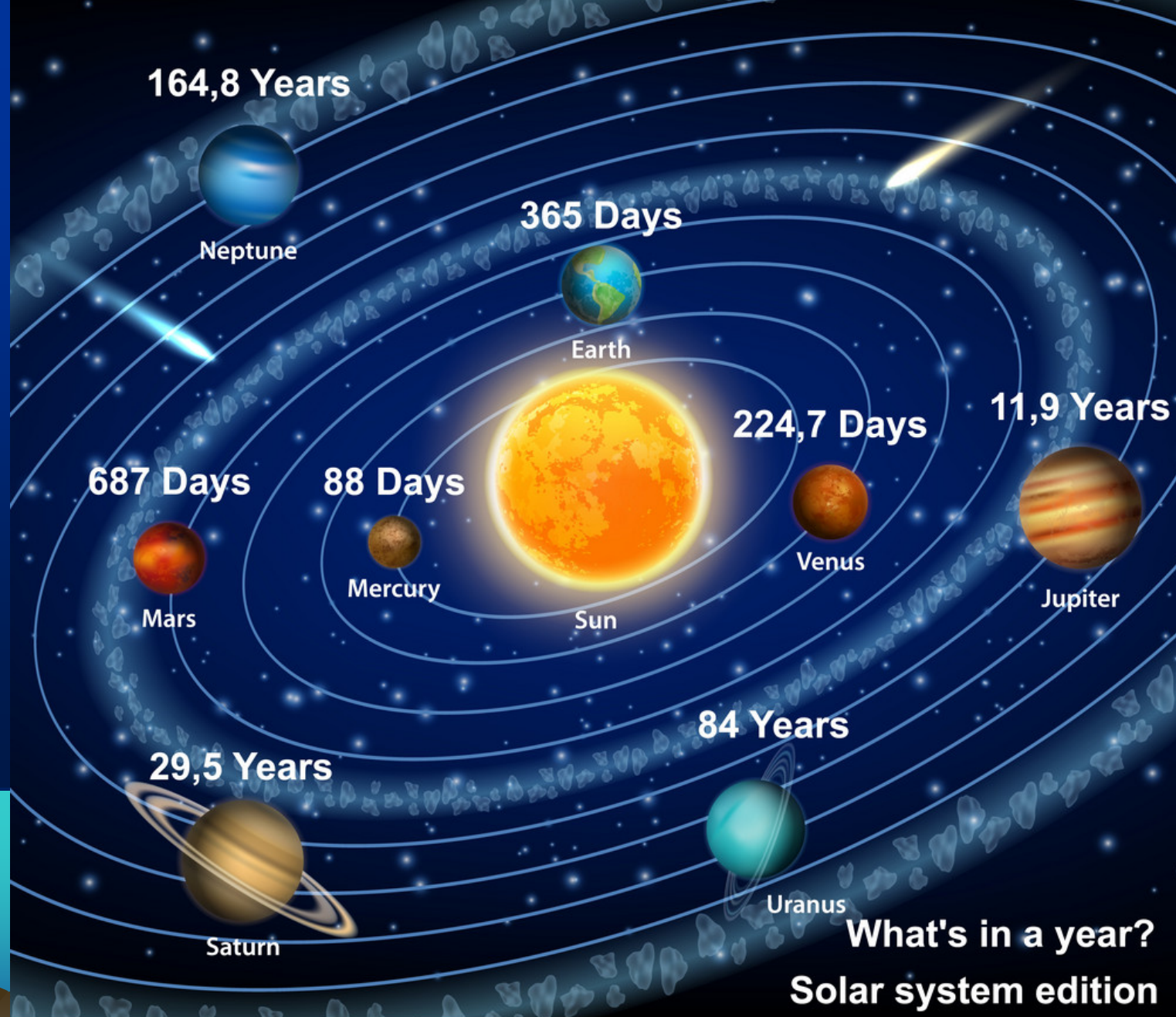


# ШЕЋА ПО СУНЧЕВОМ СИСТЕМУ

Милан С. Димитријевић  
Астрономска опсерваторија

Београд





**What's in a year?  
Solar system edition**

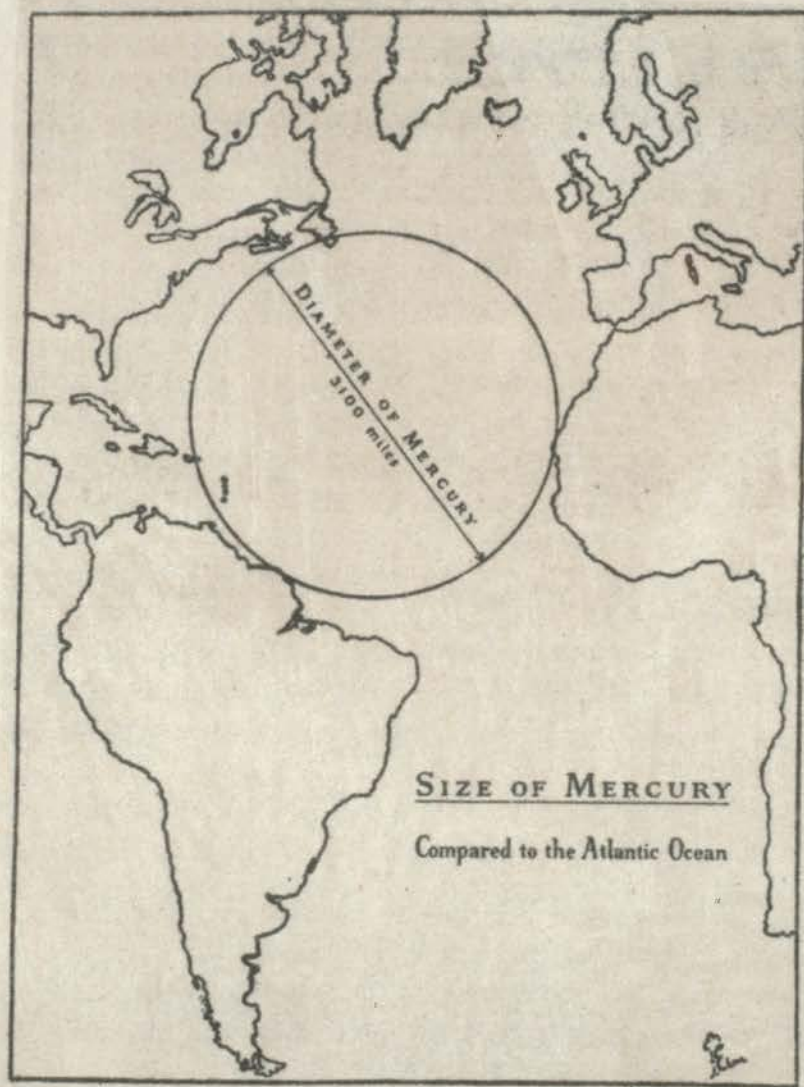
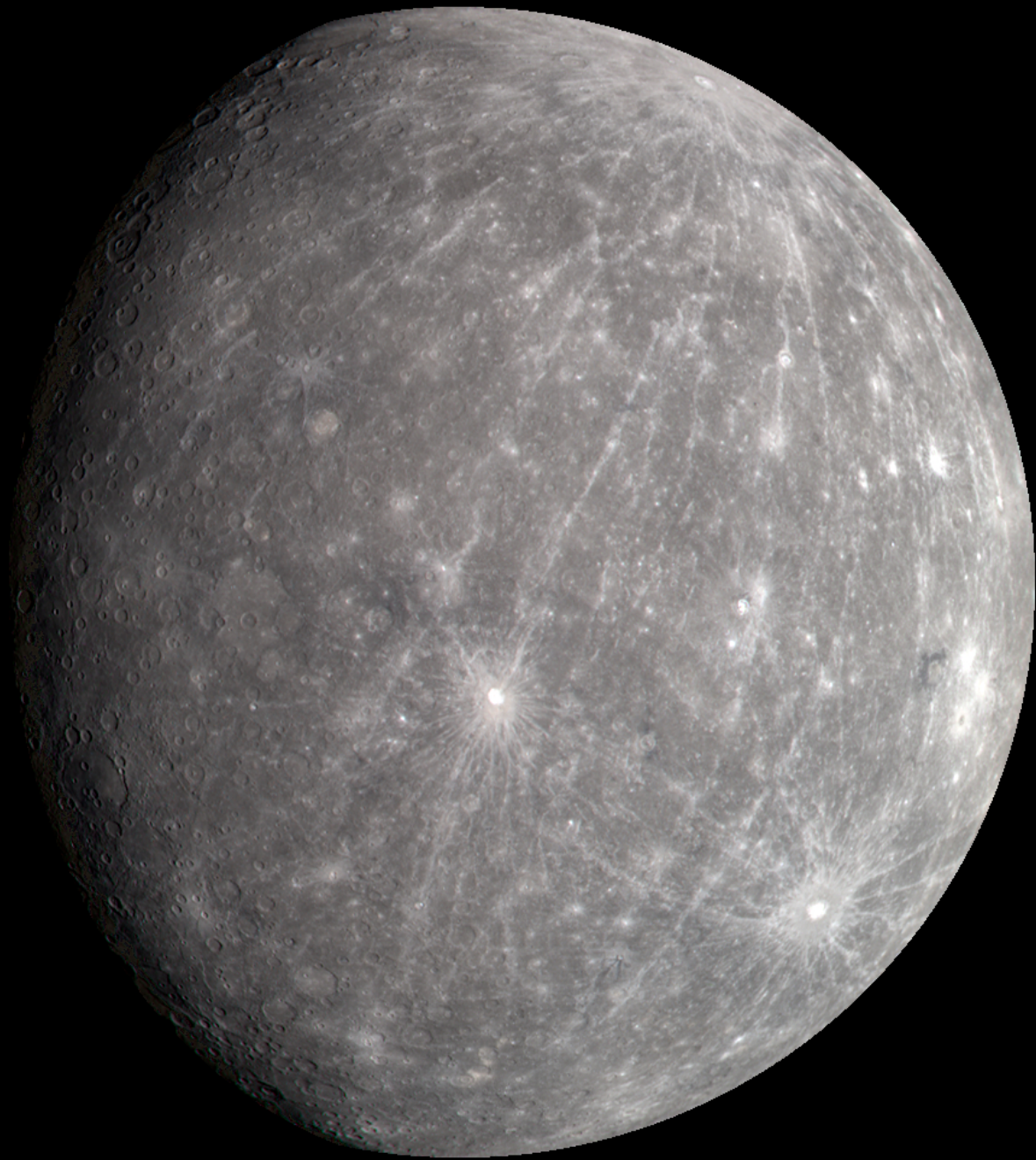
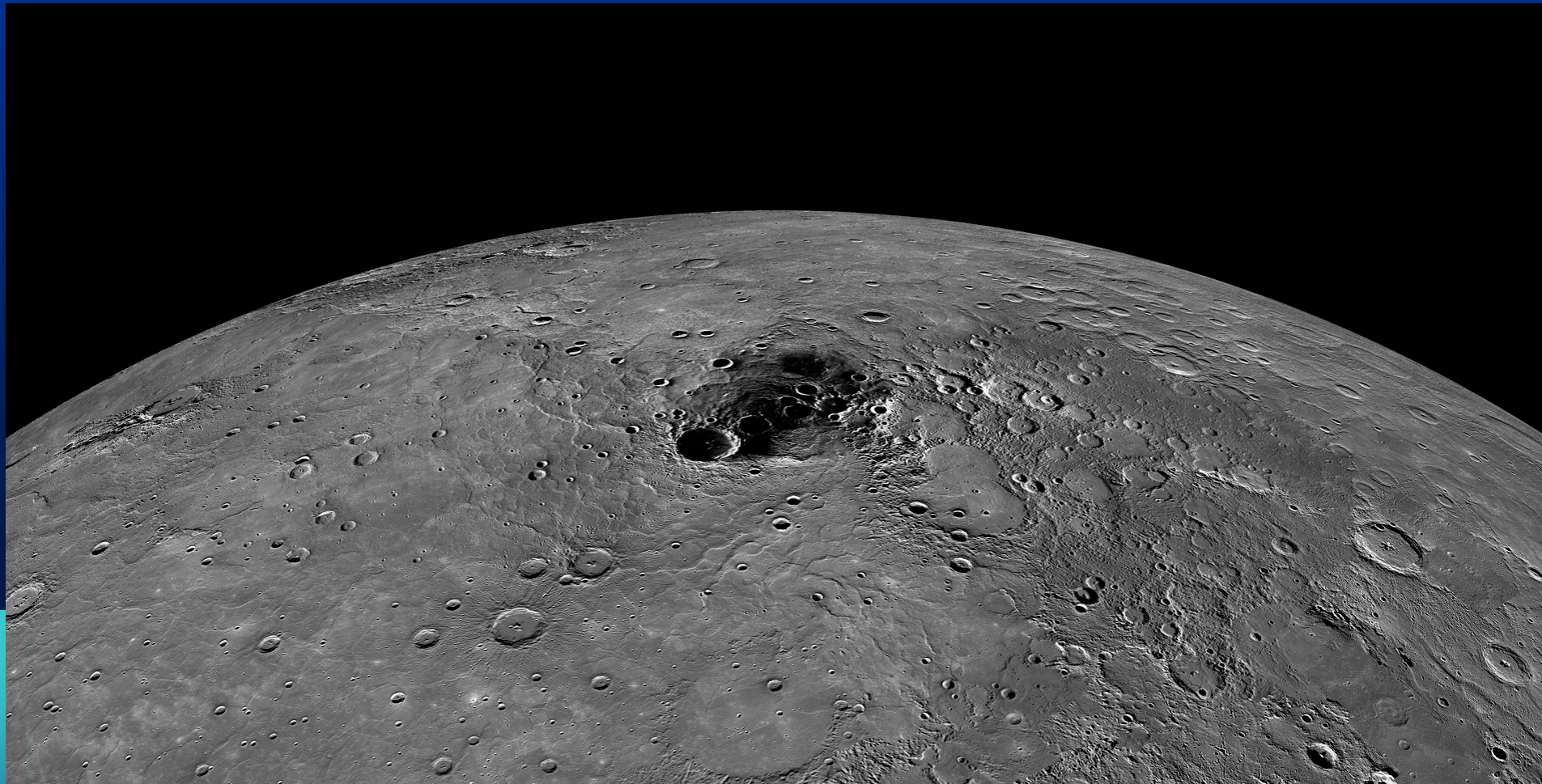
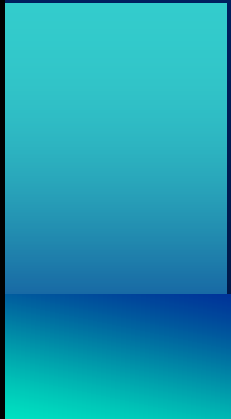
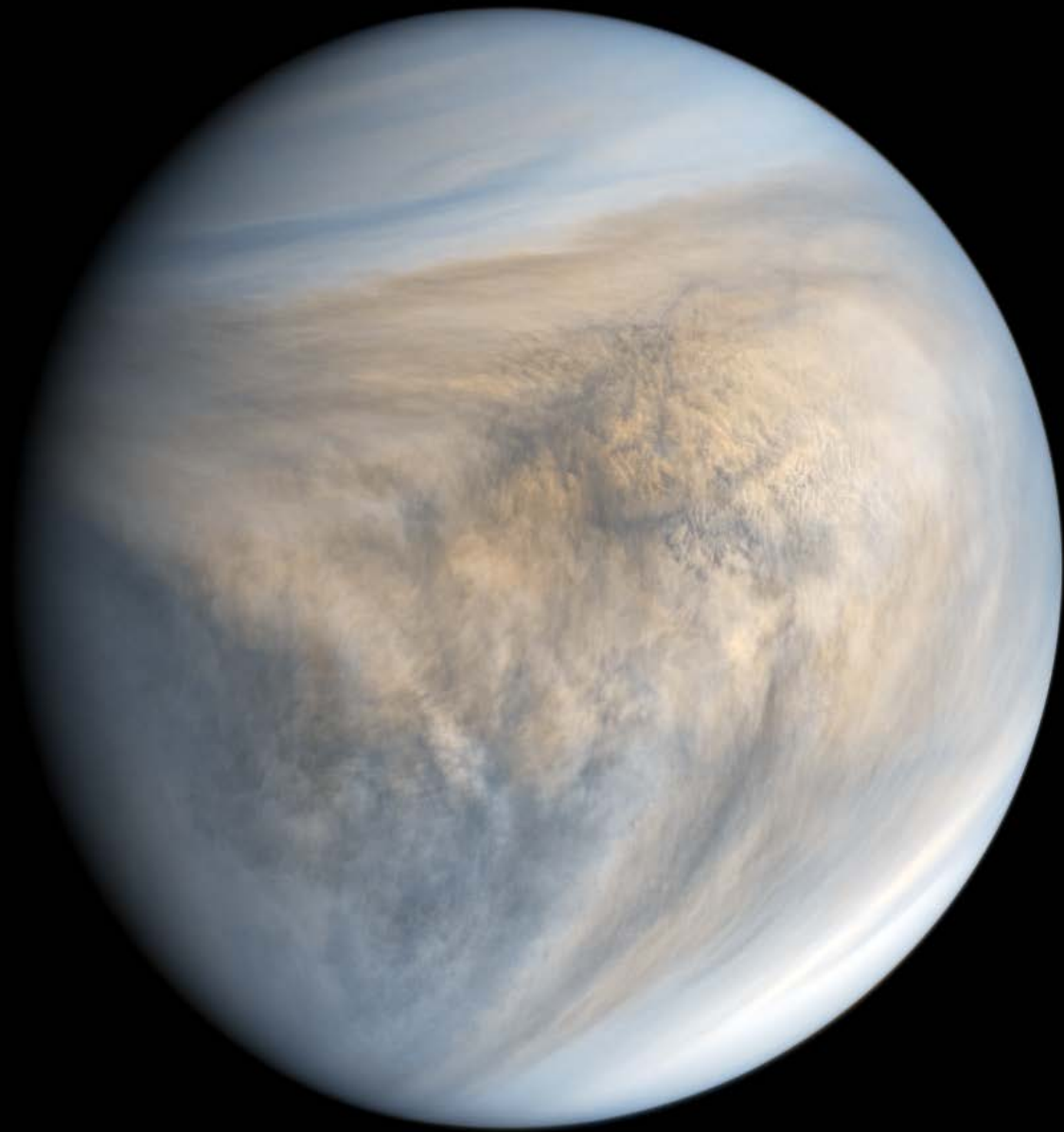
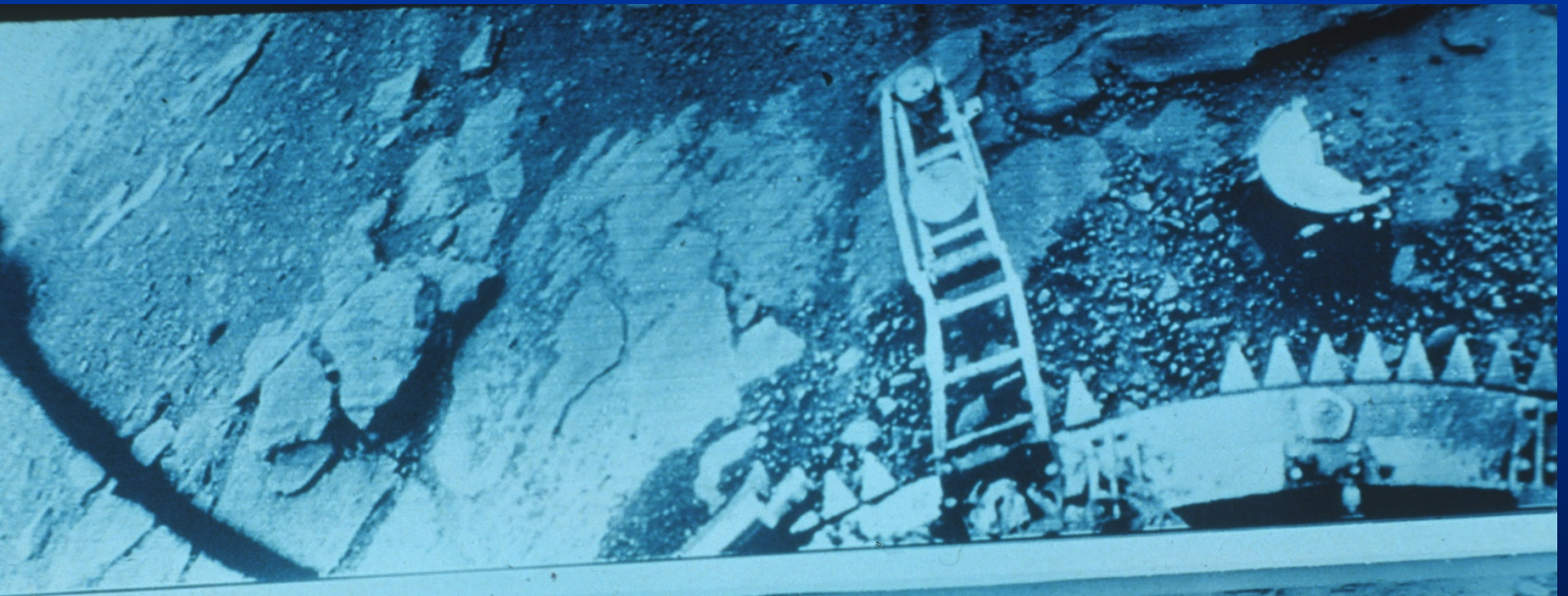


