

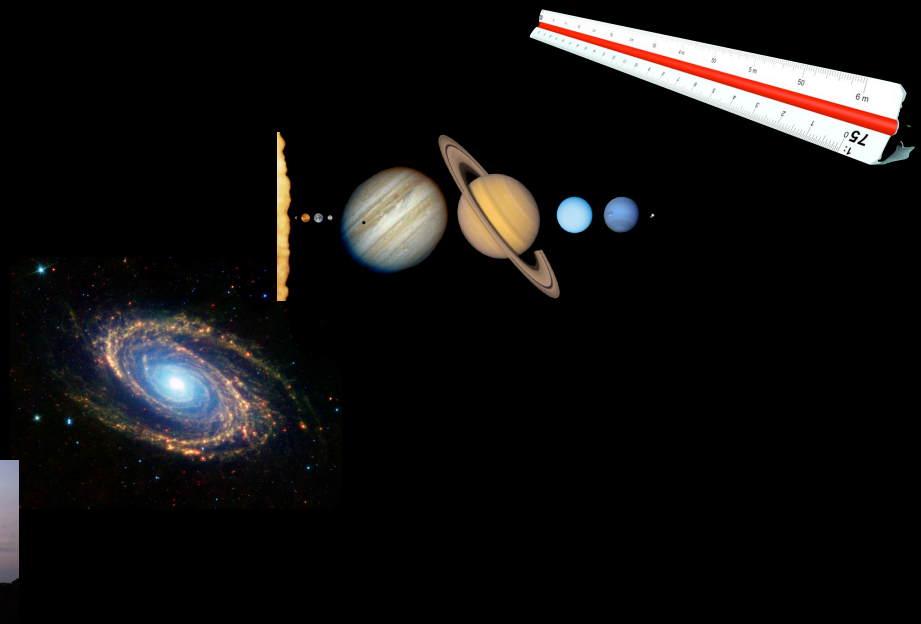
Astronomy

Ralf Klessen

Zentrum für Astronomie der Universität Heidelberg

Overview

- Astronomical Scales
- Sun and Planets
- Milky Way
- Telescopes



Astronomical Scales

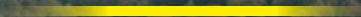


l m

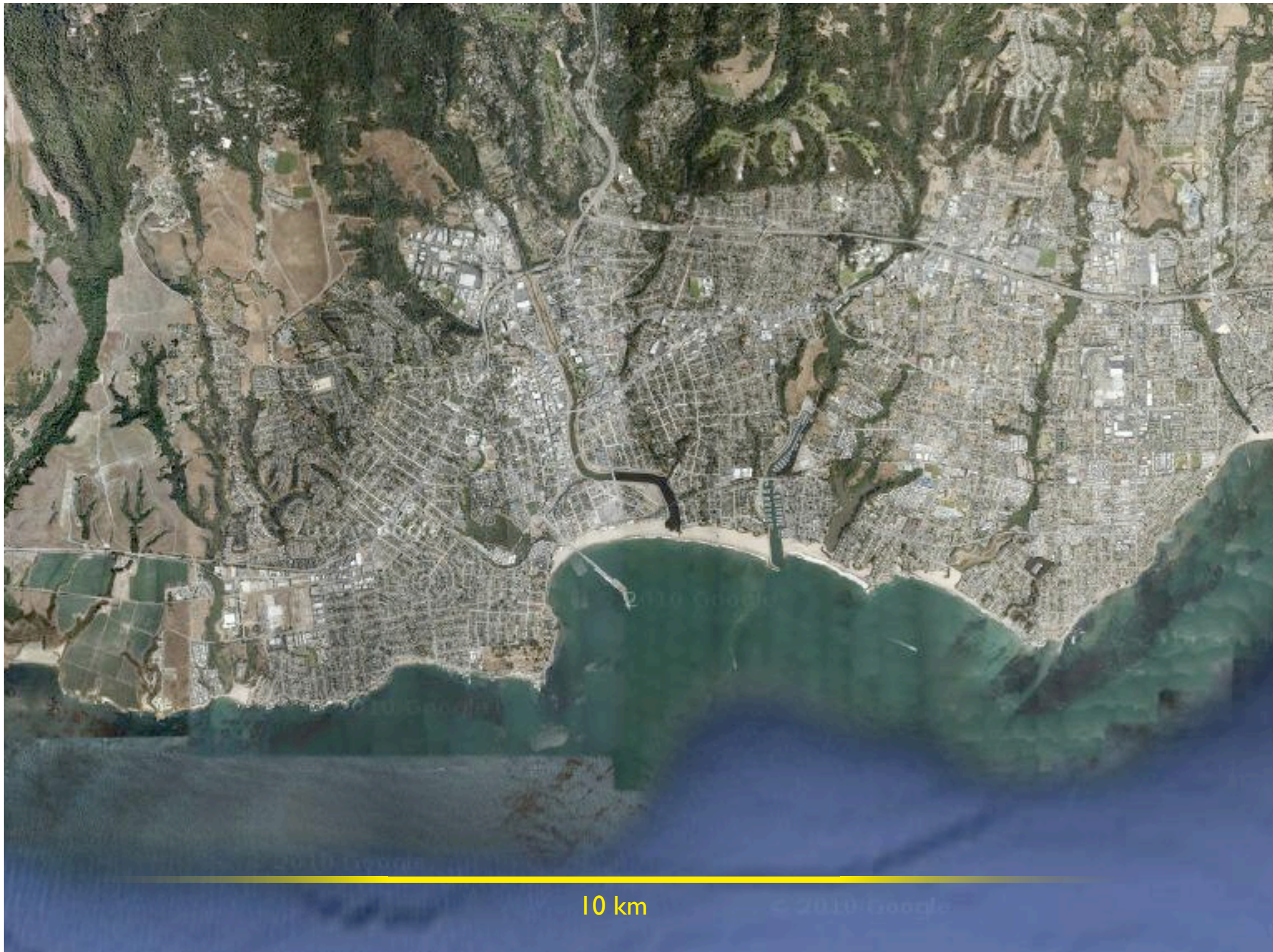


10 m

100 m







10 km

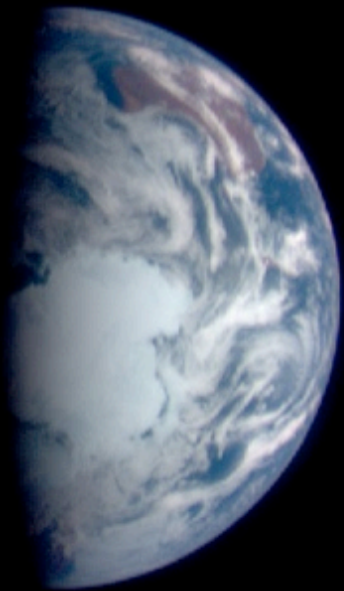
© 2010 Google



1000 km

10.000 km

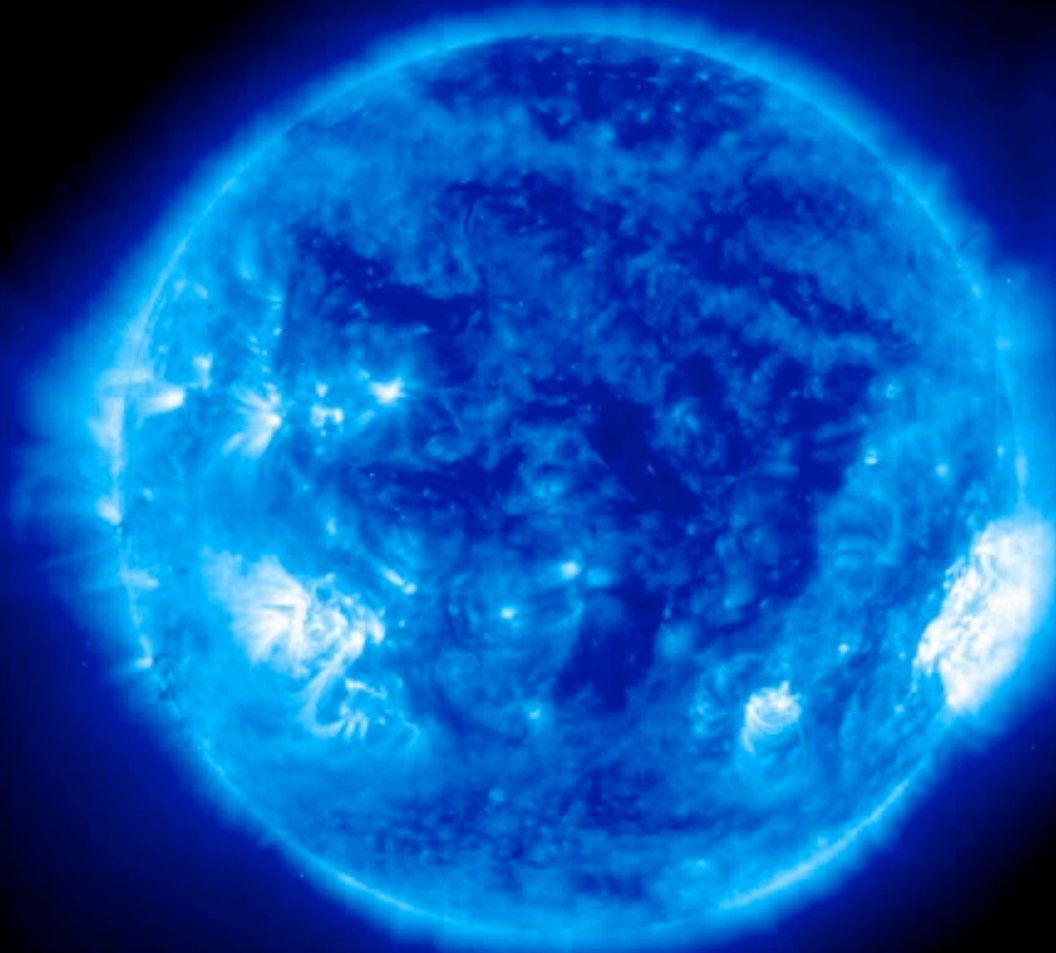




100.000 km

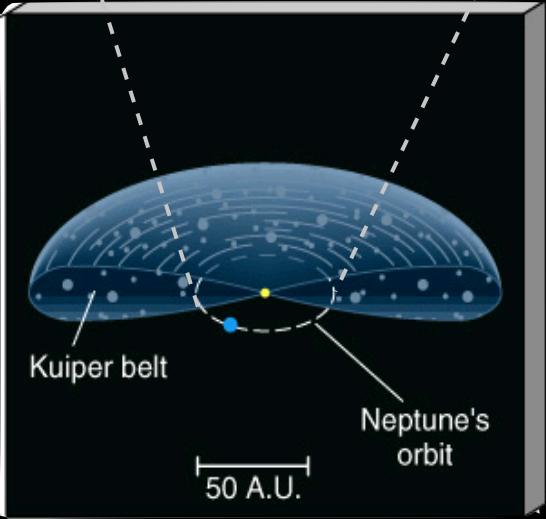
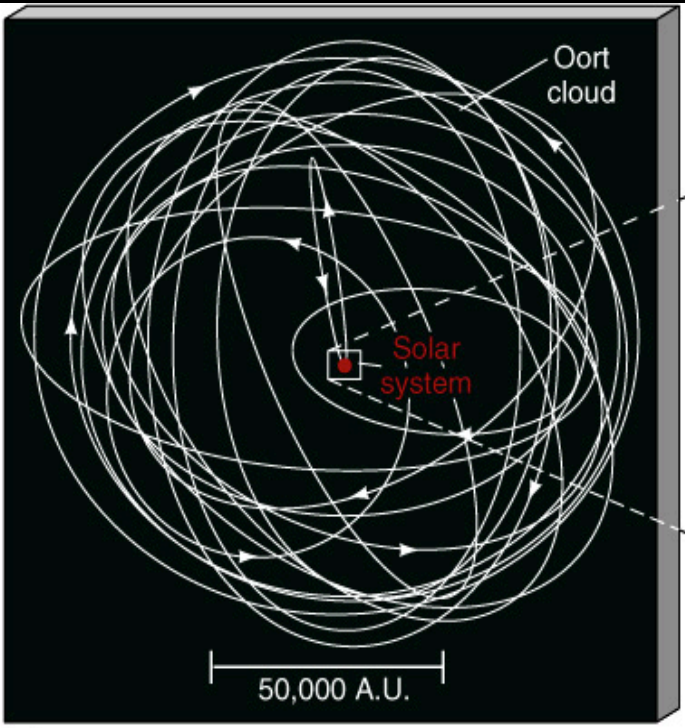
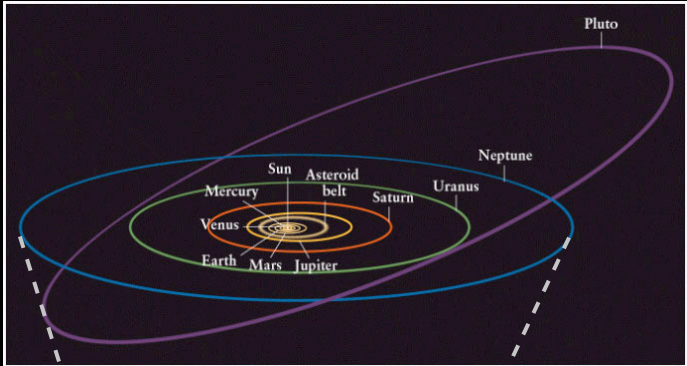


