



20 al 26 de mayo de 2019
Semana de la Ciencia y la Tecnología



Ciencia,
tan fundamental como

Registra tu Jornada de
Puertas Abiertas en
www.semanacyt.org.uy



semancyt@mec.gub.uy
Tel: 2915 0103 / 2915 0203 int. 1632, 1633 y 1634
[/UruguayCyT](https://twitter.com/UruguayCyT) [/Semanadelacienciaylatecnologiauy](https://www.facebook.com/Semanadelacienciaylatecnologiauy)

PLANETAS: formación y evolución

Tabaré Gallardo

Departamento de Astronomía

Instituto de Física

Facultad de Ciencias



FACULTAD DE
CIENCIAS
UDELAR | fcien.edu.uy

Nuestra galaxia

1.300.000 millones de estrellas

**Our Planet
Hunting
Neighborhood**

Sun →



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

www.iau-100.edu.uy/exoplanetas

IAU-100 Uruguay

Celebrando los cien años de la Unión Astronómica Internacional (1919 - 2019)

[Portada](#)

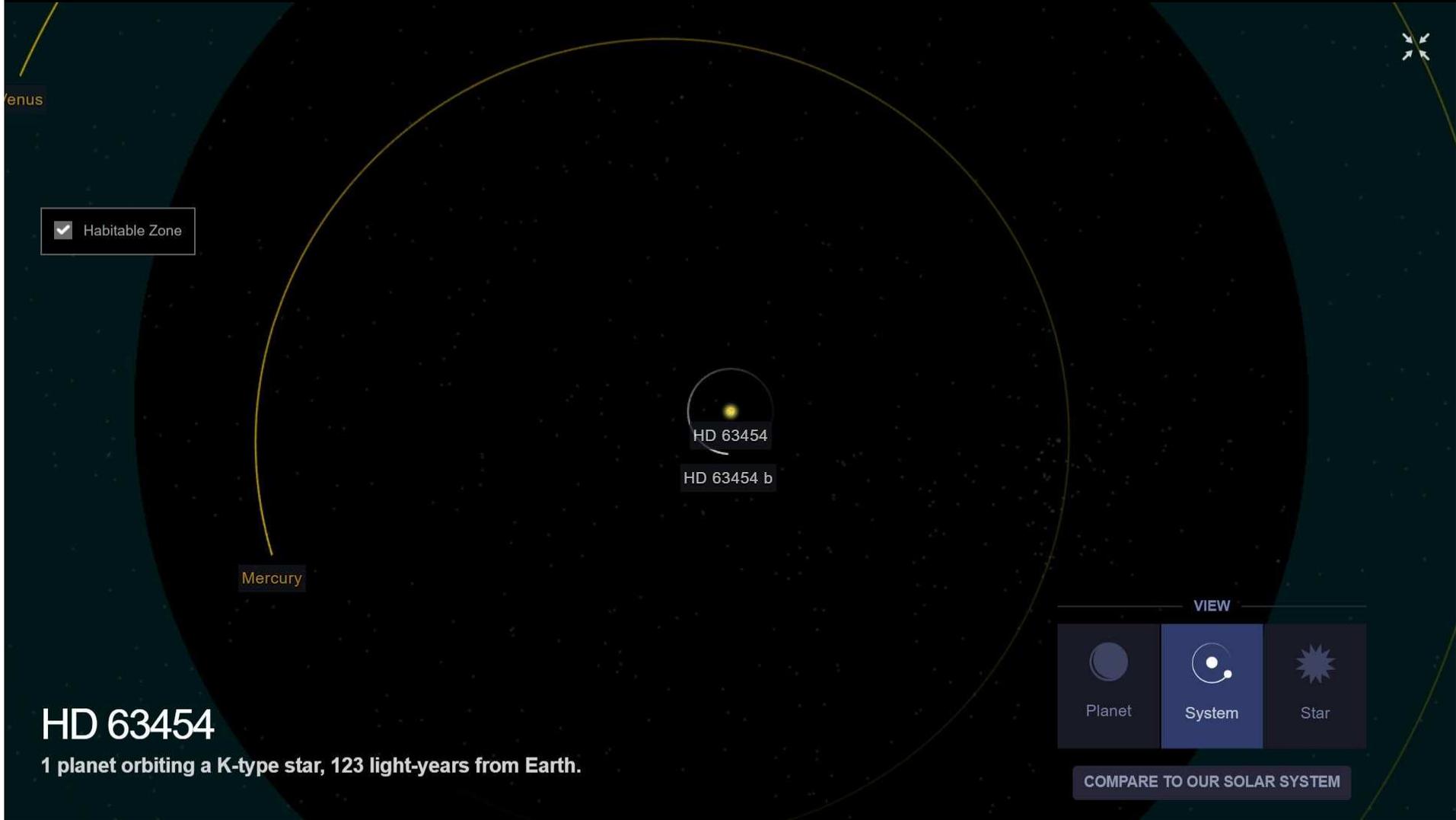
[Eventos en Uruguay](#)



Nombra Tu Exoplaneta



IAU 100
NombraTuExoplaneta
URUGUAY



HD 63454

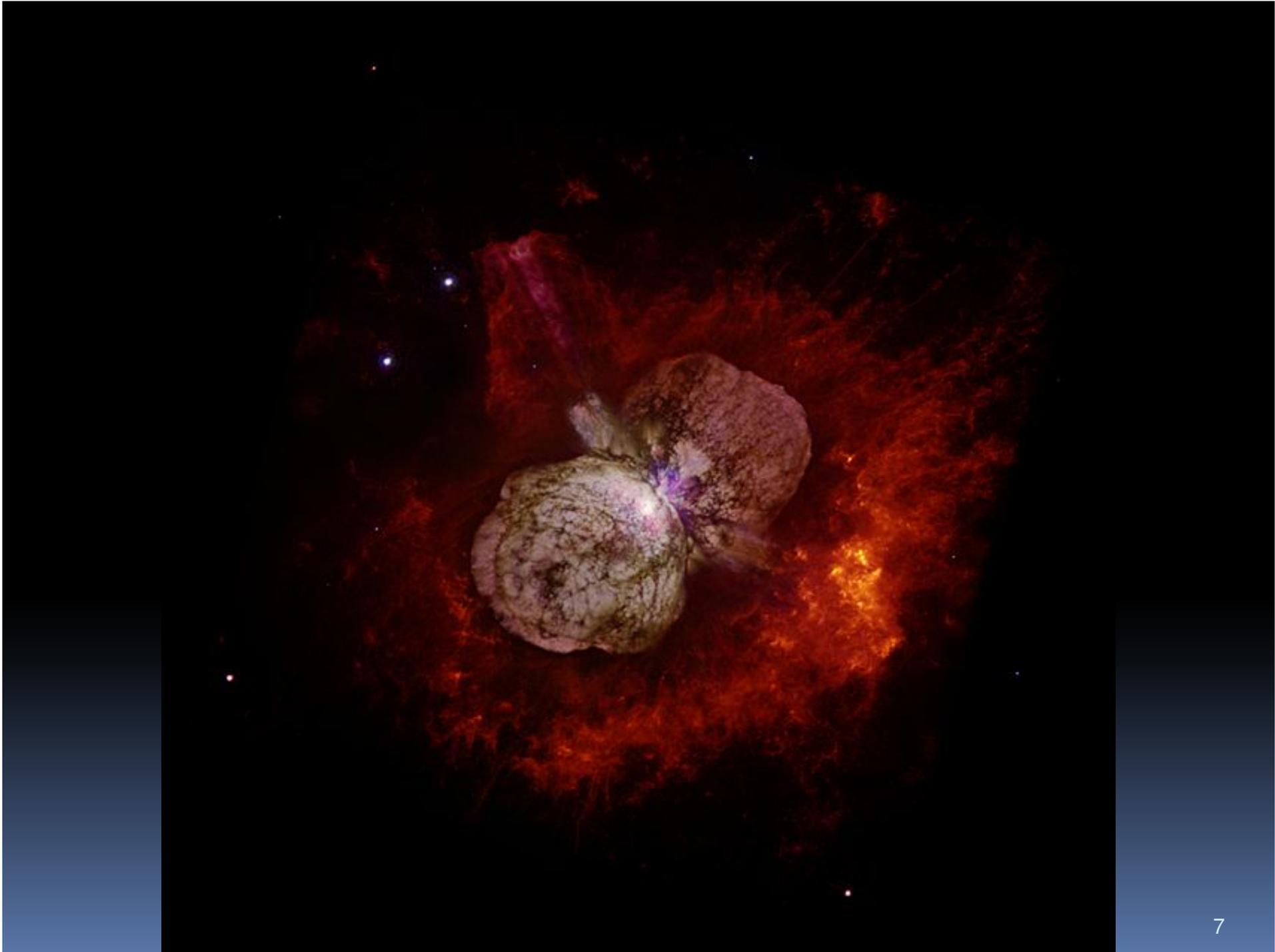
1 planet orbiting a K-type star, 123 light-years from Earth.

Muerte estelar





www.hubblesite.org



Medio interestelar enriquecido con "polvo" de estrellas.



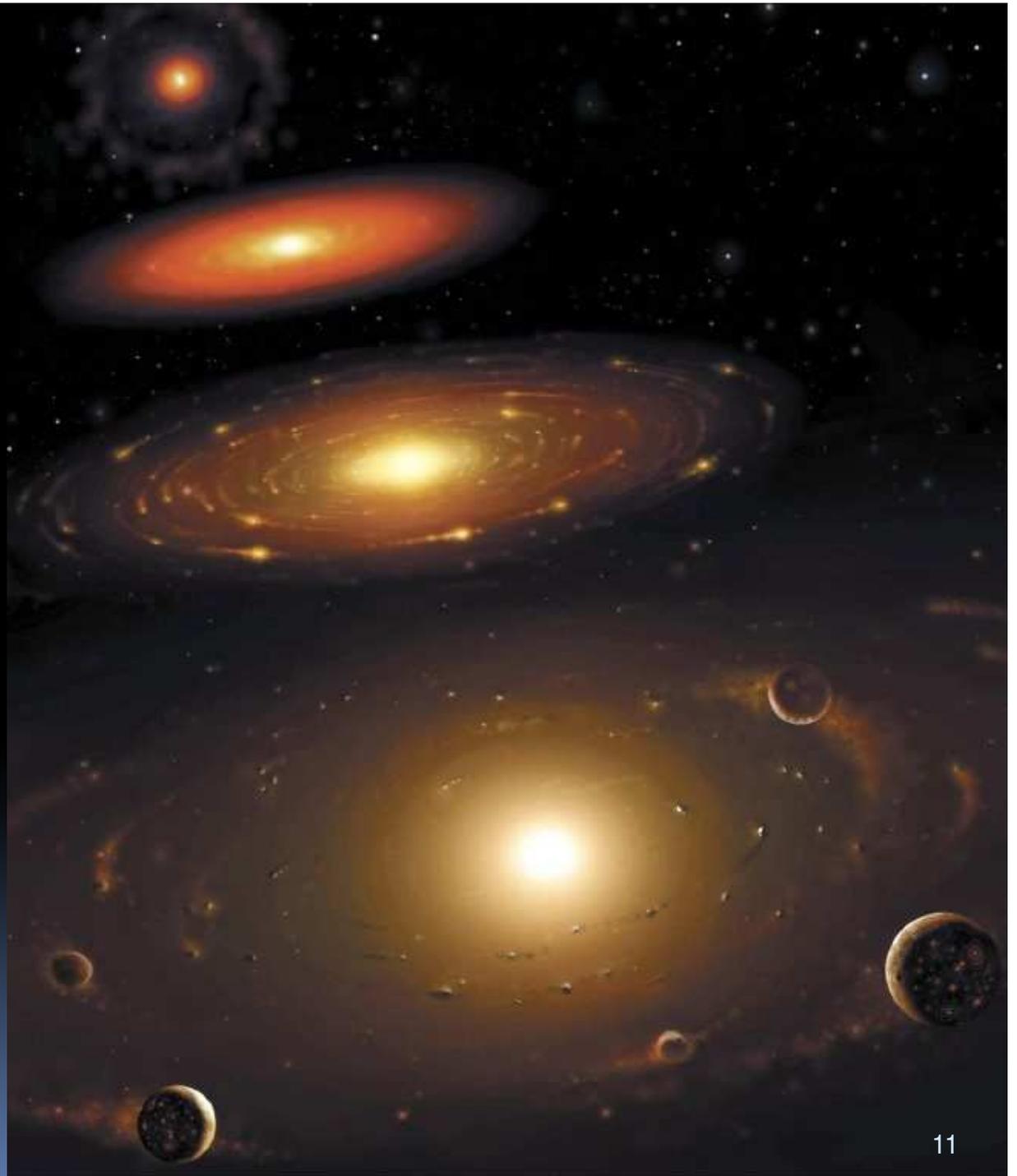
Principales elementos en el polvo: **CHON**



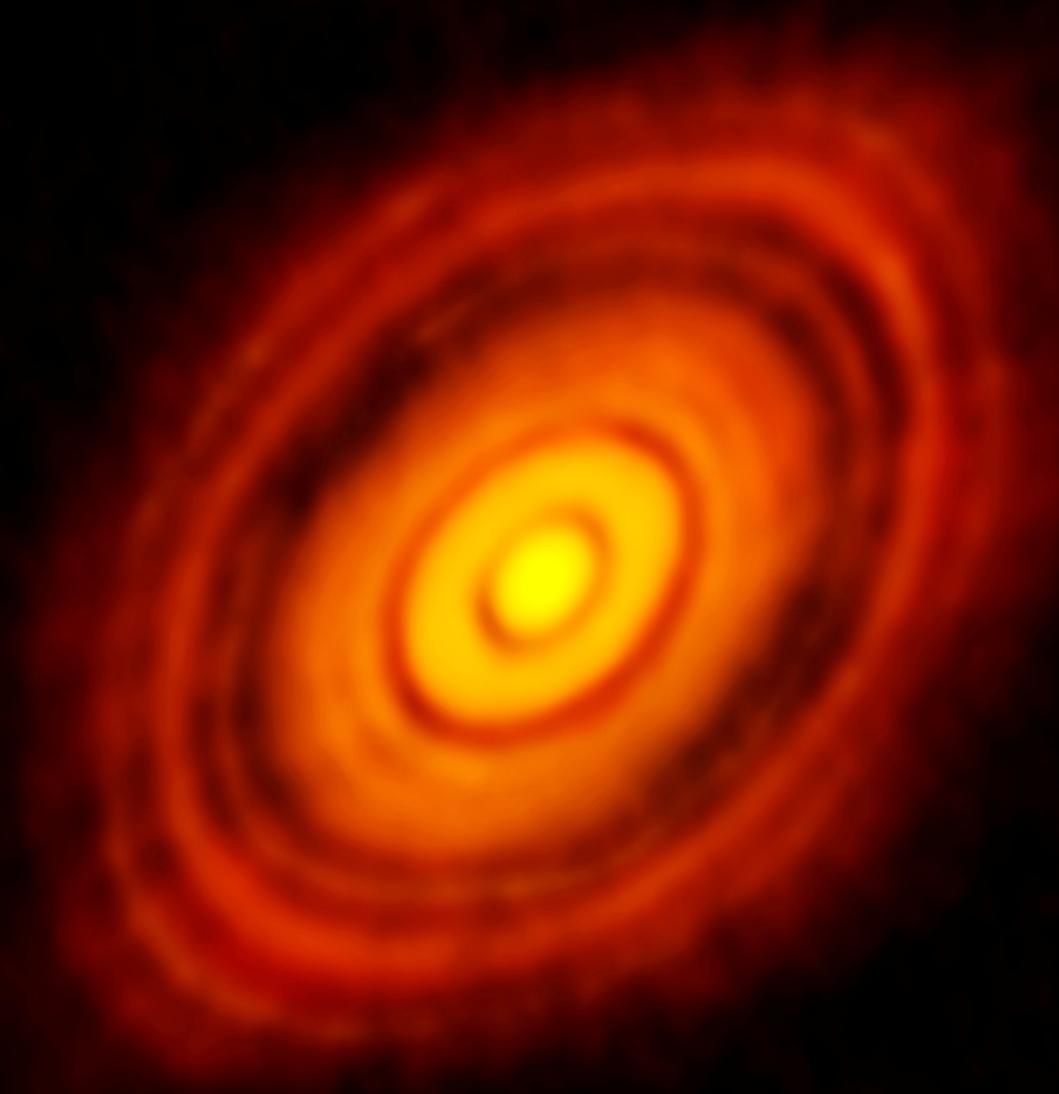
Formación estelar



Formación del Sistema Solar



Disco protoplanetario a 450 AL de la Tierra



Discos protoplanetarios

PROTOPLANETARY DISKS

RH J1615

Light-years from Earth: 600
Instrument: SPHERE

HD 163296

Light-years from Earth: 600
Instrument: SPHERE

HD 169142

Light-years from Earth: 380
Instrument: ALMA

Specimens exhibiting
rings, gaps, & spirals

TW HYDRAE

Light-years from Earth: 194
Instrument: ALMA

AS 209

Light-years from Earth: 400
Instrument: ALMA

ELIAS 2-27

Light-years from Earth: 450
Instrument: ALMA

HD 135344B

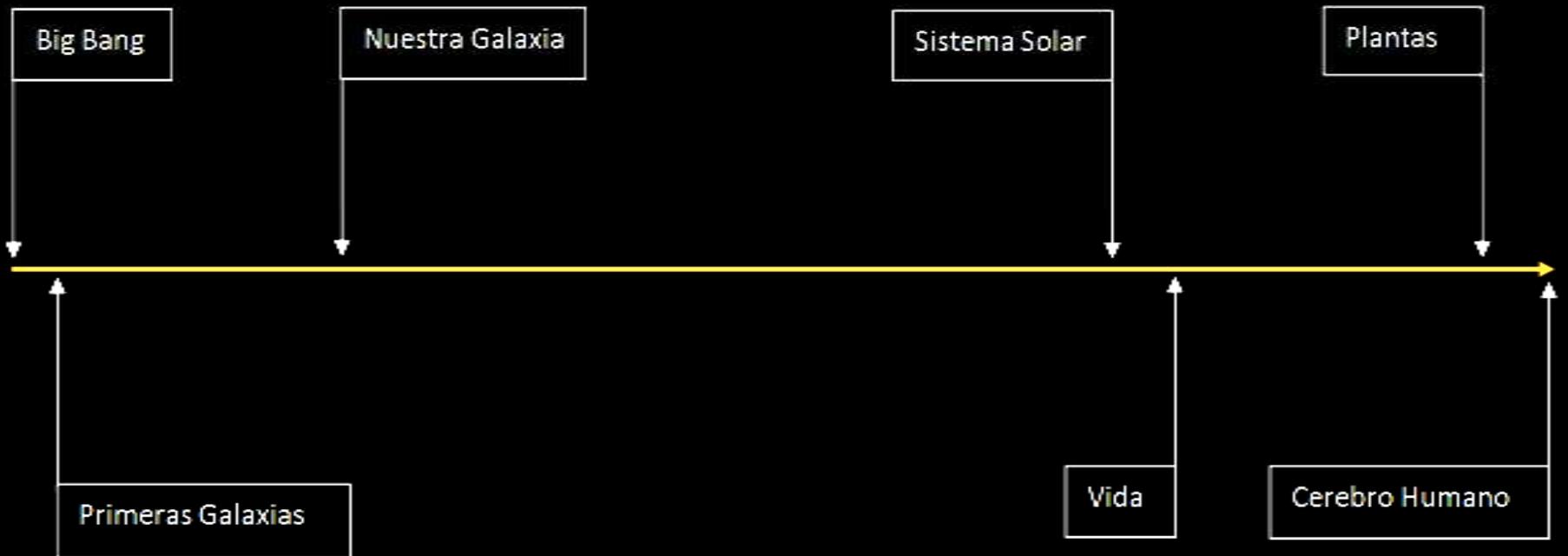
Light-years from Earth: 450
Instrument: SPHERE

HL TAURI

Light-years from Earth: 450
Instrument: ALMA

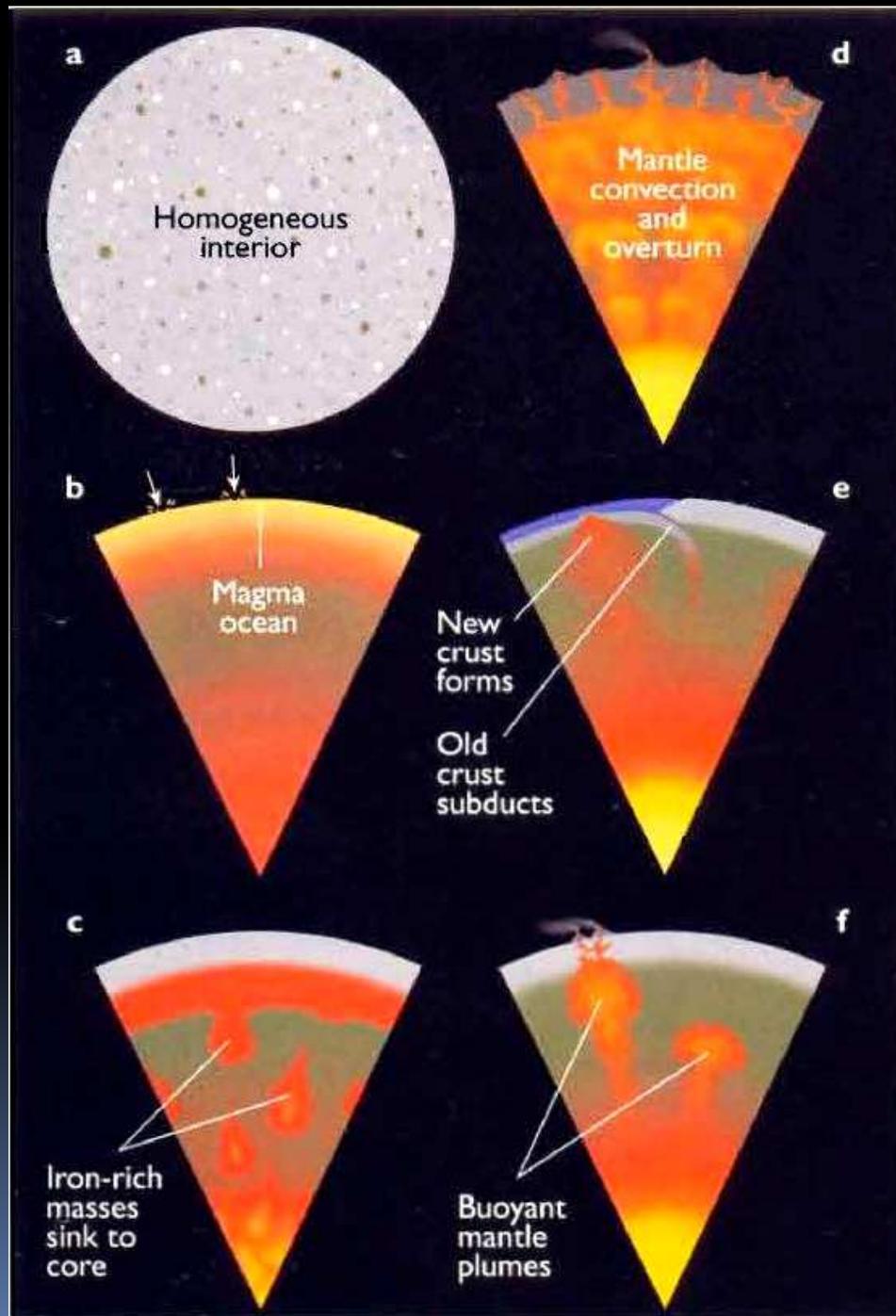
WARNING: OBJECTS NOT TO SCALE

Cronología



Big Bang: hace 13.700 millones de años

Evolución planetaria

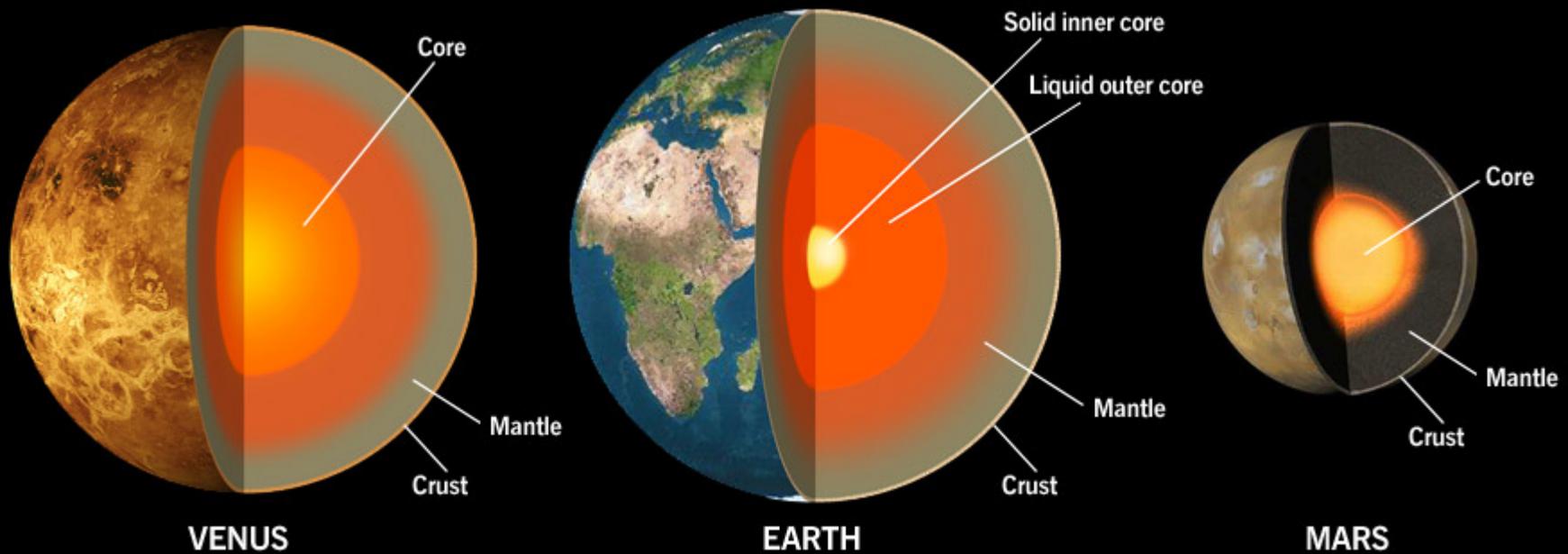


Meteorito de San Carlos



Meteorito: material primitivo

Evolución planetaria: administración del calor interno + geoquímica



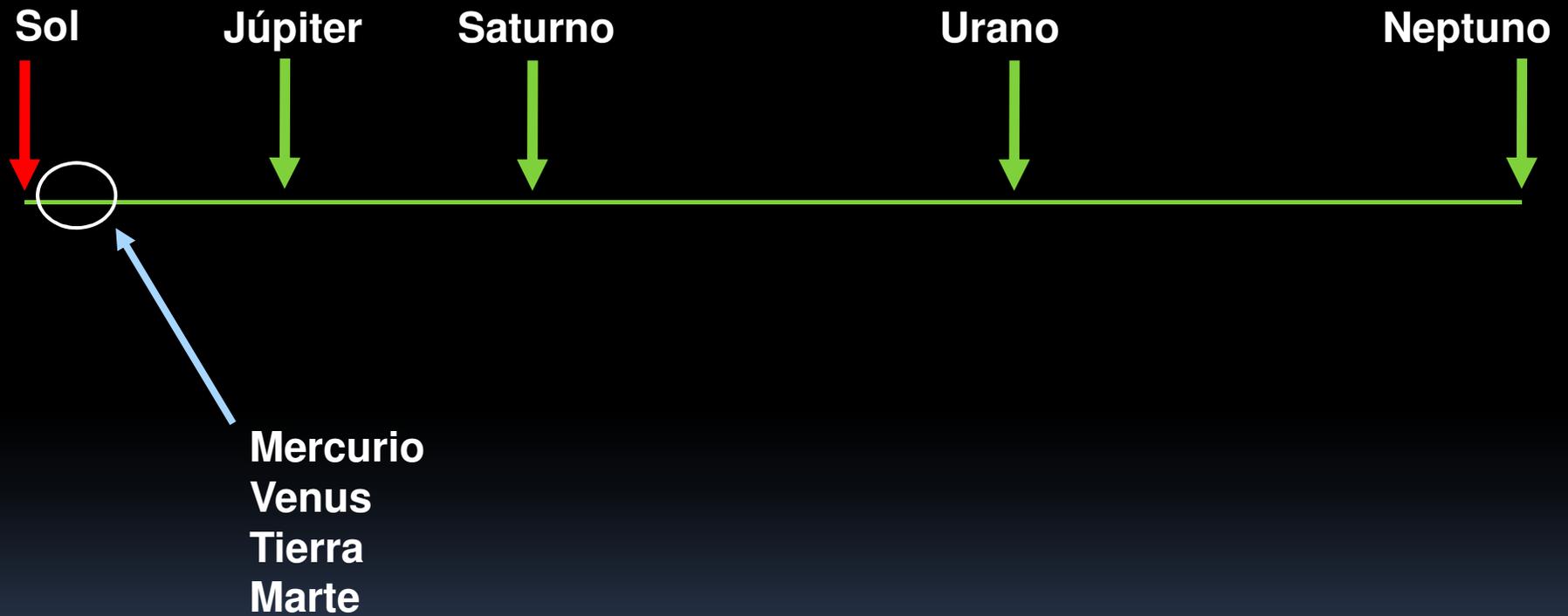
Sistema Solar

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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Uruguay

