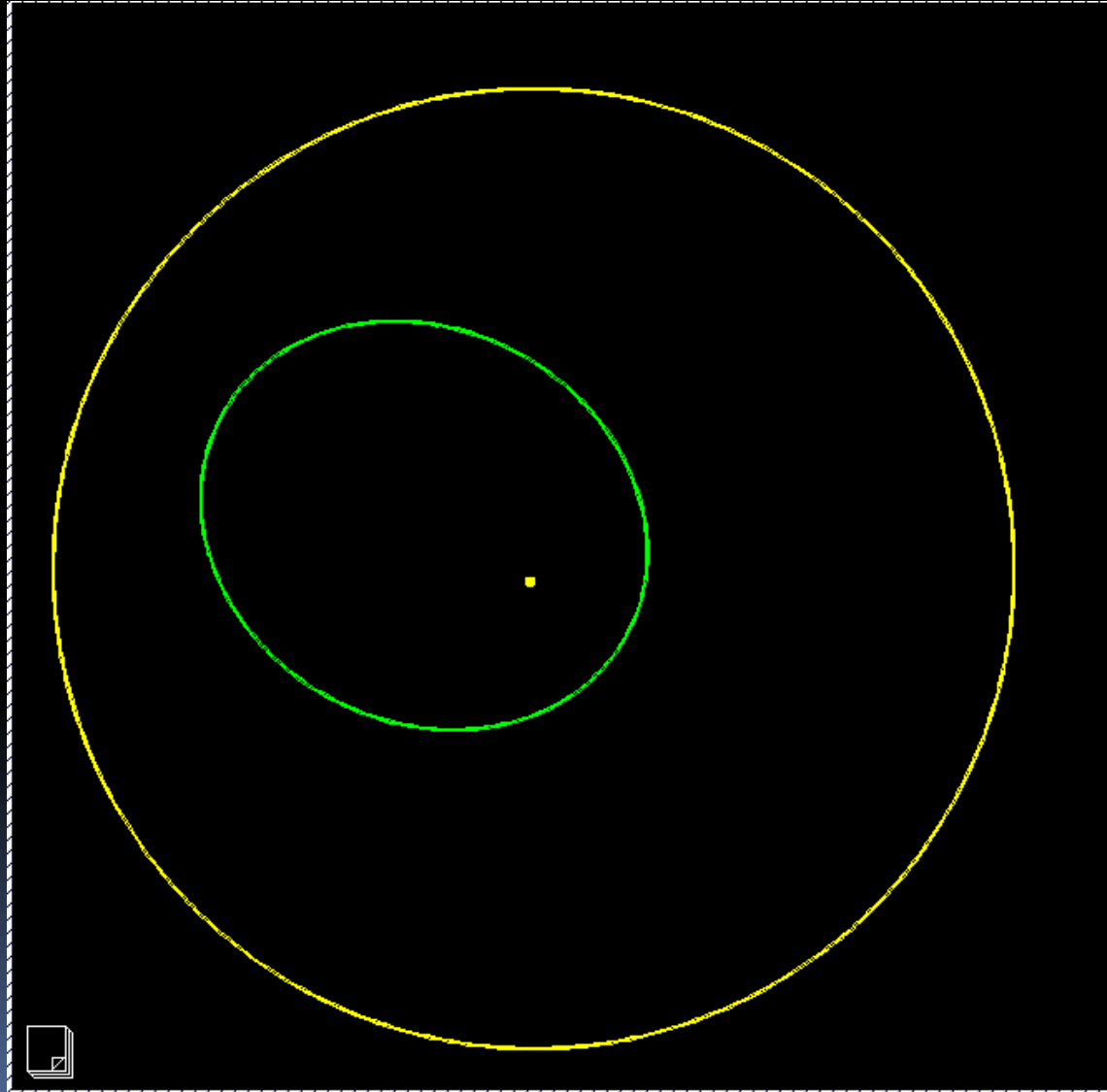
81P/Wild 2
 $5.5 \times 4.0 \times 3.3$ km
Stardust, 2004