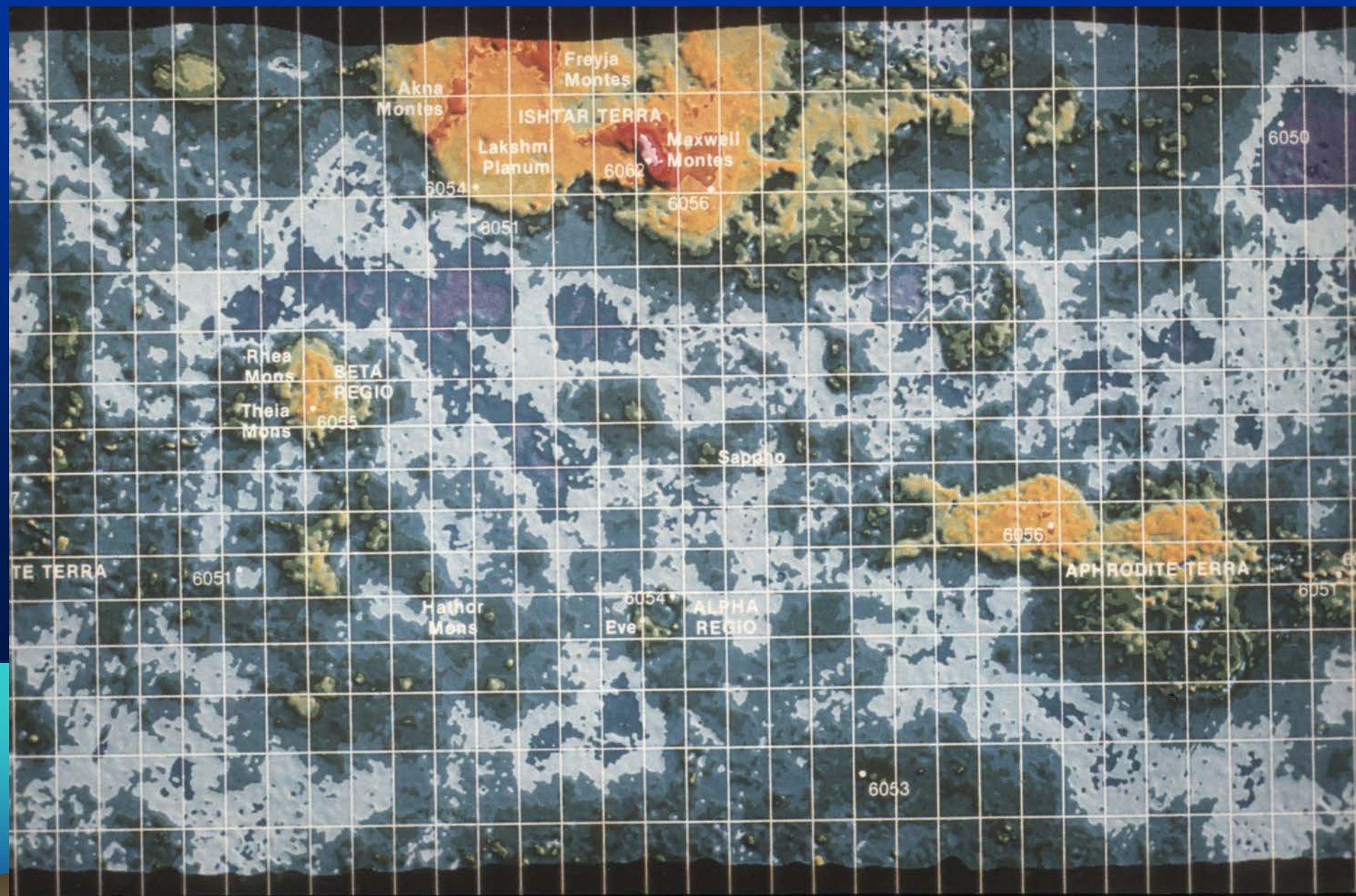
FIG. 4. Size of Mercury, compared to the Atlantic Ocean