www.fisica.edu.uy/~gallardo

<https://youtu.be/O6Jltwgpiho>

MUNDOS ROCOSOS

Mercurio: fosilizado y sin atmósfera

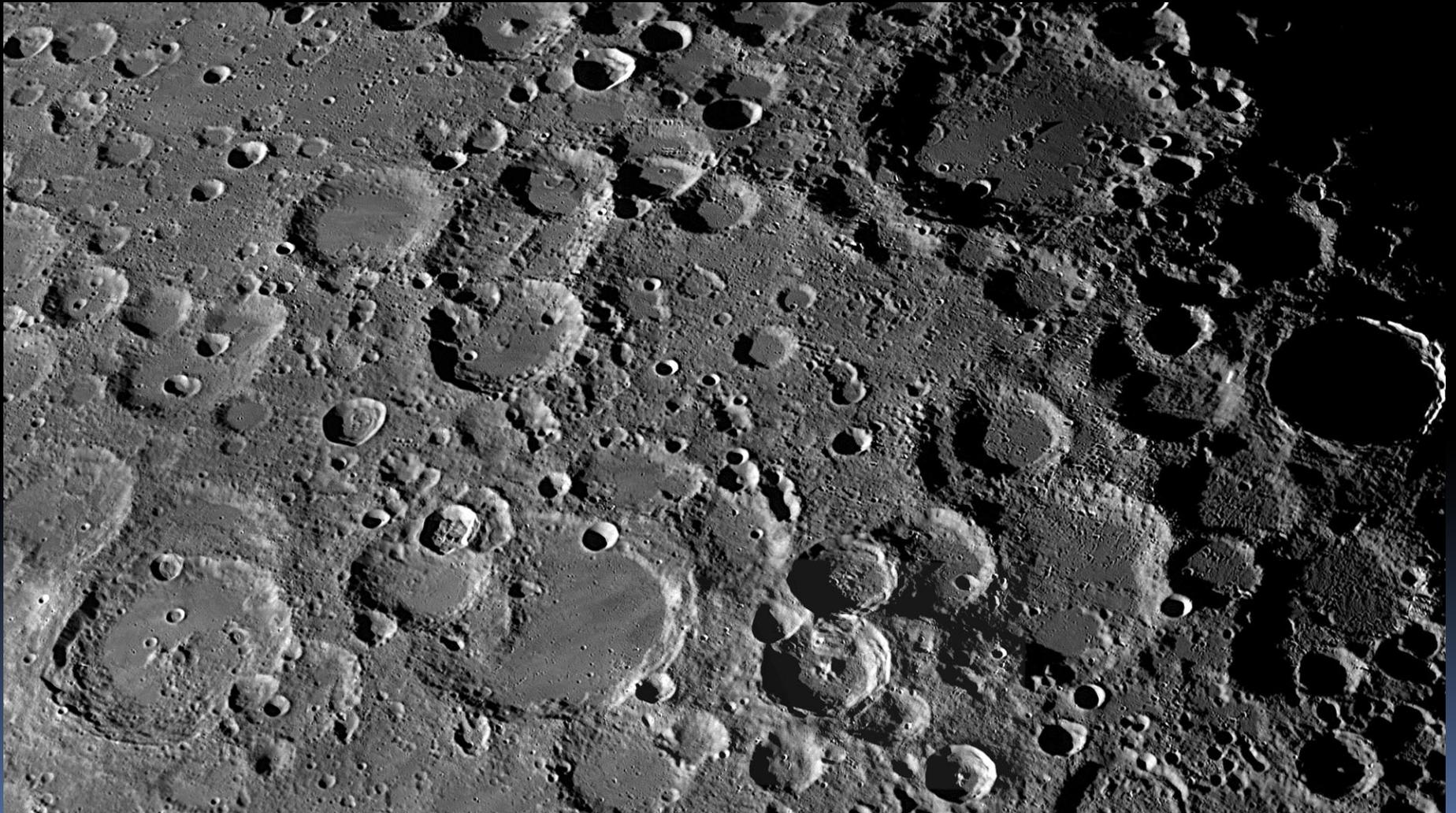
Día = 2 años mercurianos !
Resonancia por mareas
-170 C < Temperatura < 400 C

DIA

NOCHE

Cráteres Lunares: bombardeo

EDAD de las superficies



Venus: atmósfera

Temperatura media = 500 C

Presión = 90 atm.

CO₂

No hay agua



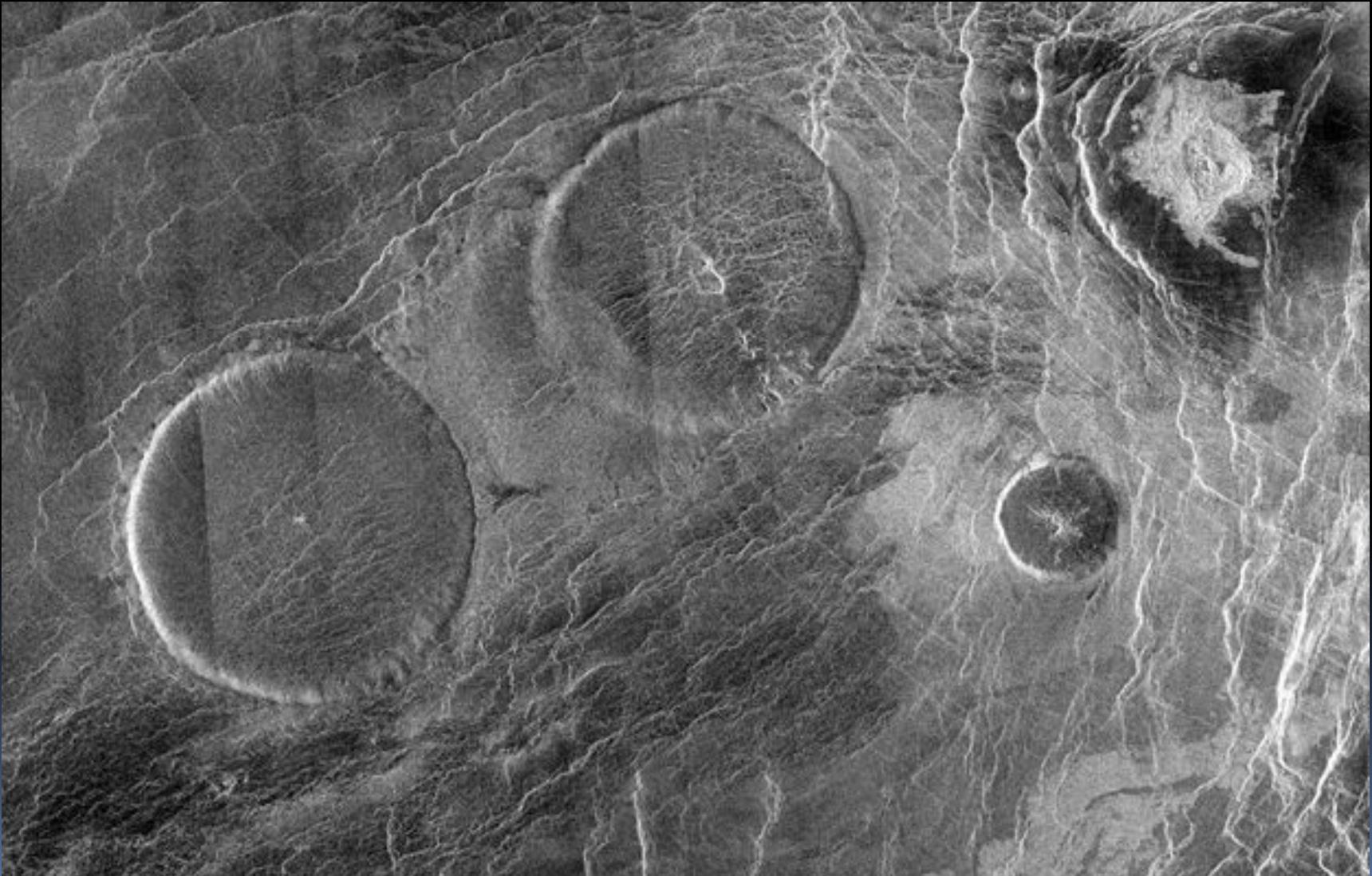
Venus: superficie

Miles de volcanes inactivos
Imágenes de radar



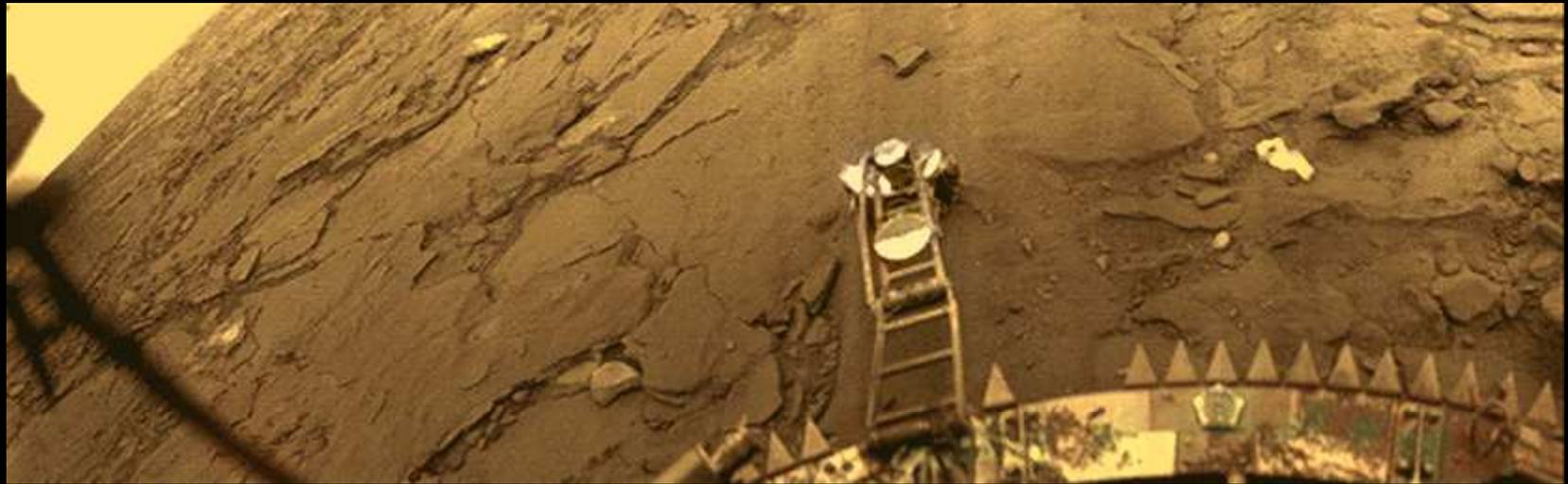
Venus

“panqueques” de lava muy viscosa



Venus

Roca sólida y seca (basaltos)



Elementos (Silicio)



Minerales (SiO_2)



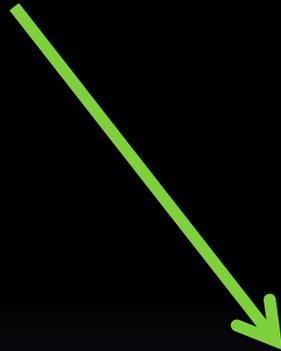
Rocas (Basalto)



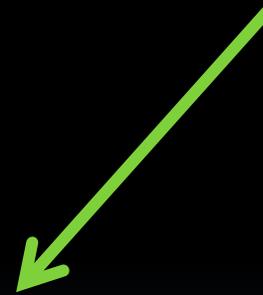
Procesos Geológicos

MOTORES:

GRAVEDAD



CALOR

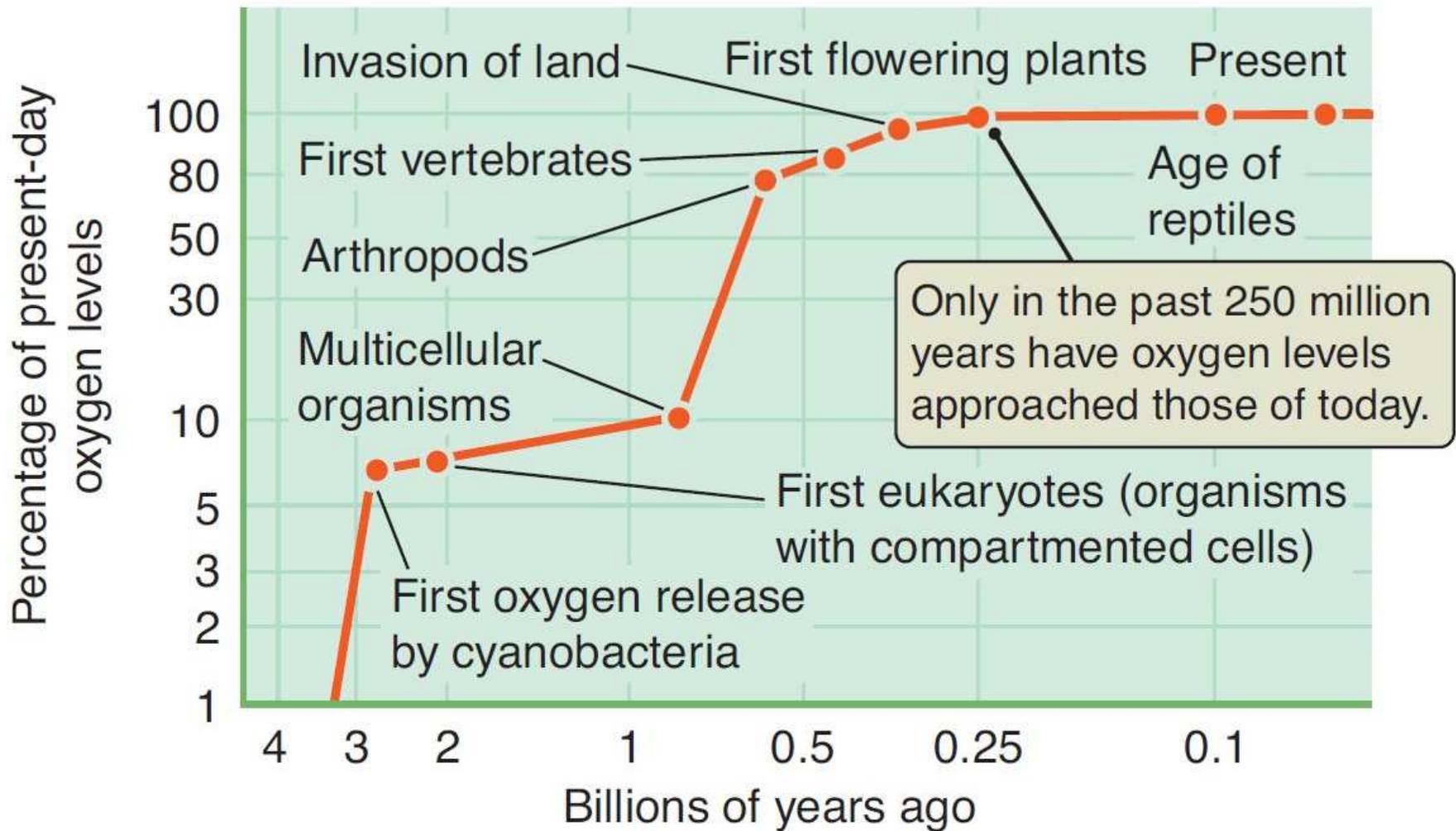


Procesos Geológicos

Agua sólida, líquida y gaseosa.
Única atmósfera rica en Oxígeno: energía y protección UV.
Biósfera.



Evolución del Oxígeno



Luna

Sin atmósfera: cielo negro



REGOLITO

Luna

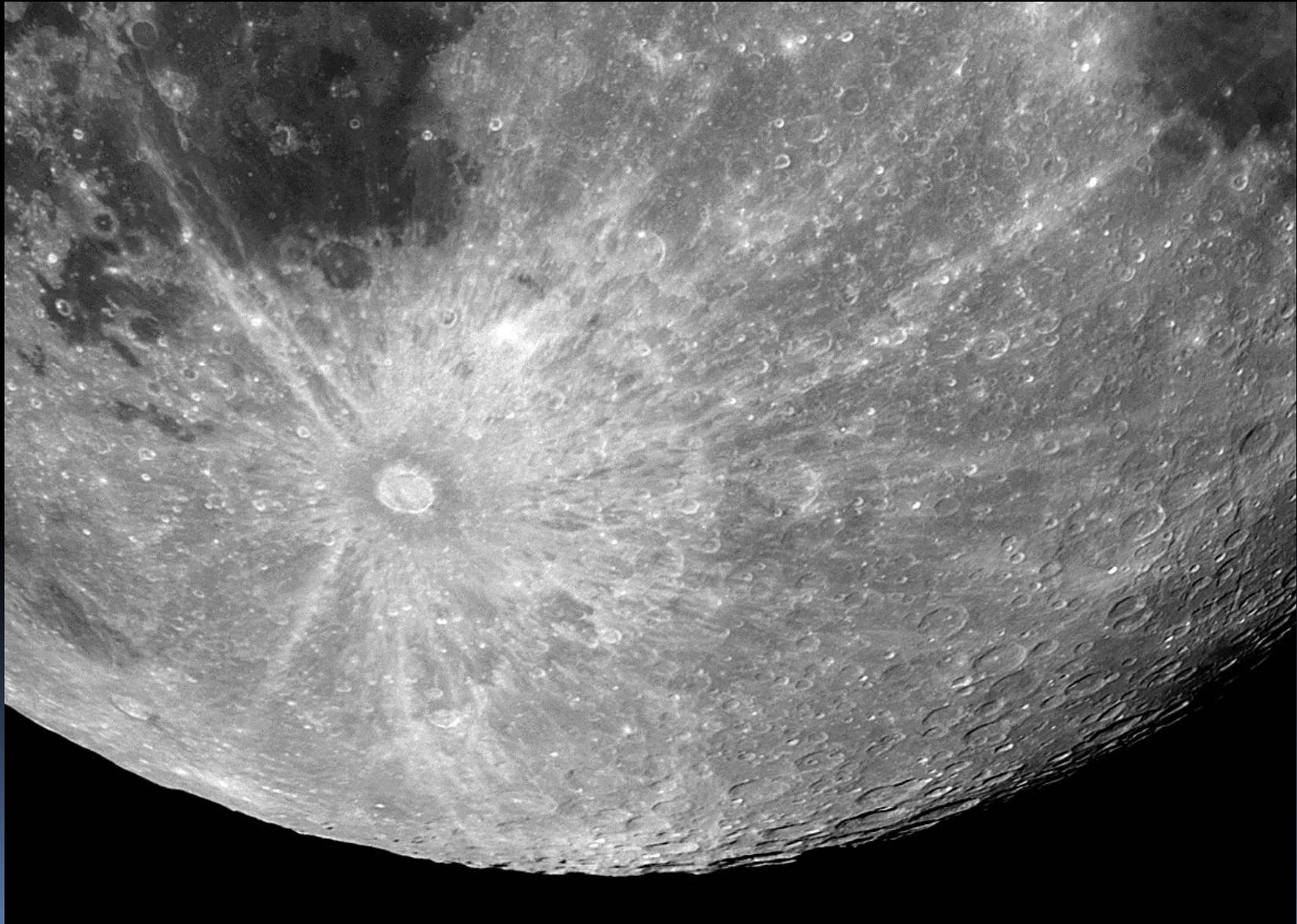
“Mares” de lava
(mas jóvenes)

Rotación sincrónica
por mareas



Cráter Tycho

"Joven" gran cráter (100 MA)