Asteroides



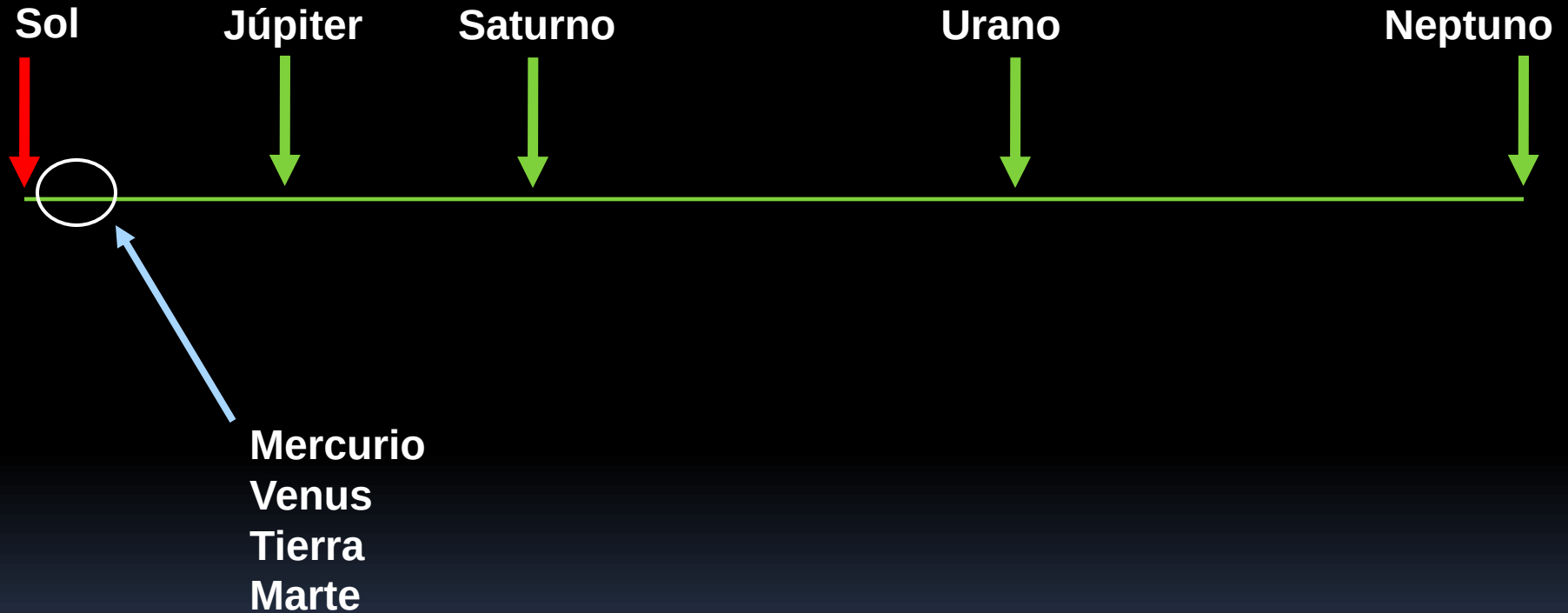
2015 685731

Evolution orbital de asteroide



Sistema Solar

Distancias a escala



MUNDOS GASEOSOS Y HELADOS

Júpiter

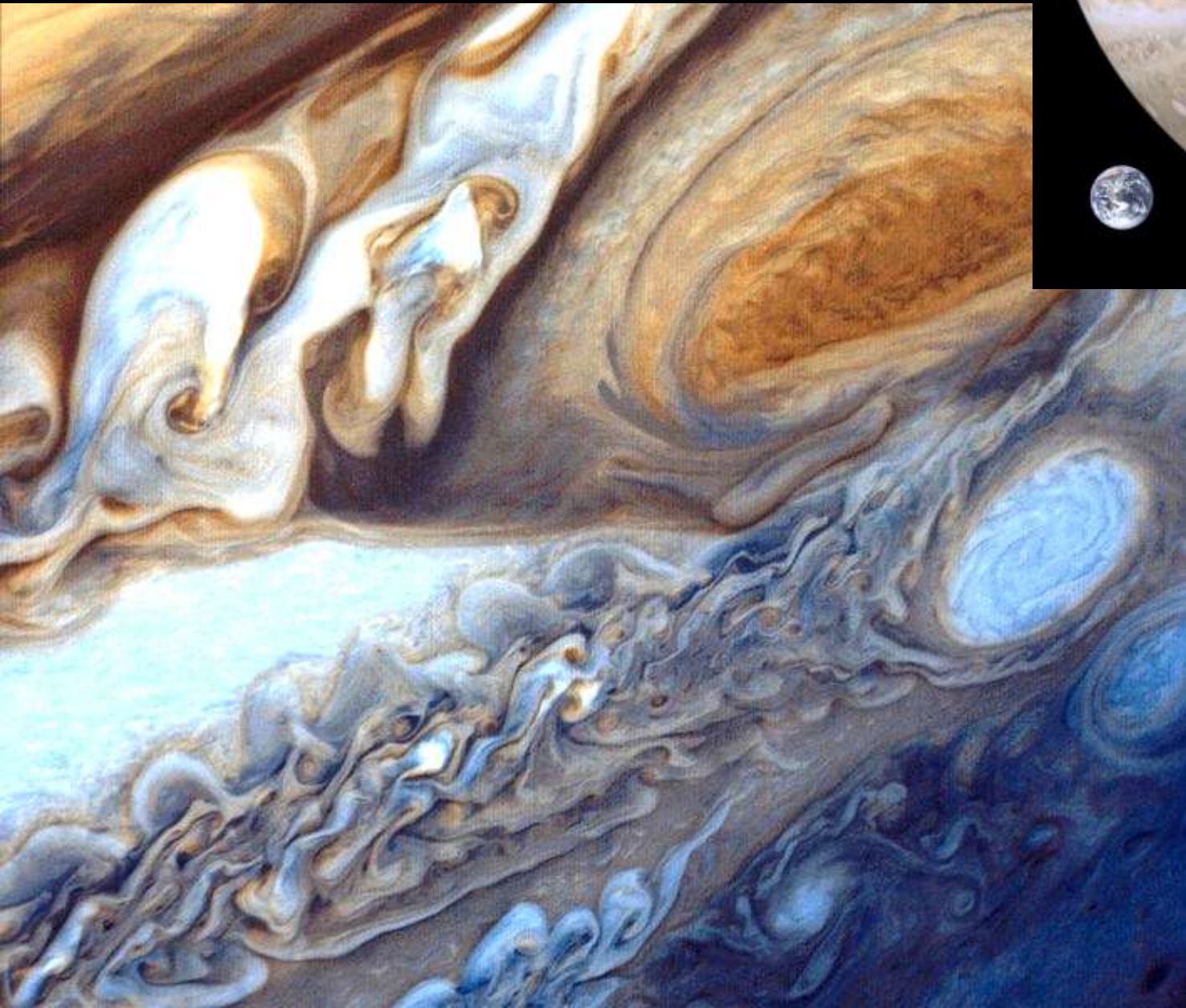
H + He

Temp.: -170 C

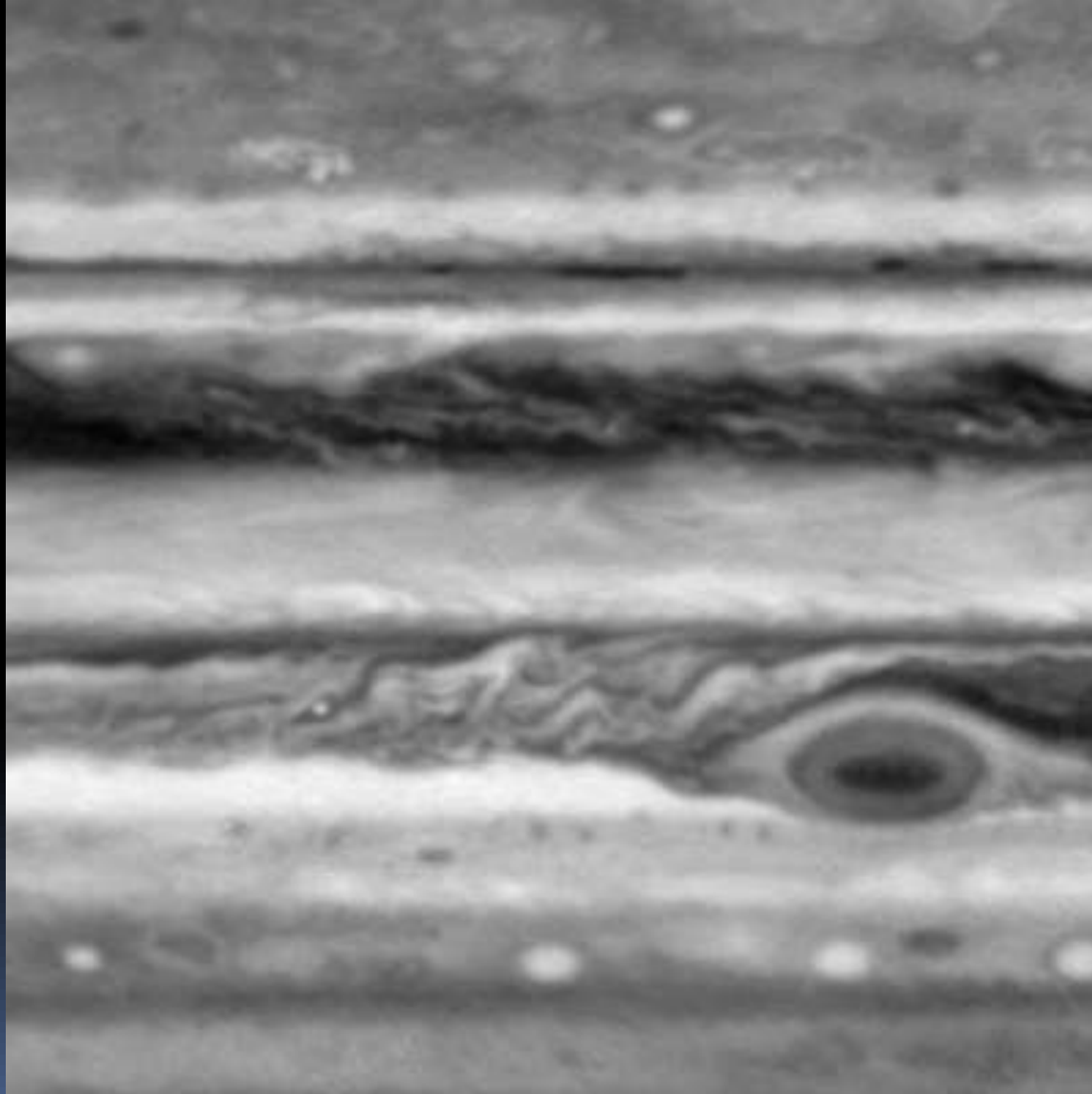
Masa $\approx$ 300 Tierras



Júpiter



Júpiter



Júpiter





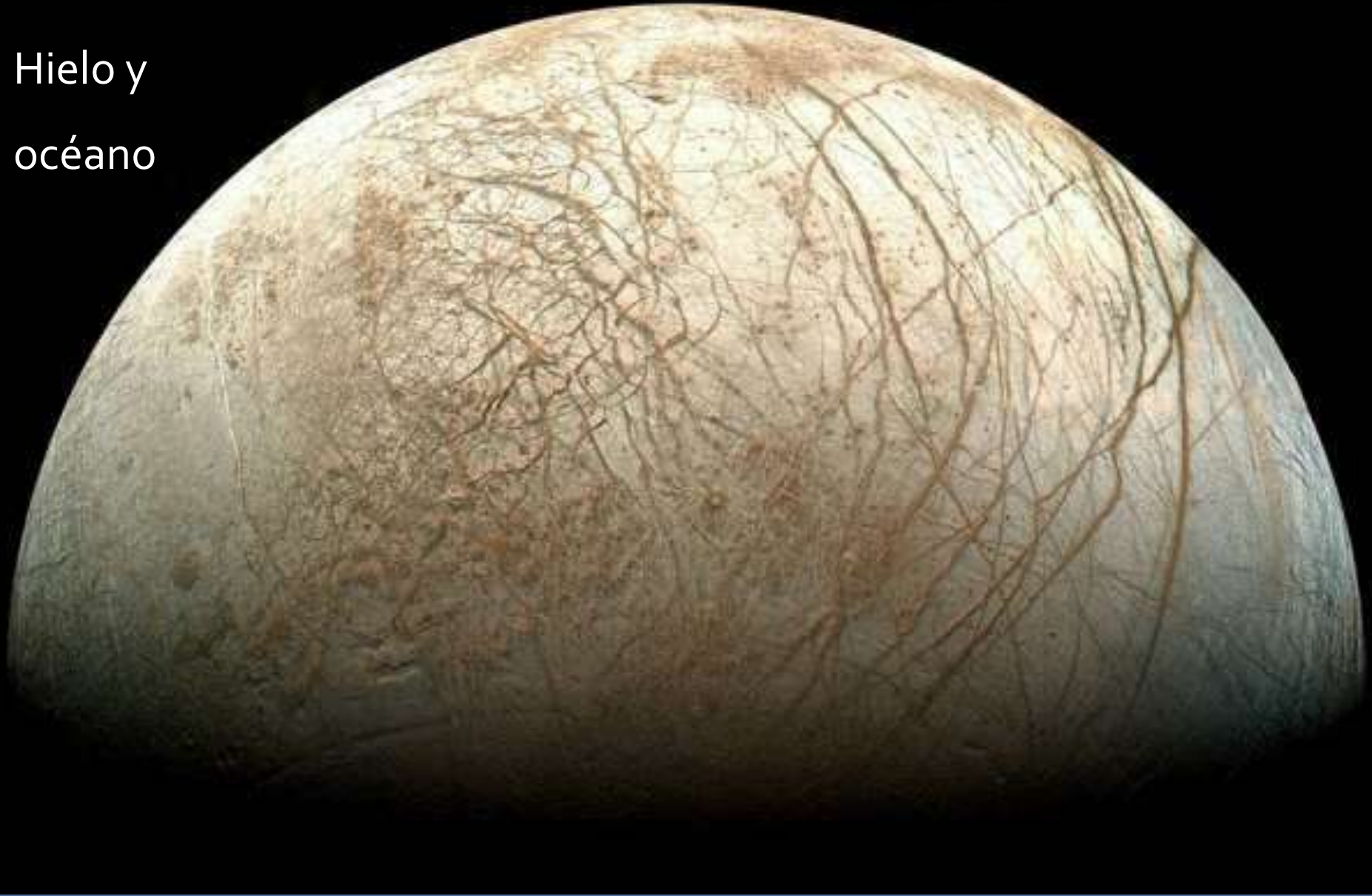
Satélites Galileanos



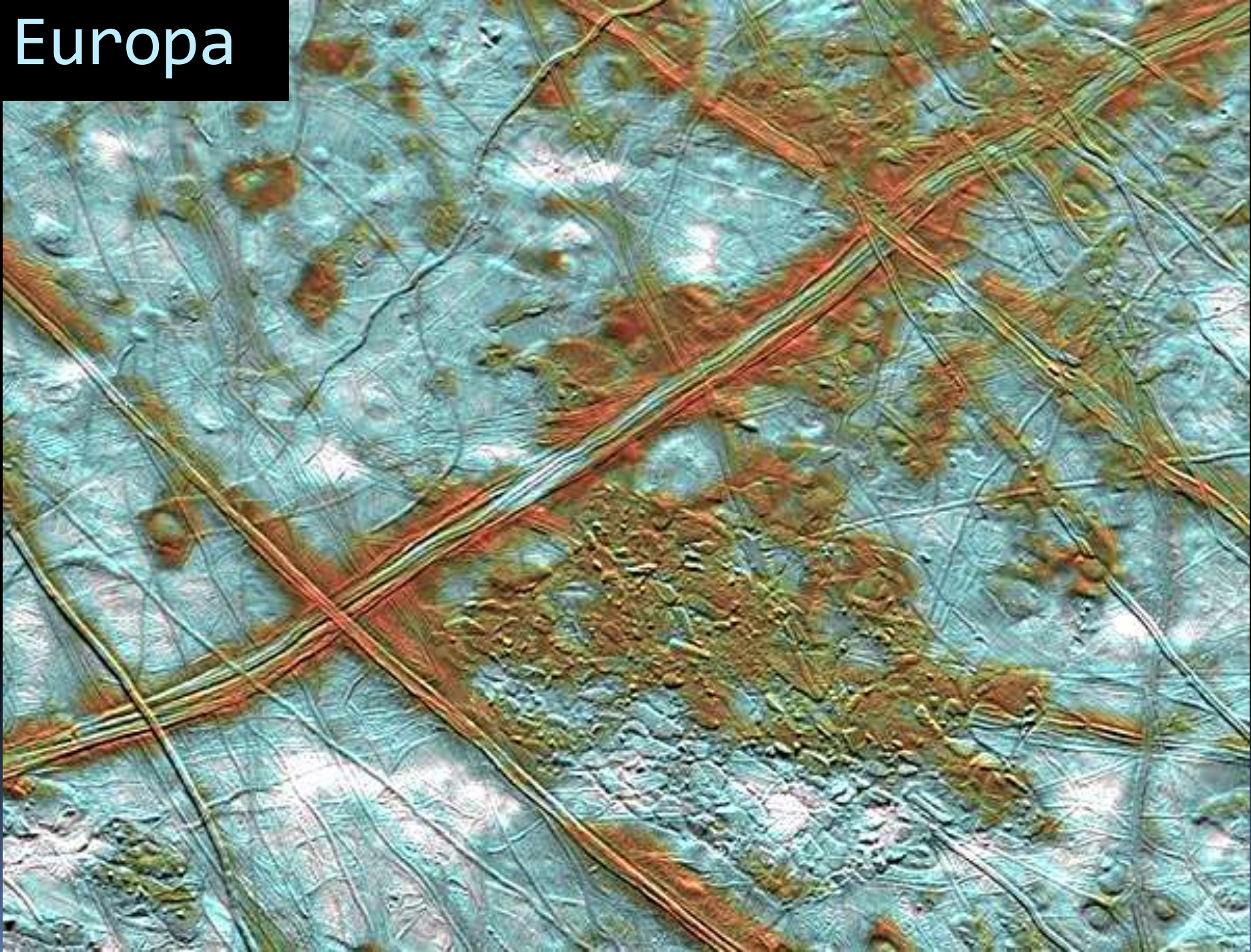
Rotación sincrónica por mareas

Europa (satélite)