1.000.000 km



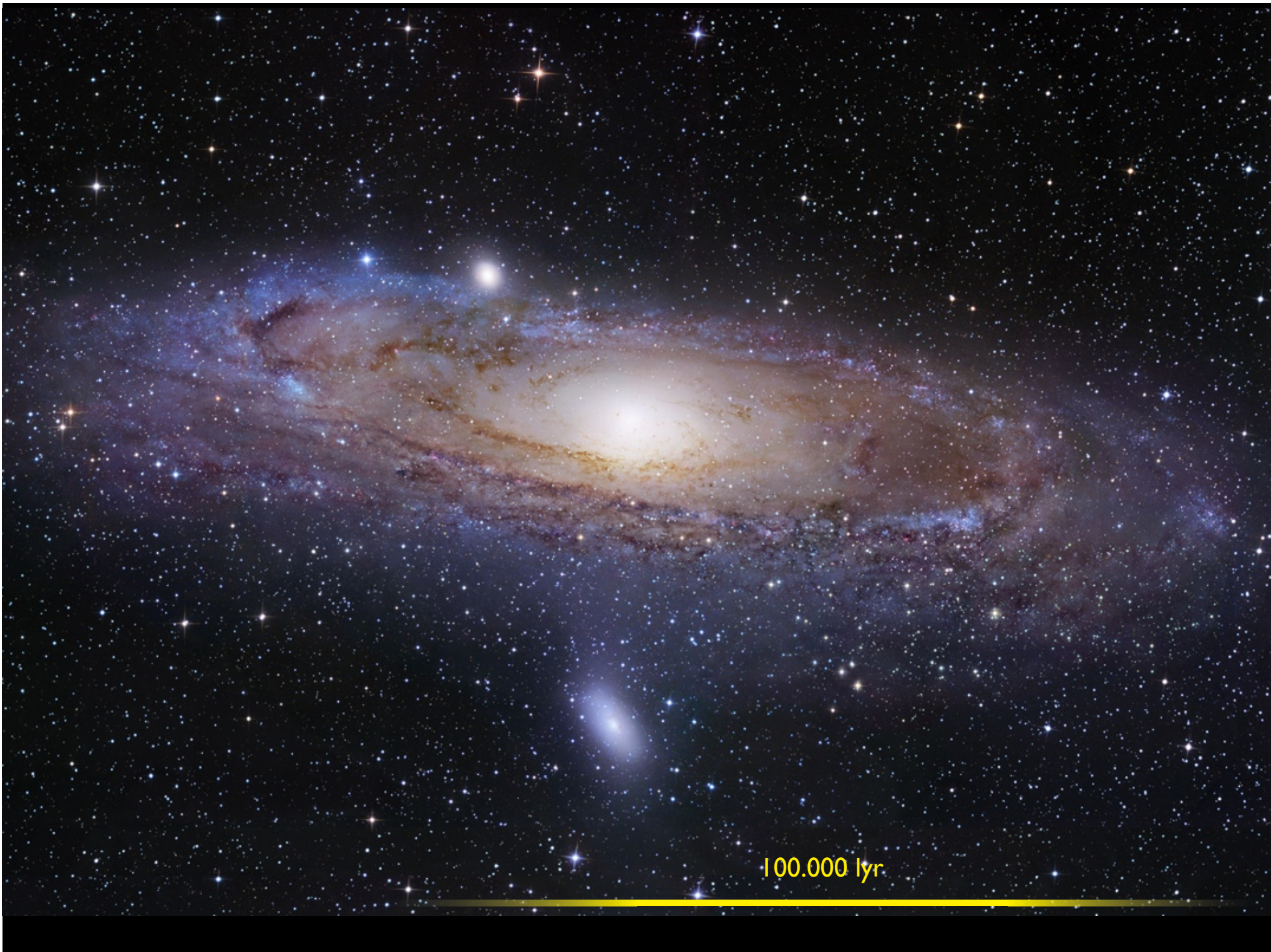
2003/08/12 13:00

10.000.000.000.000 km



10 lyr

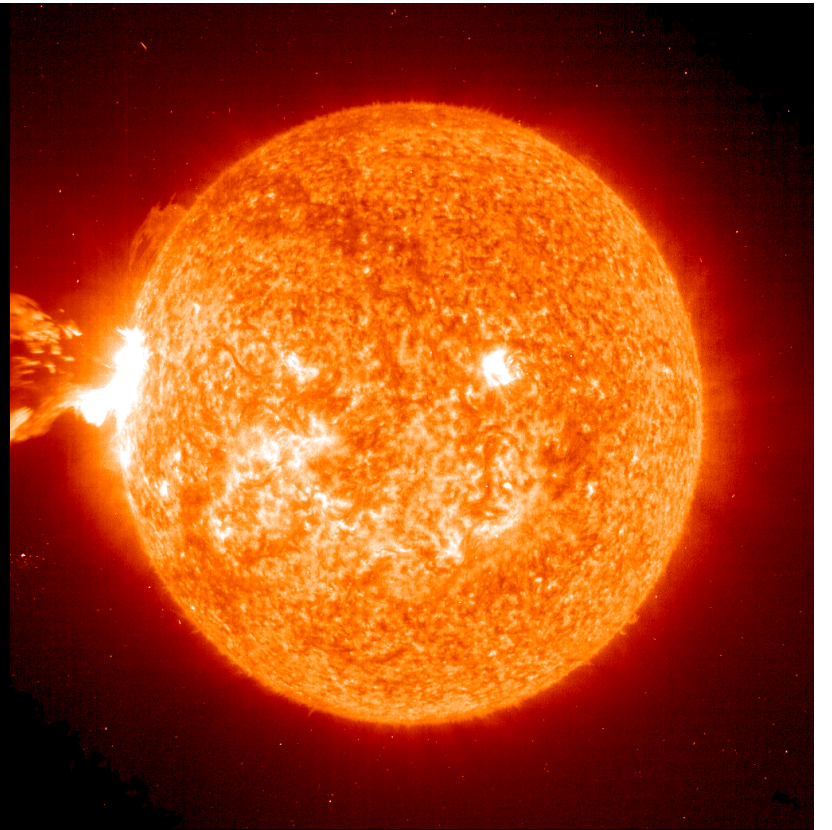




100.000 lyr

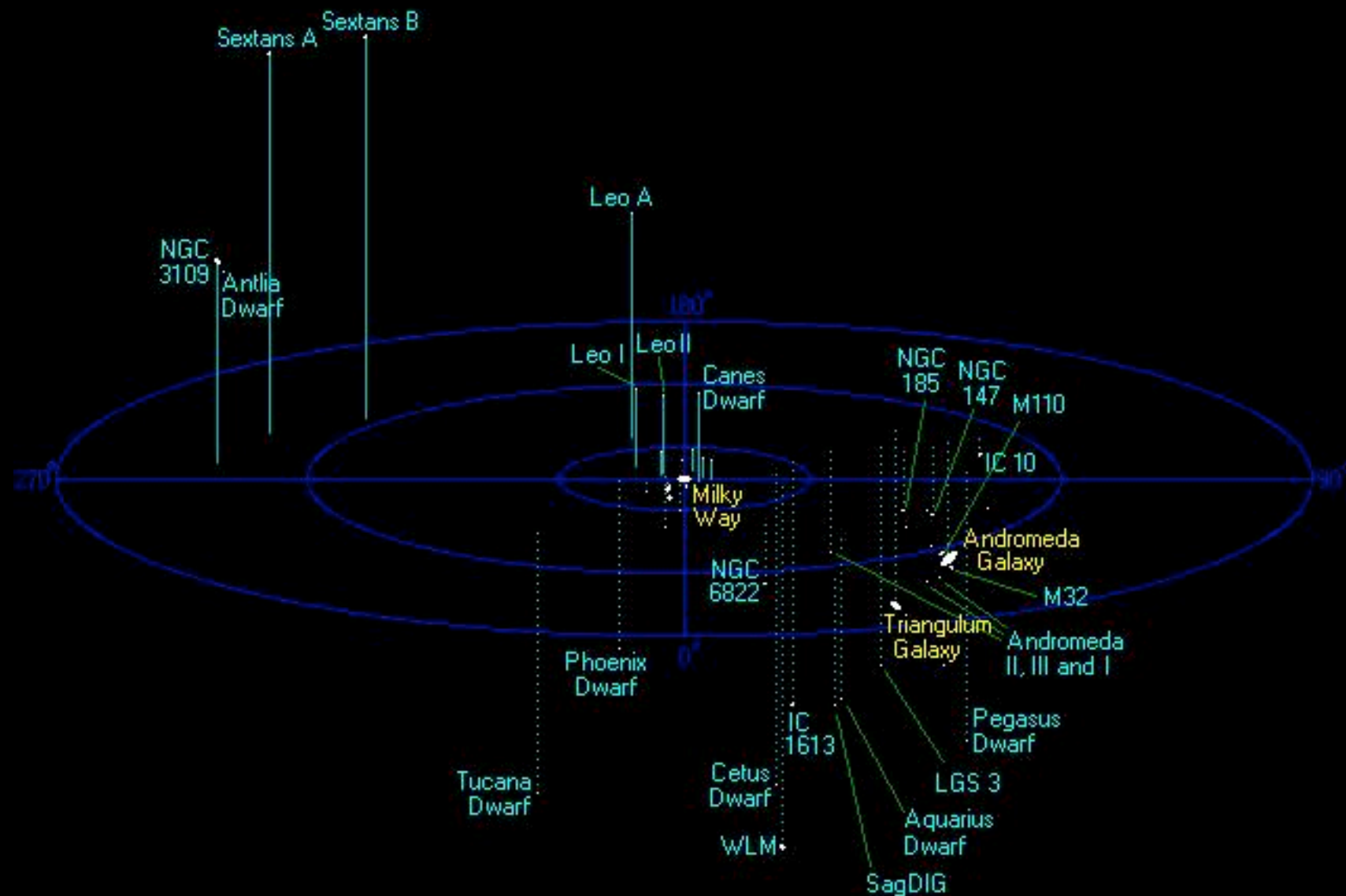


?



1.000.000 lyr

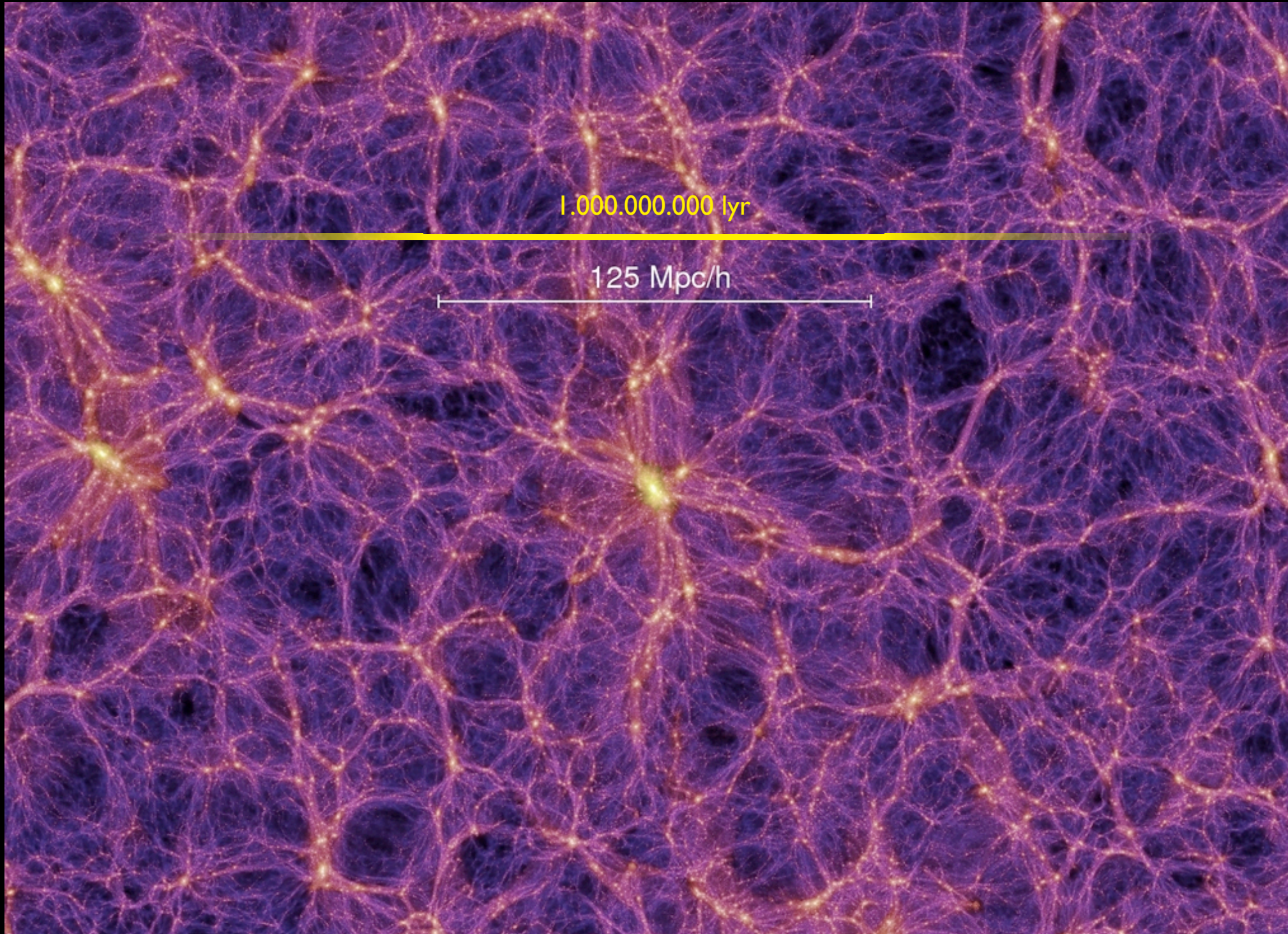




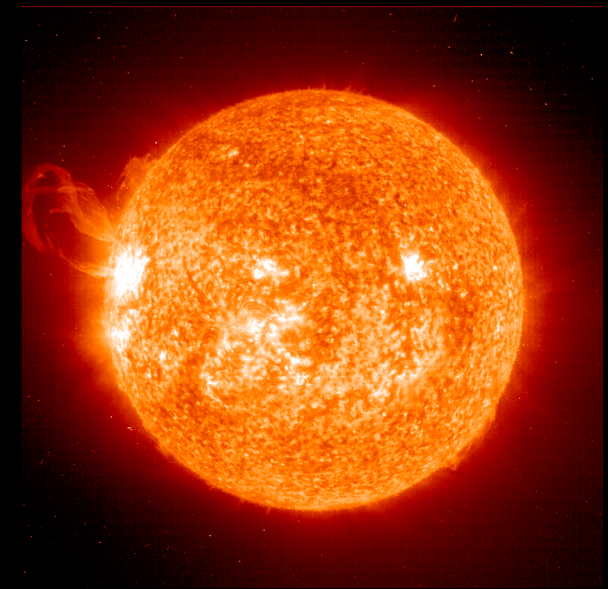
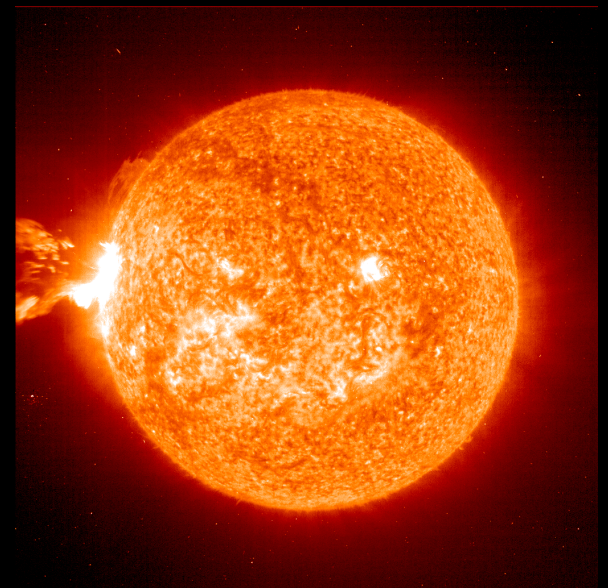
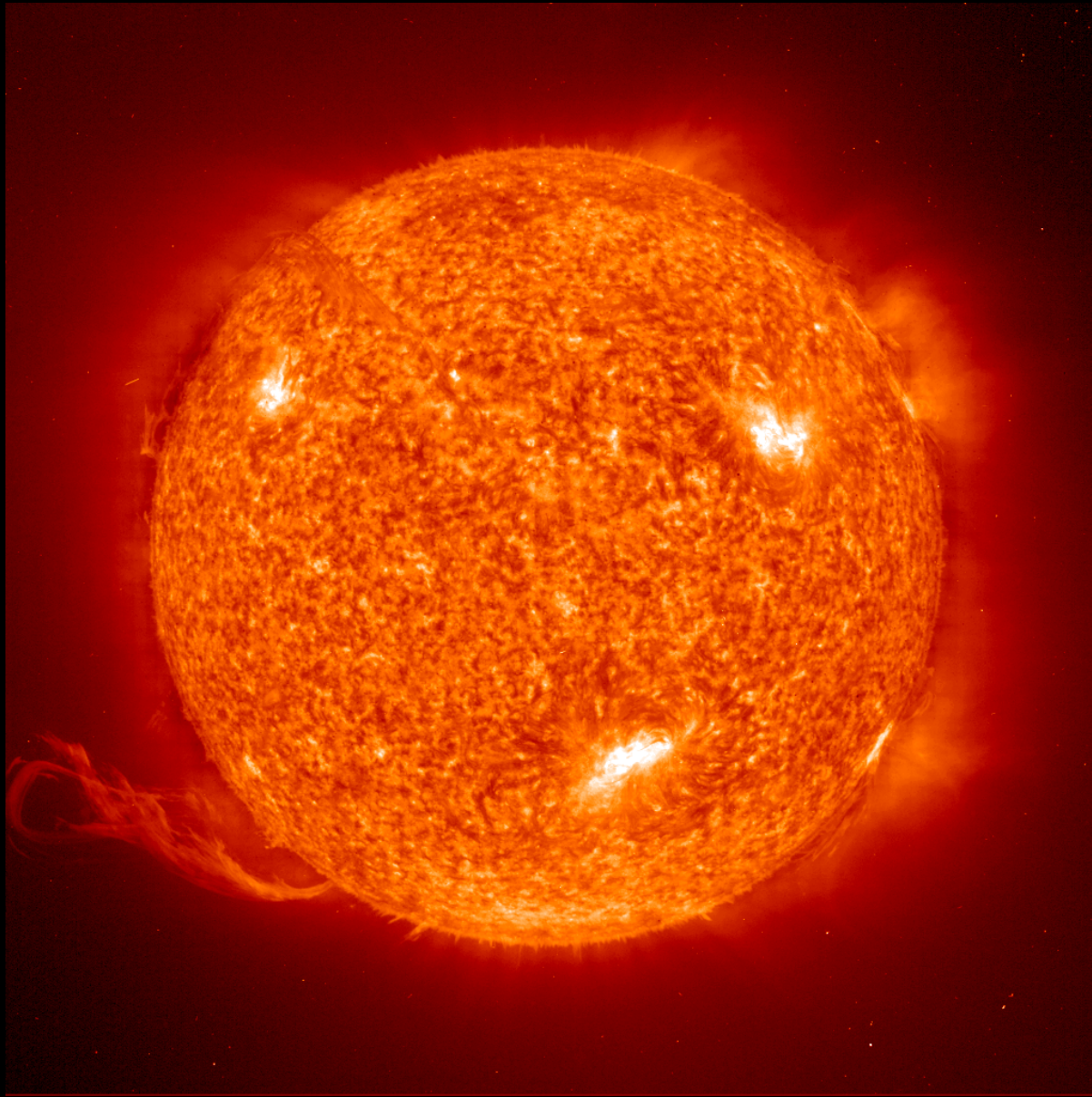
10.000.000 lyr

