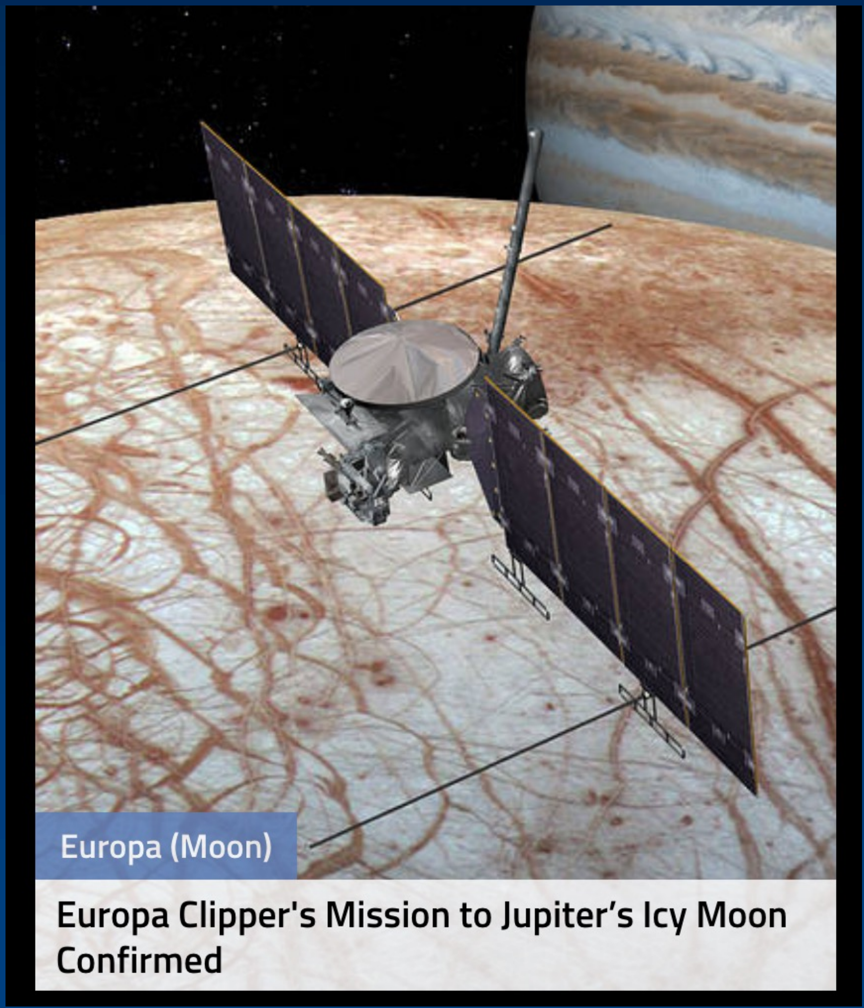
Astronomy 2110

Prof. Greg Taylor   Spring 2024



Europa Clipper: Launch in Oct. 2024 on Falcon Heavy

Course Goals

- Introduction to the science of astronomy
  - Fundamental concepts/tools of modern astronomy
  - How do we study such distant objects? How do we understand objects/processes?
- Study the Solar System

Astro 2110.001

Professor: Greg Taylor

Office Hours: M 10am-11am, Th 9am-10am or by appt, PAIS 3236

TAs: Evan David, Dustin Edgeman, Rachel Weller

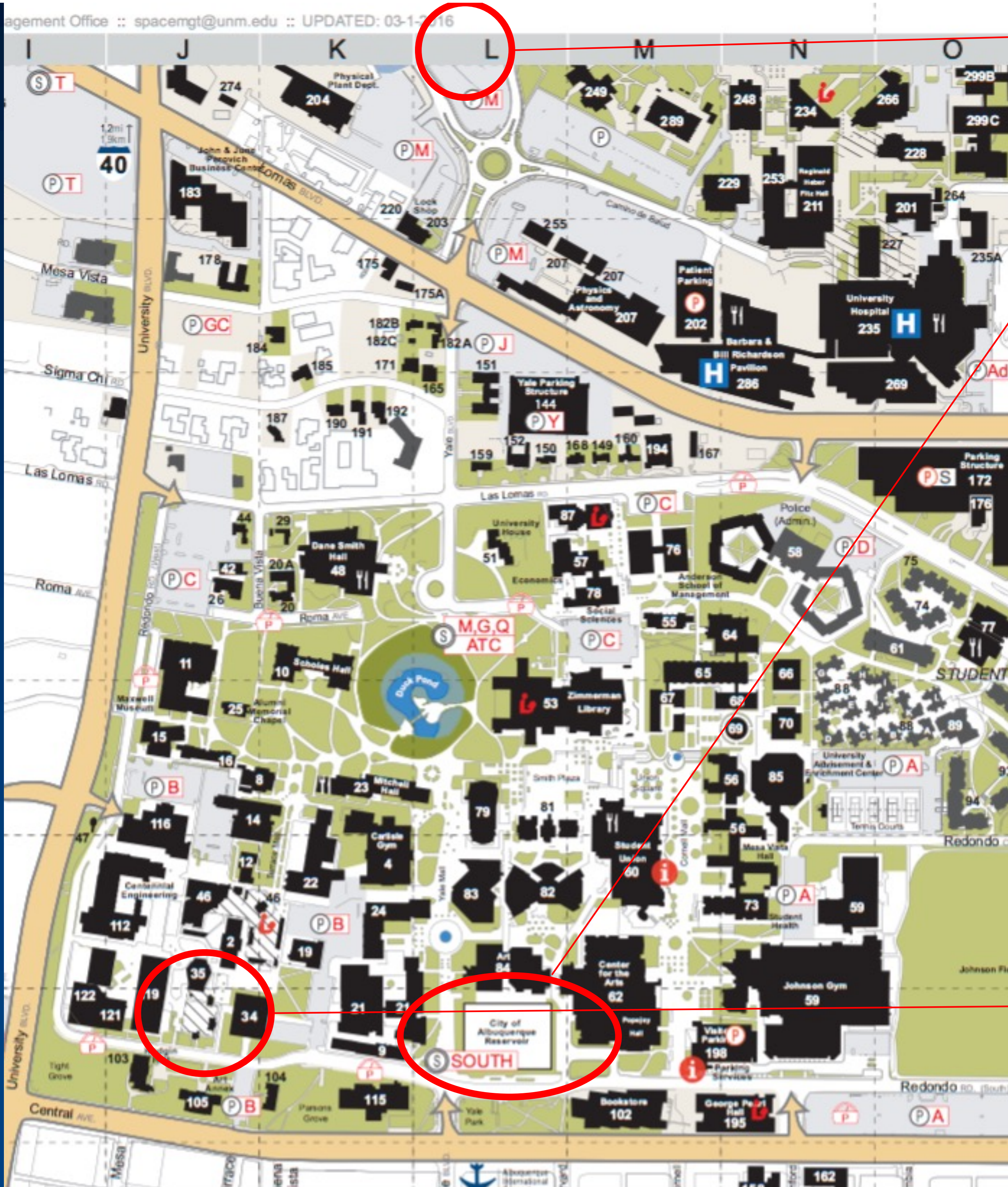
Class Web page: www.phys.unm.edu/~gbtaylor/astr2110

Course Text: *Universe, 11th edition*, Geller, Freedman & Kaufmann

Homework: Reading and homework assignments (roughly weekly)

Grading: 25% homework; 50% based on 2 tests; 20% on final project and 5% class participation (worksheets). NOTE: there will be NO makeup tests except by prior arrangement.

Worksheets: Handed out in class roughly once/week and graded credit/no credit.



Campus obs.

Physics and Astronomy

Room 3236

Mondays 10-11am
Thursdays 9-10am
or by appointment

you are here

Announcements

• The Lab is required for all astrophysics majors

• We do have lab this week

• We need to balance the labs – currently:
ASTR2110L 001 (Tu) : 11
ASTR2110L 003 (We) : 4
ASTR2110L 002 (Th) : 11

We can have no more than 9 in each lab

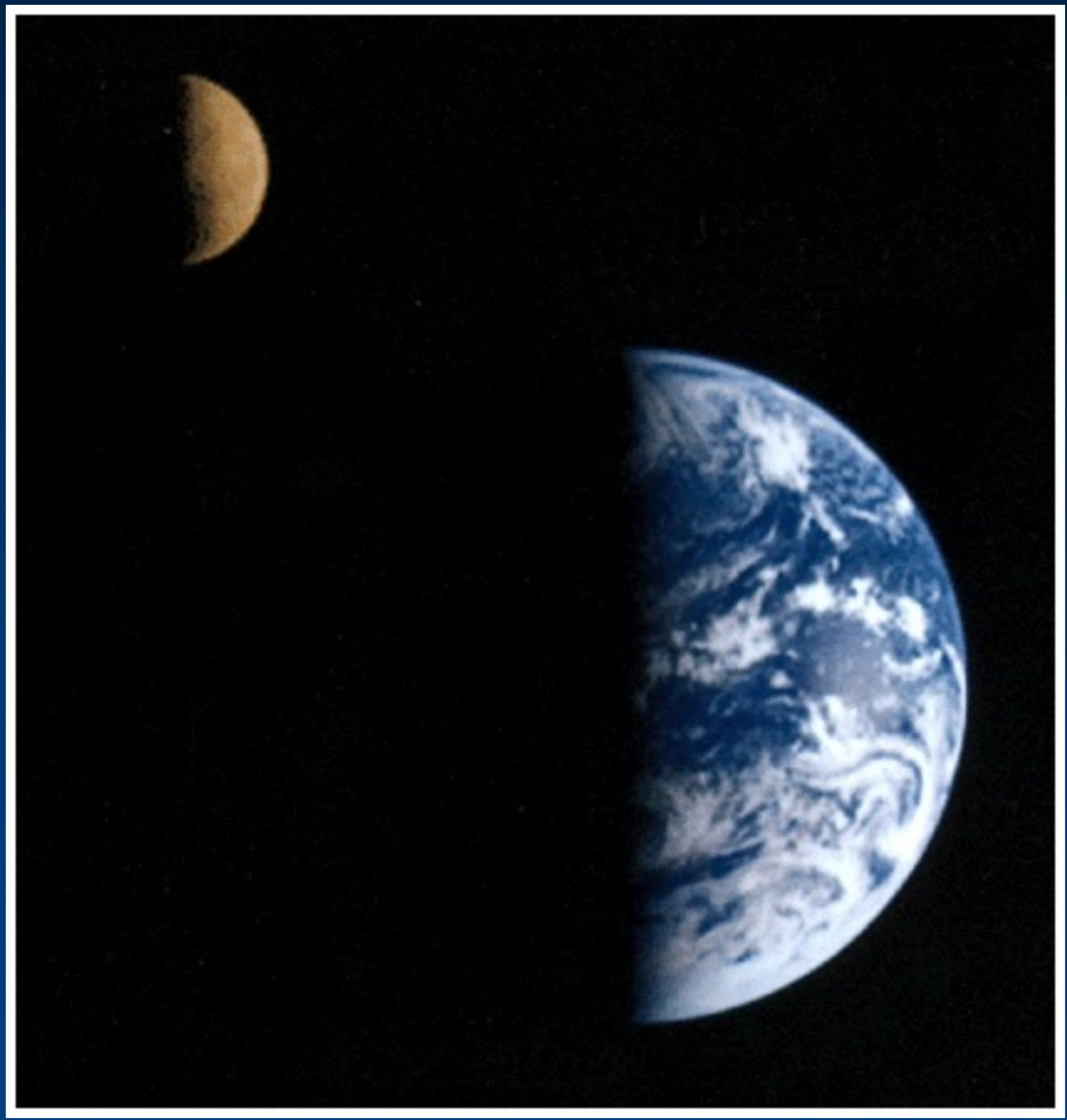
• First Homework is due Thursday, Jan. 25 at beginning of class

This class is in person. Participation counts! Please ask questions, contribute ideas and tell us about interesting astronomy articles or events

Introductions

What would you like to get from this course?


MOON



What is in our Solar System?

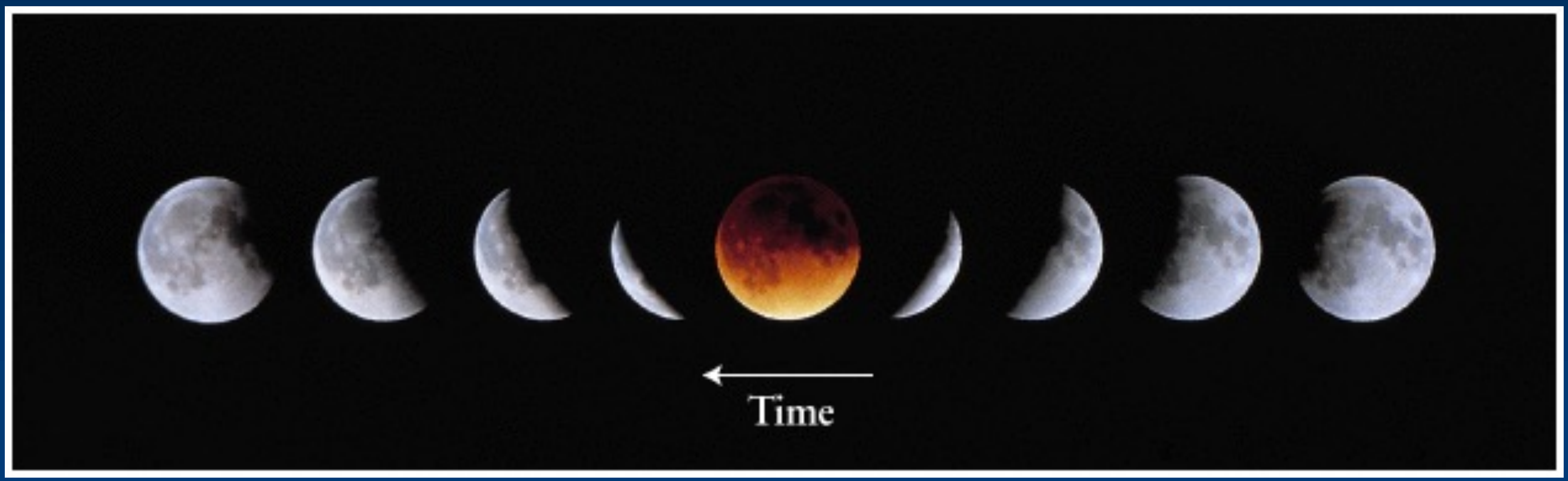
What is in our Solar System?

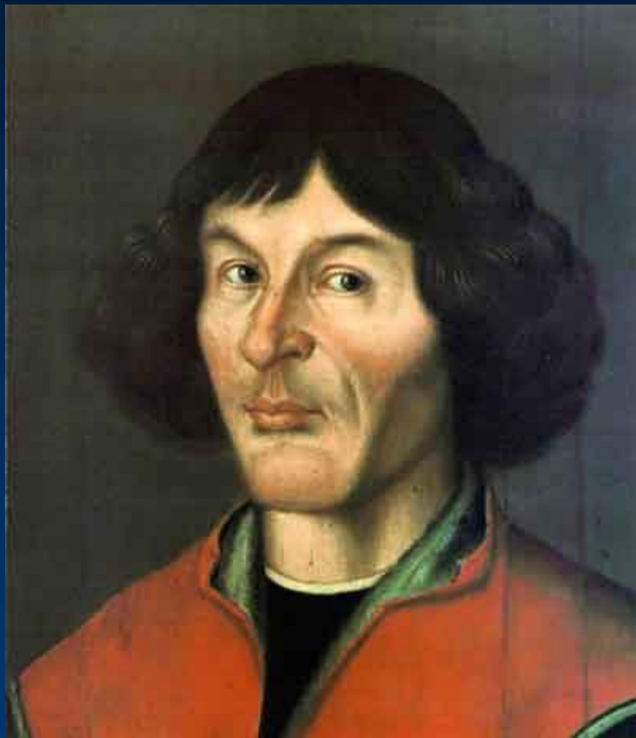
Sun, Planets, Moons, Asteroids, Comets

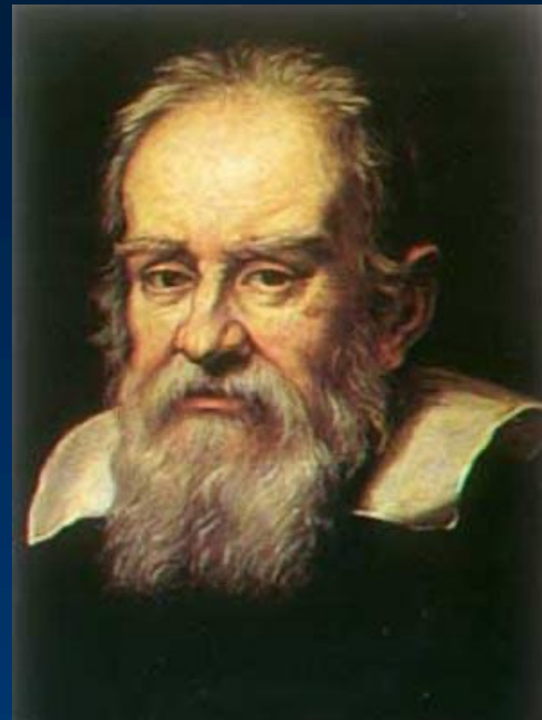
Meteors, Dust, Solar Wind, Cosmic Rays

Photons, Neutrinos, Gravitational Waves

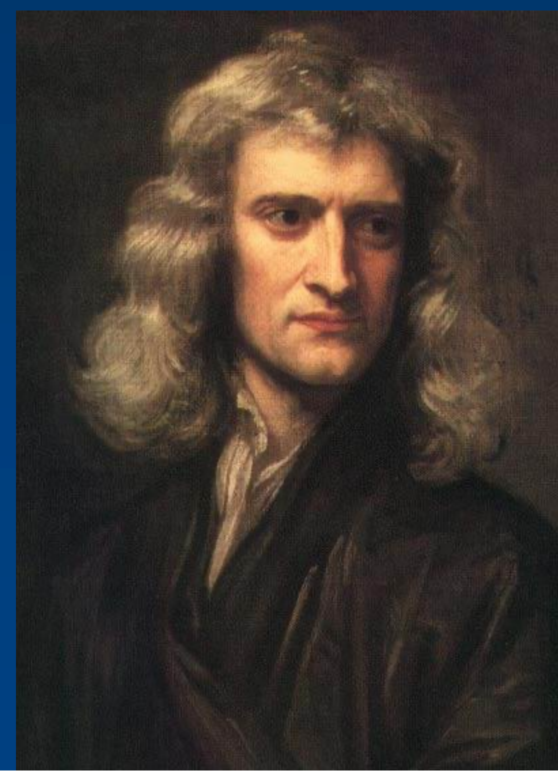
Dark Matter?

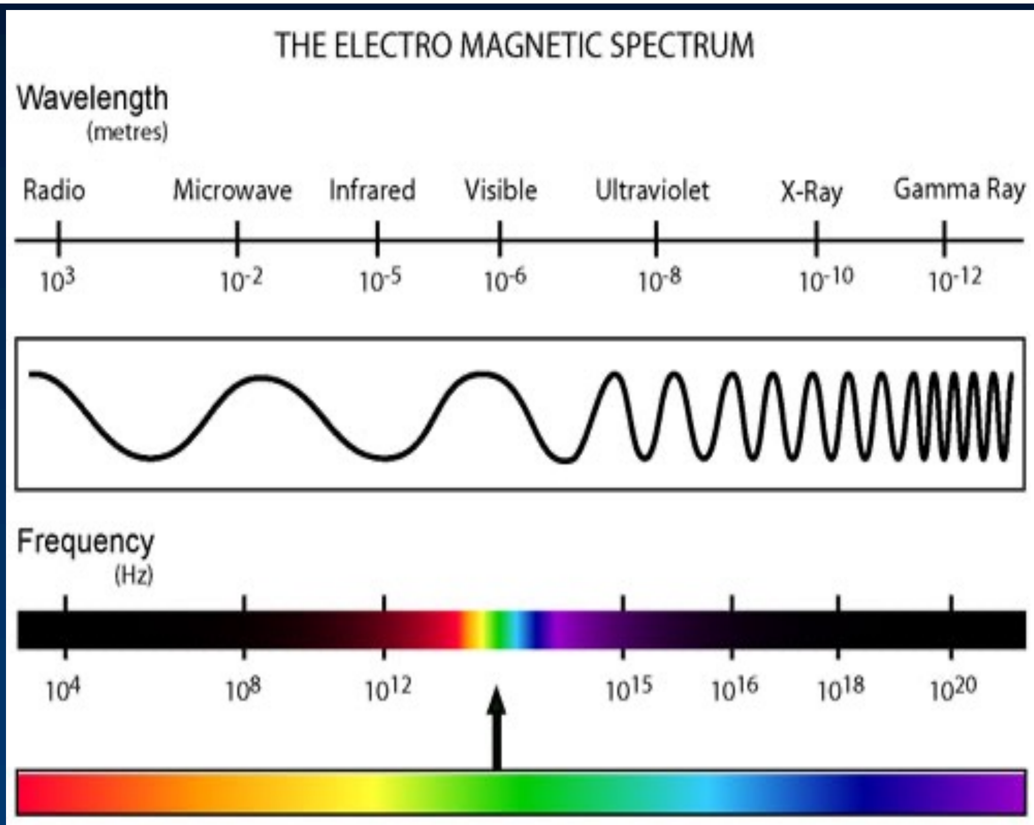

Time

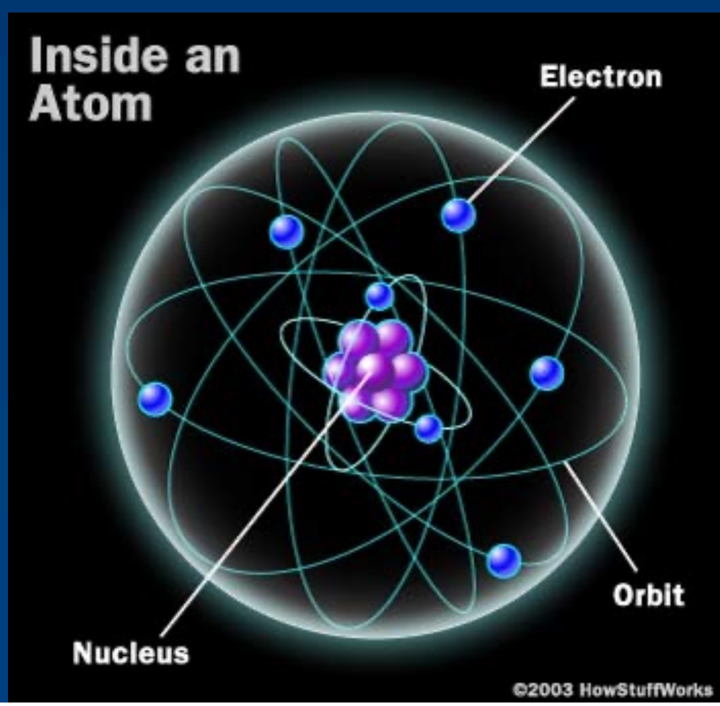


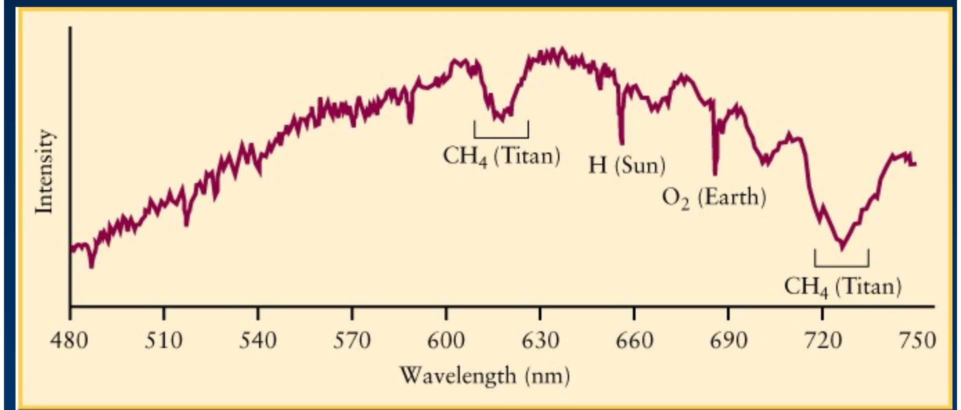



IOANNIS KEPPLERI
Mathematici Cæſarei
hanc Imaginem
ARGENTORATENSI BIBLIOTHECÆ
Conſecr.
MATTHIAS BERNEGGERUS
Kal. Ianuar. Anno Chr.
MDC. XXVII