Hielo y
océano

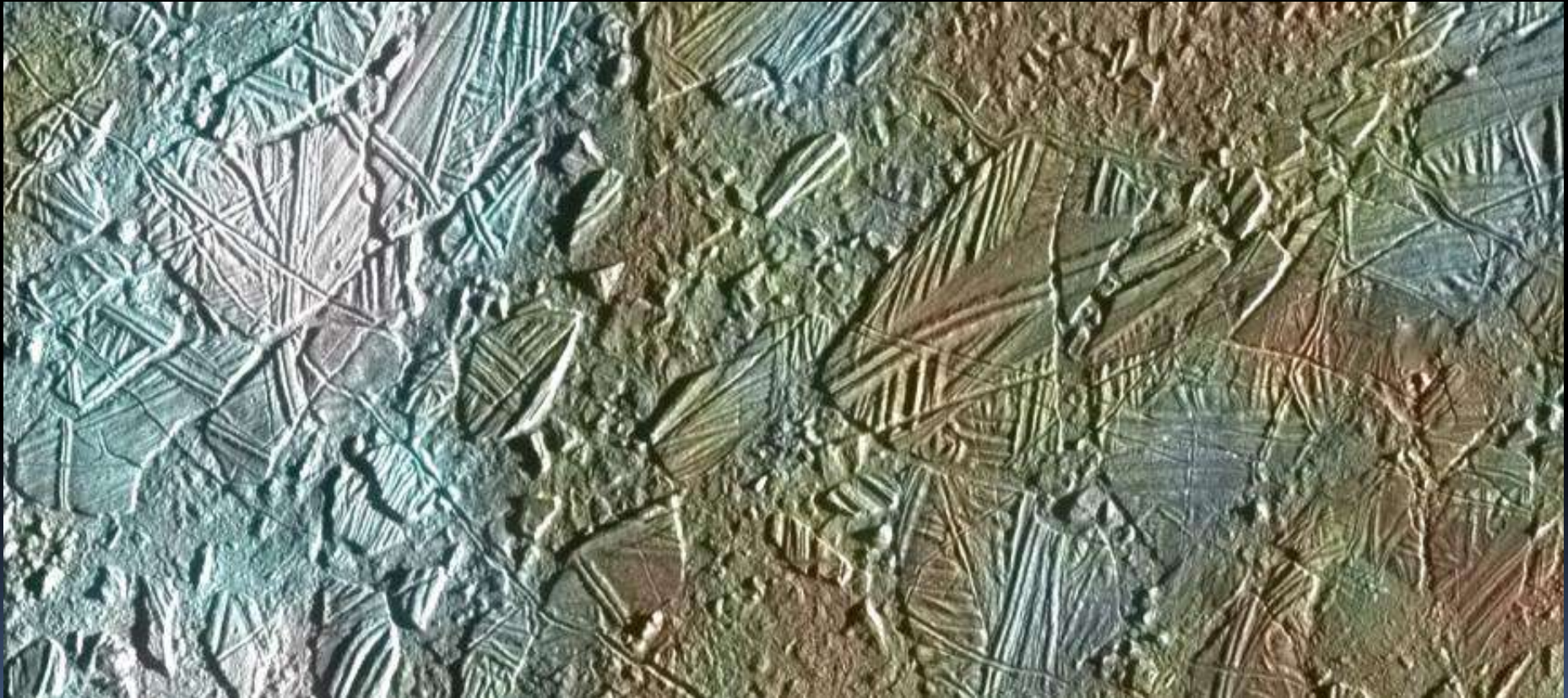


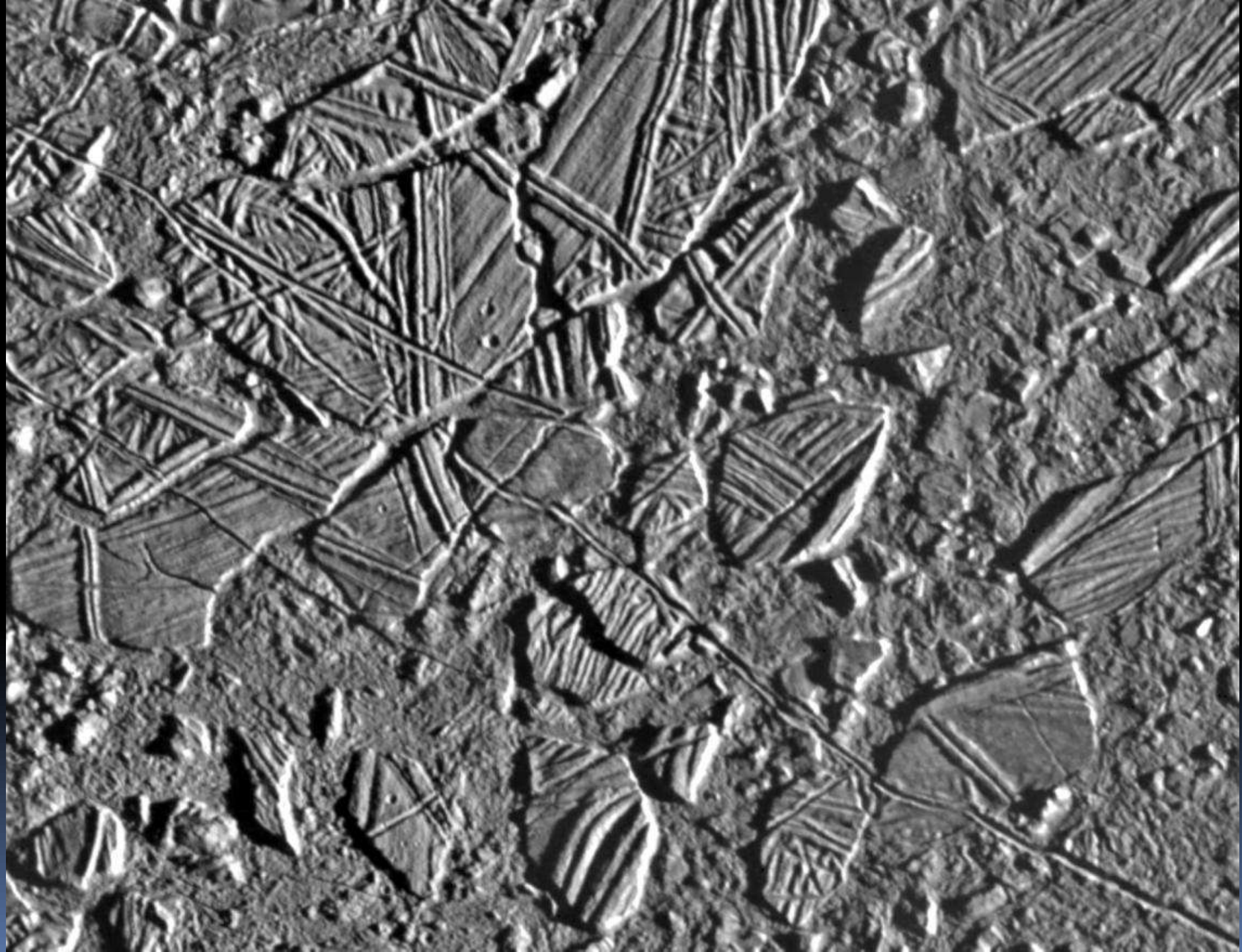
Europa

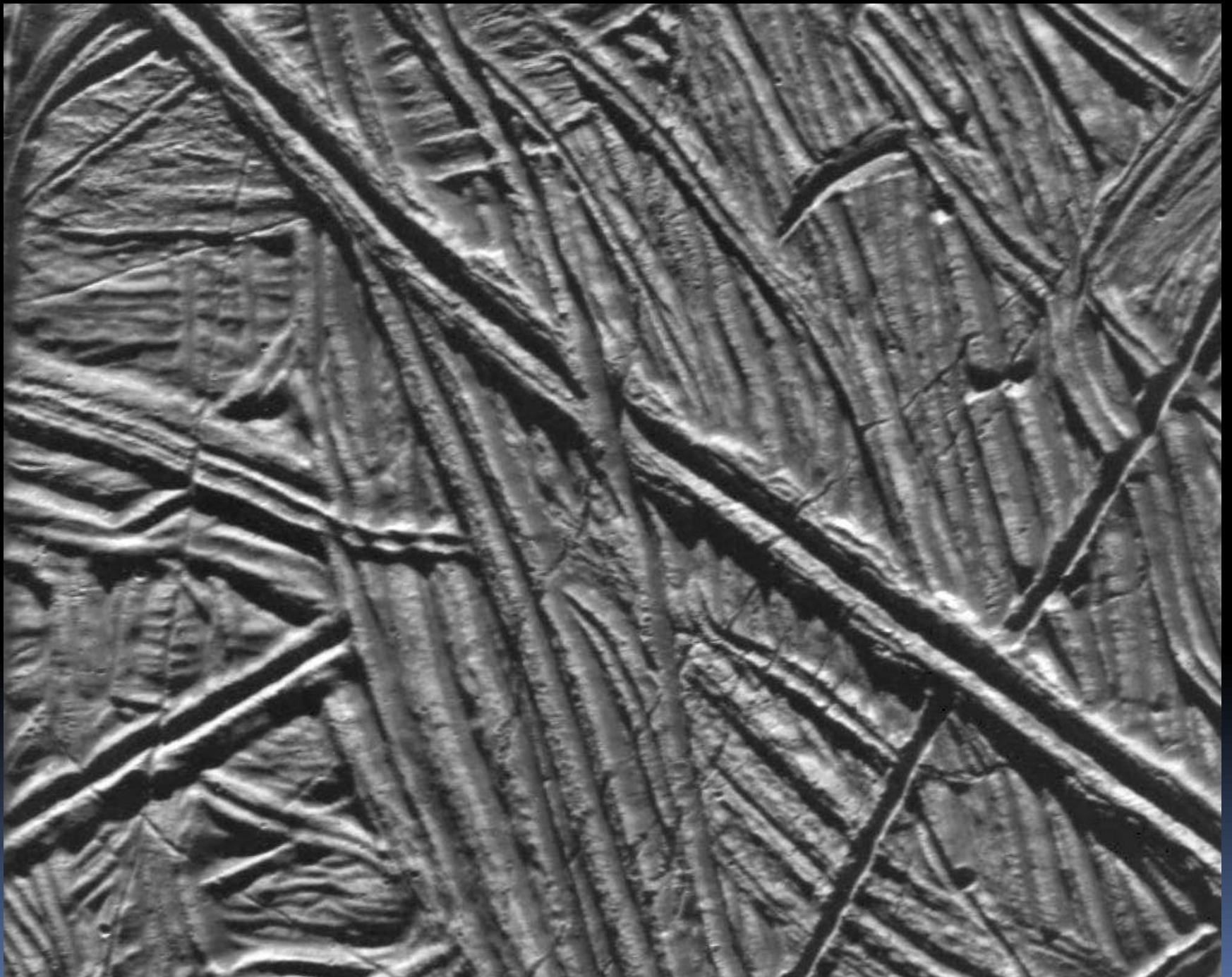


Europa

Manchas marrones: tholins



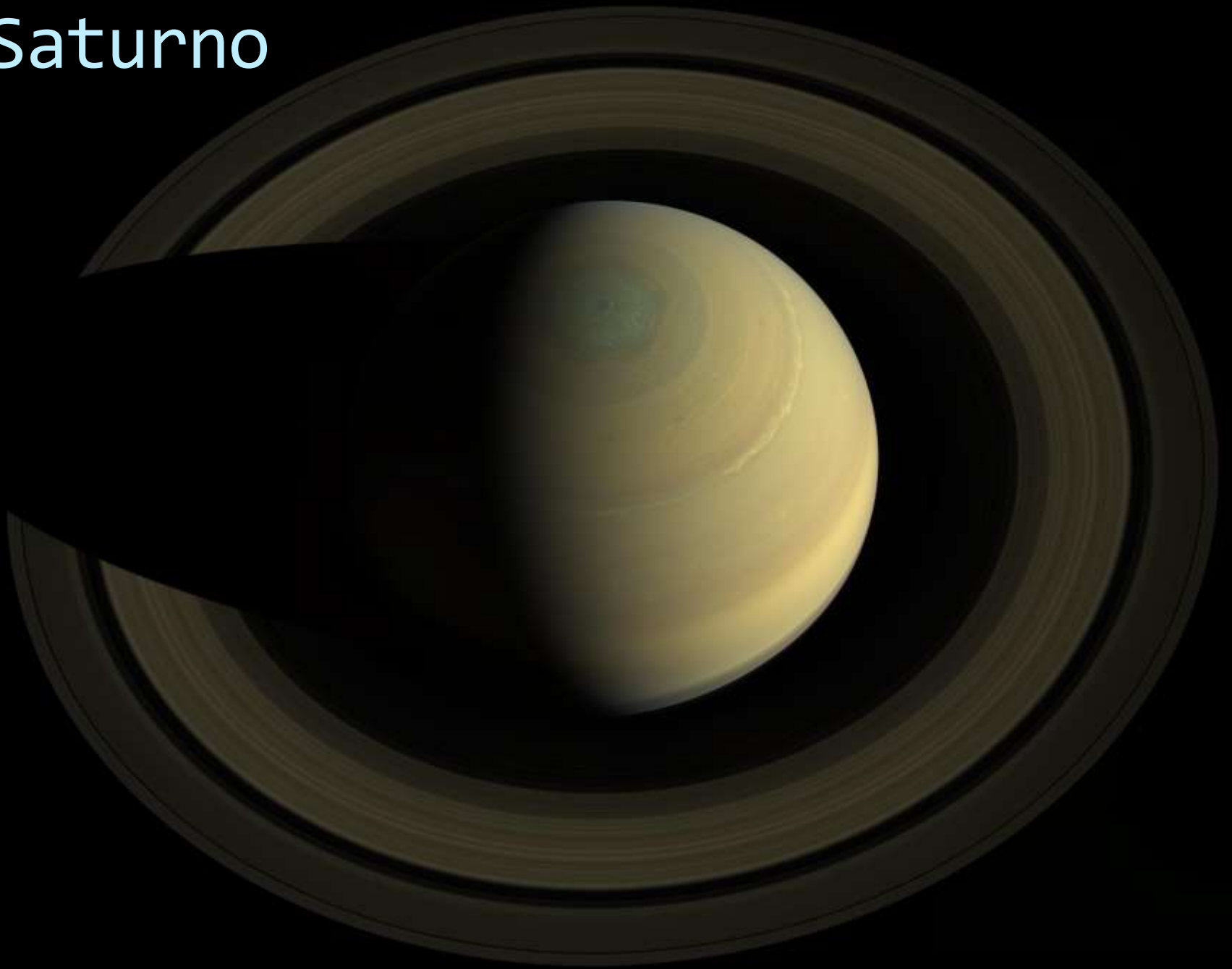




Ganímedes

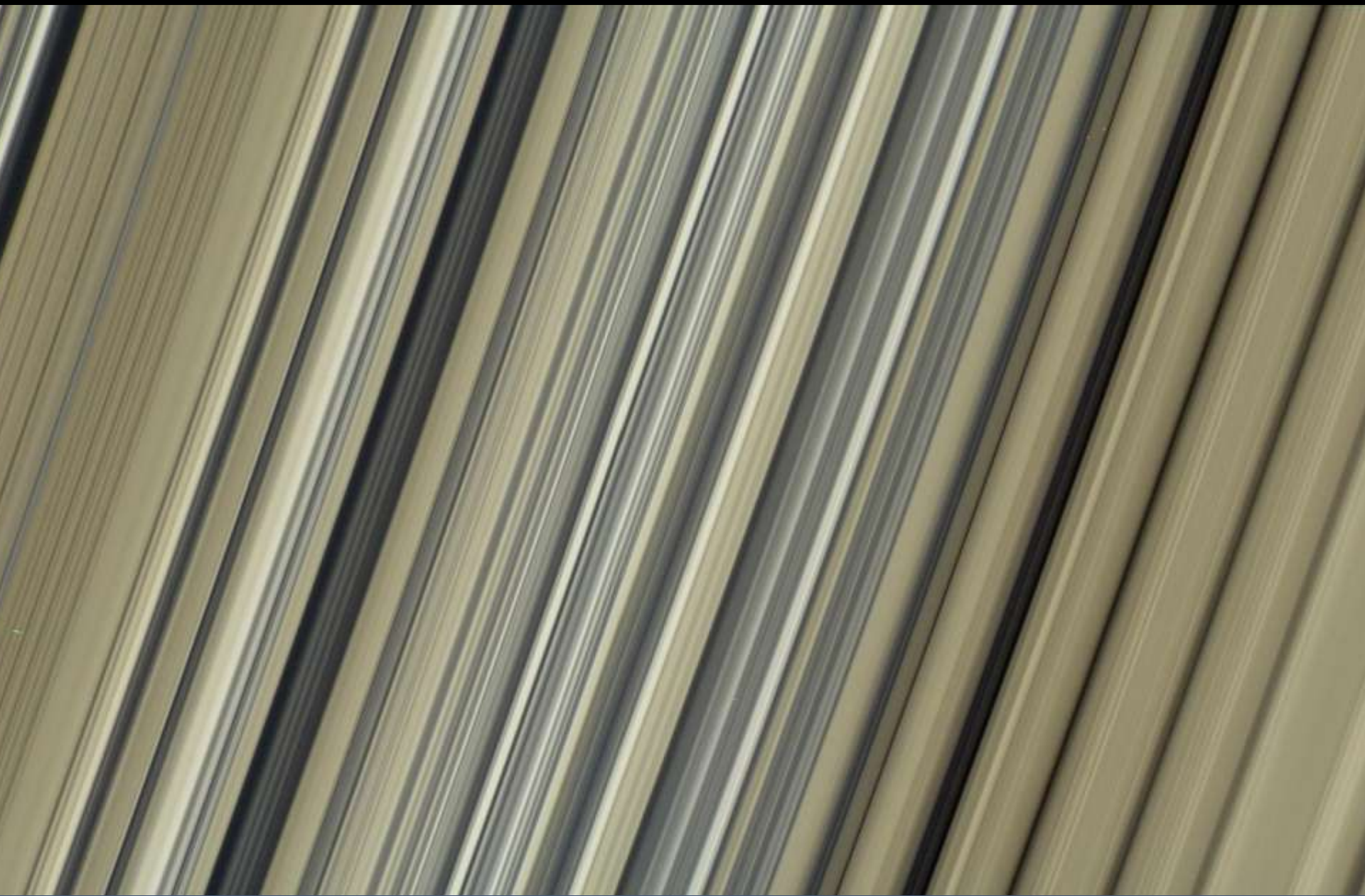