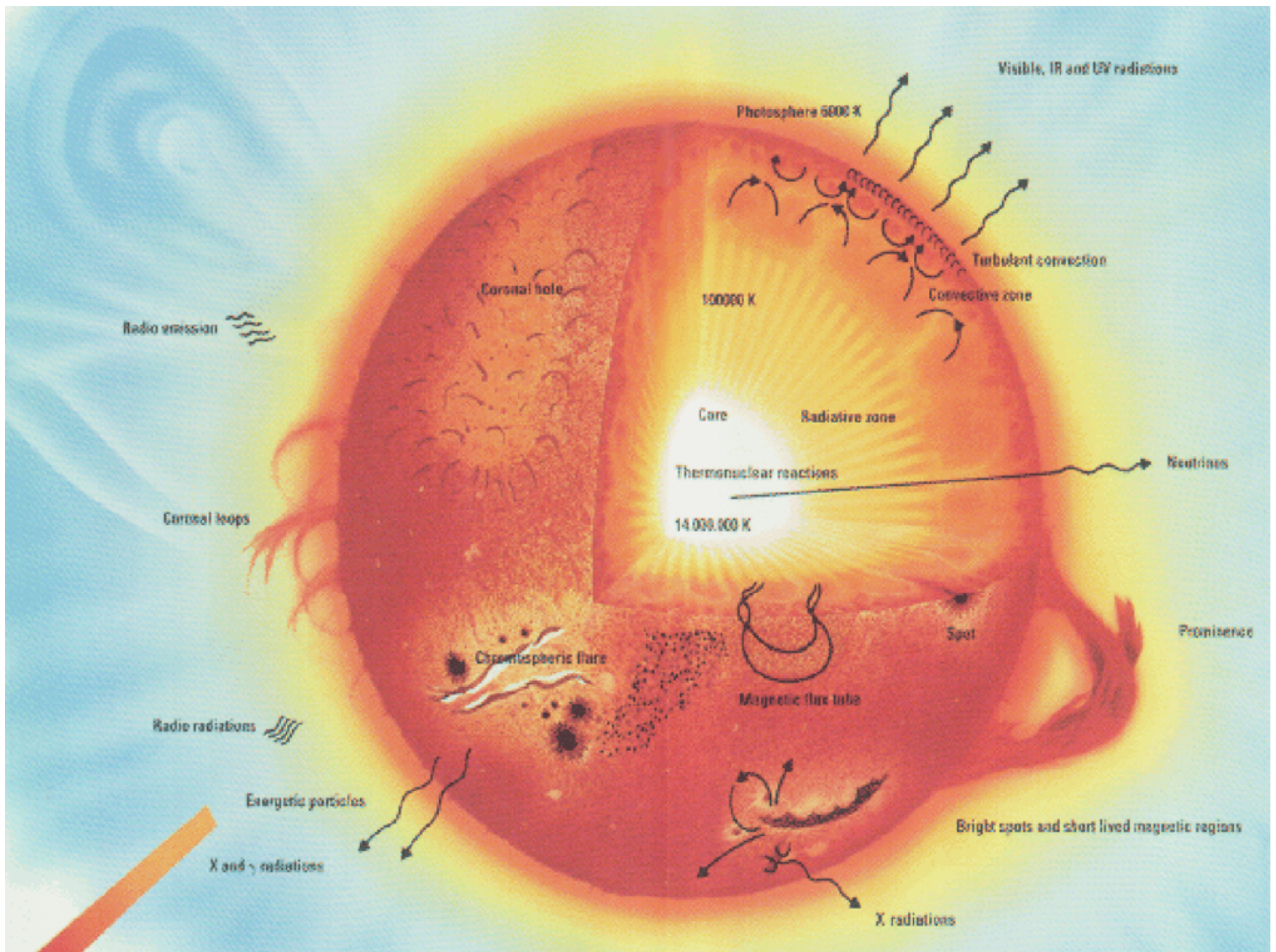


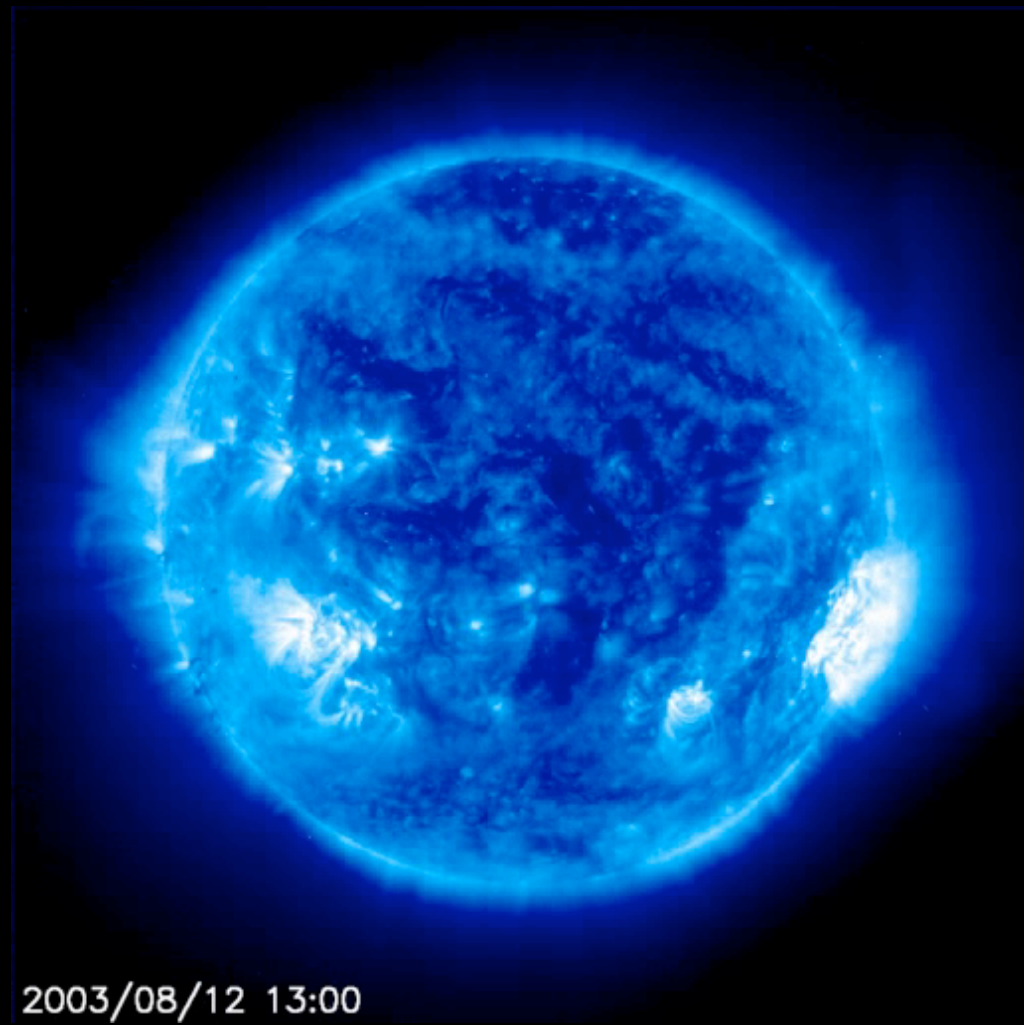
100.000.000 lyr

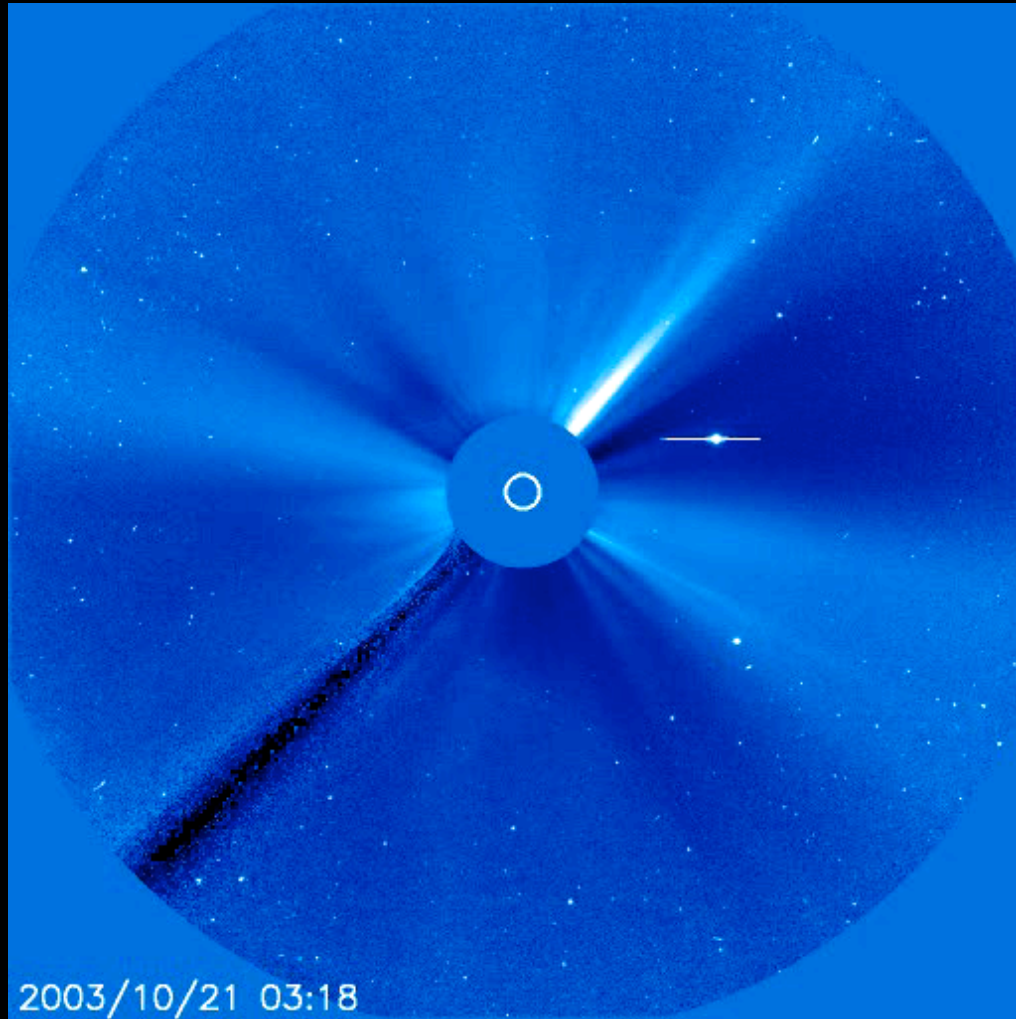


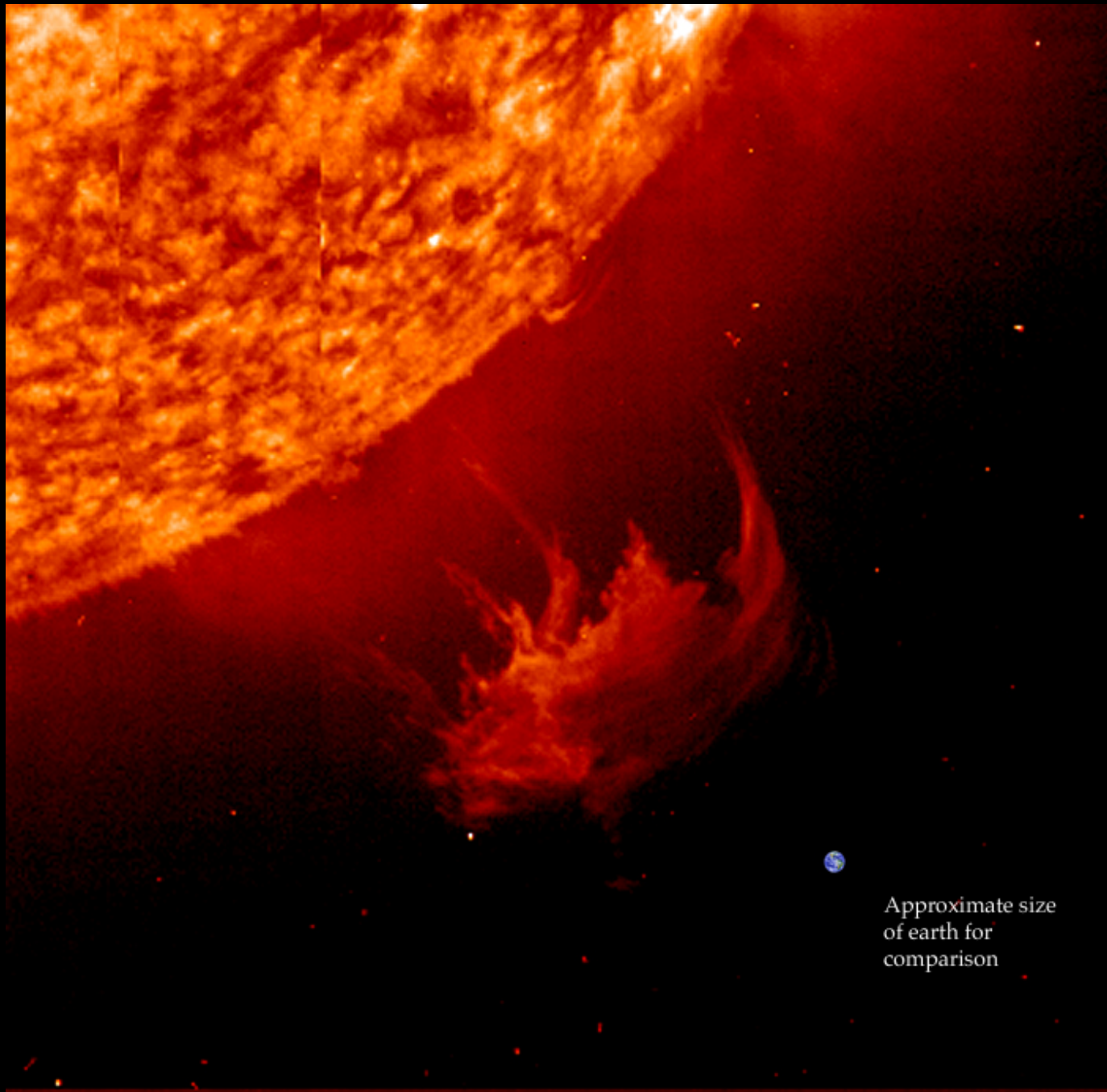
Sun and Planets





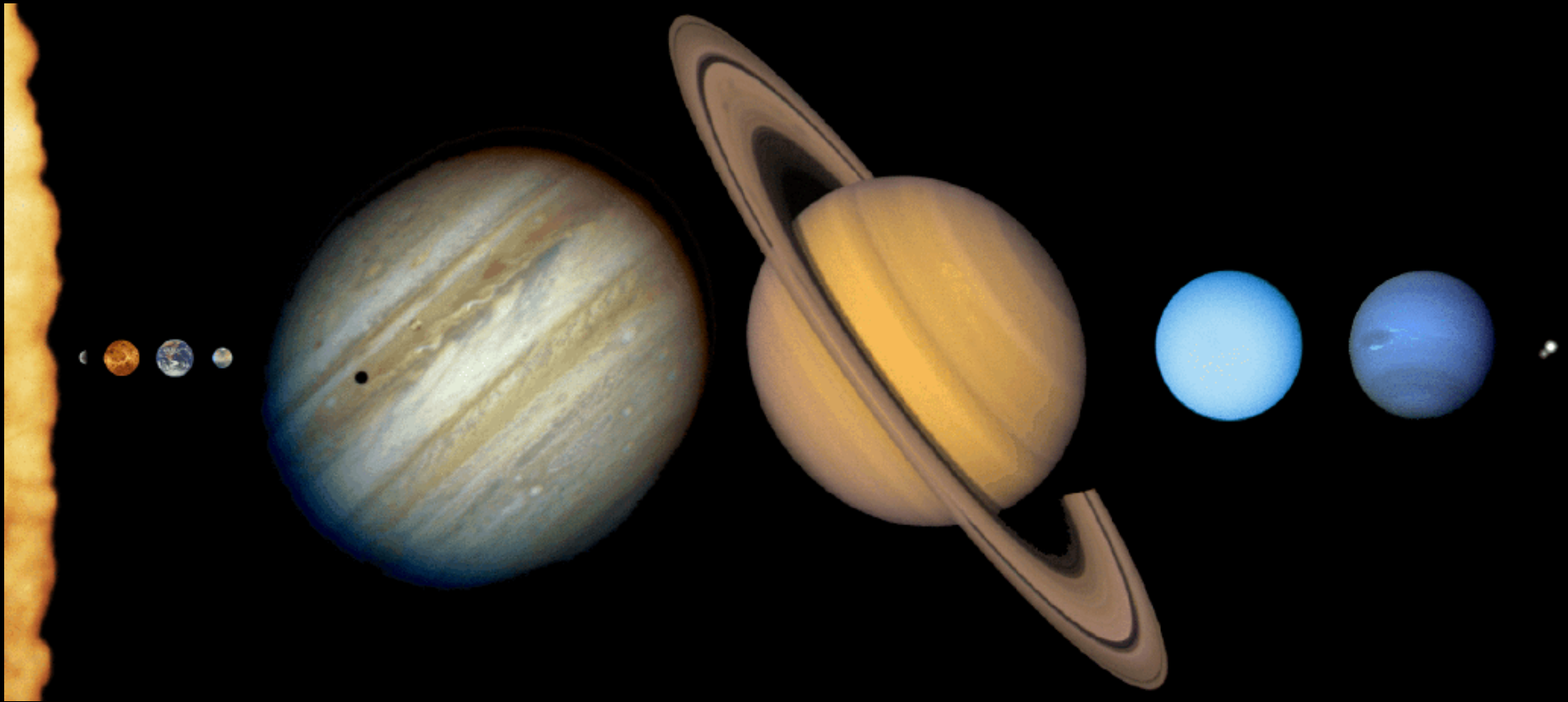






Approximate size
of earth for
comparison


Comparison of Sizes



Seven large satellites (moons) are almost as big as the terrestrial planets.

Table 7-2 **The Seven Giant Satellites**

	Moon	Io	Europa	Ganymede	Callisto	Titan	Triton
Parent planet	Earth	Jupiter	Jupiter	Jupiter	Jupiter	Saturn	Neptune
Diameter (km)	3476	3642	3130	5268	4806	5150	2706
Mass (kg)	7.35×10^{22}	8.93×10^{22}	4.80×10^{22}	1.48×10^{23}	1.08×10^{23}	1.34×10^{23}	2.15×10^{22}
Average density (kg/m ³)	3340	3530	2970	1940	1850	1880	2050
Substantial atmosphere?	No	No	No	No	No	Yes	No

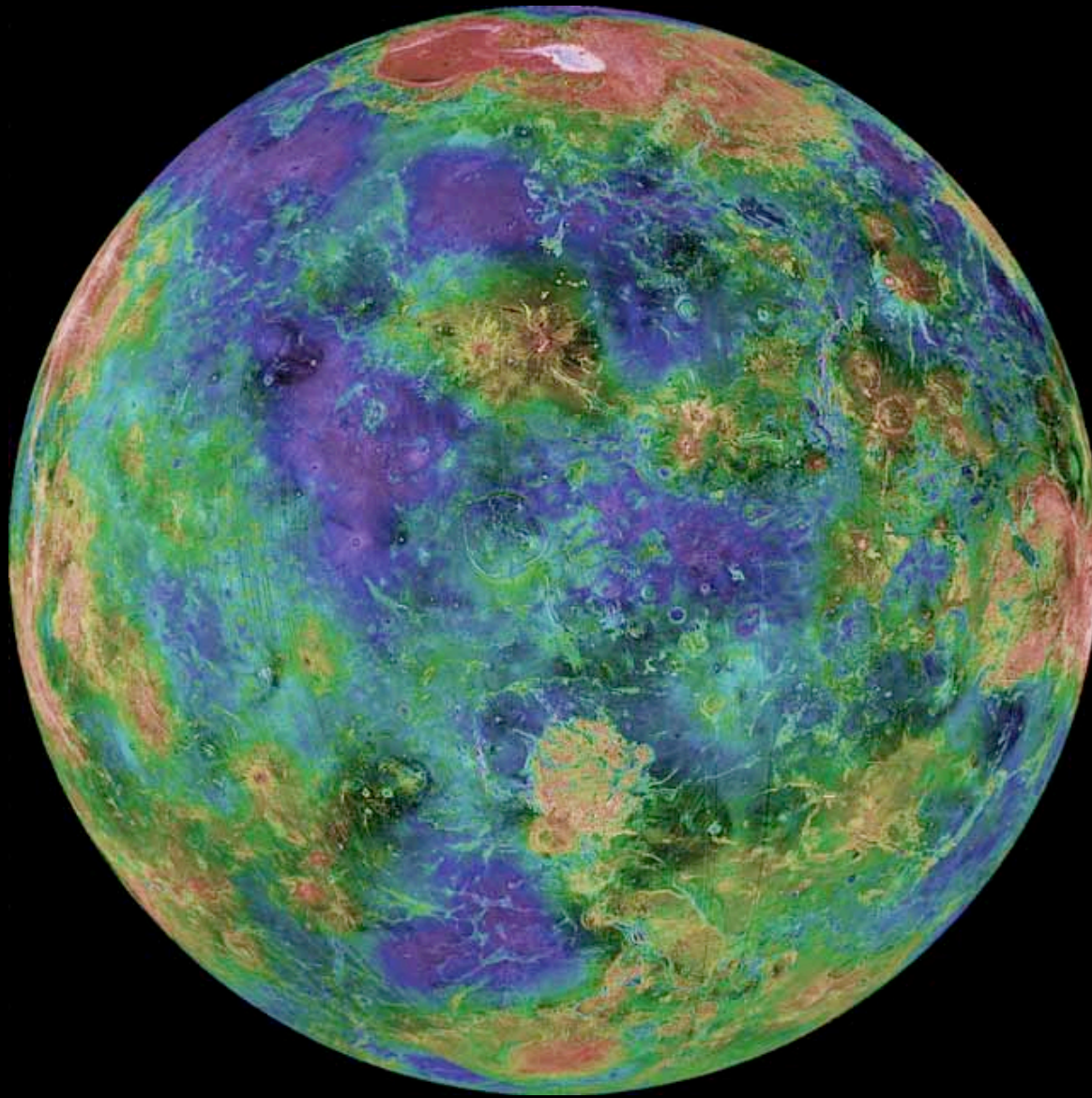


The image shows seven celestial bodies in a row against a black background. From left to right: the Moon (blue and white), Io (orange and yellow), Europa (light blue and white), Ganymede (grey and brown), Callisto (dark brown and black), Titan (orange and yellow), and Triton (light blue and white). Below each image is its name: Moon, Io, Europa, Ganymede, Callisto, Titan, and Triton.



Mercury

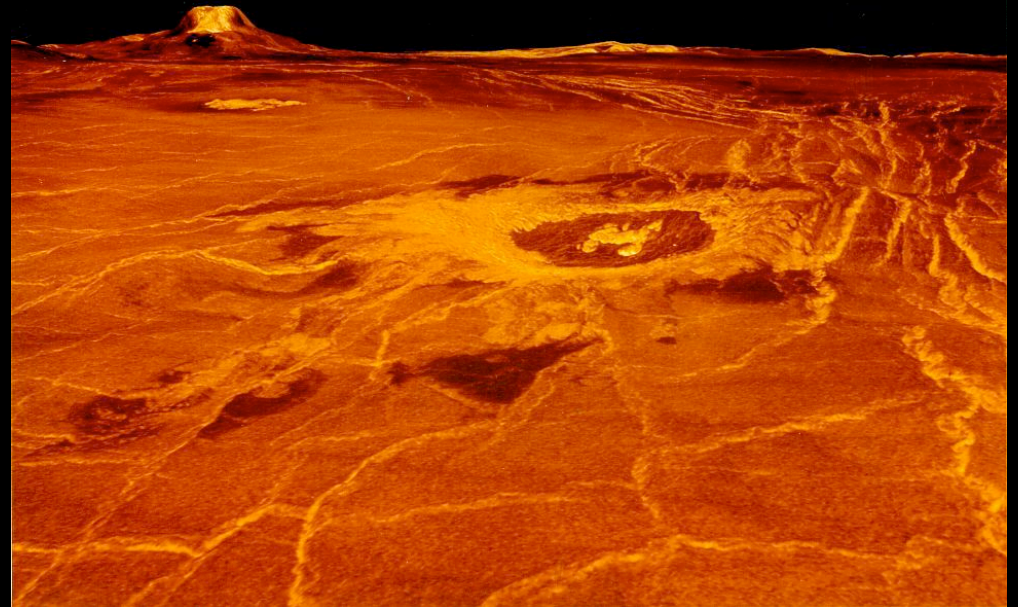
- Mercury is the innermost planet.
- Its diameter is $\frac{1}{3}$ of the Earth's diameter.



Venus

- Venus is the second planet.
- It has roughly the same size as the Earth.