27/2/04



17/3/04



22/3/04



27/3/04



3/4/04



13/4/04



1/5/04



7/5/04



11/5/04



16/5/04



19/5/04



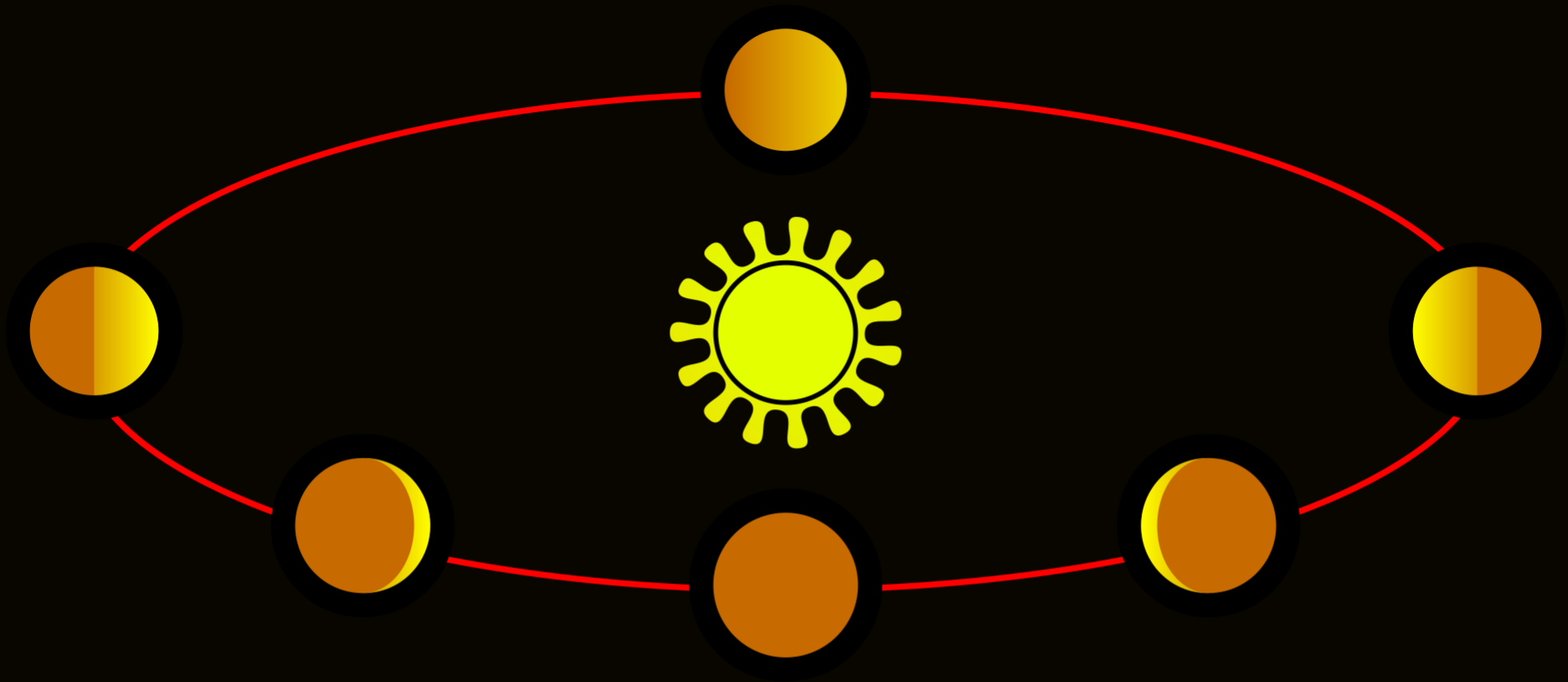
25/5/04



30/5/04



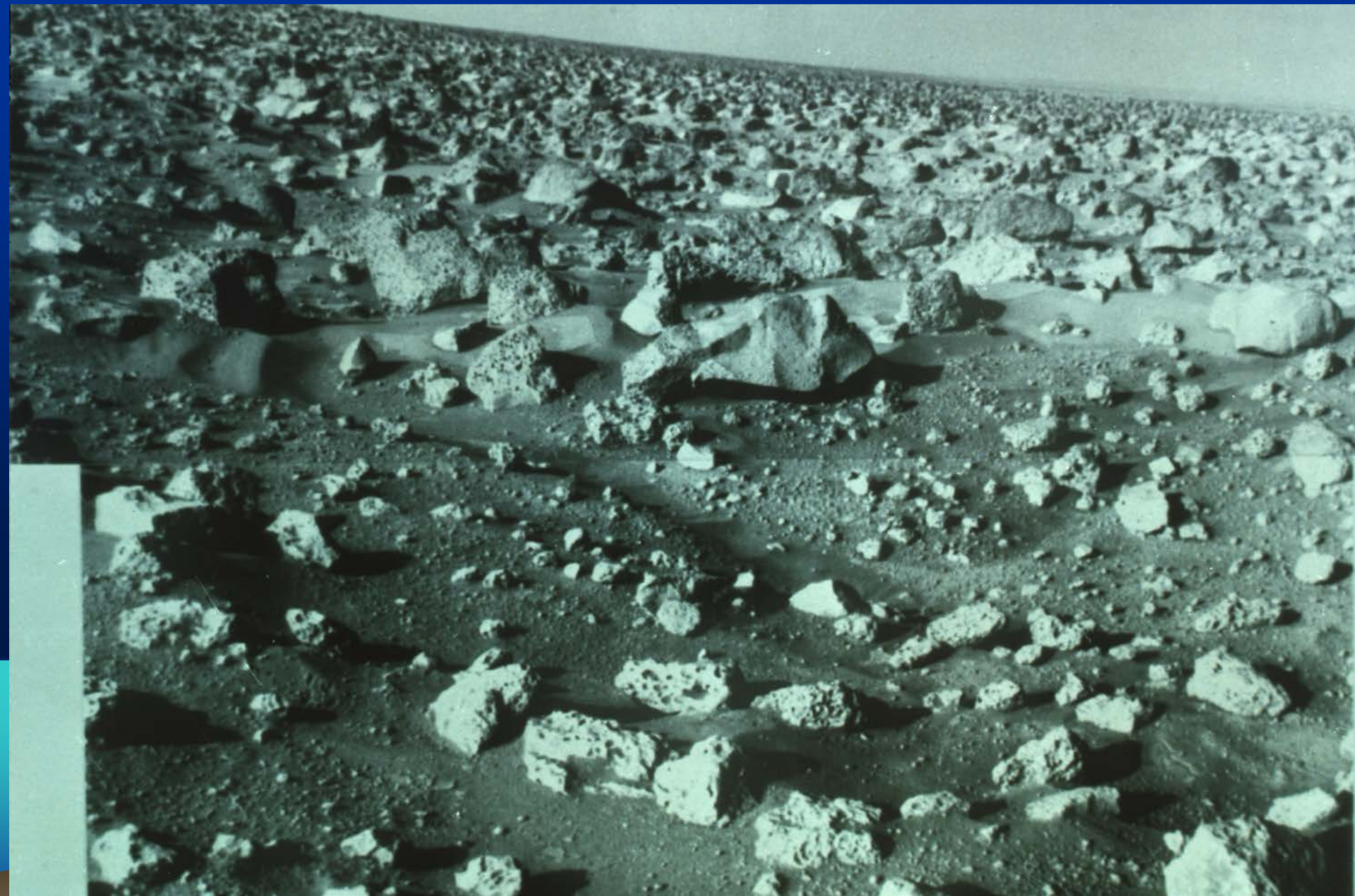
8/6/04



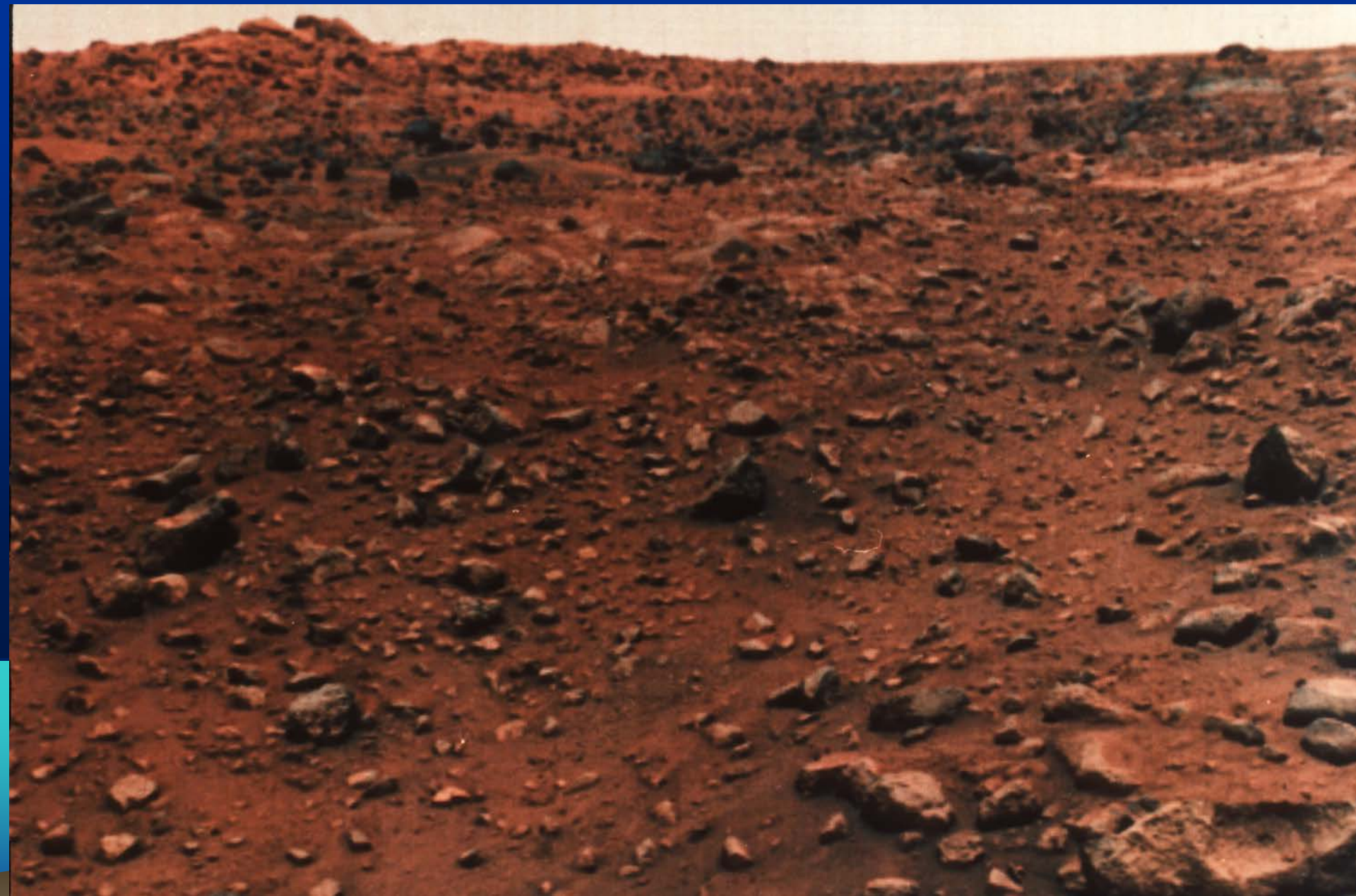
**EARTH**

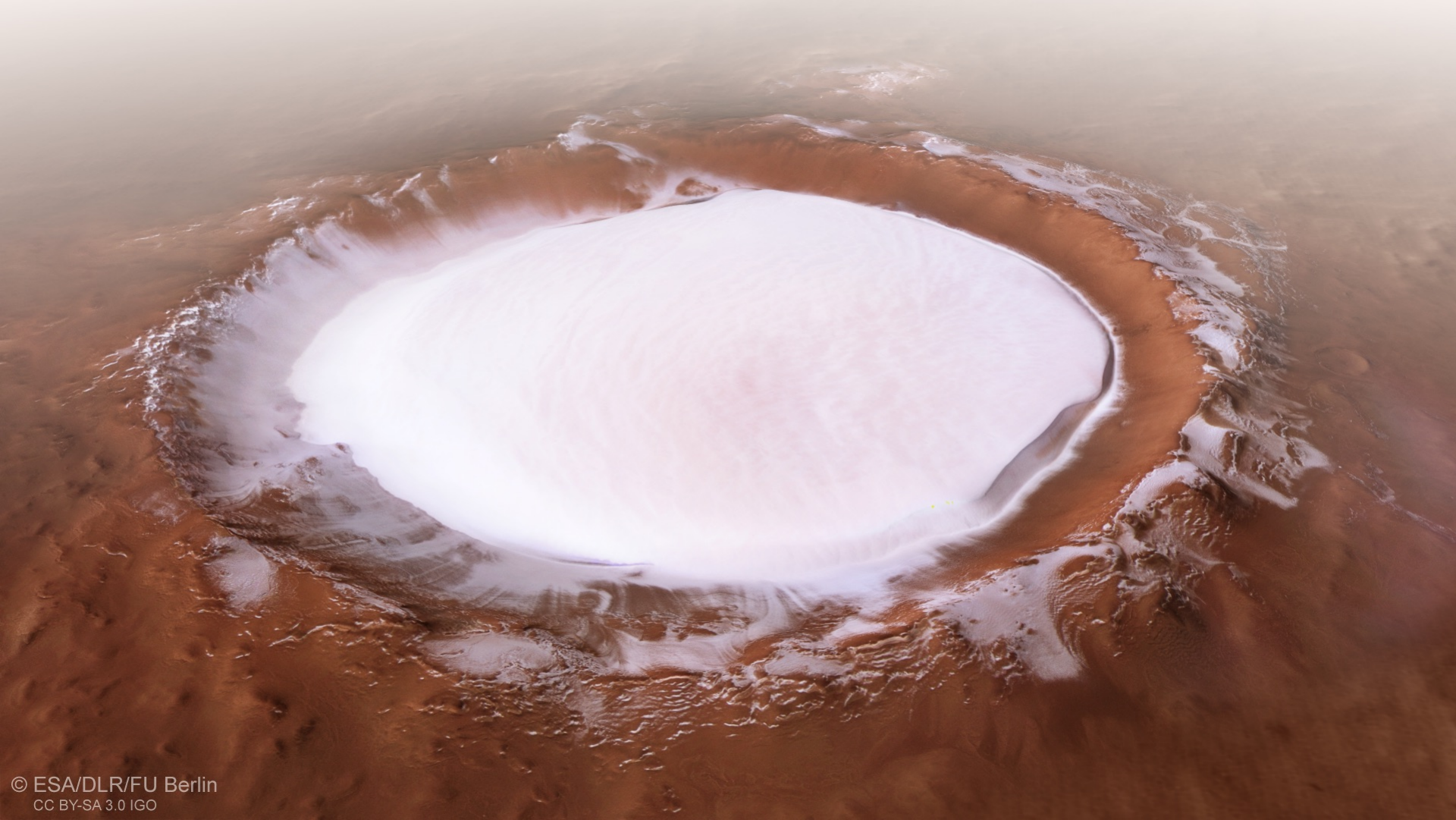




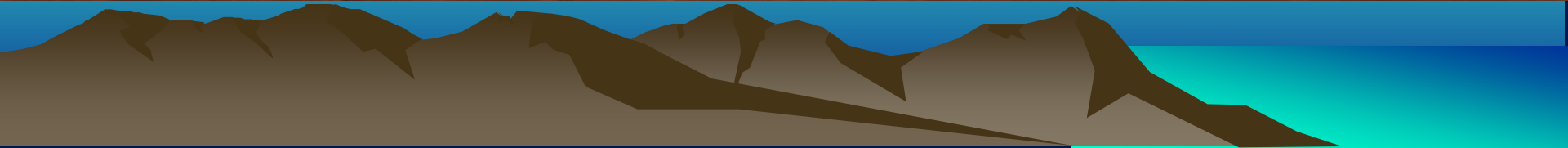




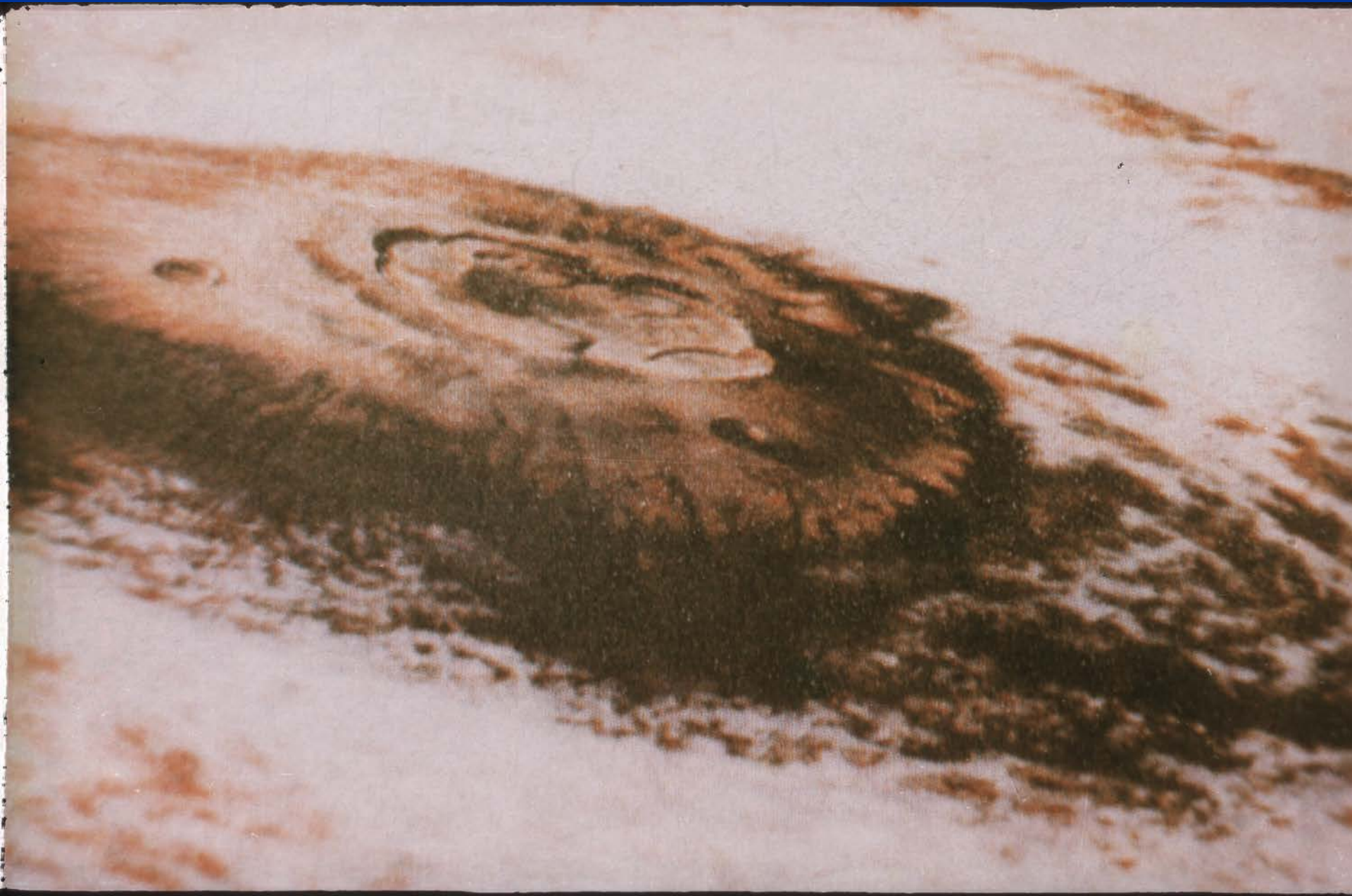




© ESA/DLR/FU Berlin  
CC BY-SA 3.0 IGO



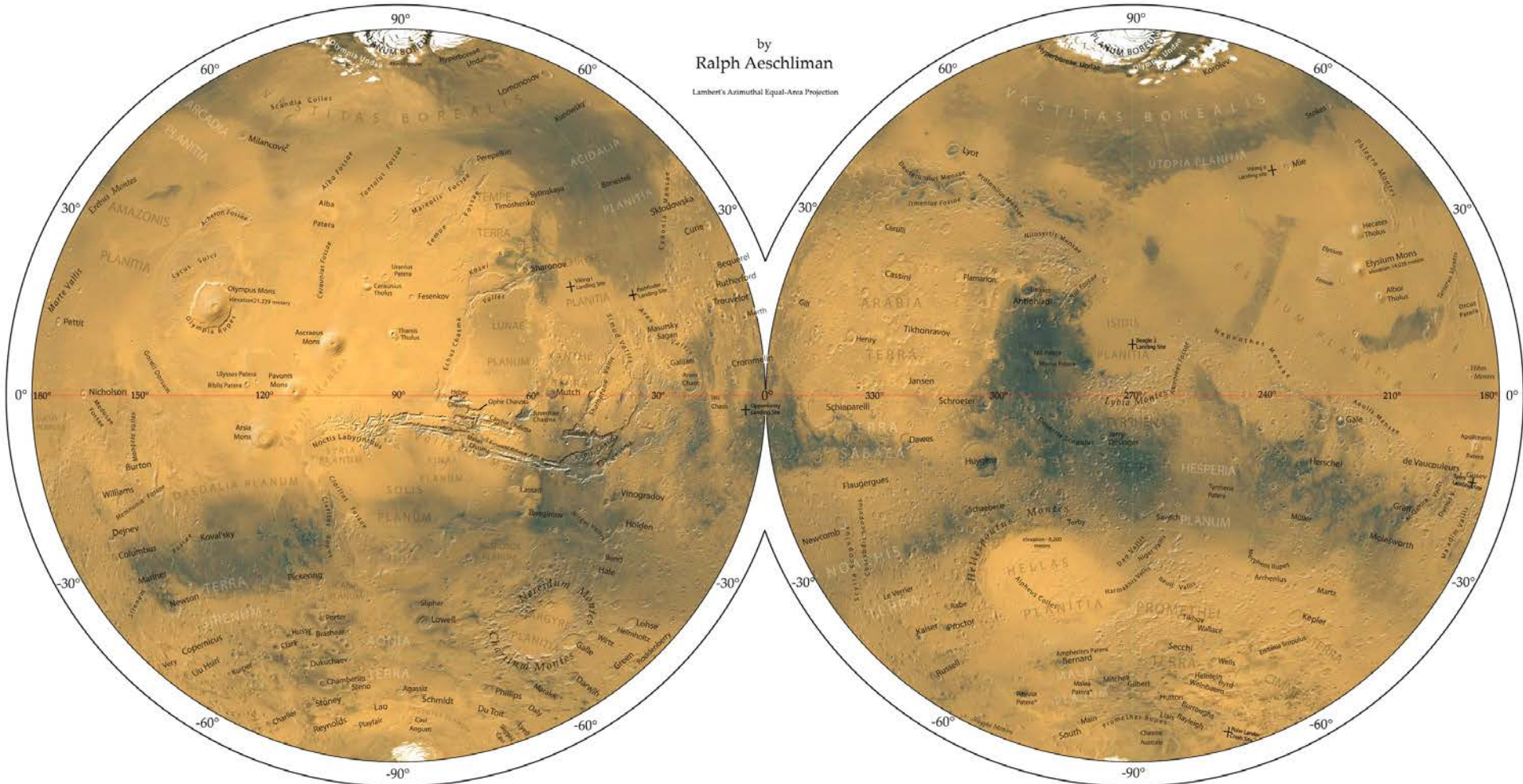


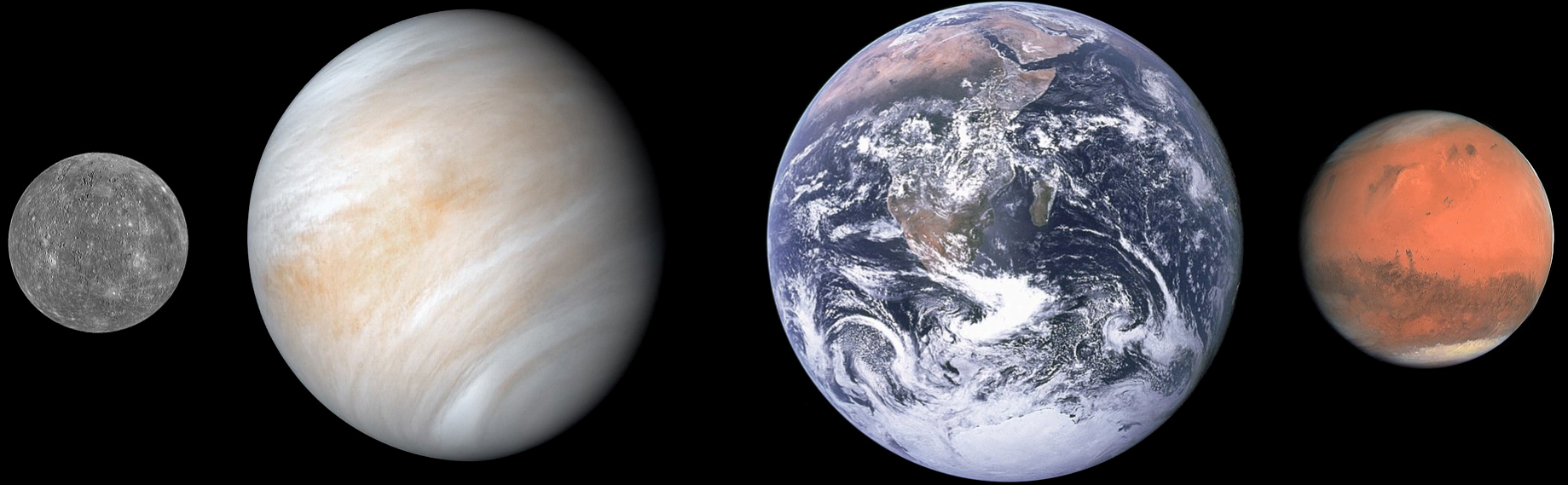


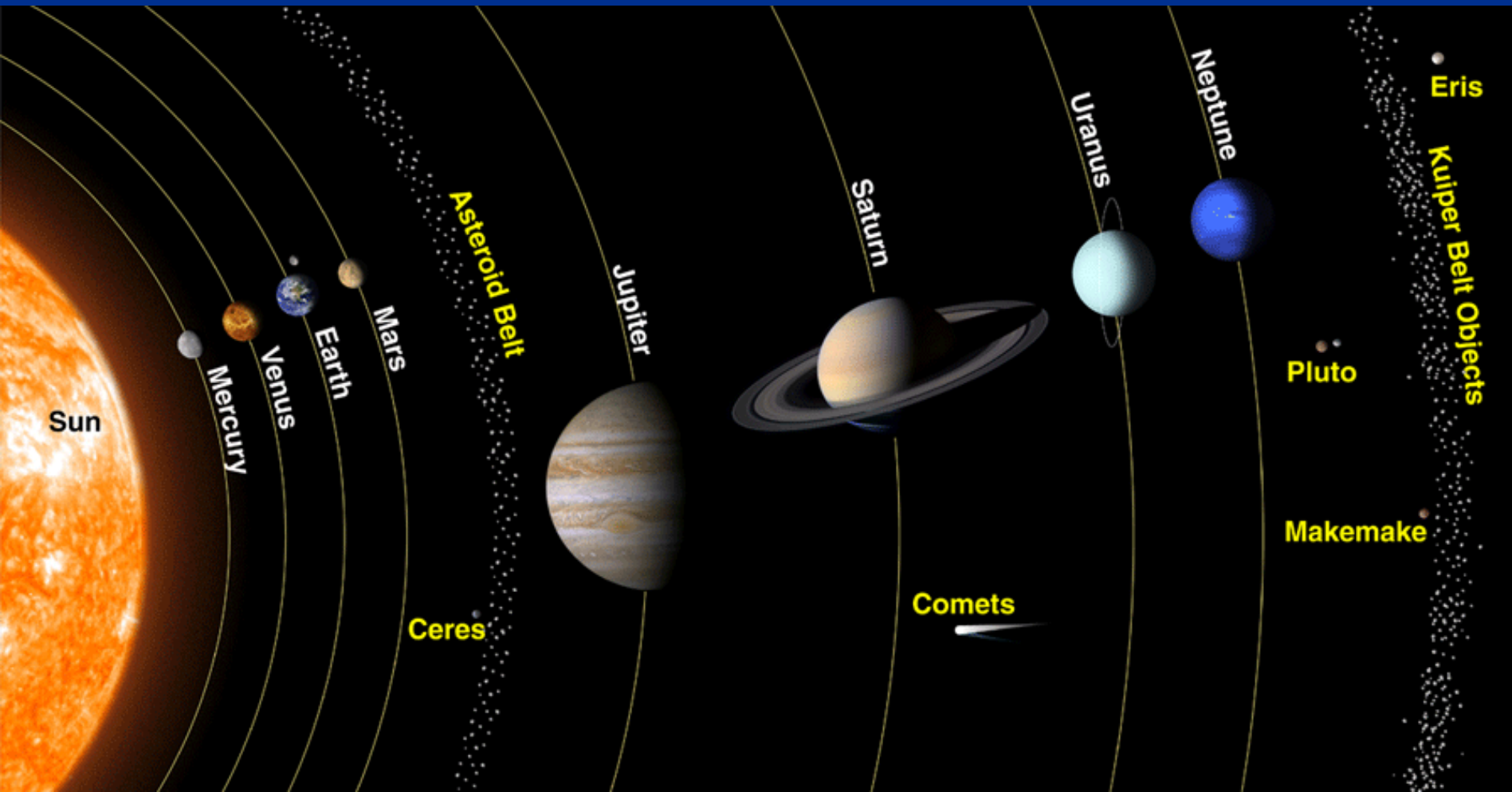


# Mars Shaded Relief and Surface Coloration Map

by  
Ralph Aeschliman  
Lambert's Azimuthal Equal-Area Projection







Sun