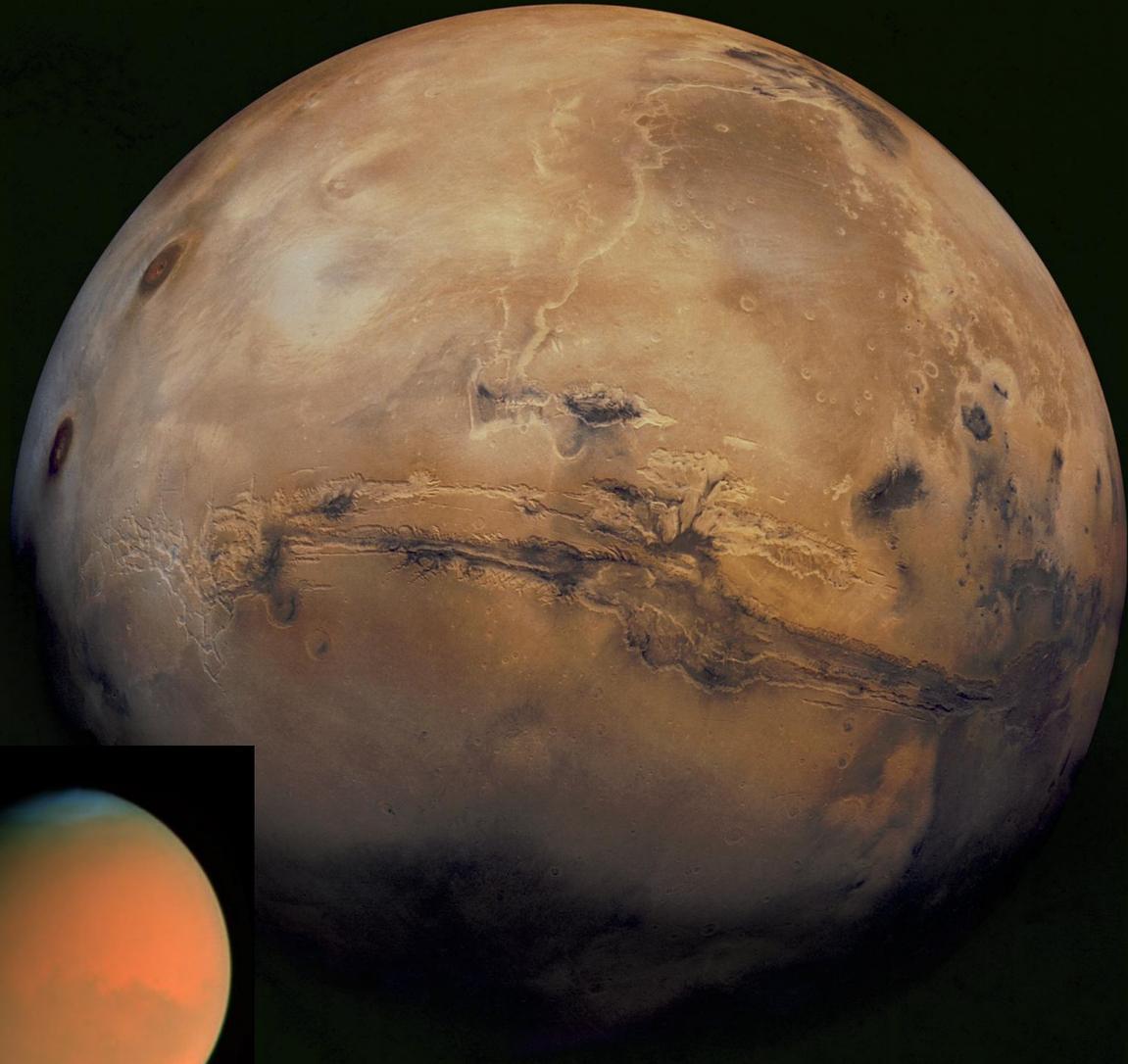
Cráter Arizona: hace 10.000 años

IMPACTO = EXPLOSION



Marte

Volcanes fosilizados
Erosión por fluidos
Agua en el pasado

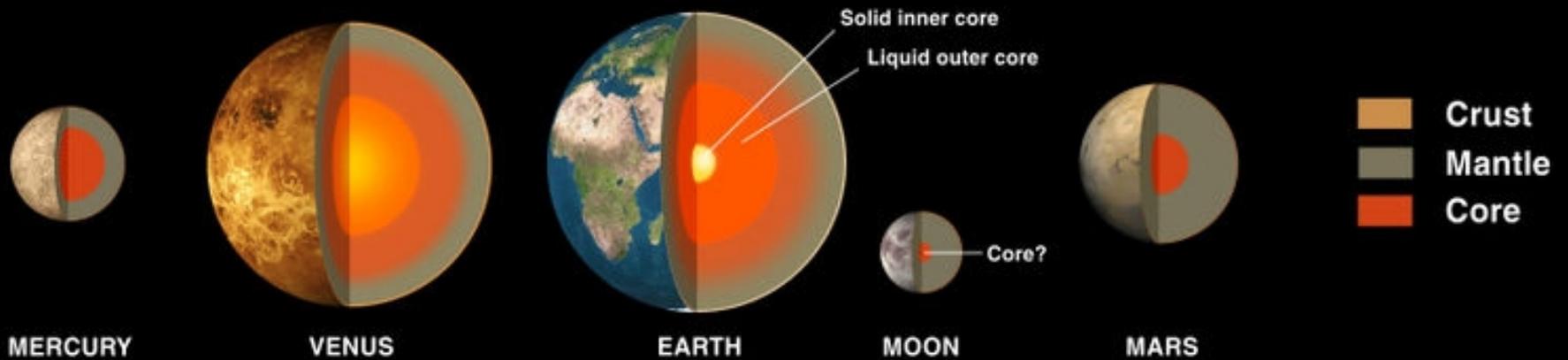


June 26, 2001



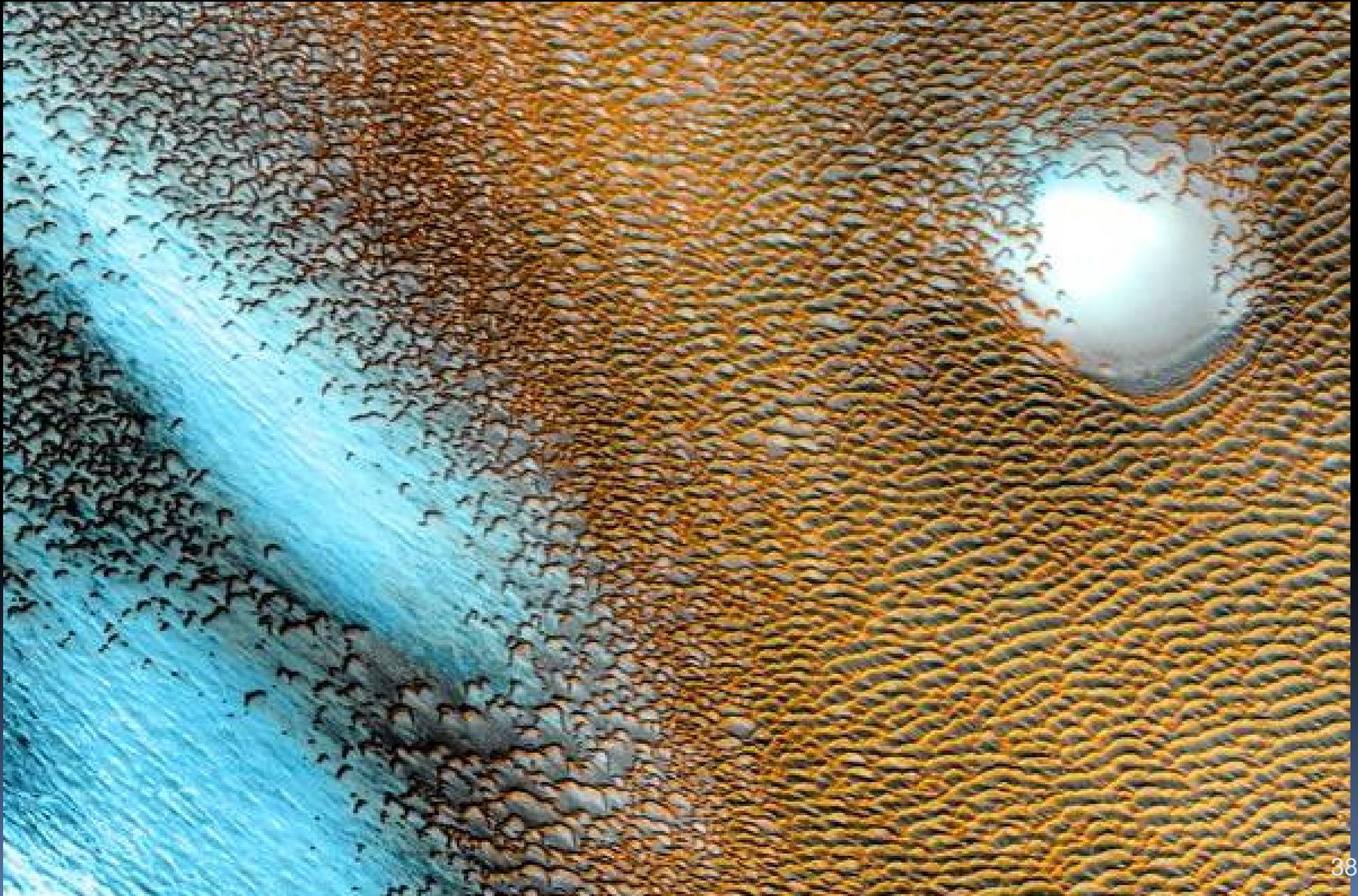
September 4, 2001

Interiores



Marte

Dunas



Marte

Dunas: actividad eólica

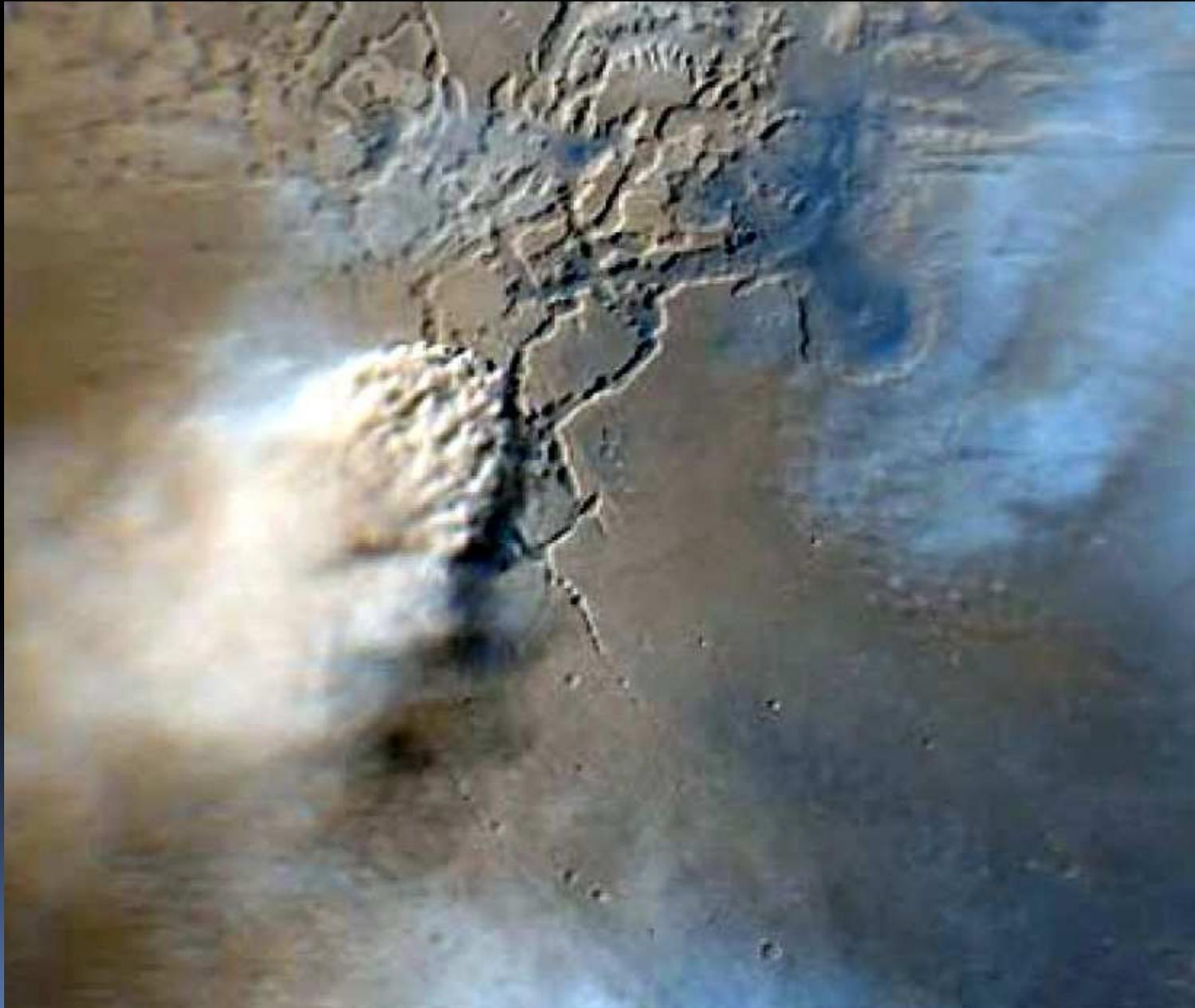


Marte

Tornados



Tormenta de polvo



Marte

Dunas cubiertas de CO₂



Marte



Marte

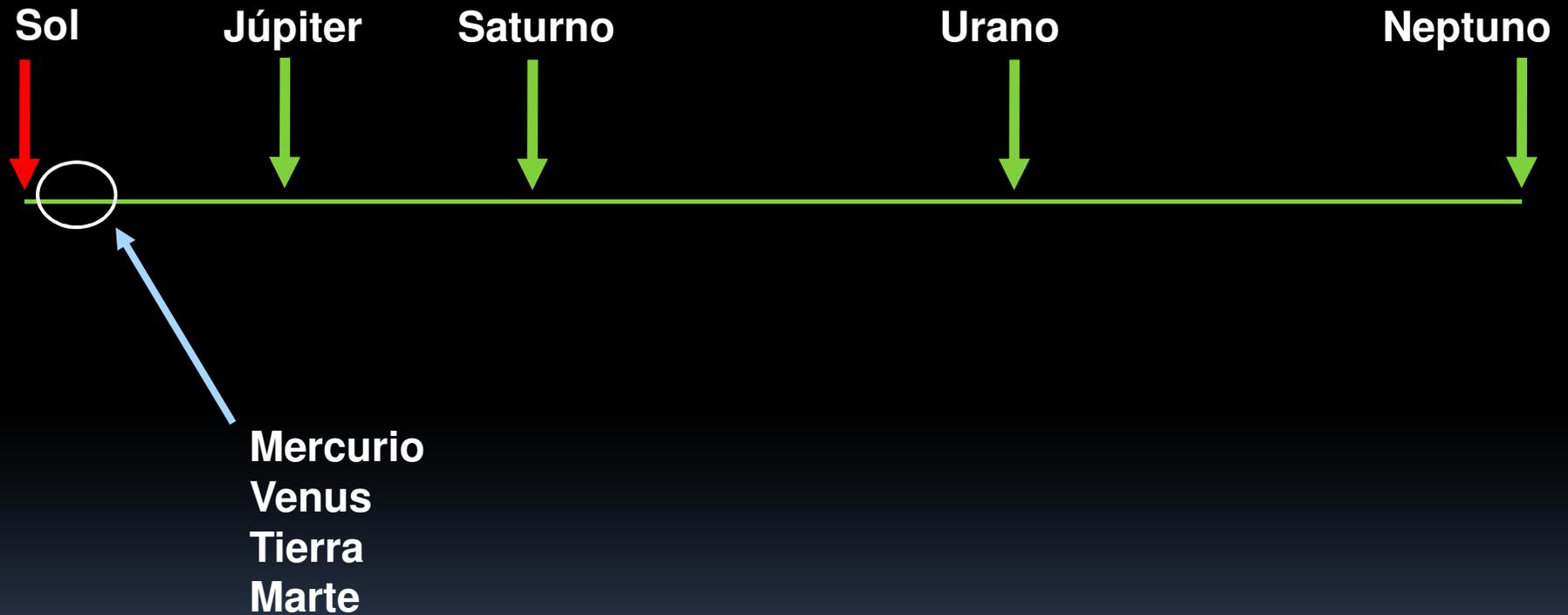
Sin agua superficial.

Hielo subsuperficial (permafrost)



Sistema Solar

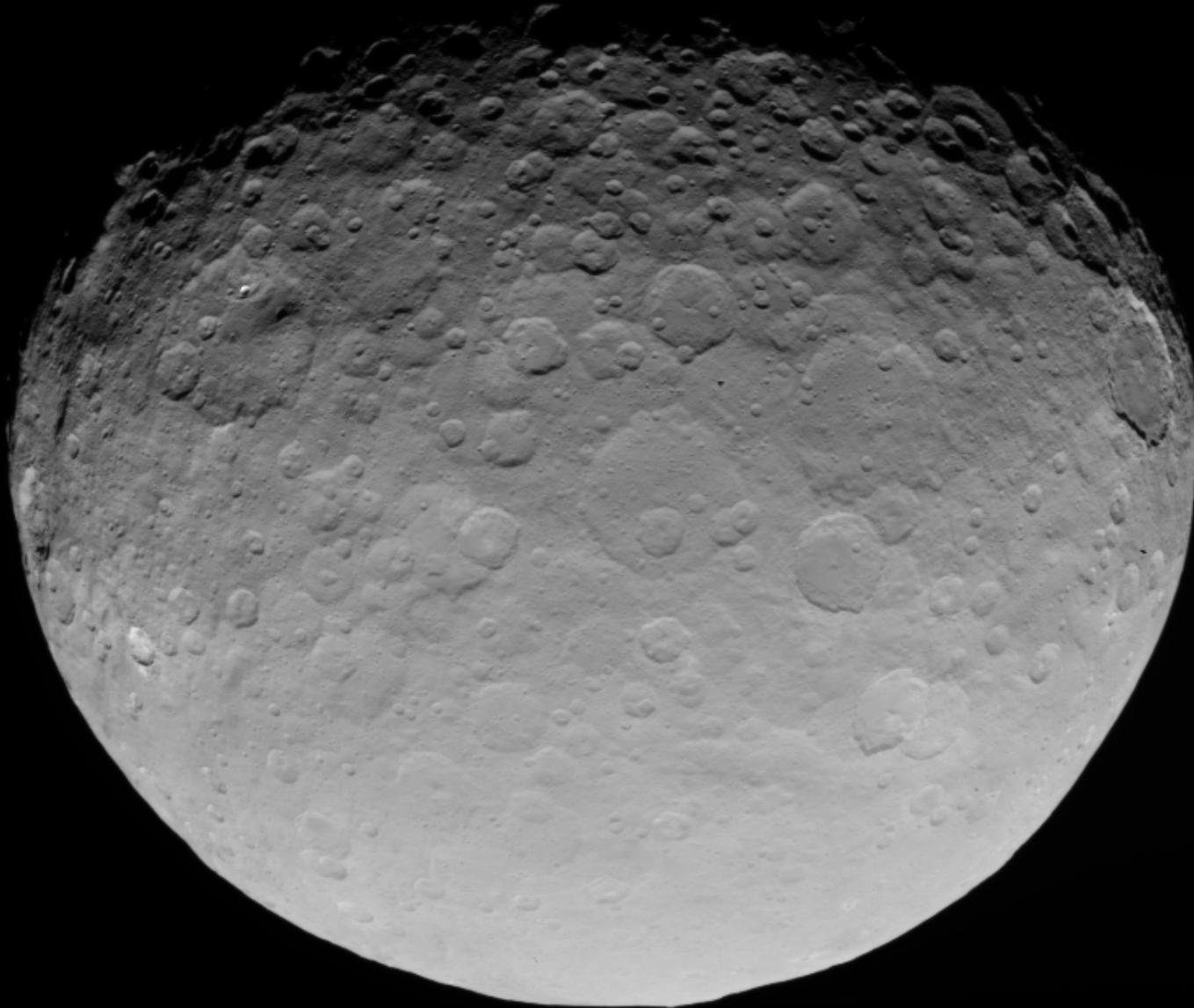
Distancias a escala



Asteroide Eros



Ceres (planeta enano)