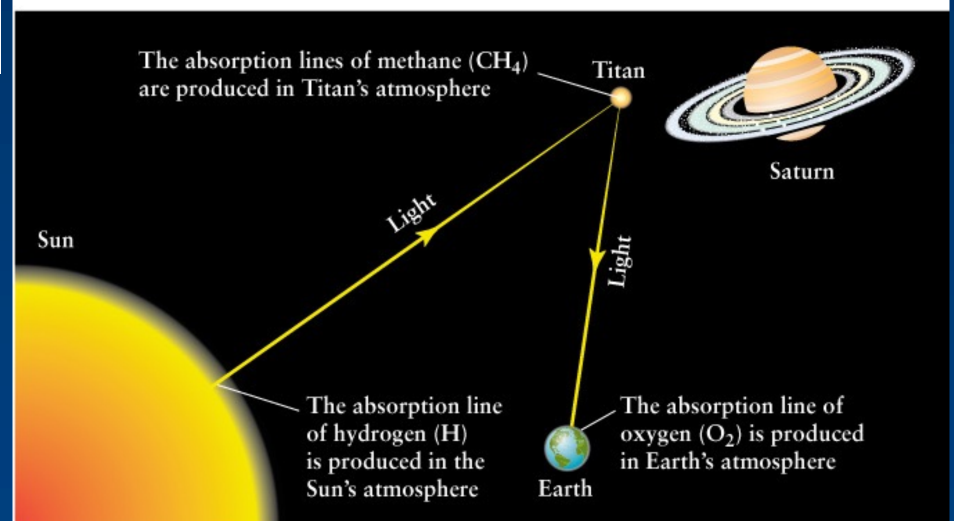




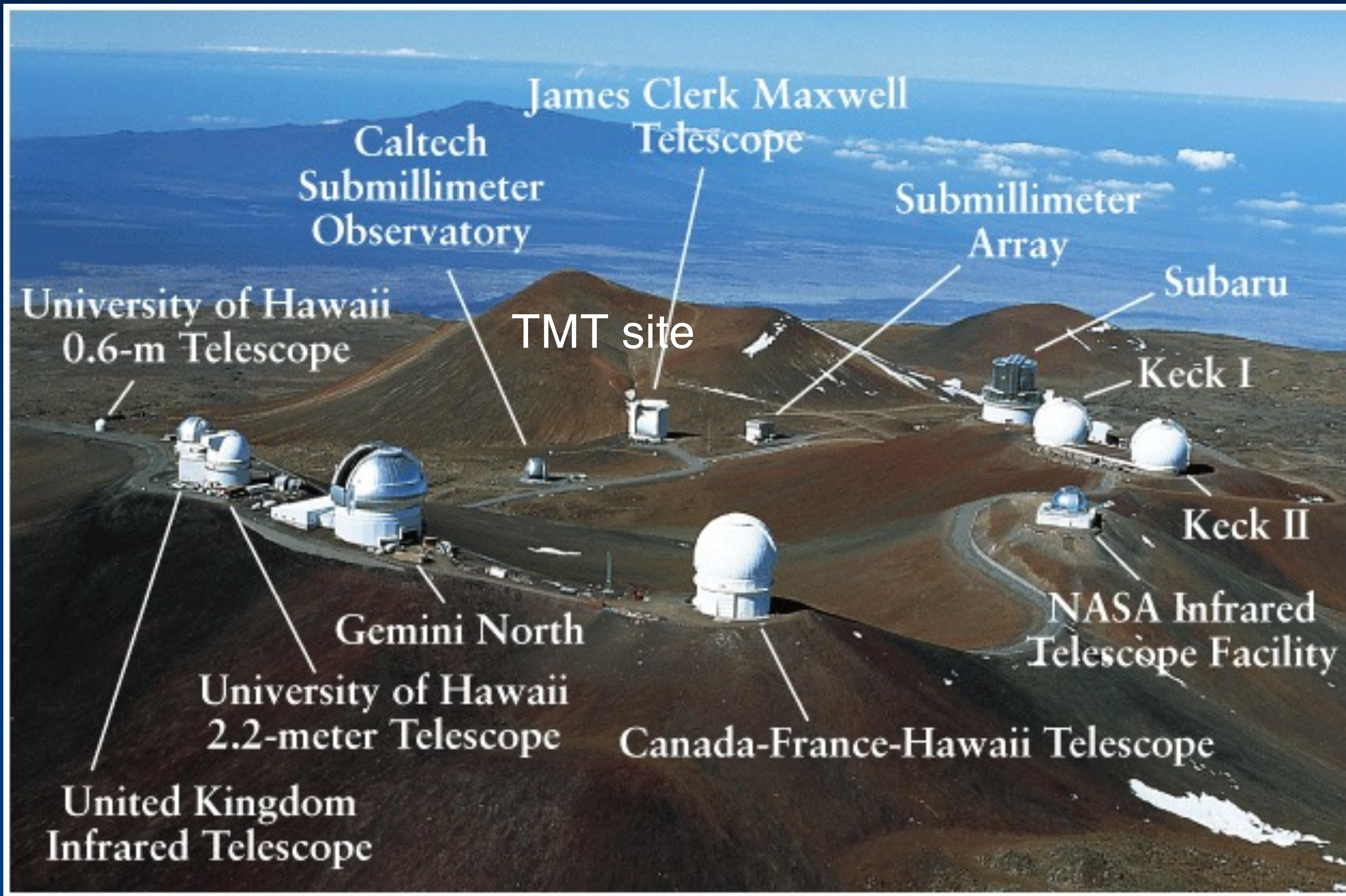




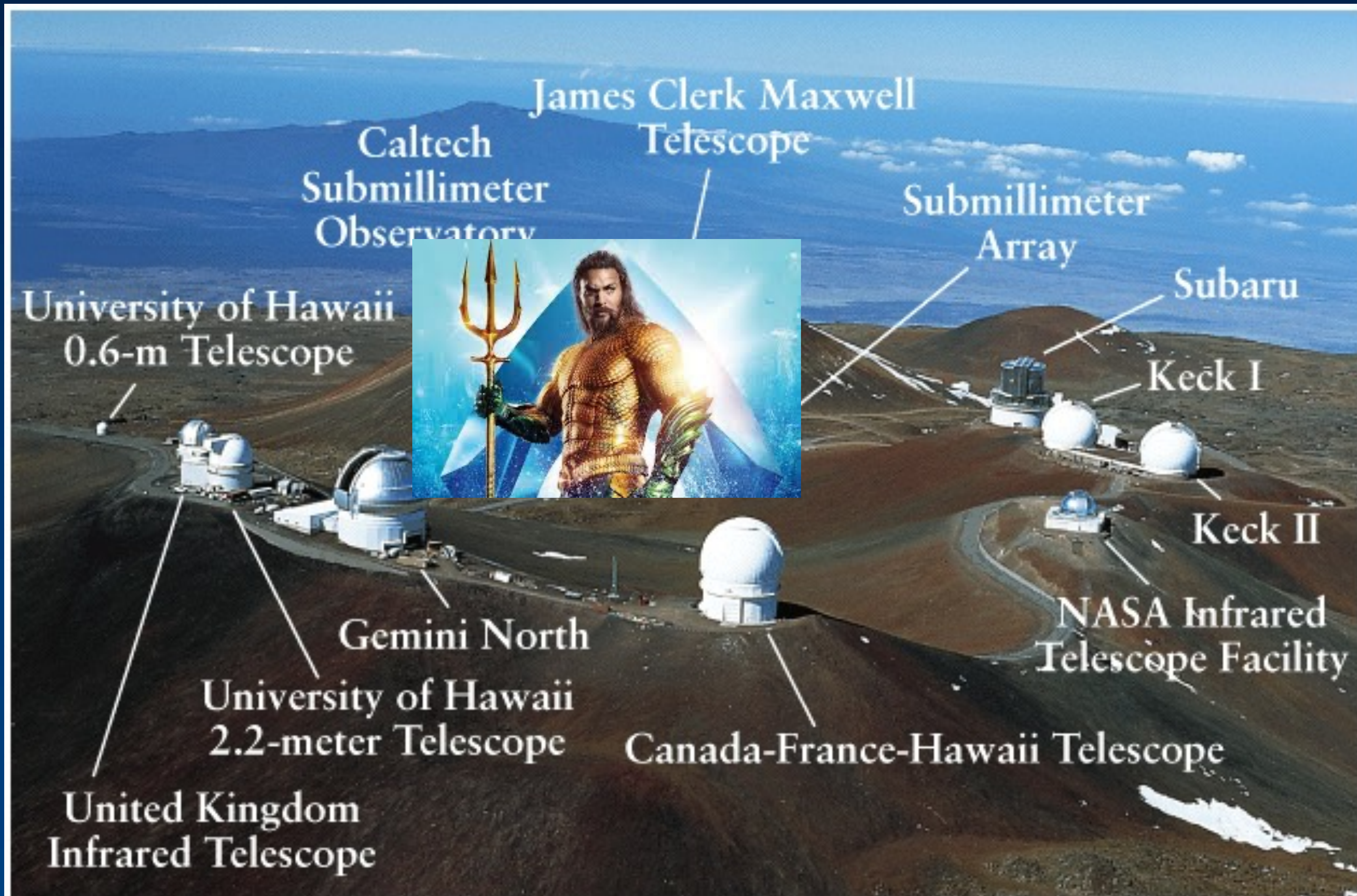
(b) The spectrum of sunlight reflected from Titan



(c) Interpreting Titan's spectrum

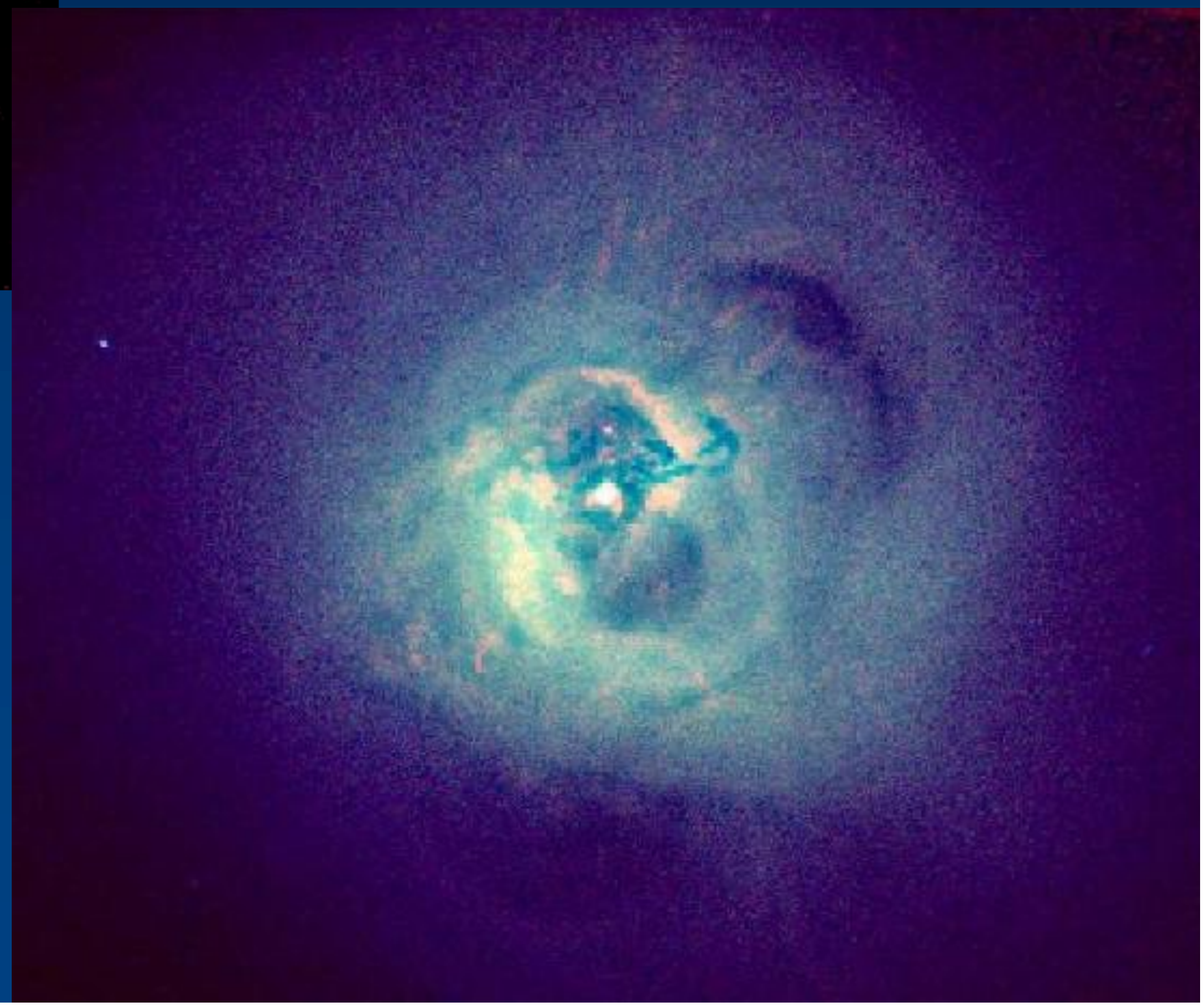


James Clerk Maxwell Telescope
Caltech Submillimeter Observatory
Submillimeter Array
Subaru
University of Hawaii 0.6-m Telescope
TMT site
Keck I
Keck II
NASA Infrared Telescope Facility
Gemini North
University of Hawaii 2.2-meter Telescope
Canada-France-Hawaii Telescope
United Kingdom Infrared Telescope



James Clerk Maxwell
Telescope
Caltech
Submillimeter
Observatory
Submillimeter
Array
Subaru
University of Hawaii
0.6-m Telescope
Keck I
Keck II
NASA Infrared
Telescope Facility
Gemini North
University of Hawaii
2.2-meter Telescope
Canada-France-Hawaii Telescope
United Kingdom
Infrared Telescope

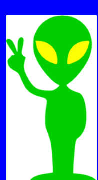
Chandra X-ray Observatory



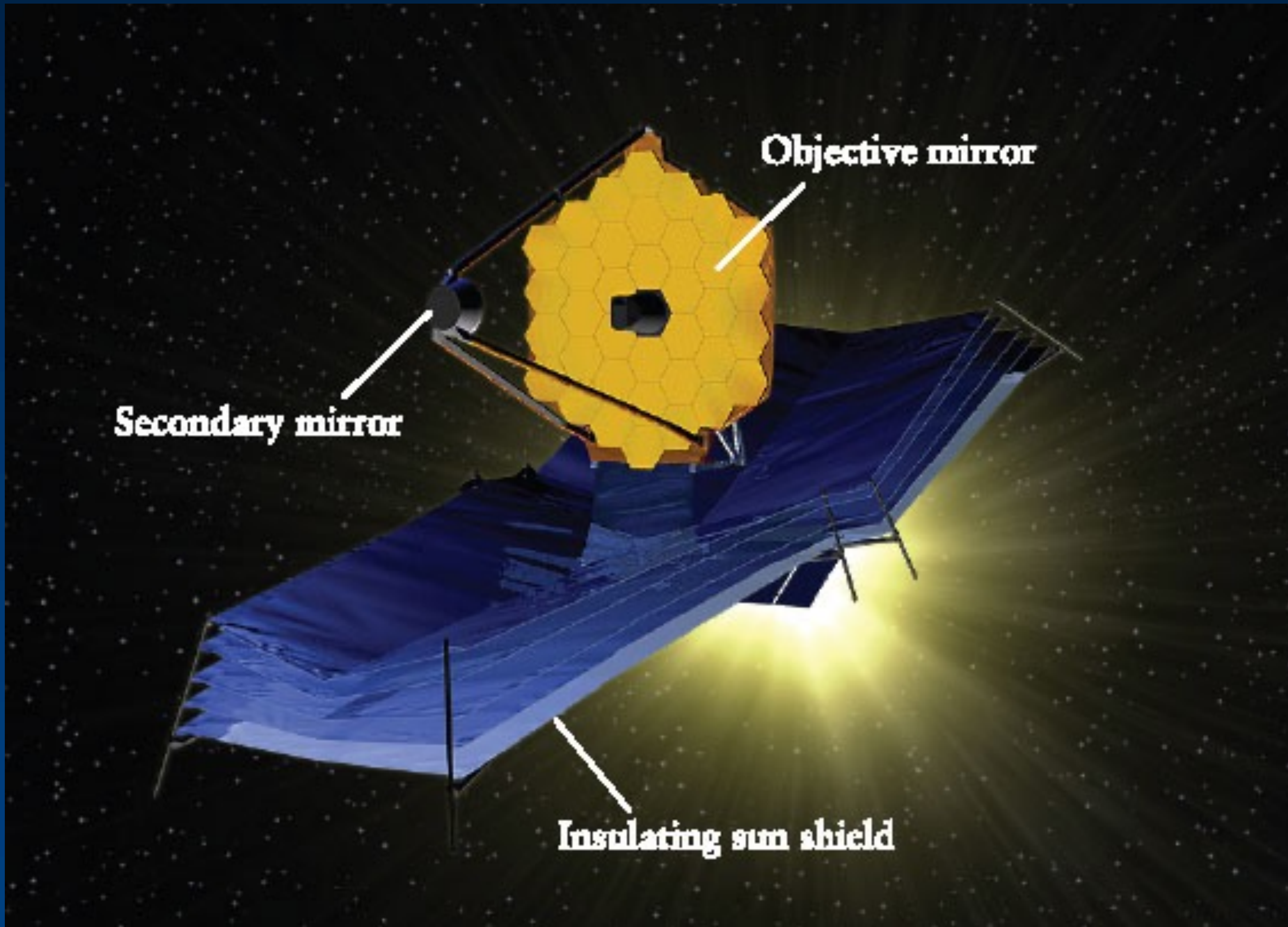
Perseus Cluster

TESS

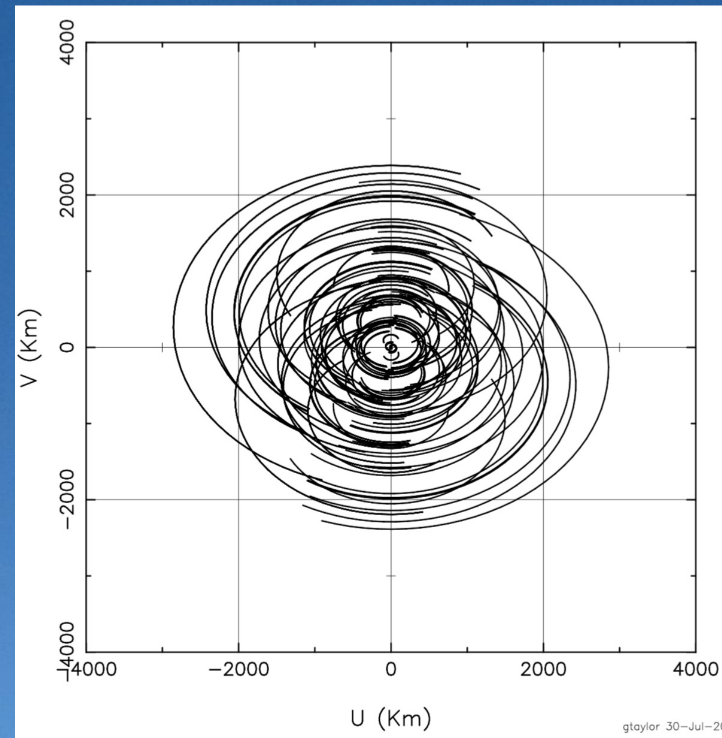
The Transiting Exoplanet Survey Satellite (TESS) will survey 200,000 of the brightest nearby stars.



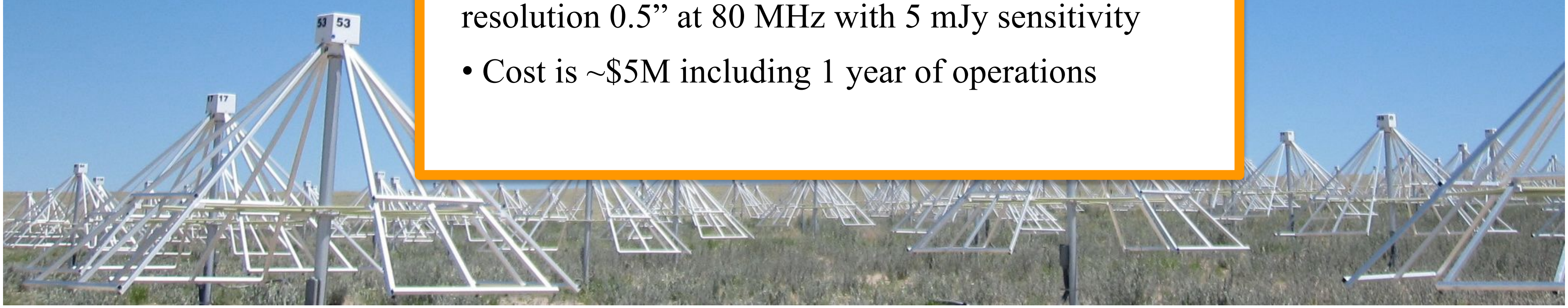
JWST

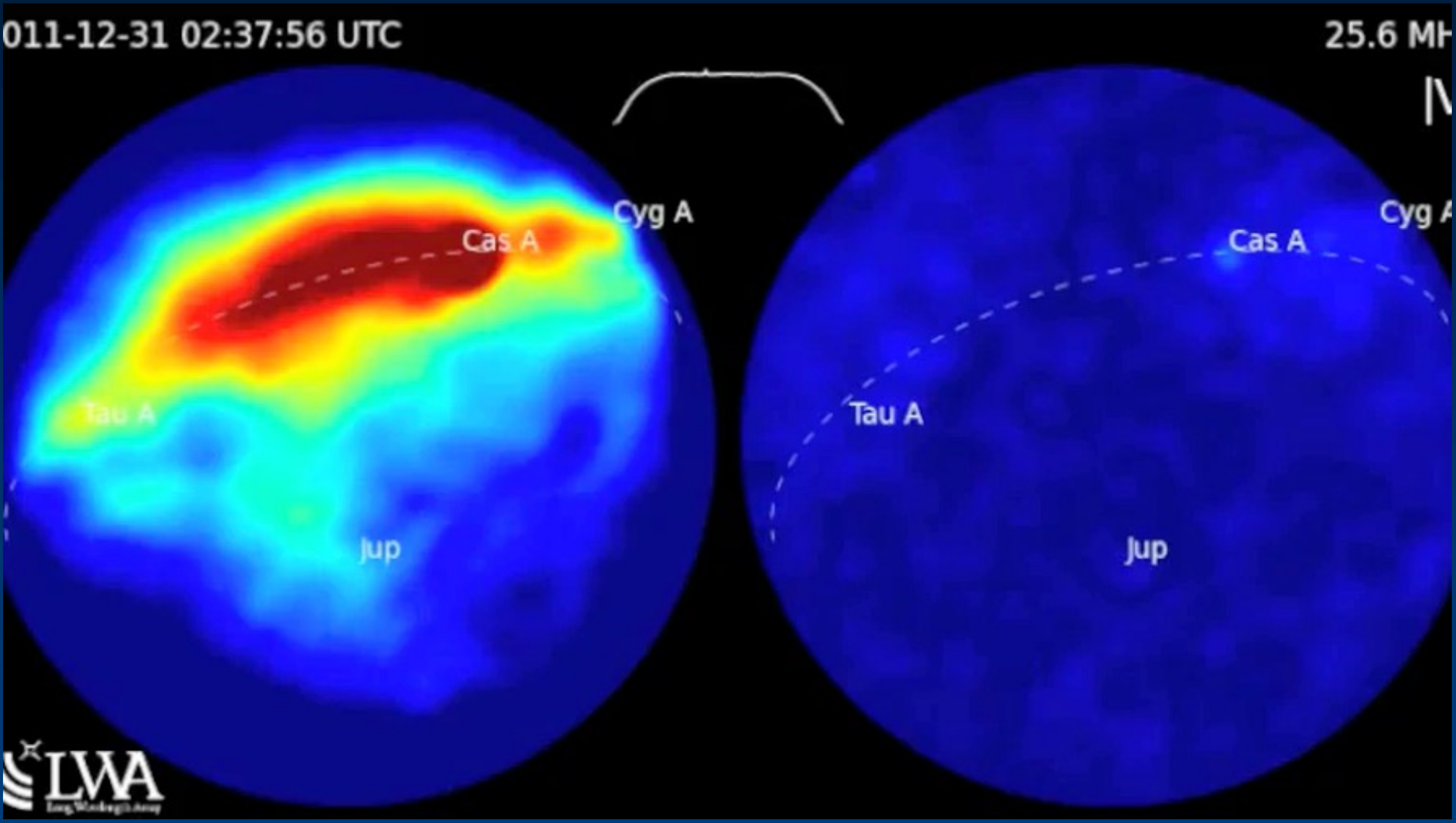


LWA Swarm Concept



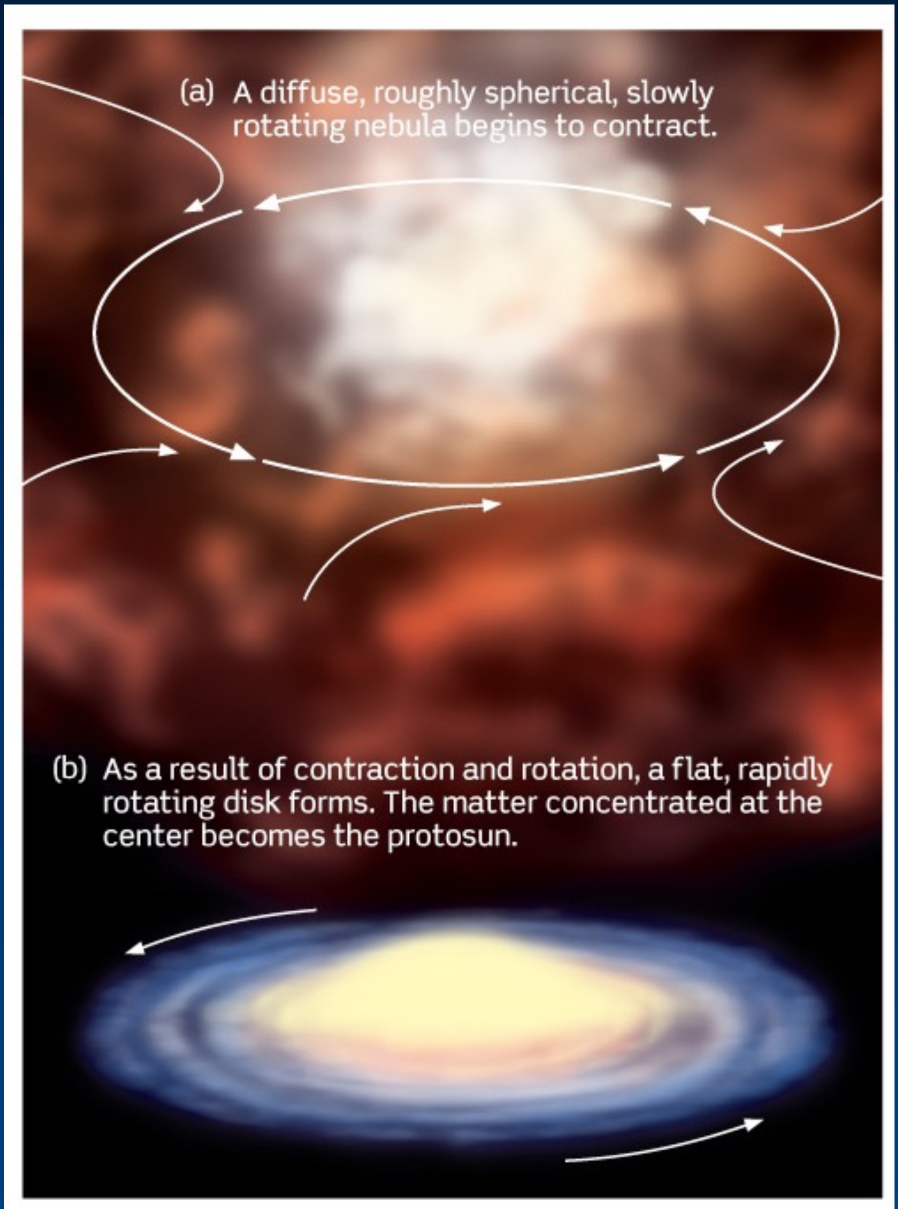
- Goal of 3 existing full stations (●) plus ~10 LWA mini stations (●), baselines up to 2500 km for resolution 0.5” at 80 MHz with 5 mJy sensitivity
- Cost is ~$5M including 1 year of operations