Mercury

Venus

Earth

Mars

Asteroid Belt

Ceres

Jupiter

Saturn

Uranus

Neptune

Pluto

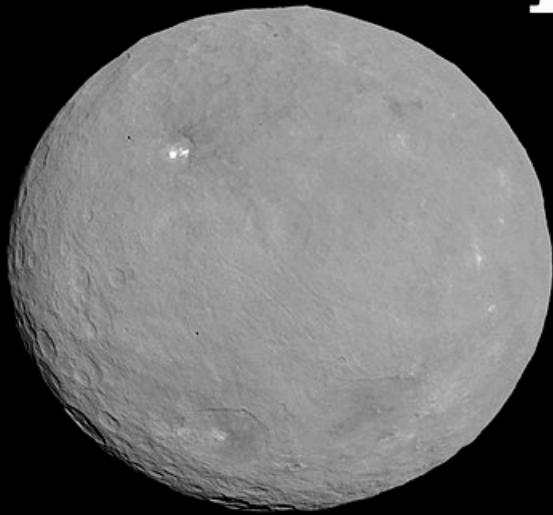
Makemake

Eris

Kuiper Belt Objects

Comets

# The four largest asteroids



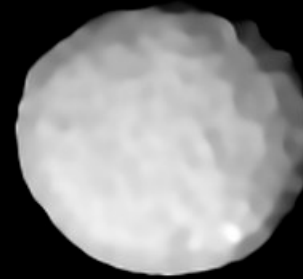
**Ceres**

939 km



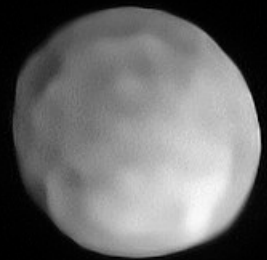
**Vesta**

525 km



**Pallas**

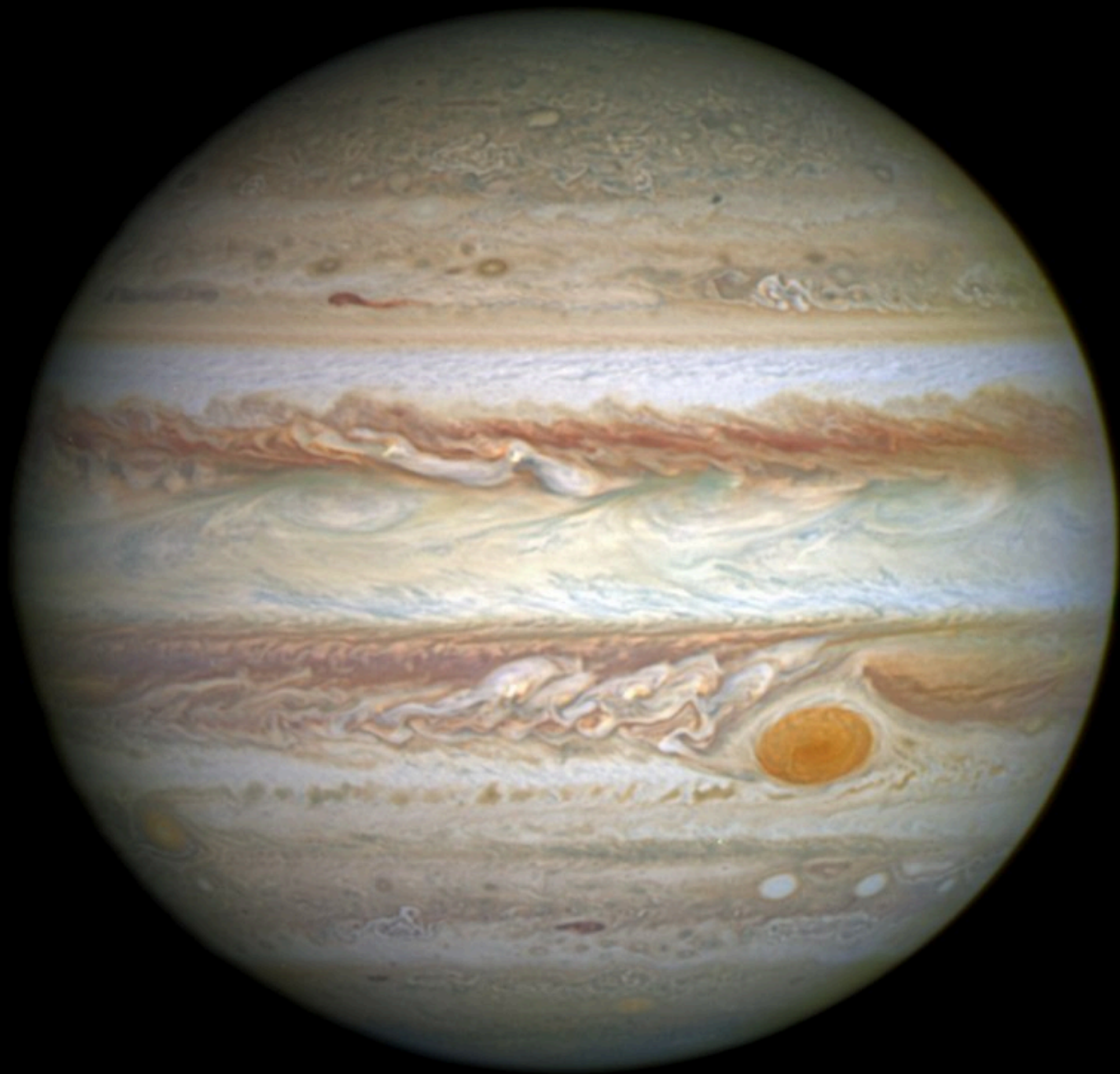
512 km

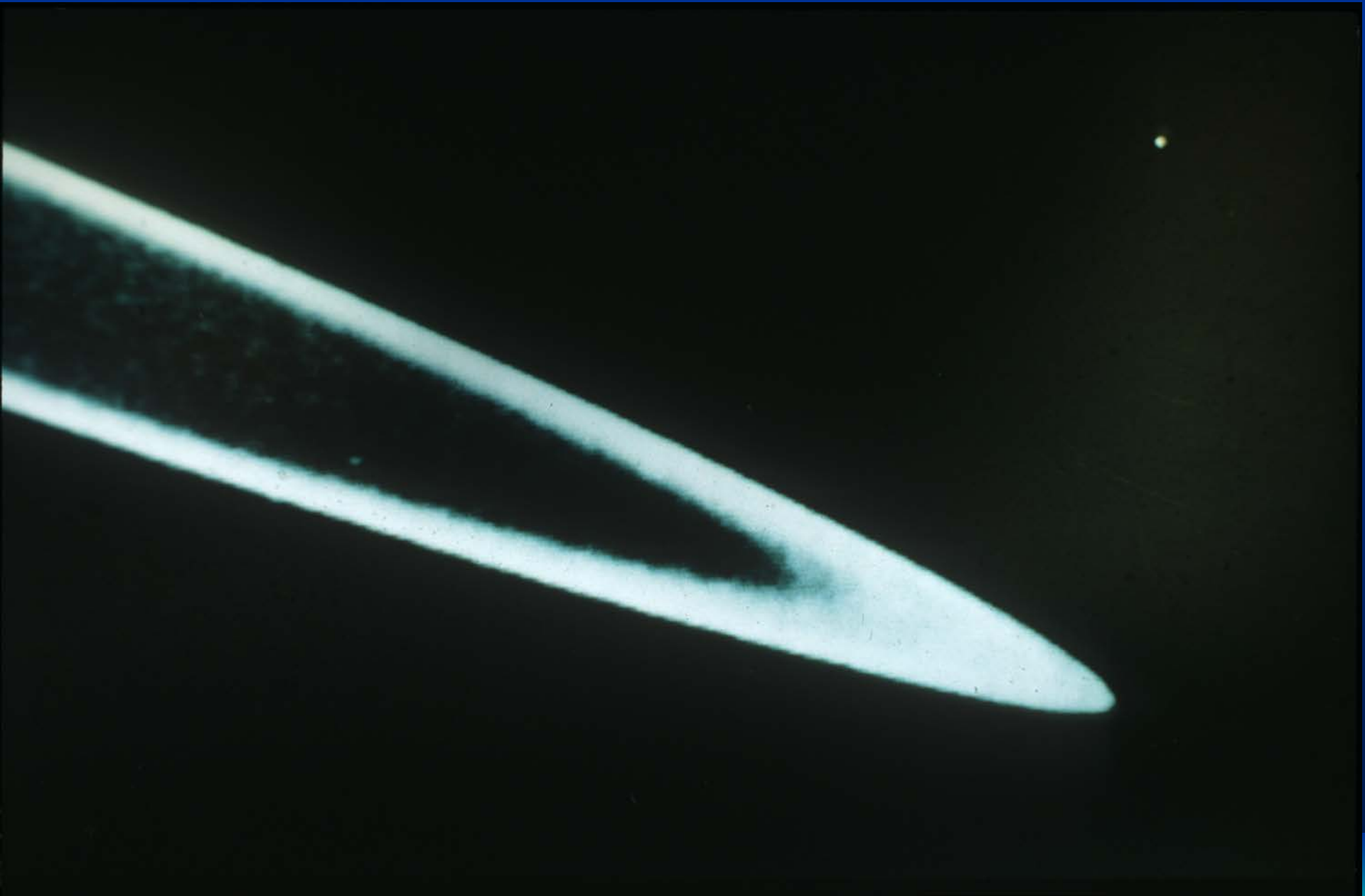


**Hygiea**

434 km



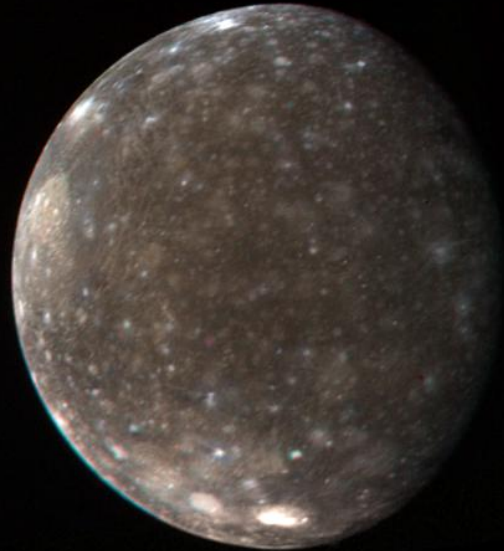




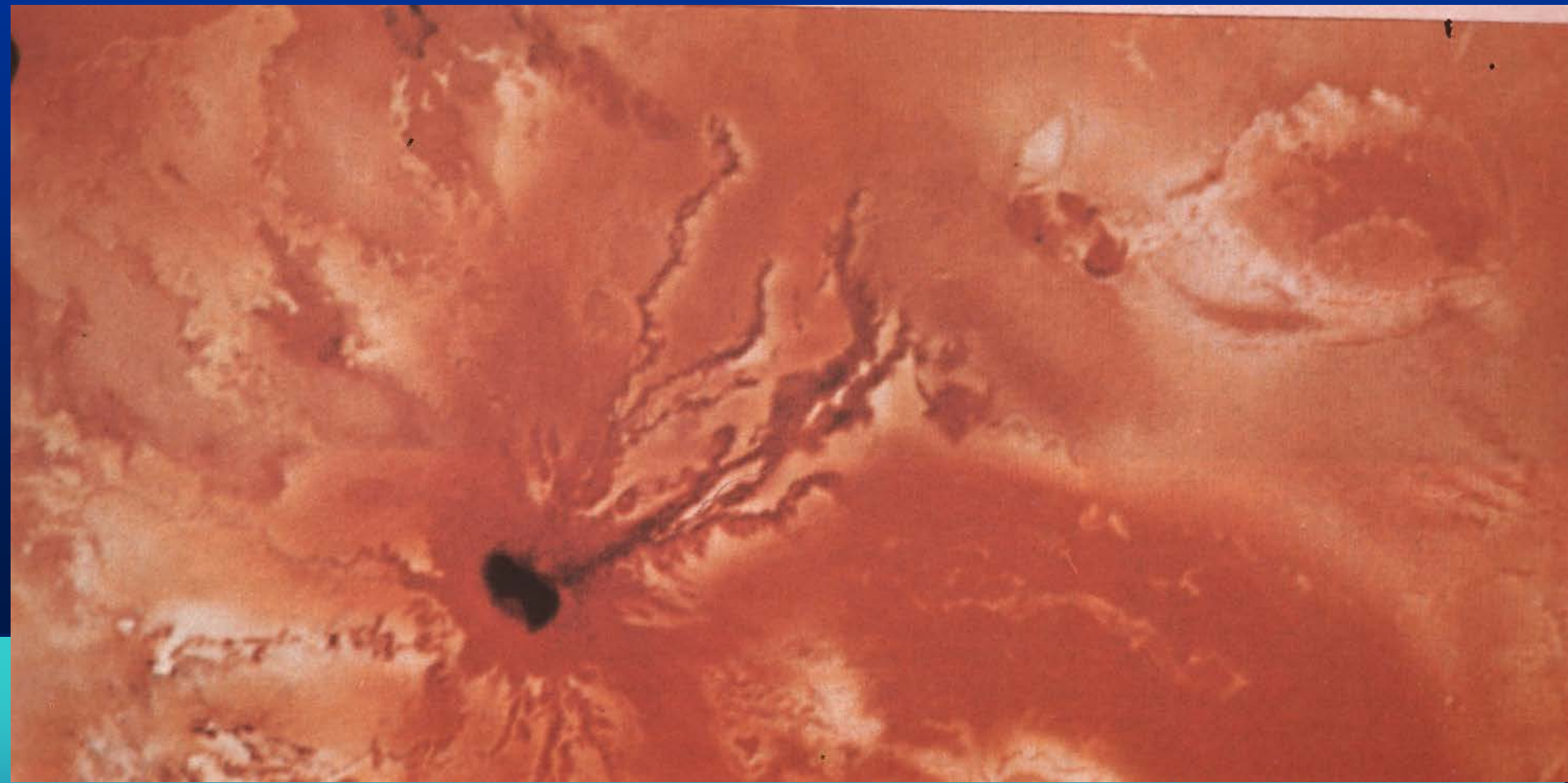


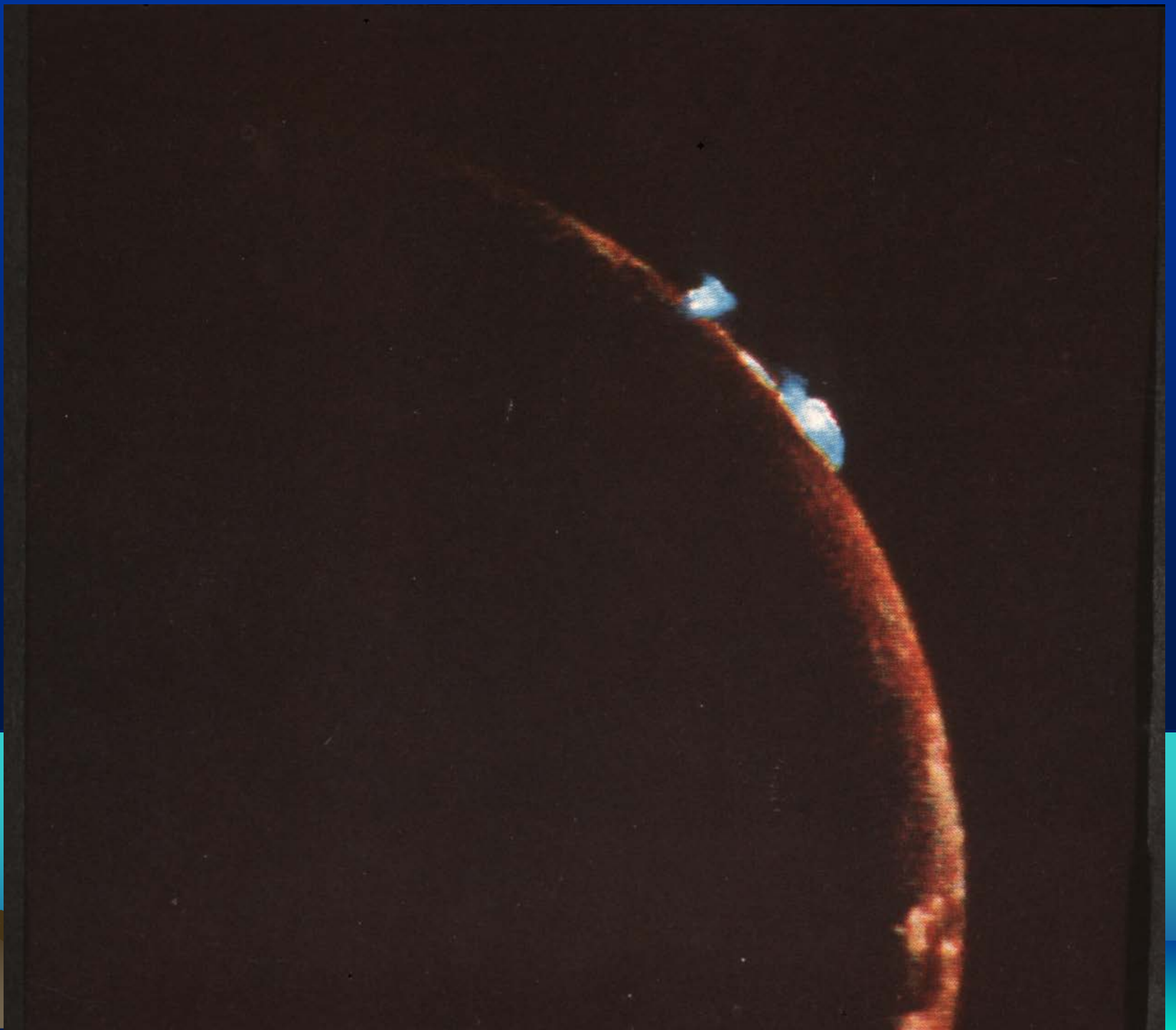


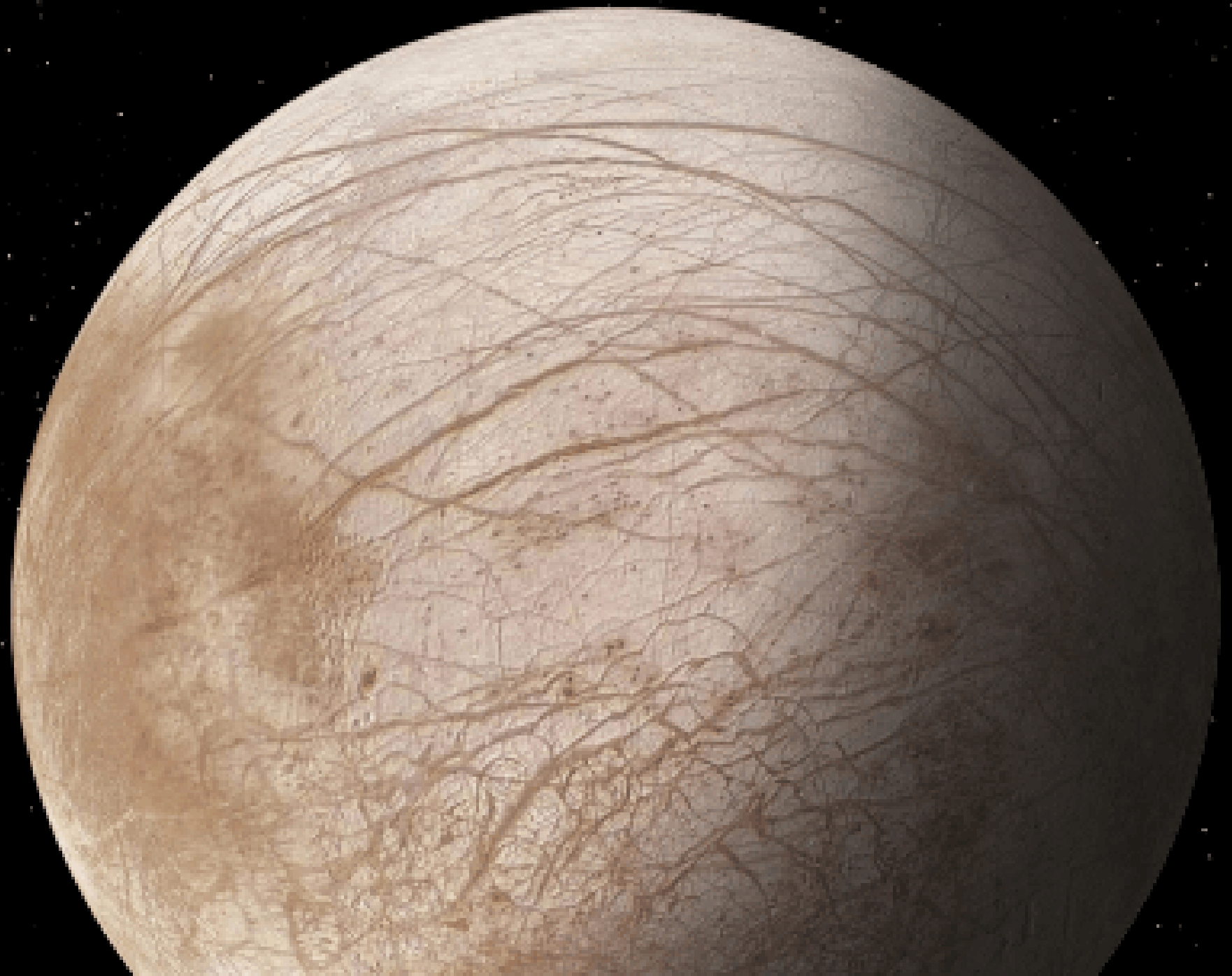








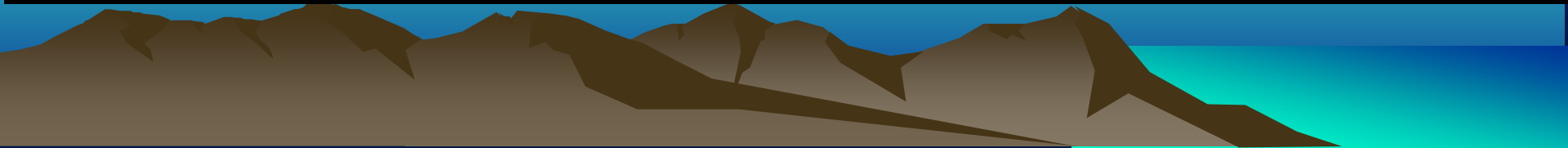
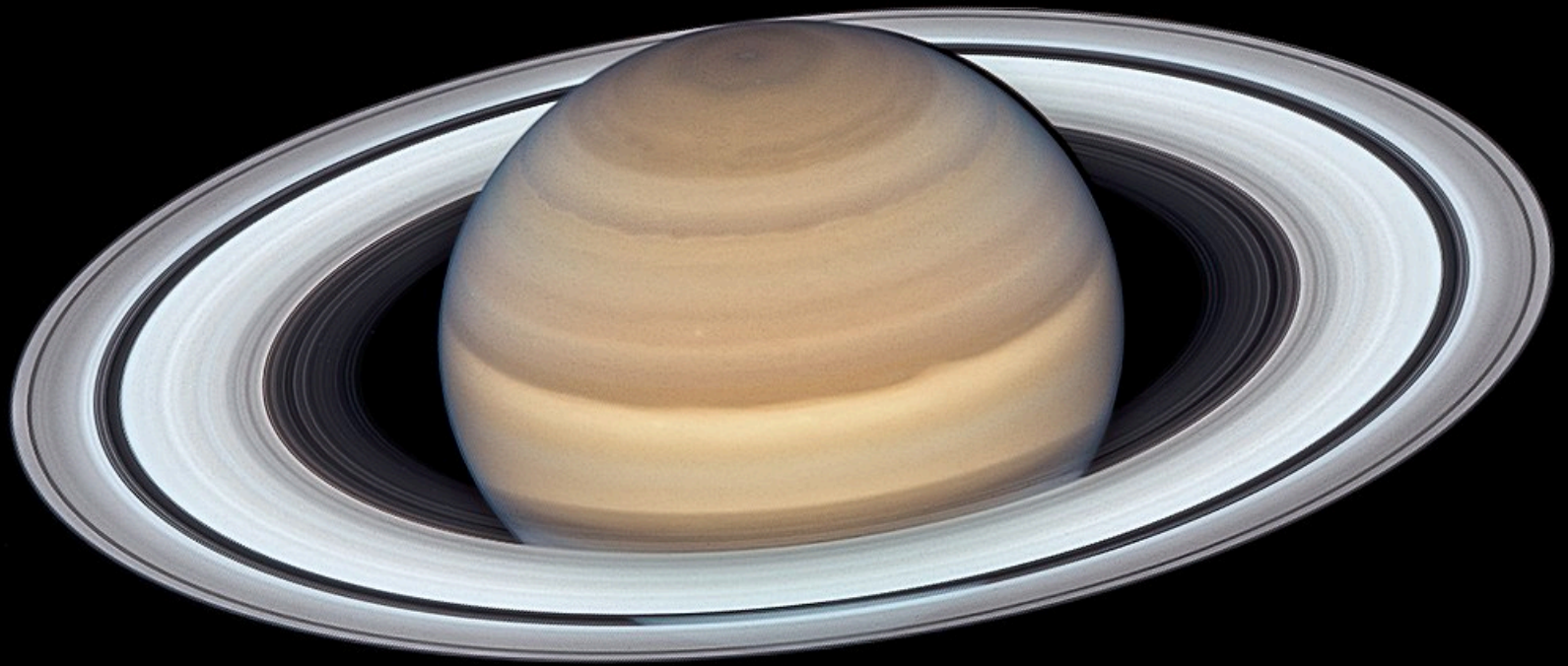