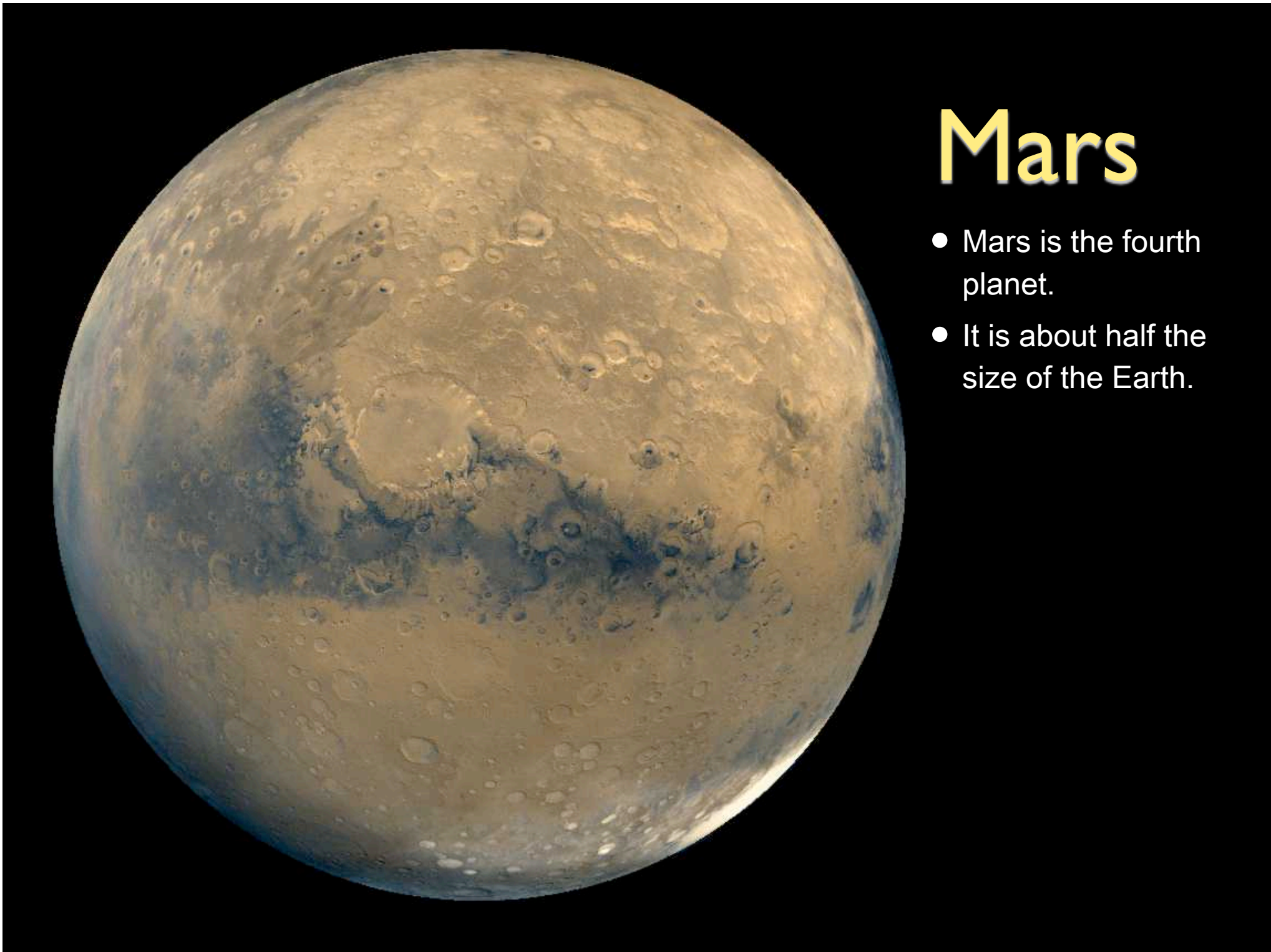
Venus





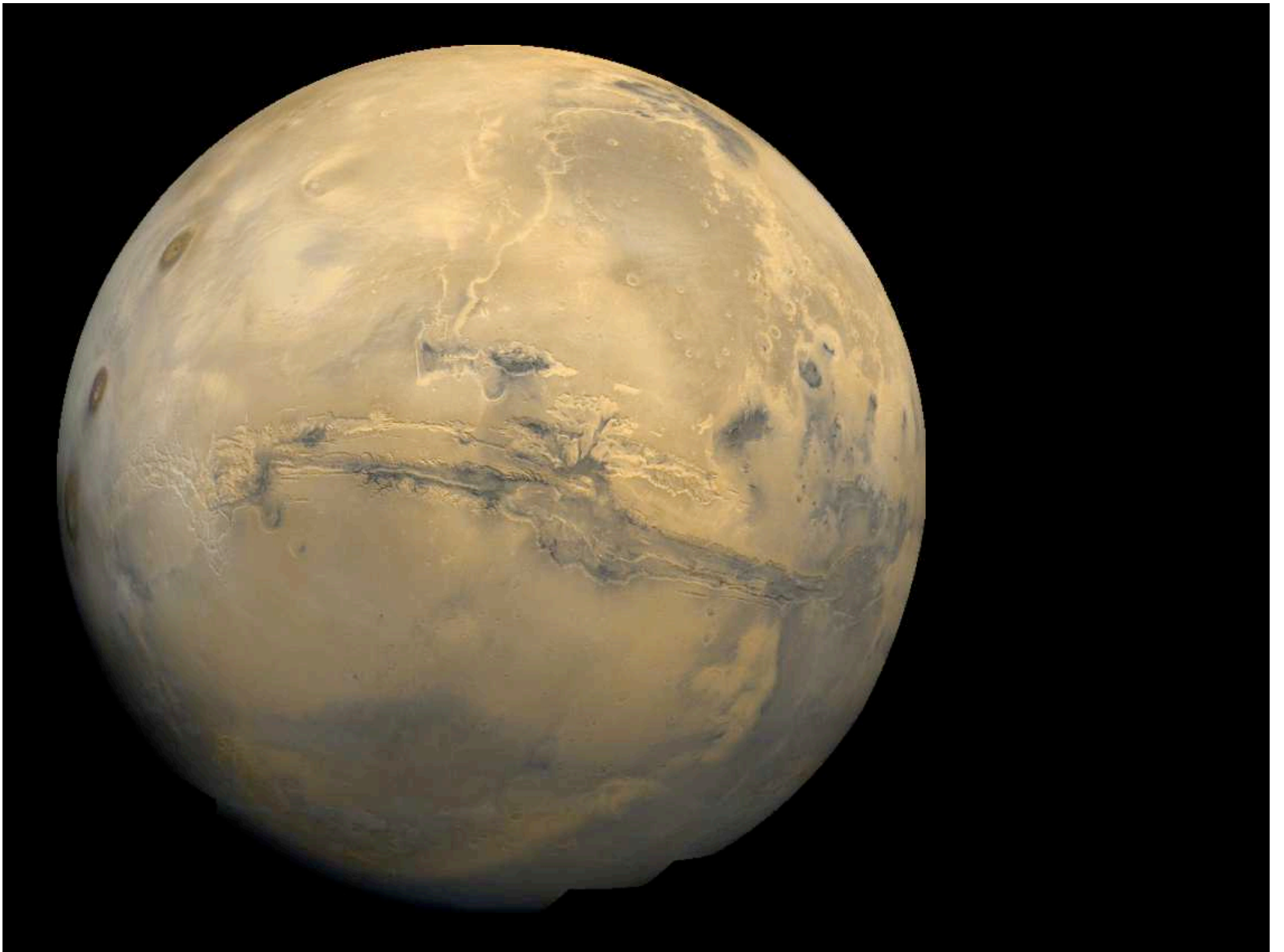
Erde

- Earth is the third planet.
- It has a diameter of 12.000 km.

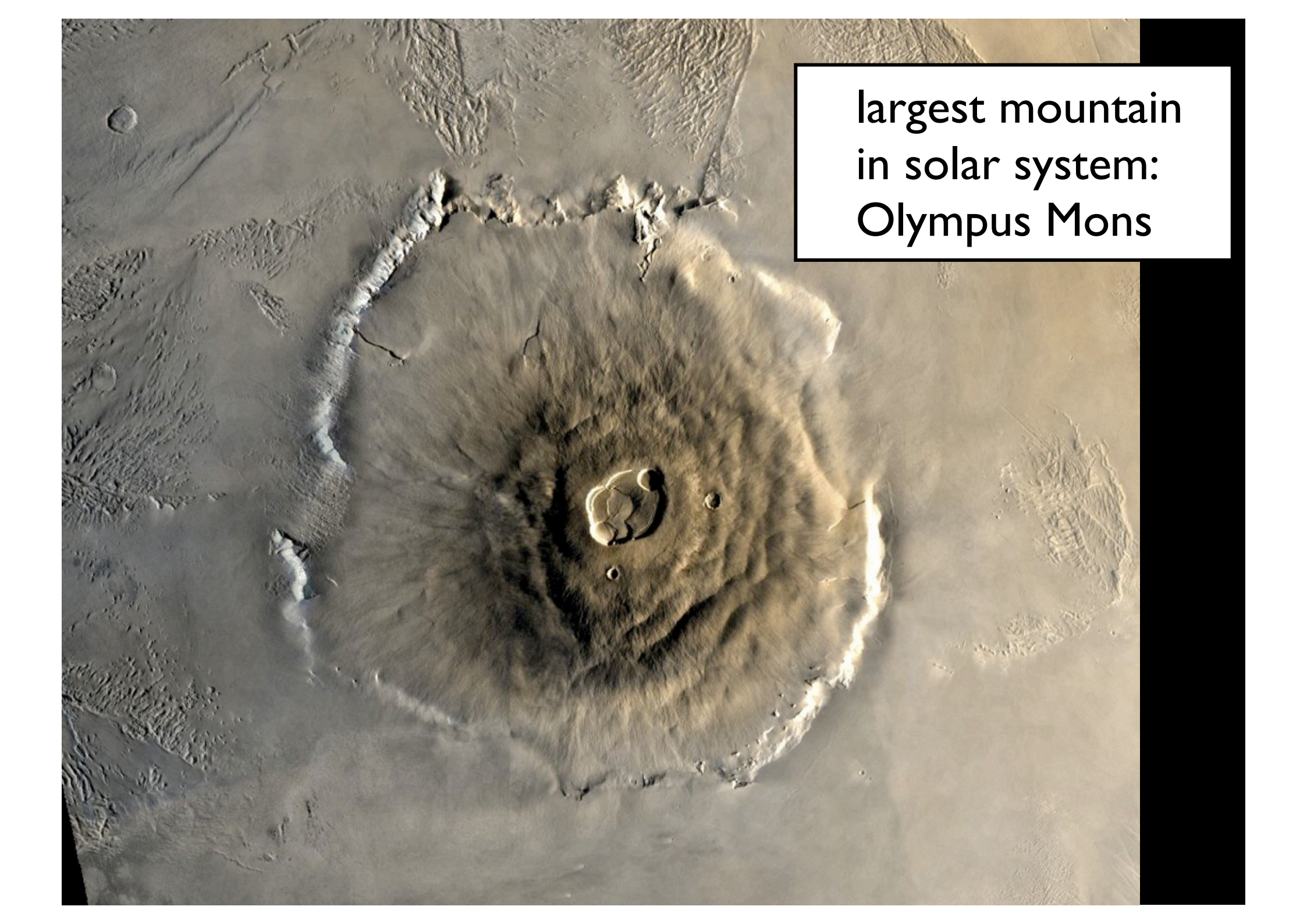


Mars

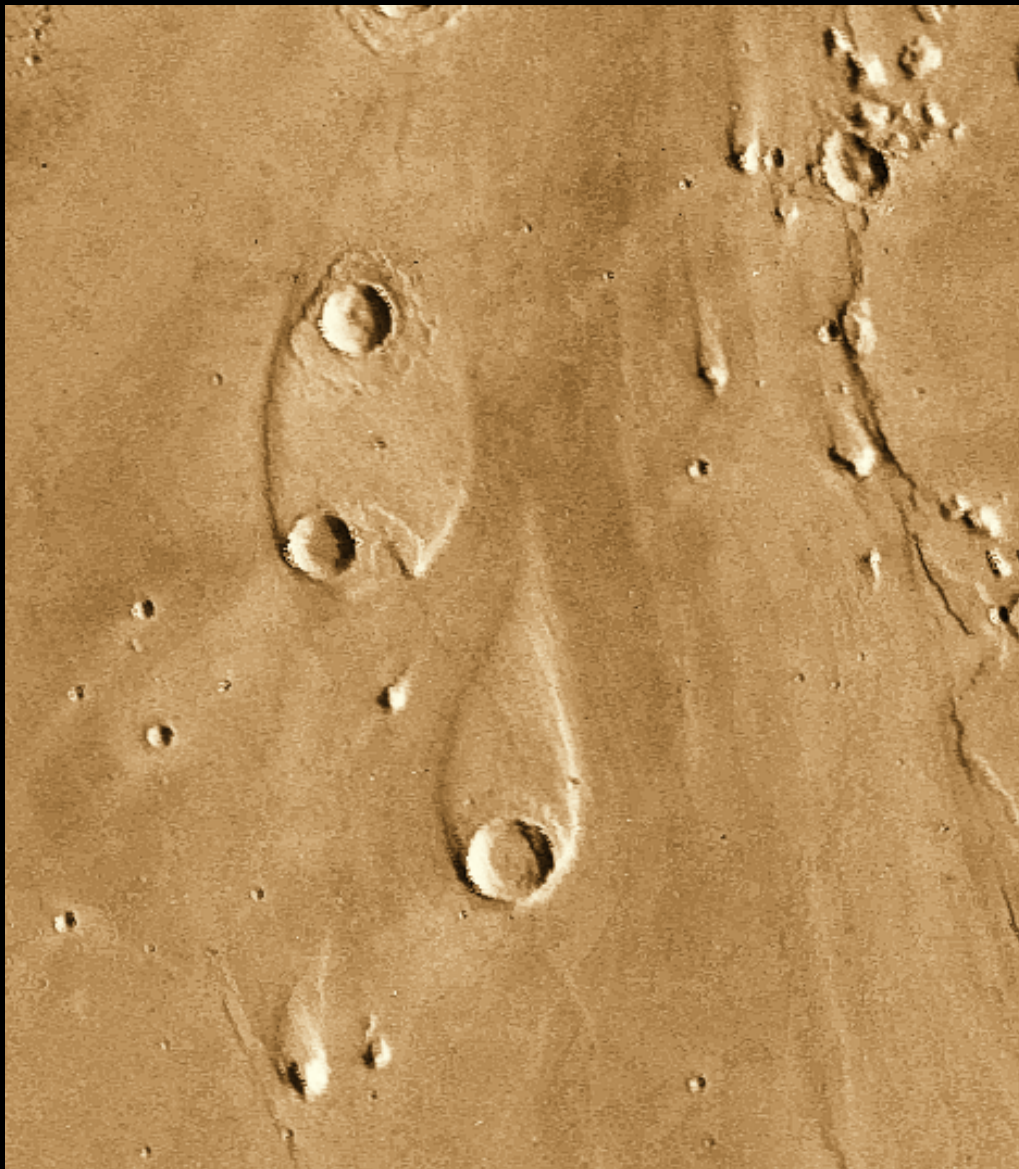
- Mars is the fourth planet.
- It is about half the size of the Earth.





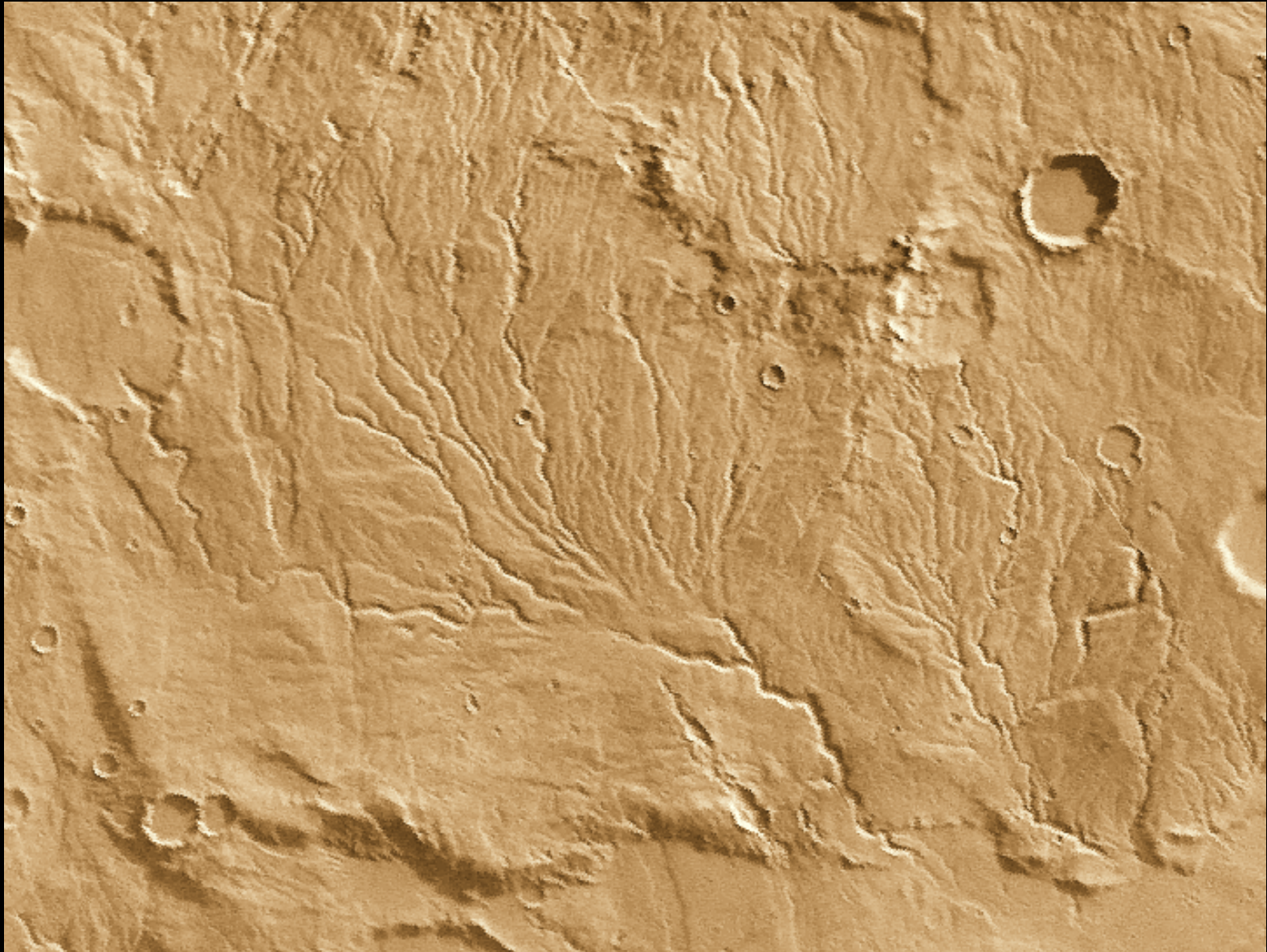
An aerial photograph of the Martian surface, showing the massive shield volcano Olympus Mons. The volcano is a large, roughly circular feature with a prominent rim and a central caldera. The surrounding terrain is relatively flat with some smaller craters and ridges. The lighting creates shadows that emphasize the topography.