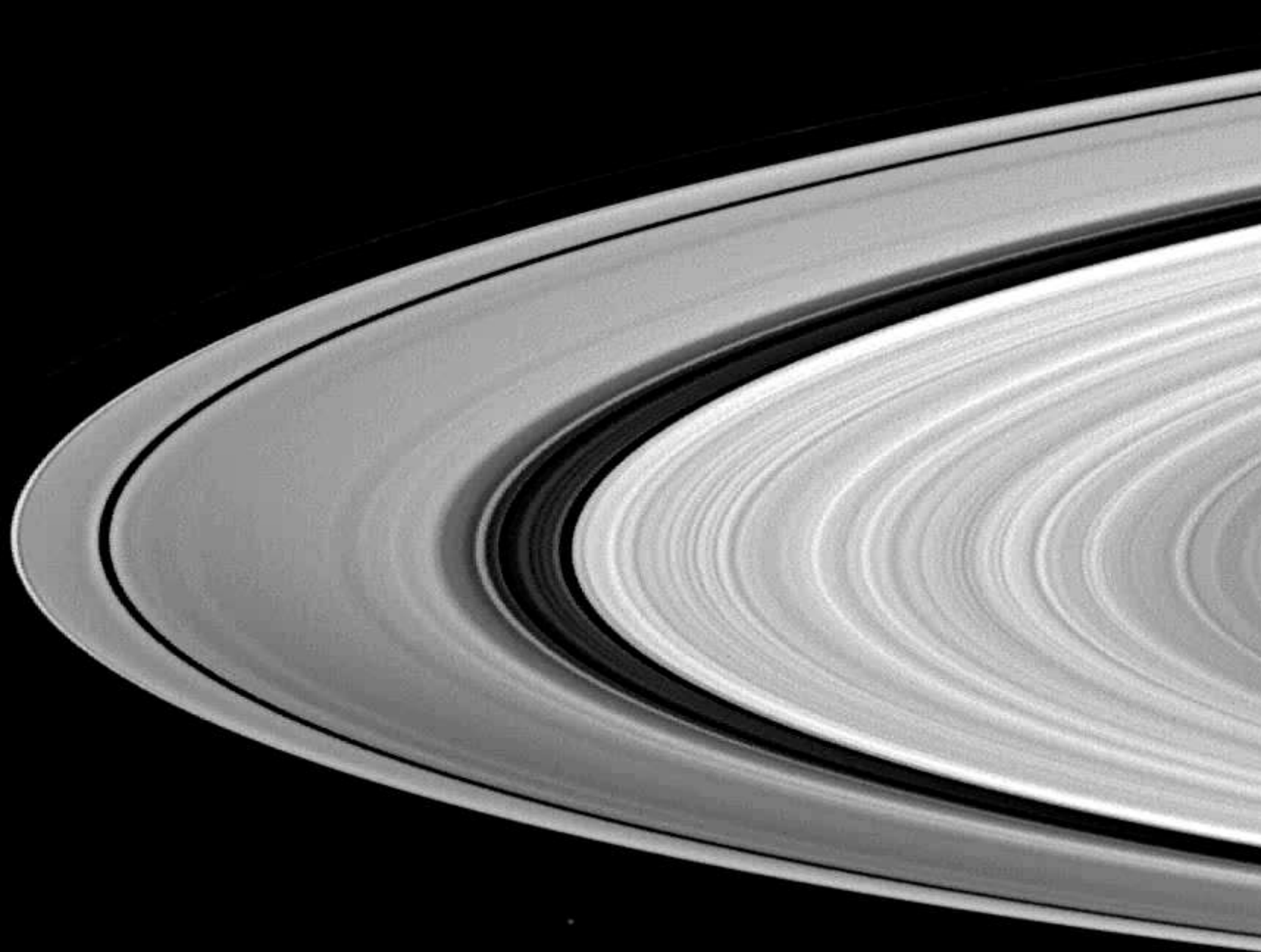
Saturno



Saturno



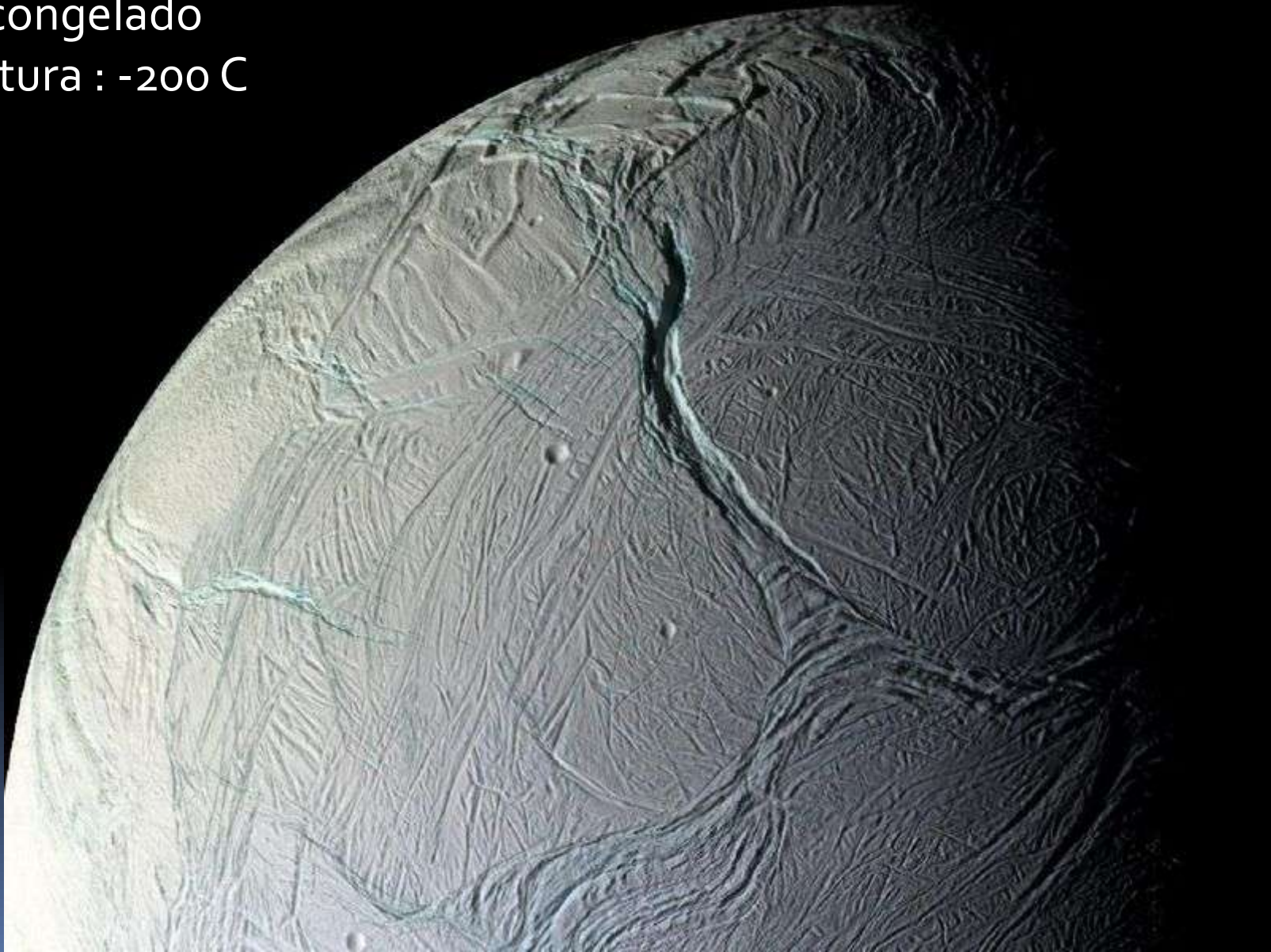




Encelado

Océano congelado

Temperatura : -200 C

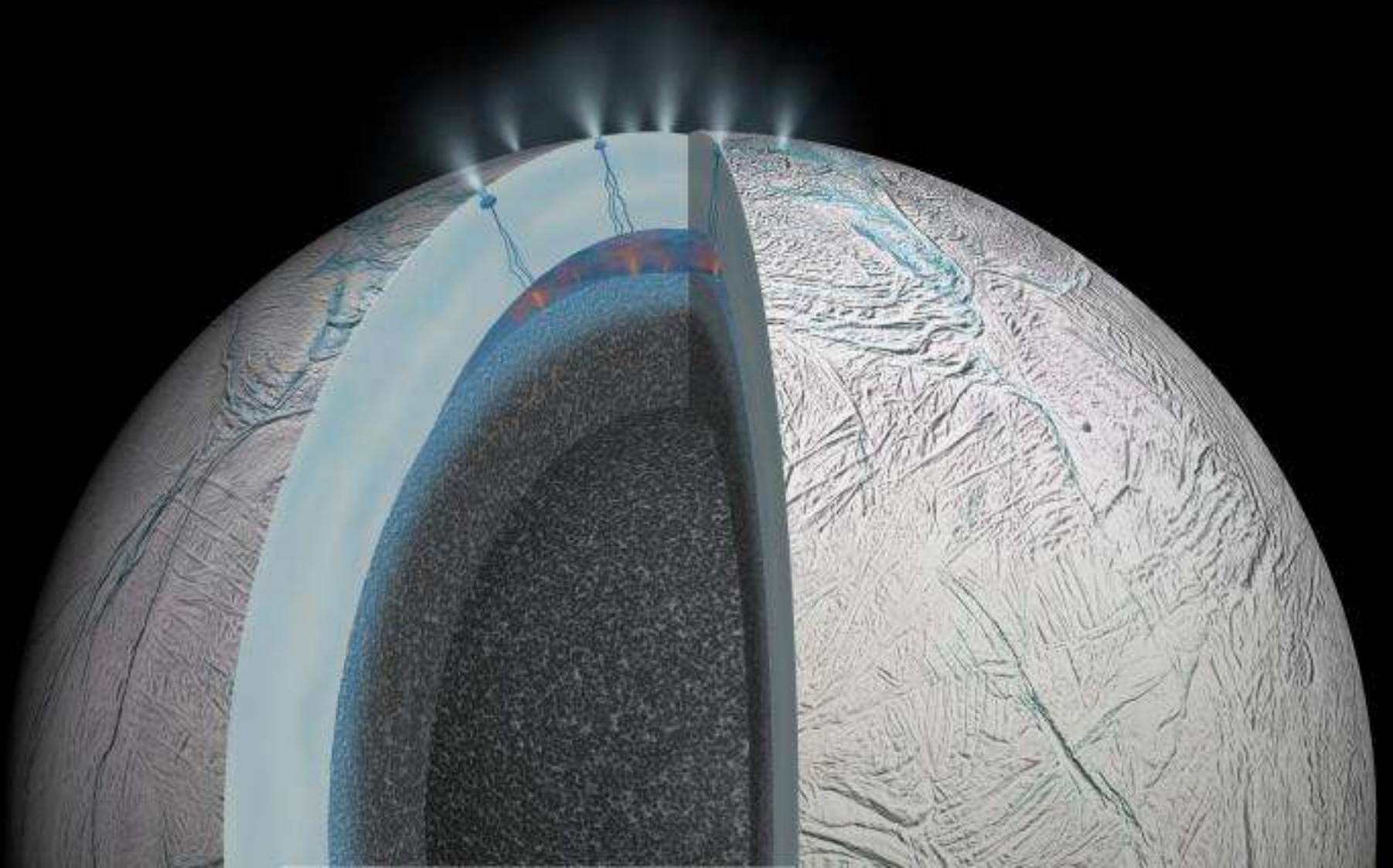


Encelado

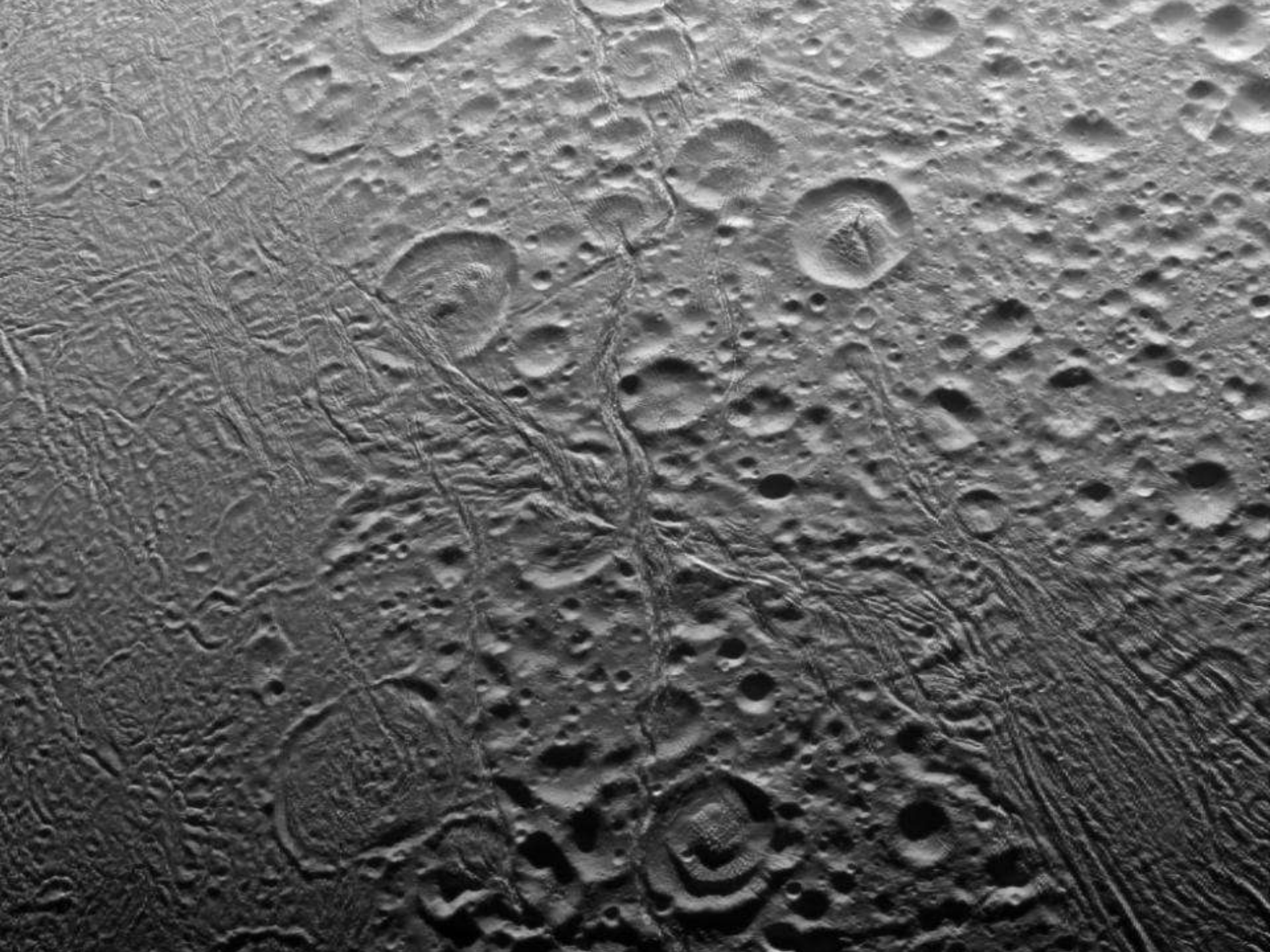