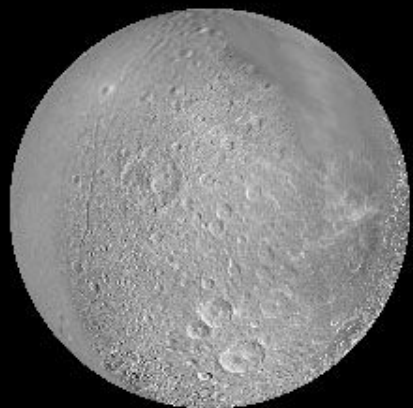




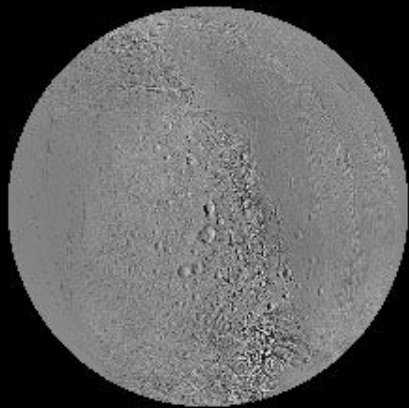




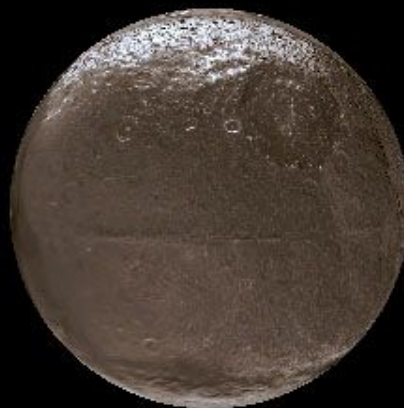




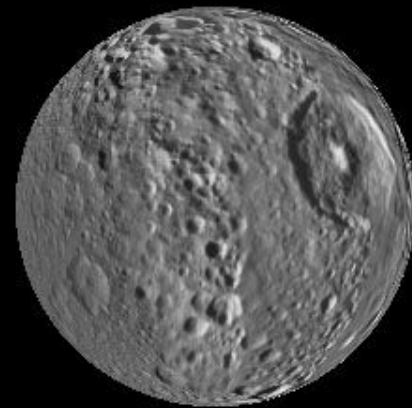
Dione



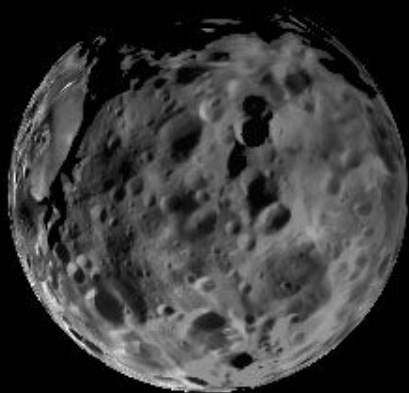
Enceladus



Iapetus



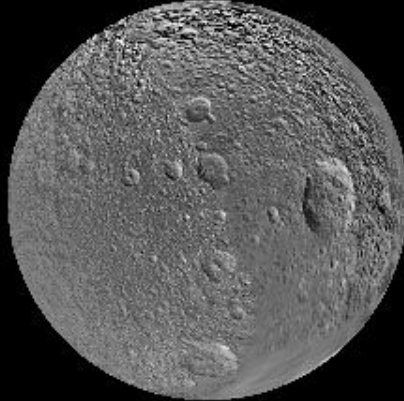
Mimas



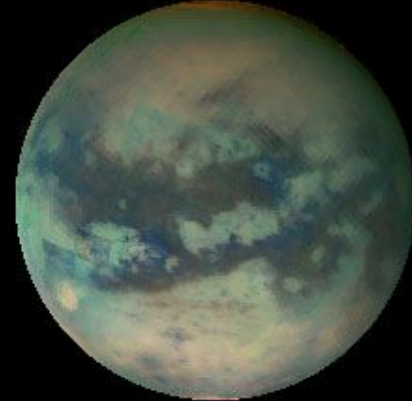
Phoebe



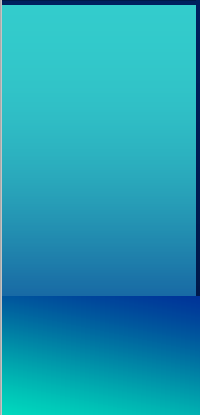
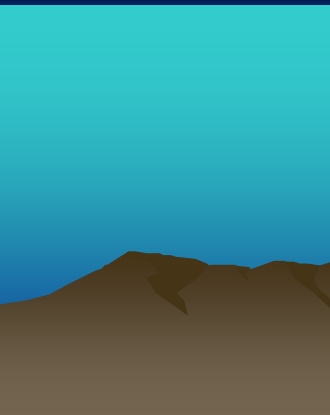
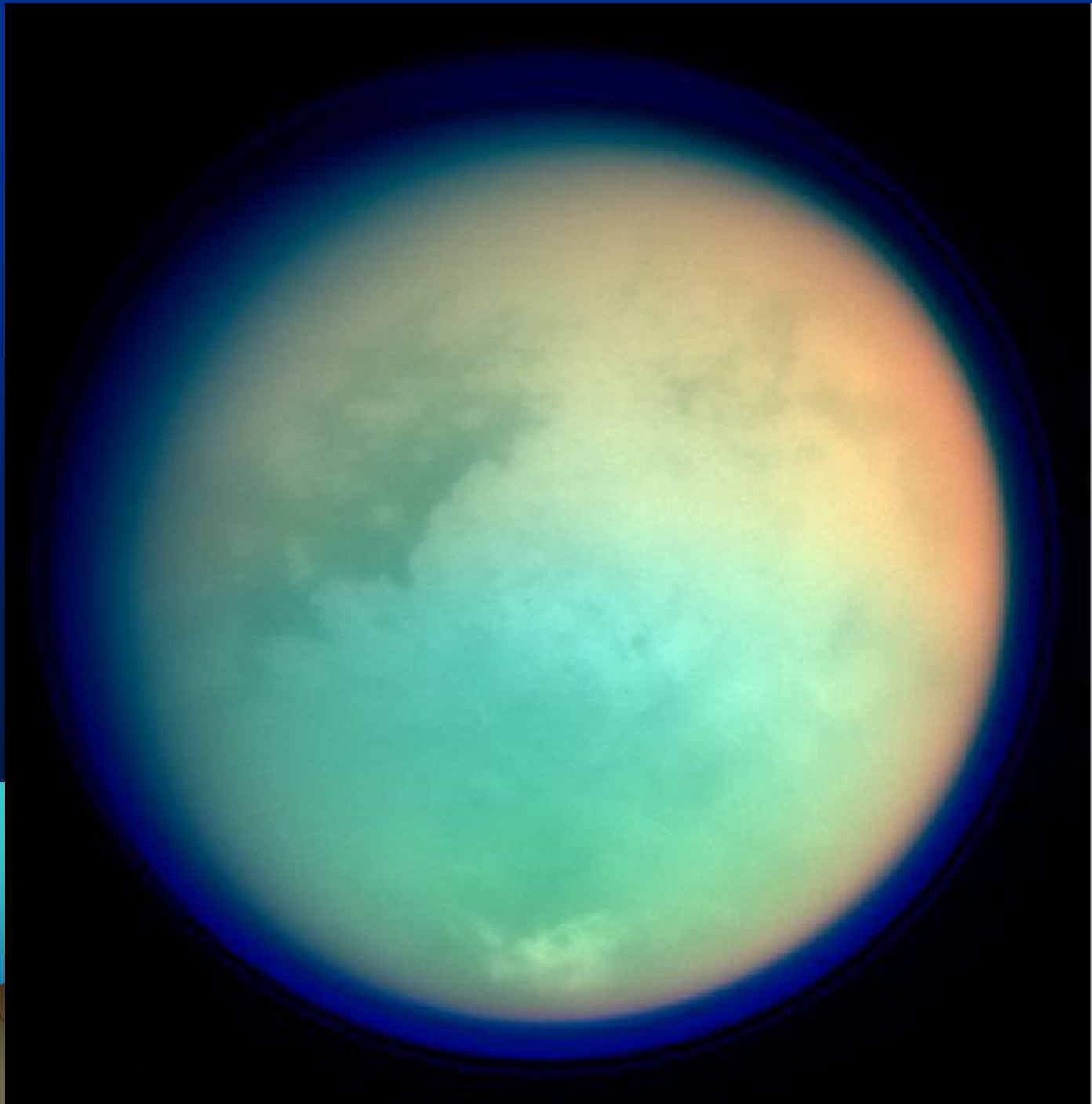
Rhea

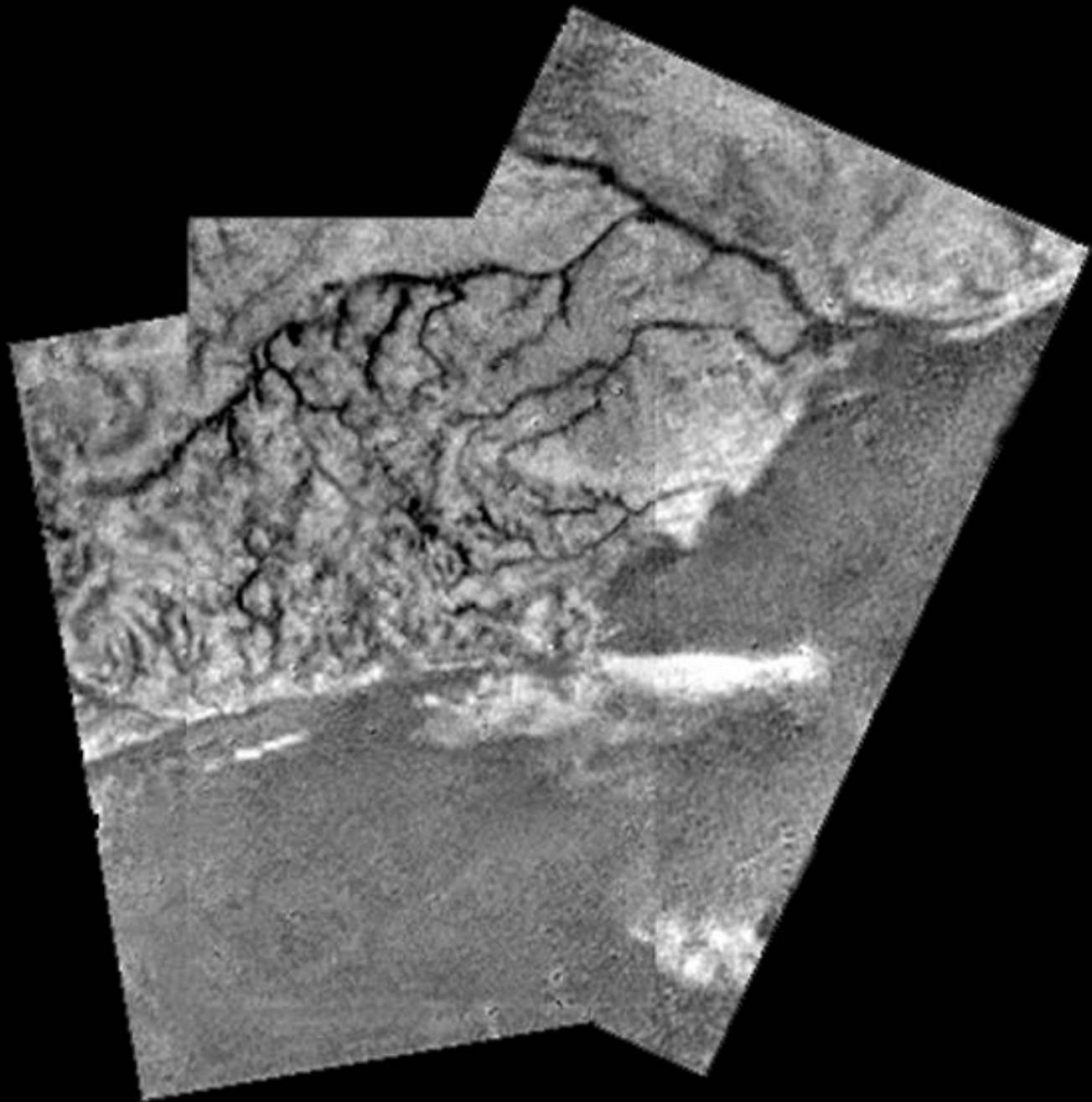


Tethys

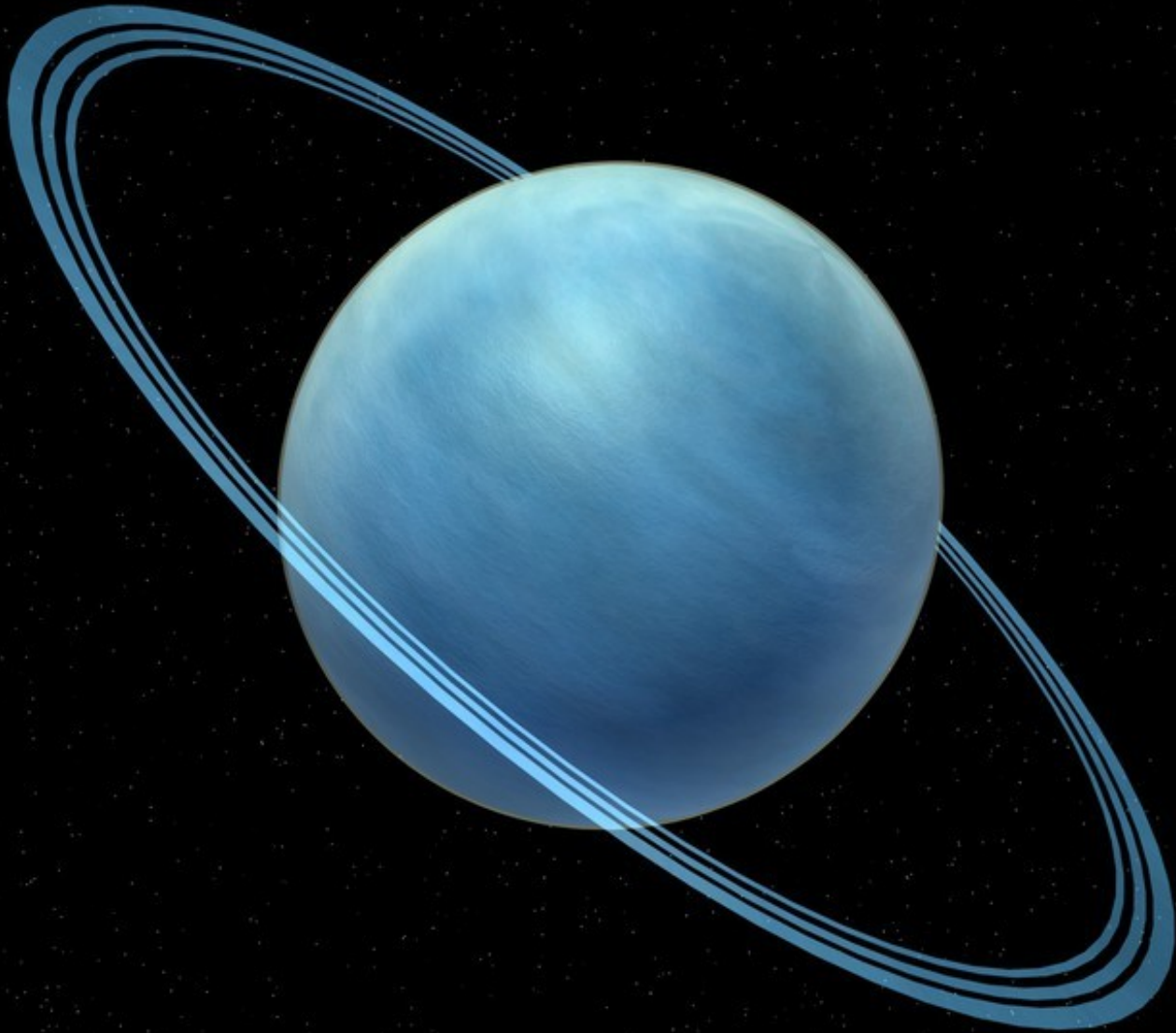


Titan











Titania

Umbriel

Miranda

Portia →

← Puck

Ariel

Oberon

20 arcsec



# Uranus's Moons

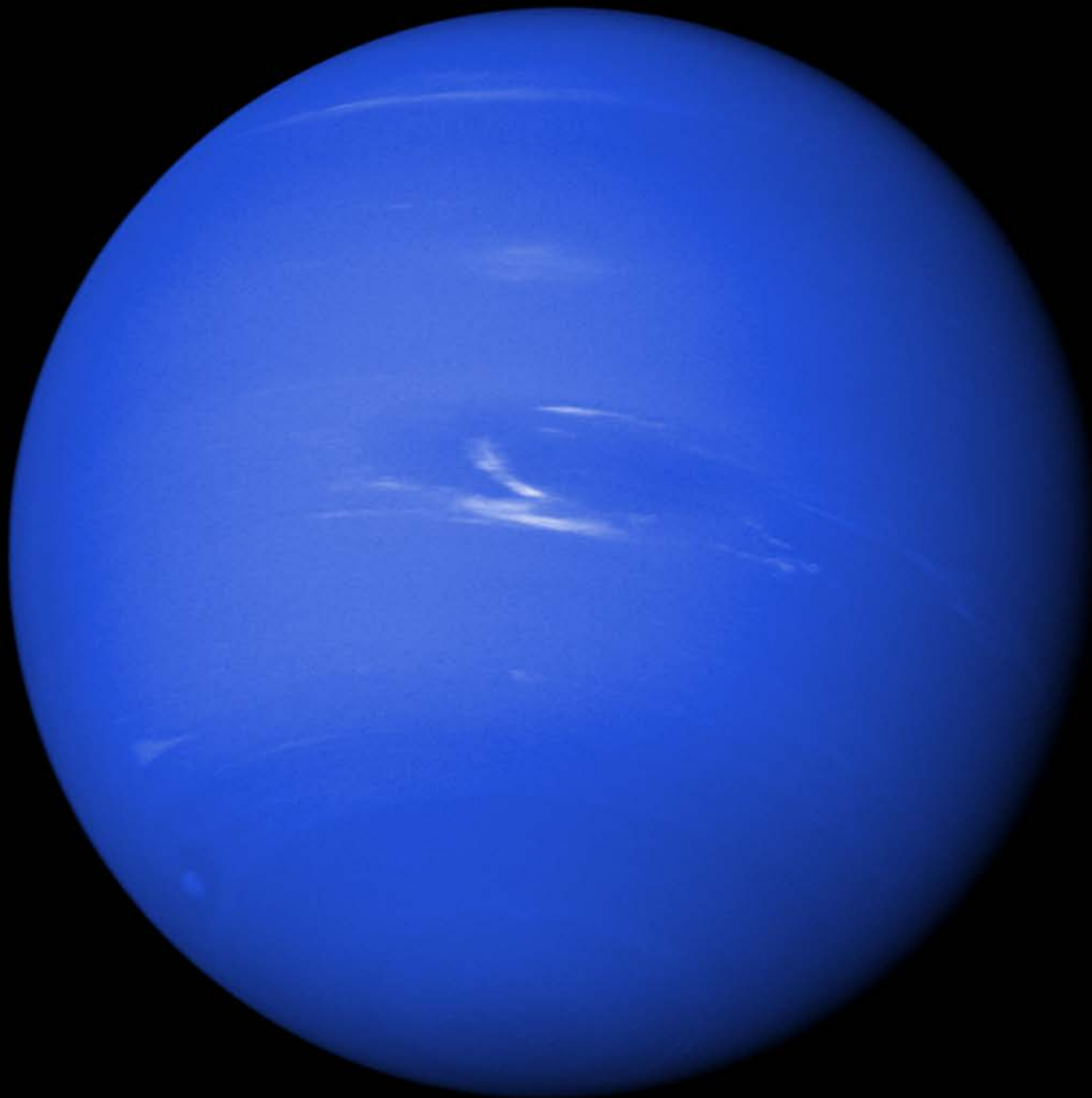
- Uranus has 27 known moons.
- Oberon and Titania are the largest moons of Uranus.