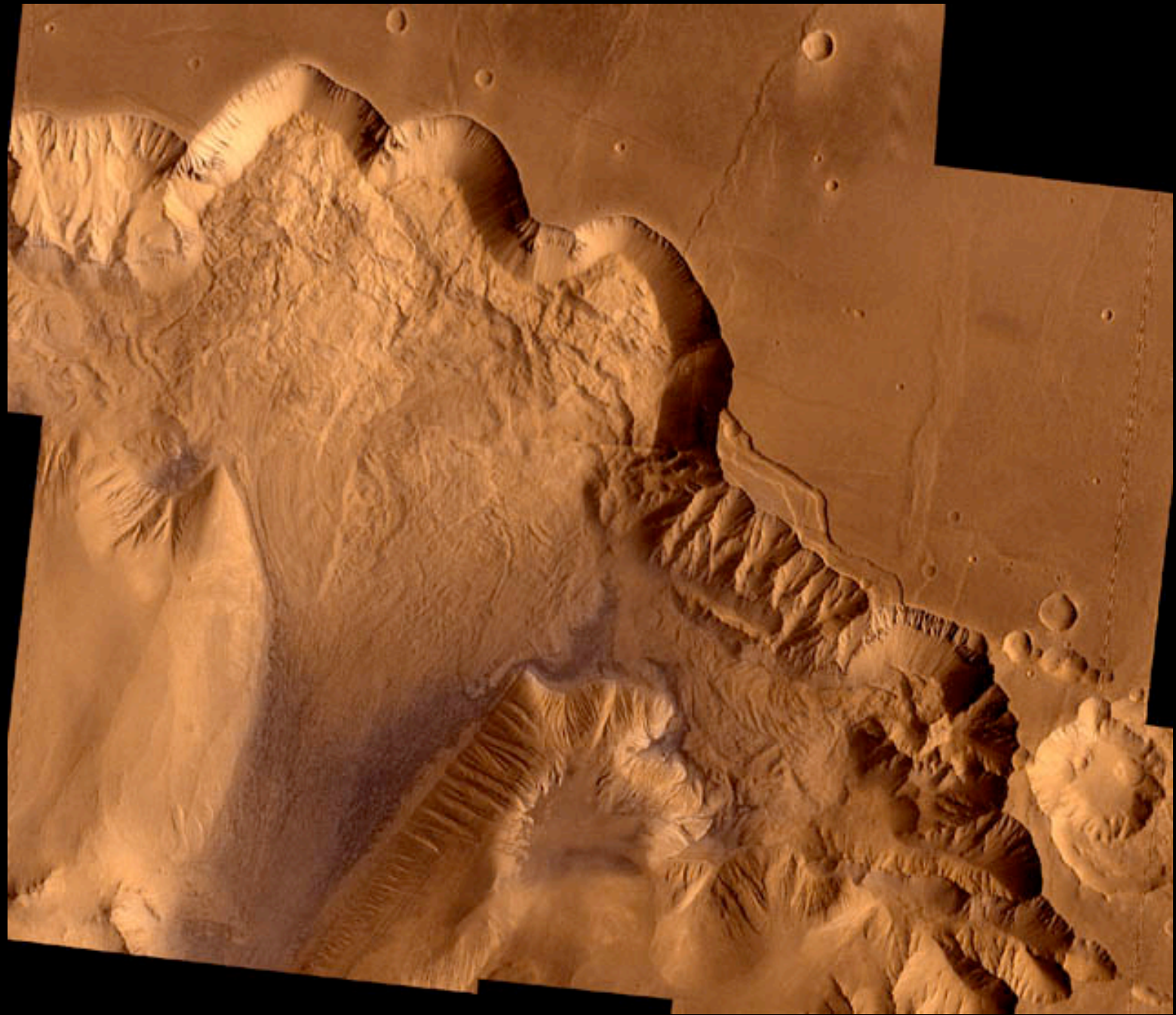
largest mountain
in solar system:
Olympus Mons



“islands” on Mars

Netzwerk von Tälern

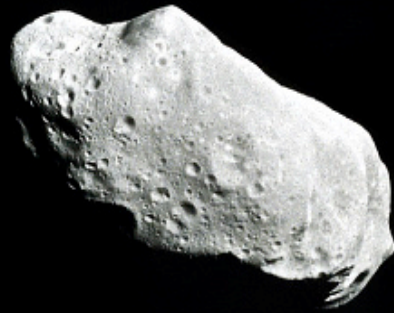




Asteroids



Gaspra

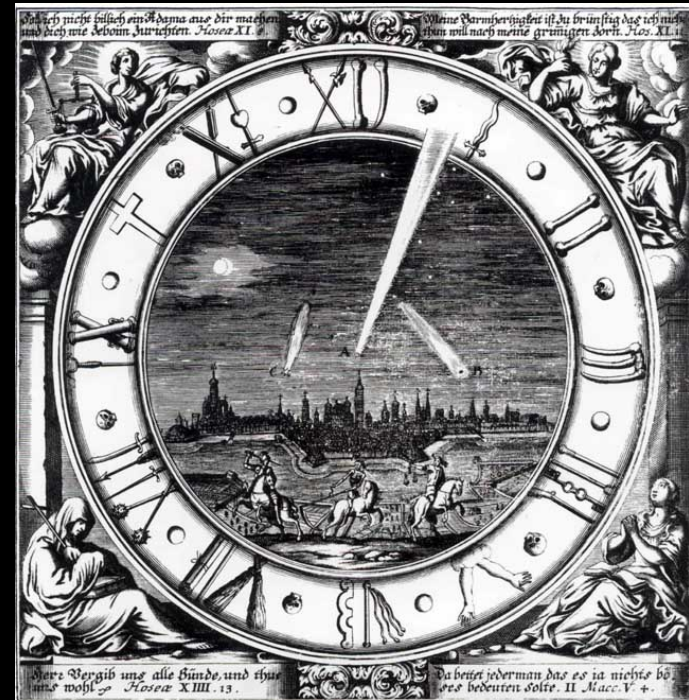


Ida



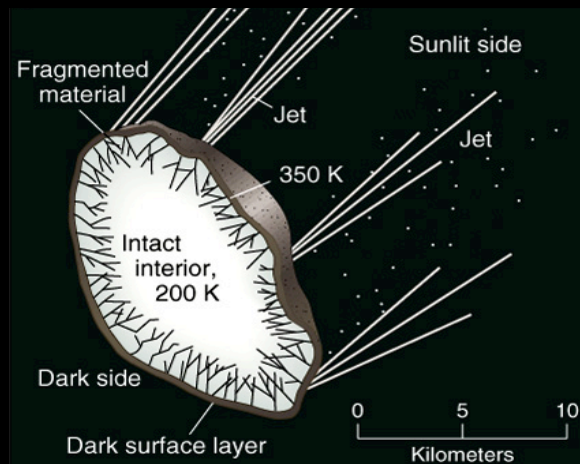
Mathilda

Comets

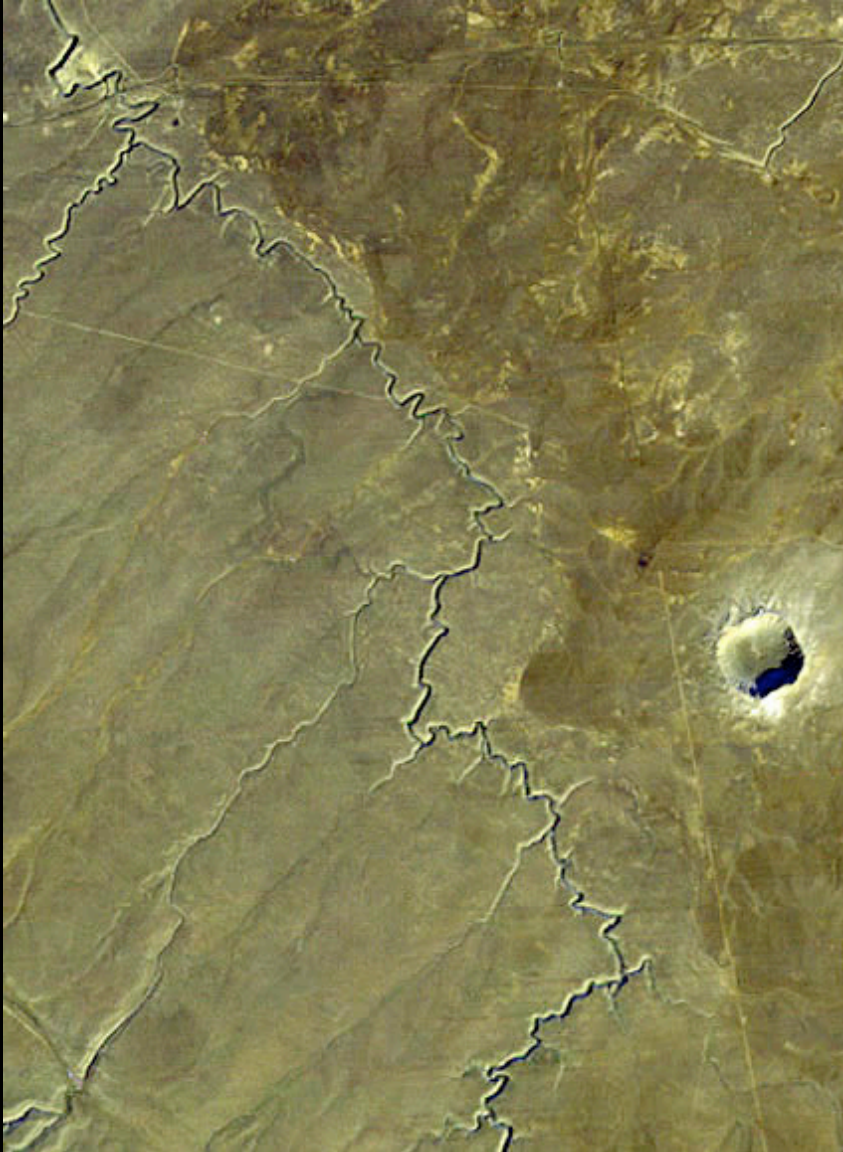




Comet Cores



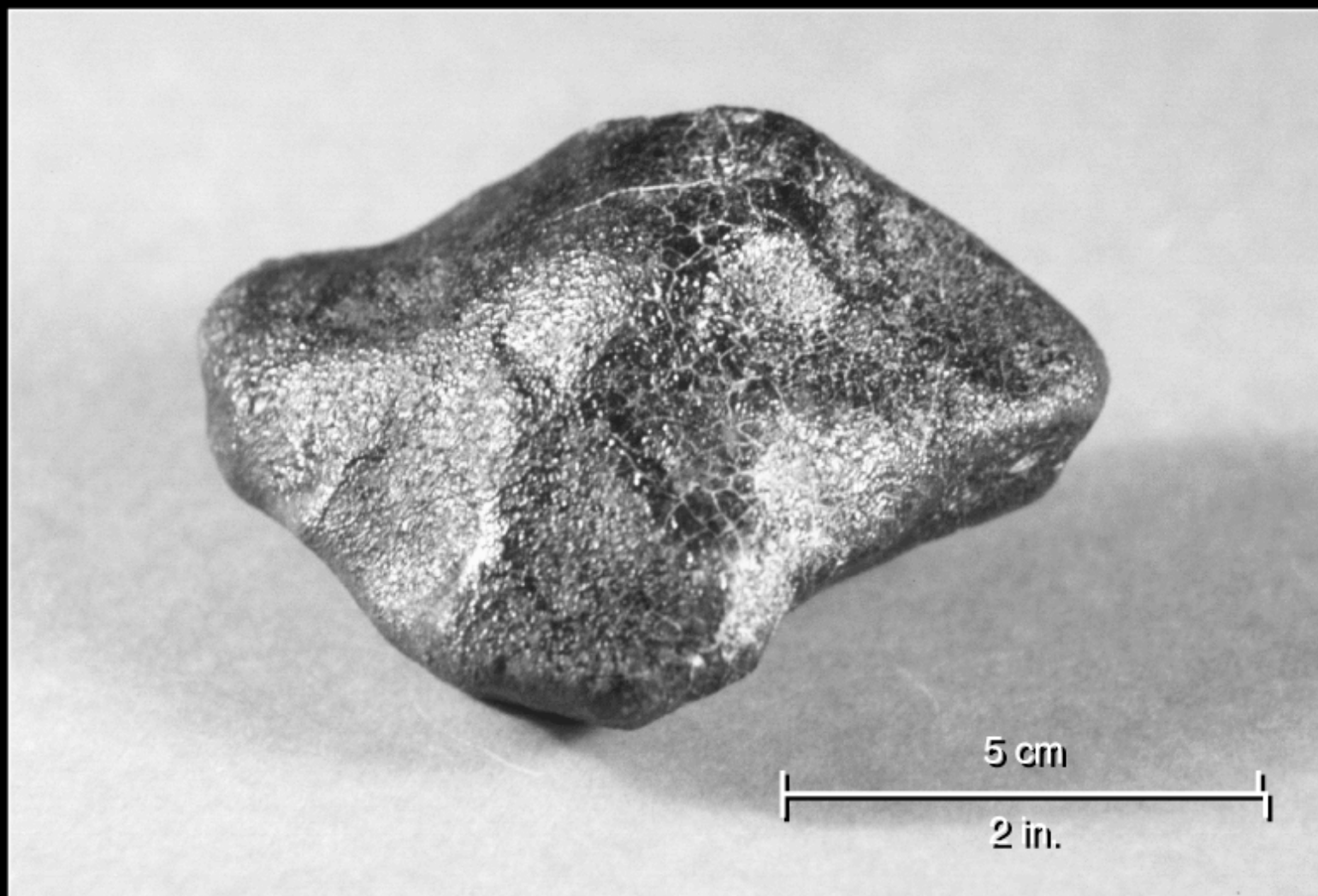
- Comets are “dirty snowballs”
- They start to melt and evaporate when getting close to the Sun.
- This is the tail of the comet.



**Barringer Crater in
Arizona**



Lake
Manicouagan in
Eastern Ontario



Meteroite · Fragment of Vesta

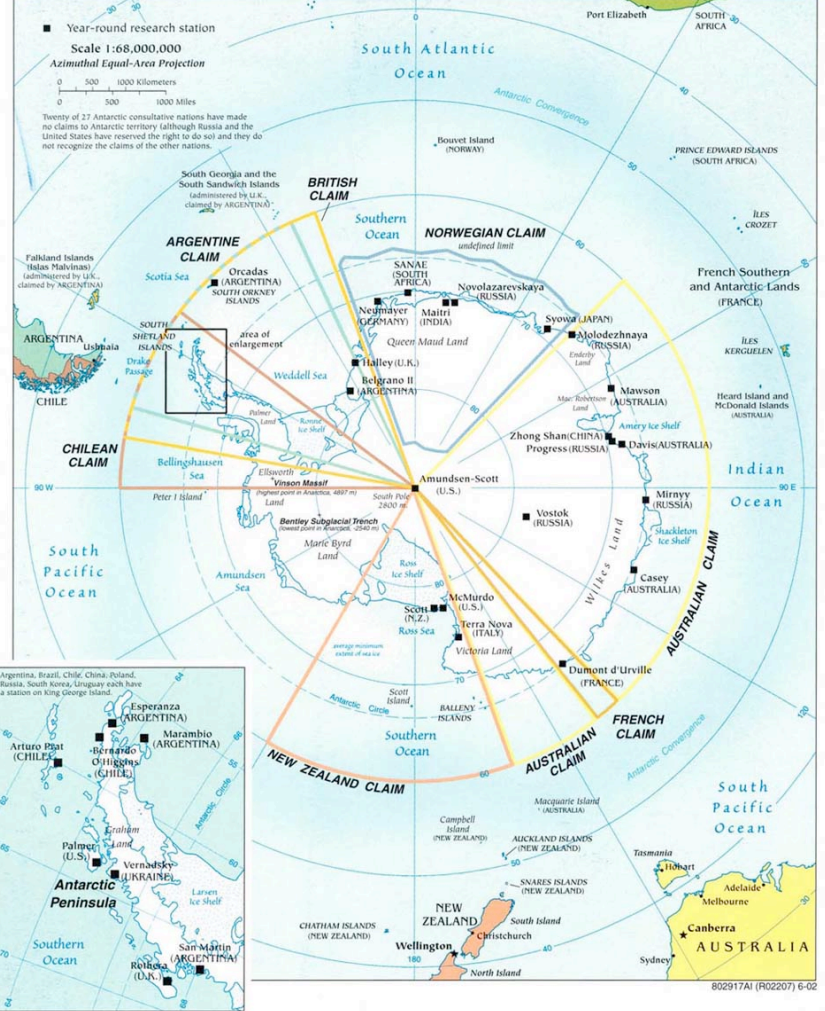
Lab Photograph · Russel Kempton, New England Meteoritical Services

PRC95-20B · ST Scl OPO · April 19, 1995 · B. Zellner (GA Southern Univ.), NASA

Antarctica

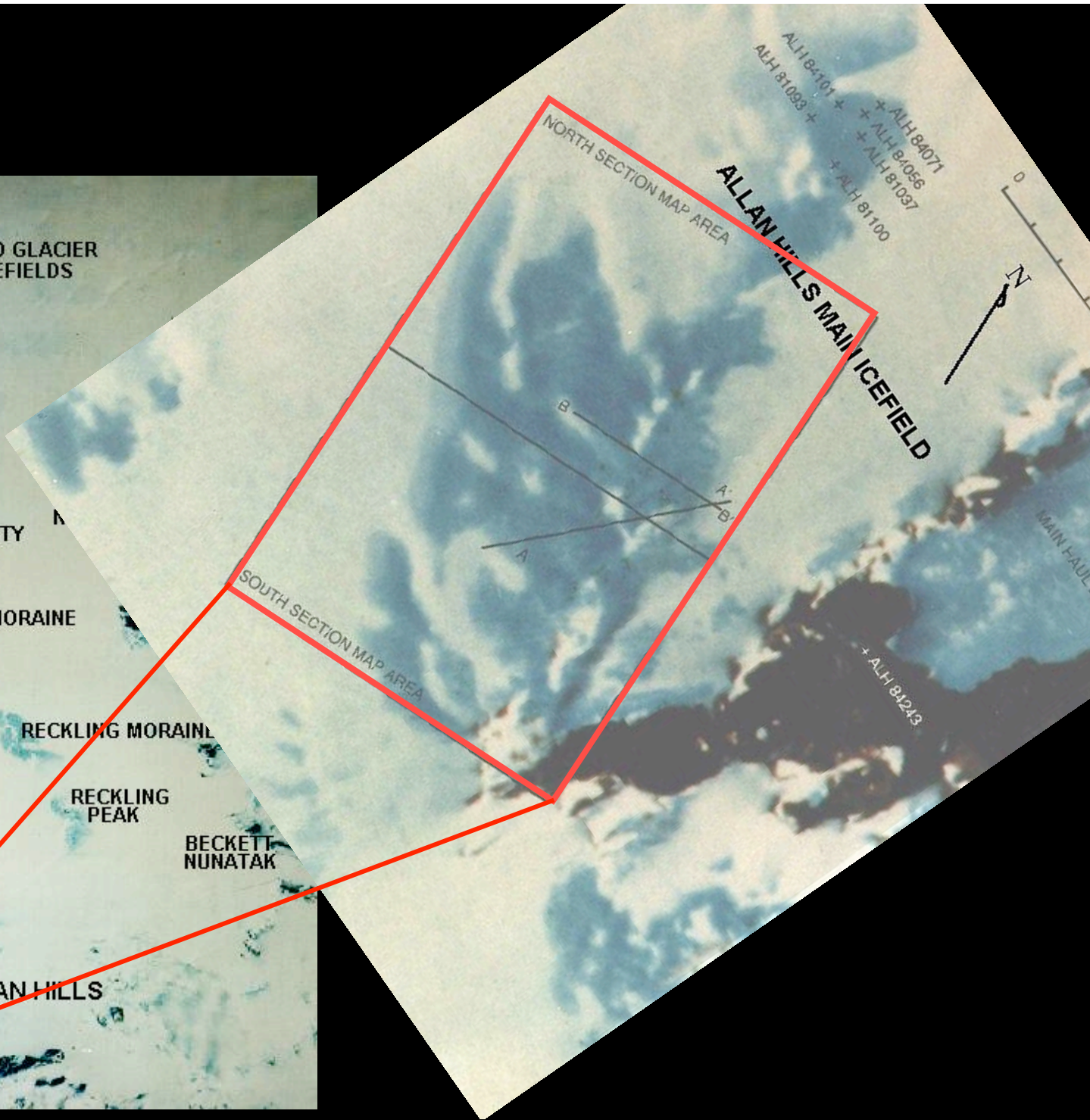
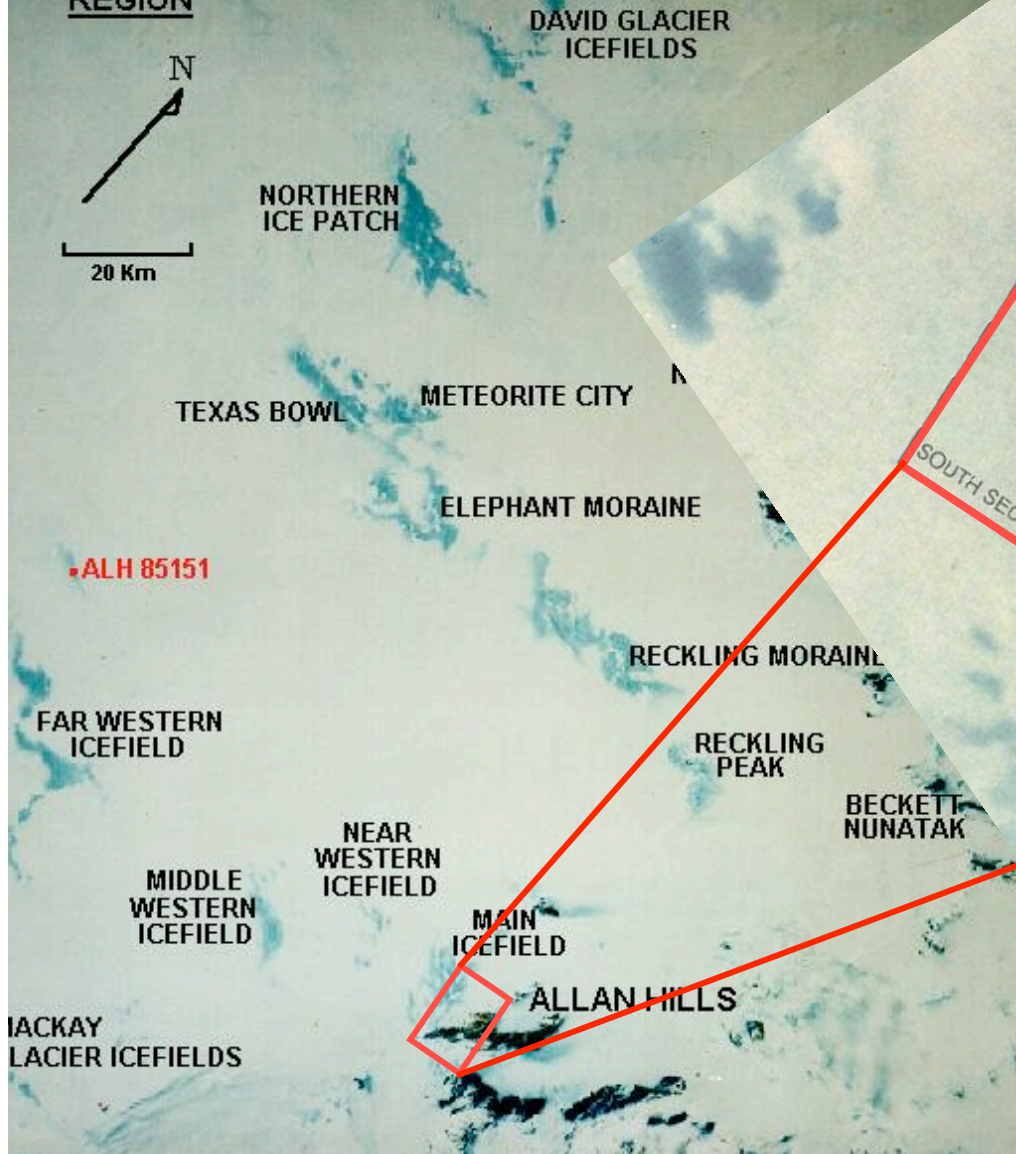


ANTARCTIC REGION



ALLAN HILLS-DAVID GLACIER

REGION





Jupiter



- Largest planet in solar system.
- It is $\sim 10x$ larger than the Earth.
- It is $\sim 10x$ smaller than the Sun.