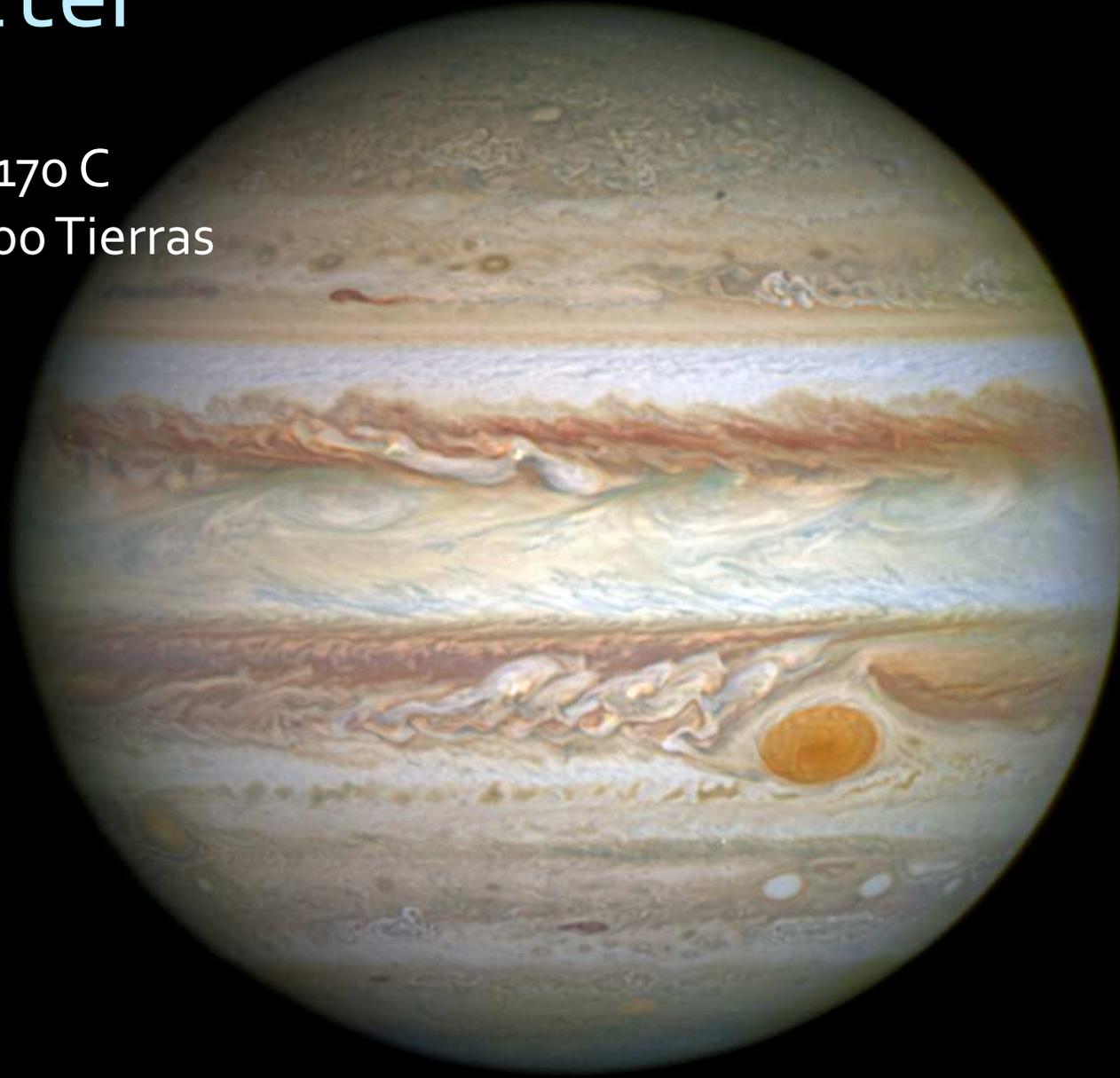
MUNDOS GASEOSOS Y HELADOS

Júpiter

H + He

Temp.: -170 C

Masa \approx 300 Tierras

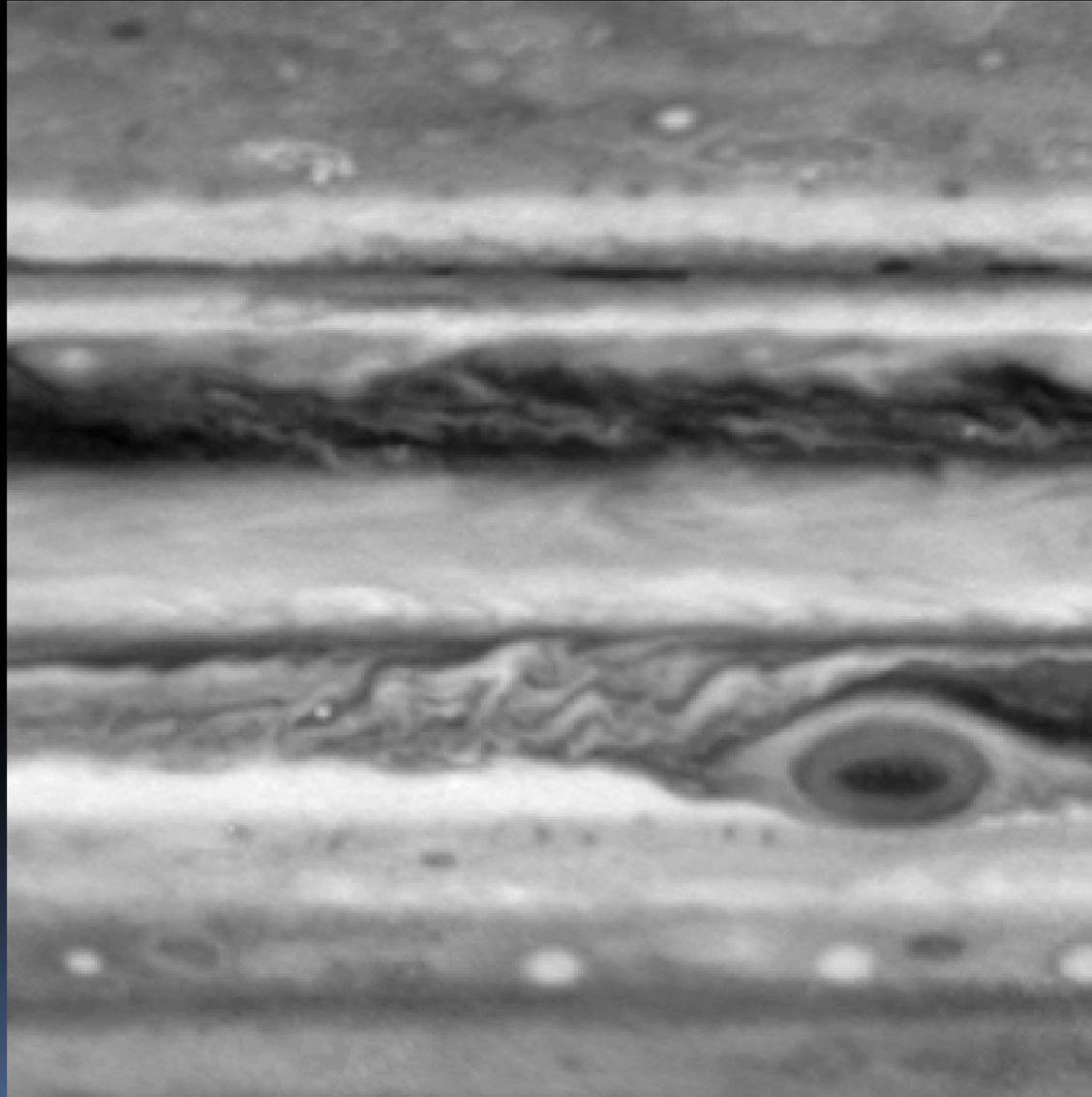


Júpiter

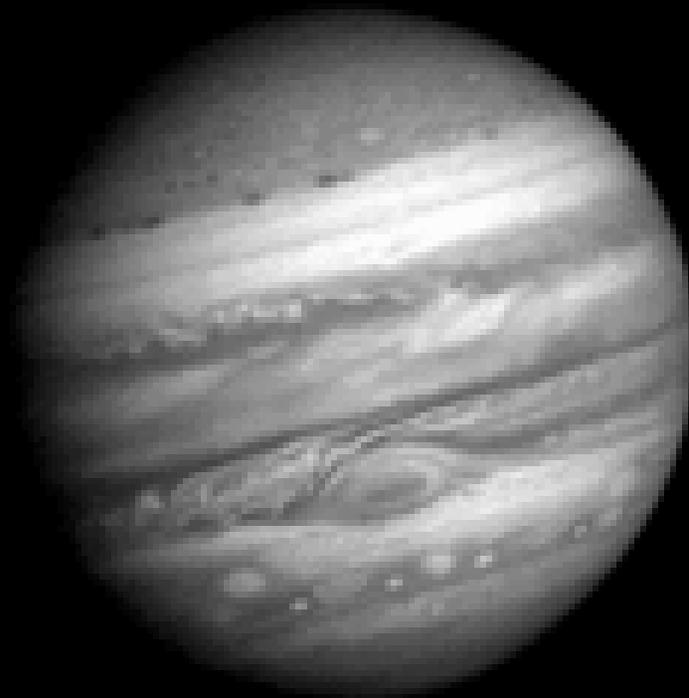


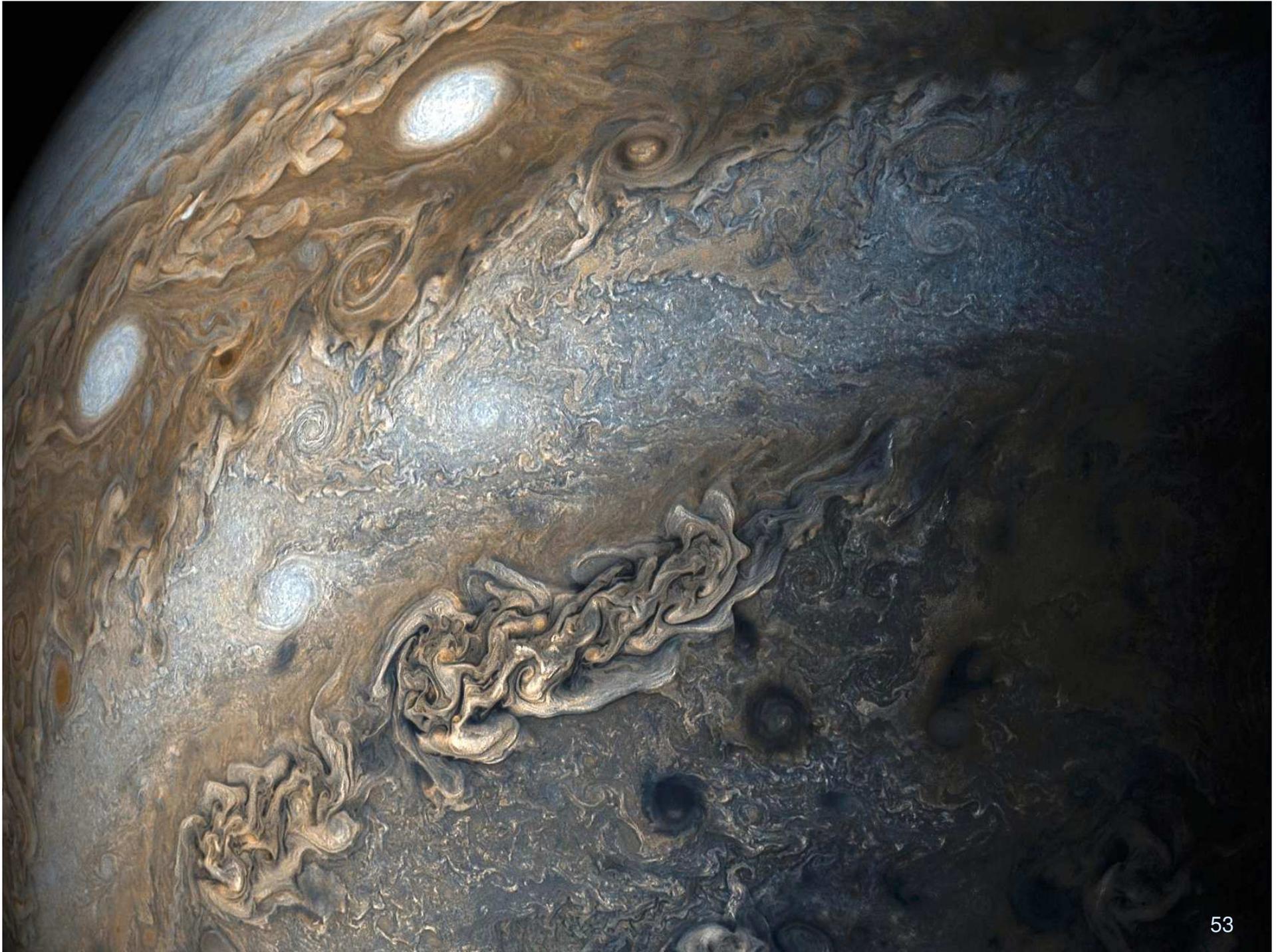
Júpiter

Rotación?

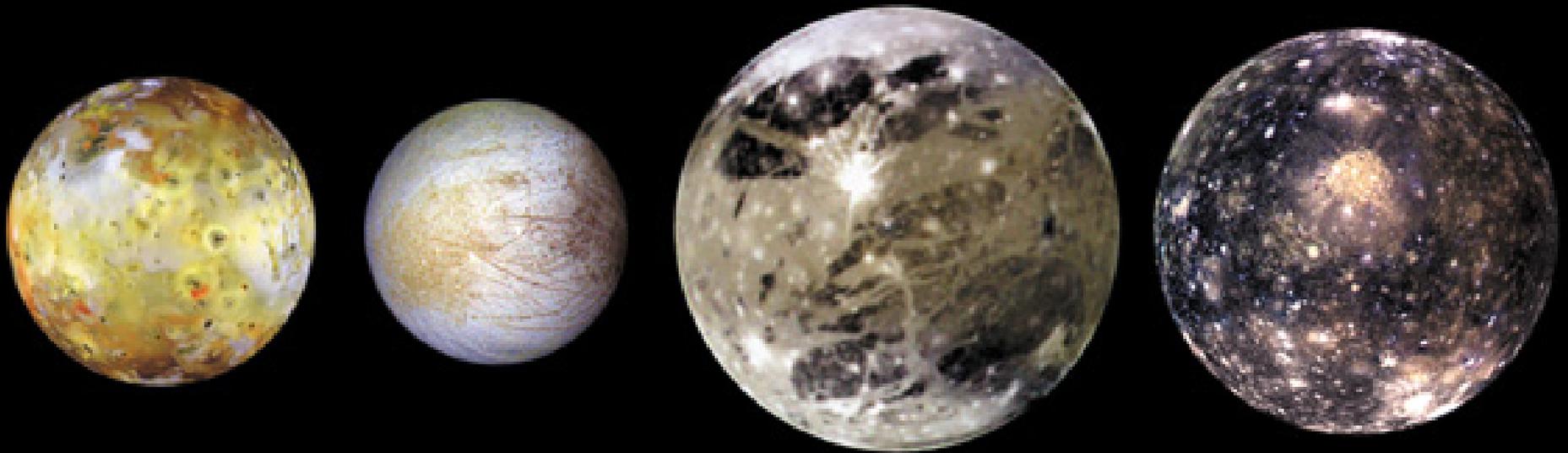


Júpiter





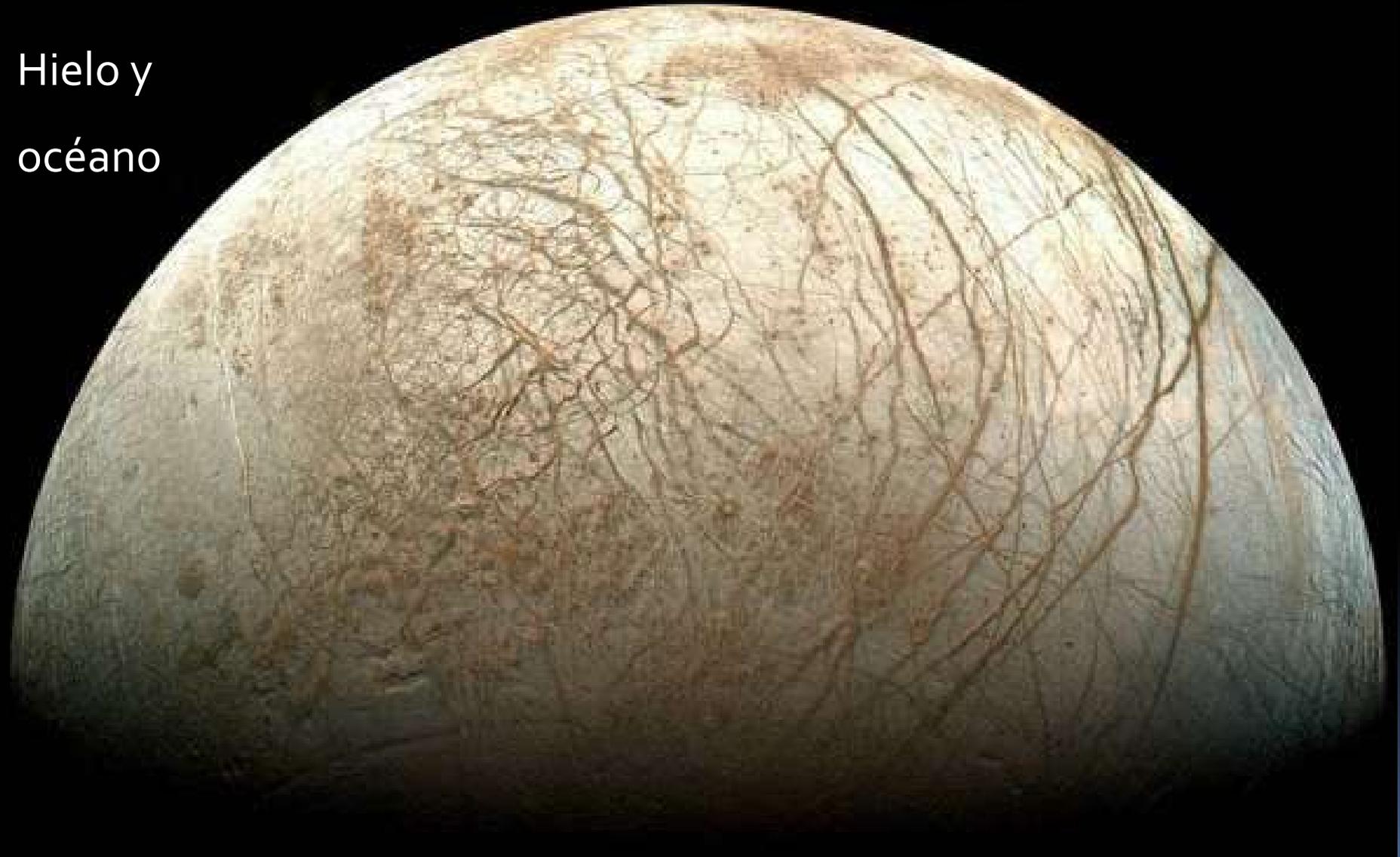
Satélites Galileanos



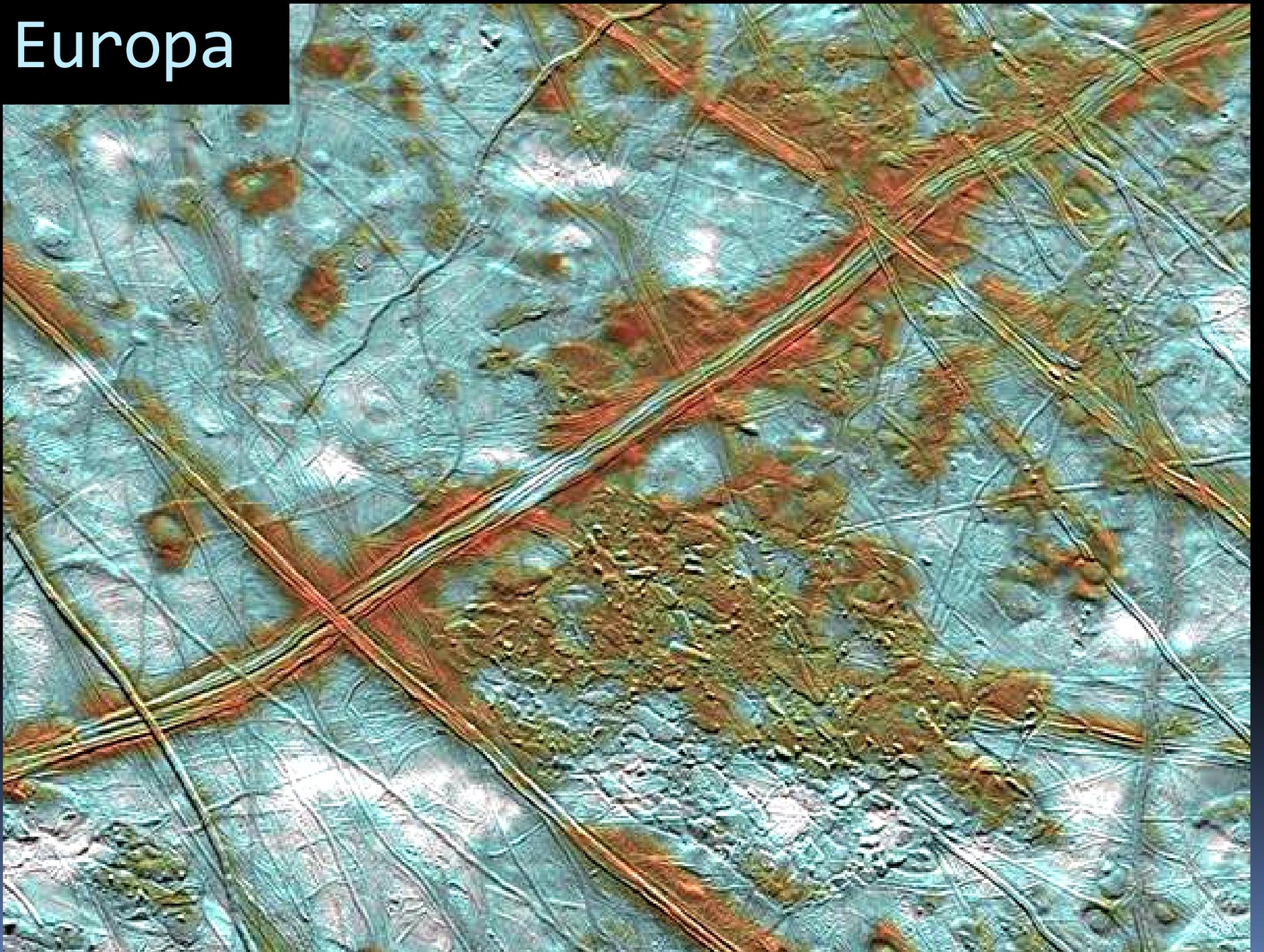
Rotación sincrónica por mareas

Europa (satélite)