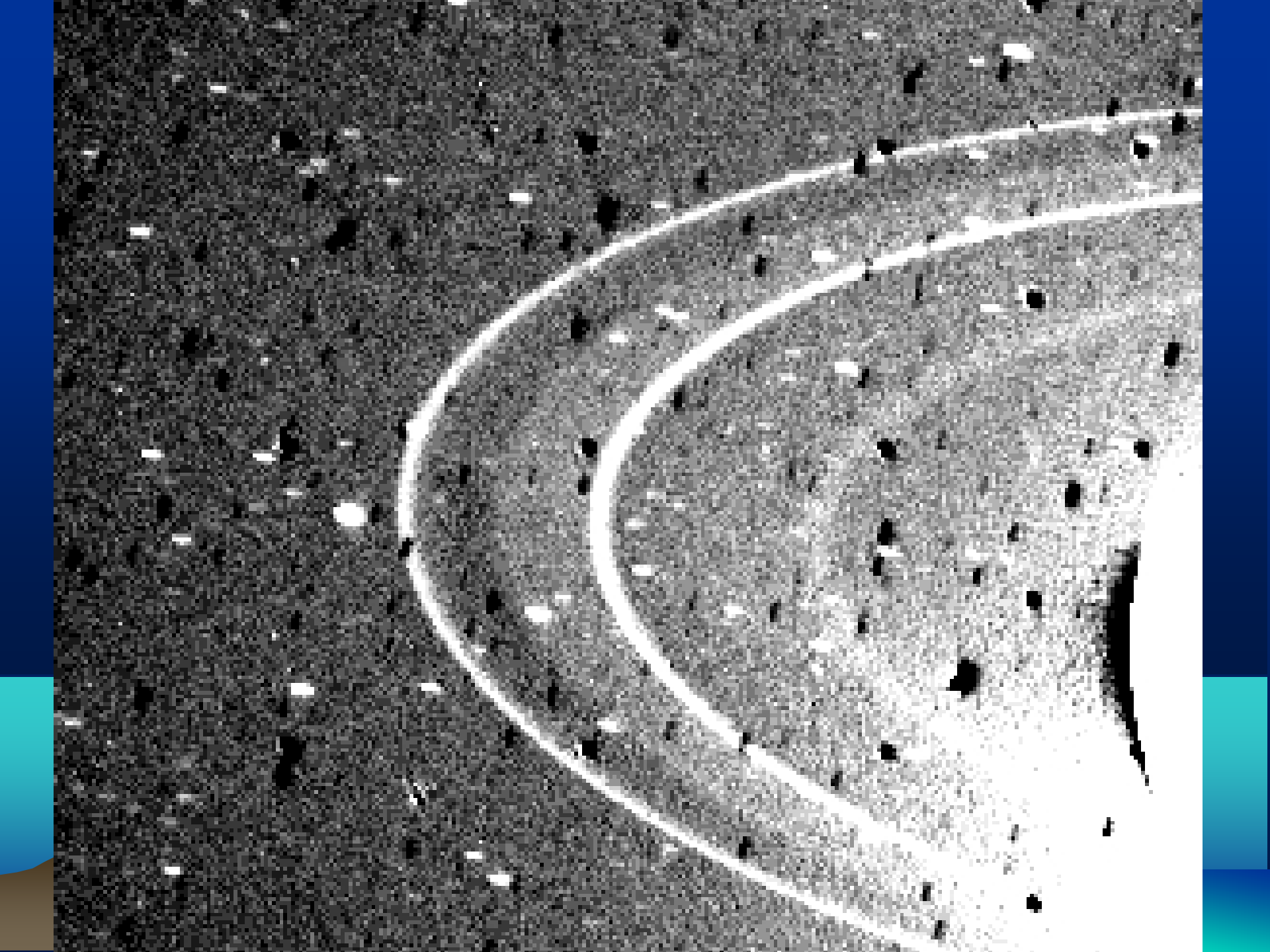


Oberon



Titania





# Neptune

# Triton

Neptune has 14 known moons

Naiad  
Thalassa  
Despina  
Galatea  
Larissa  
Hippocamp  
Proteus

Triton  
Nereid  
Halimede  
Sao  
Laomedeia  
Psamathe  
Neso

Lorem ipsum dolor sit amet, sit ex reque expetenda.  
Qui et causae audire utamur vel vivendo  
rationibus ea, ex probo graece petentium mel.  
Has duis offendit constituam ad. Ut soleat appareat mel,  
postea equidem denique eos et. At consul dicunt aeterno  
His tritani quaeque epicuri et.

Triton is the largest Neptunian moon

*Pluto*



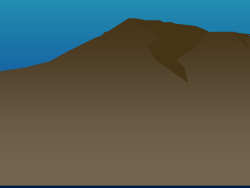
*Charon*



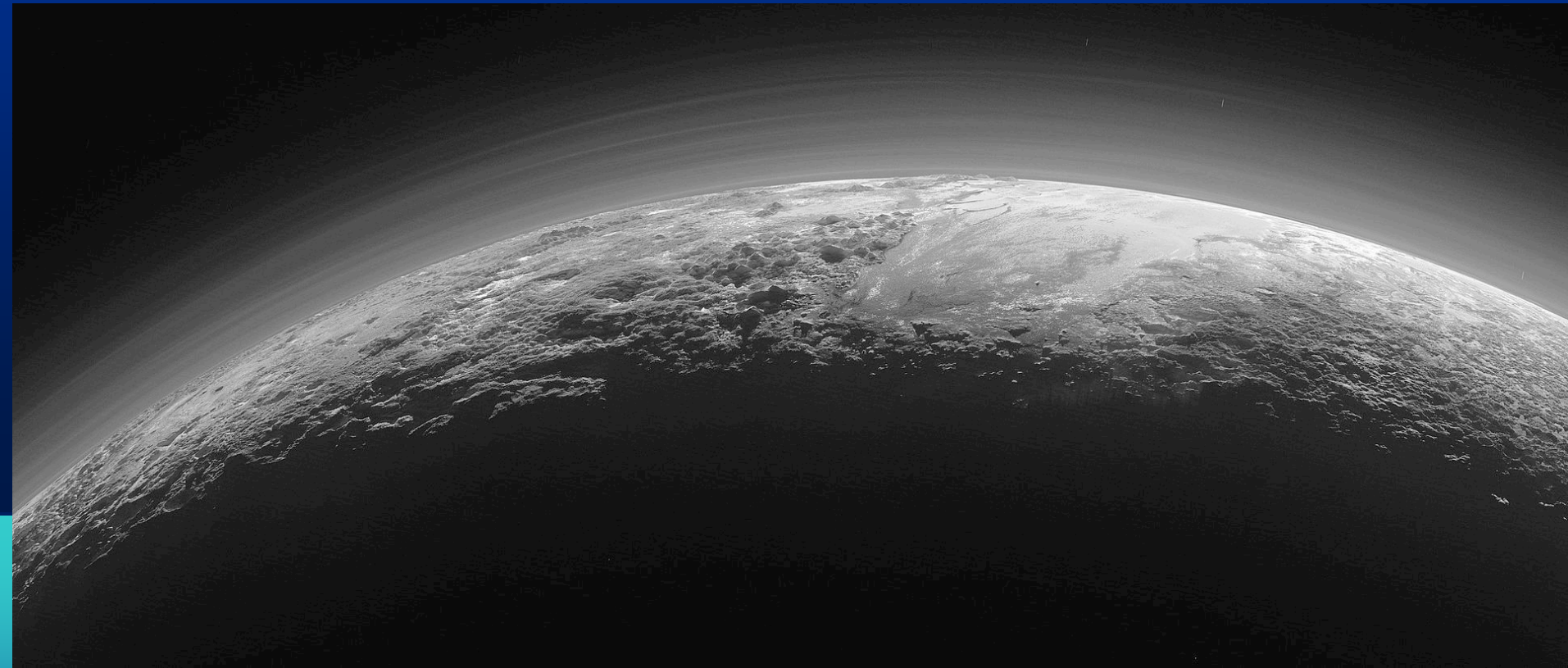
*Nix*



*Hydra*











# Charon and the Small Moons of Pluto

Styx

Nix

Kerberos

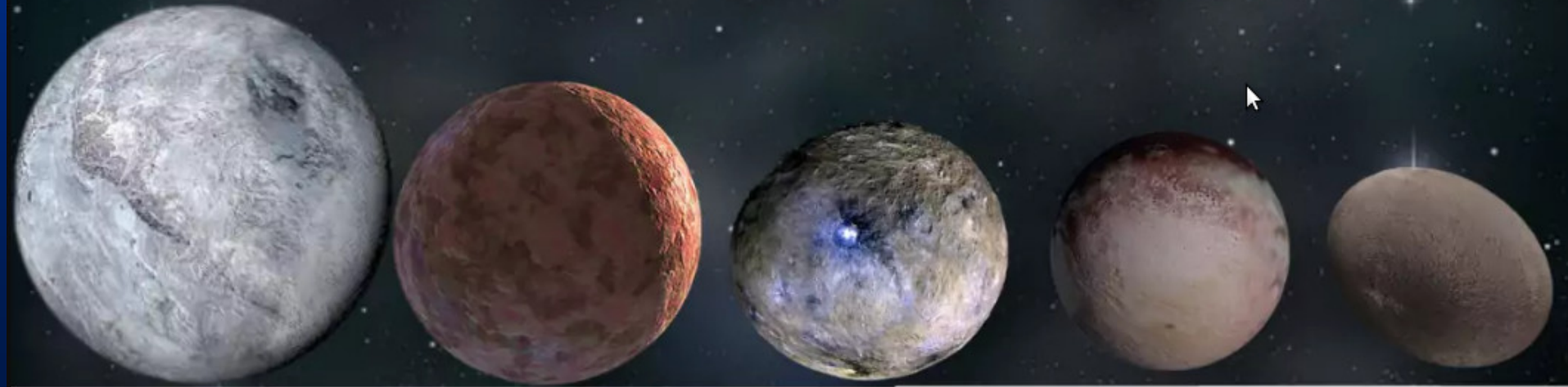
Hydra

Charon

10 miles  
10 km



# THE DWARF PLANETS



Eris

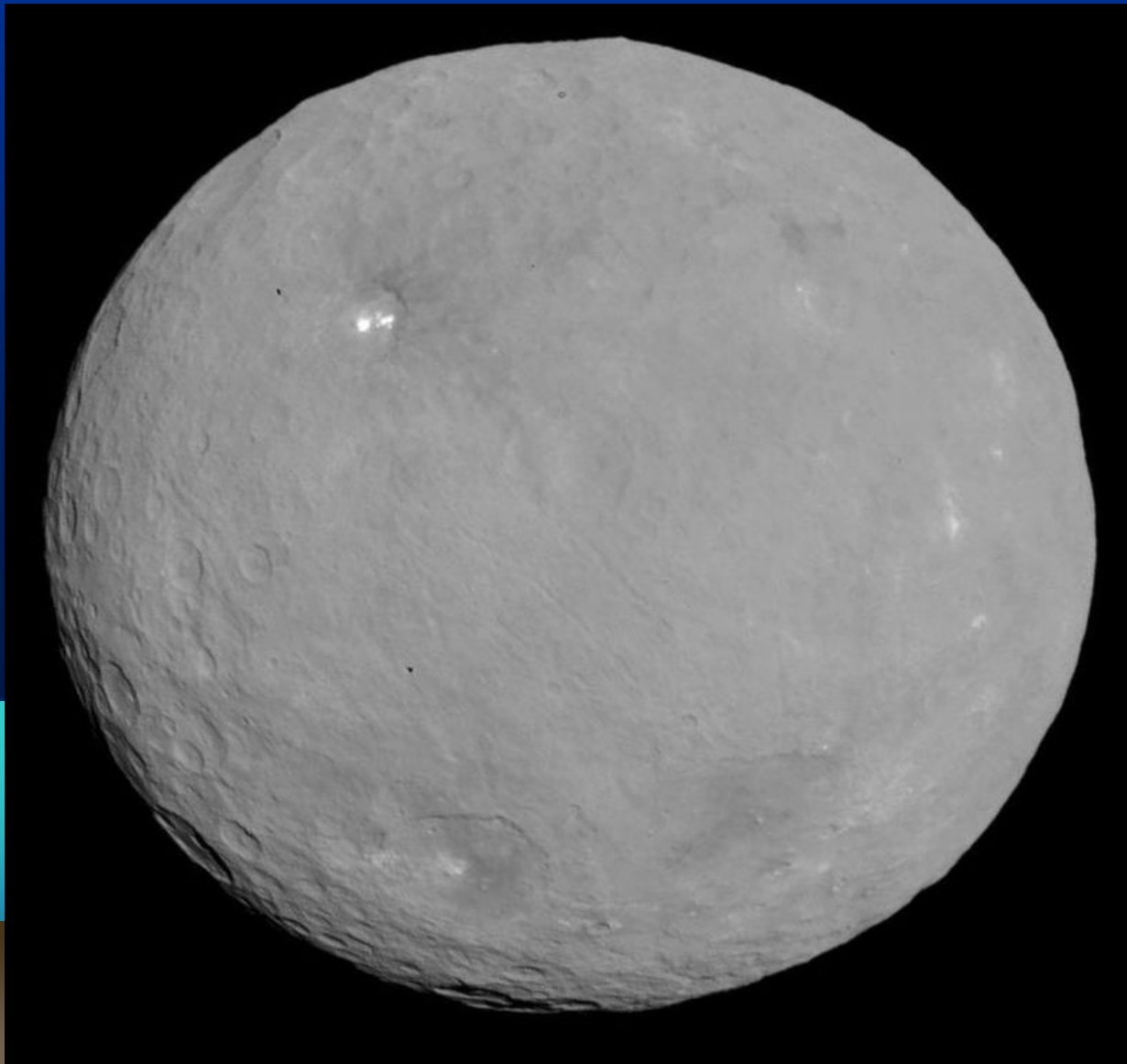
Makemake

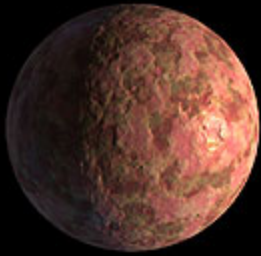
Ceres

Pluto

Haumea

# Церес





**Sedna**  
800-1100 miles  
in diameter



**Quaoar**  
(800 miles)



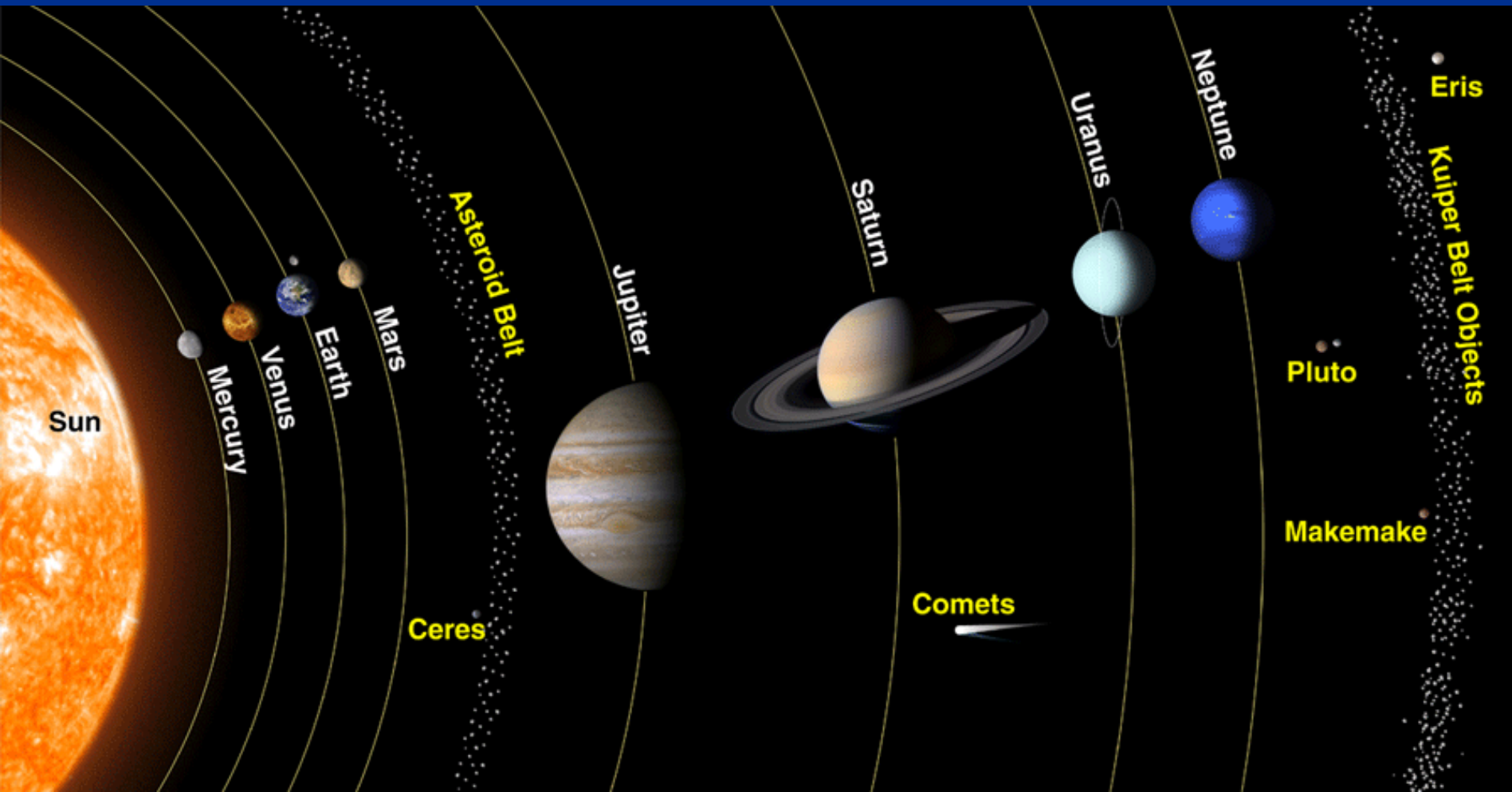
**Pluto**  
(1400 miles)