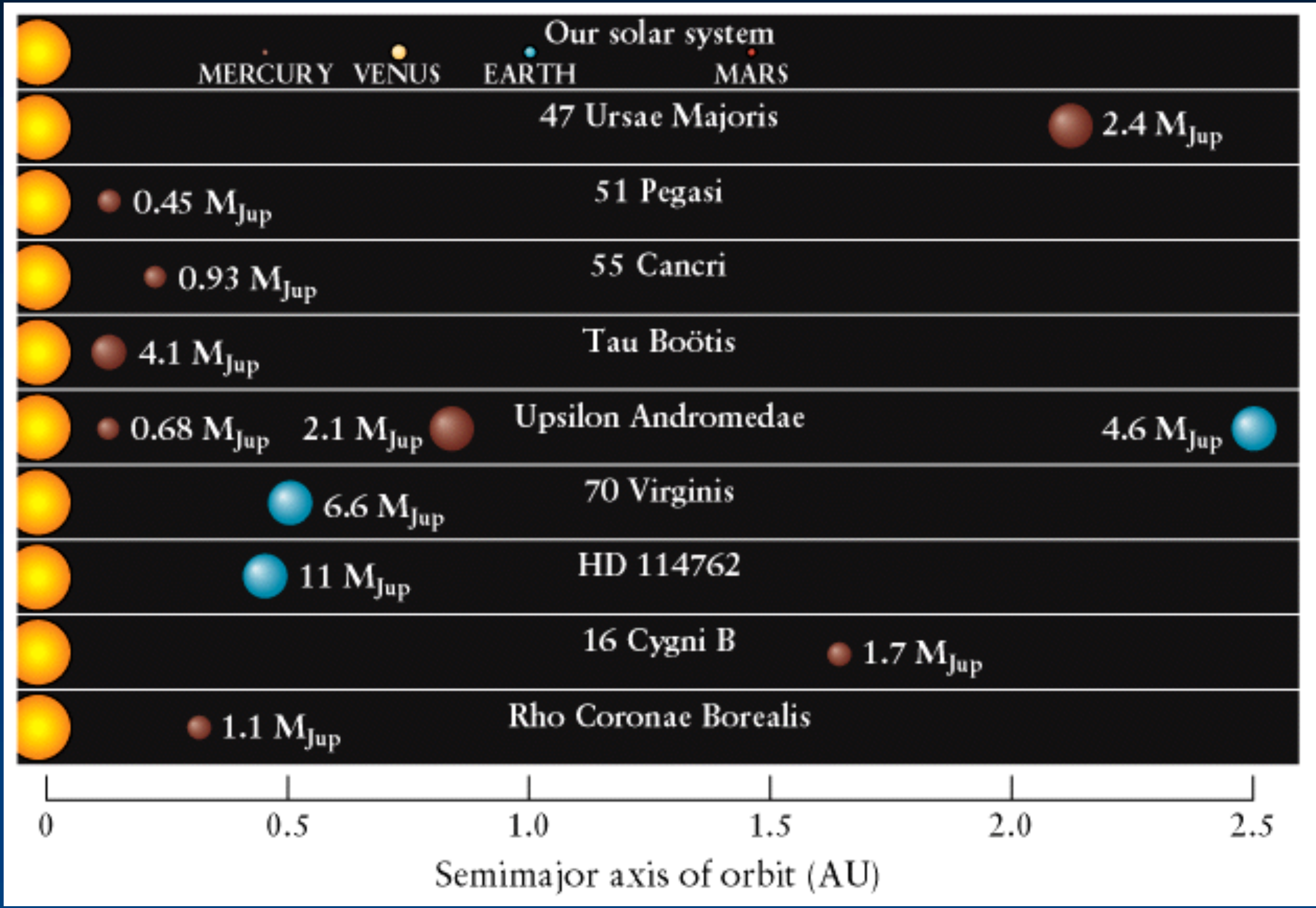




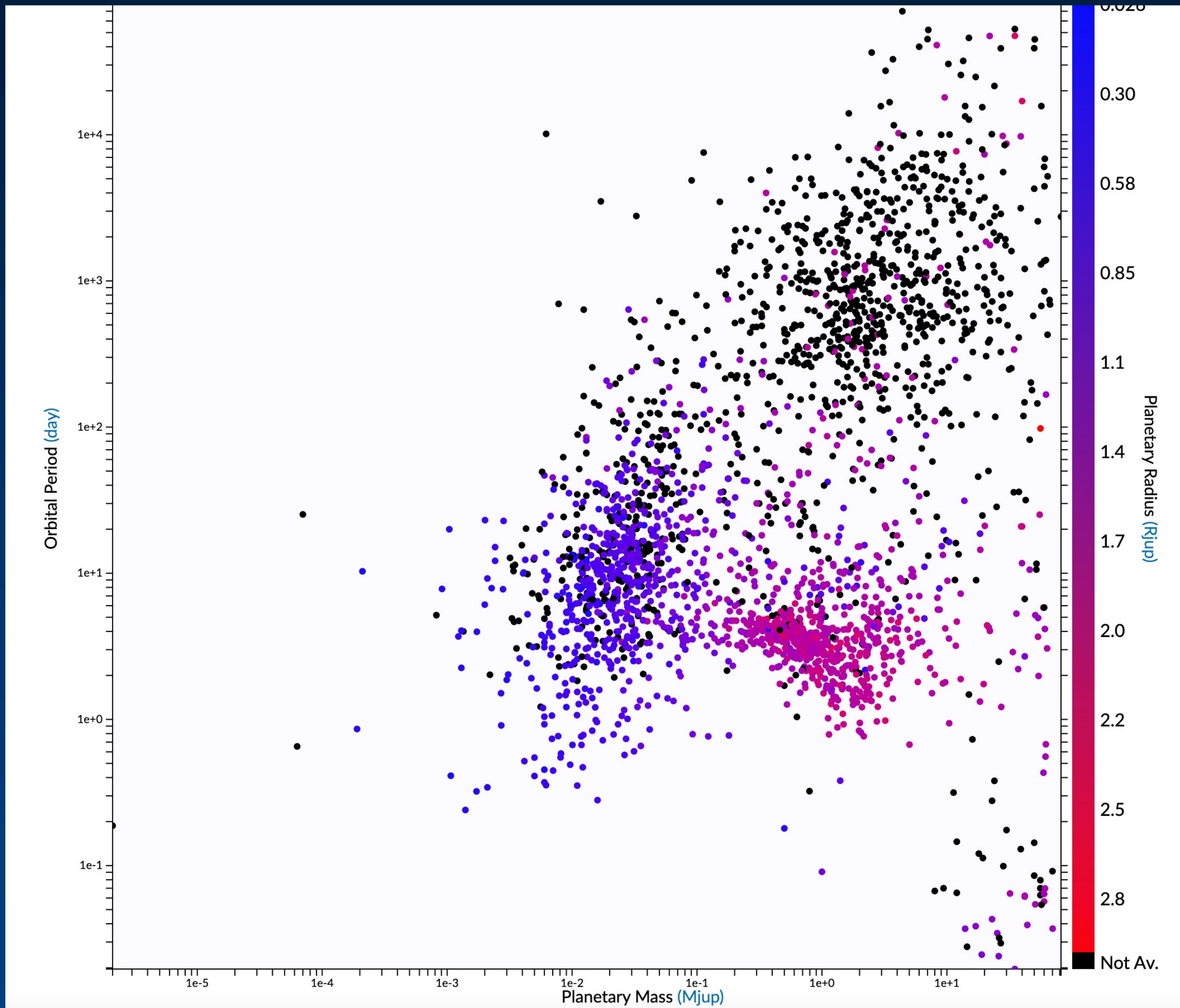
http://www.phys.unm.edu/~lwa/lwatv.html

Solar System Formation

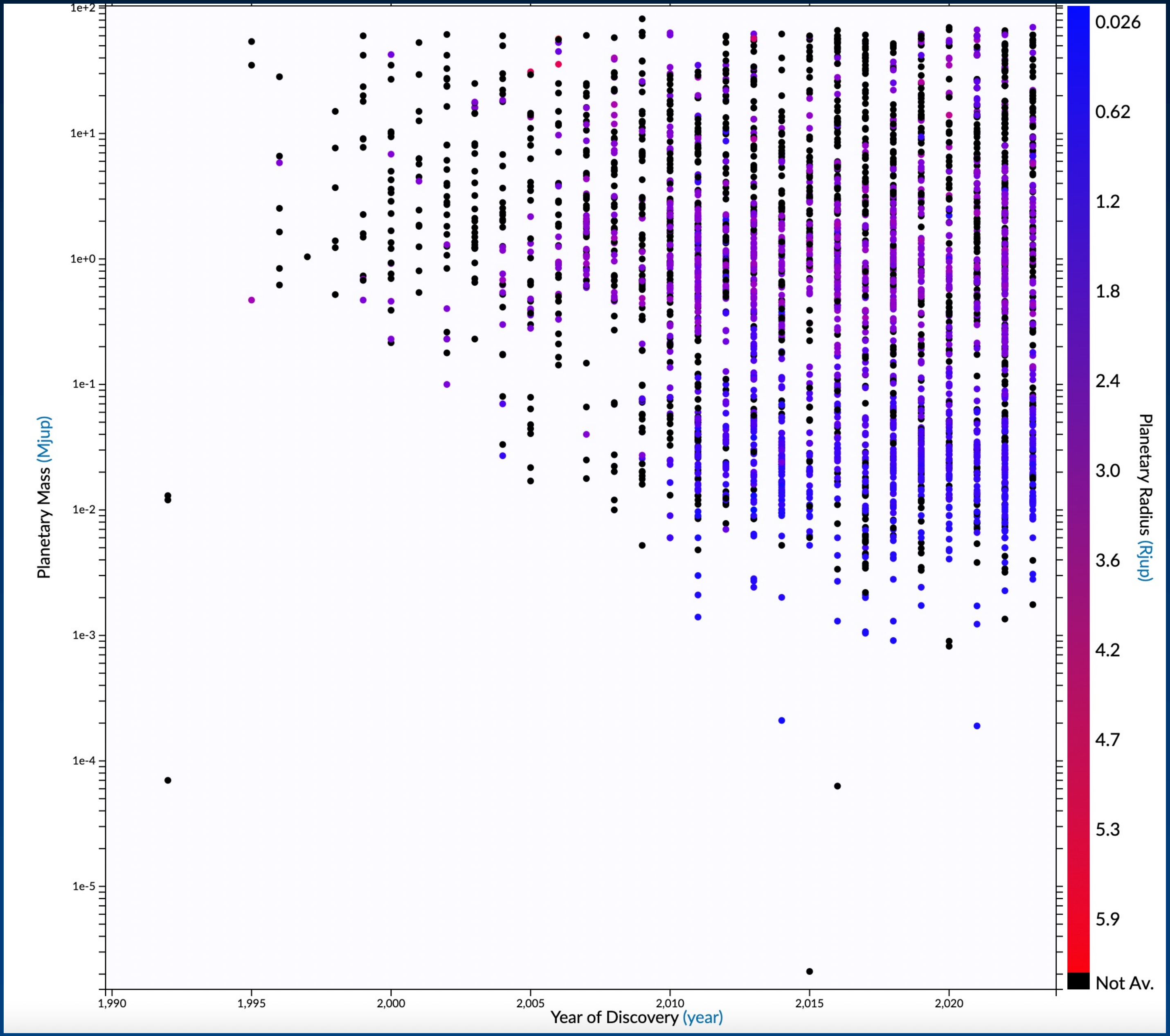




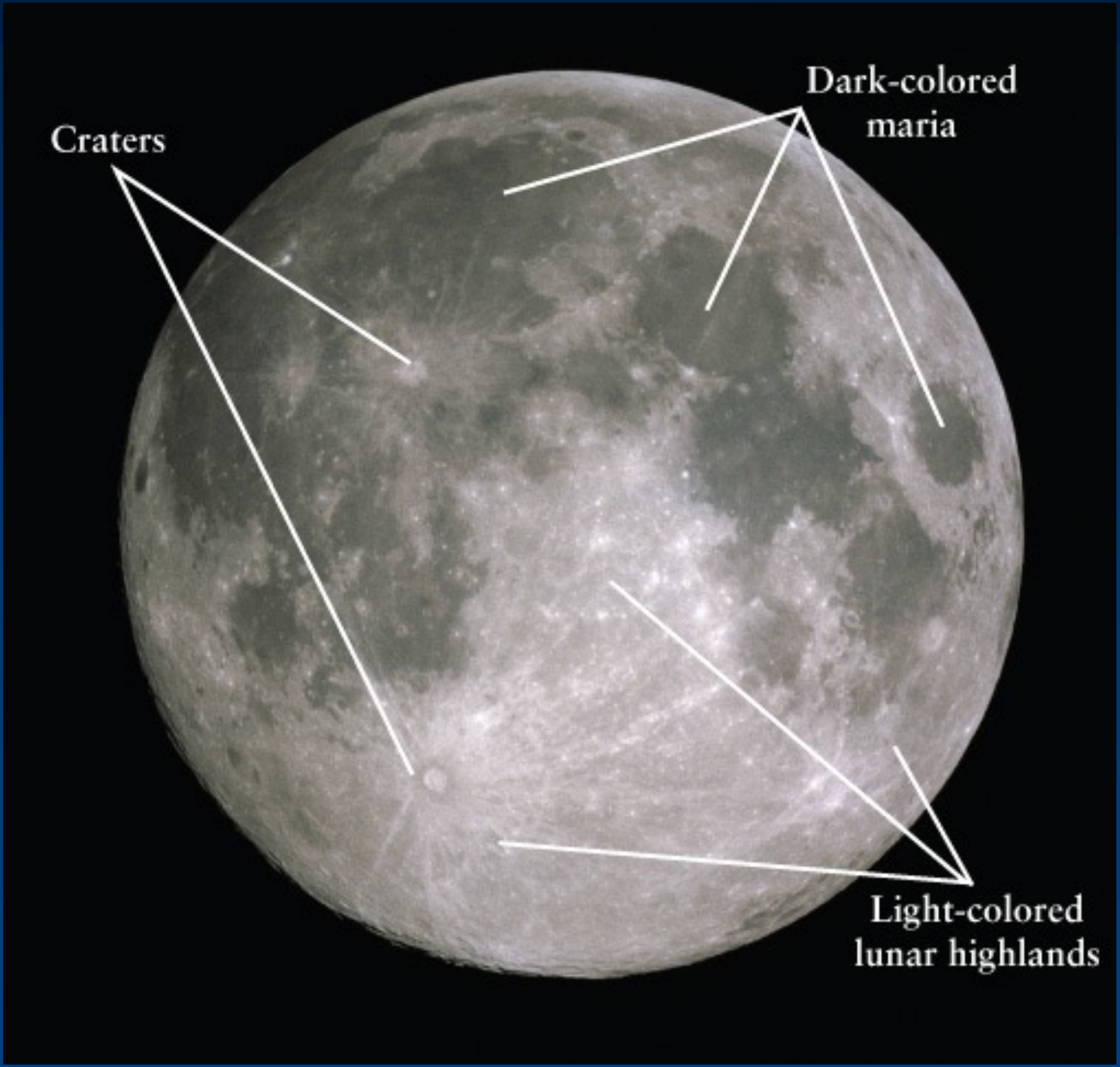
2014 count: 1811 planets, around 1126 stars

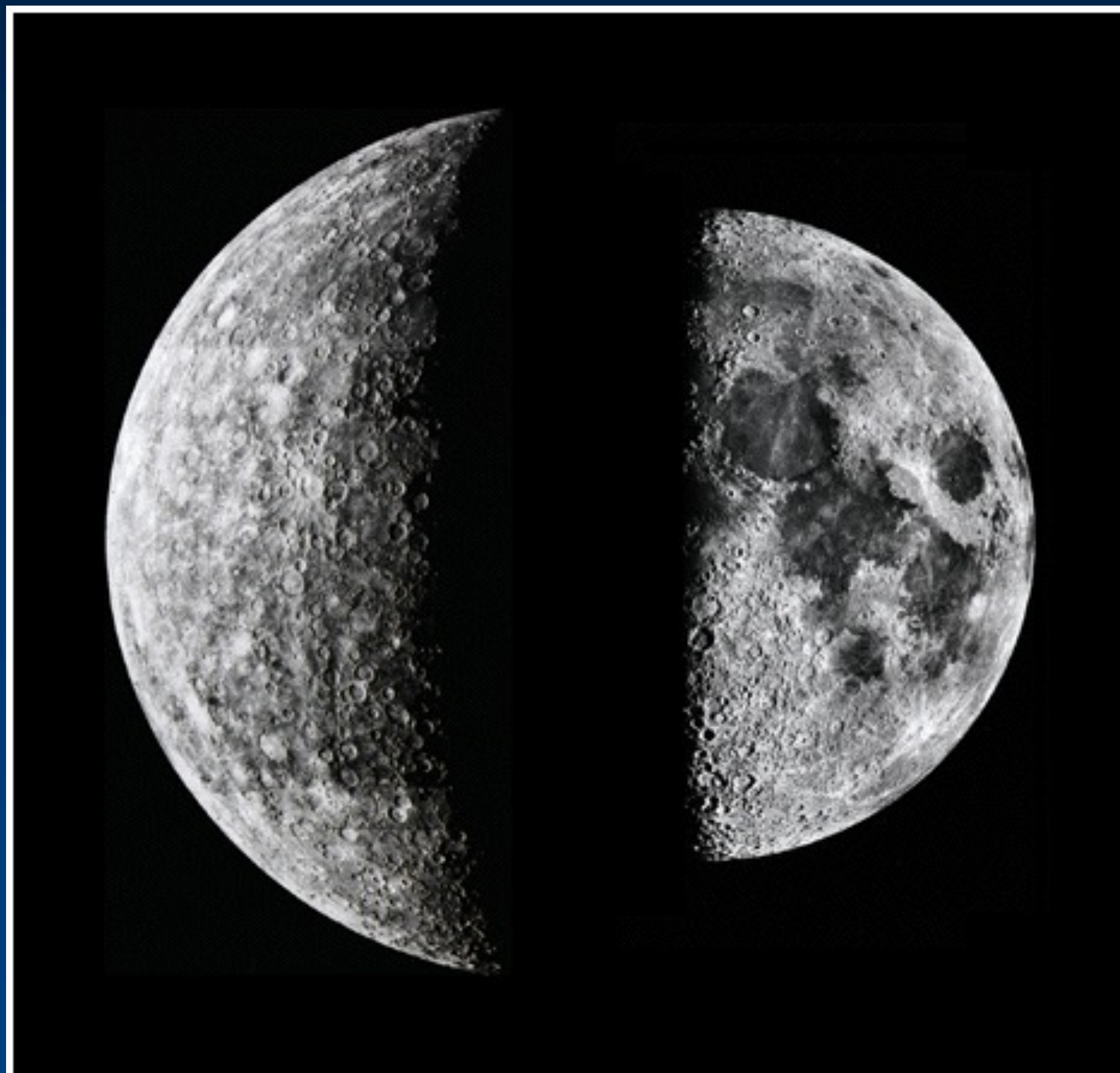


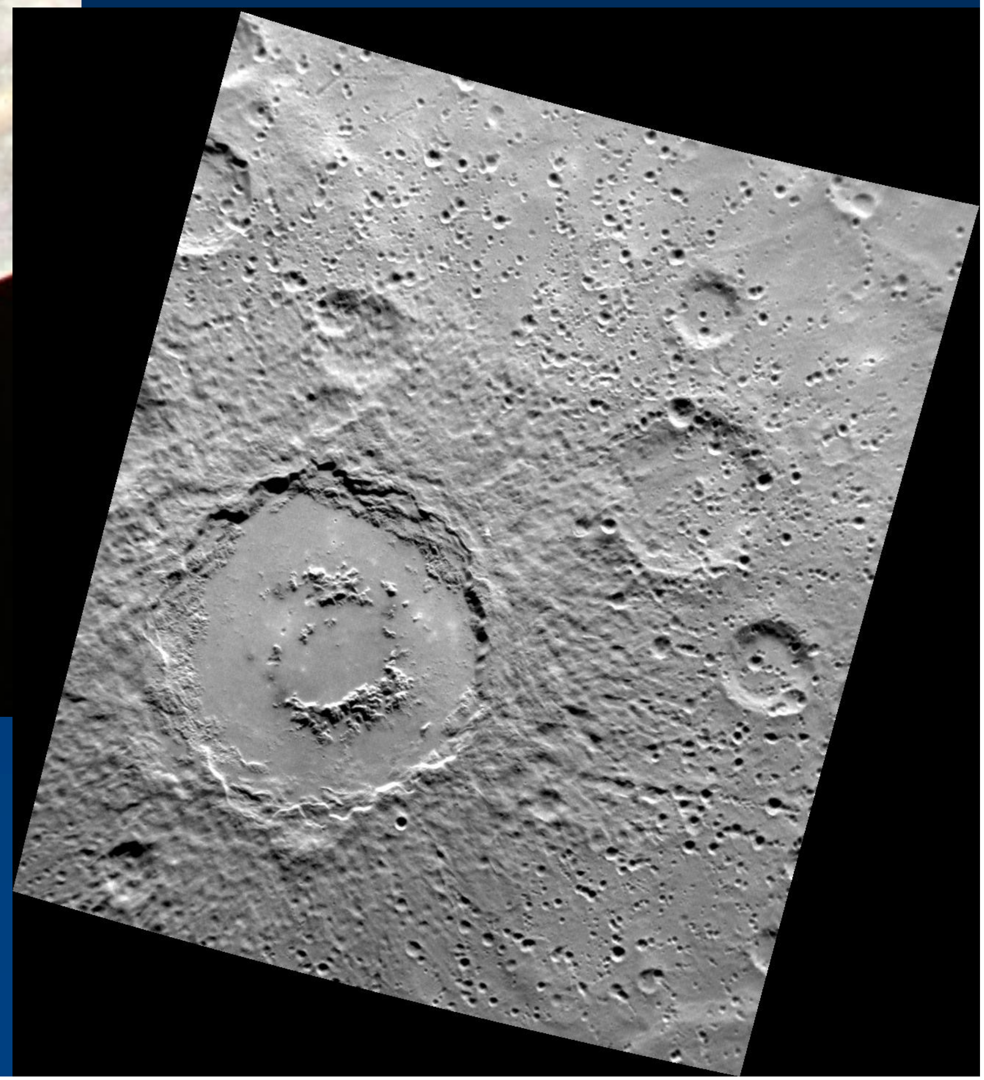
Current count: 5586 planets, around 4419 stars as of 1/11/2024