Compuestos orgánicos de 200 uma



Encelado







Glaciar terrestre

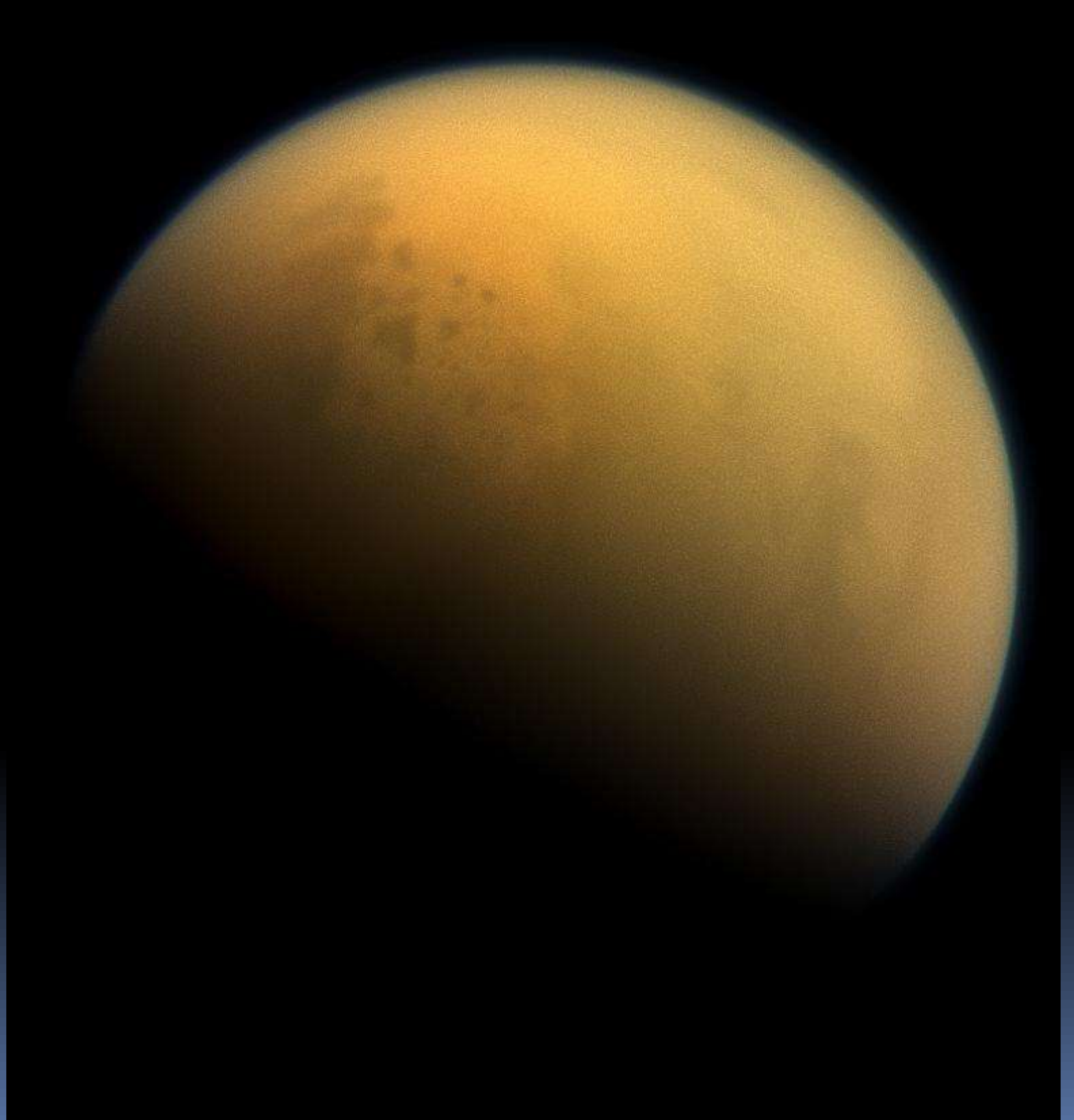


Titán

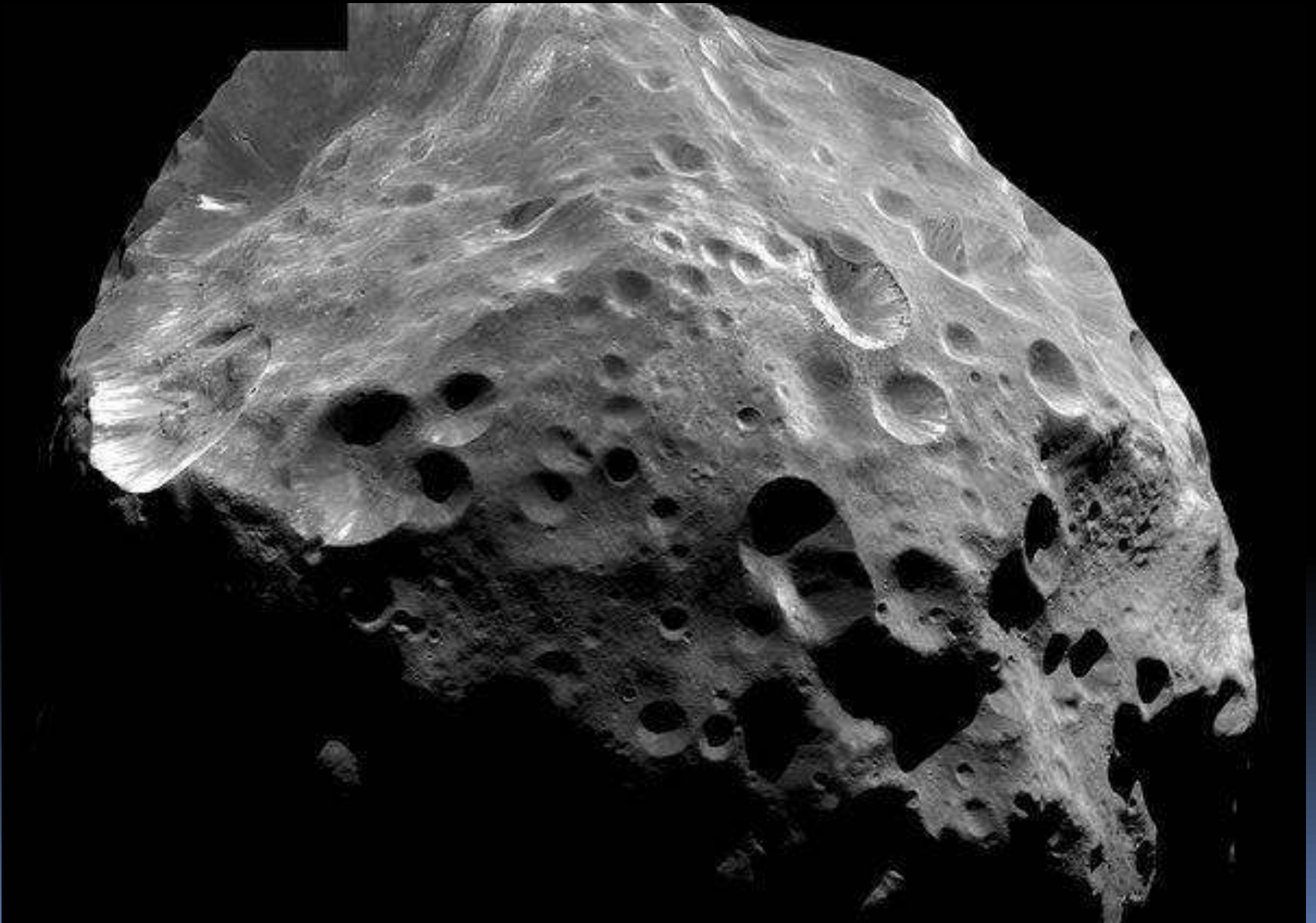
Atmósfera de Nitrógeno
Temperatura media = -170°C
Presión $> 1\text{ atm.}$
Metano sólido en superficie
Lagos de nitrógeno