Hielo y
océano

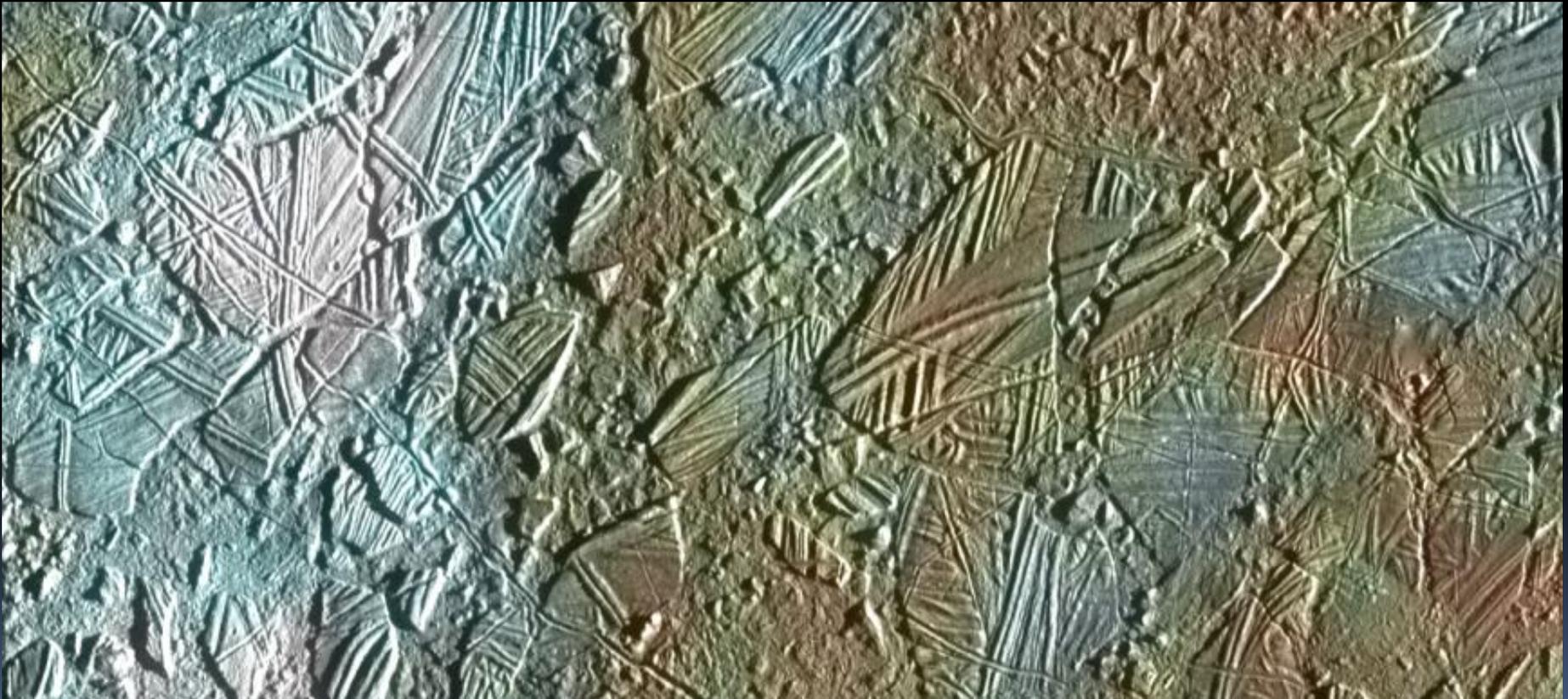


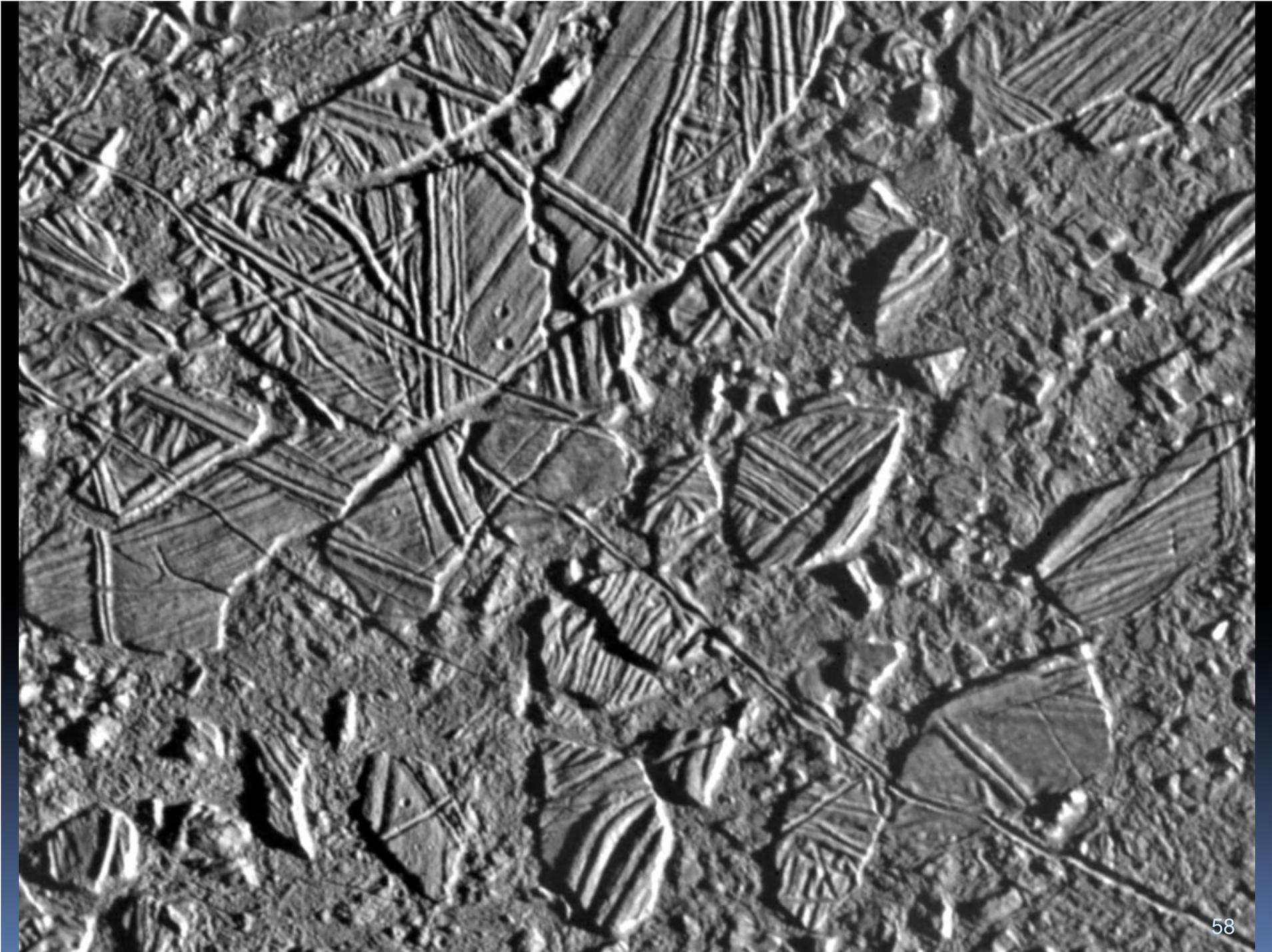
Europa

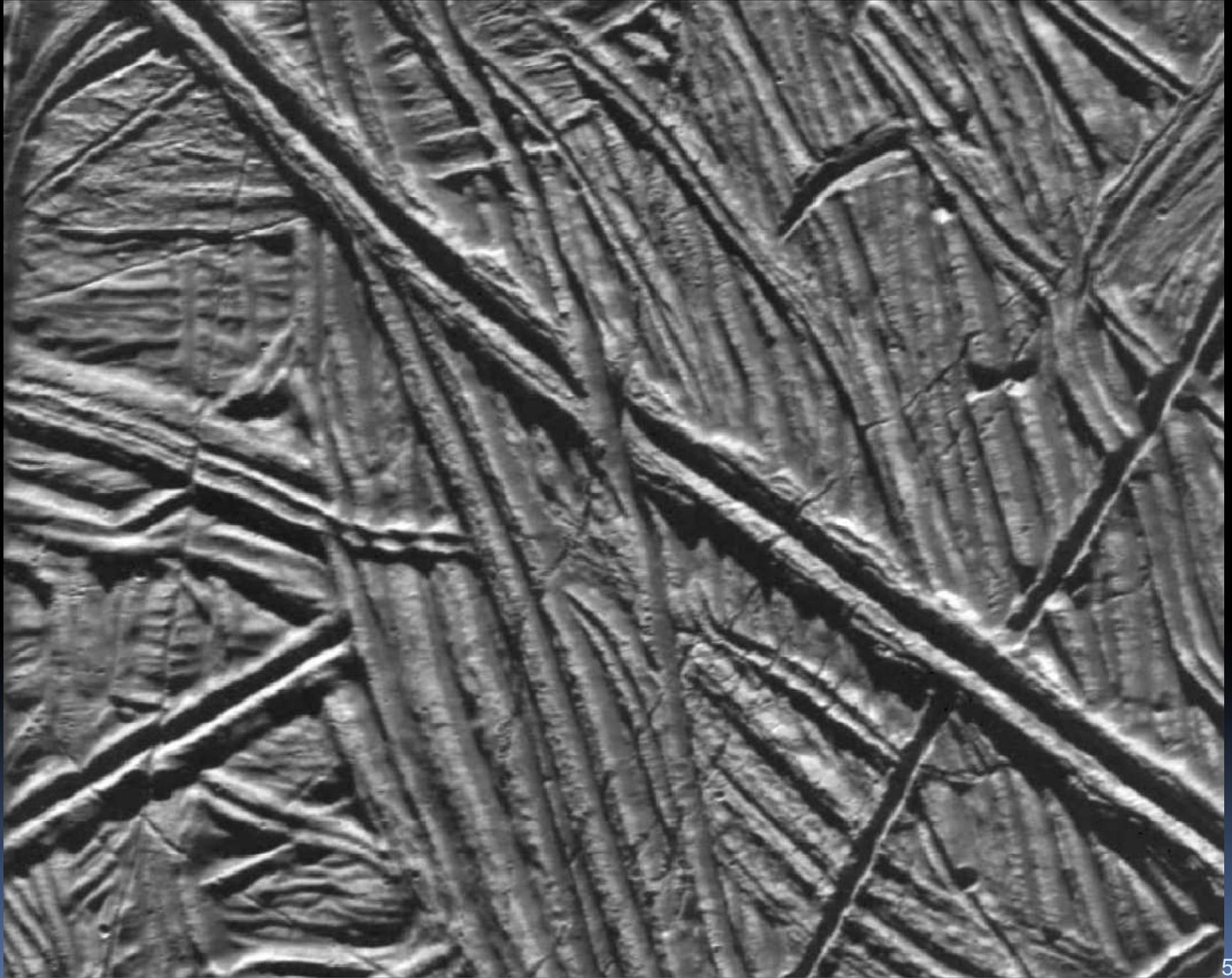


Europa

Manchas marrones: **tholins**



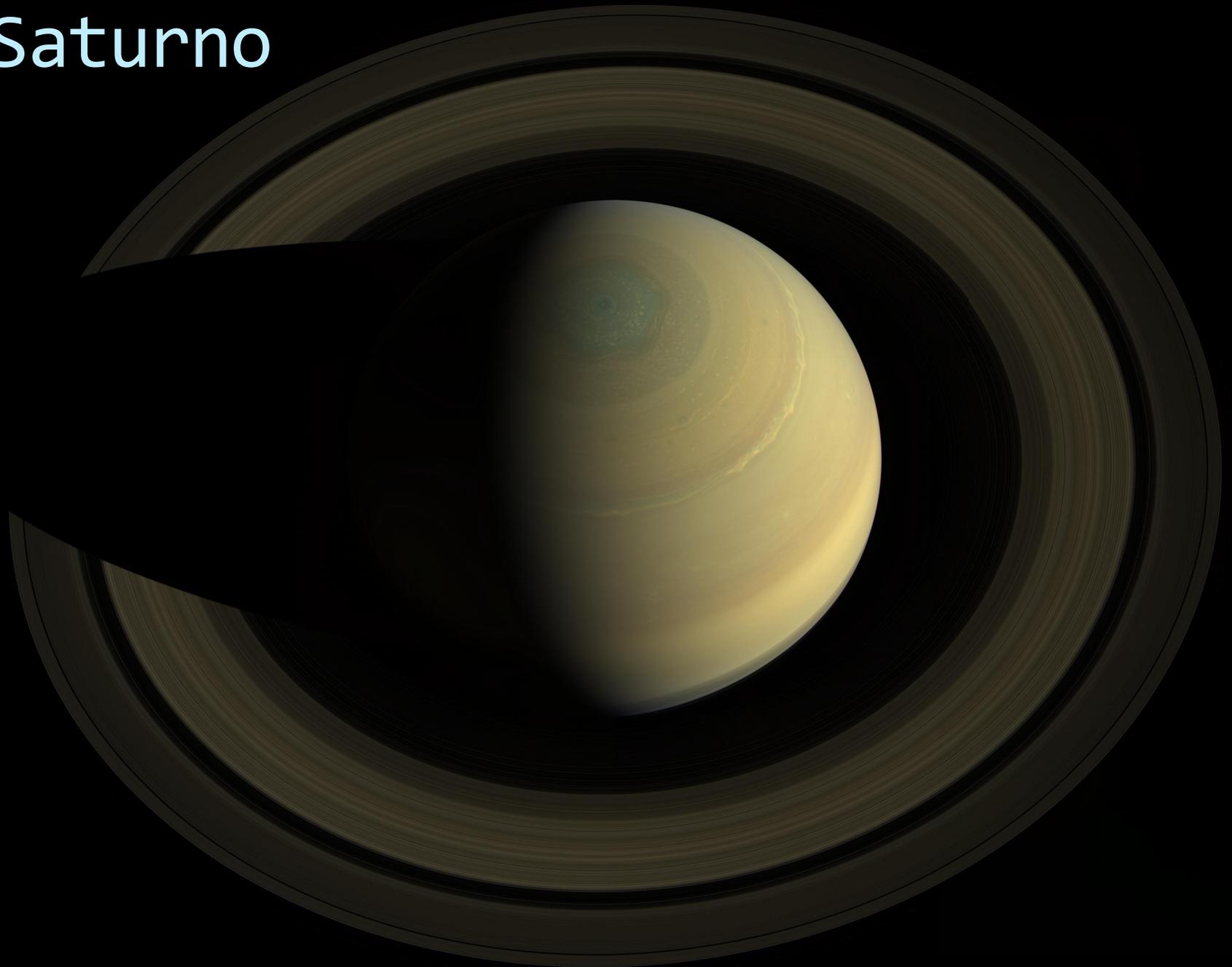




Ganímedes

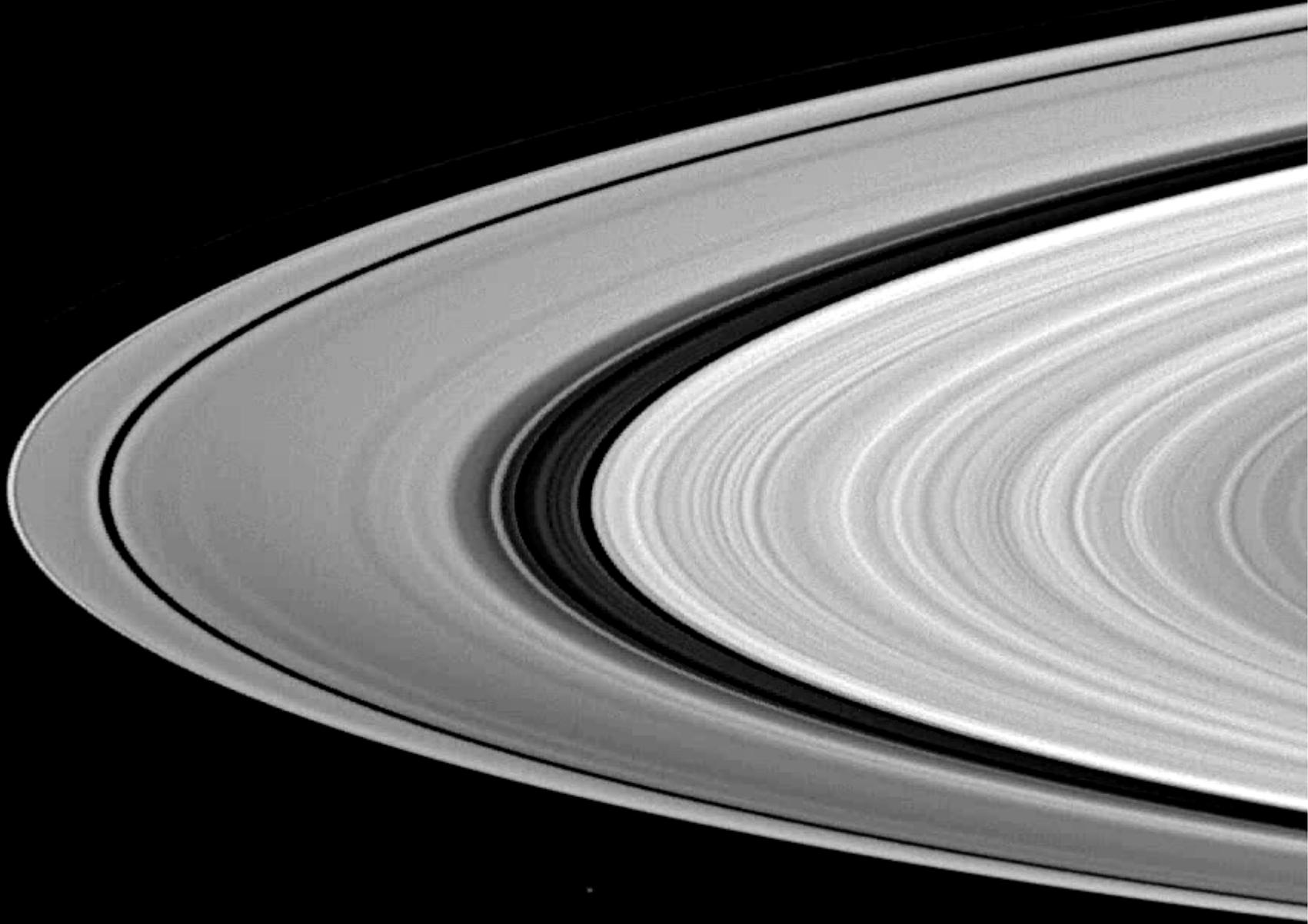


Saturno



Saturno

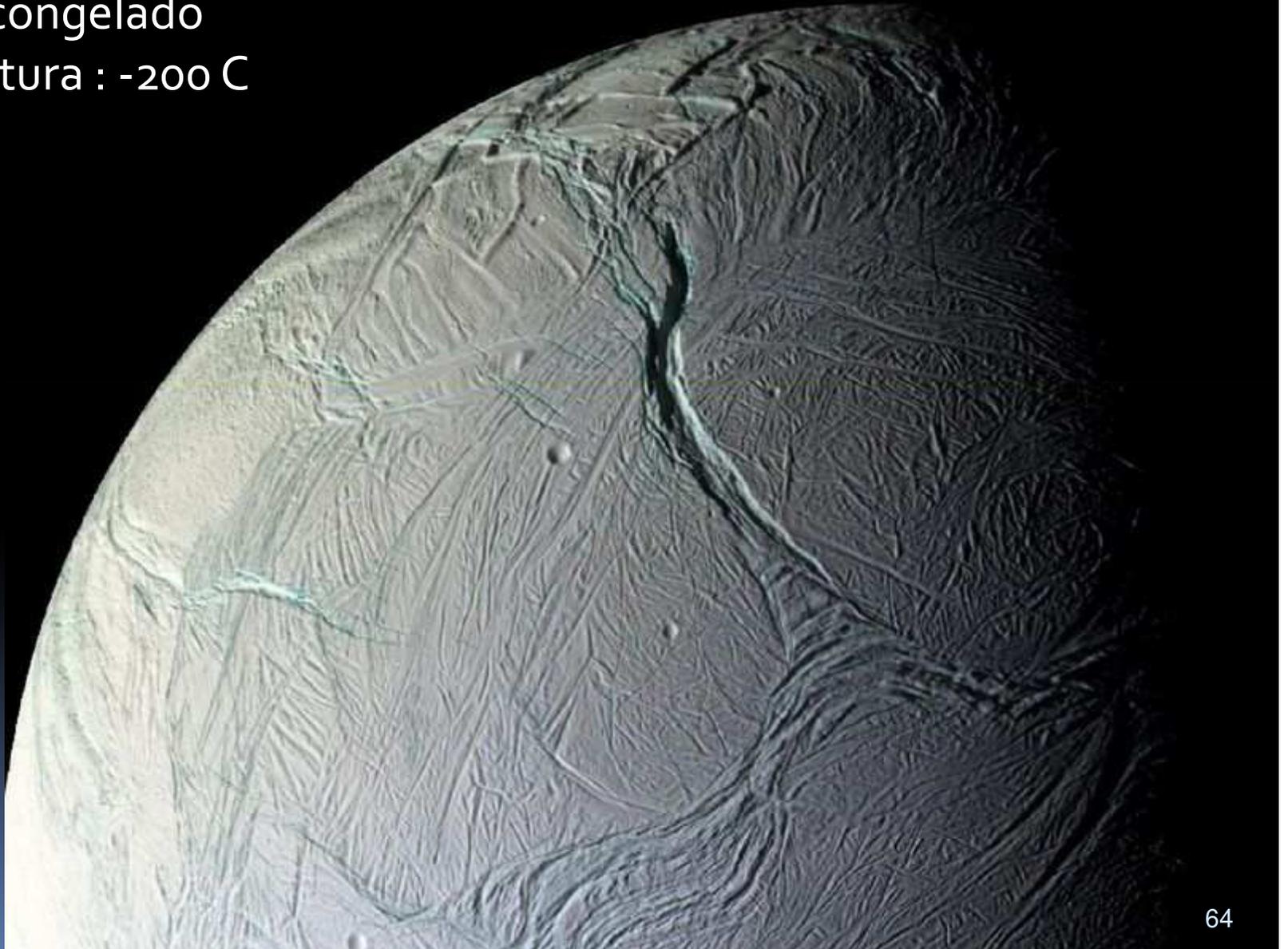




<https://photojournal.jpl.nasa.gov/targetFamily/Saturn>

Encelado

Océano congelado
Temperatura : -200 C

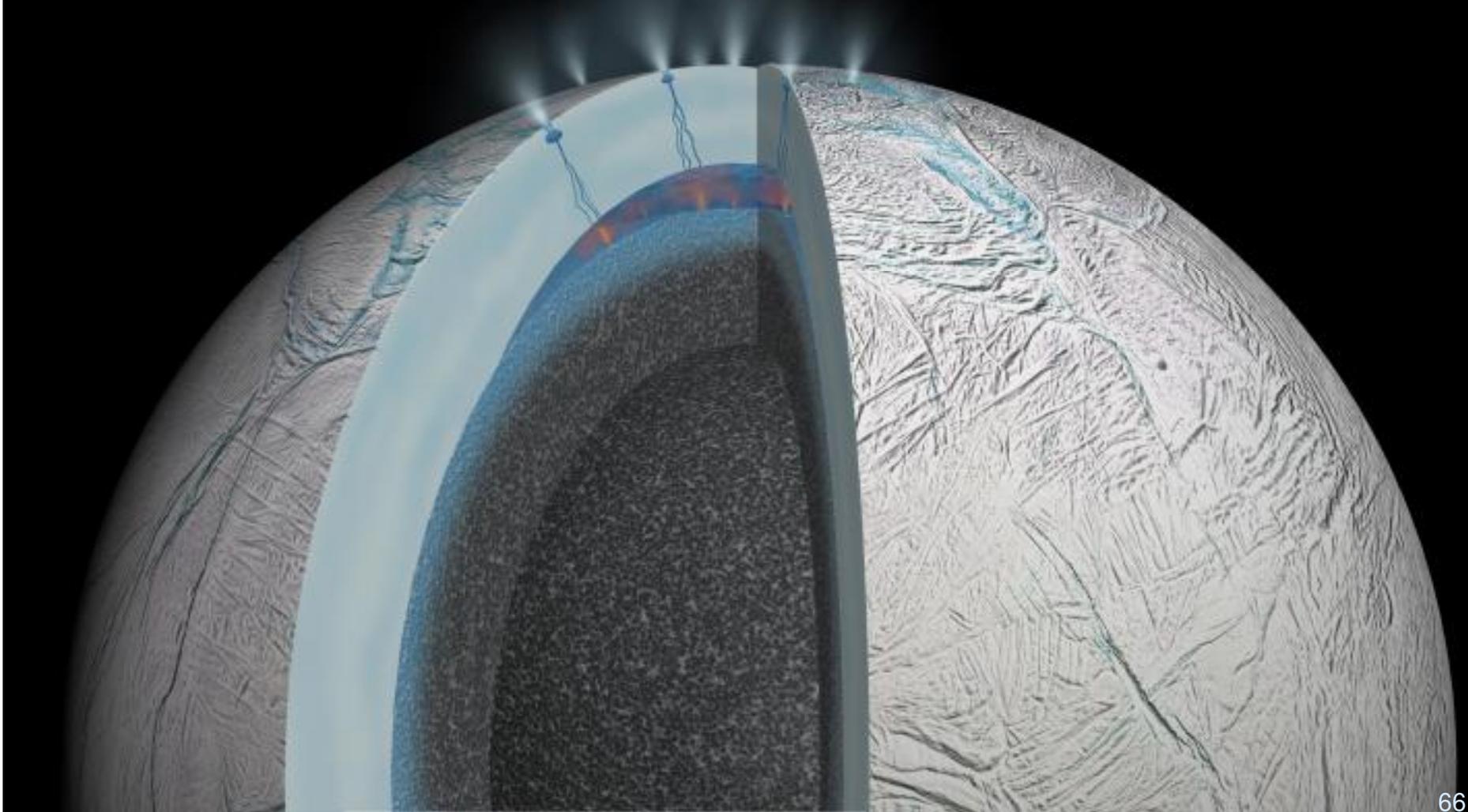


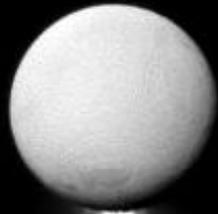
Encelado

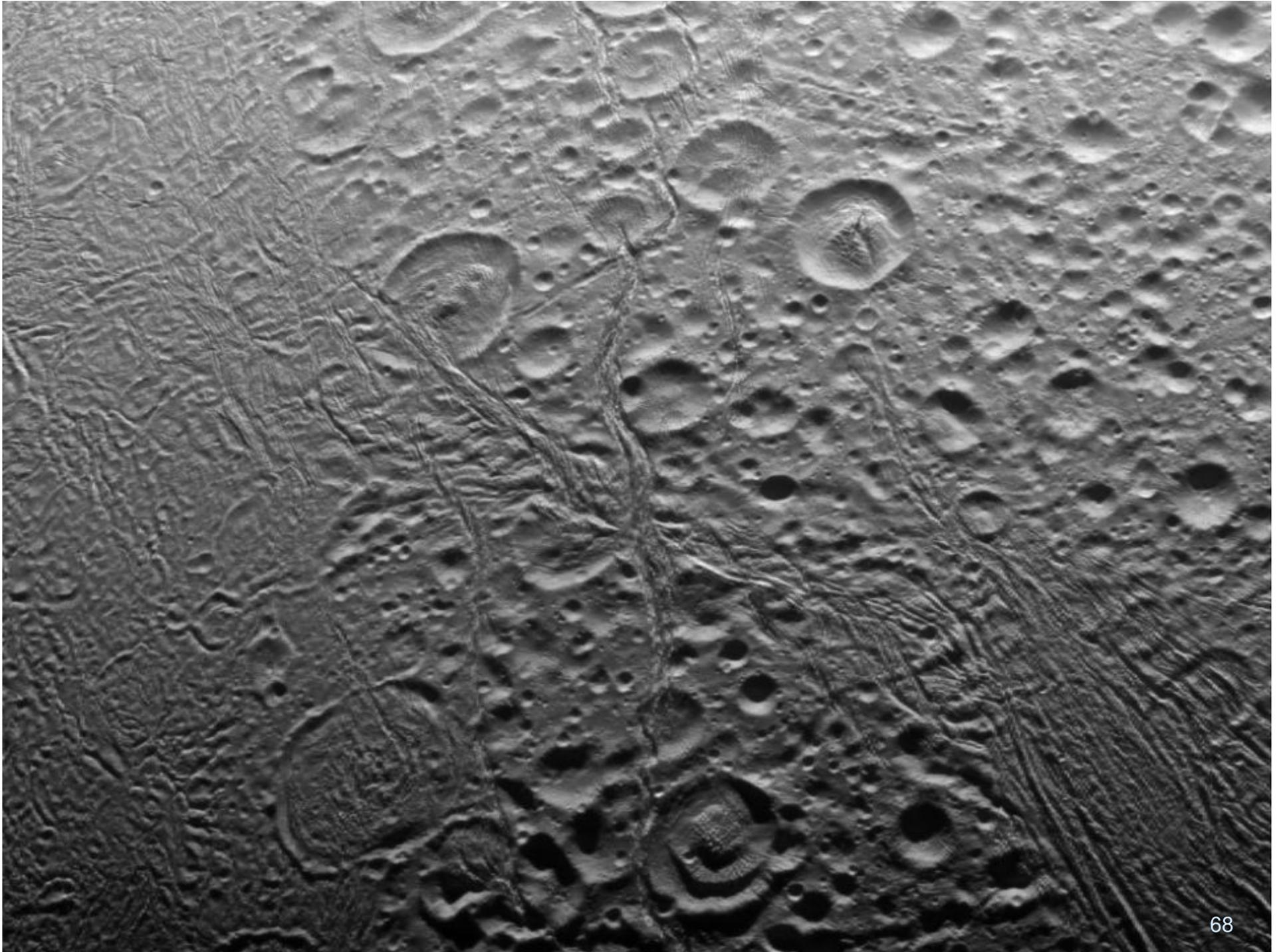
Compuestos orgánicos de 200 uma



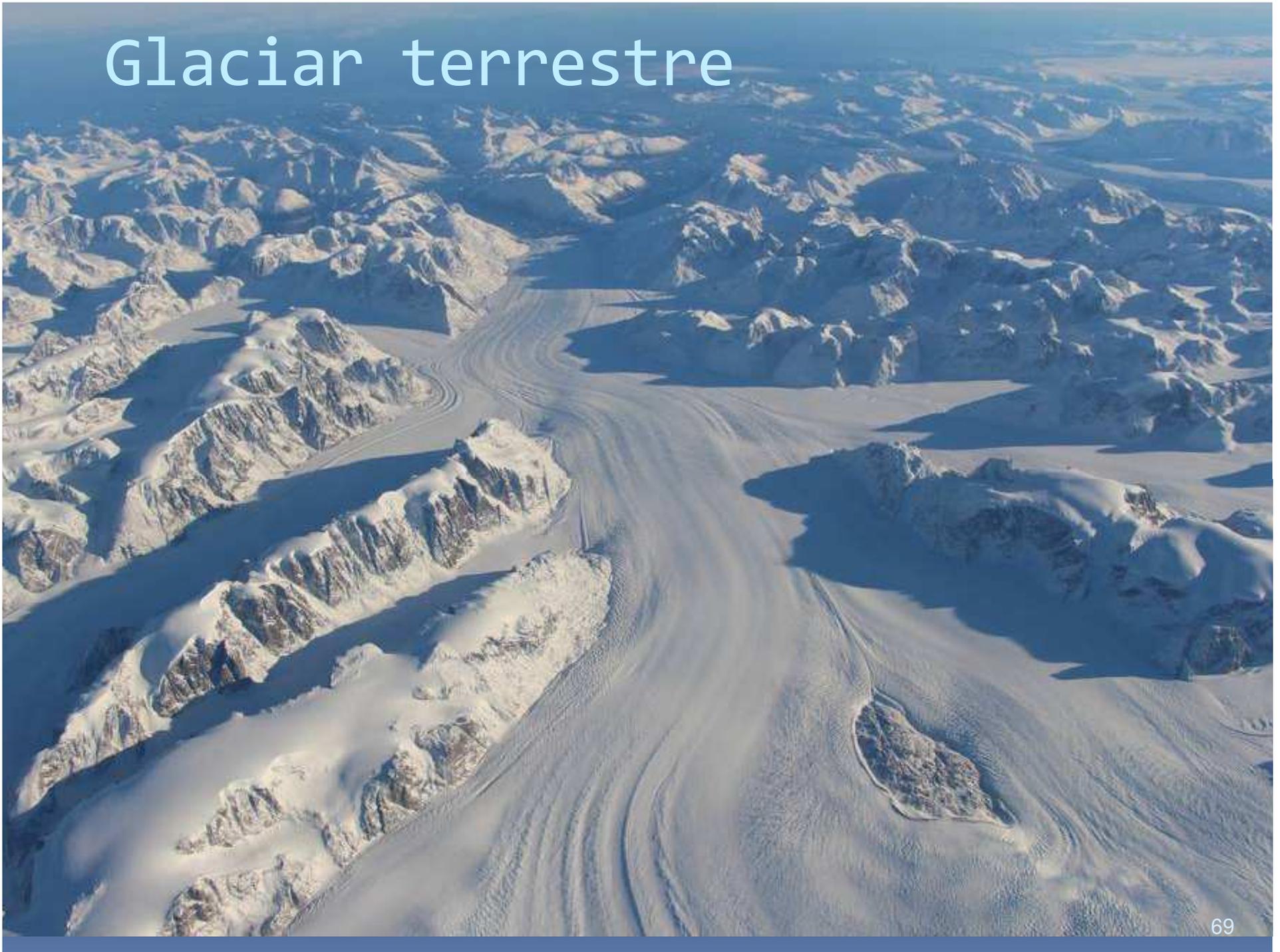
Encelado







Glaciar terrestre



Titán

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



Titán

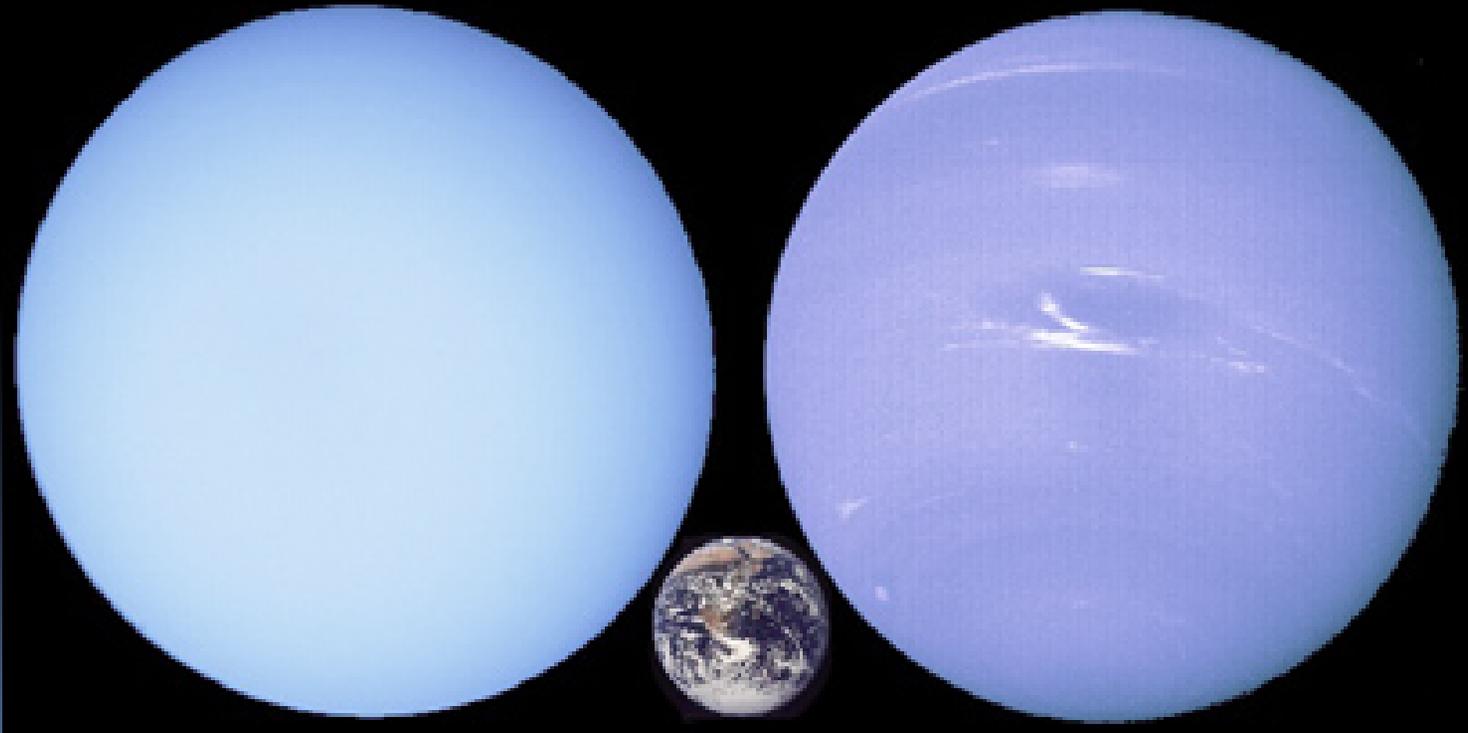
Una "Tierra" primitiva?