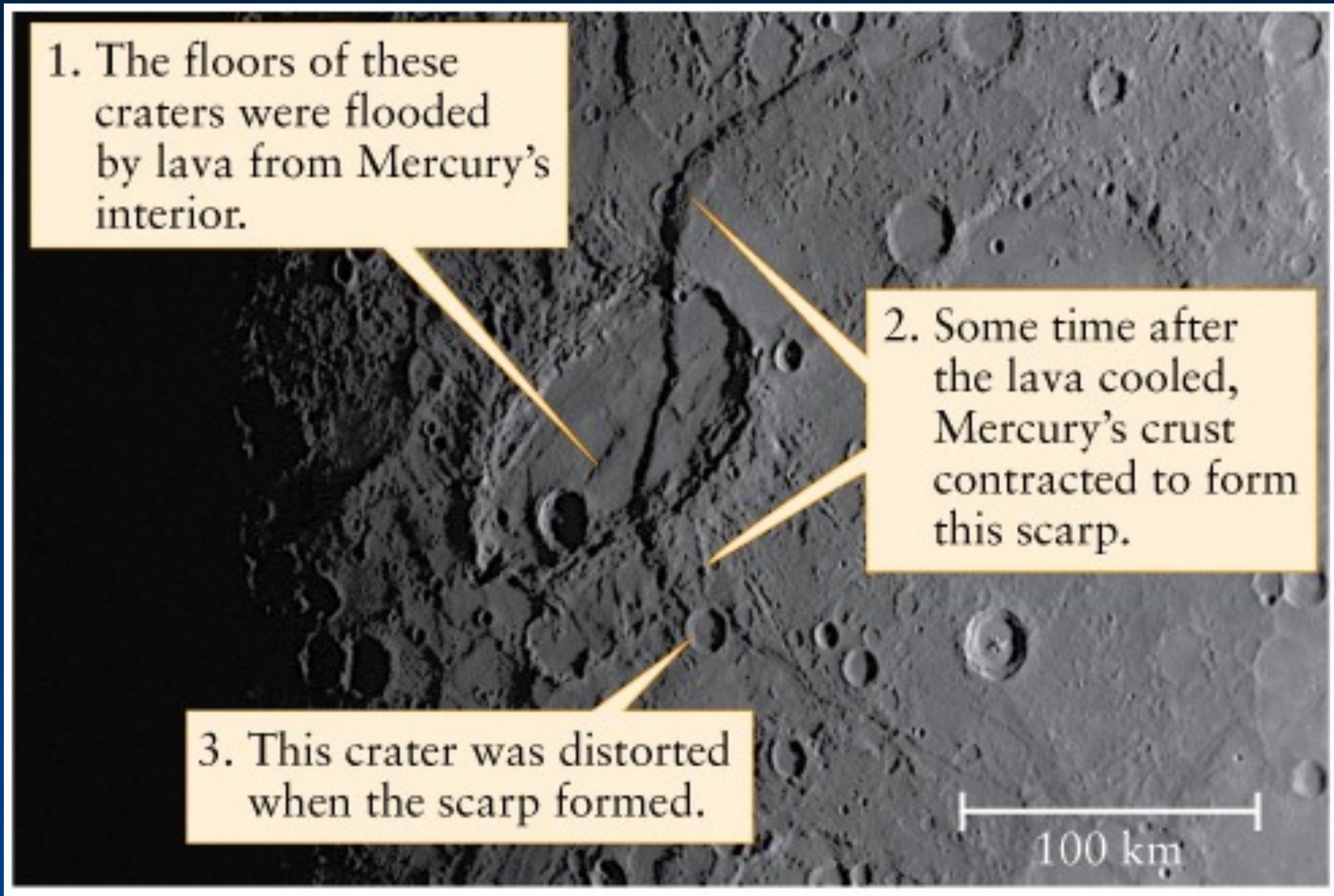


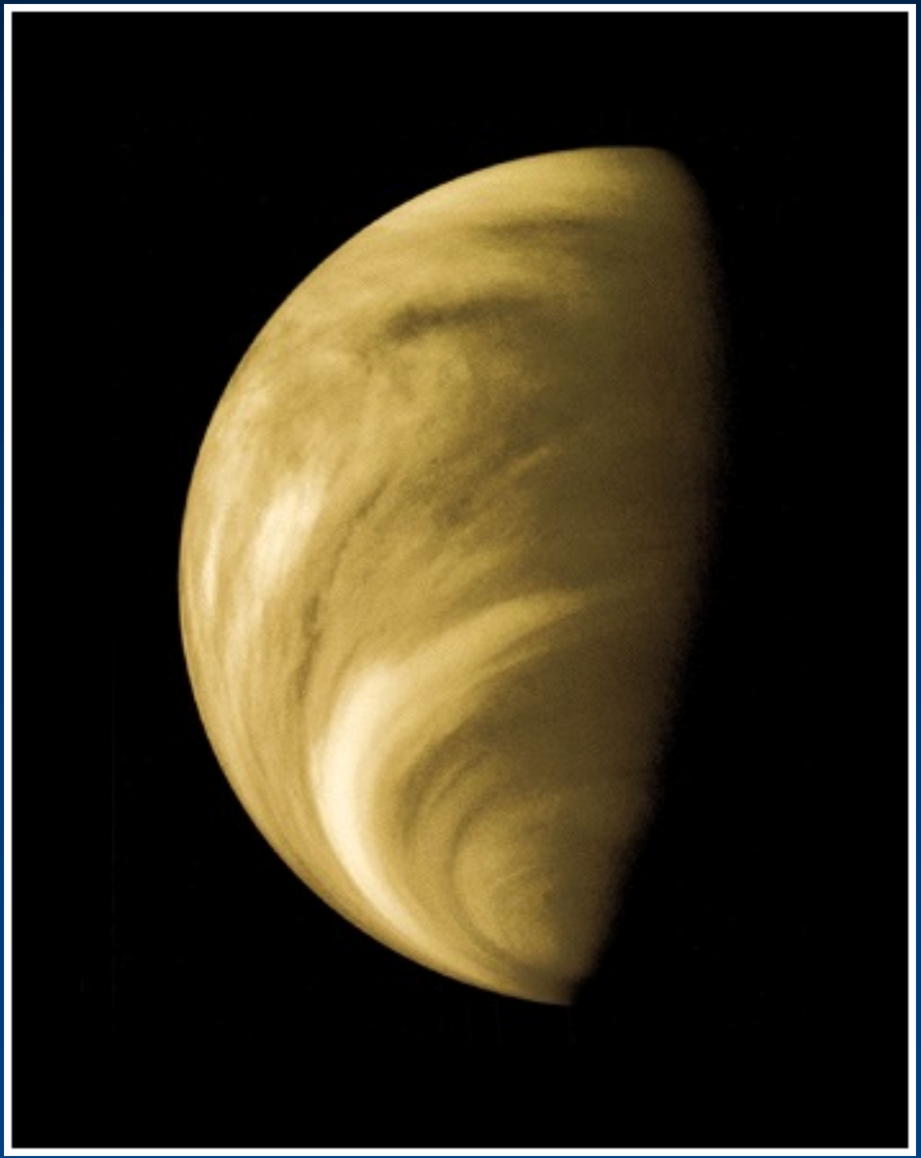
Number and Mass of planets discovered with time

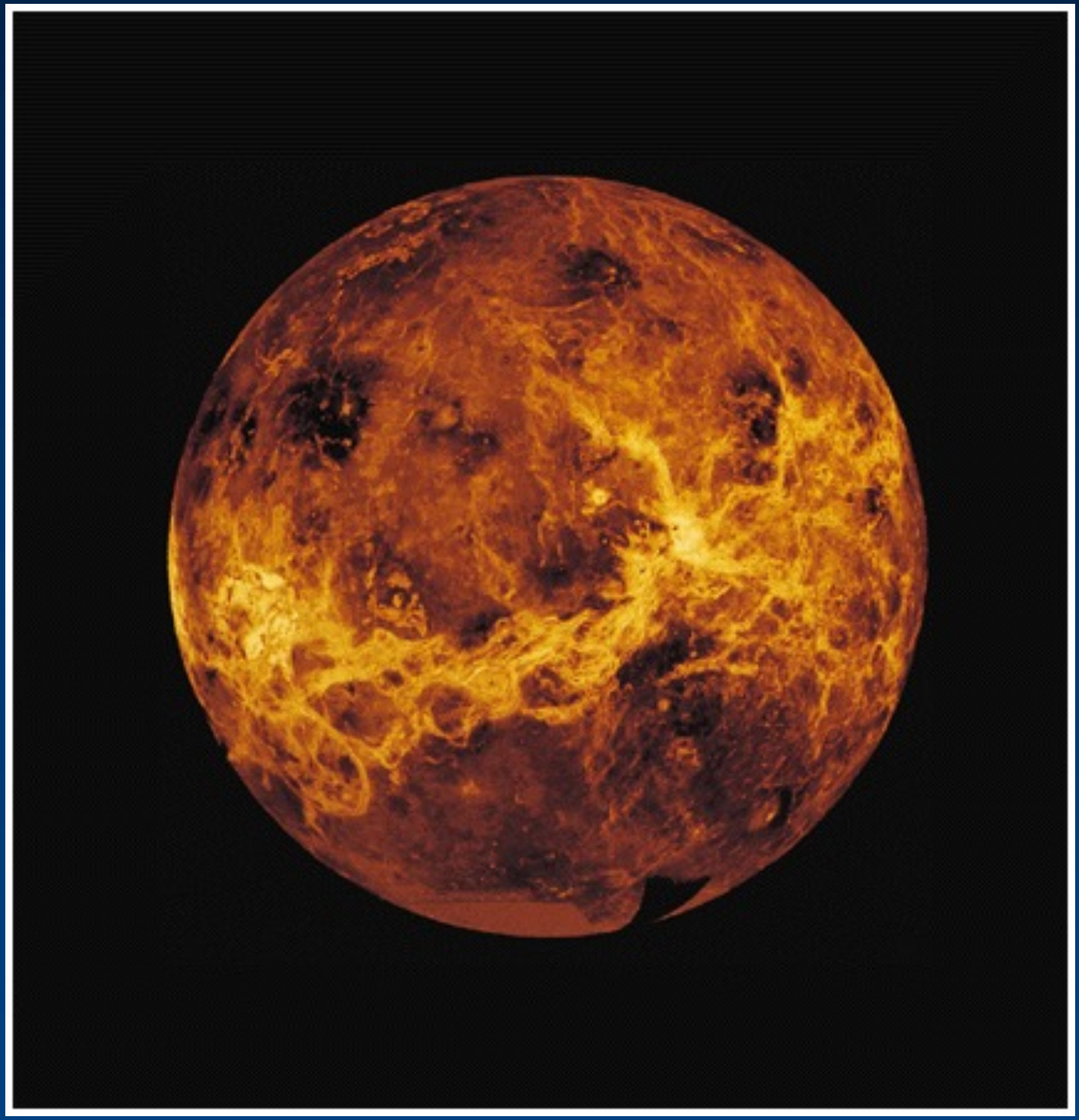

Craters
Dark-colored
maria
Light-colored
lunar highlands

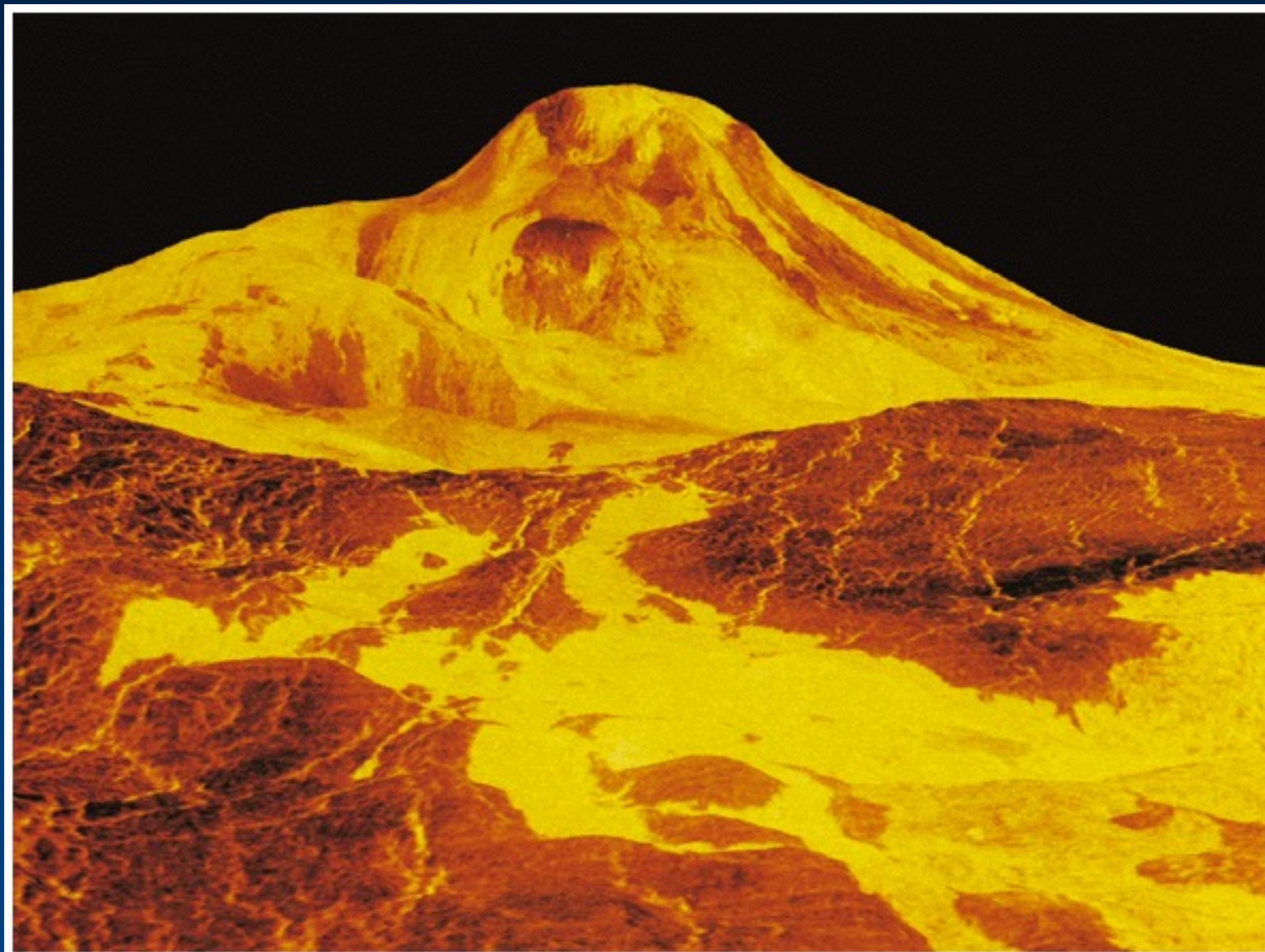


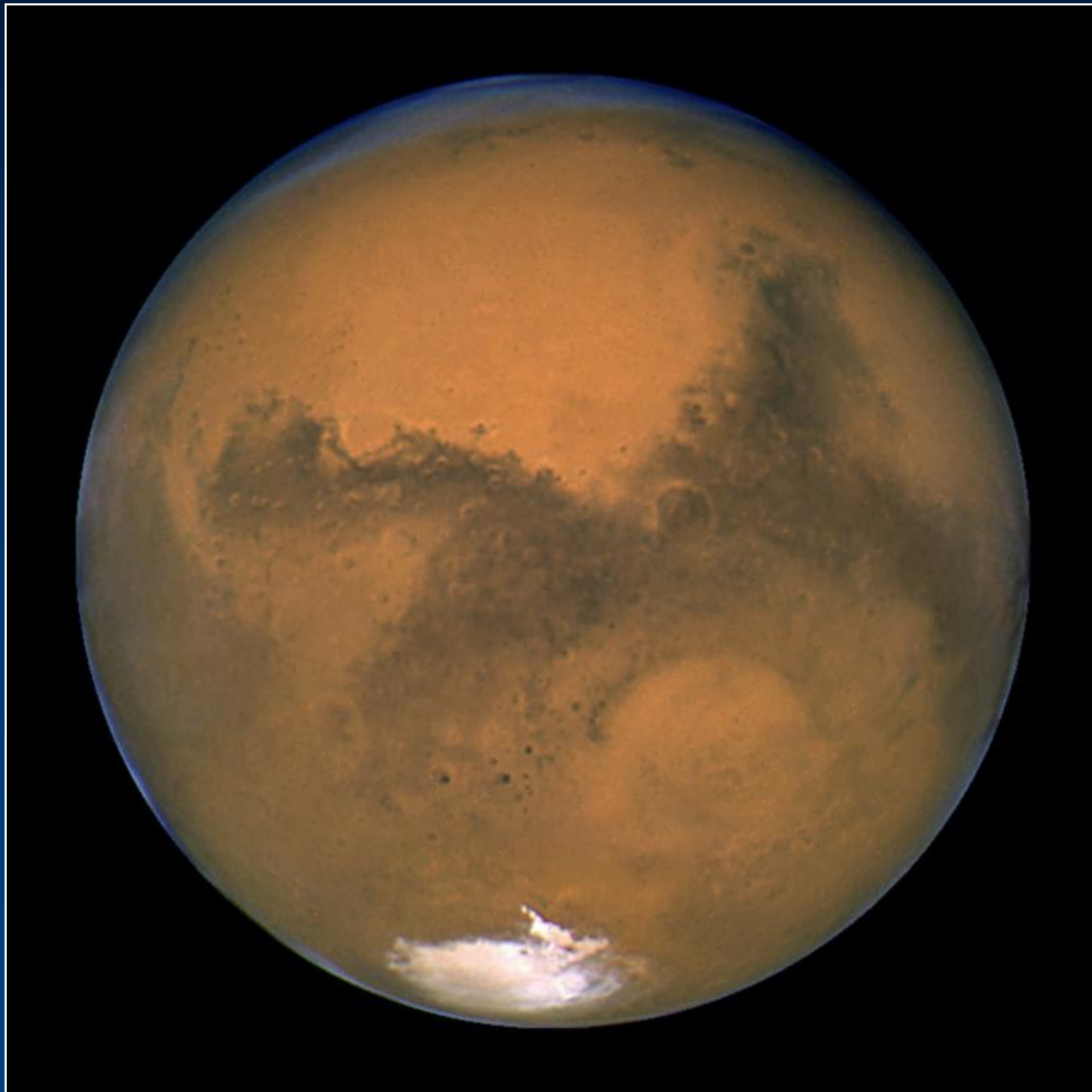



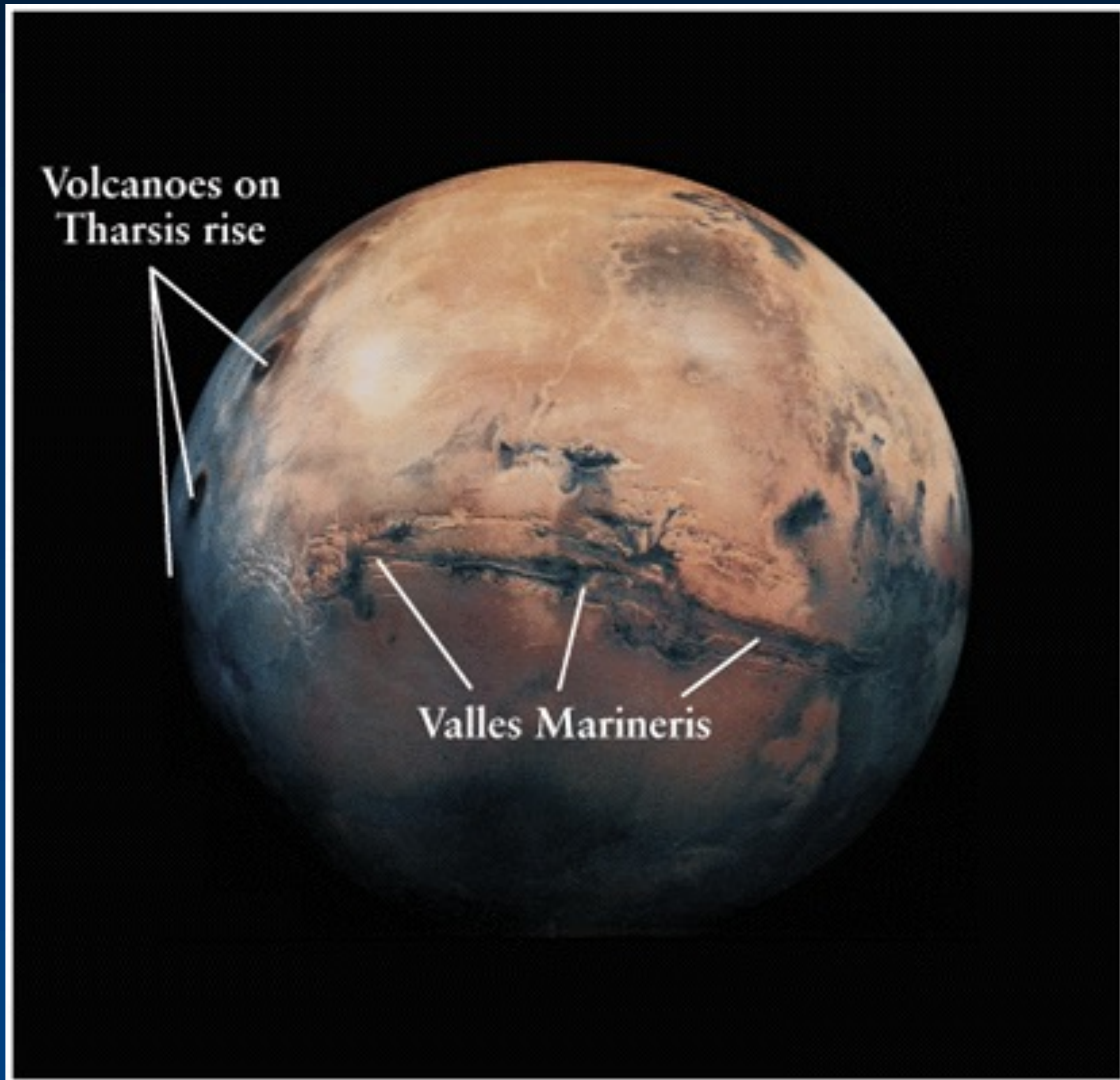

1. The floors of these craters were flooded by lava from Mercury's interior.
2. Some time after the lava cooled, Mercury's crust contracted to form this scarp.
3. This crater was distorted when the scarp formed.
100 km