Titán

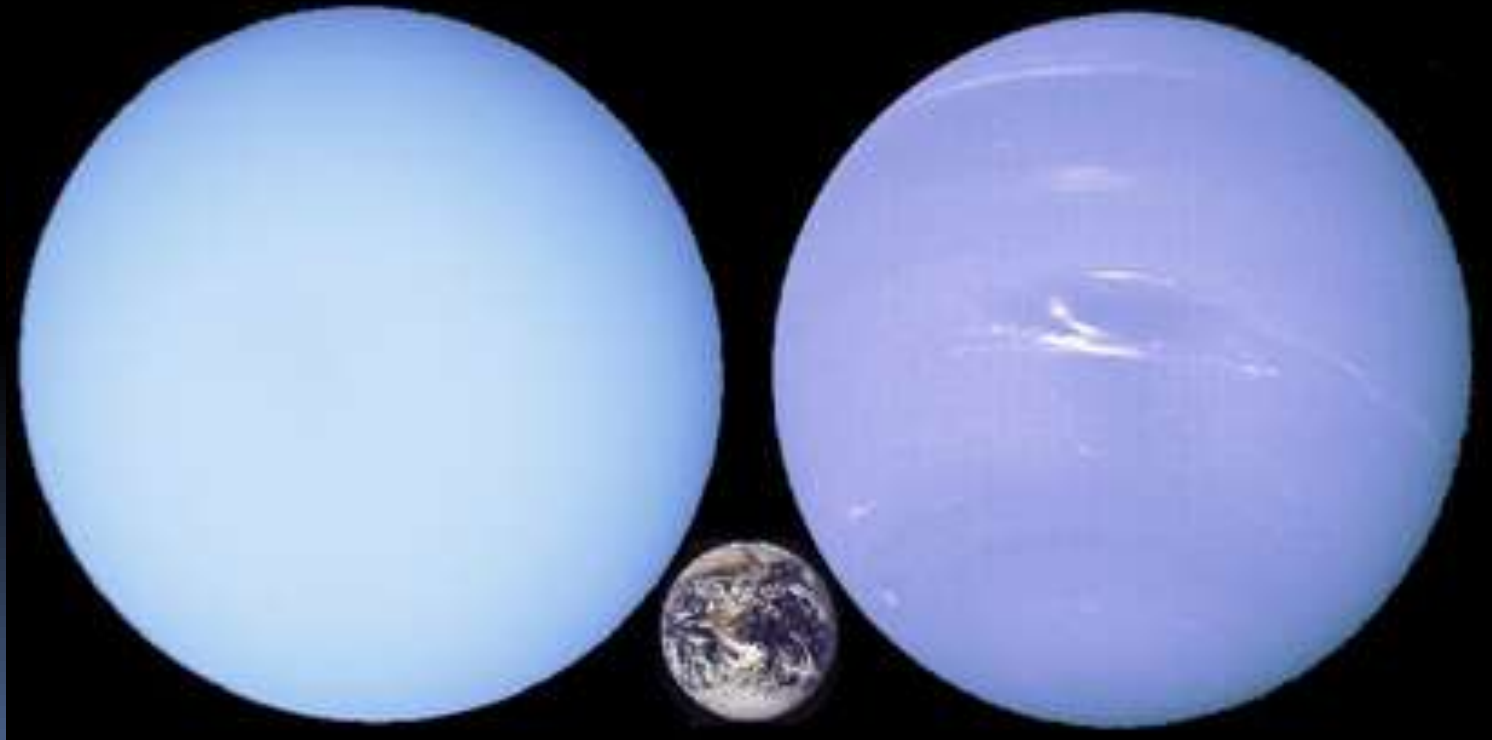


Phoebe



Urano y Neptuno

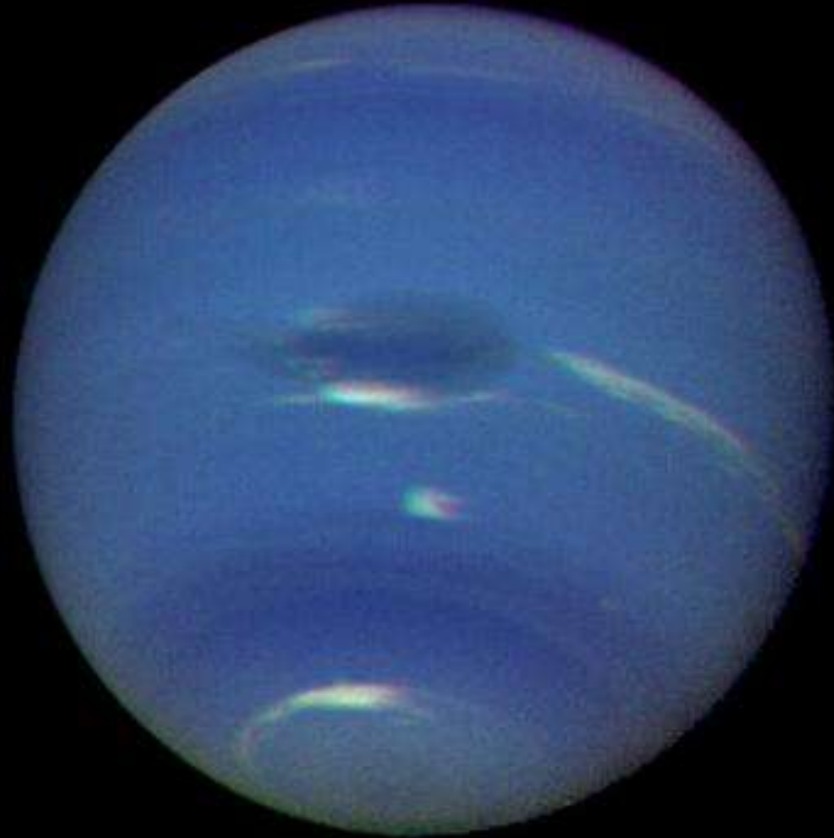
$\text{CH}_4 + \text{NH}_3$
Temp: -220 C