**Moon**  
(2100 miles)



**Earth**  
(8000 miles)



Sun

Mercury

Venus

Earth

Mars

Asteroid Belt

Ceres

Jupiter

Saturn

Comets

Uranus

Neptune

Pluto

Makemake

Eris

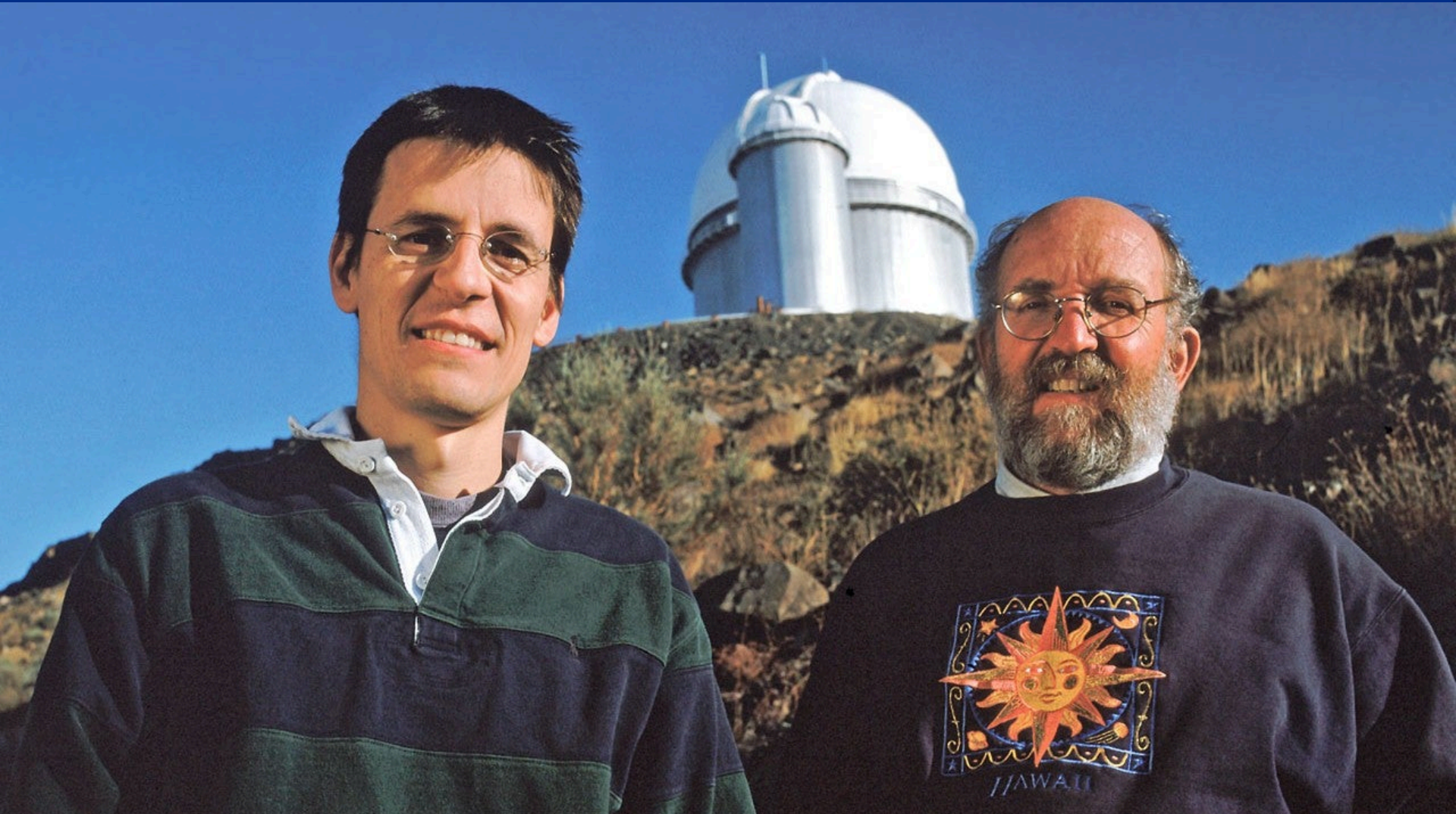
Kuiper Belt Objects

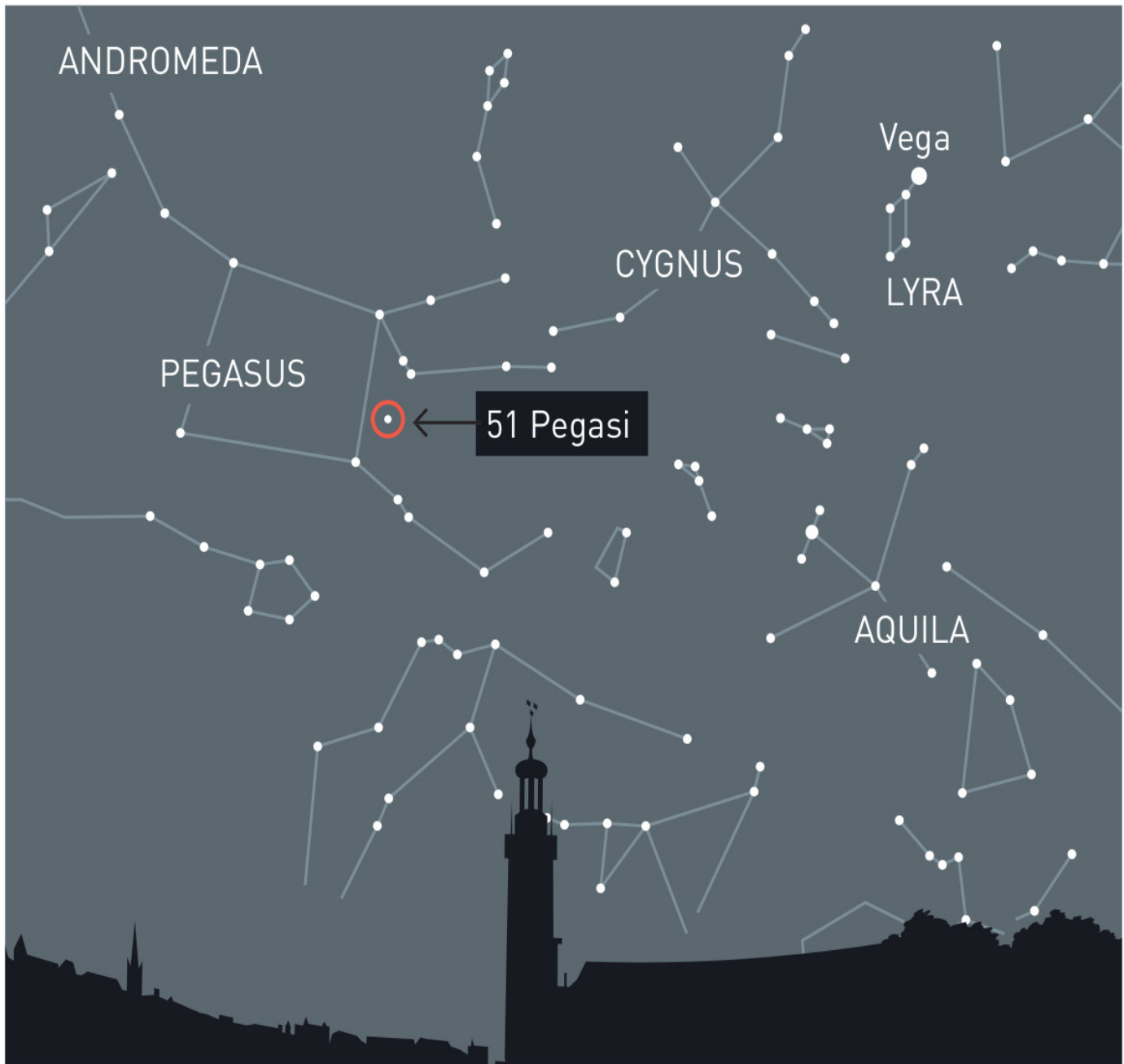
# Largest known trans-Neptunian objects (TNOs)



2000 km

# Дидје Келоз и Мишел Мајор





©Johan Jarnestad/The Royal Swedish Academy of Sciences





### TEMPERATURE

51 Pegasi b has a temperature of **1000C°/1800F°**.



### ORBITAL PERIOD

51 Pegasi b orbits its host star every **4 days**.

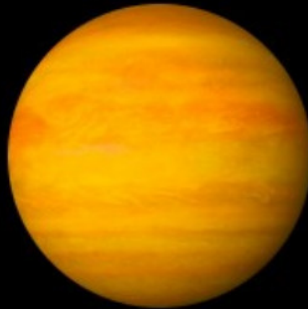


### DISTANCE FROM EARTH

51 Pegasi b is **50 light-years** from Earth.

### PLANET COMPARISON

51 Pegasi b



Jupiter



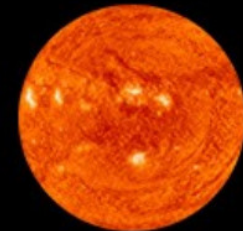
51 Pegasi b is **47% less massive**, but **50% larger** than Jupiter.

### STAR COMPARISON

51 Pegasi



Our sun



51 Pegasi is **11% more massive** and **23% larger** than our sun.

FIGURE 1.1: 51 Pegasi b, the first exoplanet to be discovered around a main sequence star. It was found to orbit the star in just 4.2 days.

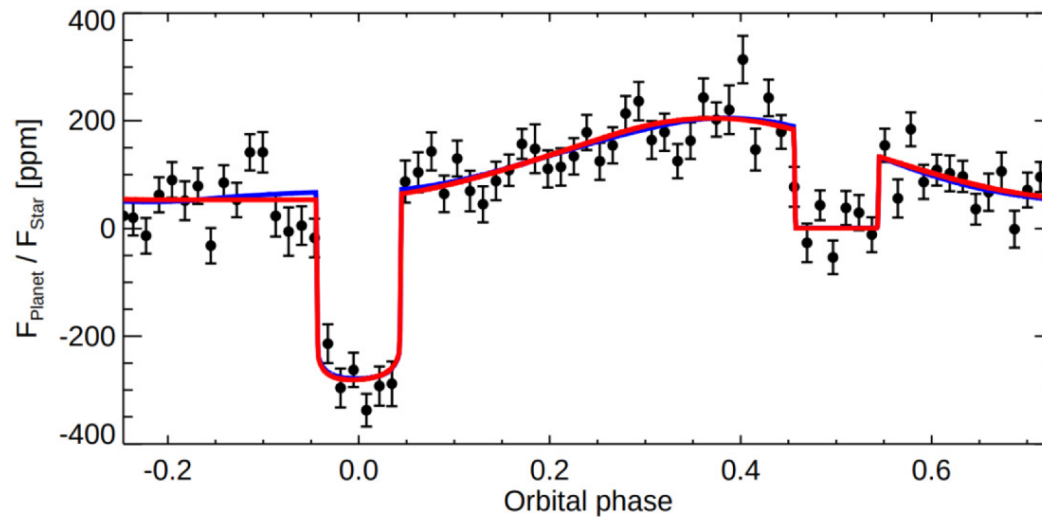
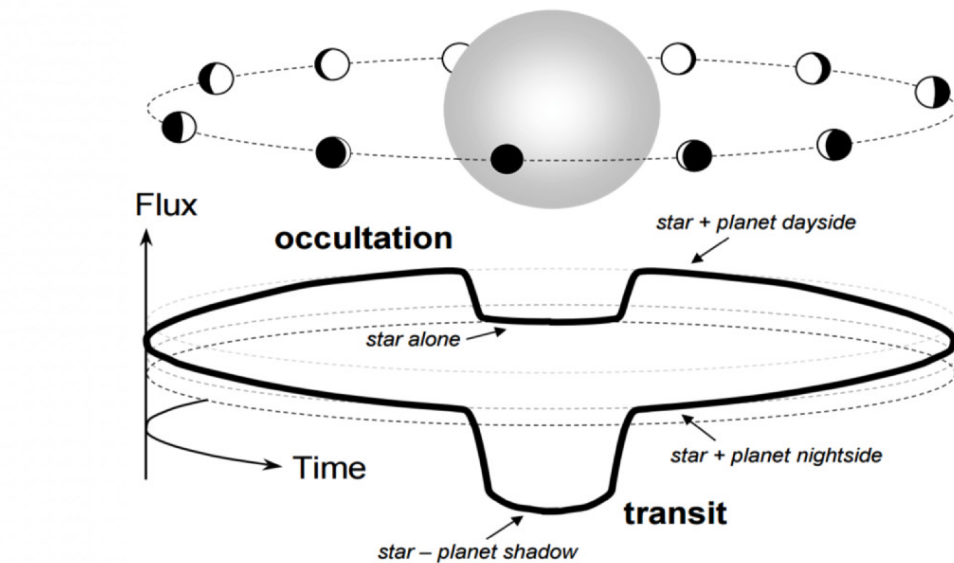
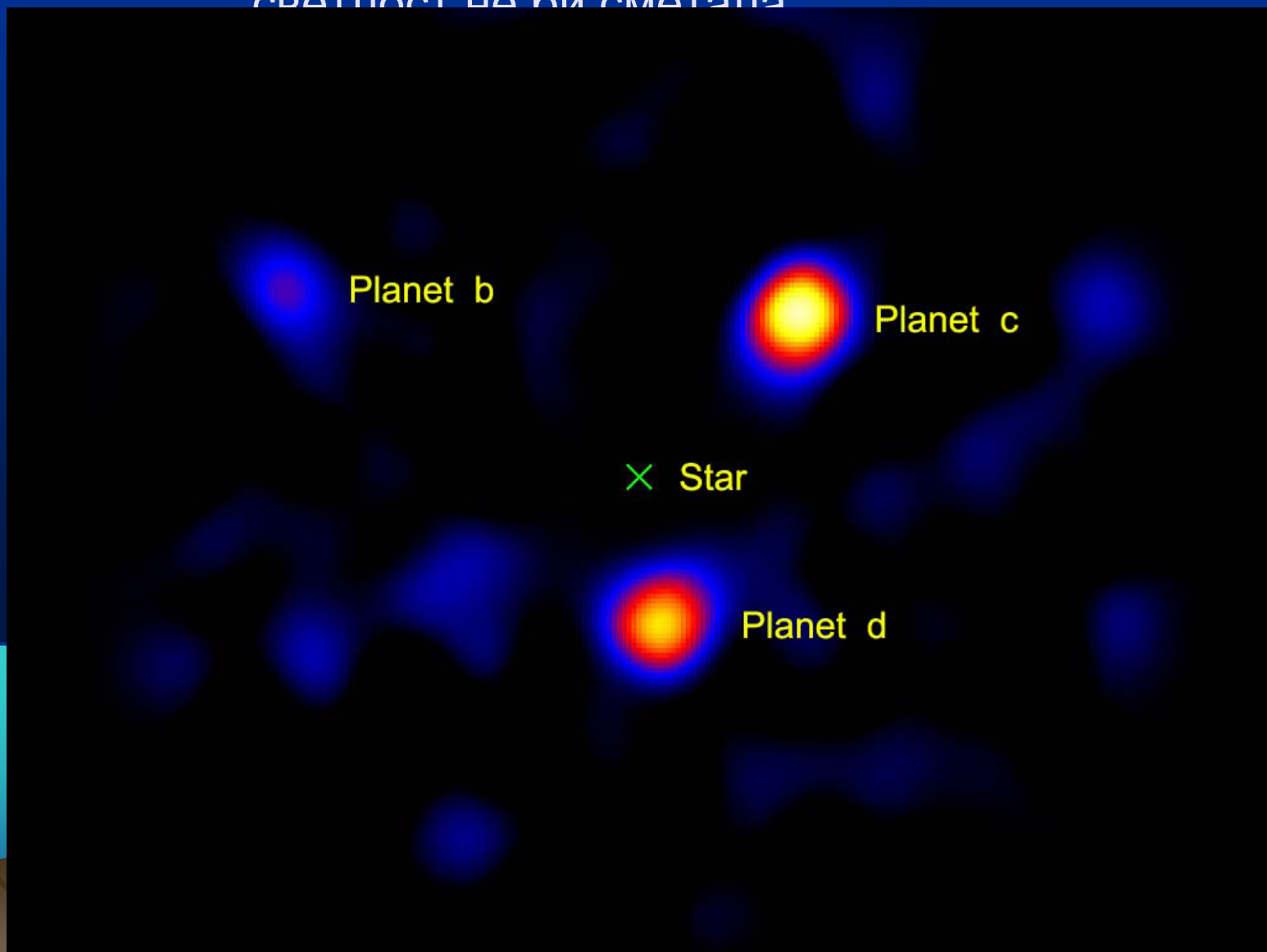


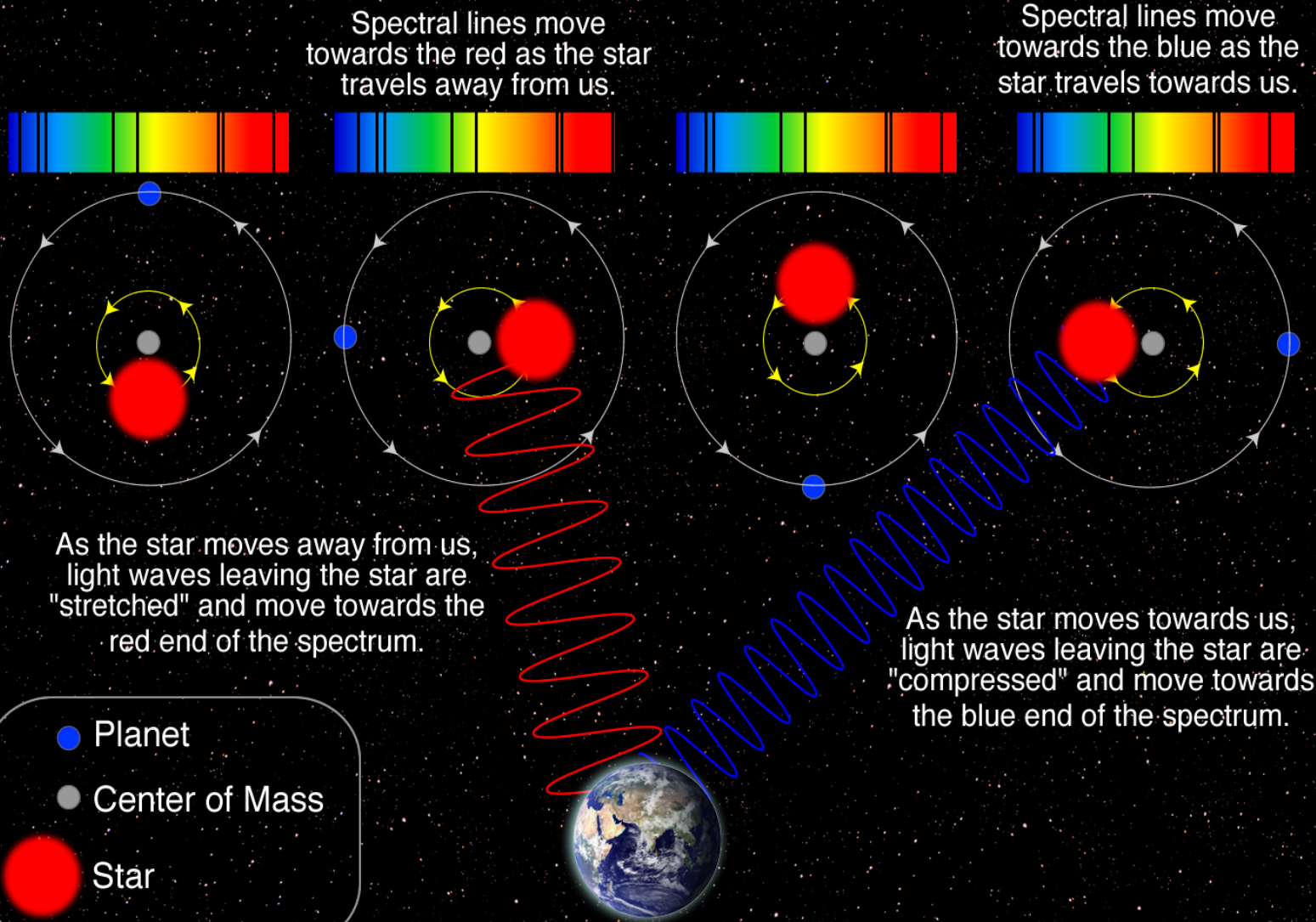
FIGURE 1.3: Upper panel illustrates phase-curve of an exoplanet transiting its host star (Source: Josh Winn). Bottom panel shows phase-curve of the exoplanet 55 Cancri e observed with Spitzer/IRAC at  $4.5\mu\text{m}$ . (Demory et al., 2016)

Фото три планете око звезде HR 8799, у Пегазу, 129 с.г. од нас. Звезда је заклоњена специјалном методом да њена светлост не би сметала