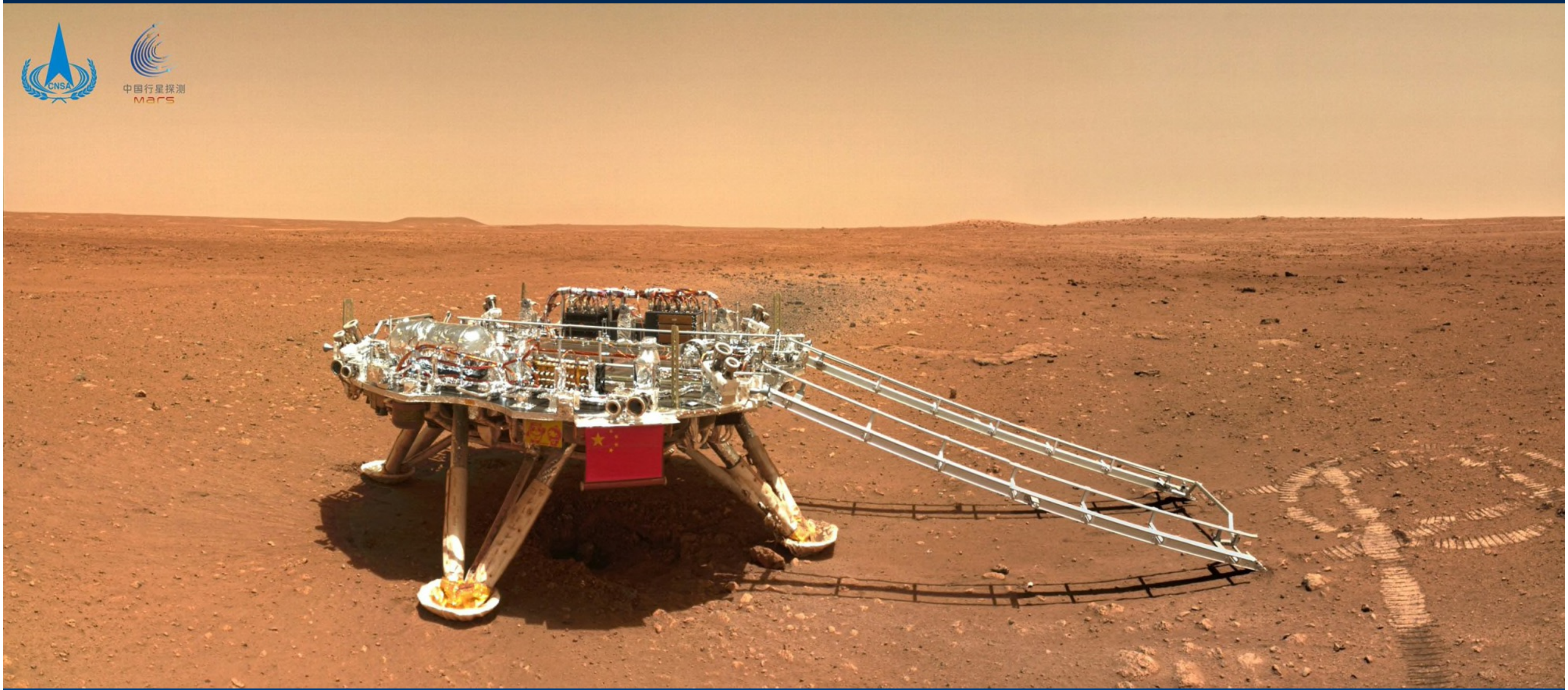




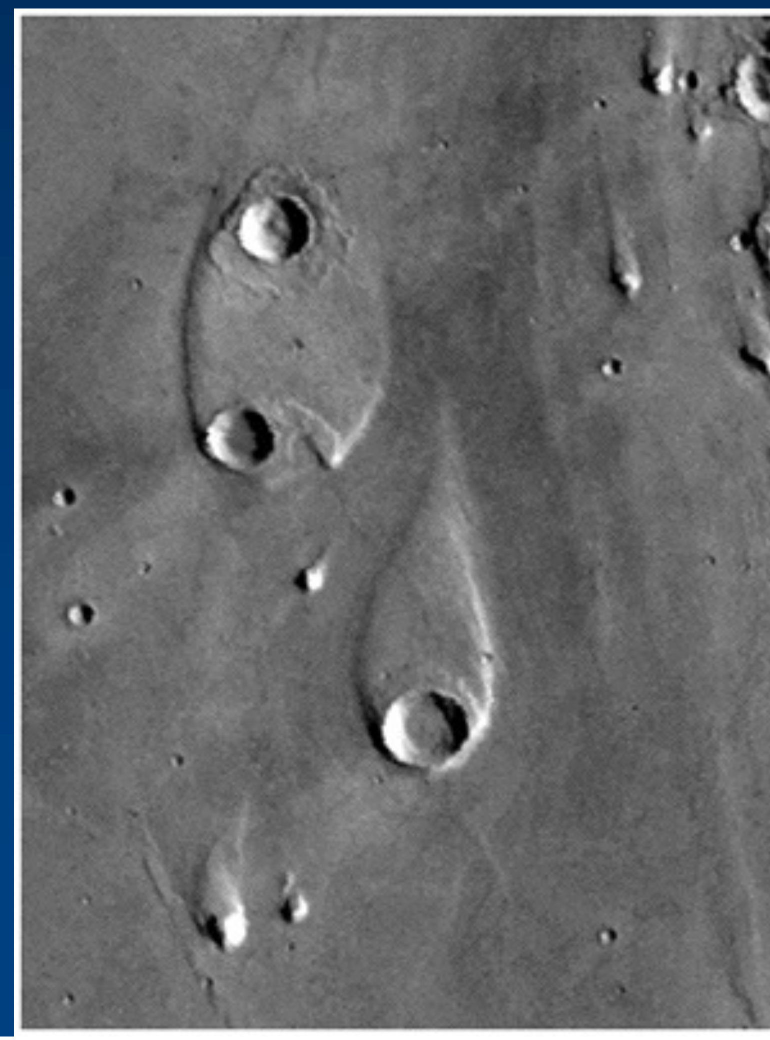


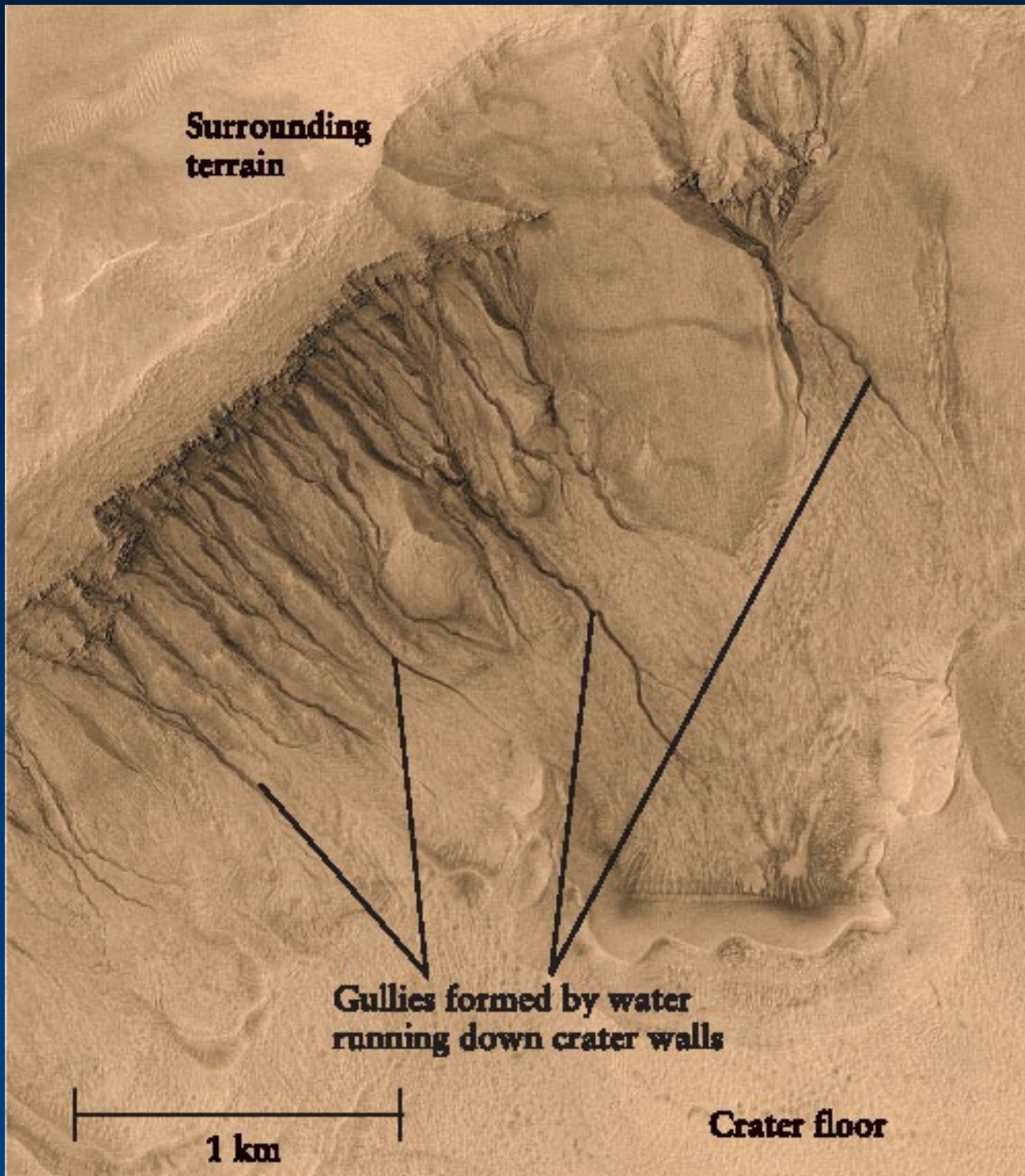

Volcanoes on
Tharsis rise
Valles Marineris

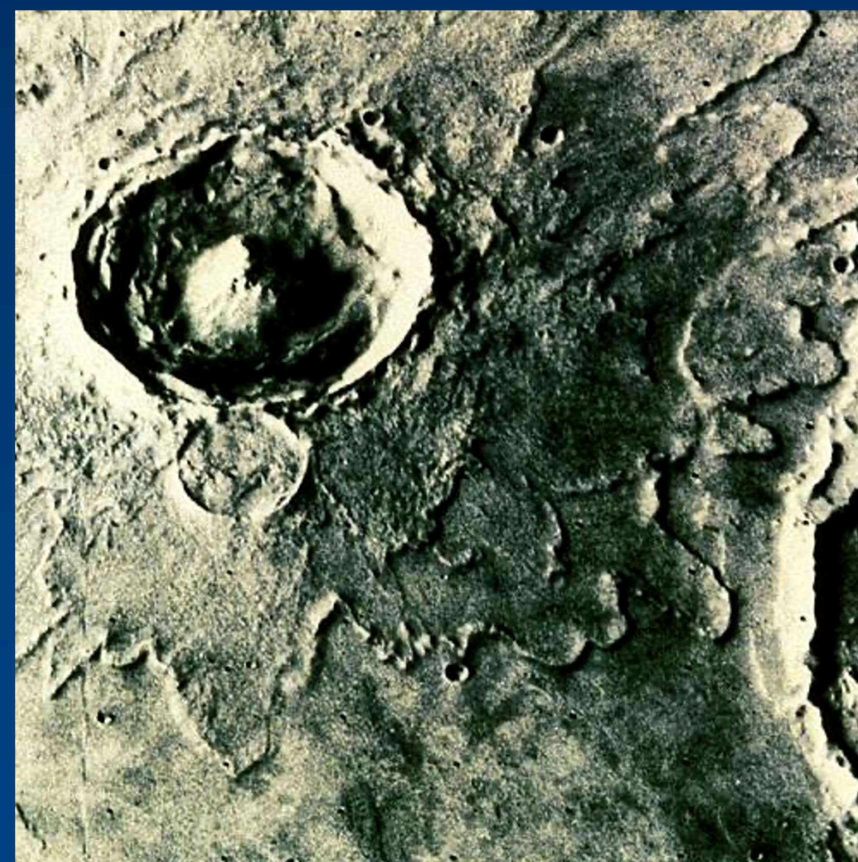

Curiosity image, Aug 13, 2018



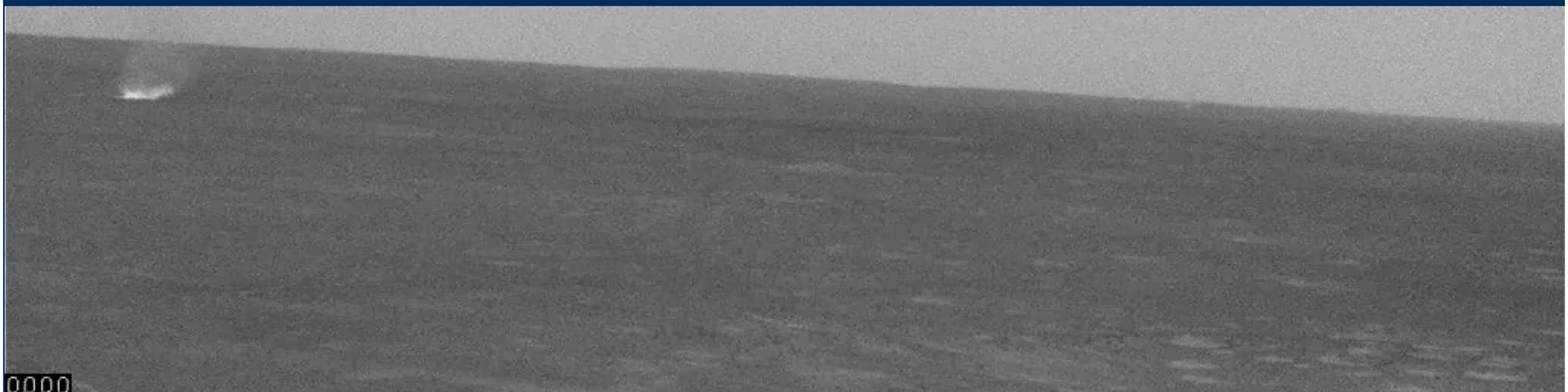
China’s Zhurong Mars rover




Surrounding terrain
Gullies formed by water running down crater walls
1 km
Crater floor



Spirit Rover sees dust devil



Escape Velocity

How large must the injection speed be to make the object escape gravity of the body it was launched from altogether?

Quantitatively, this means object gets infinitely far away from the body it is escaping when its speed has dropped to zero (if speed = 0 km/s at finite distance, gravity would bring it back)

Examine in terms of energies. Its kinetic energy is:

$$KE = \frac{1}{2}mV^2$$

At escape, then, KE = 0.

(Why?)

When it escapes, what is its potential energy?

(Recall potential energy is energy due to its position, in the presence of a force.)

$$PE = \frac{-GMm}{r}$$

At escape, its PE is 0. (Why?)

Its total energy is then TE = KE + PE, which is zero when it escapes.

If TE=0 when it escapes, it must have been 0 at launch, too (and everywhere else). WHY?

Since total energy is conserved, it is also zero at launch:

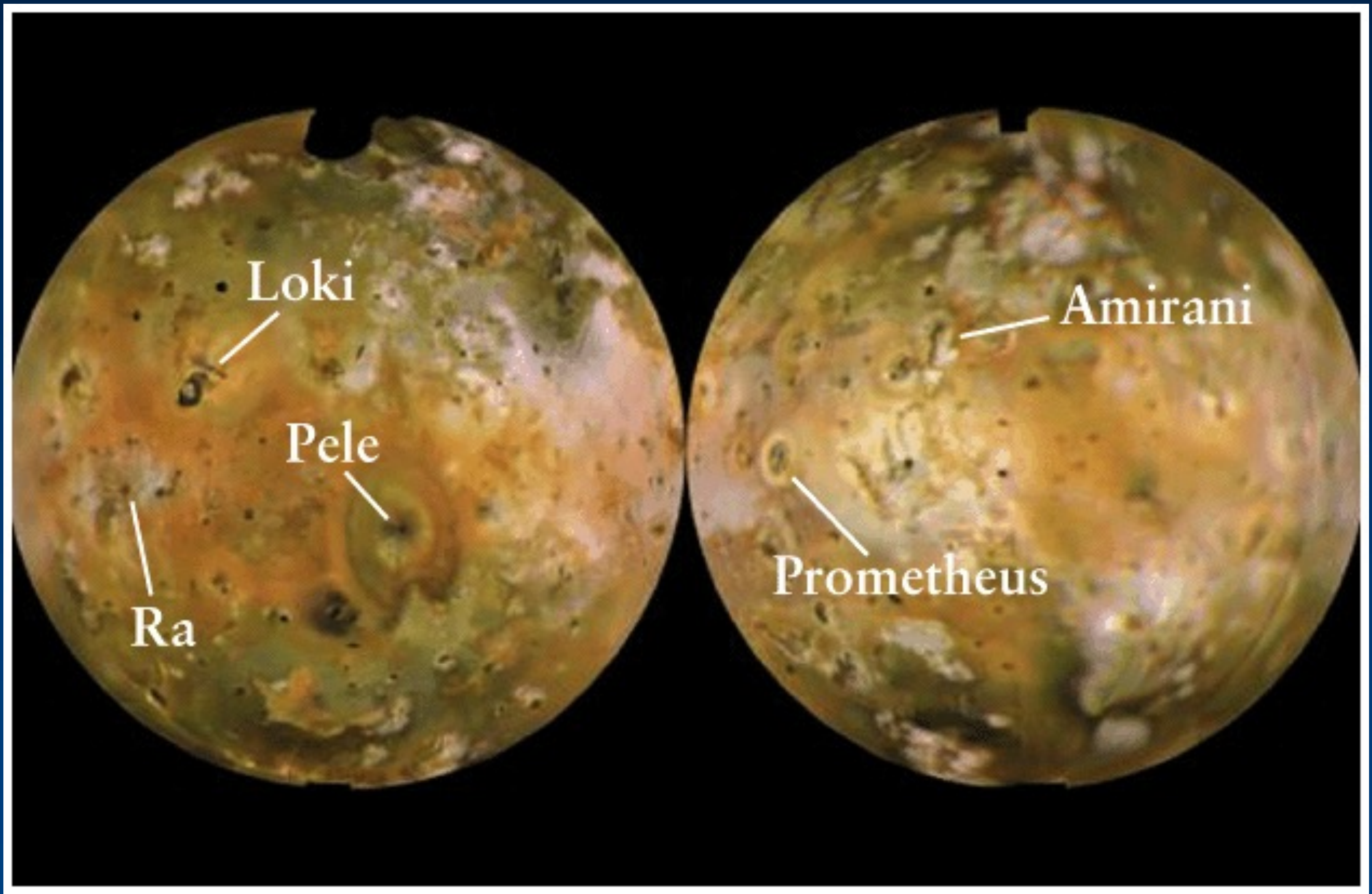
$$\frac{-GMm}{r} + \frac{1}{2} m V_{escape}{}^{2} = 0$$

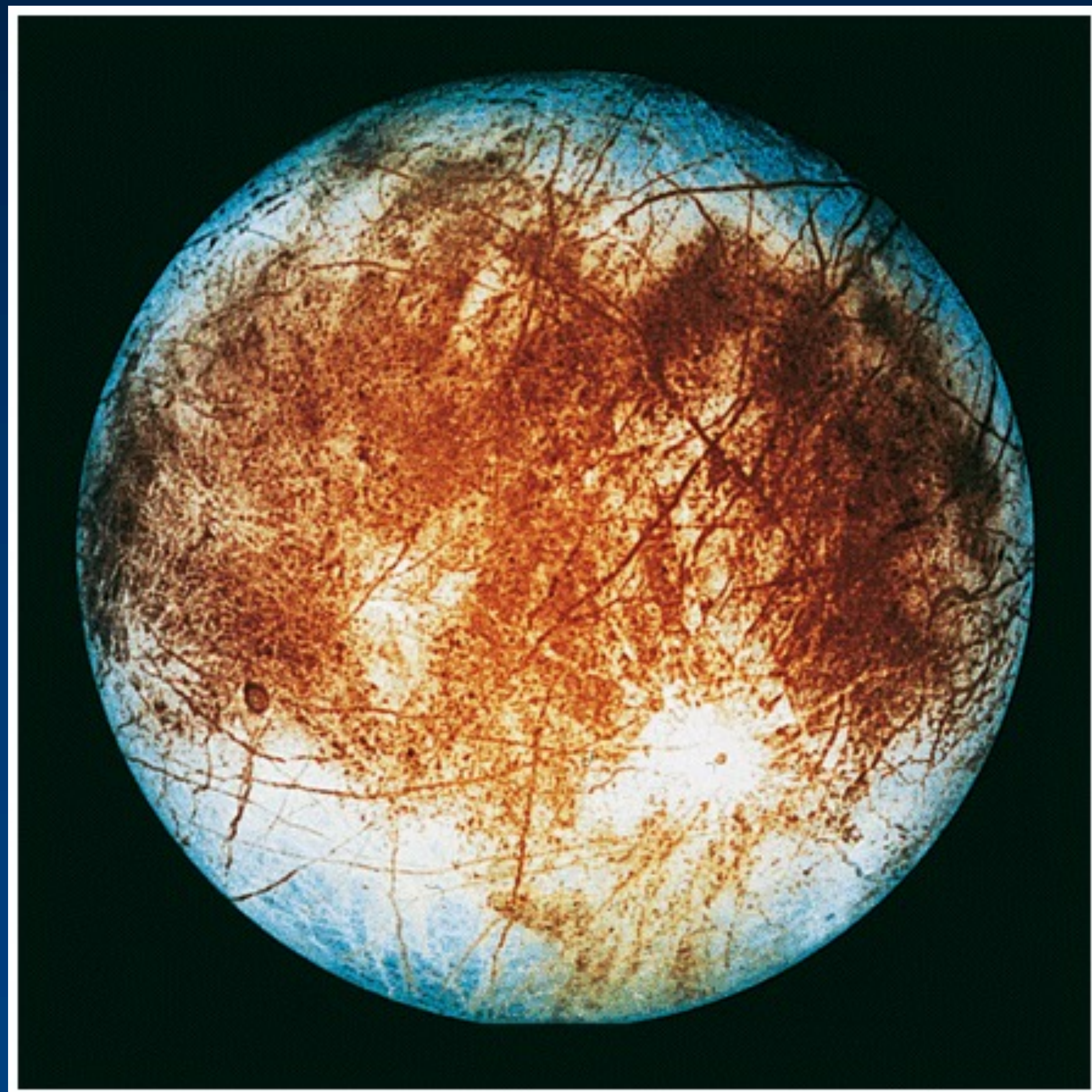
$$\Rightarrow V_{escape} = \sqrt{\frac{2GM}{r}}$$

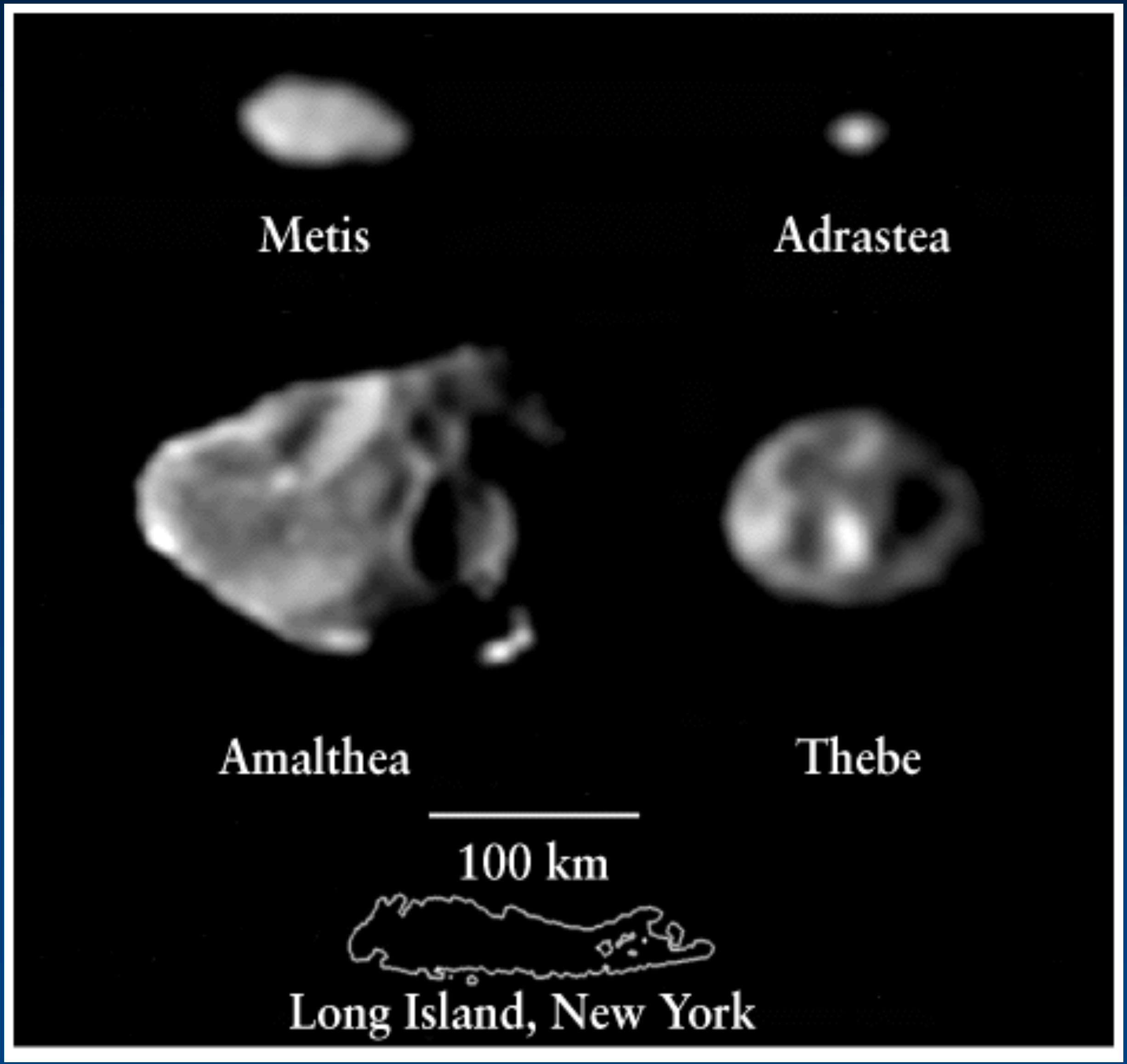
Escape speed (see box 7.2 in text)

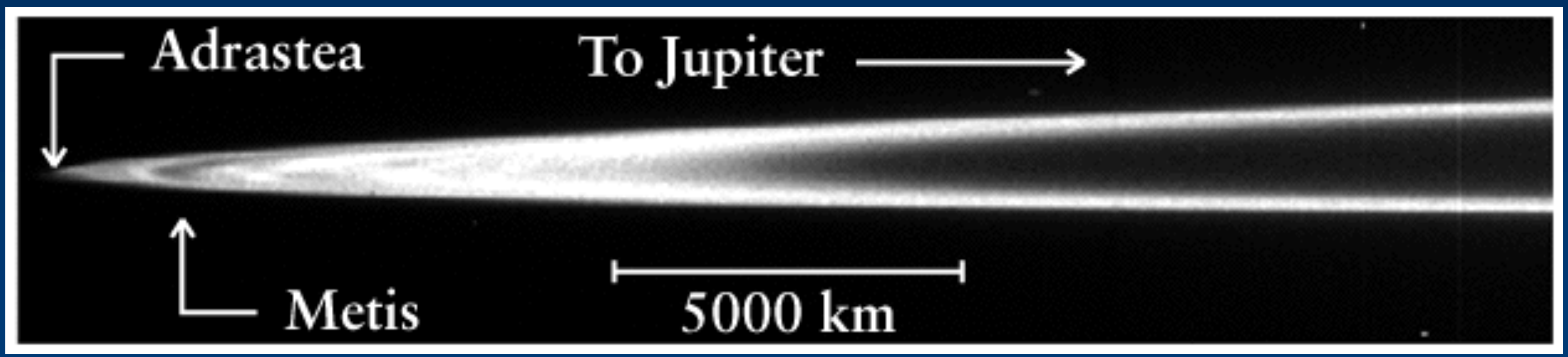
This relation is very useful!