Saturn



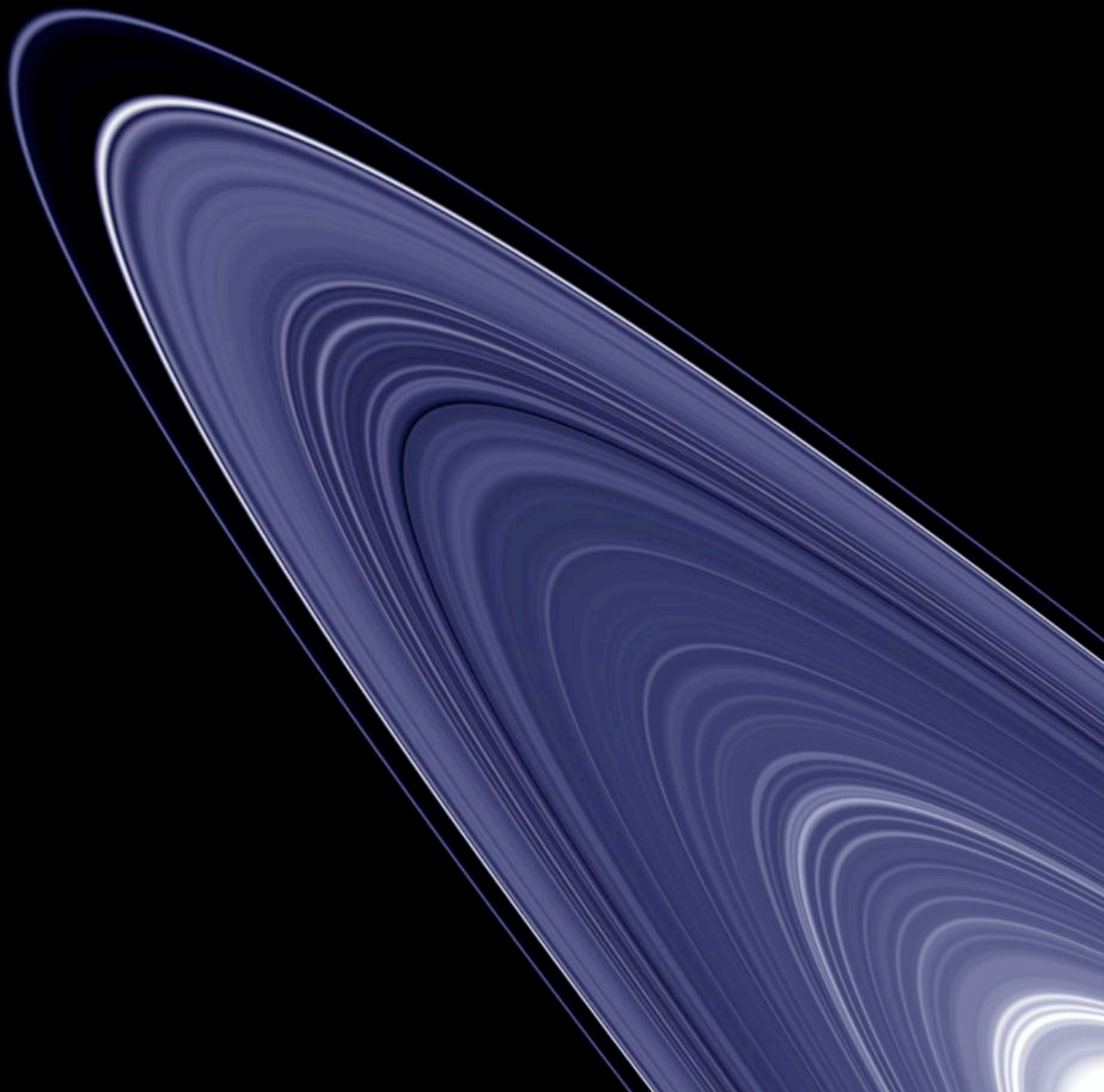
- Second largest planet in solar system.
- It is just a little smaller than Jupiter.
- It has prominent ring structure.



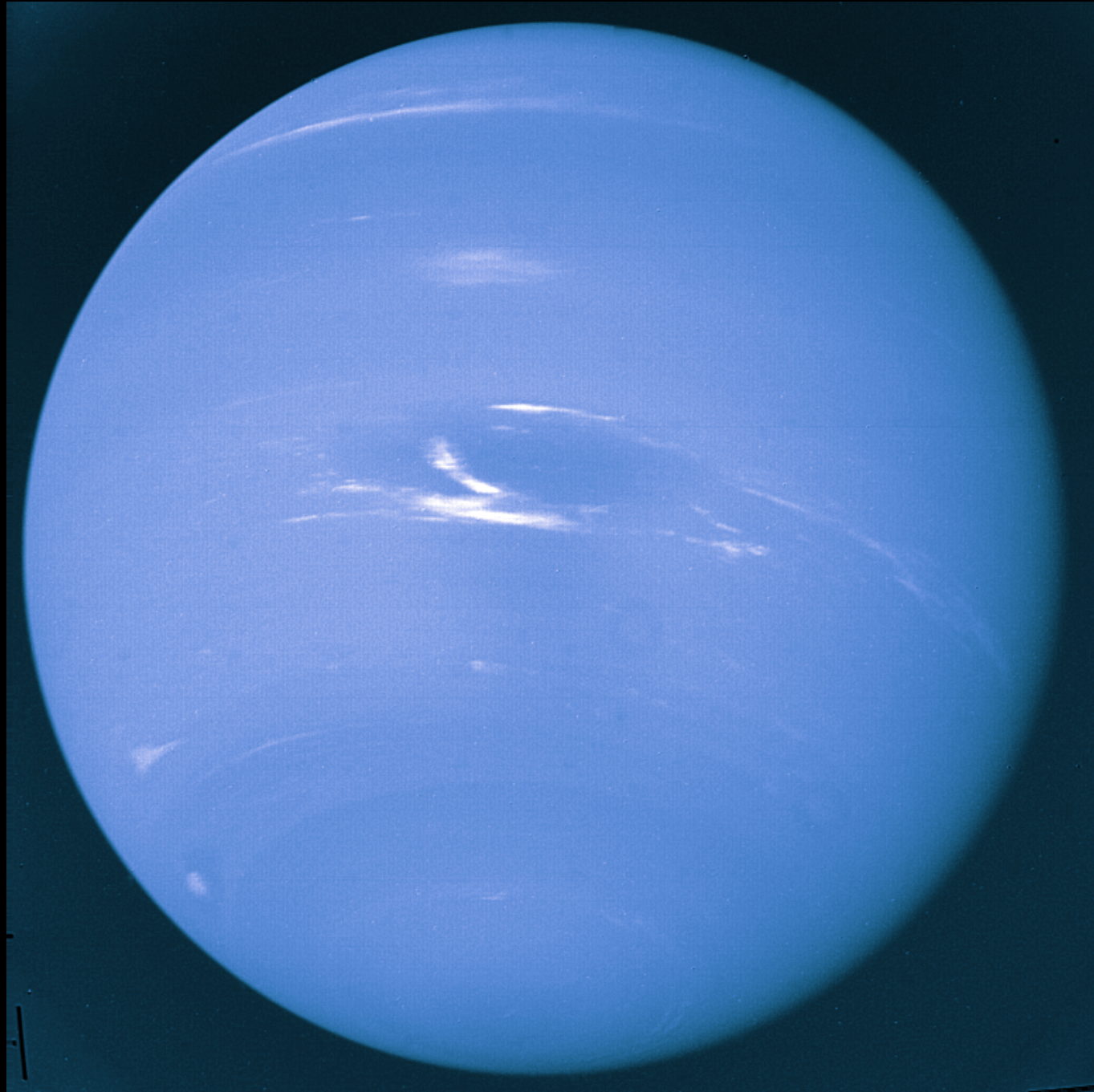
Uranus

Uranus

© Copyright Calvin J. Hamilton



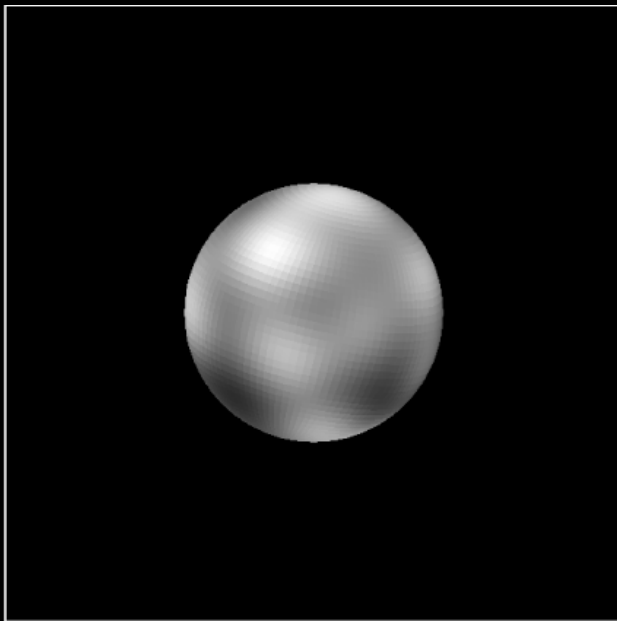
All giant gas planets have rings. This holds for Uranus.



Neptun

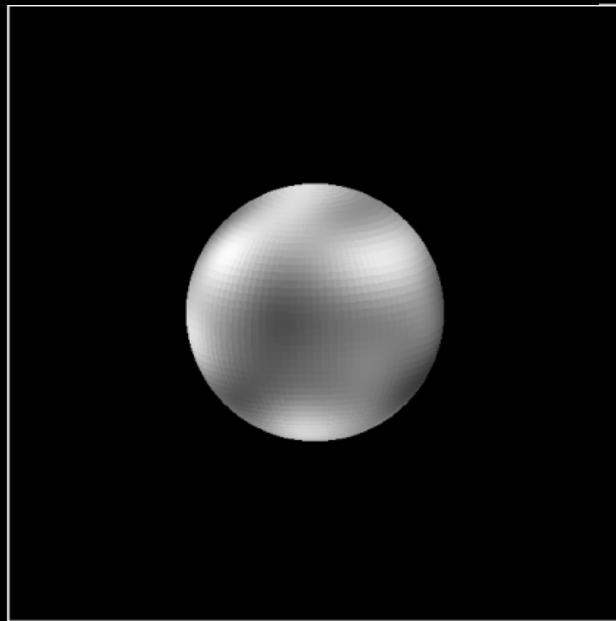
Pluto

Since a few years, Pluto no longer counts as planets. Instead it is a “minor planet”. One of many!

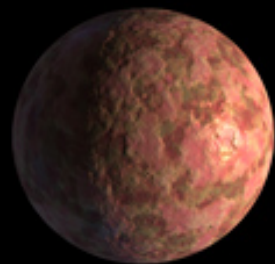


Pluto

PRC96-09a · ST ScI OPO · March 7, 1996 · A. Stern (SwRI), M. Buie (Lowell), NASA, ESA



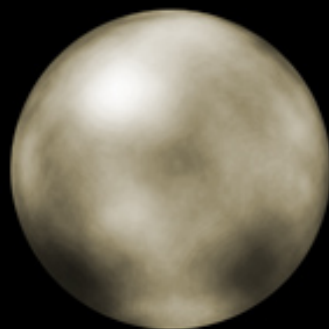
HST · FOC



Sedna
800-1100 miles
in diameter



Quaoar
(800 miles)



Pluto
(1400 miles)



Moon
(2100 miles)



Earth
(8000 miles)

Star Clusters

Plejaden



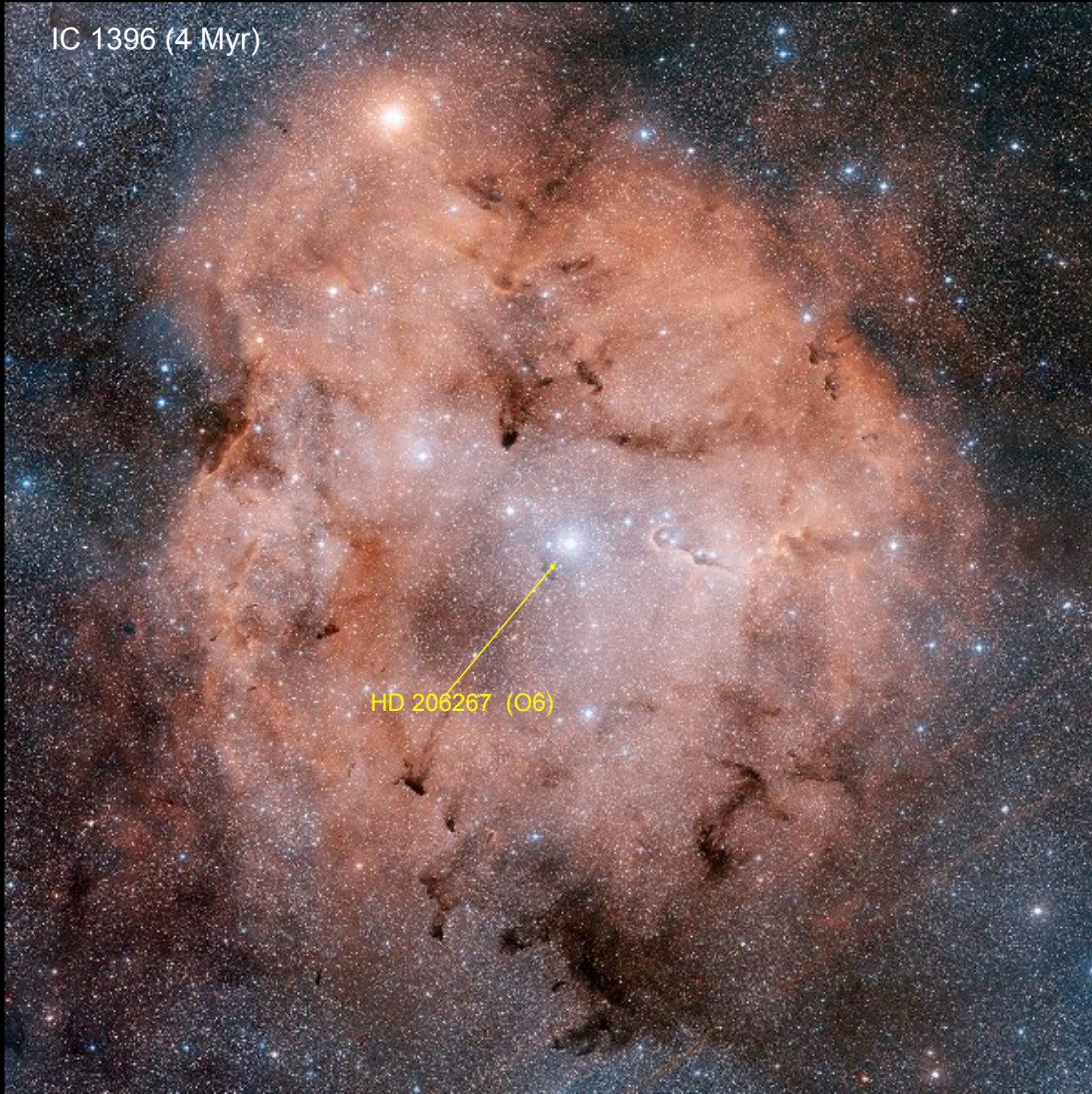
Orion-Nebel



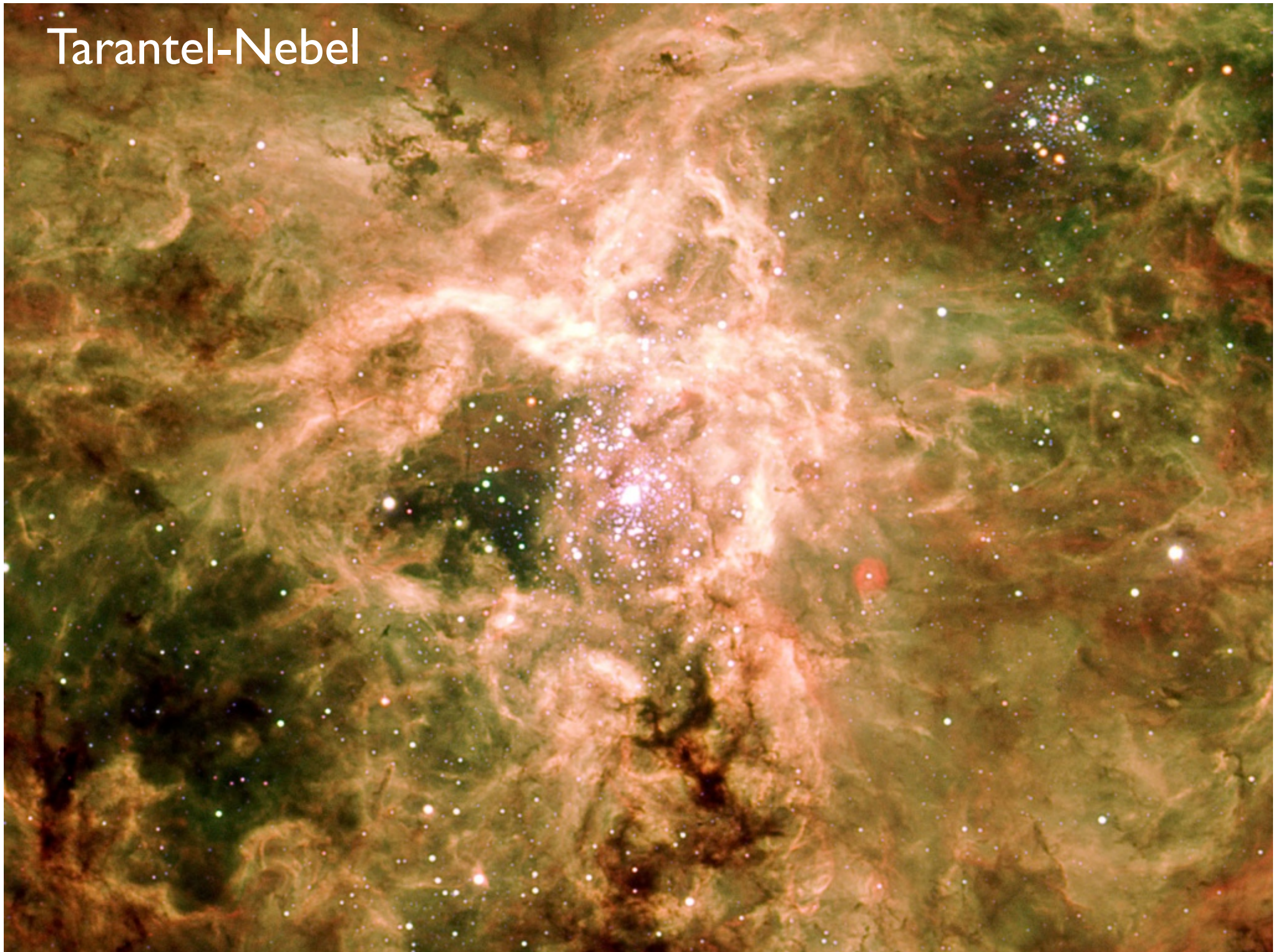
IC 1396 (4 Myr)