Urano y Neptuno

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

Eje MUY inclinado.

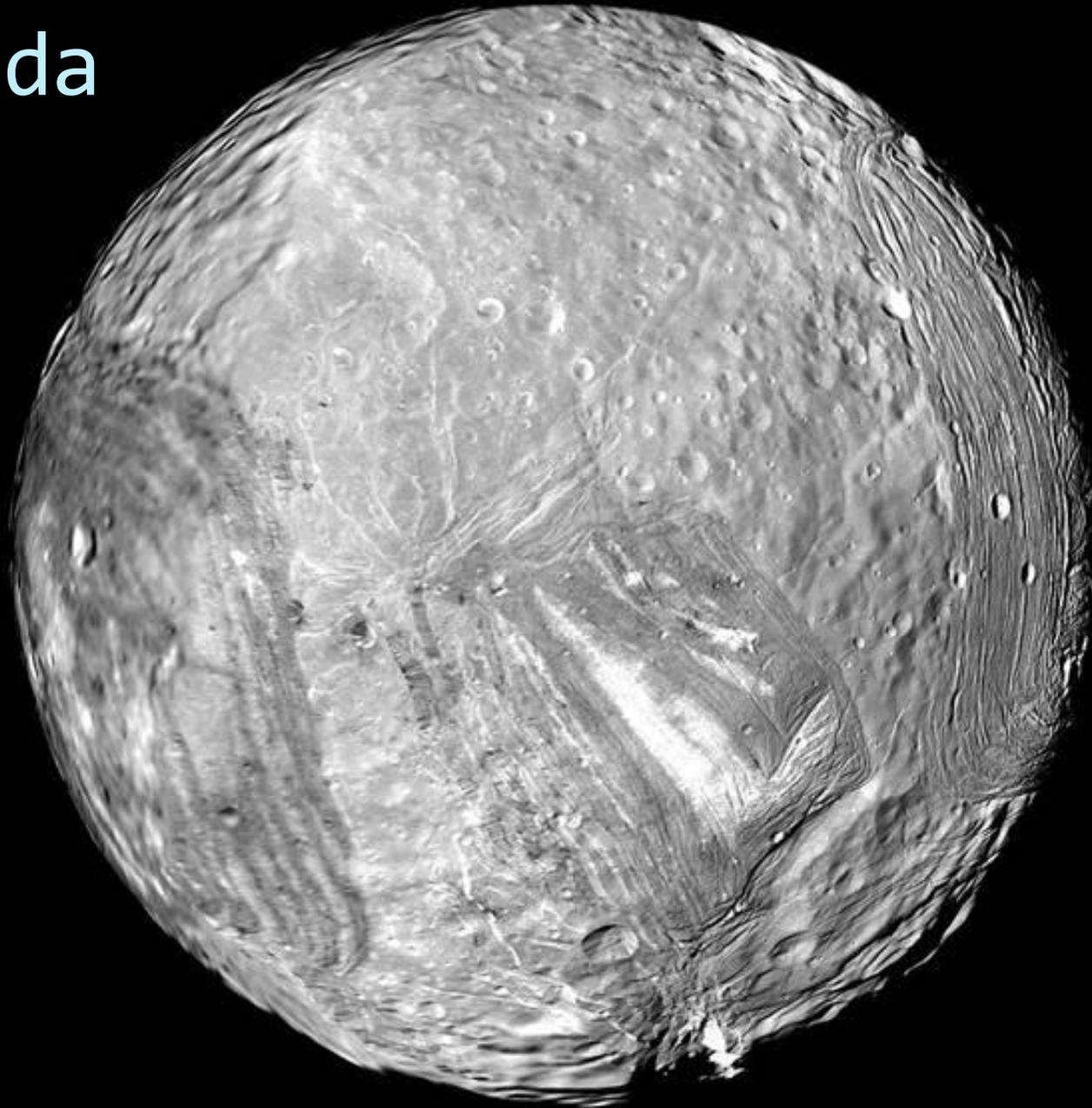
Pocos satélites.