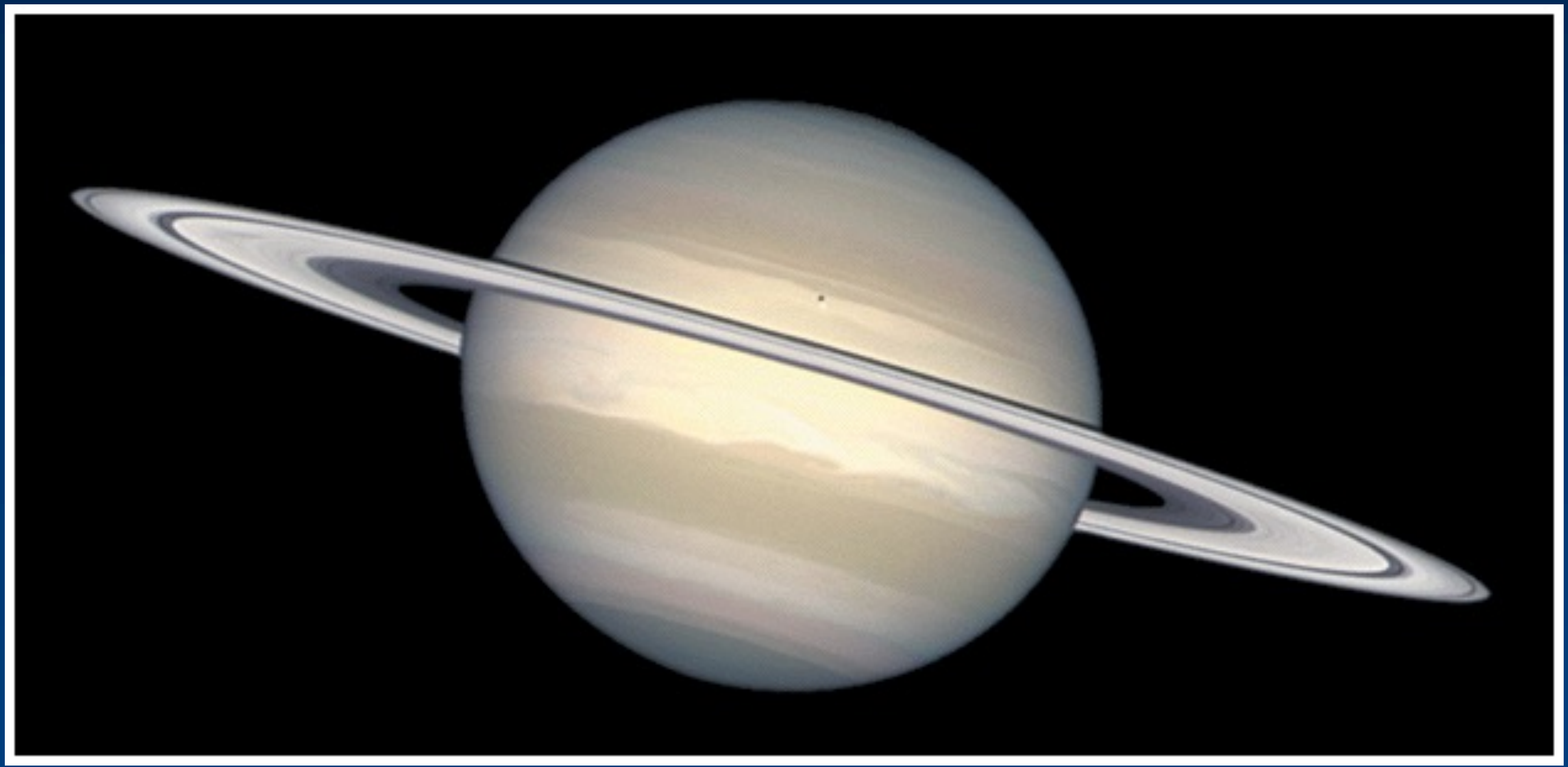
Example: V_{escape} from the surface of the Earth is 11.2 km/s (you can show this).