HD 206267 (O6)

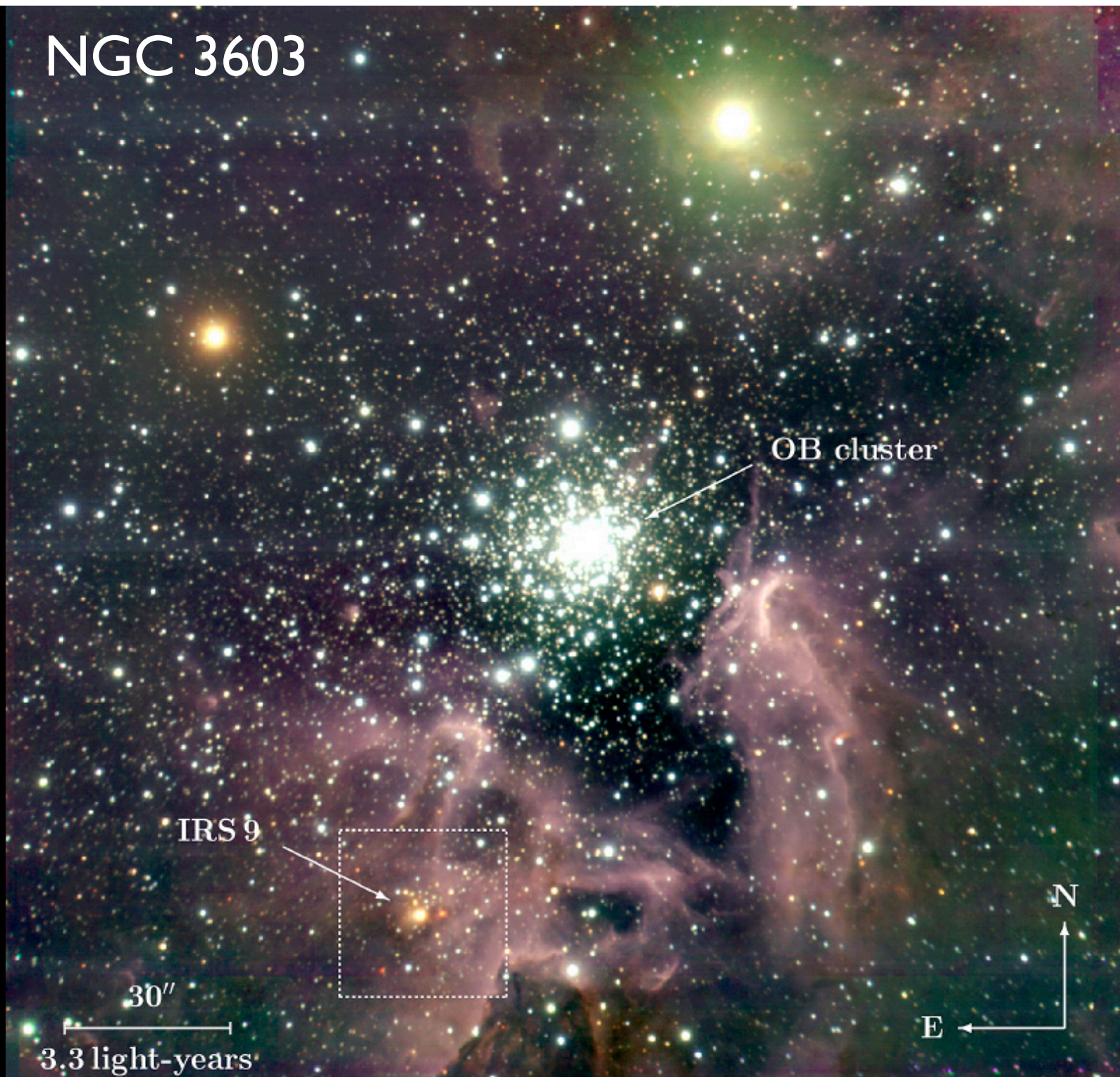
ein massereicher Stern



Tarantel-Nebel



NGC 3603



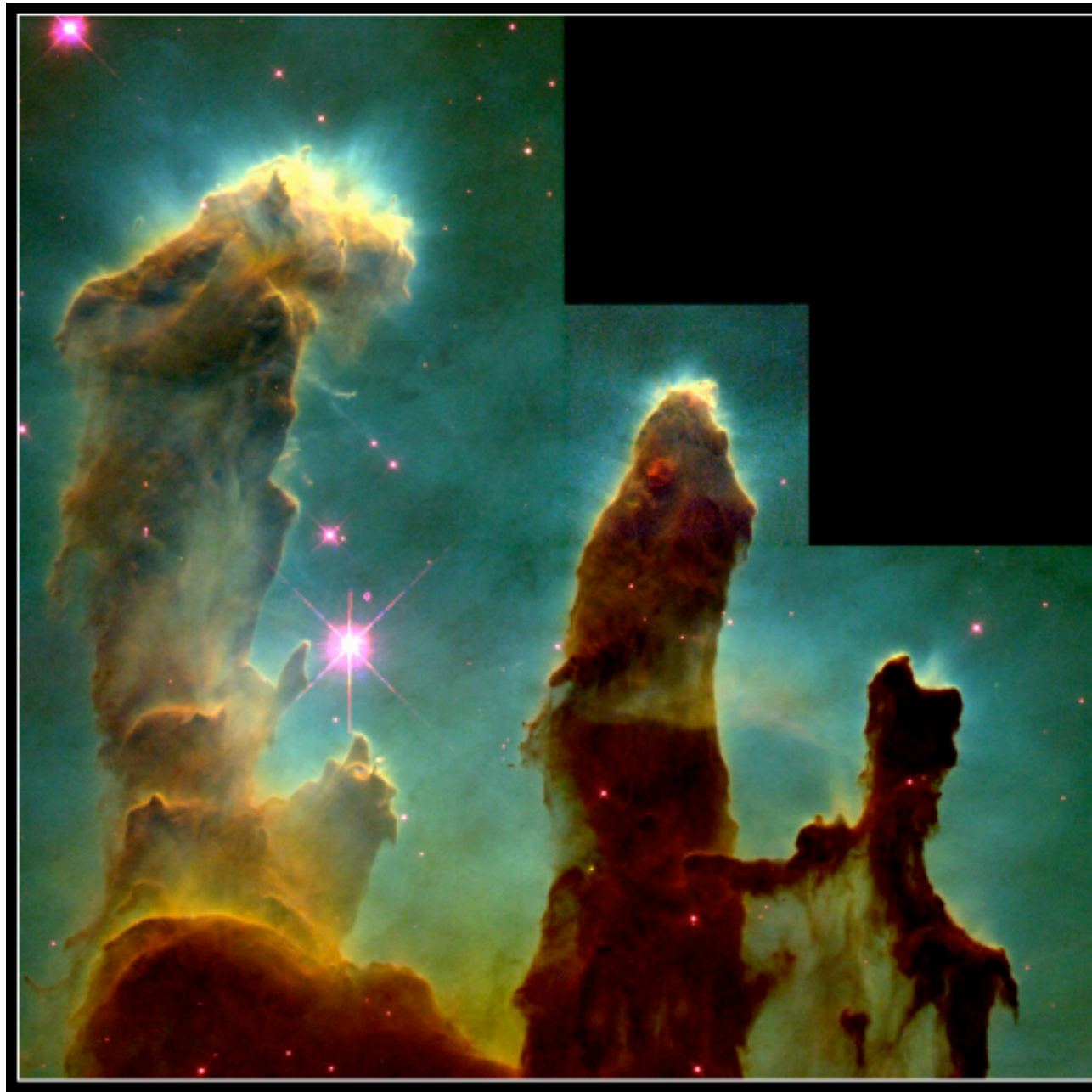
Kugelsternhaufen 47 Tuc



Sternhaufen



Pferdekopfnebel



HST Aufnahme

Pillars of God (im Adlernebel): Entstehung kleiner Gruppen junger Sterne in den "Spitzen" der Gas- und Staubsäulen....

Aufnahme im
Infraroten.



(Andersen et al 2005)



Head of Column No.1 in Eagle Nebula (IR-View)
(VLT ANTU + ISAAC)

ESO PR Photo 57c/01 (20 December 2001)

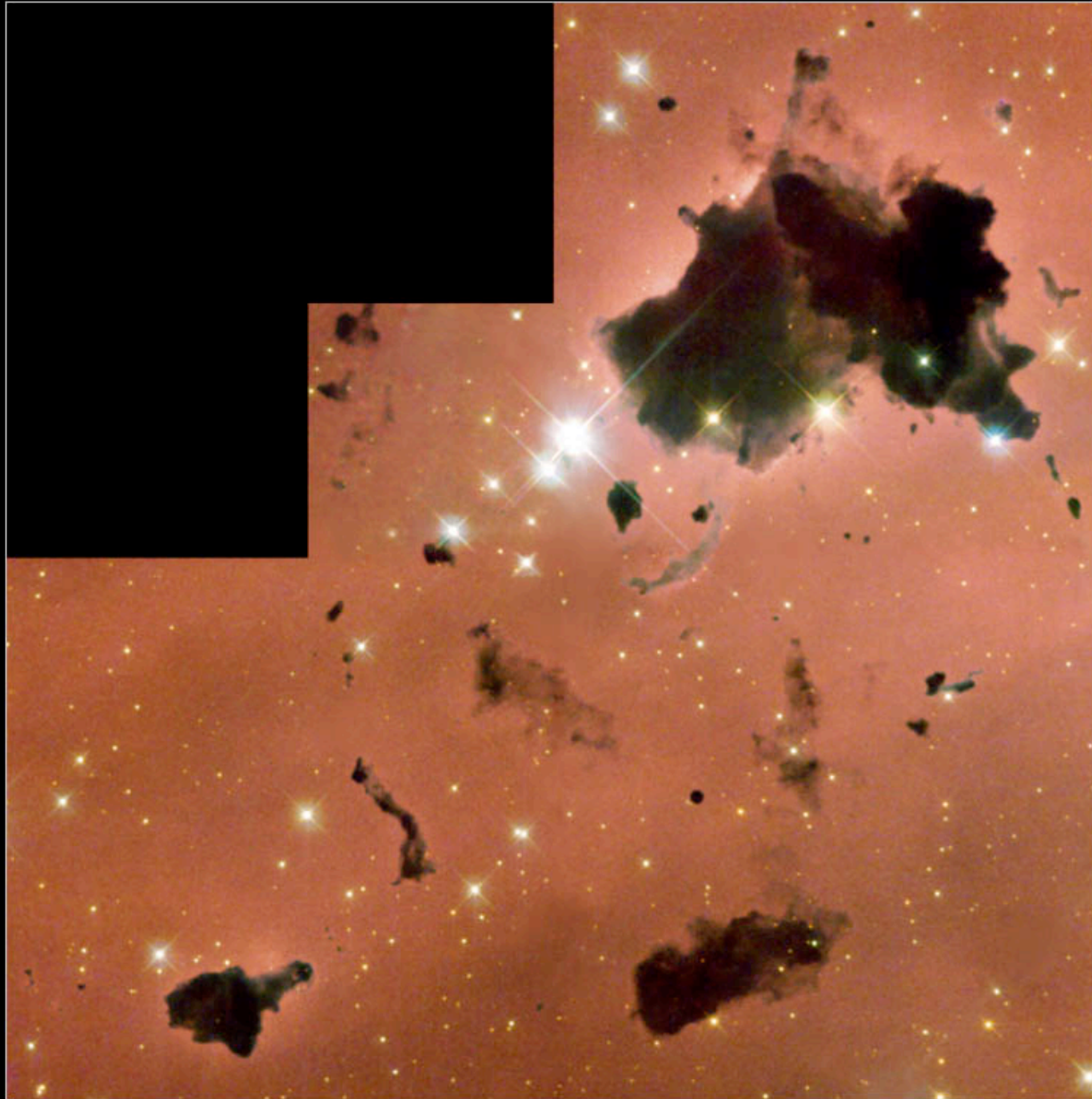
© European Southern Observatory



IR Aufnahme mit dem ESO-VLT

Pillars of God (im Adlernebel): Entstehung
kleiner Gruppen junger Sterne in den ``Spitzen``
der Gas- und Staubsäulen....

Thackeray's Globules in IC 2944



Reflection Nebula in the Pleiades • IC 349





V838 Monocerotis Light Echo • October 2004



May 2002



September 2002



October 2002



December 2002

Veil Nebula Details



Eagle Nebula
M16



Supernova Remnant • SN1006



Galaxien

Milchstraße

- Die Milchstraße ist unsere Heimatgalaxie.
- Sie besteht aus Dunkler Materie, Sternen, und Gas.
- Das Licht braucht 100.000 Jahre von einem Ende zum anderen.
- Die Milchstraße hat etwa 100.000.000.000 Sterne.