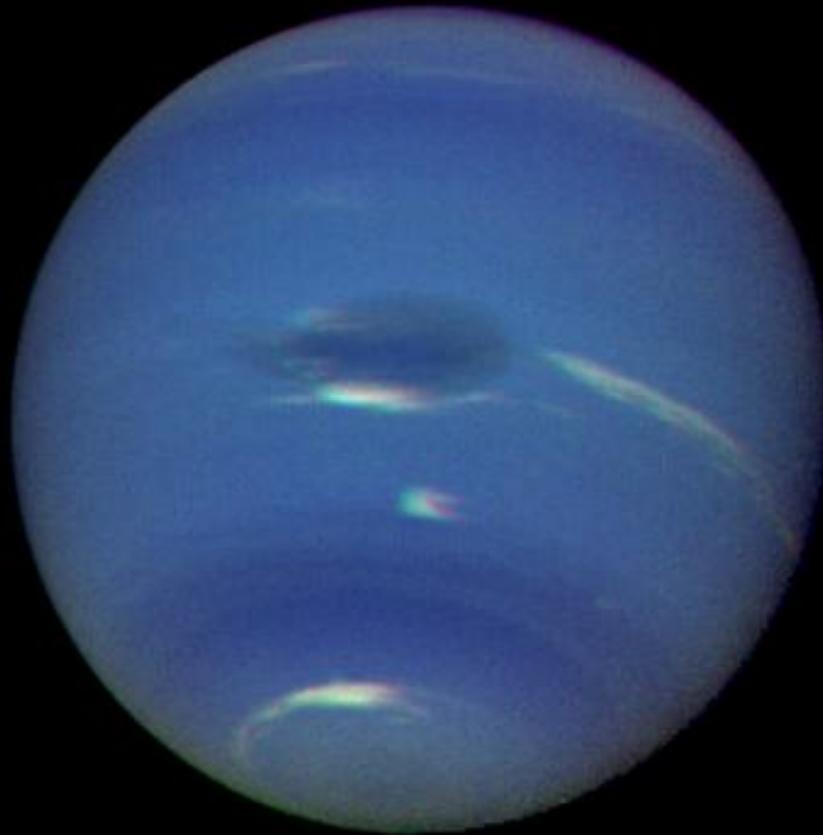
Ariel

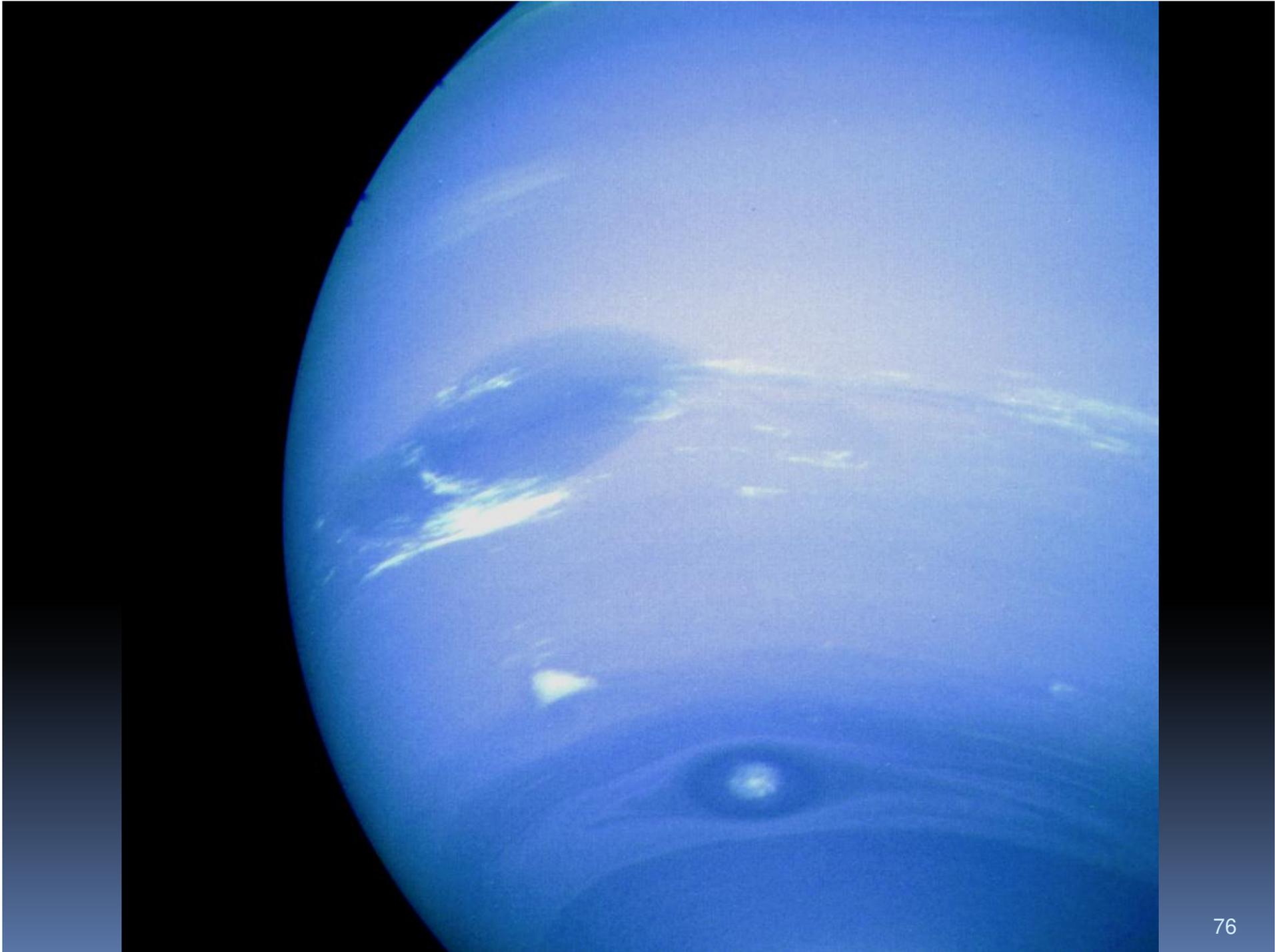


Miranda



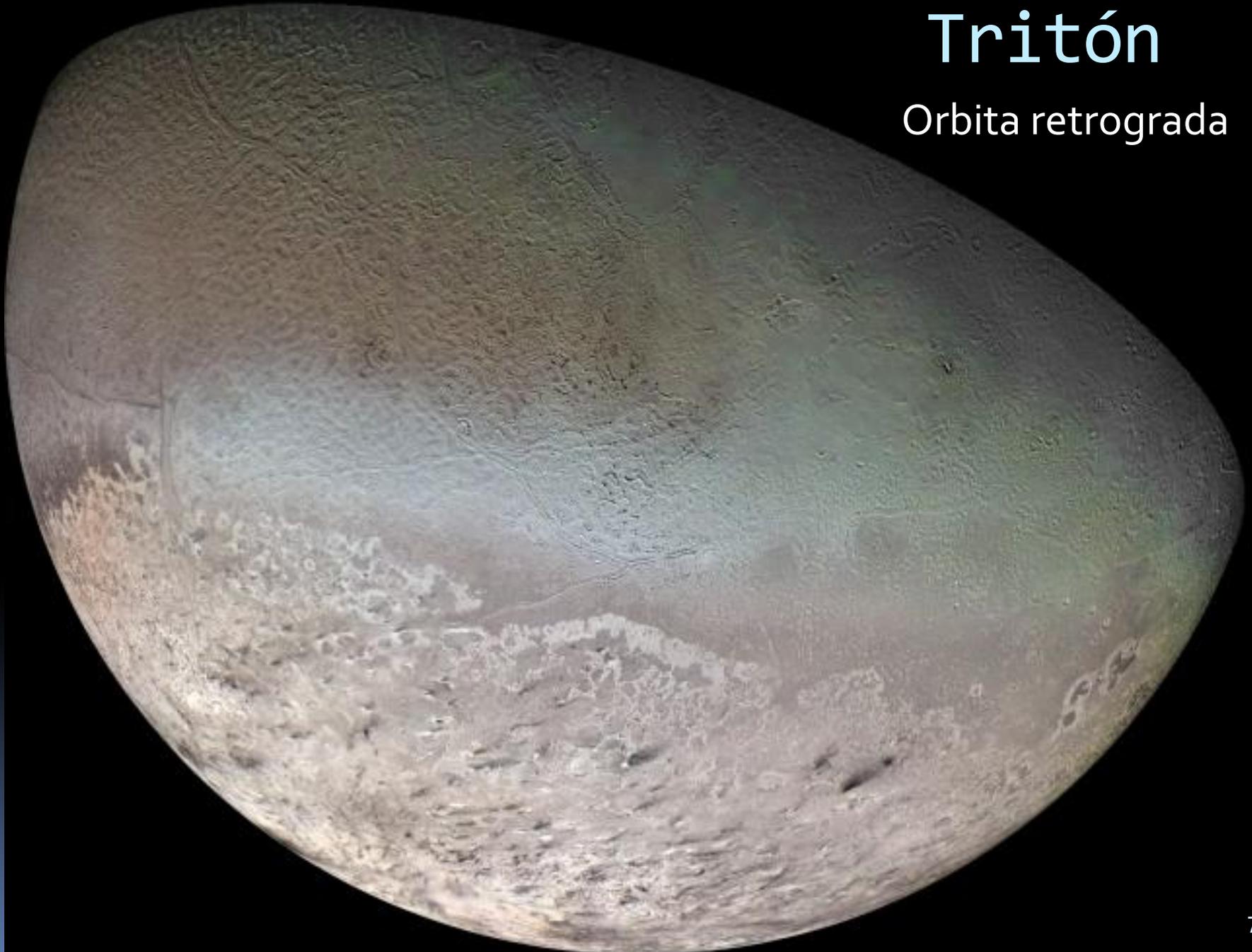
Neptuno

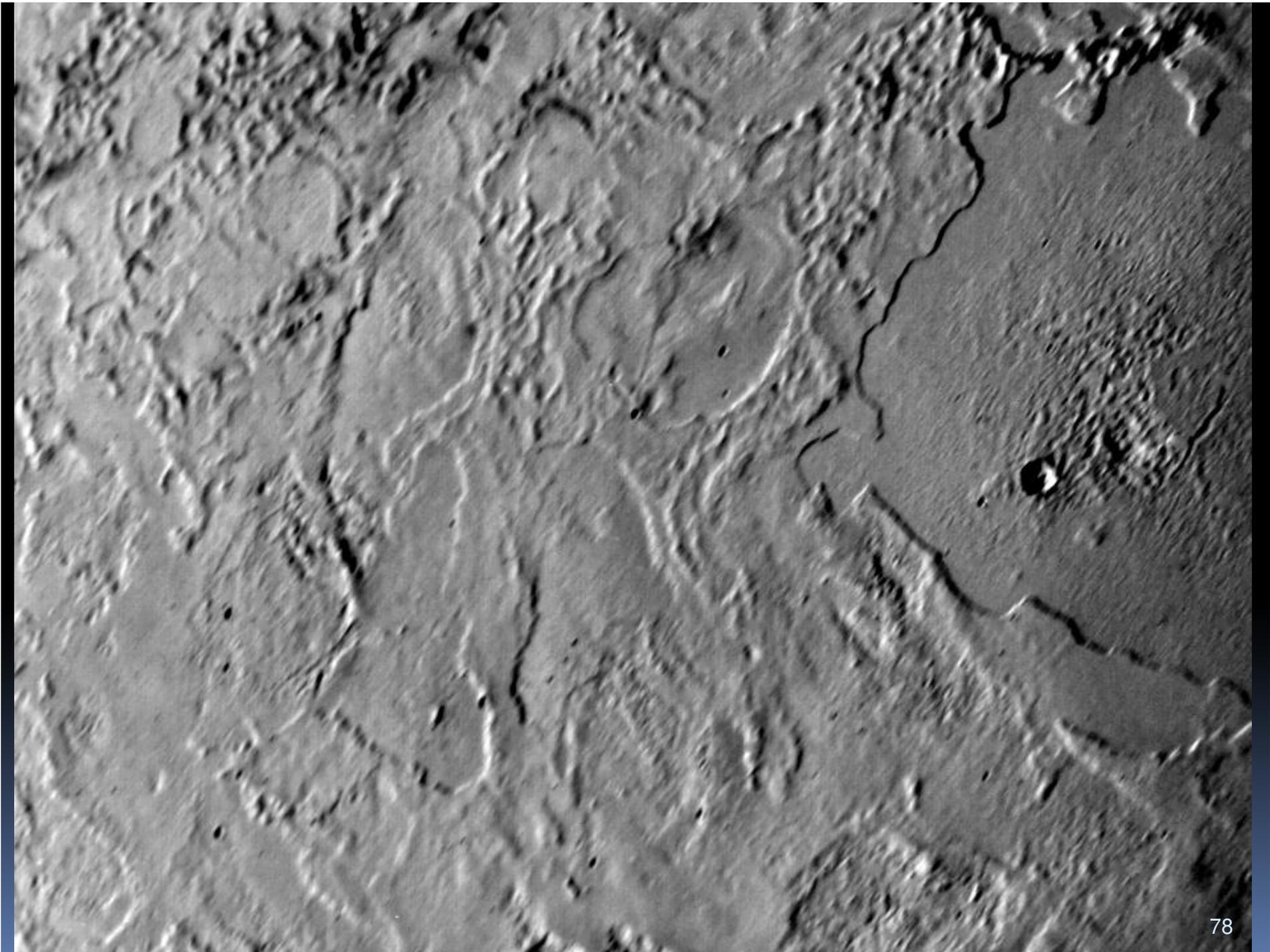




Tritón

Orbita retrograda





Mayores satélites del SS

Triton



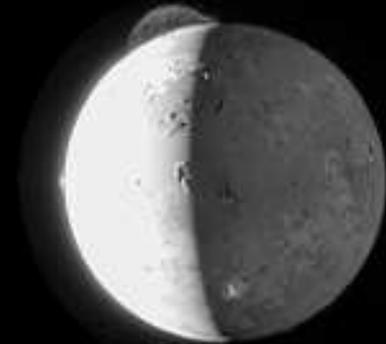
Europe



Lune



Io



Callisto



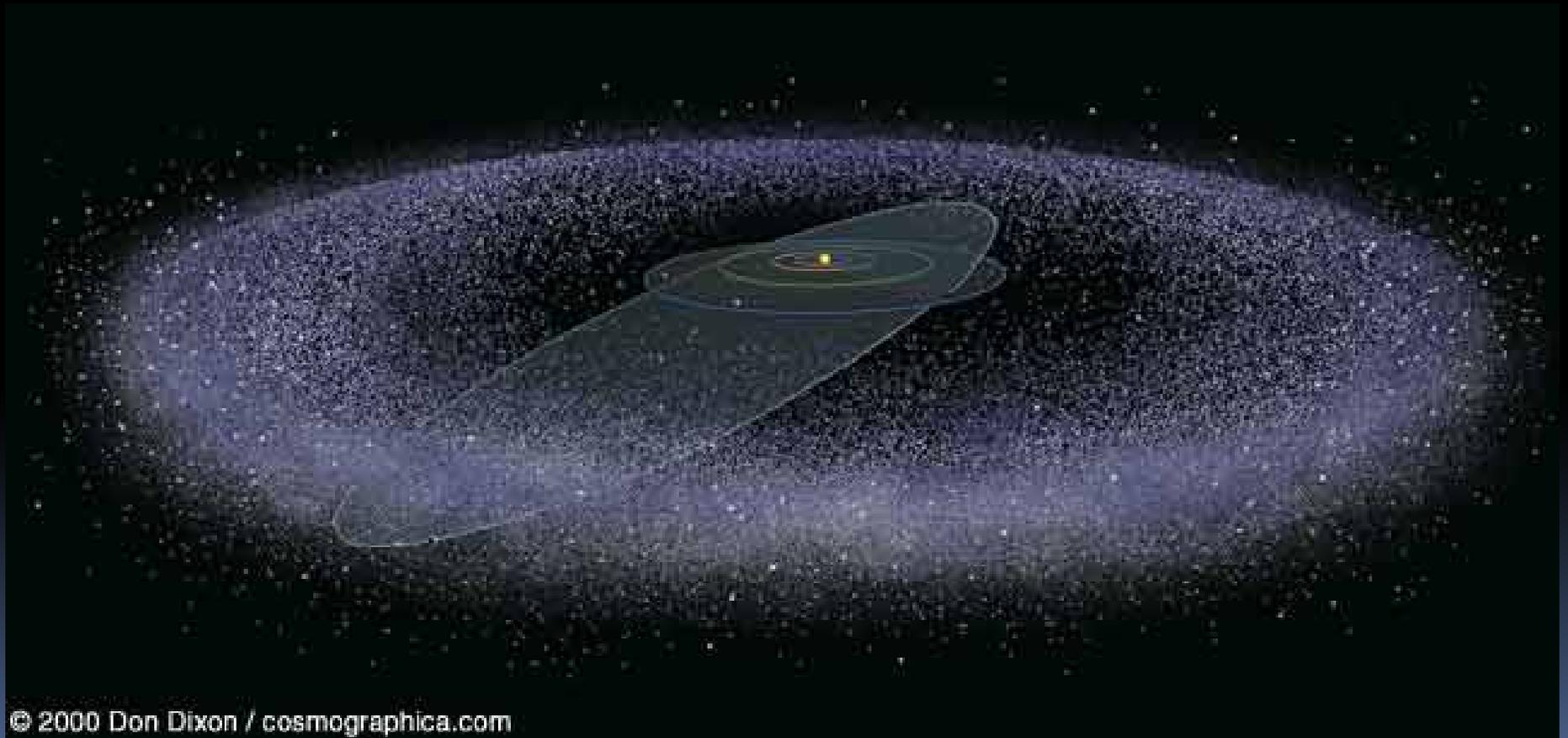
Titan



Ganymède

MAS ALLA DE NEPTUNO

Cinturón de Kuiper



© 2000 Don Dixon / cosmographica.com

Plutón y Caronte



Rotación sincrónica por mareas



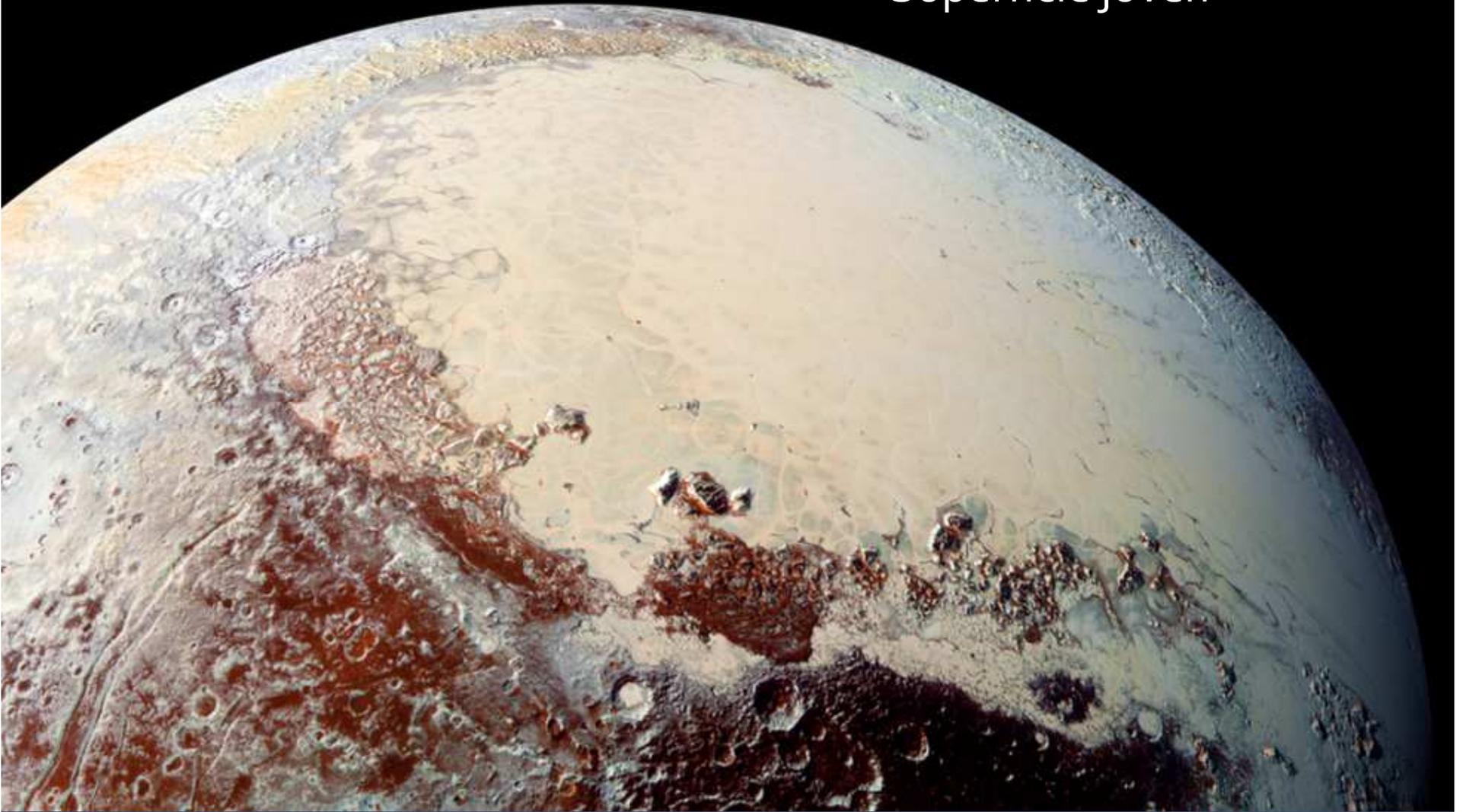
Plutón

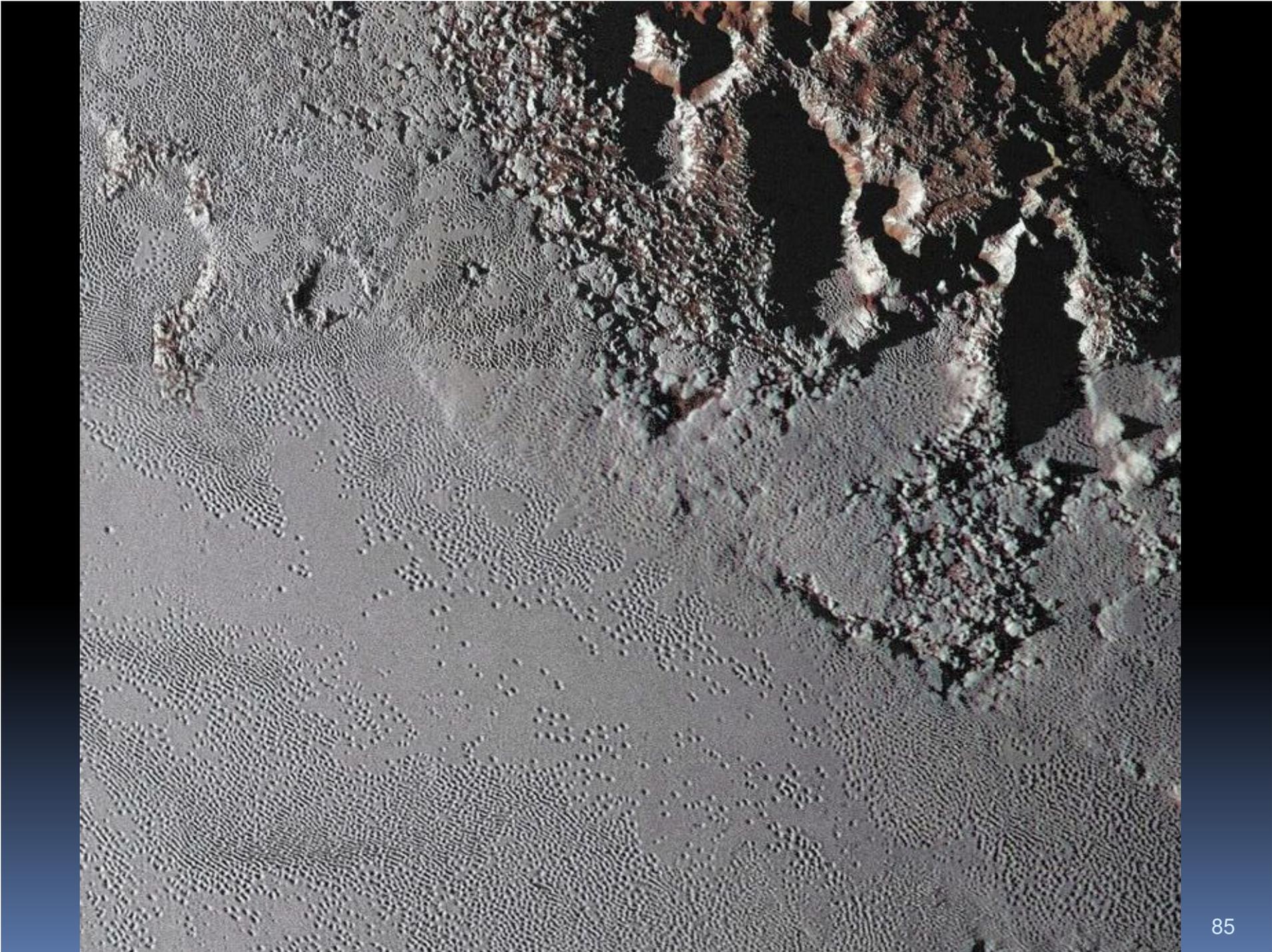


Manchas marrones: tholins

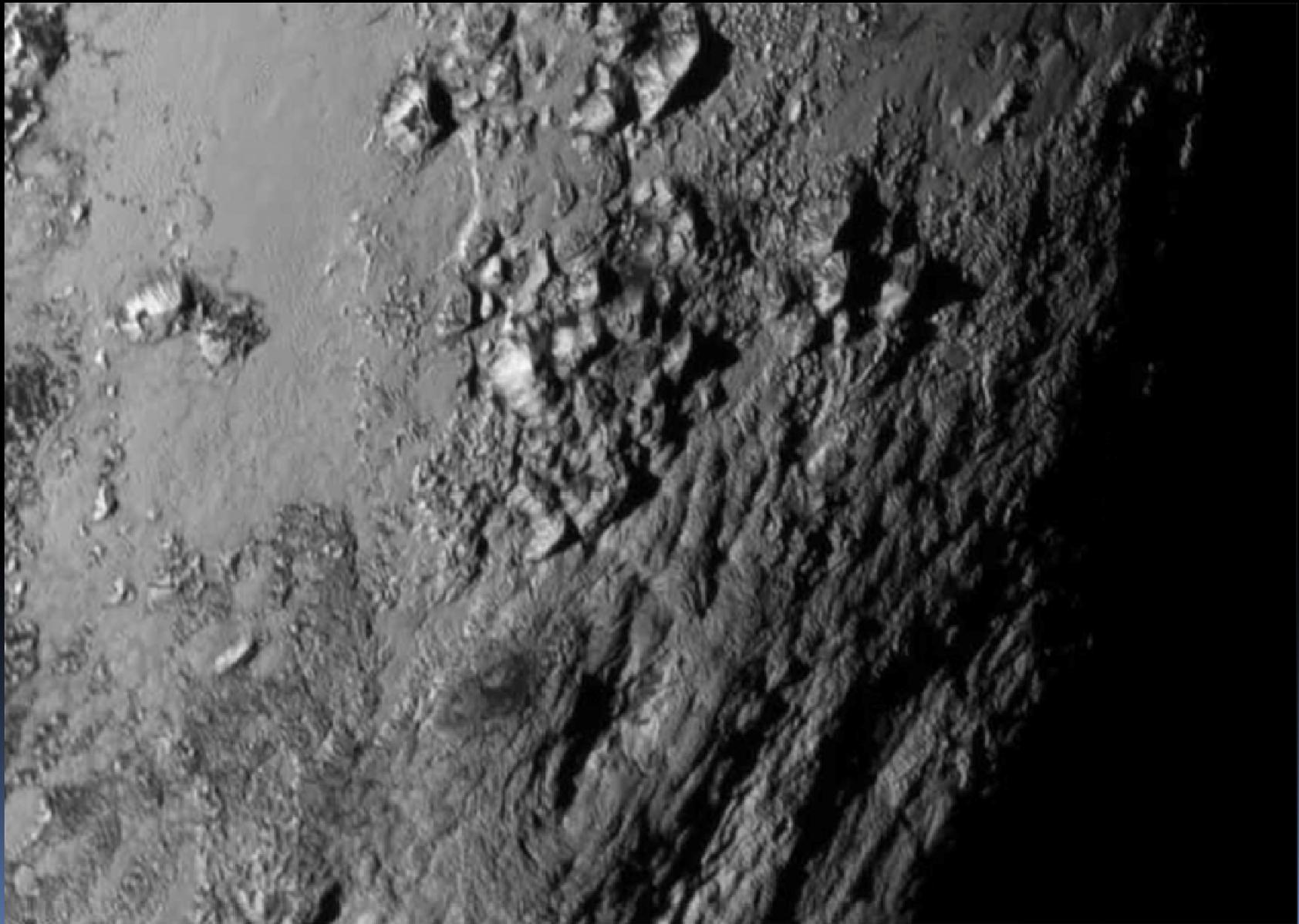
False Color

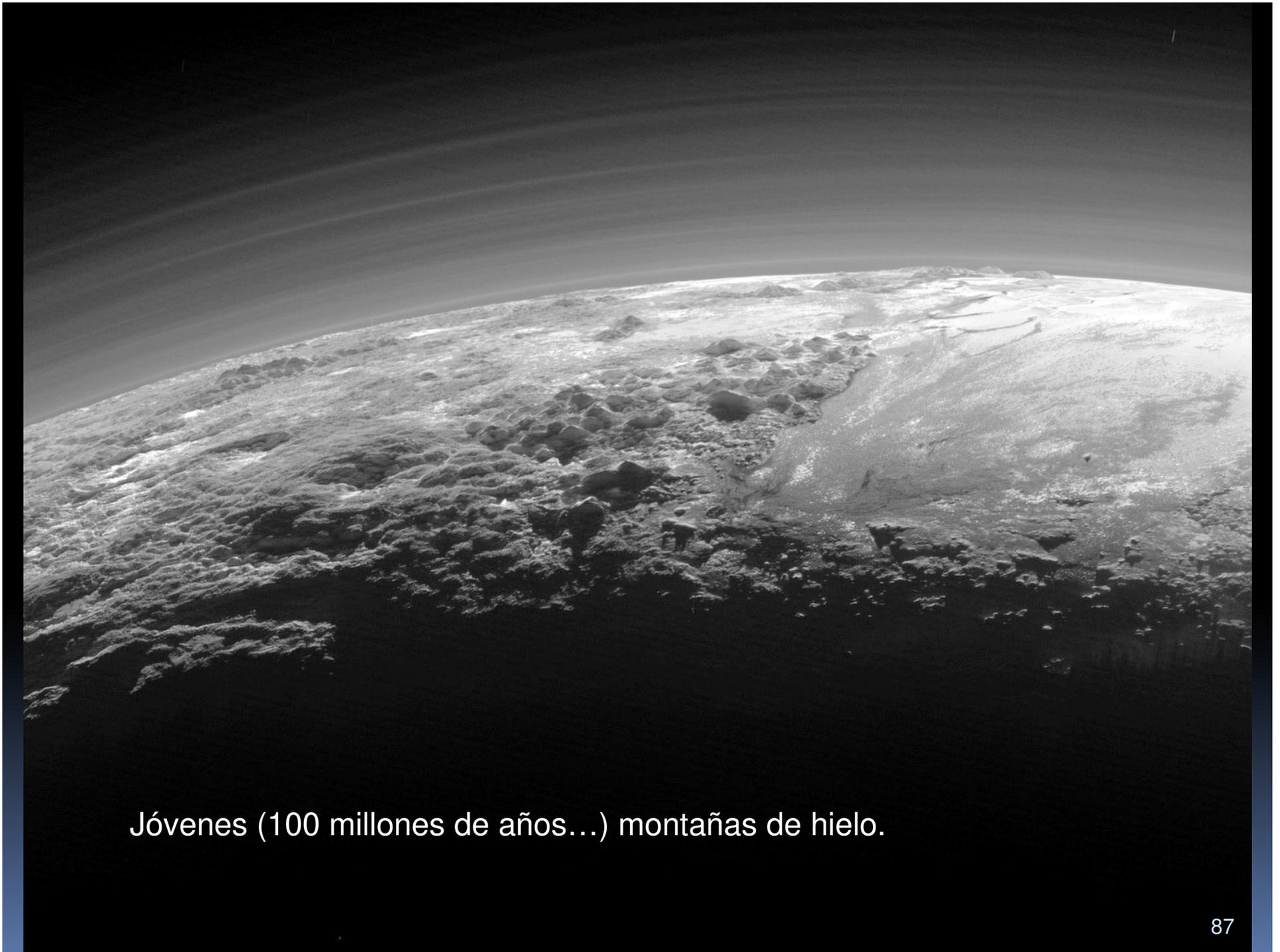
Superficie joven





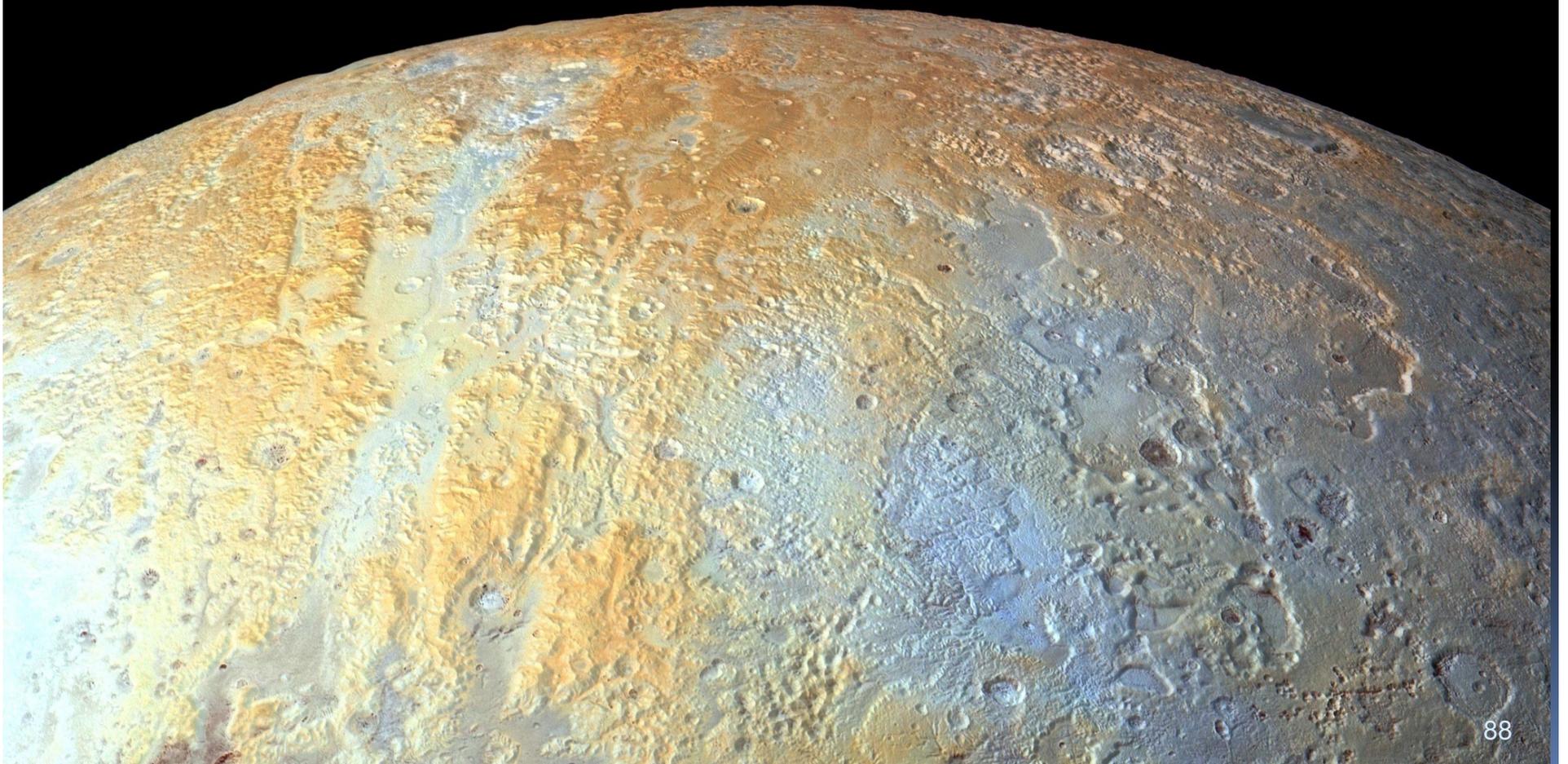
Plutón



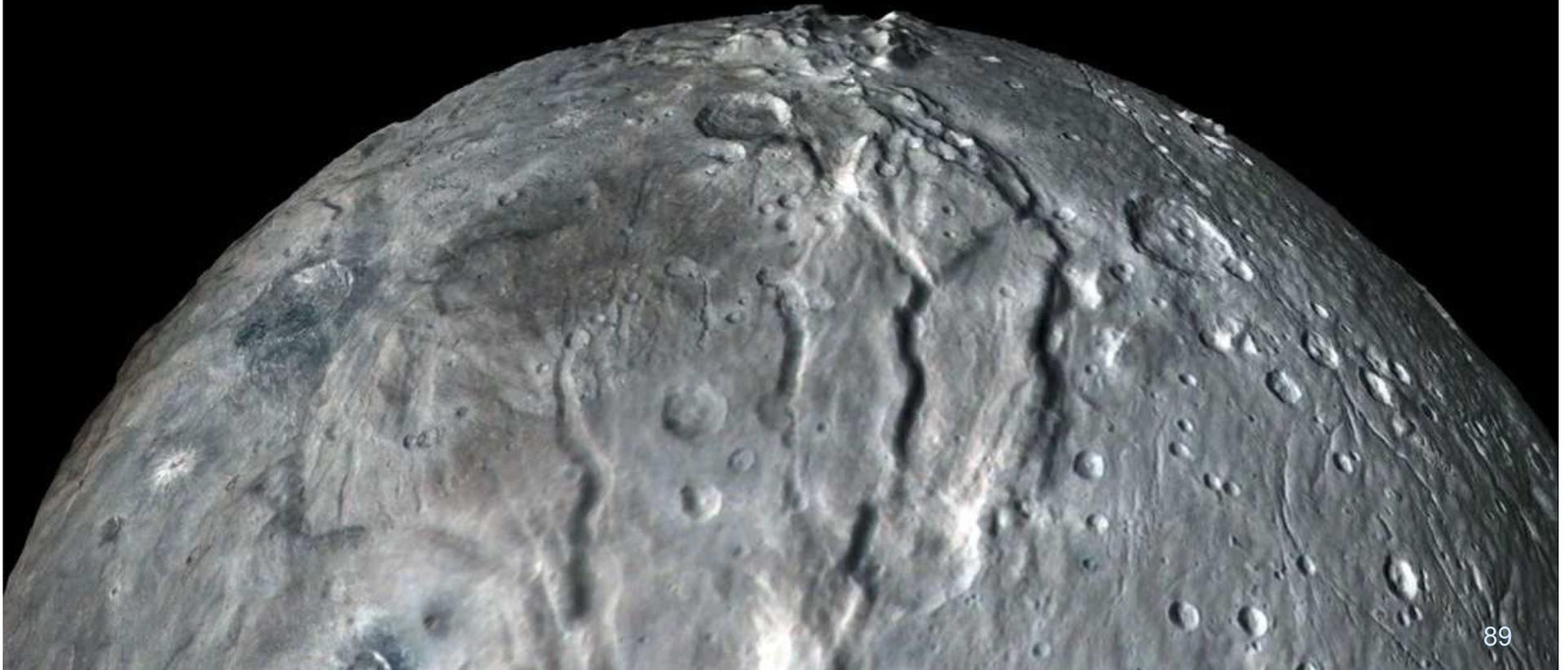


Jóvenes (100 millones de años...) montañas de hielo.