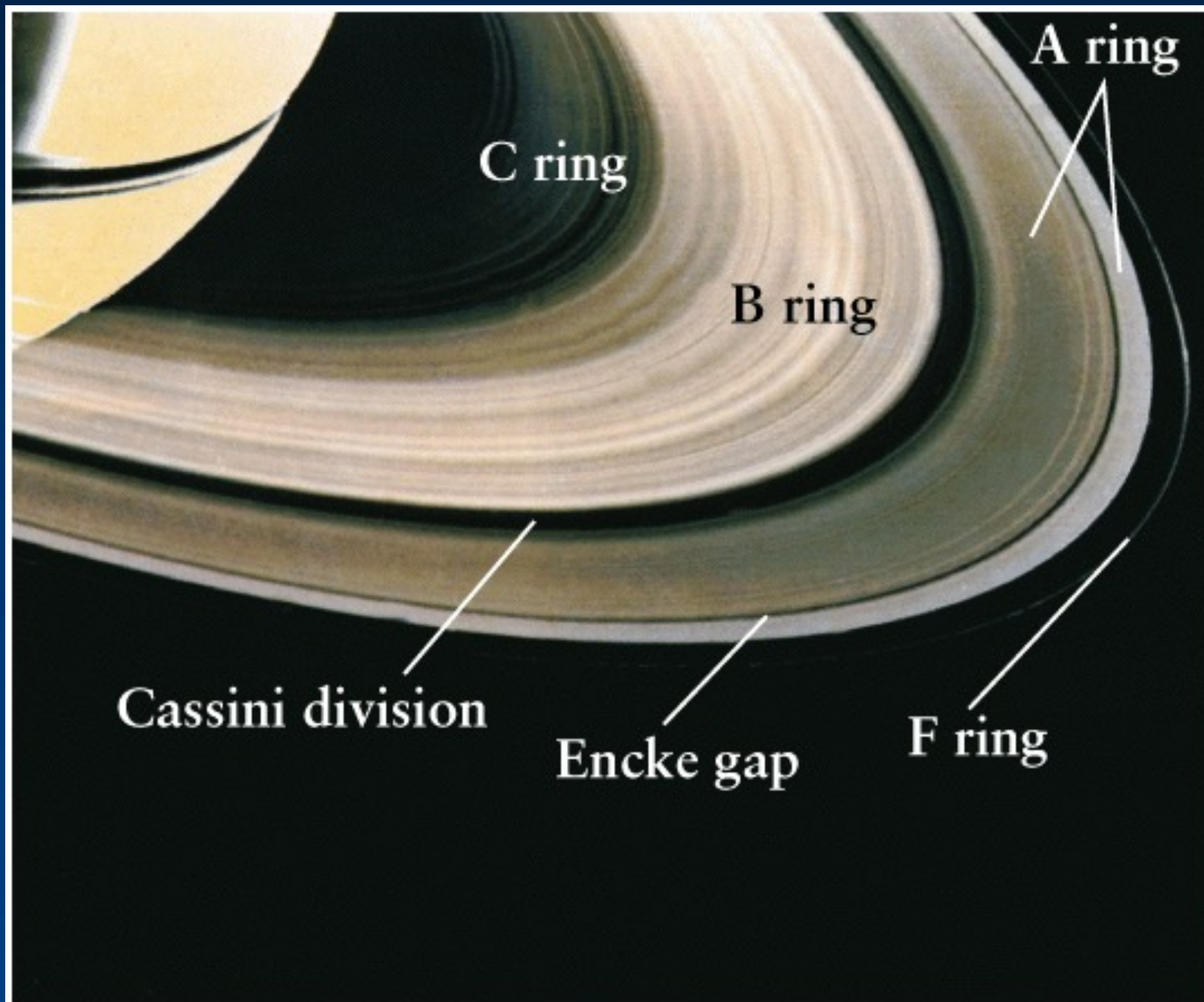

Loki
Pele
Ra
Amirani
Prometheus



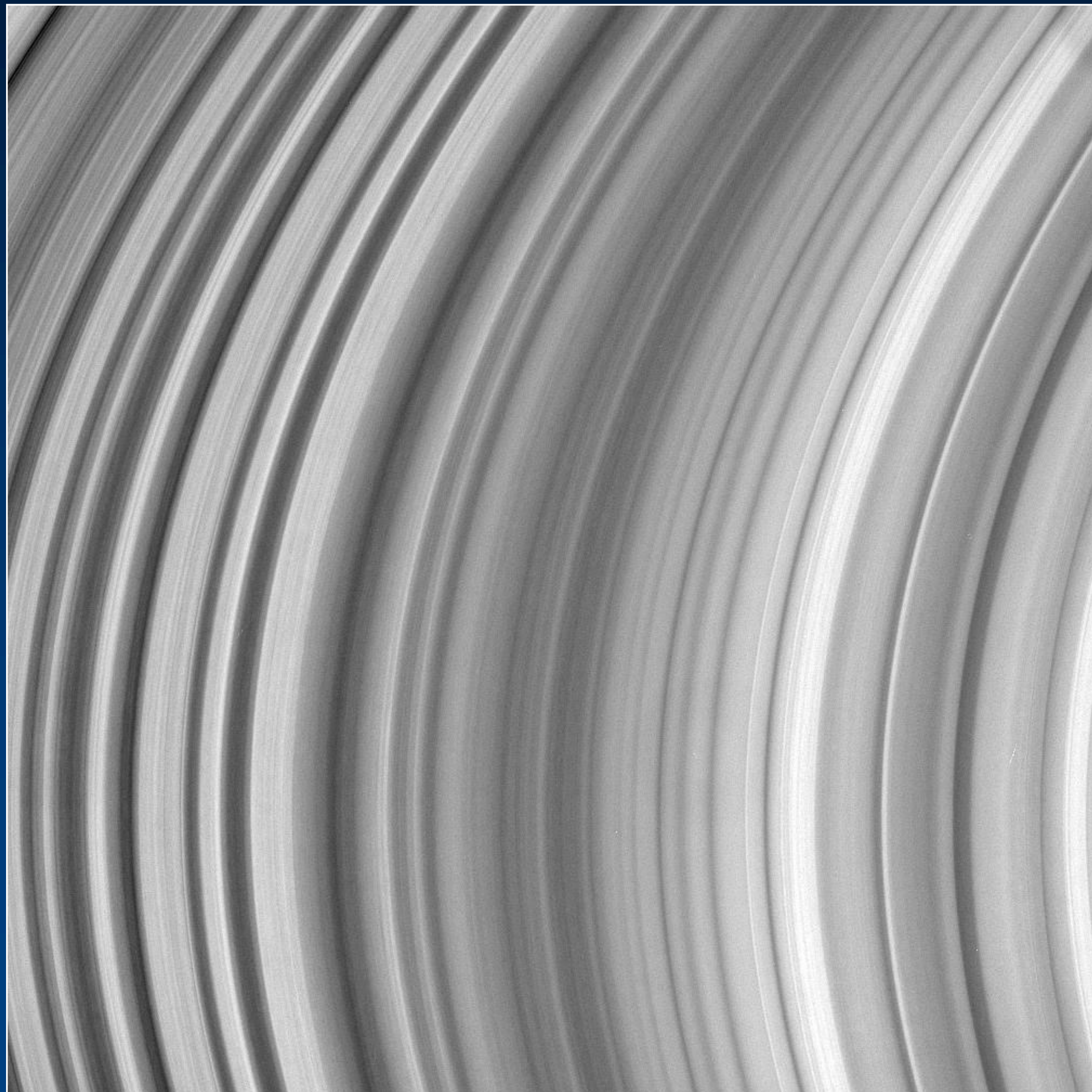

Metis
Adrastea
Amalthea
Thebe
100 km
Long Island, New York

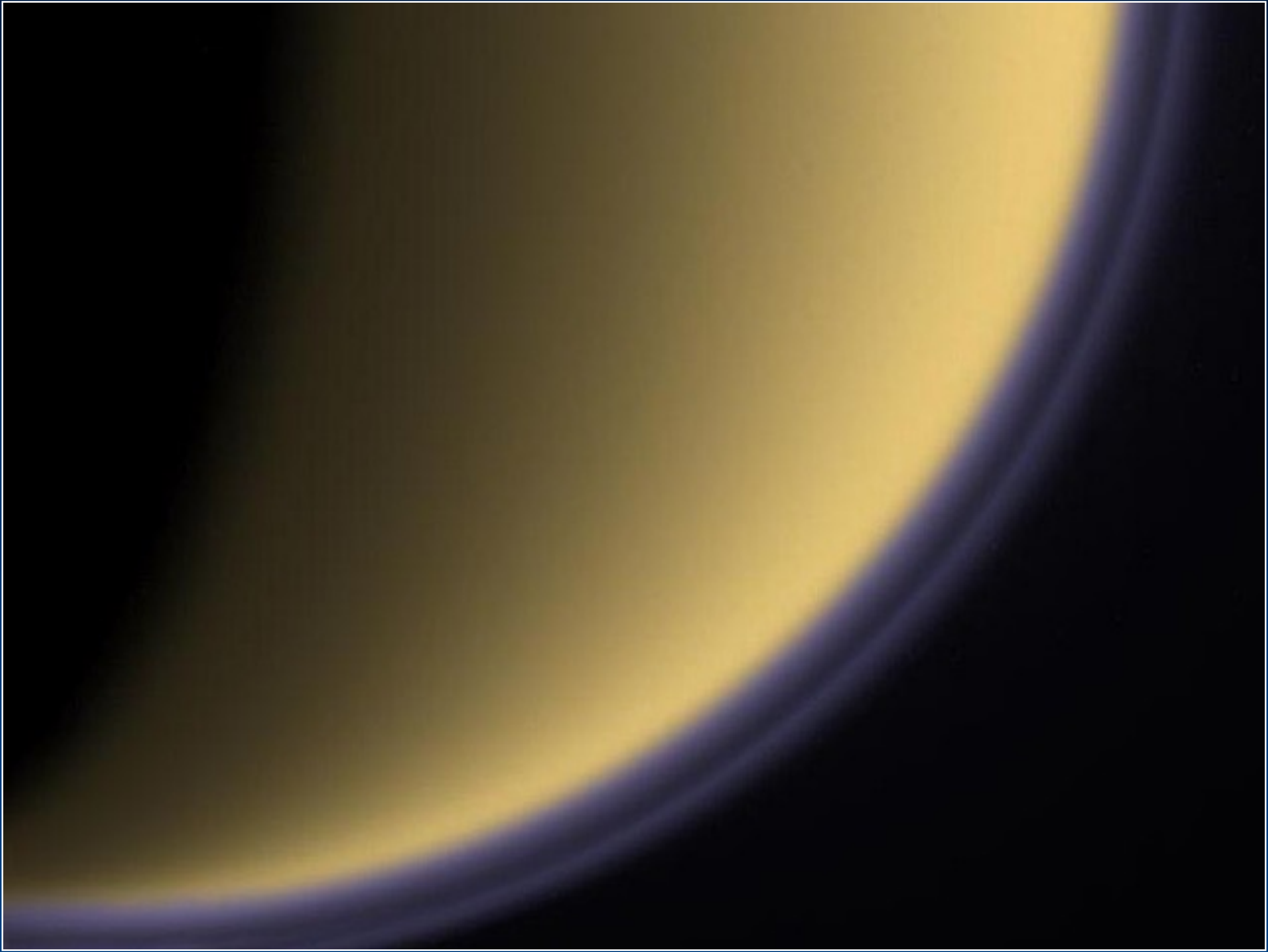

Adrastea
To Jupiter
Metis
5000 km

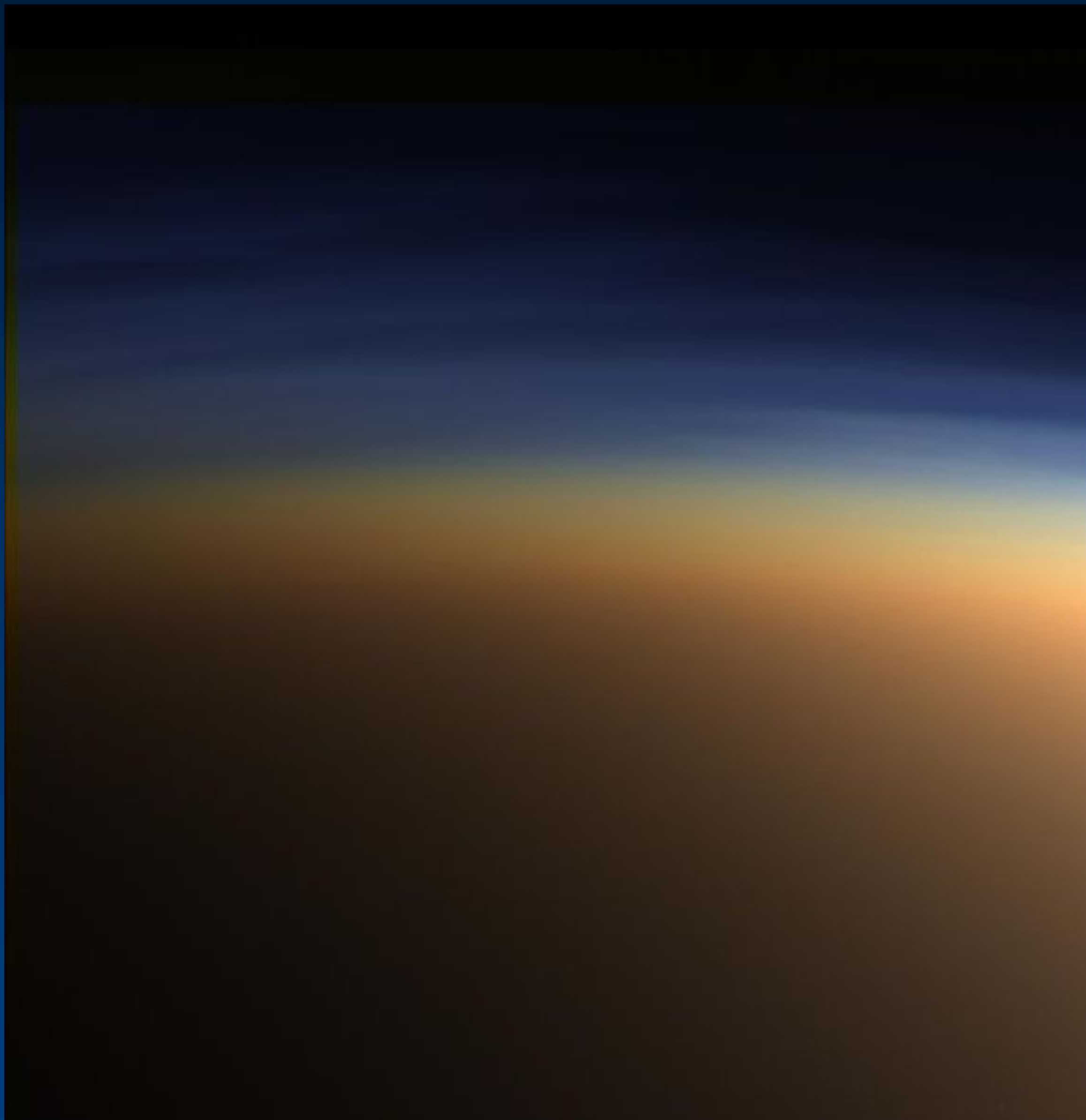


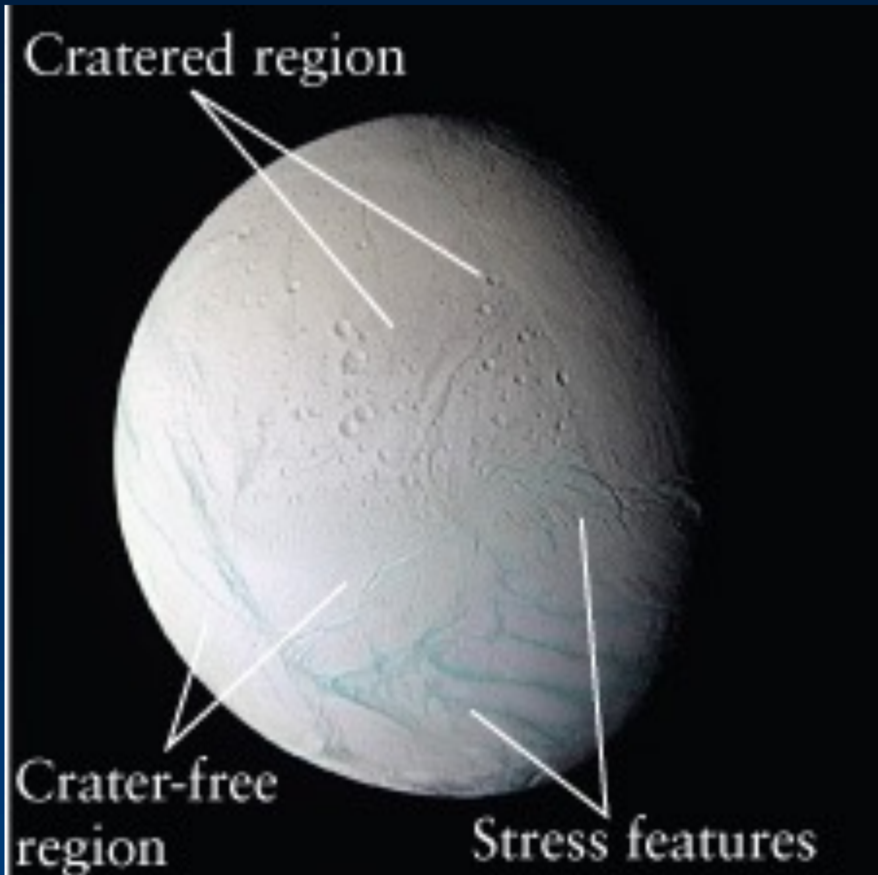

A ring
C ring
B ring
Cassini division
Encke gap
F ring


C ring
B ring
Cassini division
A ring
Encke gap

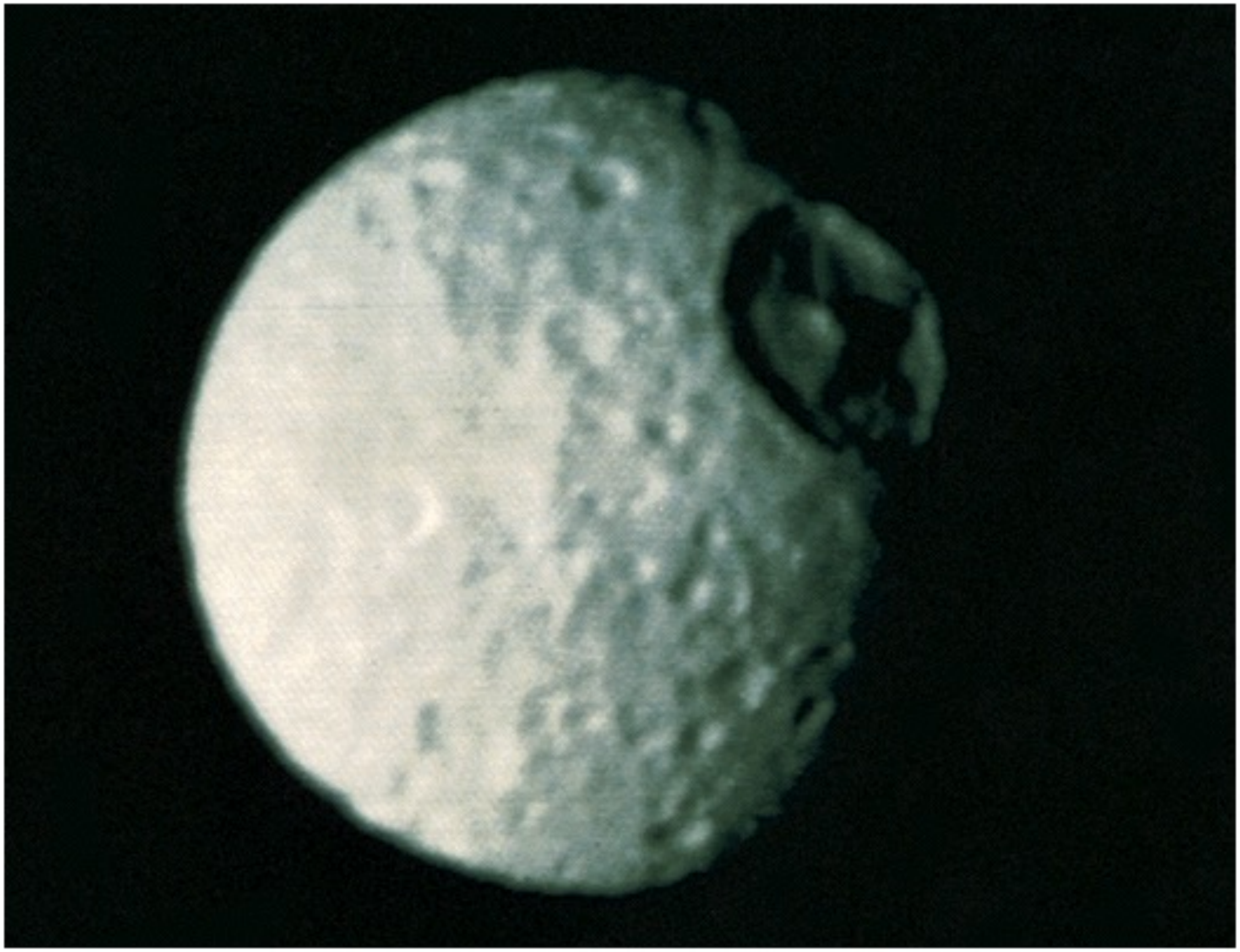




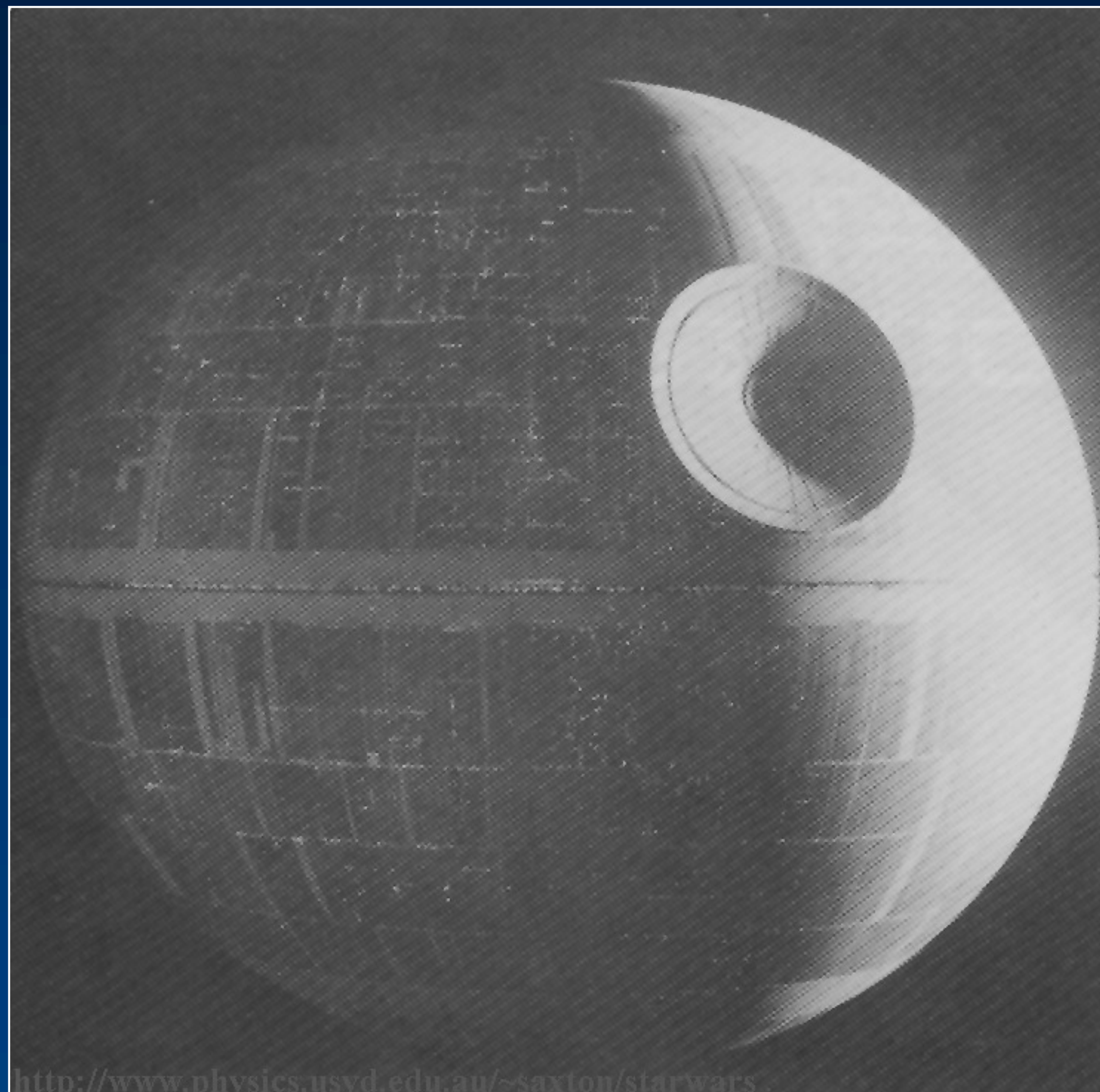


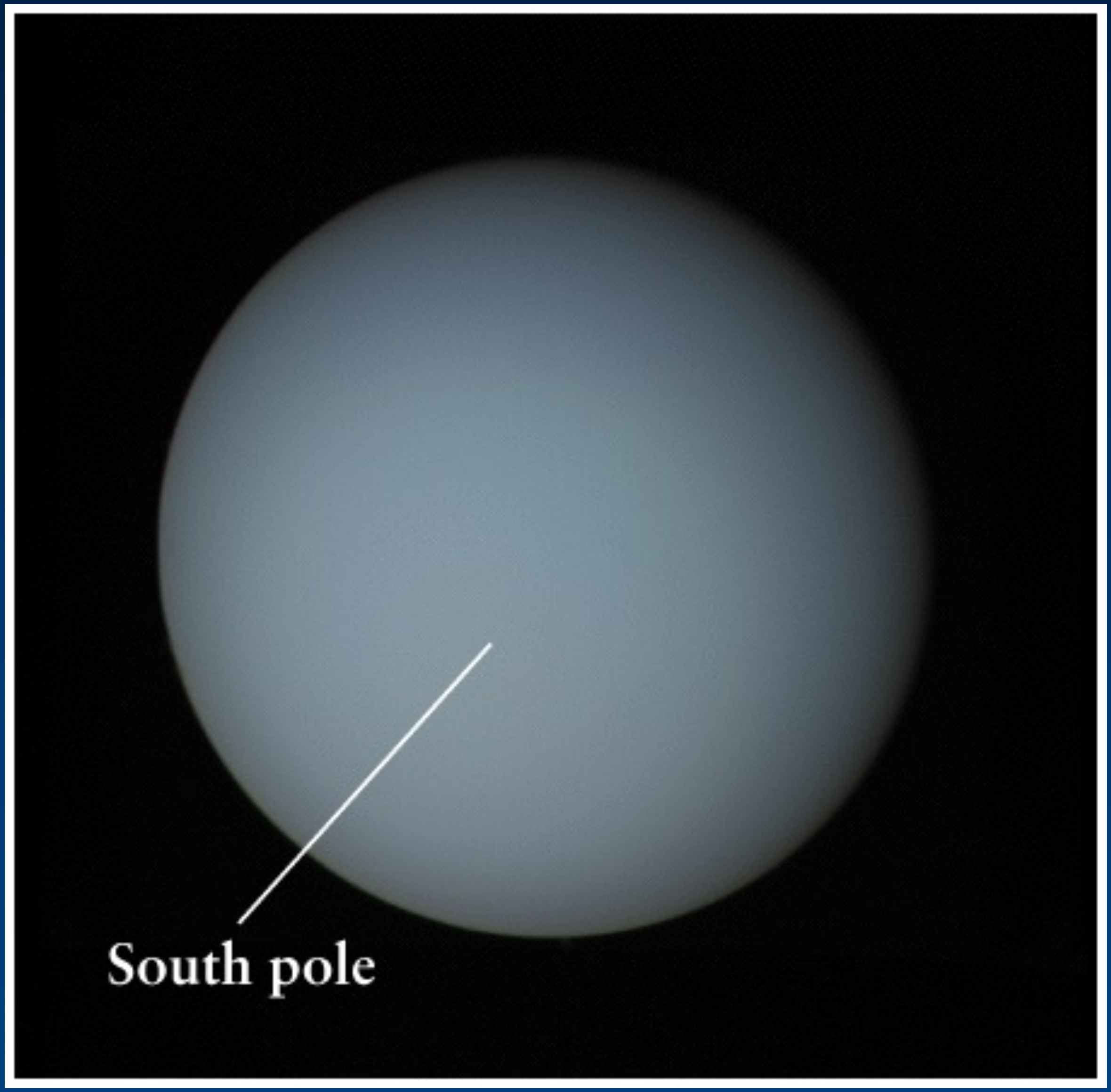



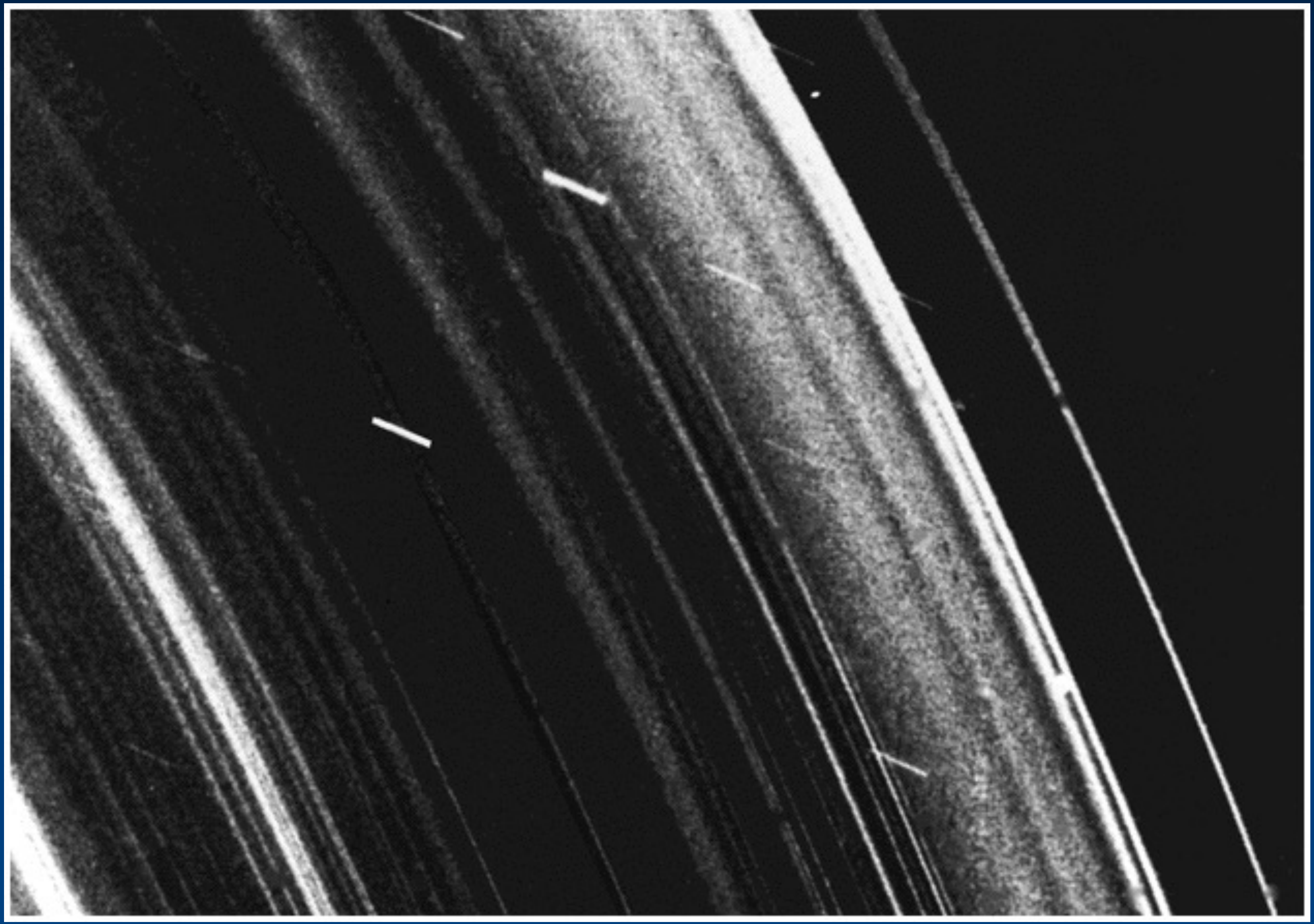
(b) Enceladus
(diameter 500 km)