180°

150°

120°

90°

60°



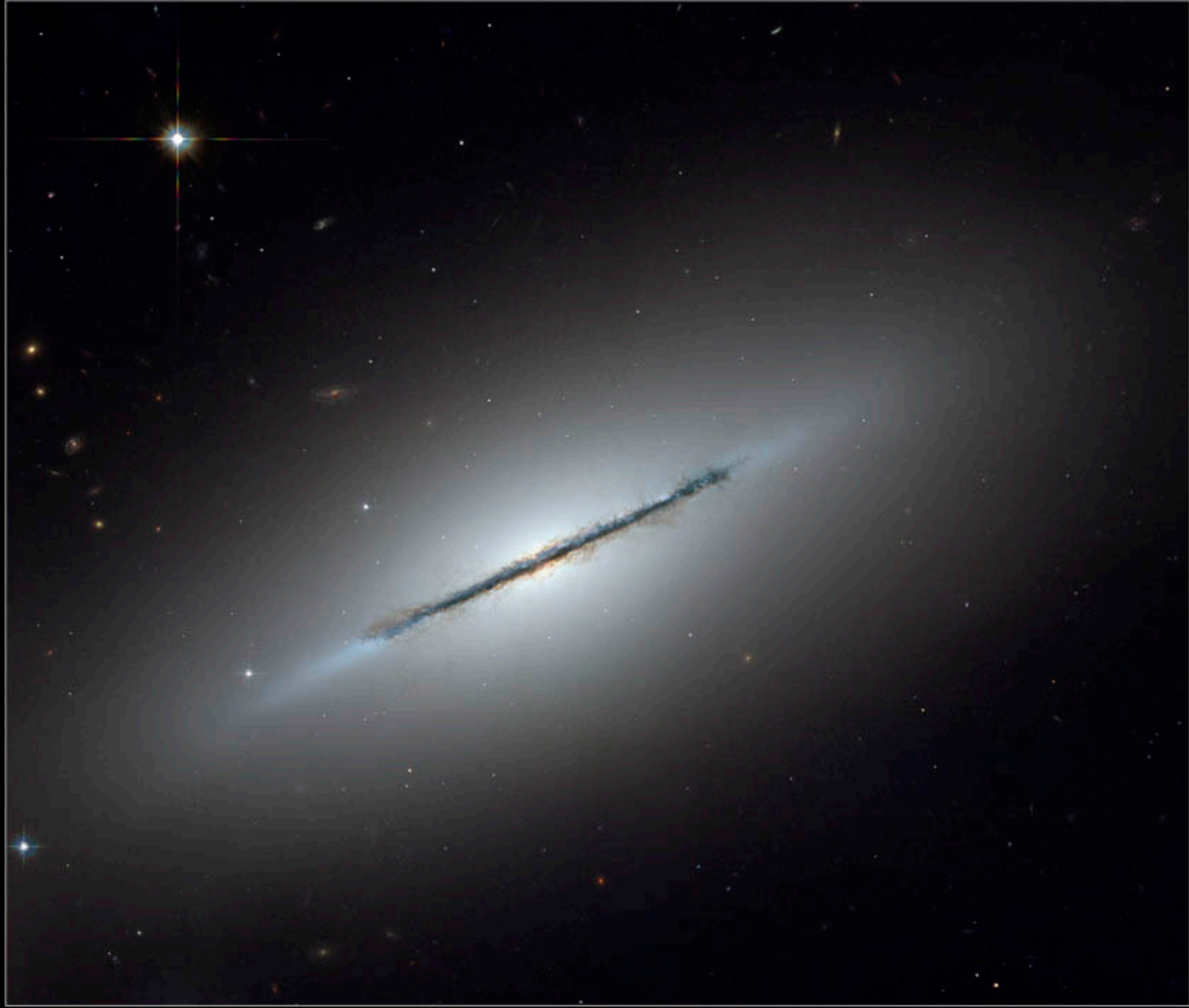




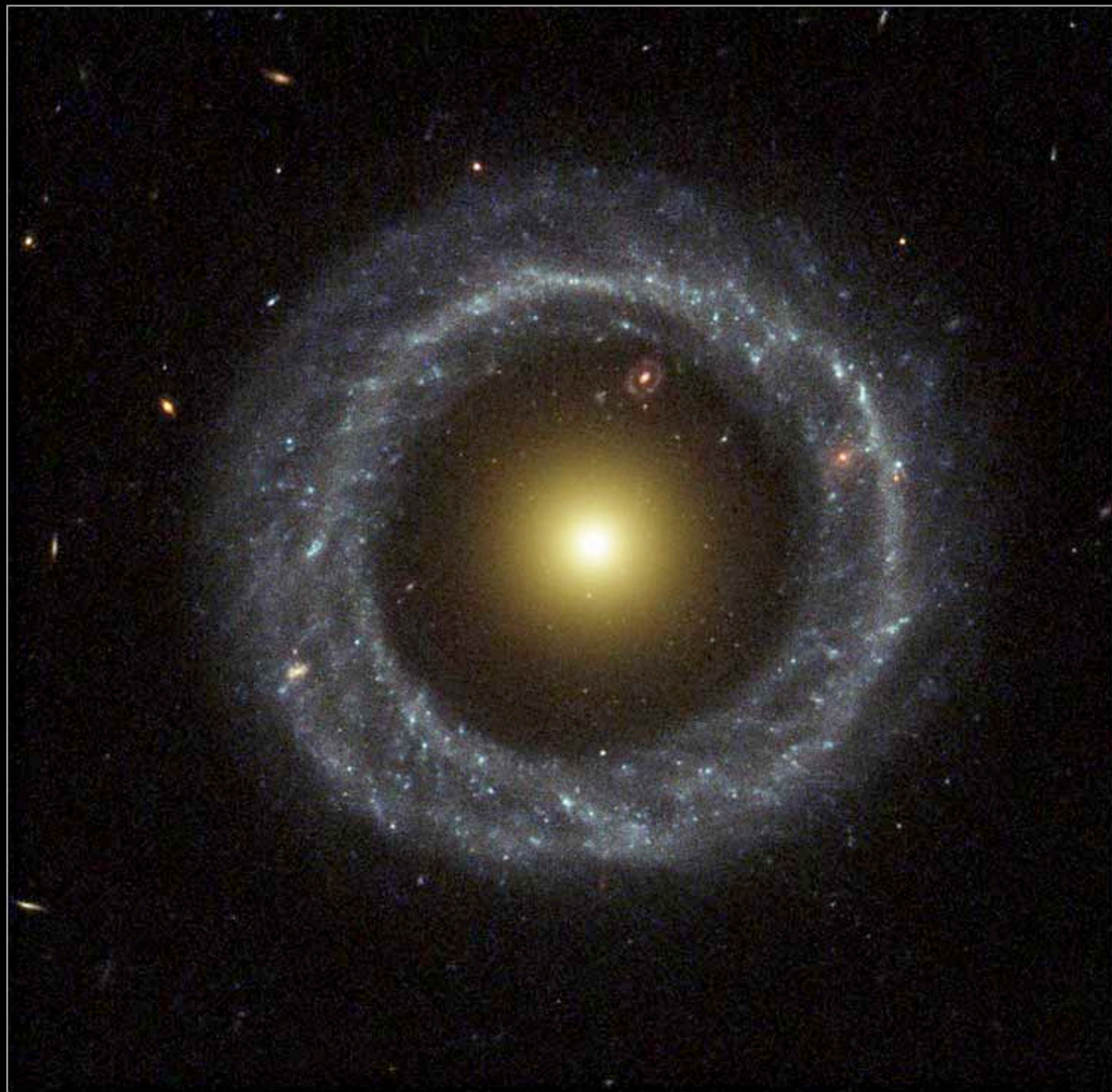


The Sombrero Galaxy — M104  HUBBLESITE.org

Edge-On Lenticular Galaxy NGC 5866







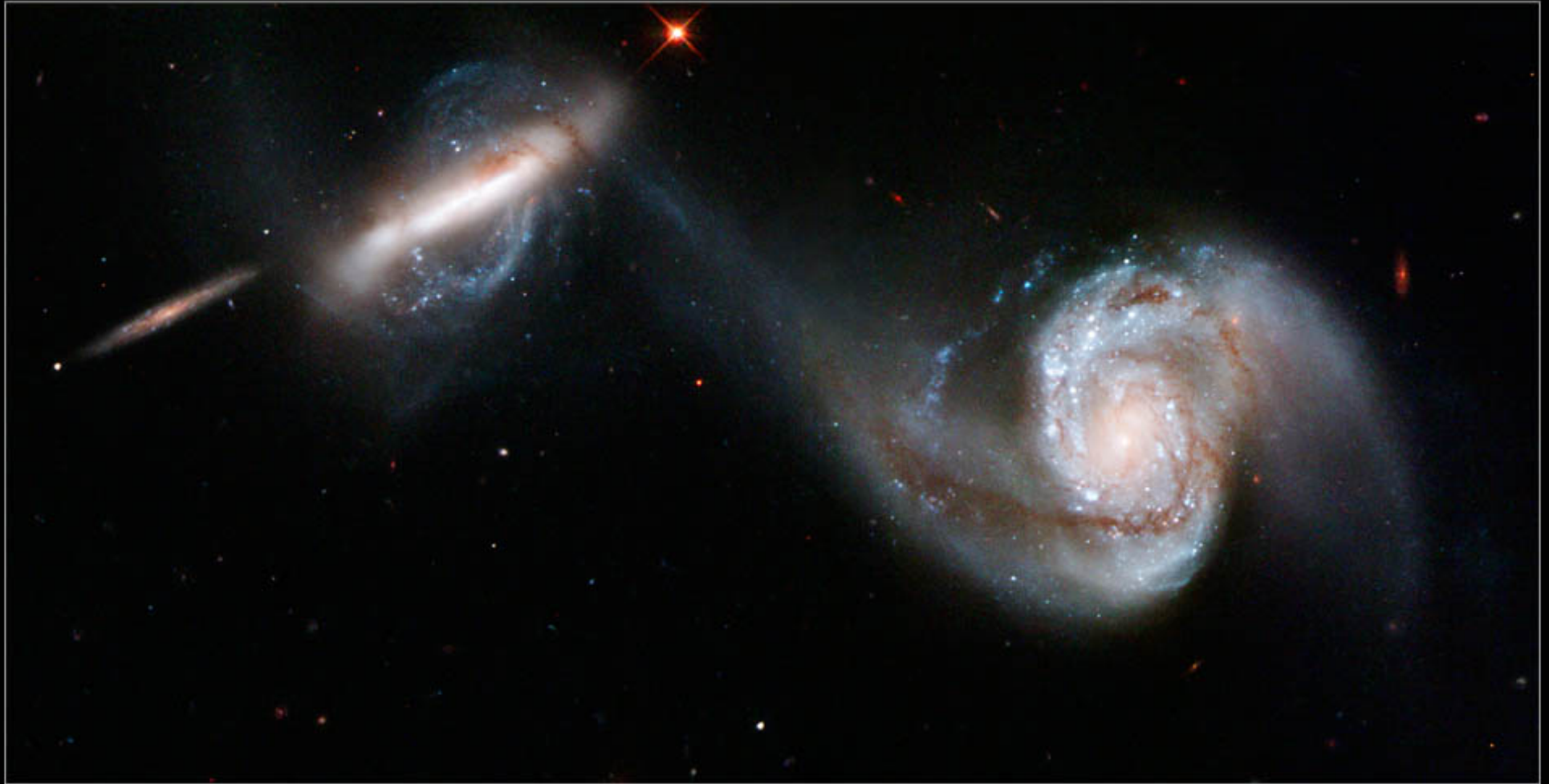
NGC 6050

Arp 148



Hubble
Heritage

Interacting Galaxies • Arp 87



Teleskope

Observational Astronomy

- How do we learn about cosmic objects?
- Telescopes
 - on Earth
 - in space
- Which light?
 - visible light, infrared light (heat), radio, x-rays, gamma-rays

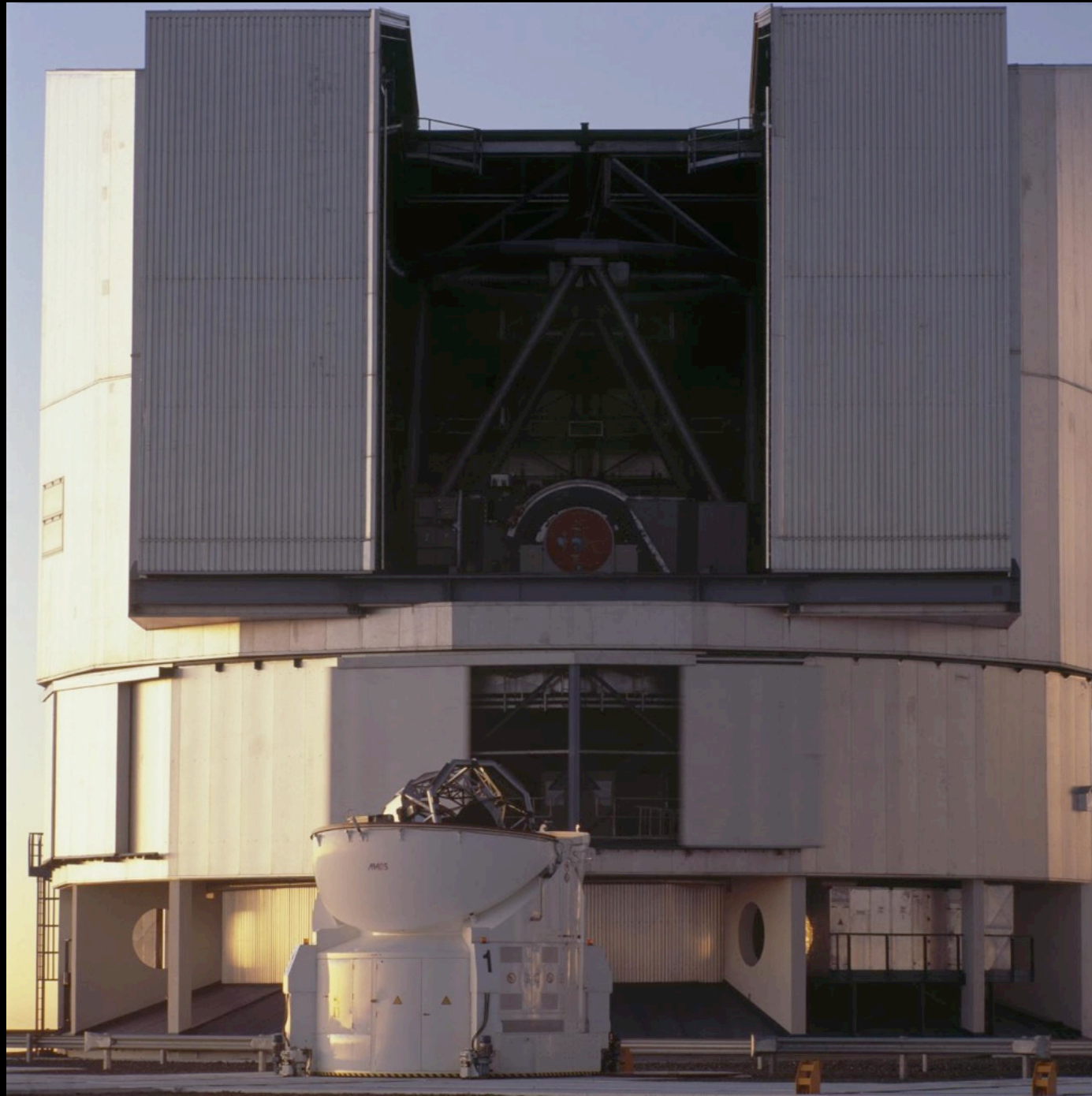
ESO:VLT



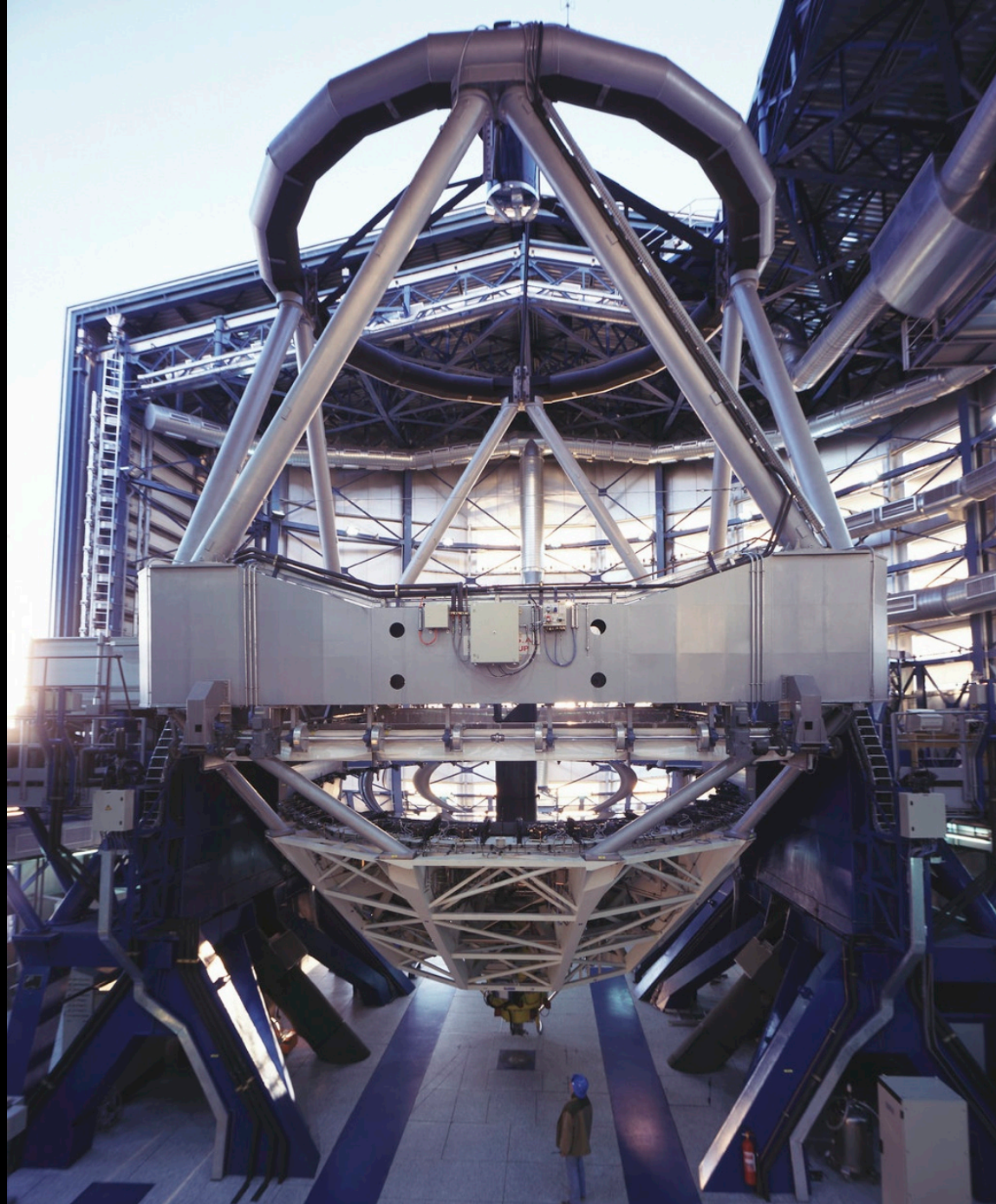
ESO:VLT

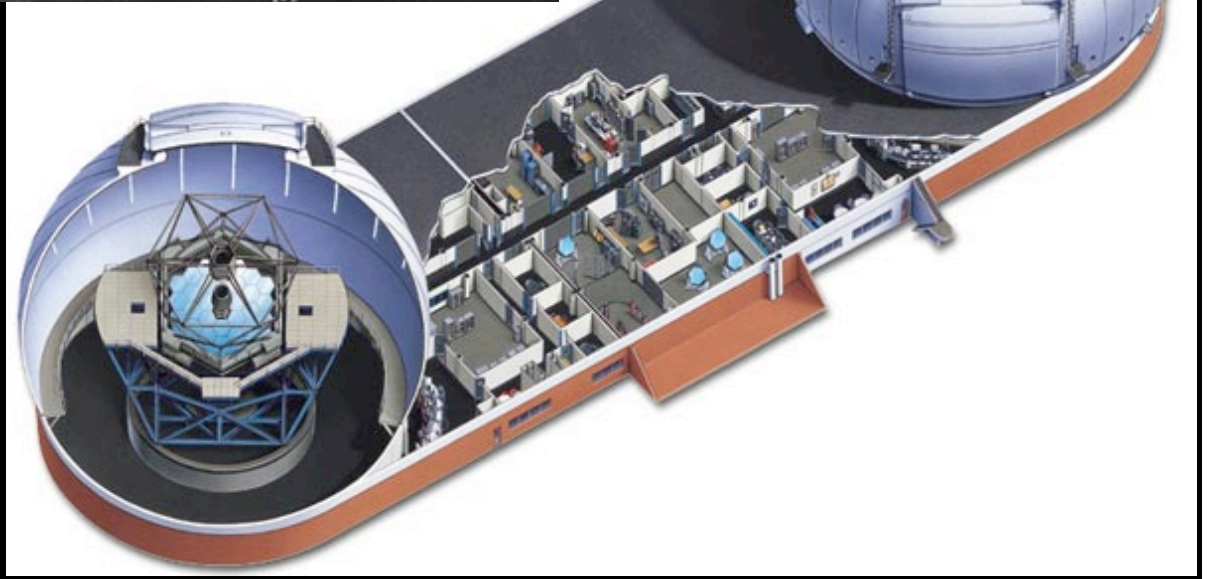


ESO:VLT



ESO:VLT





Keck Telescope
on Hawaii

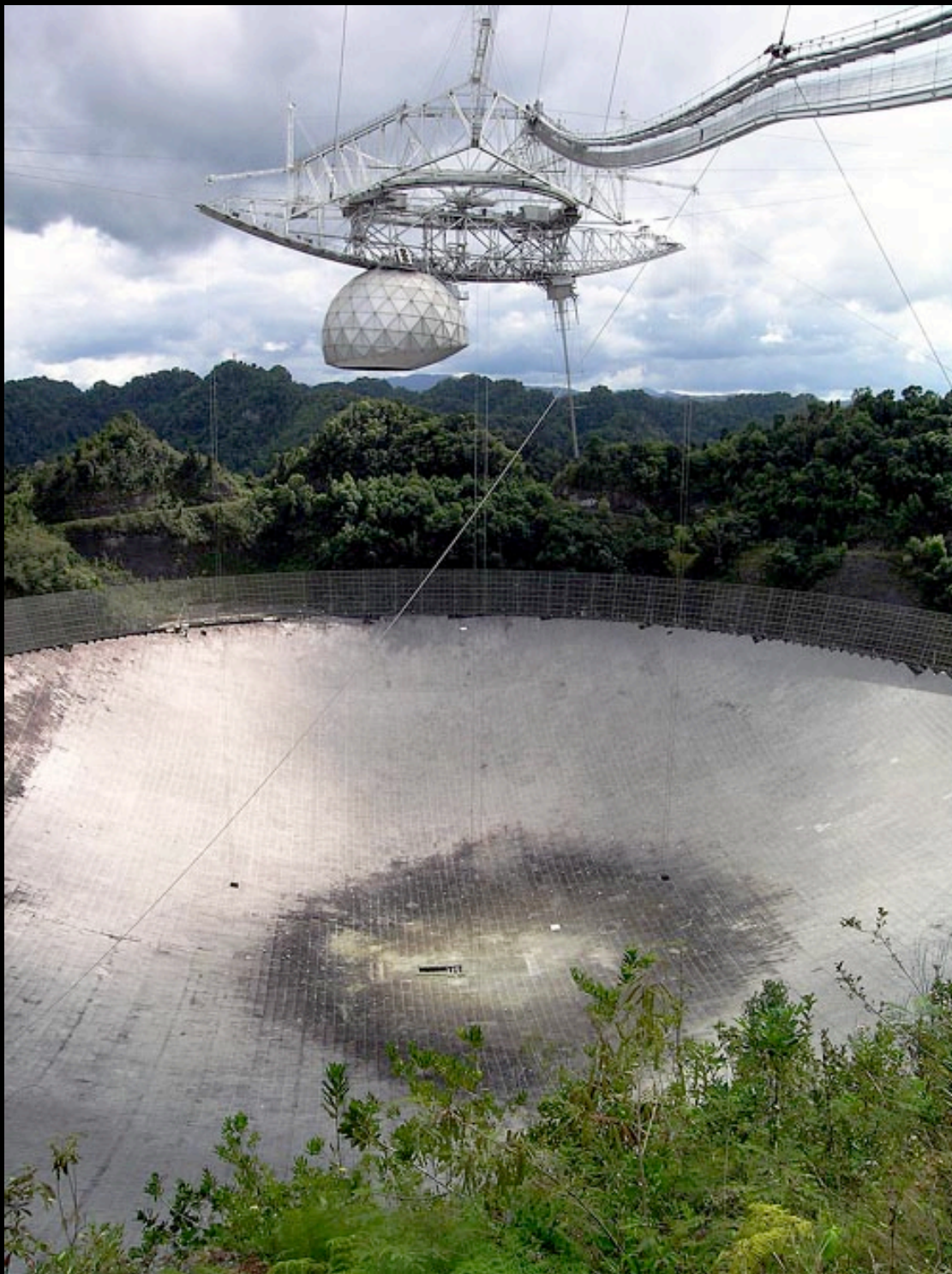
LBT on Mount Graham in Arizona





Effelsberg Radio Telescope





Arecibo Radio
Telescope in
Puerto Rico



Hubble Space Telescope



Hubble Space Telescope

Hubble Space Telescope

Launch with Space Shuttle



Launch of repair mission



E N D E