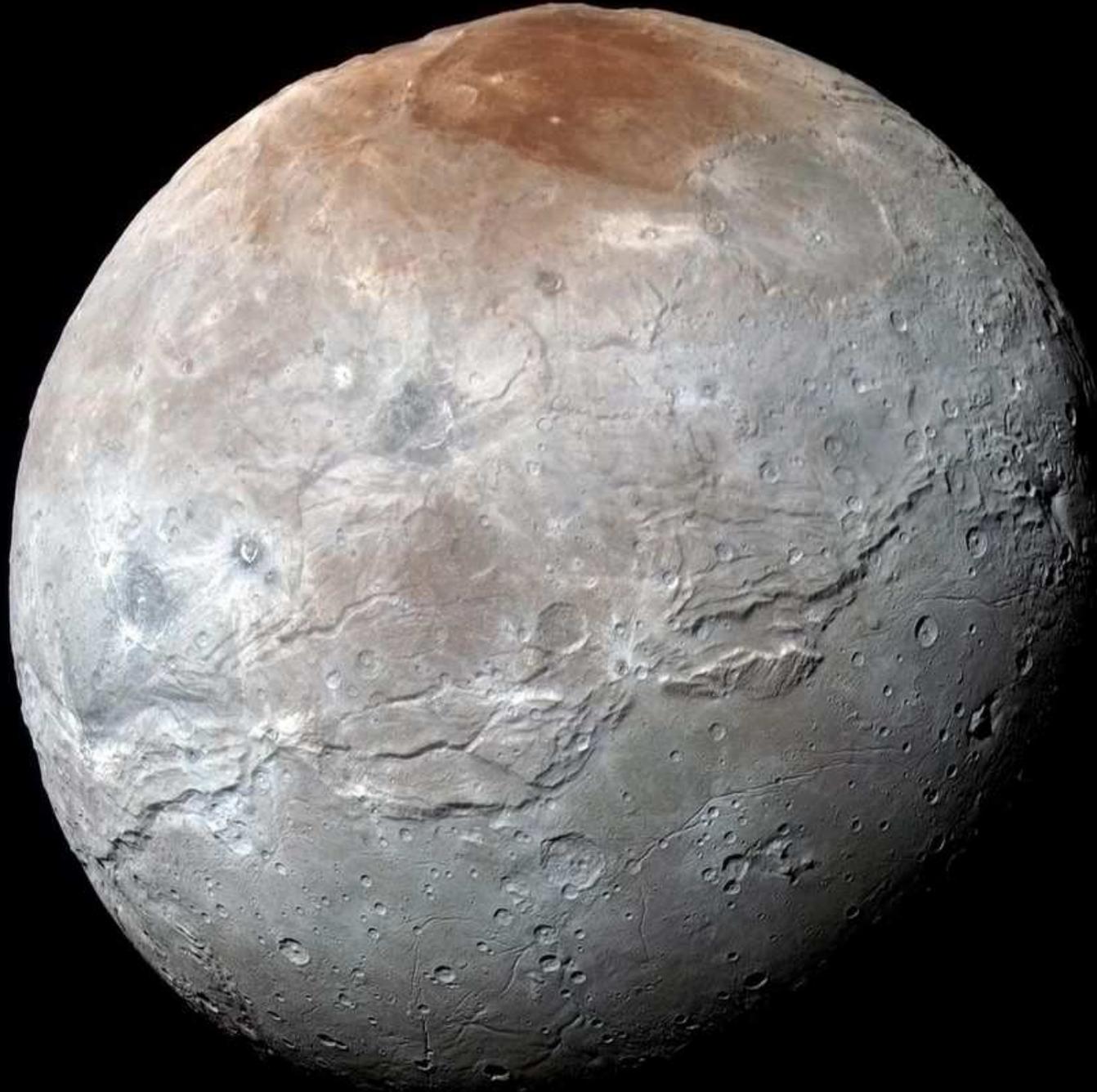
Plutón



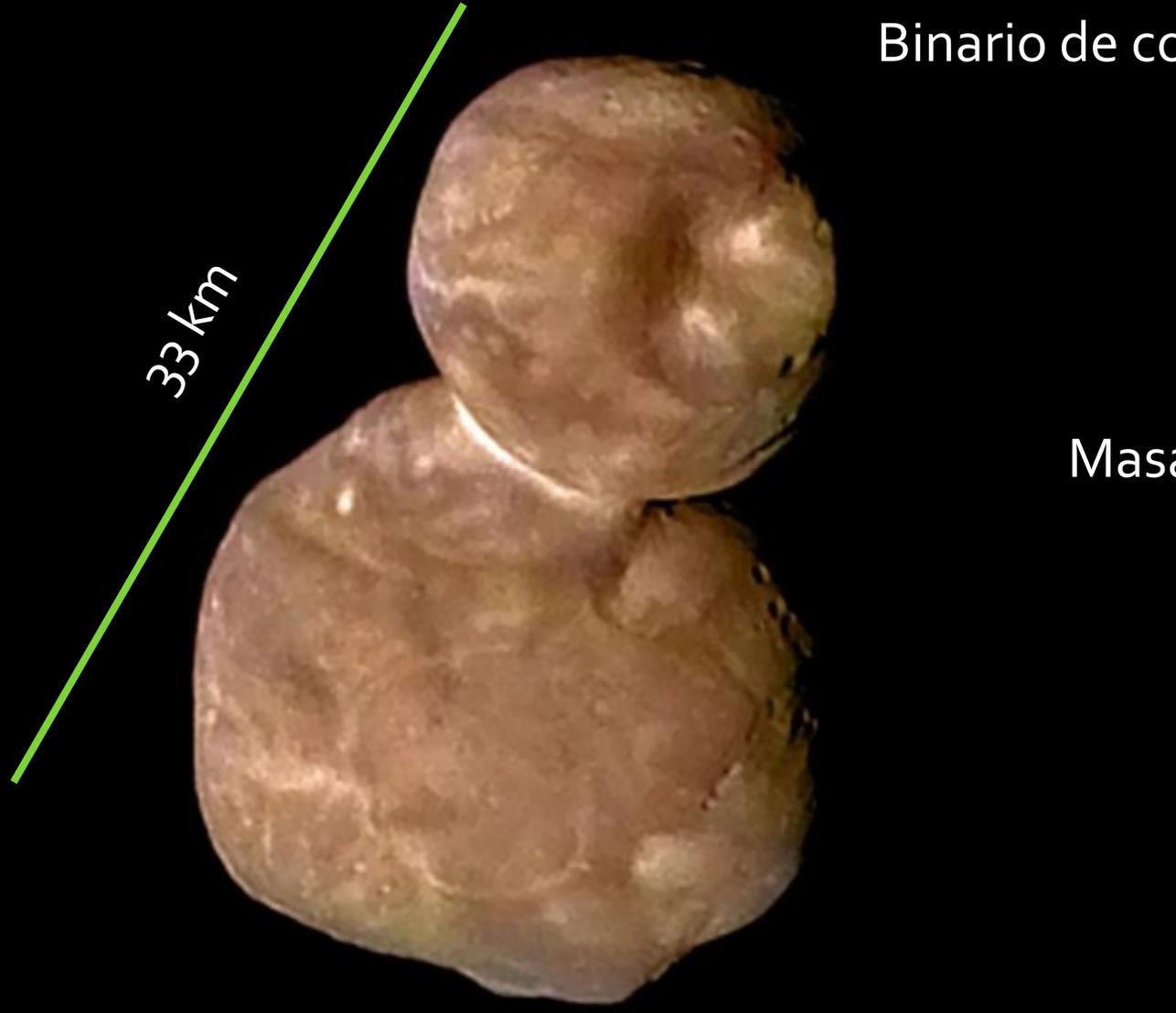
Caronte



Fractura
por
contracción



Ultima Thule

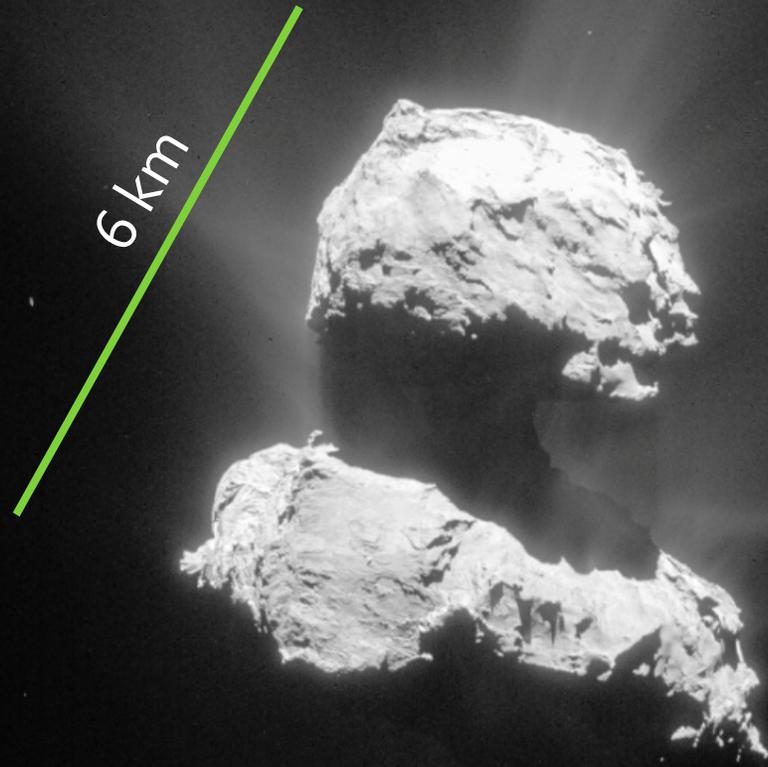


33 km

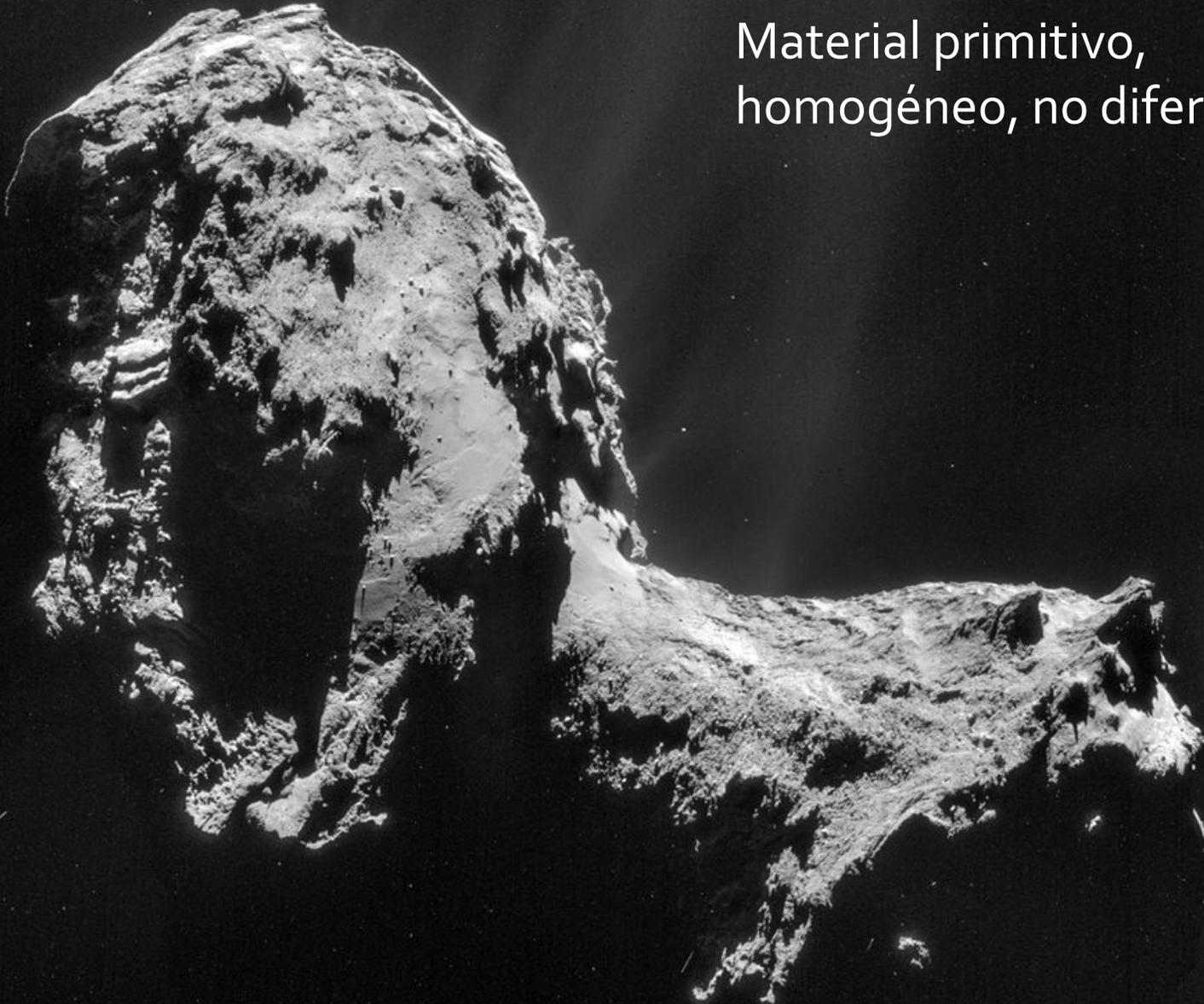
Binario de contacto

Masa?

Núcleo cometario



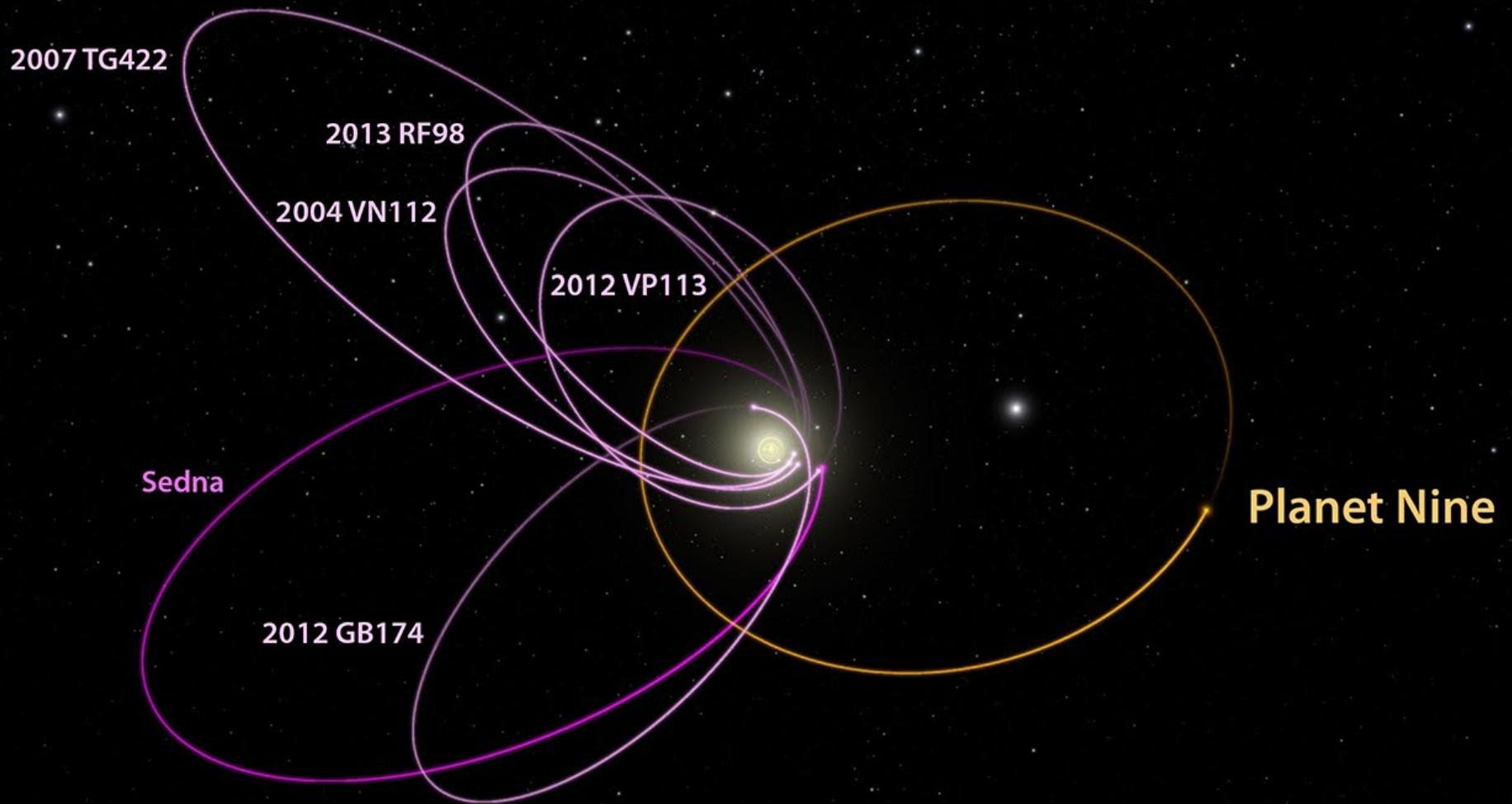
Material primitivo,
homogéneo, no diferenciado

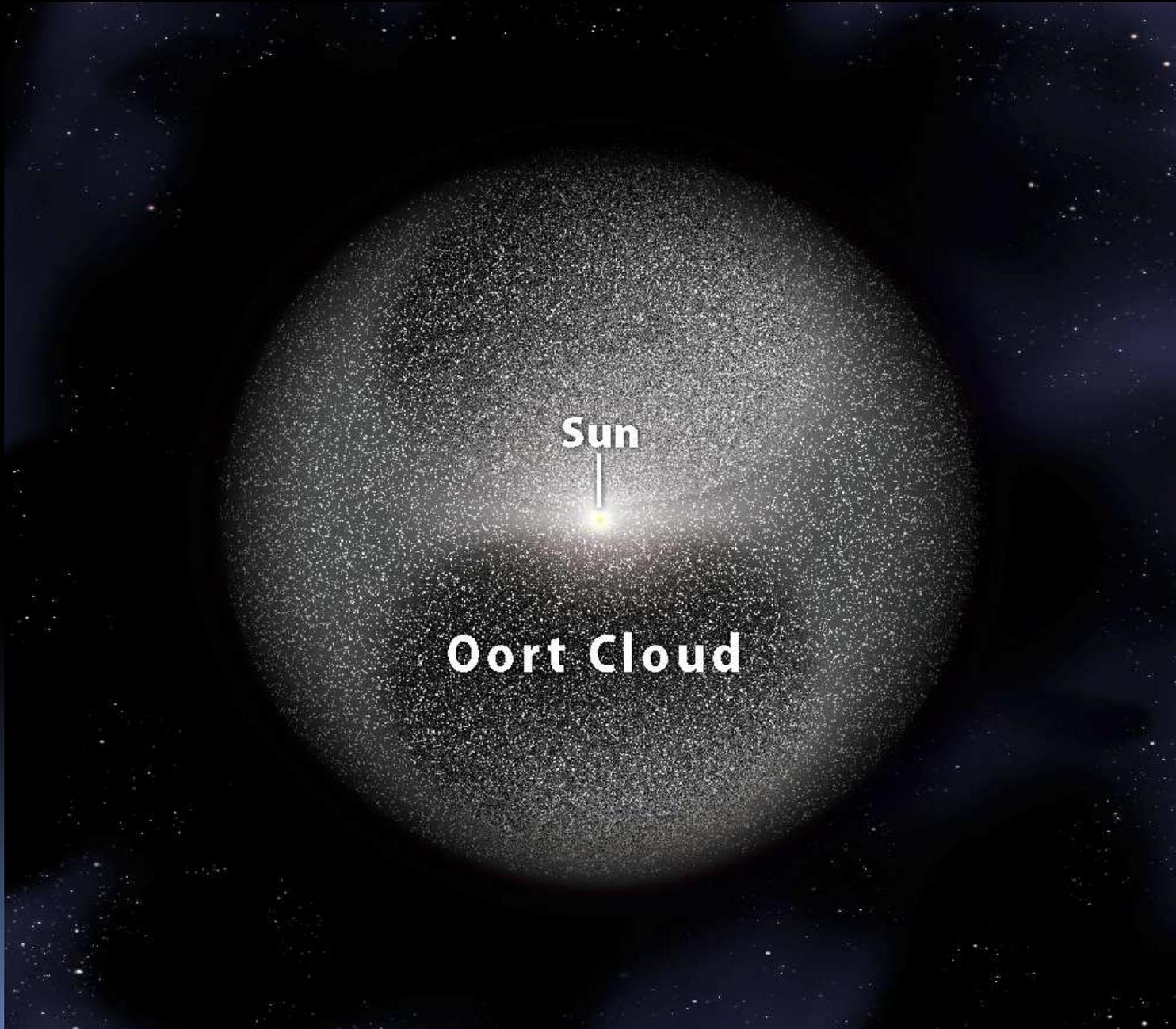


Trans-Neptunianos



¿Planeta 9?

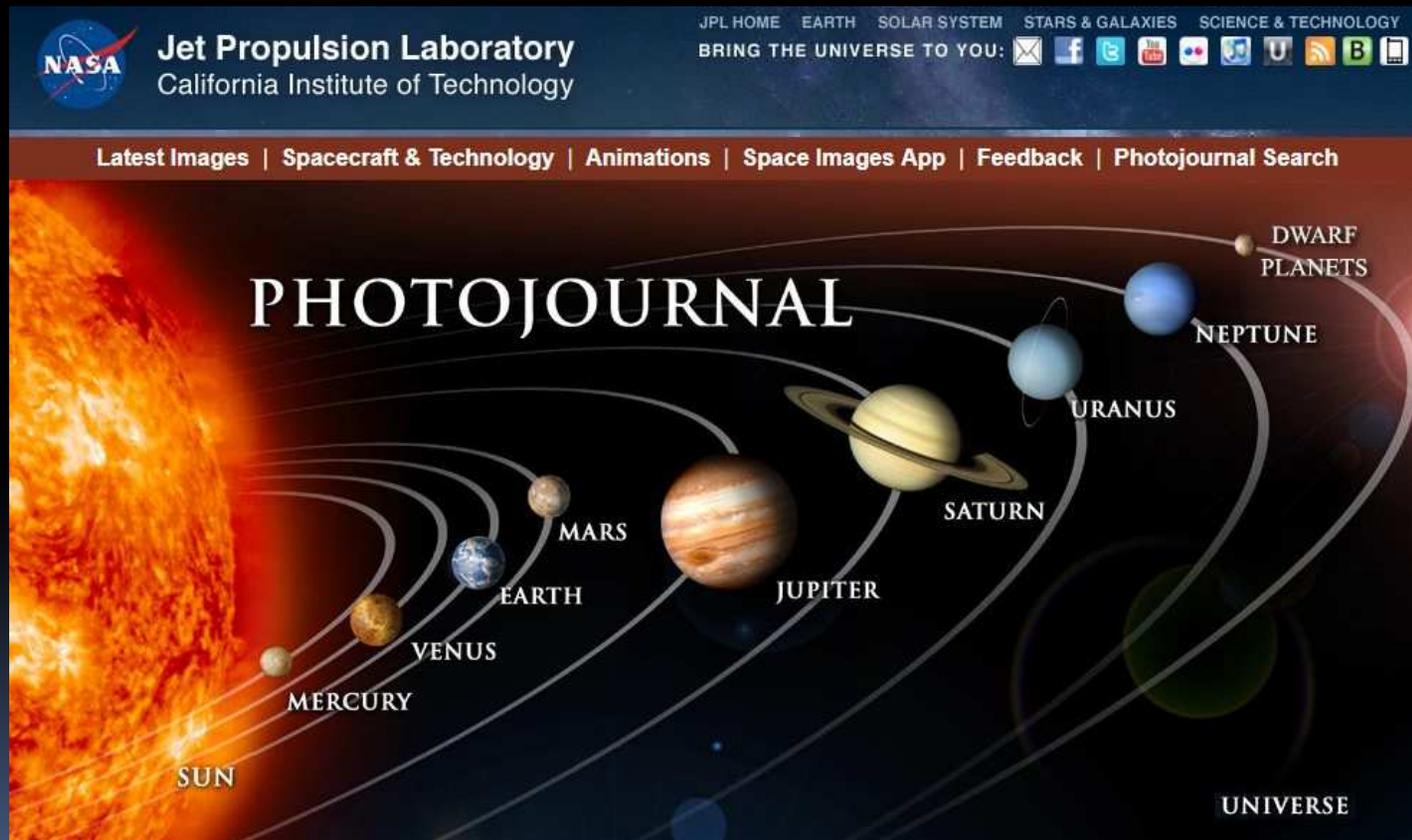




Formación y Evolución:

- Elementos y Minerales
- Gravedad y Calor
- Química
- Radiación solar
- Formación de rocas
- Procesos geológicos

photojournal.jpl.nasa.gov



¿Preguntas?

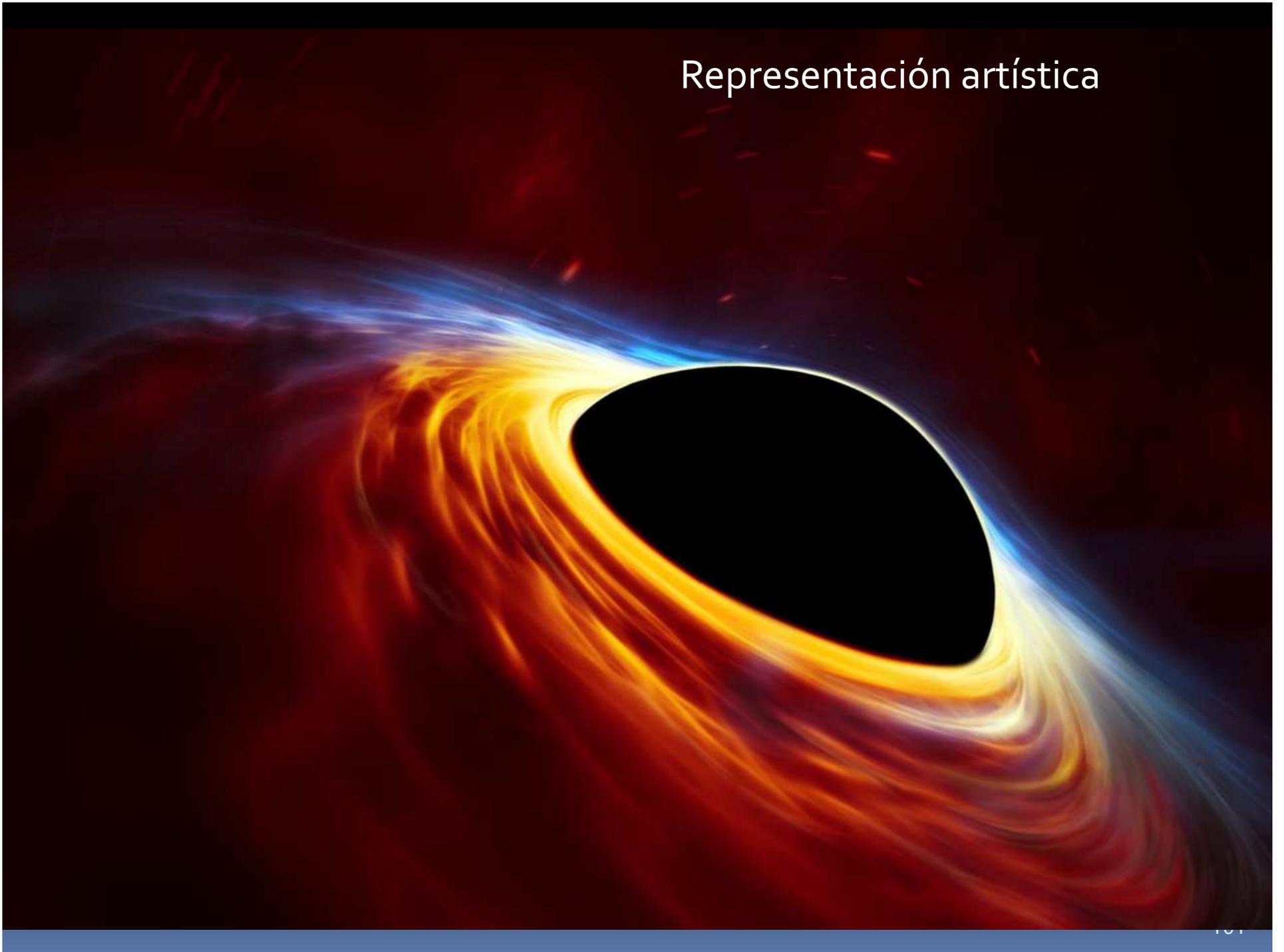
EHT BLACK HOLE IMAGE
SOURCE: NSF

Masa: 6.500 millones de soles
Distancia: 53 millones de AL



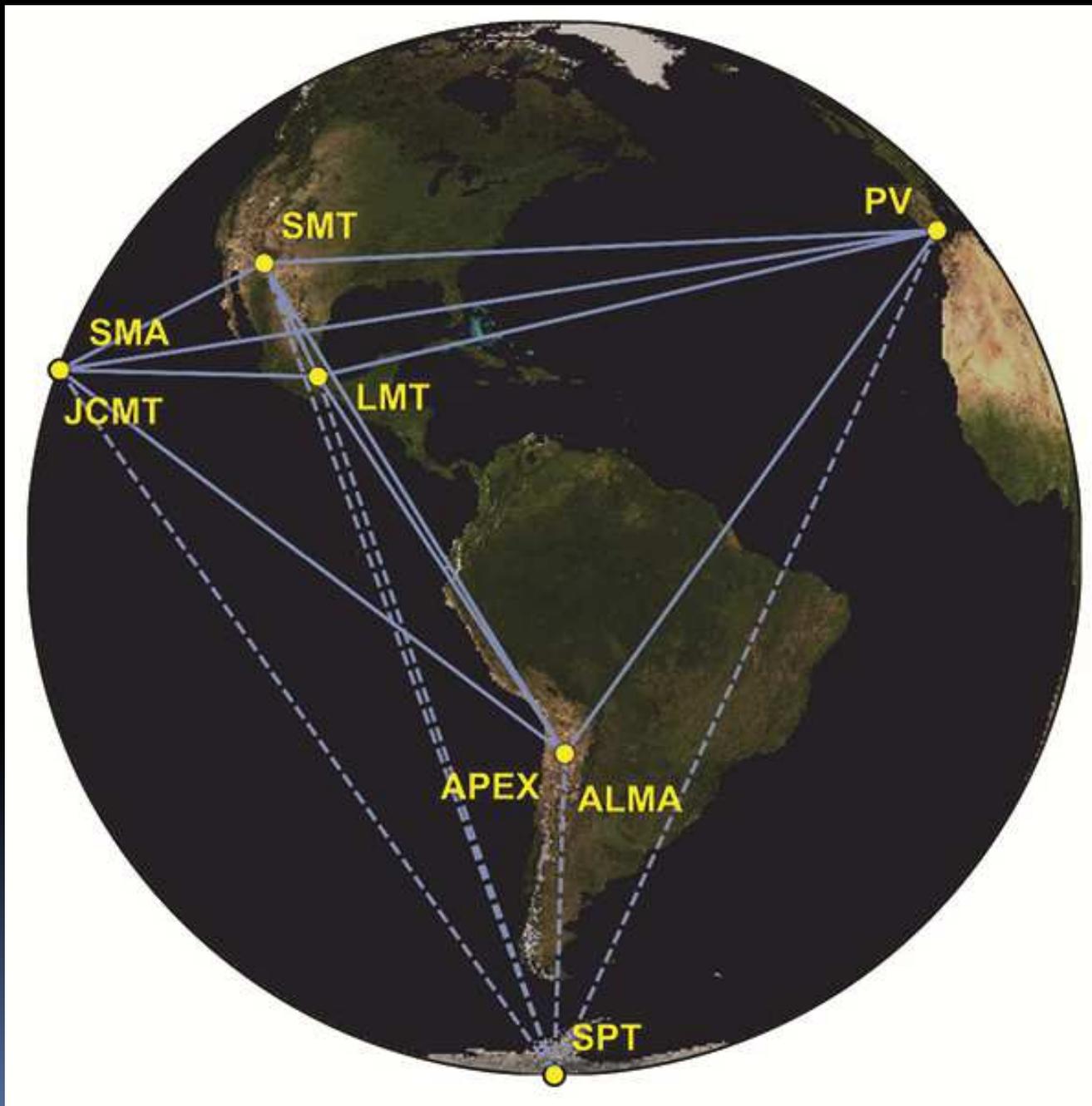
SIZE COMPARISON: THE M87 BLACK HOLE AND OUR SOLAR SYSTEM

Representación artística



¿Cómo se obtuvo?





Eclipse!!!! 2 de Julio