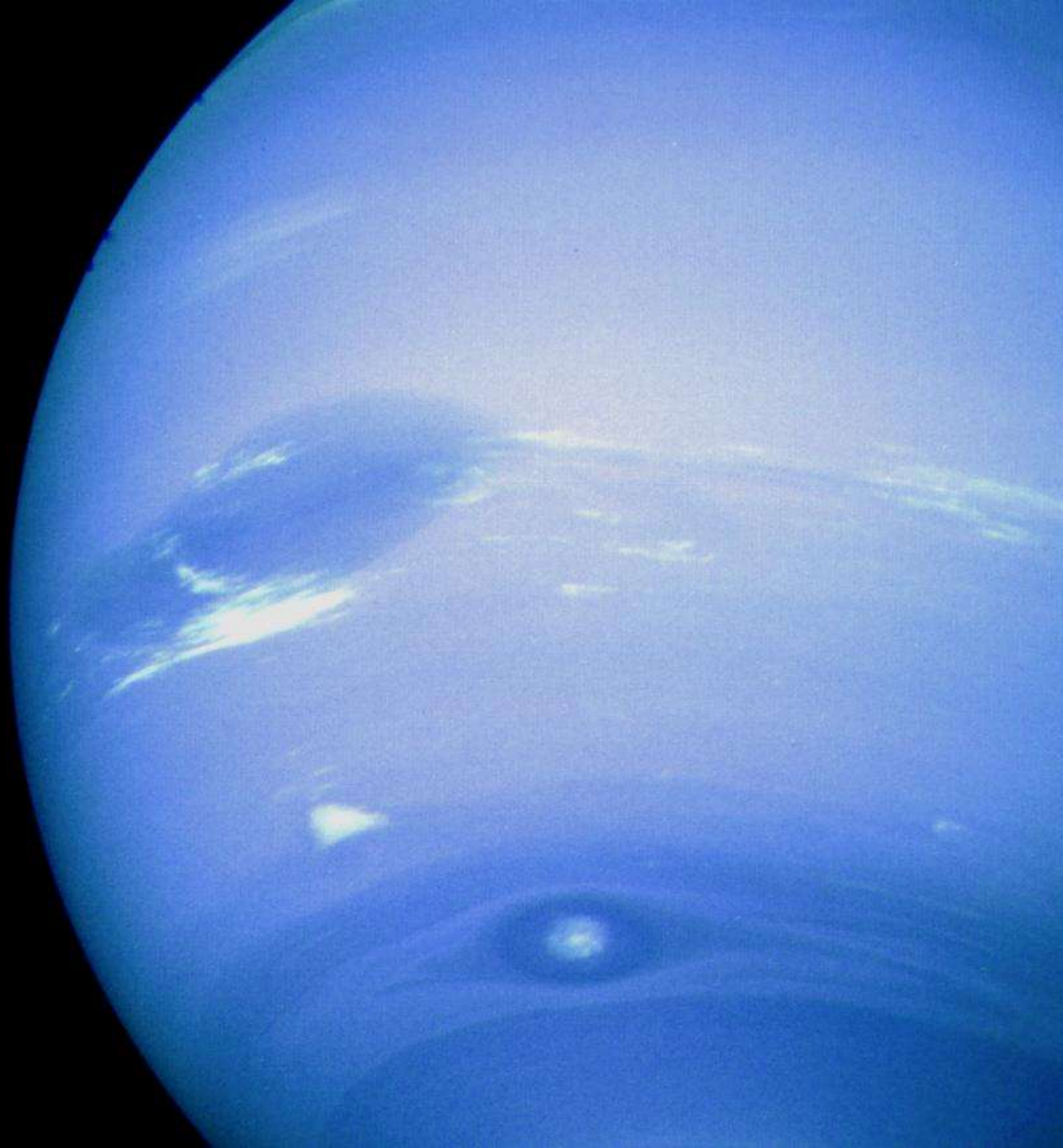


Ariel



Neptuno





Tritón





Mayores satélites del SS

Triton



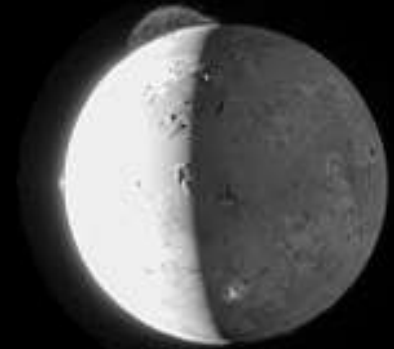
Europe



Lune



Io



Callisto



Titan



Ganymède

MAS ALLA DE NEPTUNO

Plutón y Caronte



Rotación sincrónica por mareas



Plutón

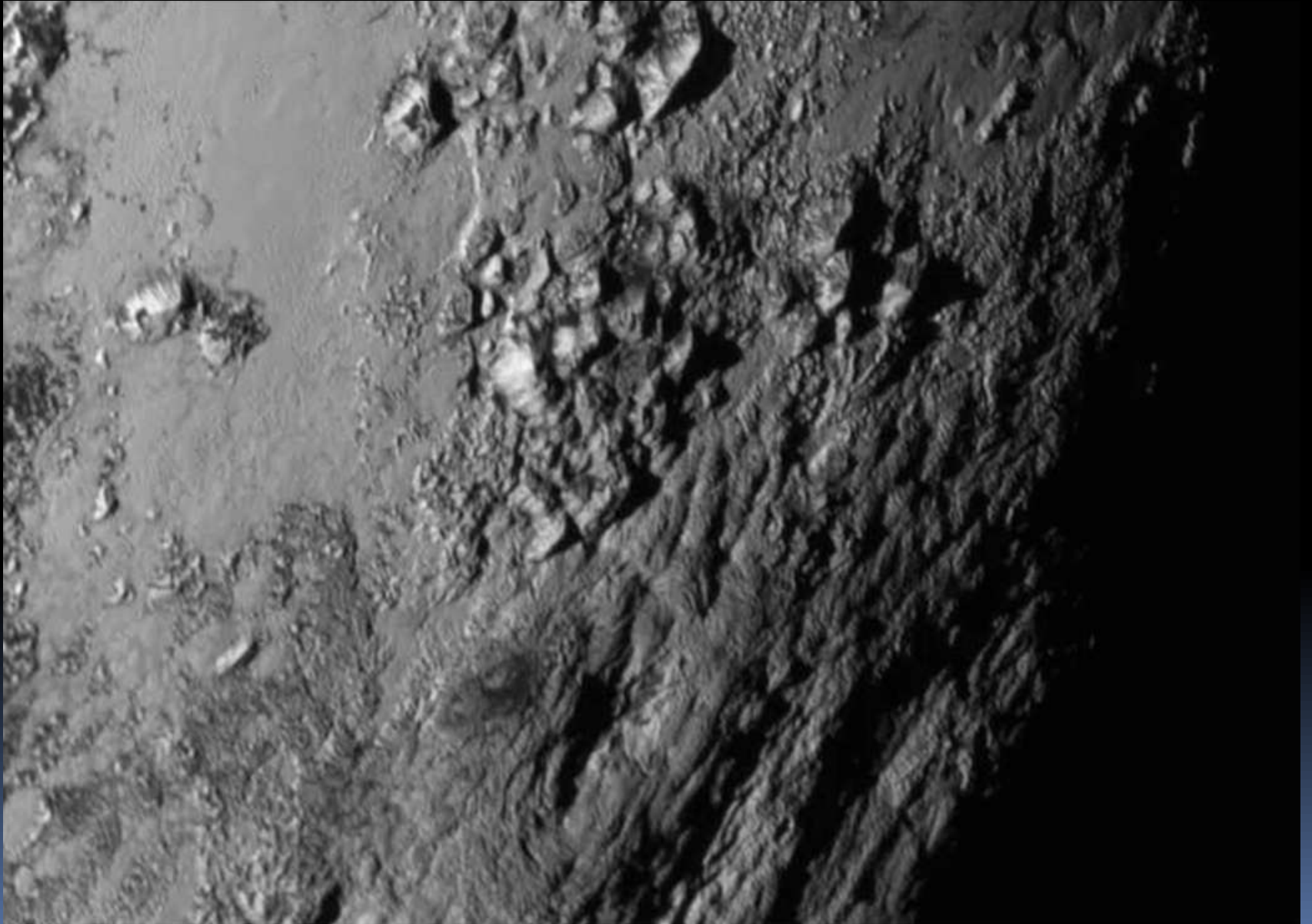


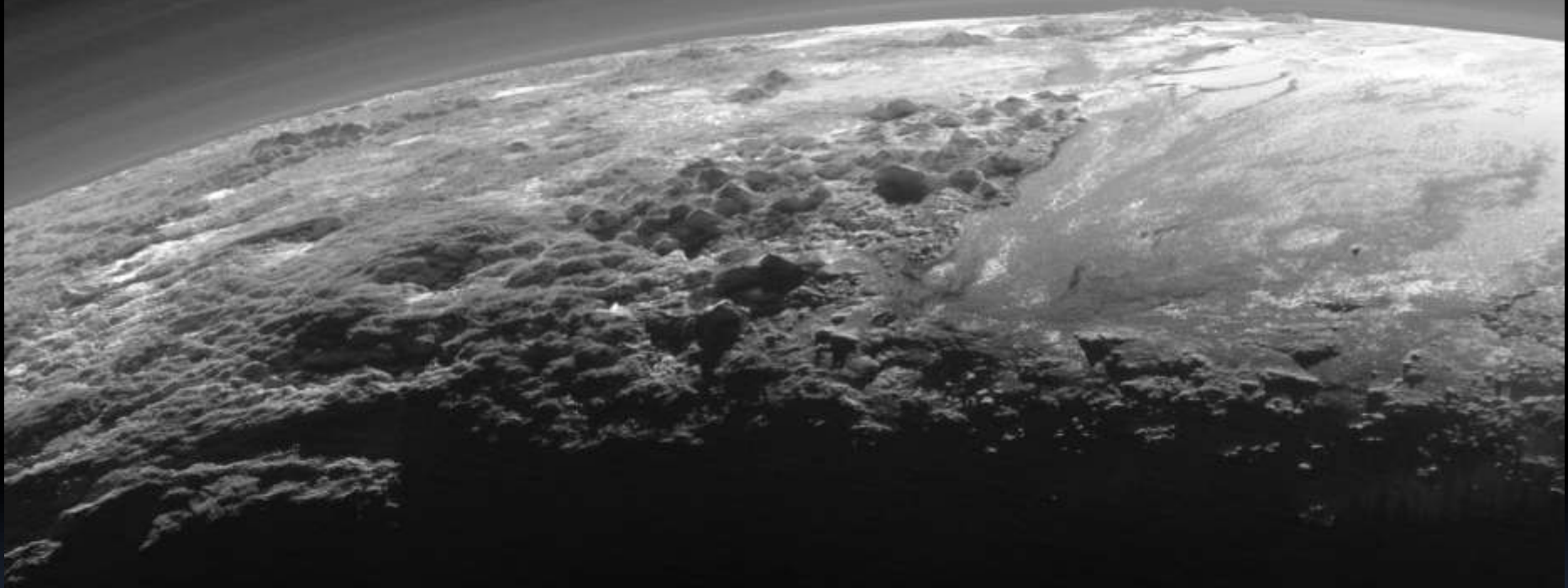
Manchas marrones: tholins

False Color



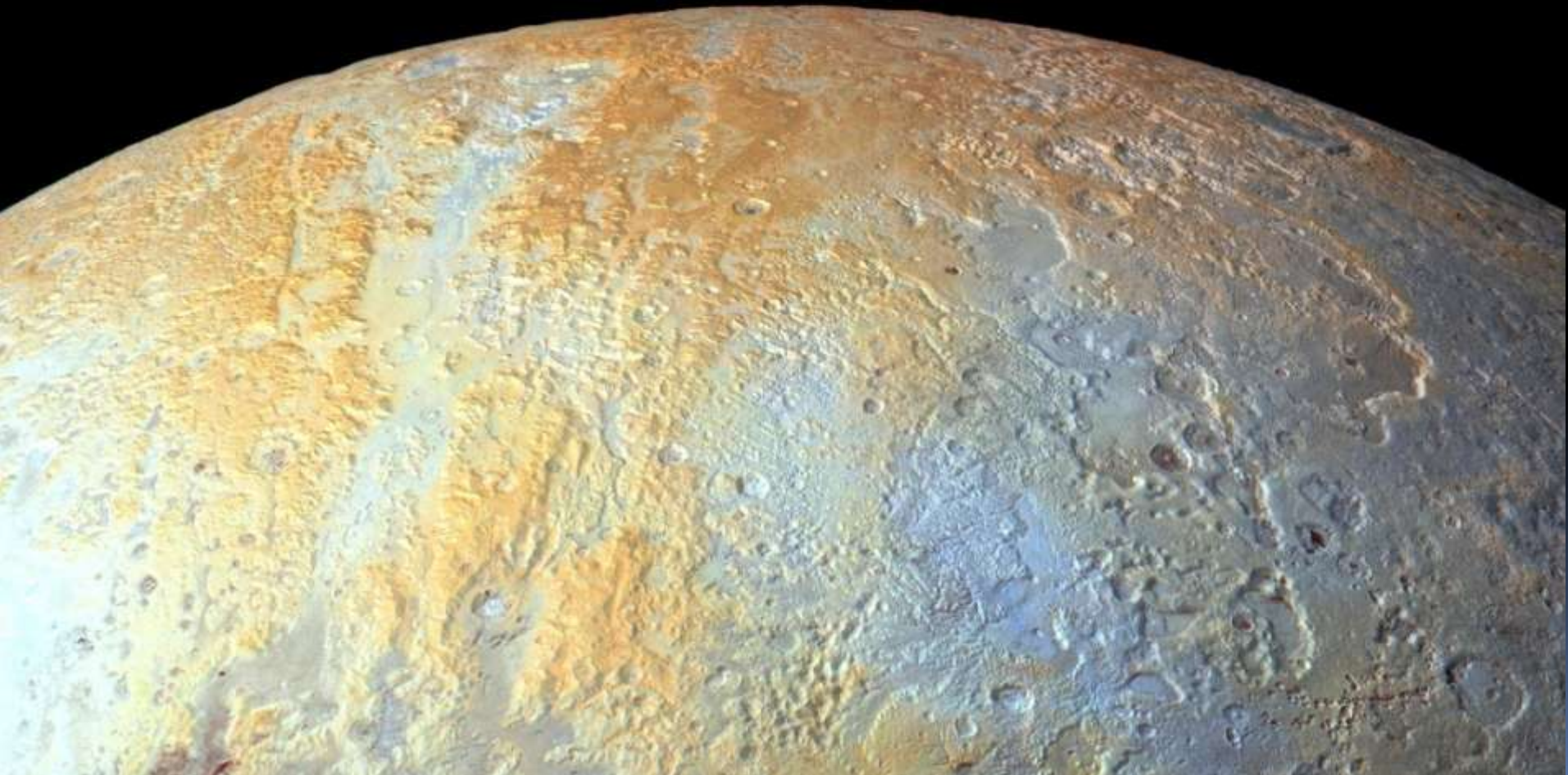
Plutón





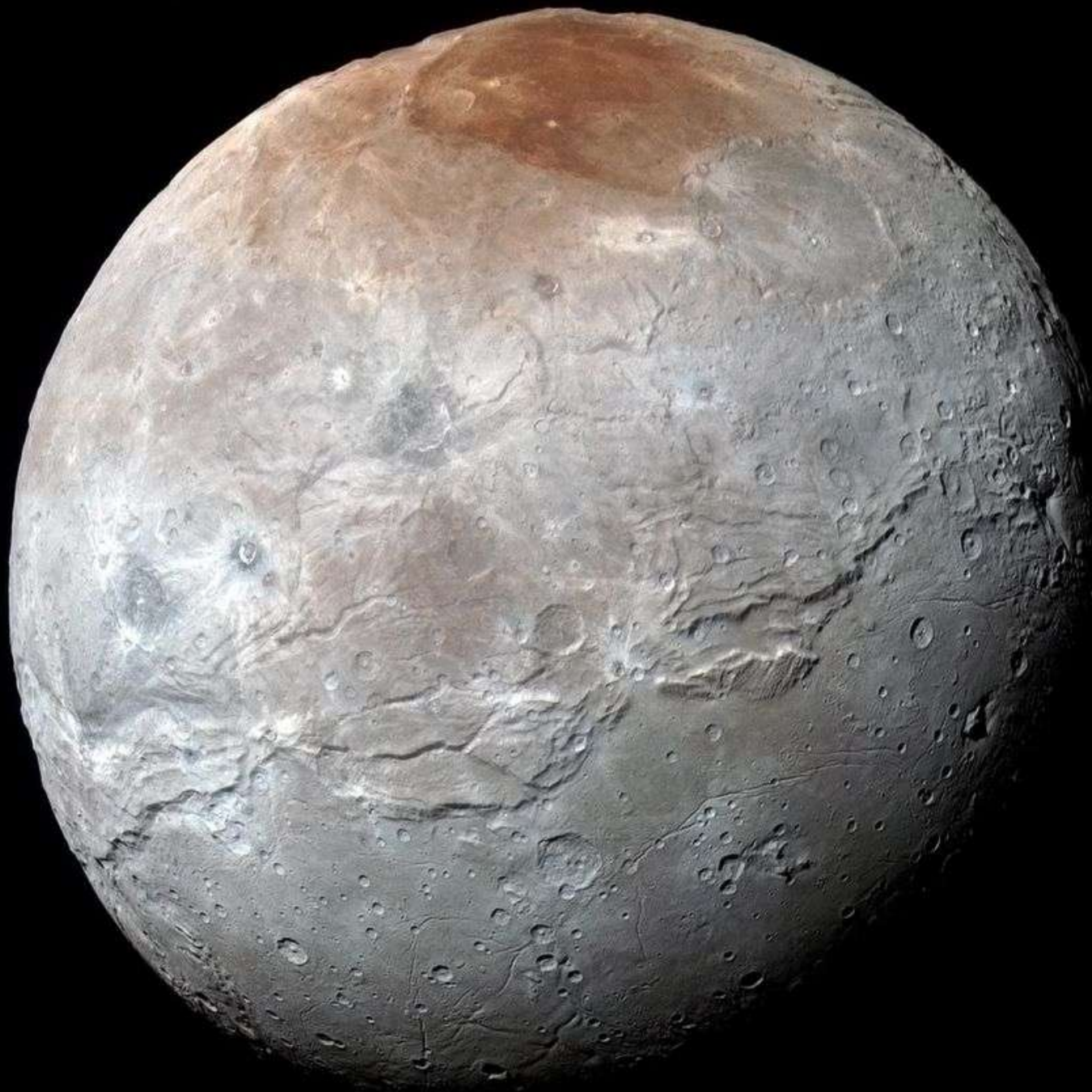
Jóvenes (100 millones de años...) montañas de hielo.