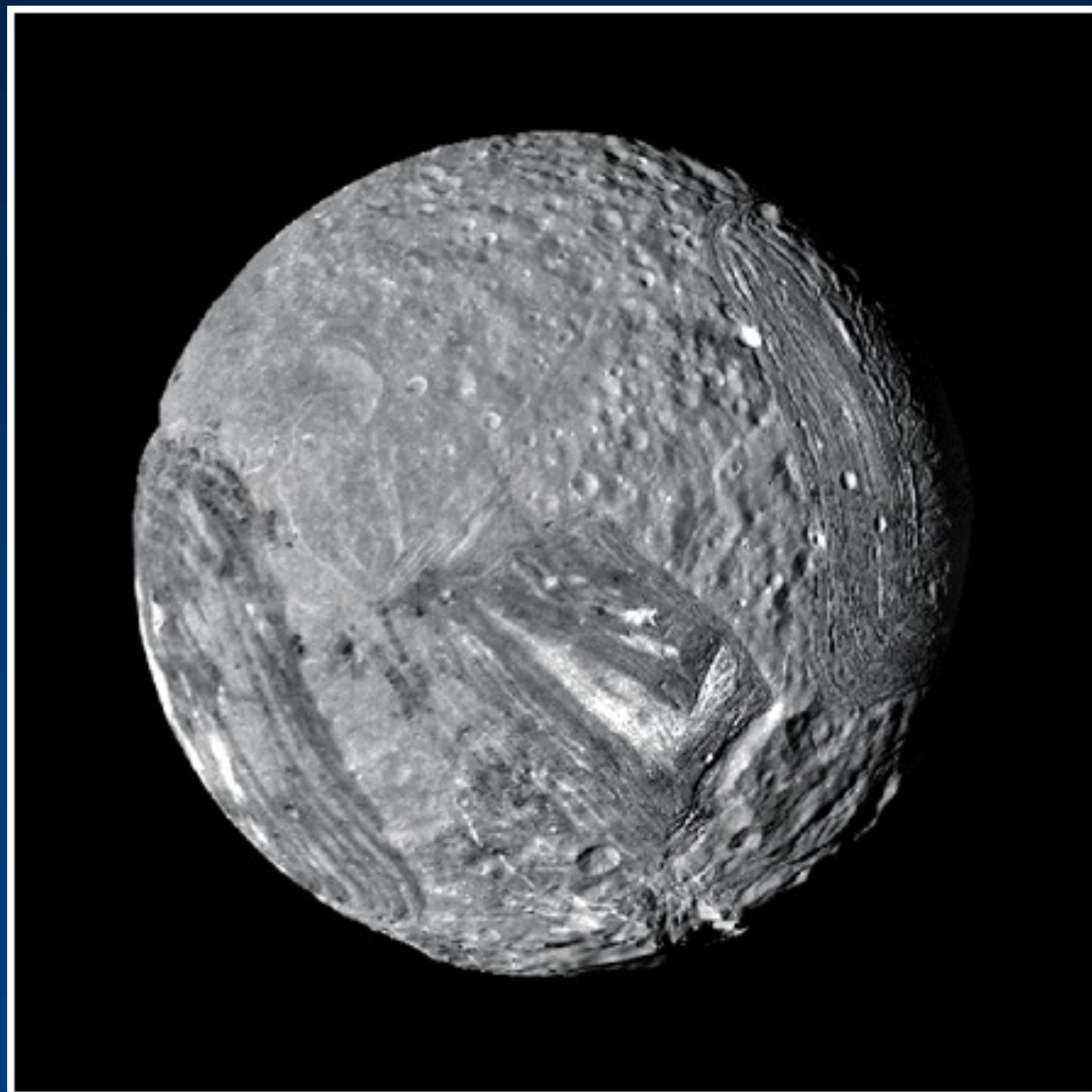


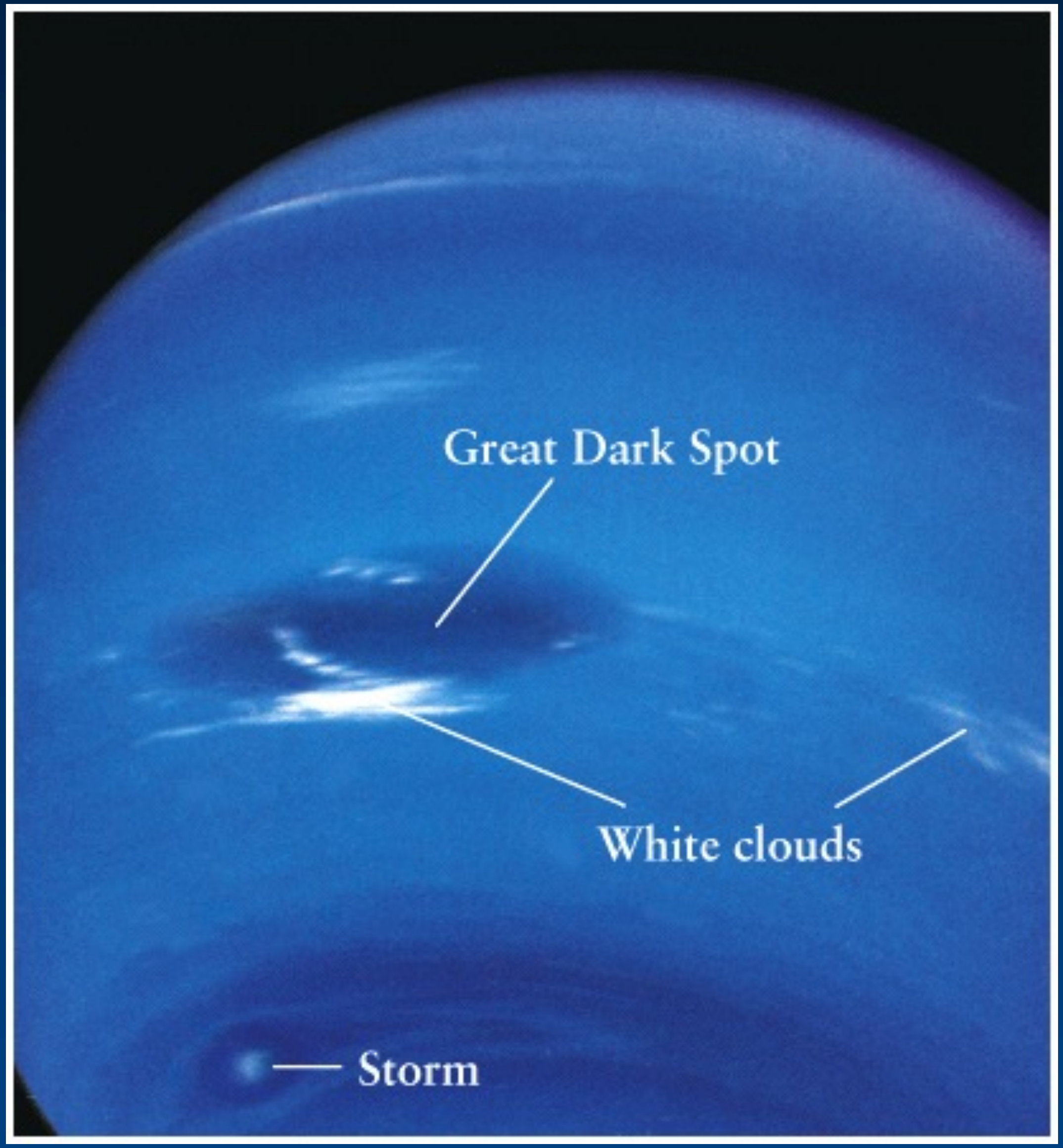
a Mimas

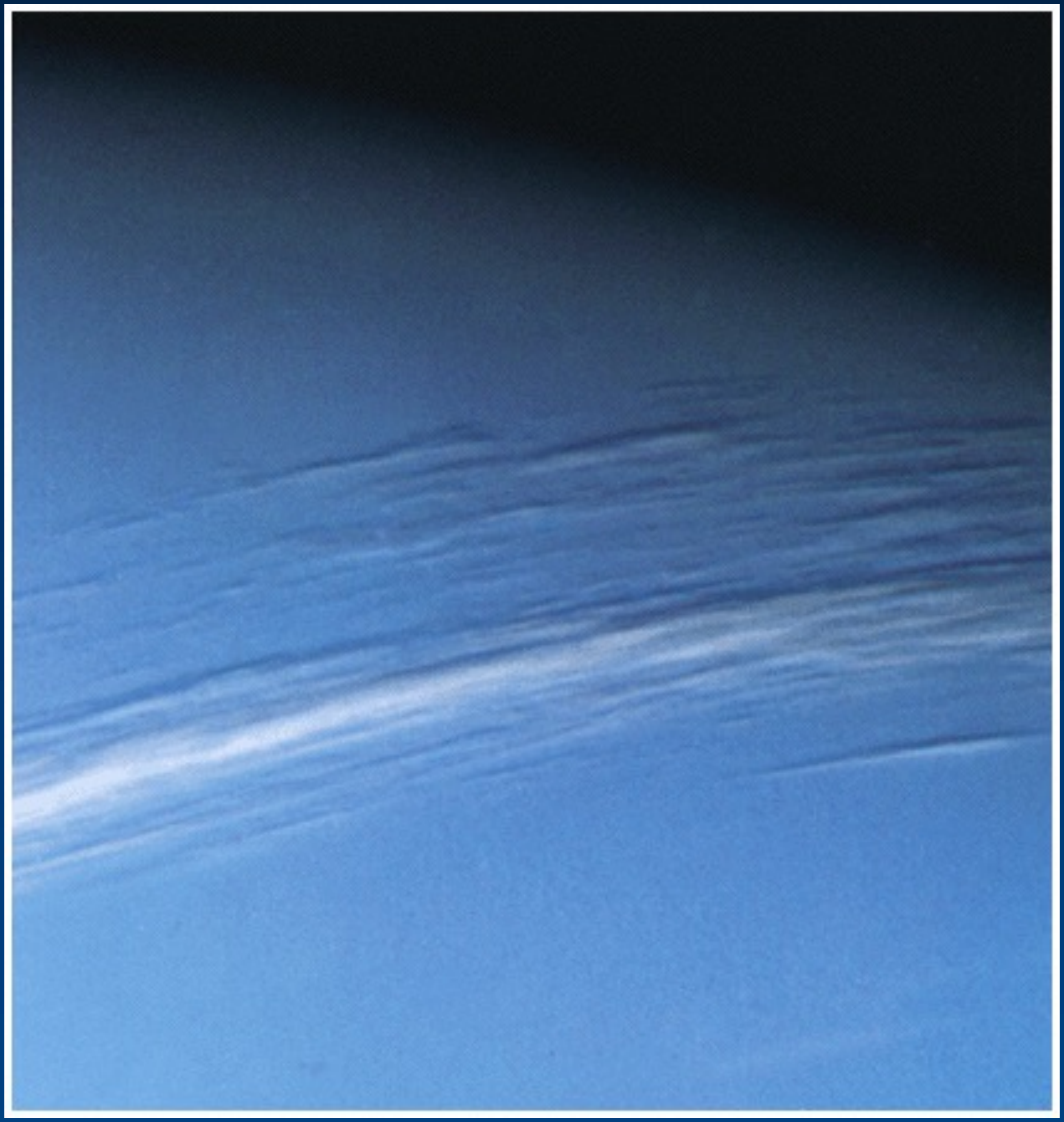

http://www.physics.usyd.edu.au/~saxton/starwars

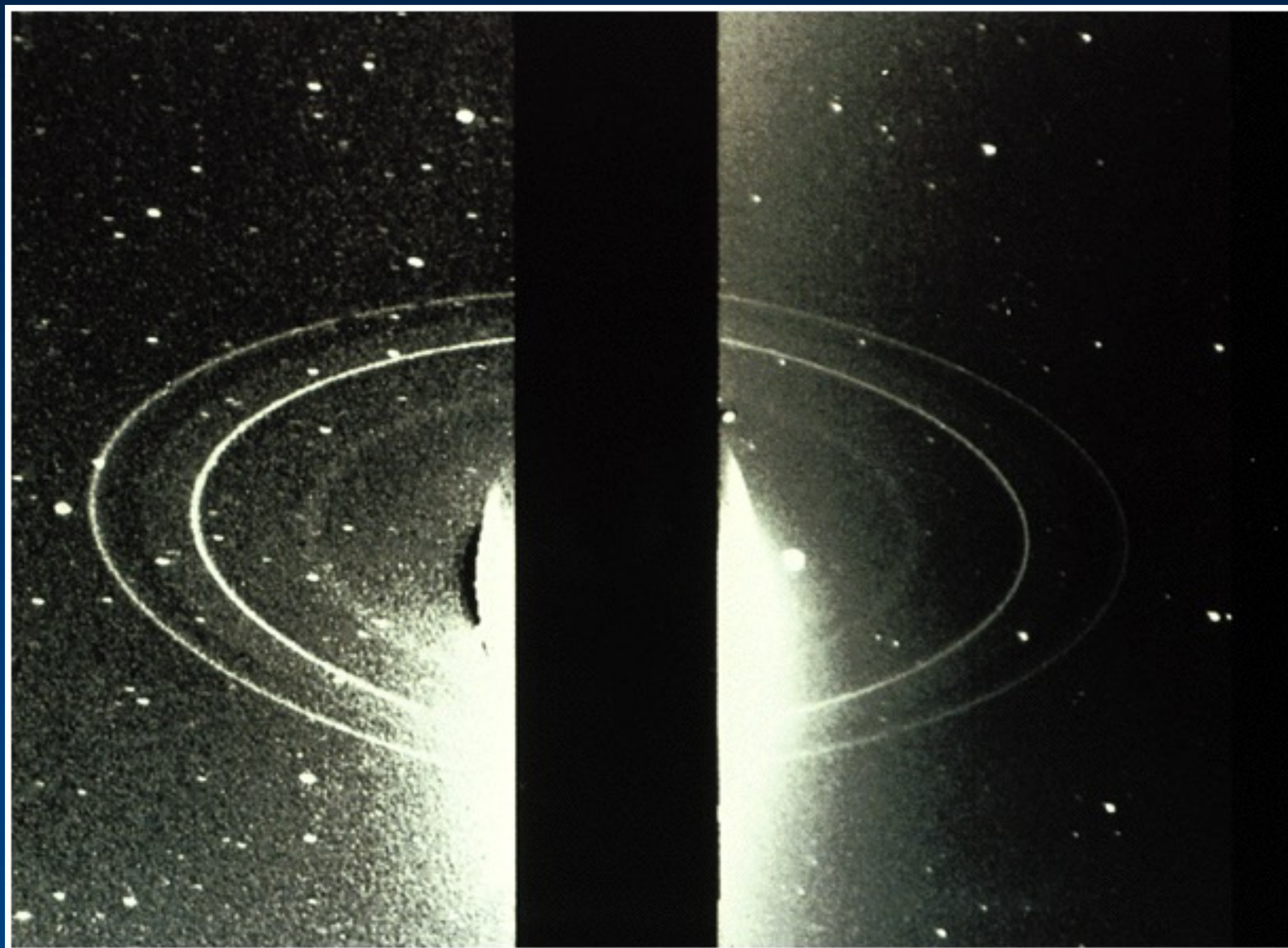

South pole

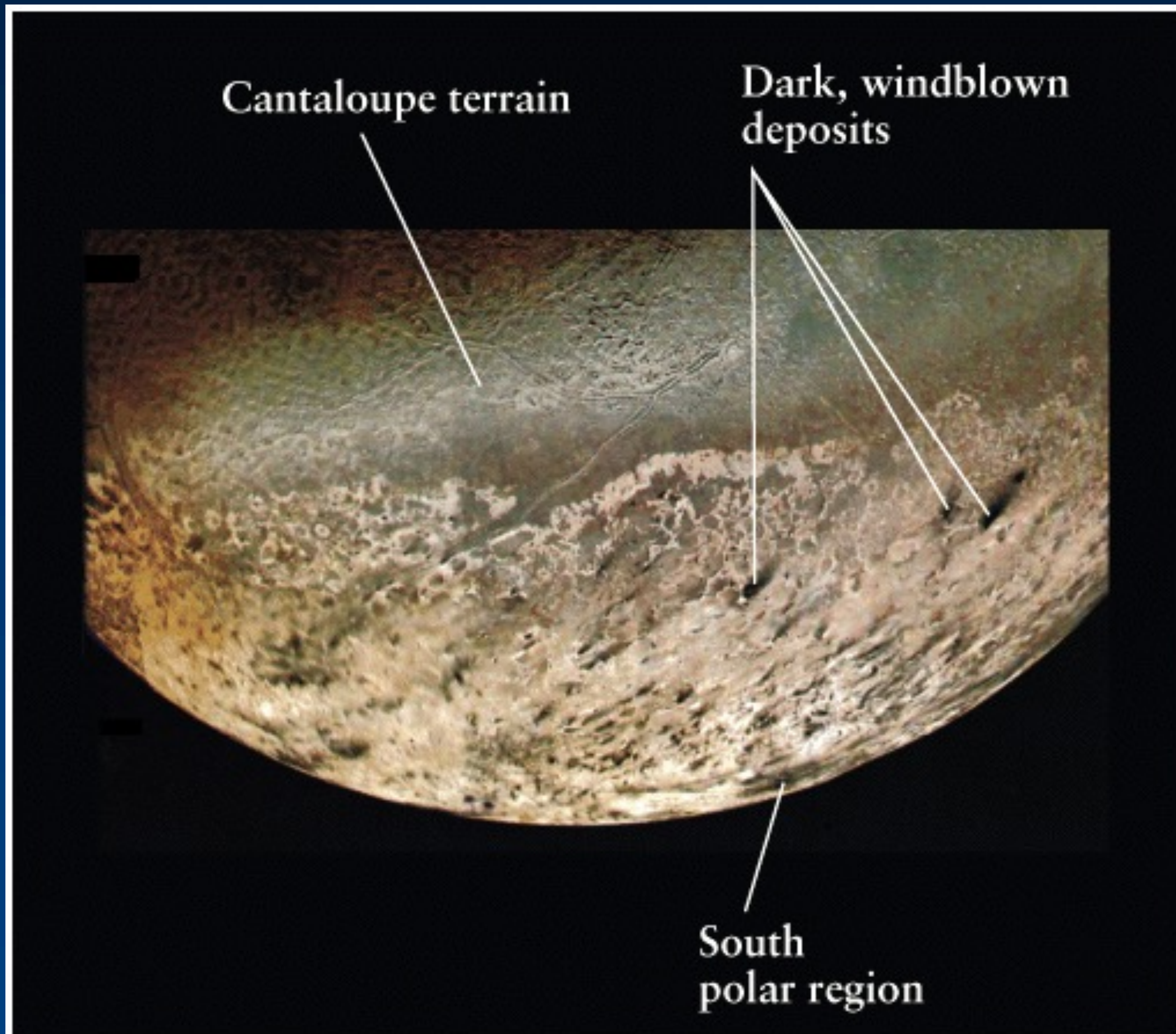





Great Dark Spot
White clouds
Storm

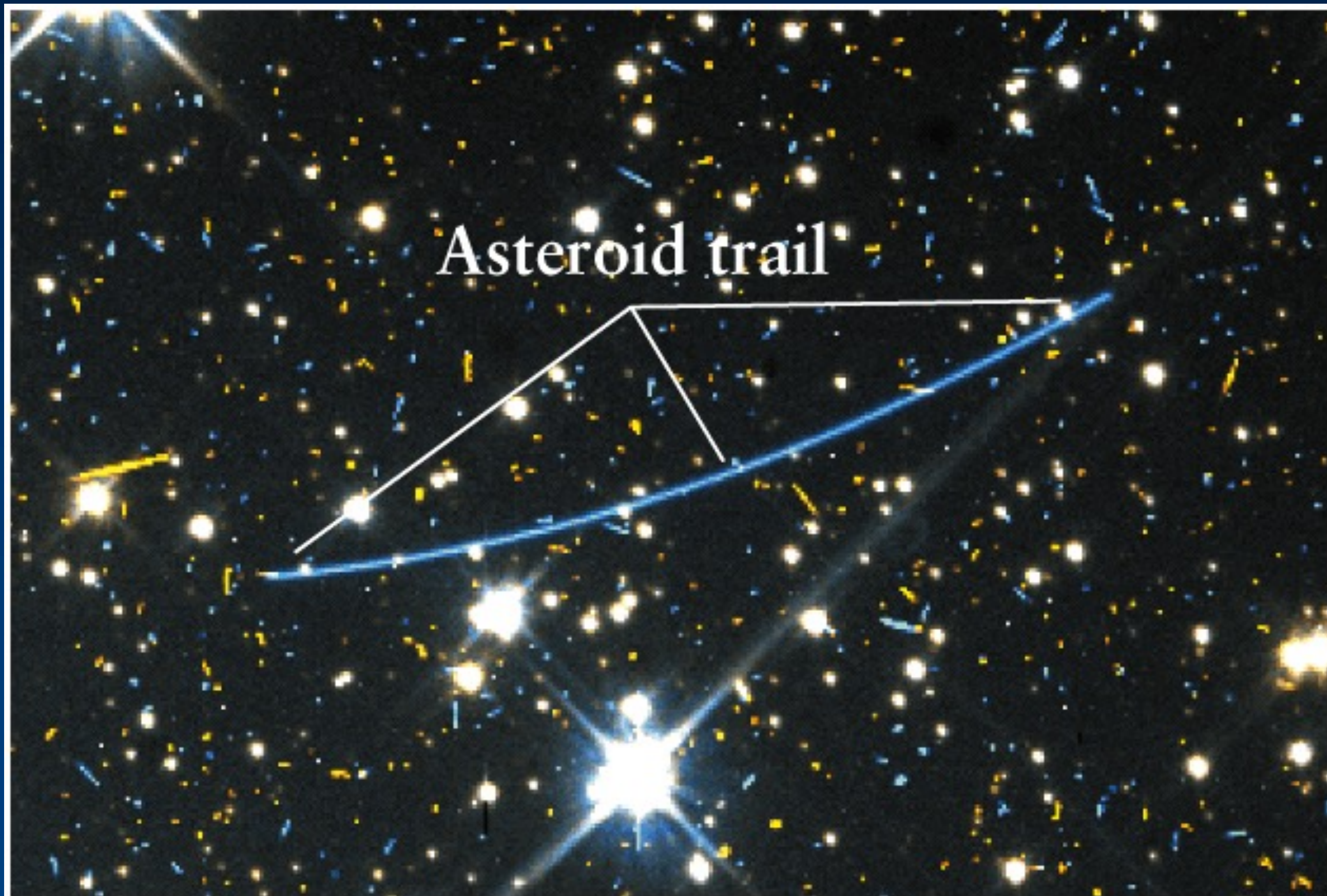


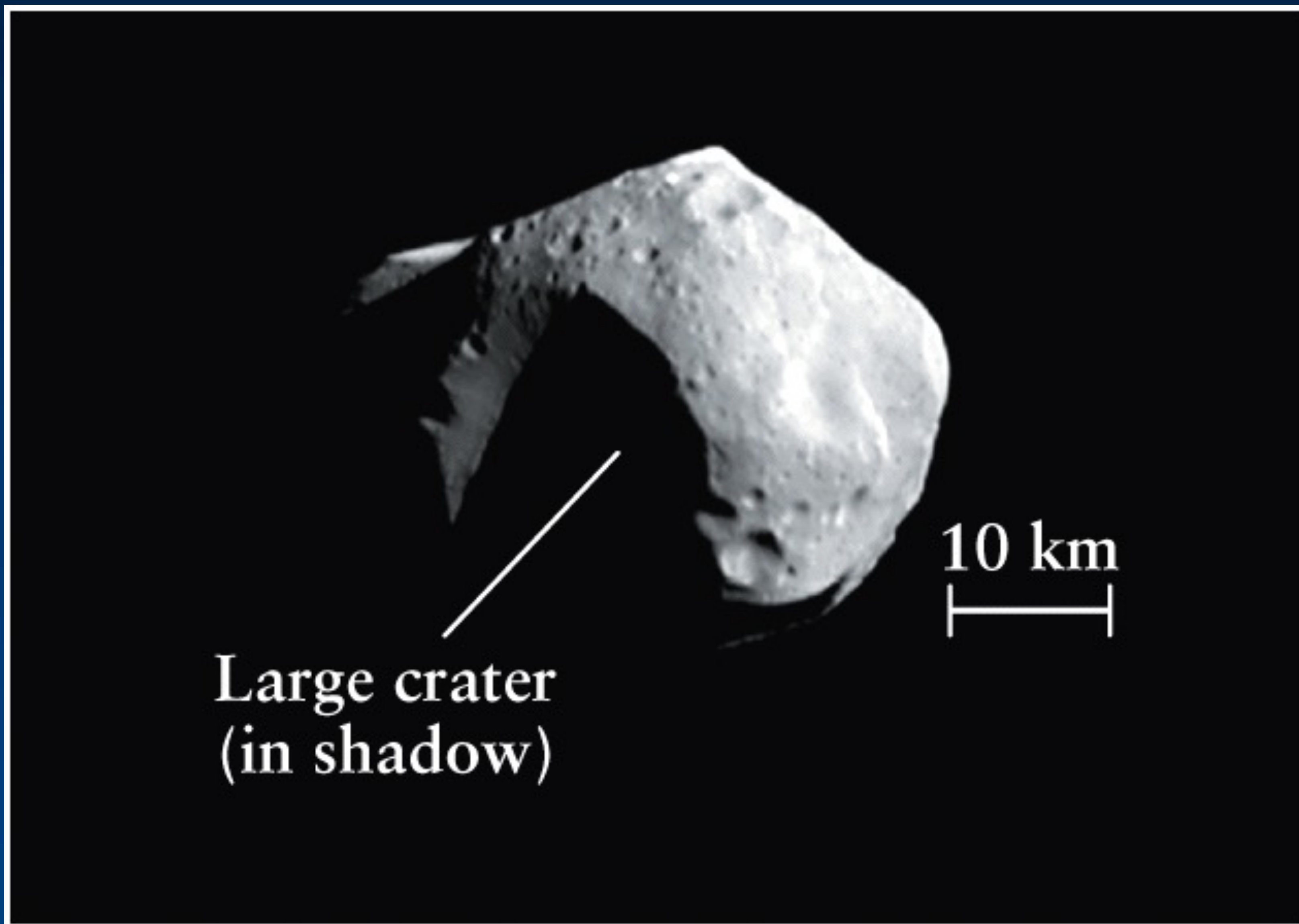


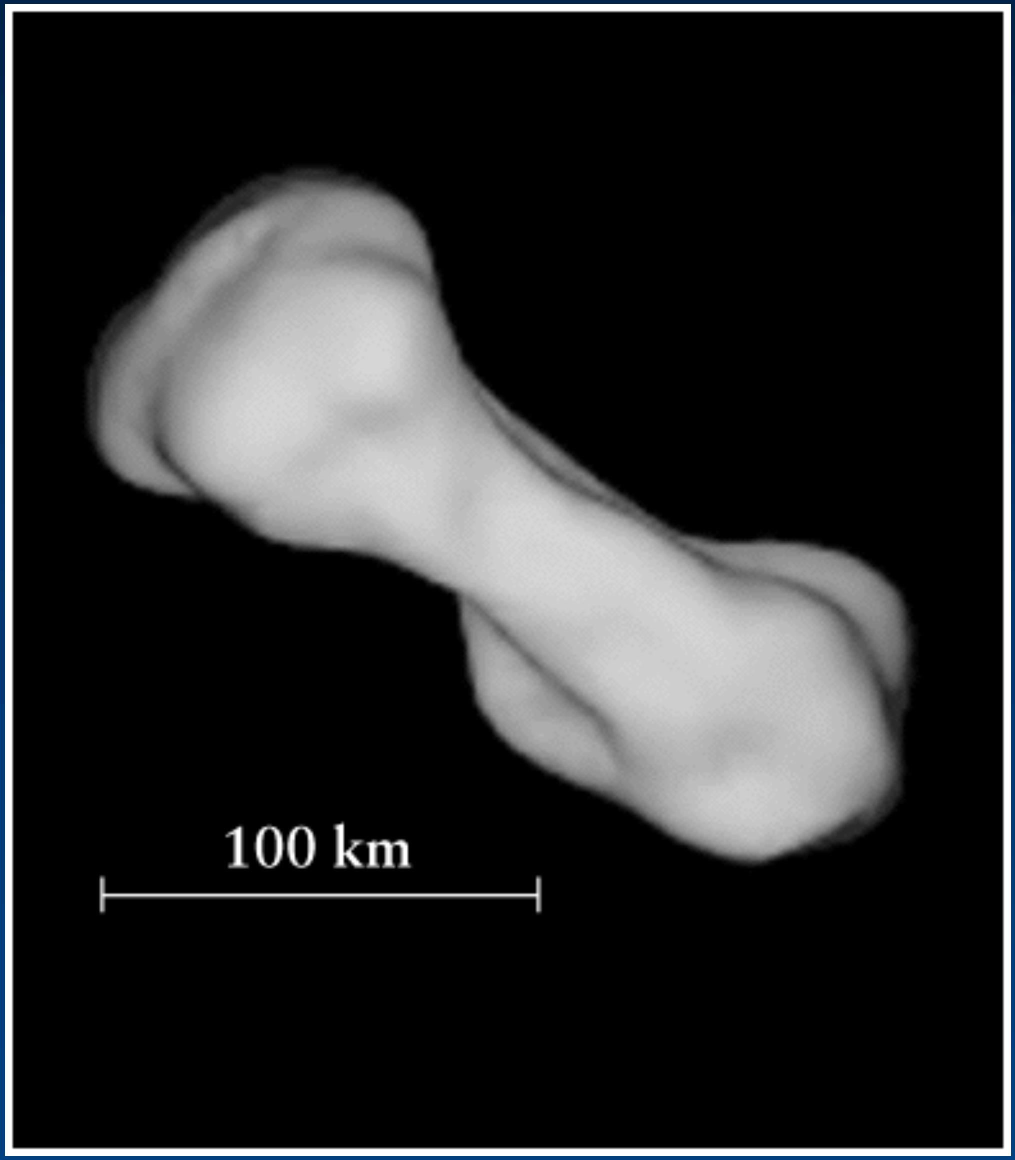


Cantaloupe terrain
Dark, windblown deposits
South polar region

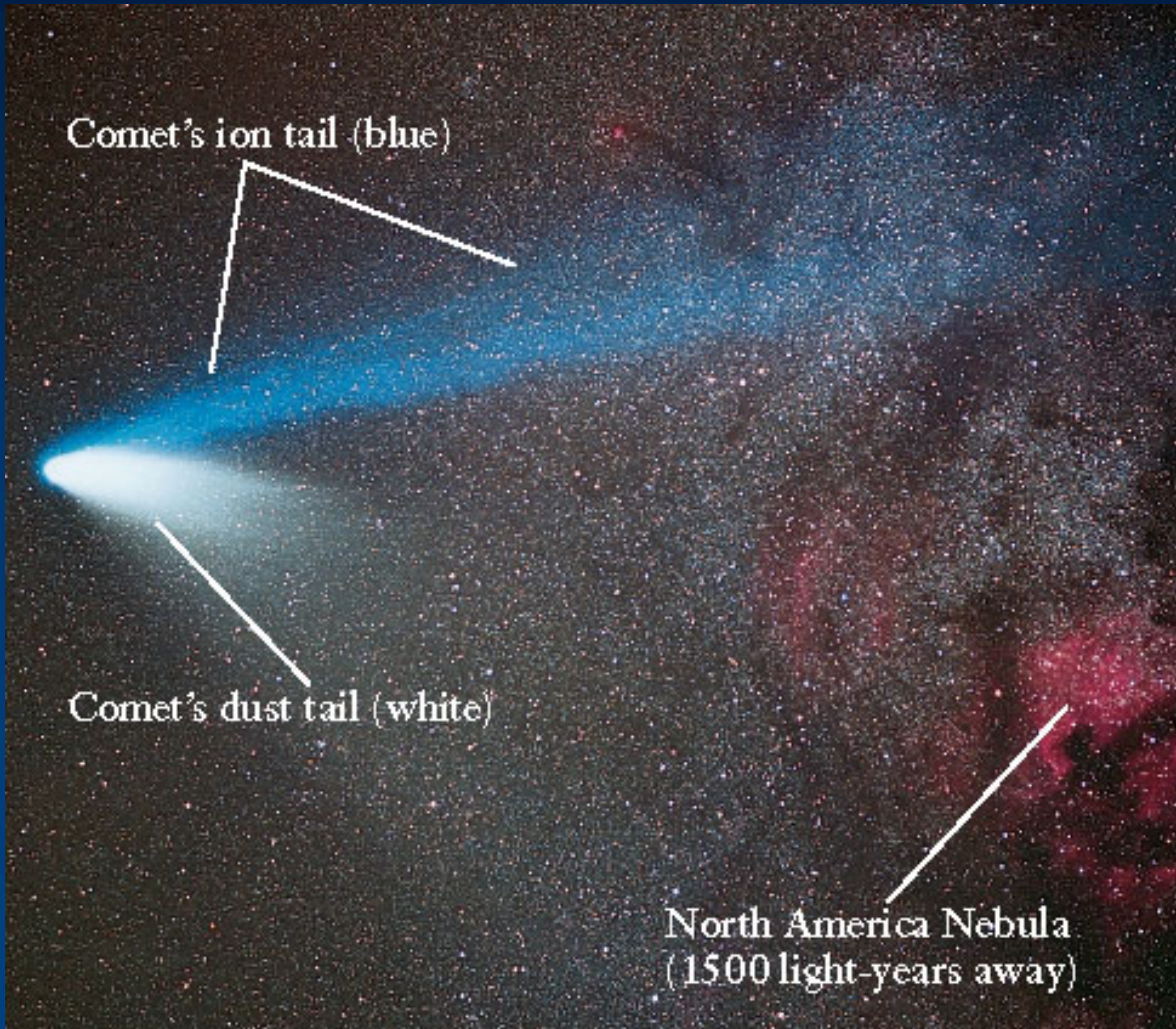
- Artist's impression of largest "Trans-Neptunian Objects", compared to Earth

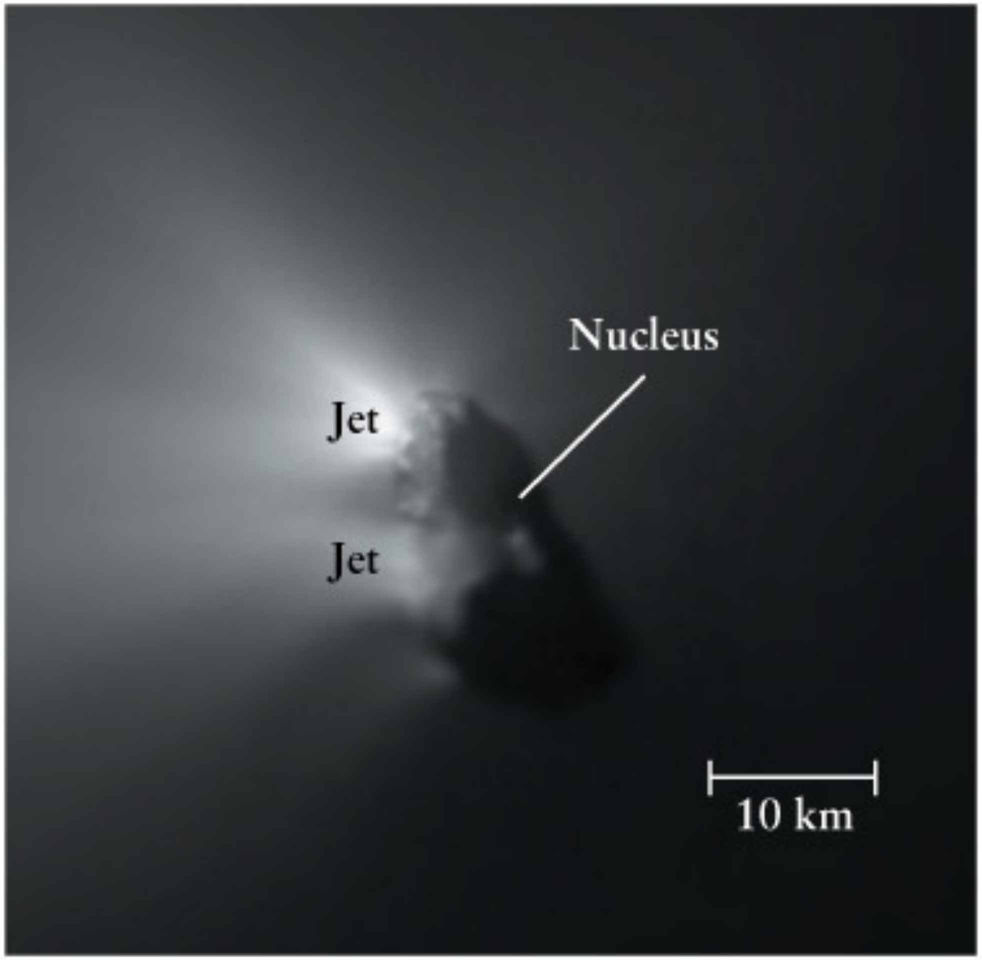

Asteroid trail


10 km
Large crater
(in shadow)

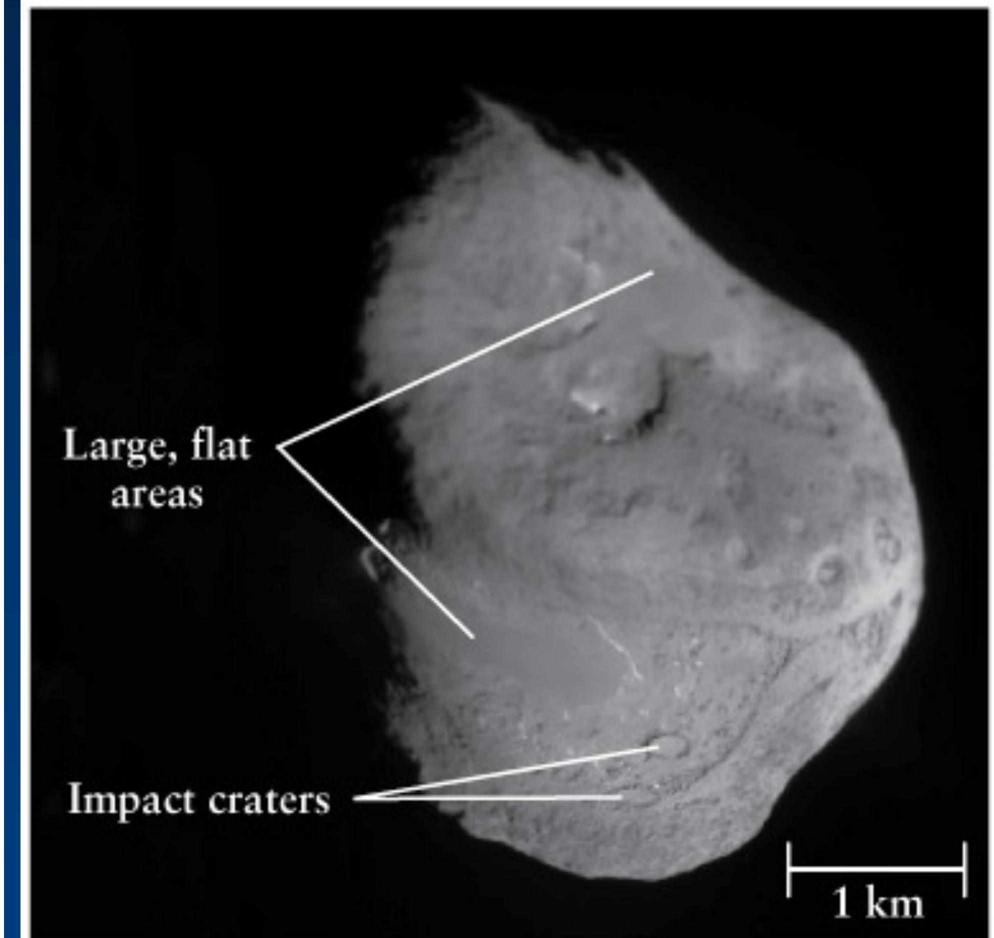

100 km


© Frank Zullo


Comet's ion tail (blue)
Comet's dust tail (white)
North America Nebula
(1500 light-years away)



(a) Comet Halley



(b) Comet Tempel 1

- Planets: understand their unique properties and commonly shared attributes
- Moons: understand why they have such variety
- "Debris": what does it tell us about history of Solar System?
- Generally:

How do we make discoveries about Solar System objects?

What tools can we use?

What are the physical laws that apply?

How do we put the facts together to a consistent, testable model of the Solar system?