Plutón



Caronte





Cinturón de Kuiper



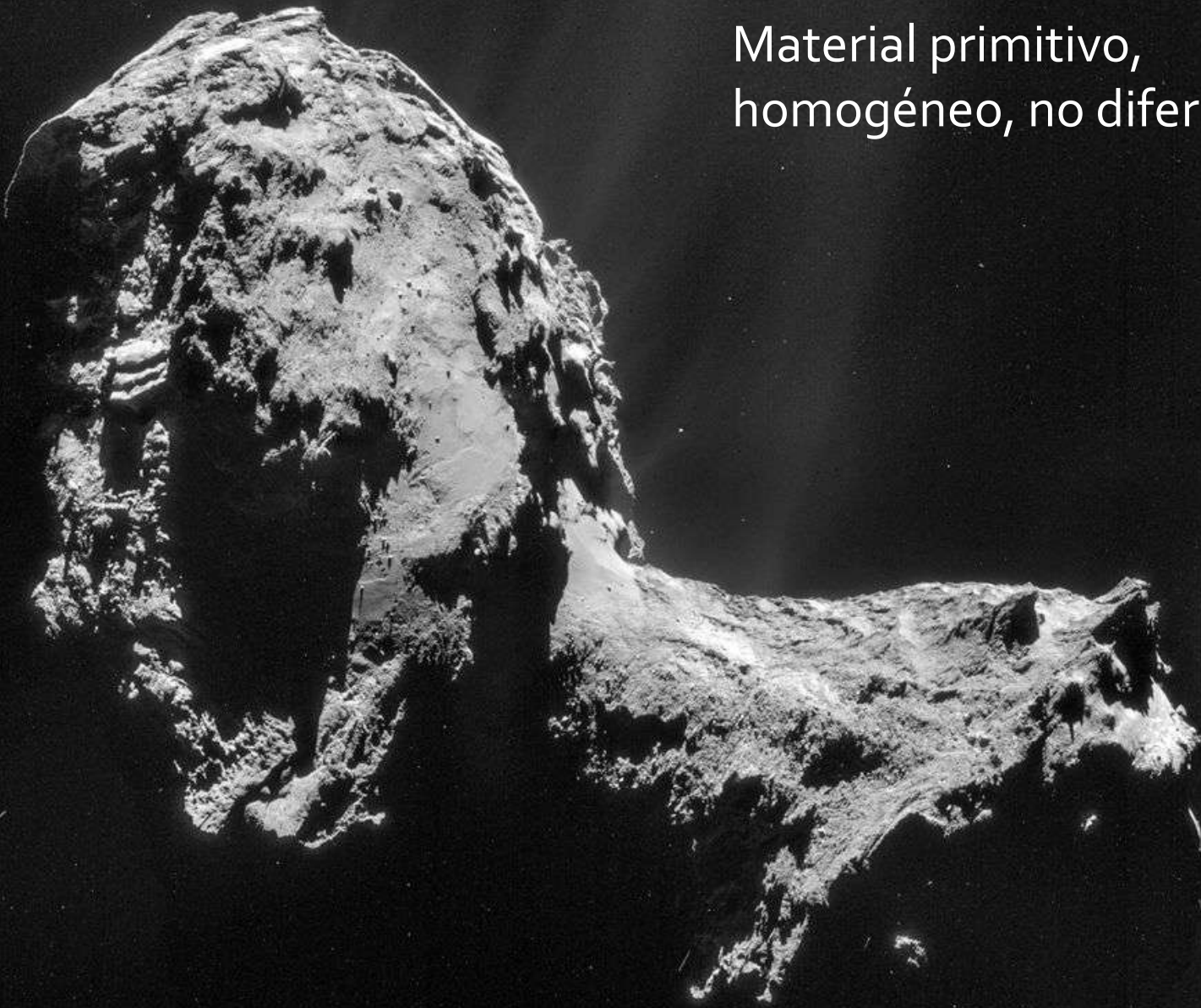
Cometa



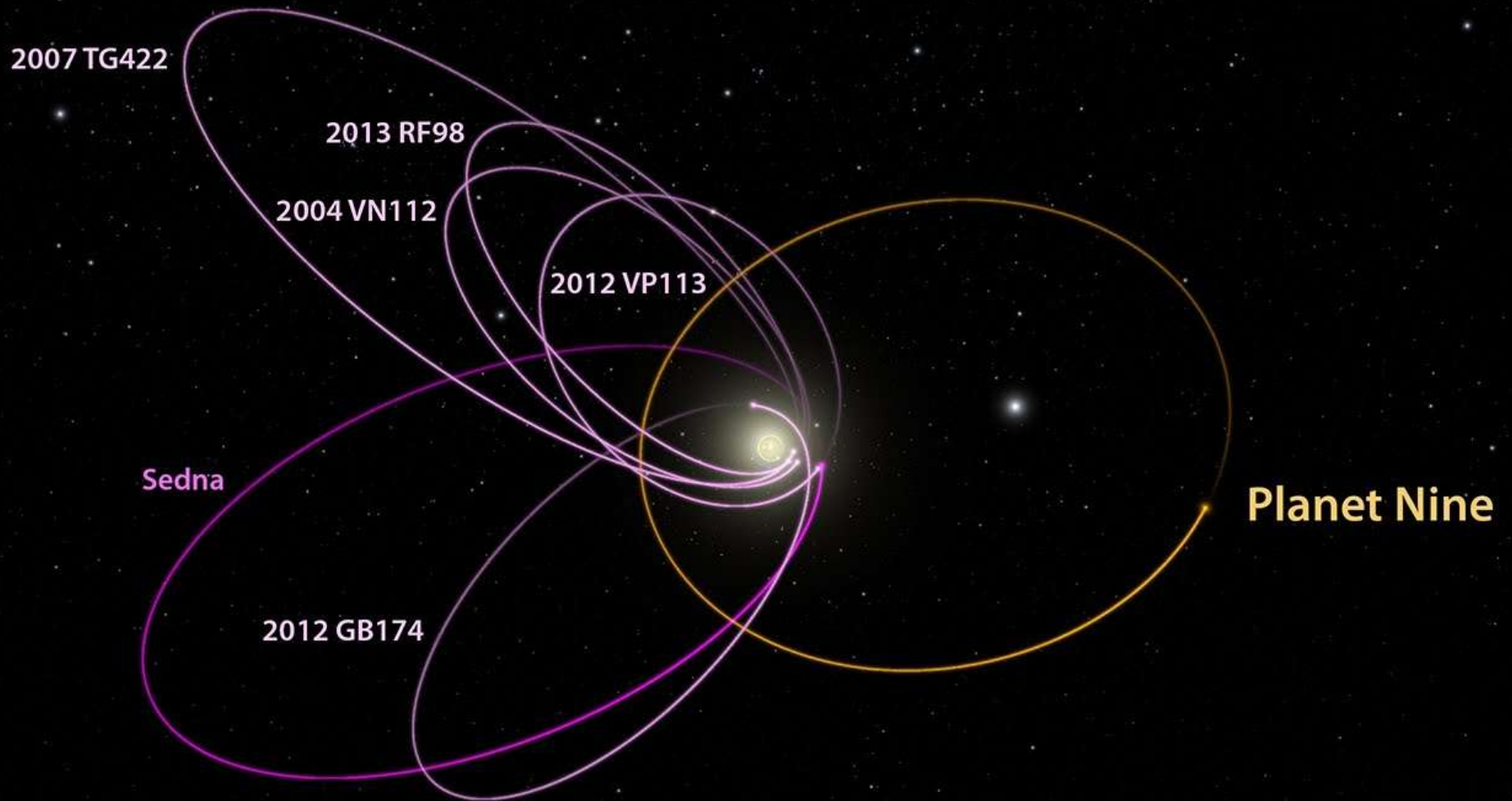
Núcleo cometario



Material primitivo,
homogéneo, no diferenciado



¿Planeta 9?



photojournal.jpl.nasa.gov



Jet Propulsion Laboratory
California Institute of Technology

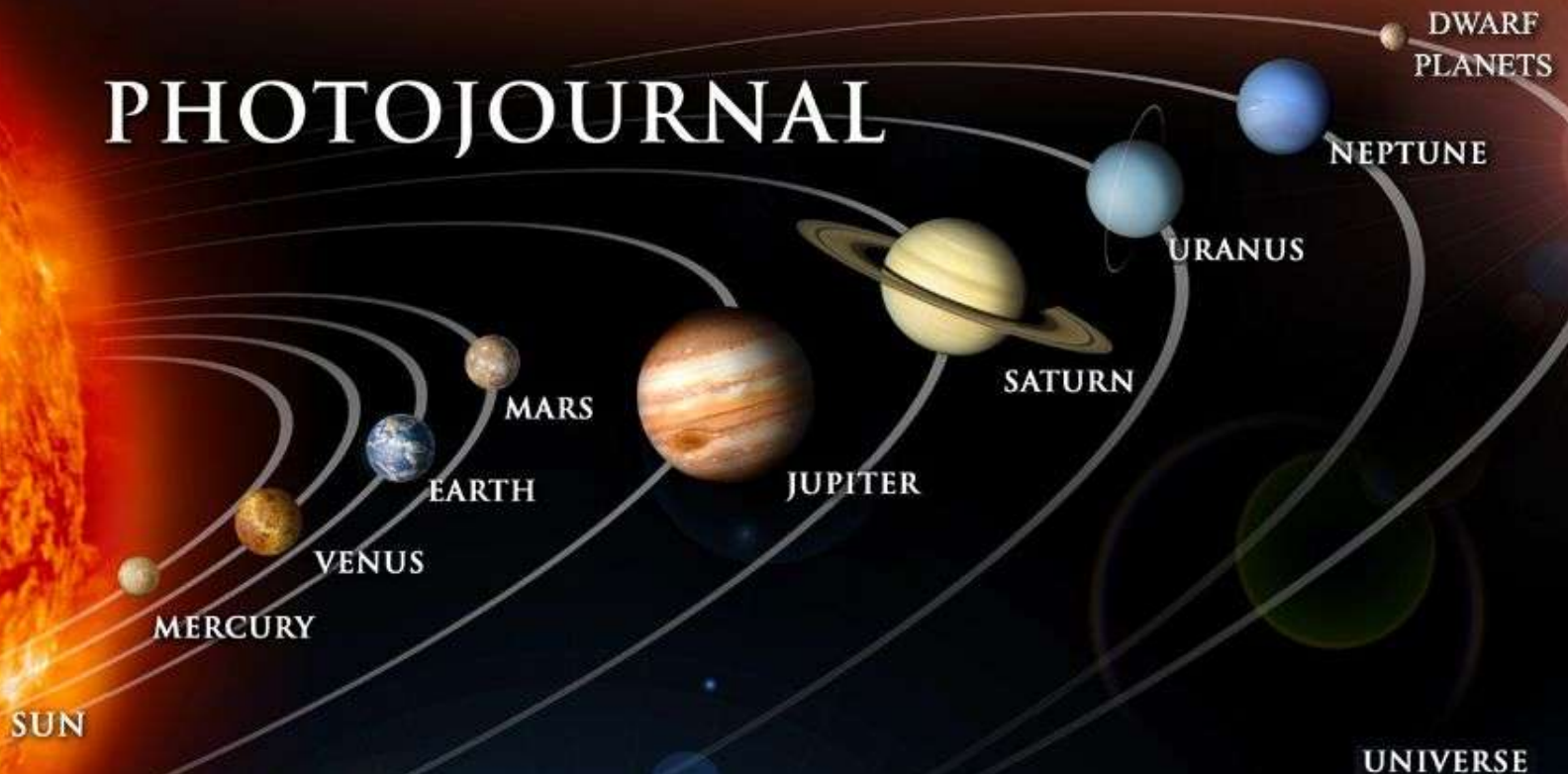
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Integradores orbitales

SOLEVORB

<https://sites.google.com/site/solevorb/>

ORBE

<http://www.astronomia.edu.uy/orbe/>

Fin

Dudar de todo o creerlo todo
son dos opciones igualmente cómodas,
pues tanto una como otra
nos eximen de reflexionar.

Henri Poincaré.