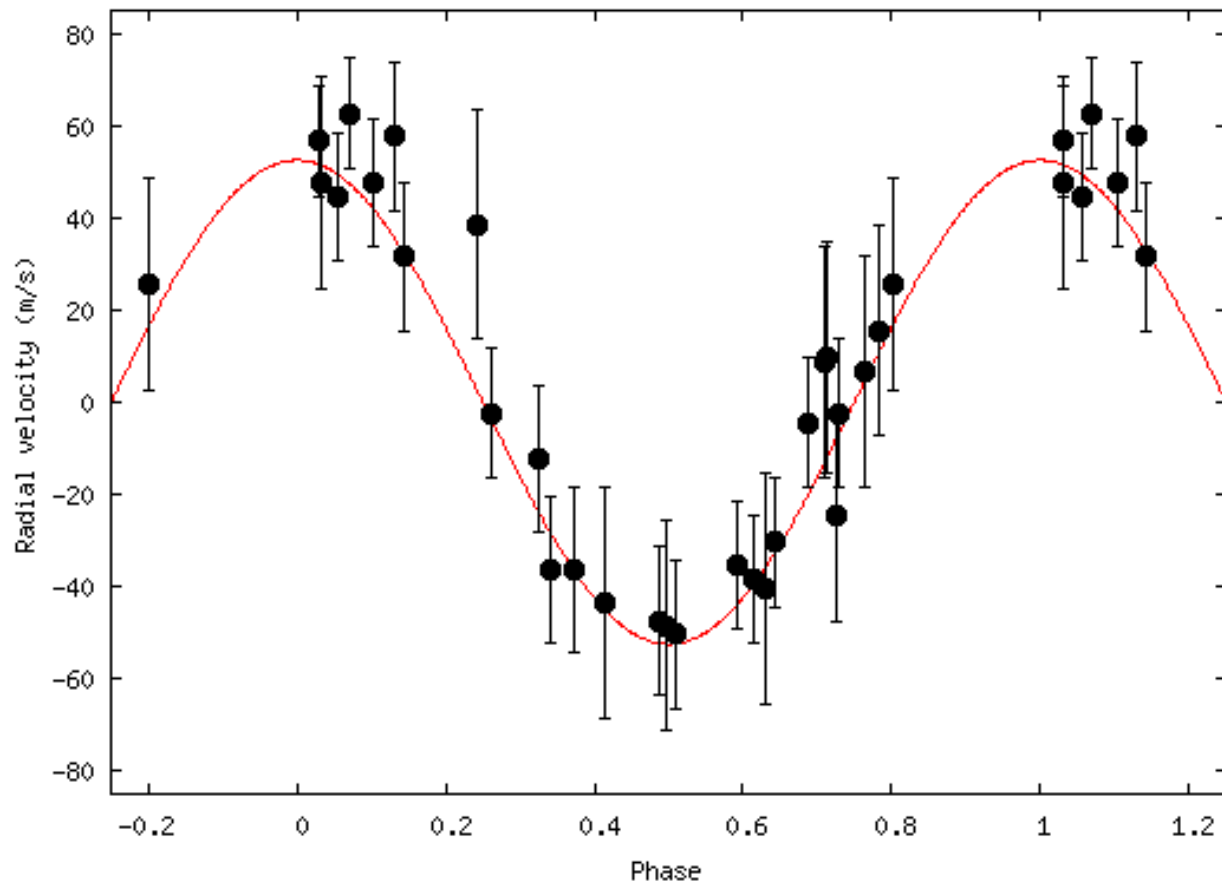
# Radial Velocity Method

The star and planet orbit their common center of mass.



*Not to scale*

51 Peg radial velocity - Phase curve - C. Buil



# Over 1000 Confirmed Exoplanets



Number of confirmed exoplanets in each category are in red, total 1010.

Credit: PHL @ UPR Arcibo, Oct 2011

# Cumulative Detections Per Year

19 Aug 2019

[exoplanetarchive.ipac.caltech.edu](http://exoplanetarchive.ipac.caltech.edu)

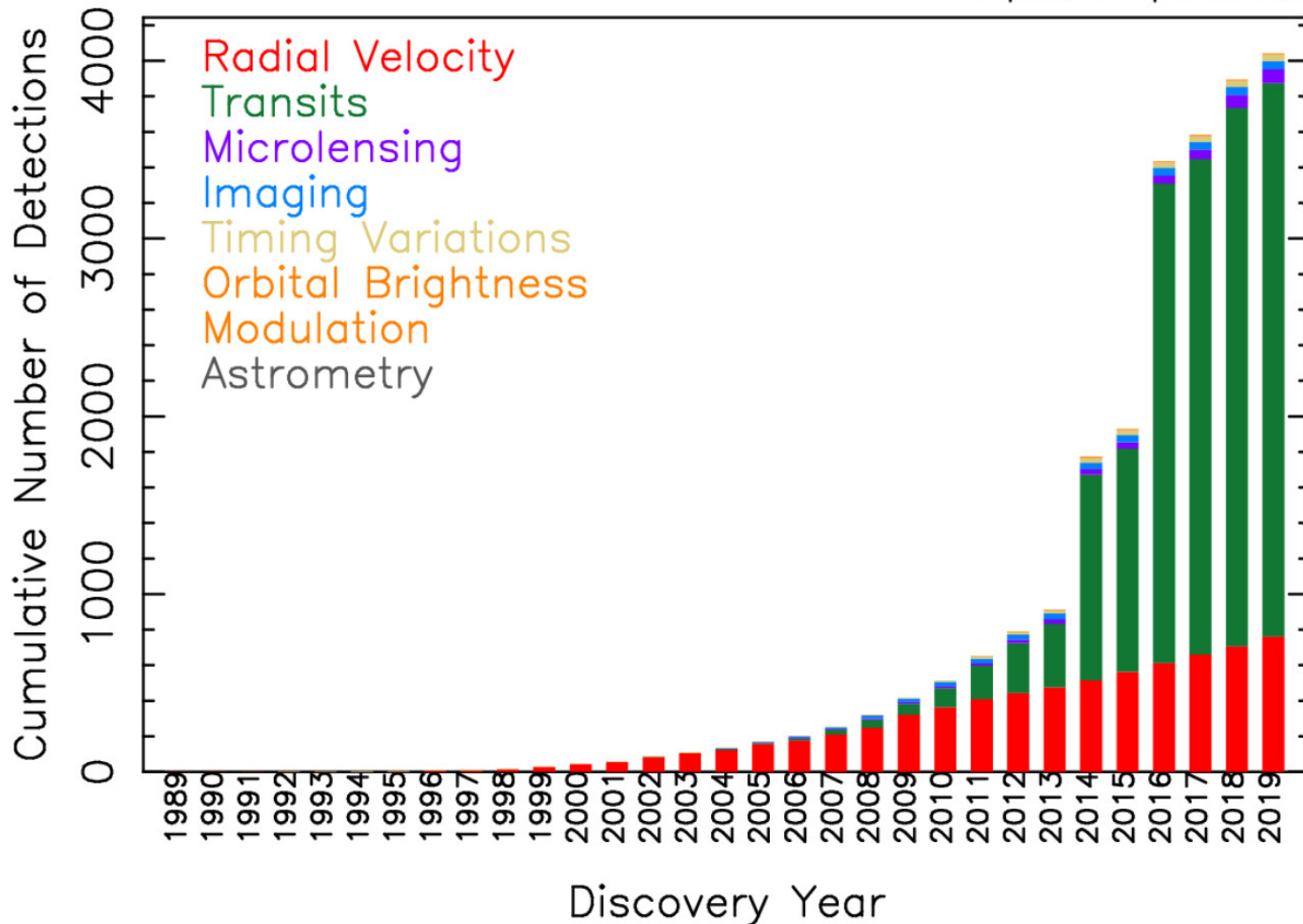


FIGURE 1.2: Cumulative number of exoplanets discovered through different methods over time. (Source: [exoplanetarchive.ipac.caltech.edu](http://exoplanetarchive.ipac.caltech.edu))

# Kepler-90 System Planet Sizes

(Artist's Concepts)



Solar System

Planet sizes are to scale; distances are not.



Данас 4905 потврђених планета у 3629 система од којих 808 имају више од једне

Поред планета око звезда и лутајуће планете. Процена више од милијарде у Млечном путу

Посматрани: Прстенови

2013 први кандидат за сателит планете

Атмосфере – прва 2001

Репови као код комете

Ерупције вулкана

2018 Планете у другој галаксији

# Habitable Zone

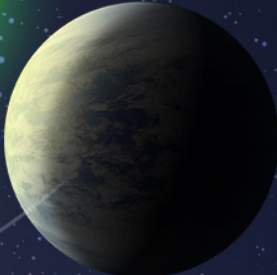
TOO HOT



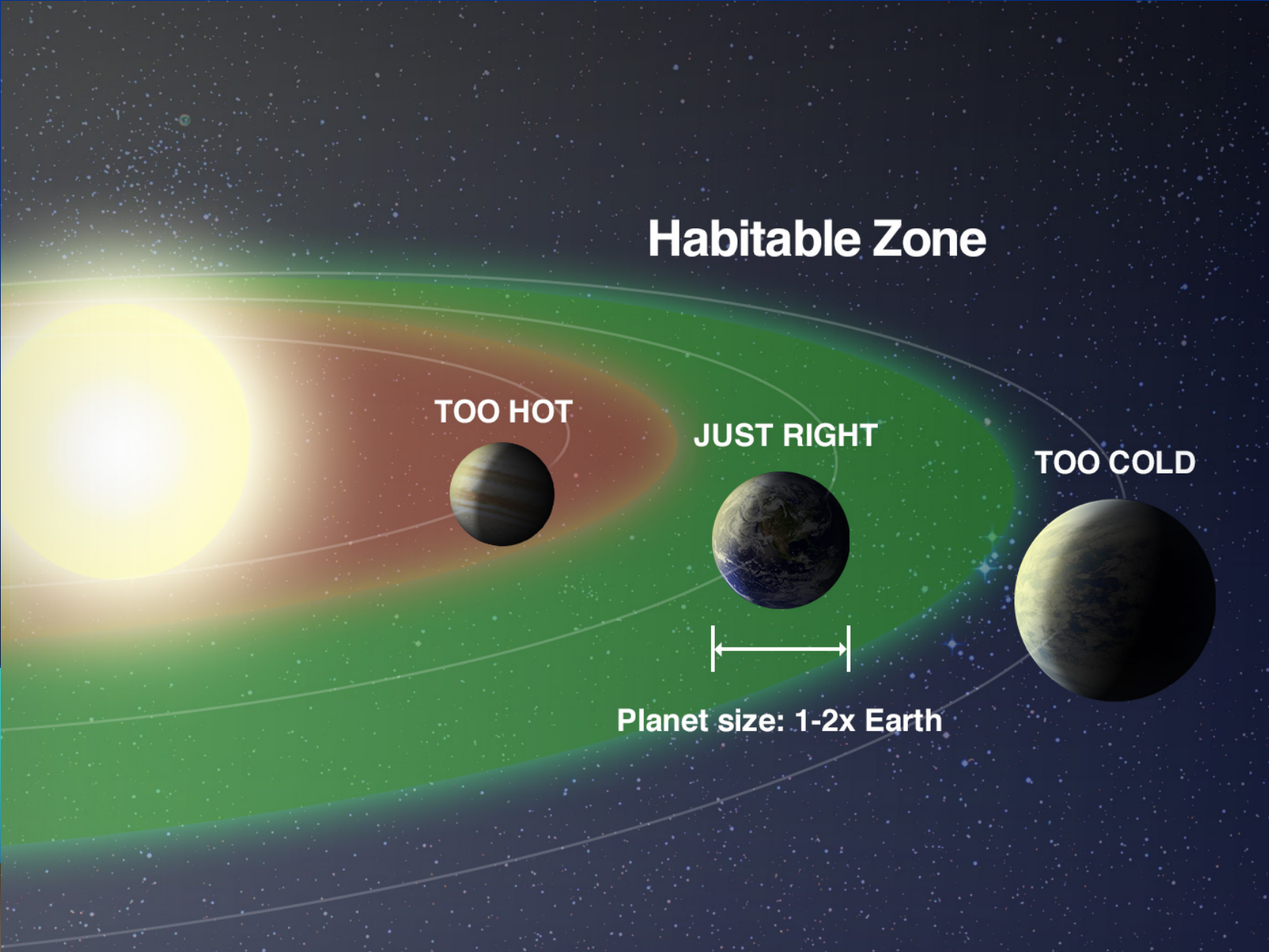
JUST RIGHT



TOO COLD

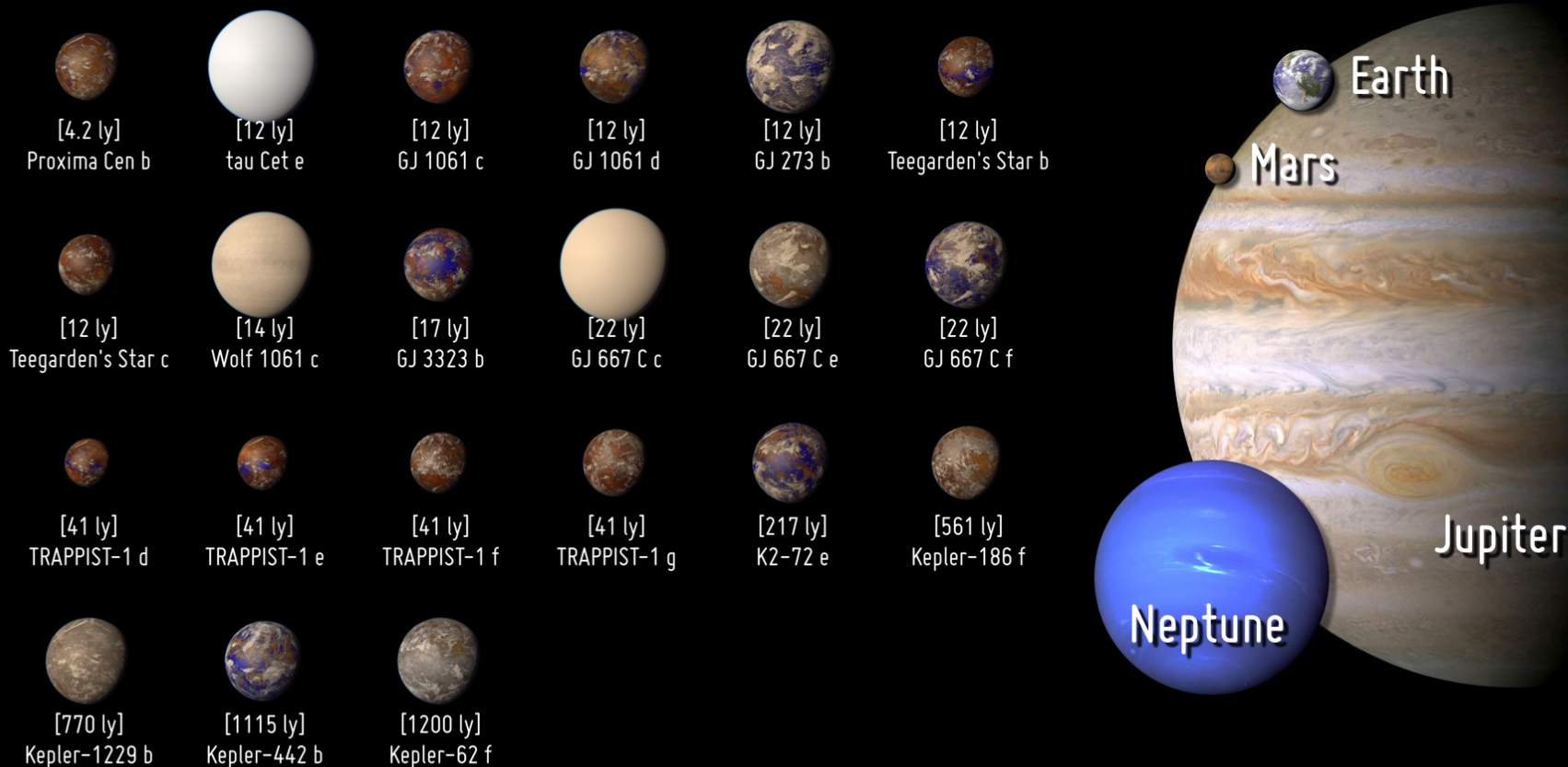


Planet size: 1-2x Earth



# Potentially Habitable Exoplanets

Ranked by Distance from Earth (light years)



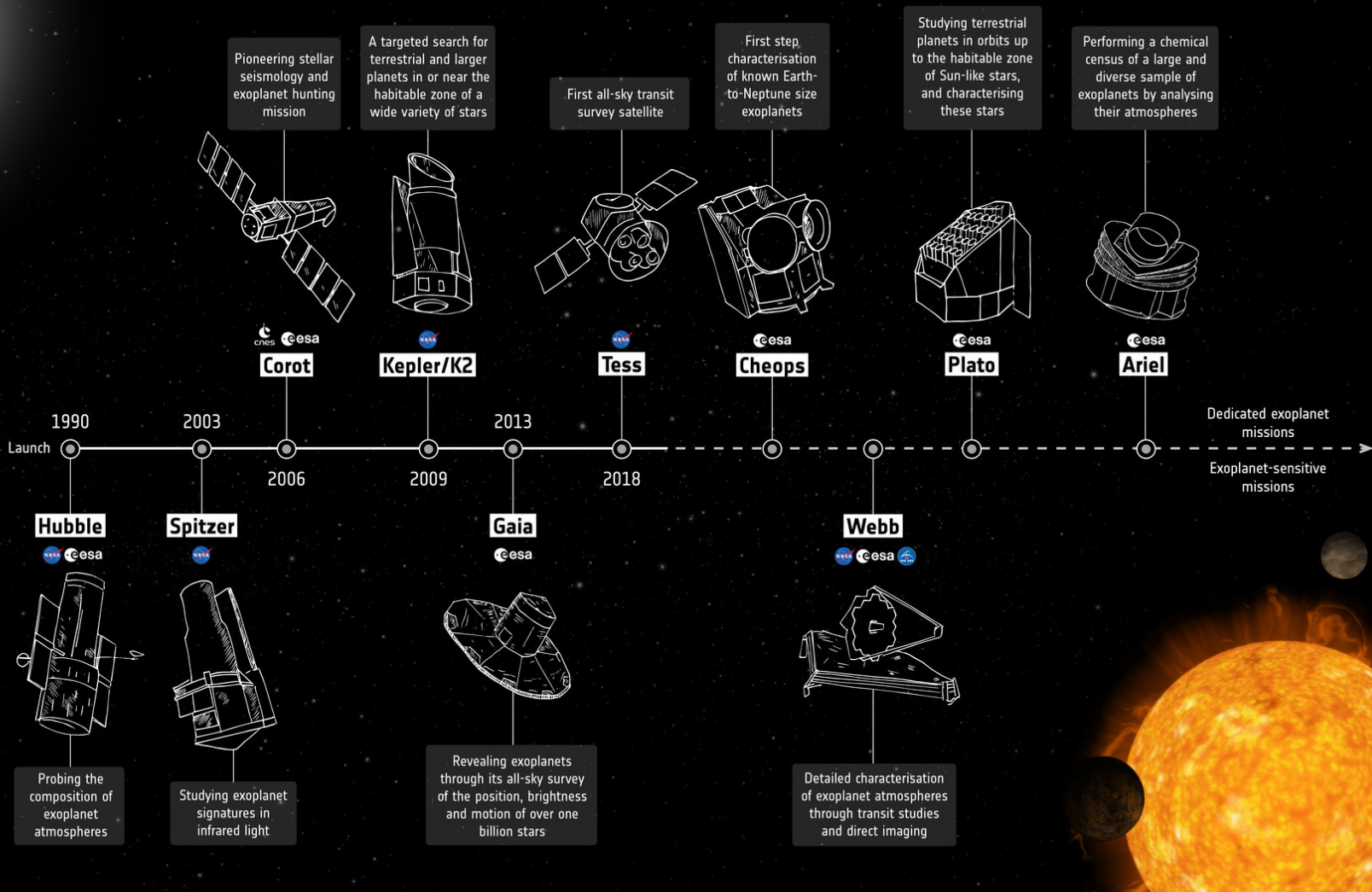
Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. Distance from Earth is between brackets.

CREDIT: PHL @ UPR Arcicibo (phl.upr.edu) Sep 4, 2019

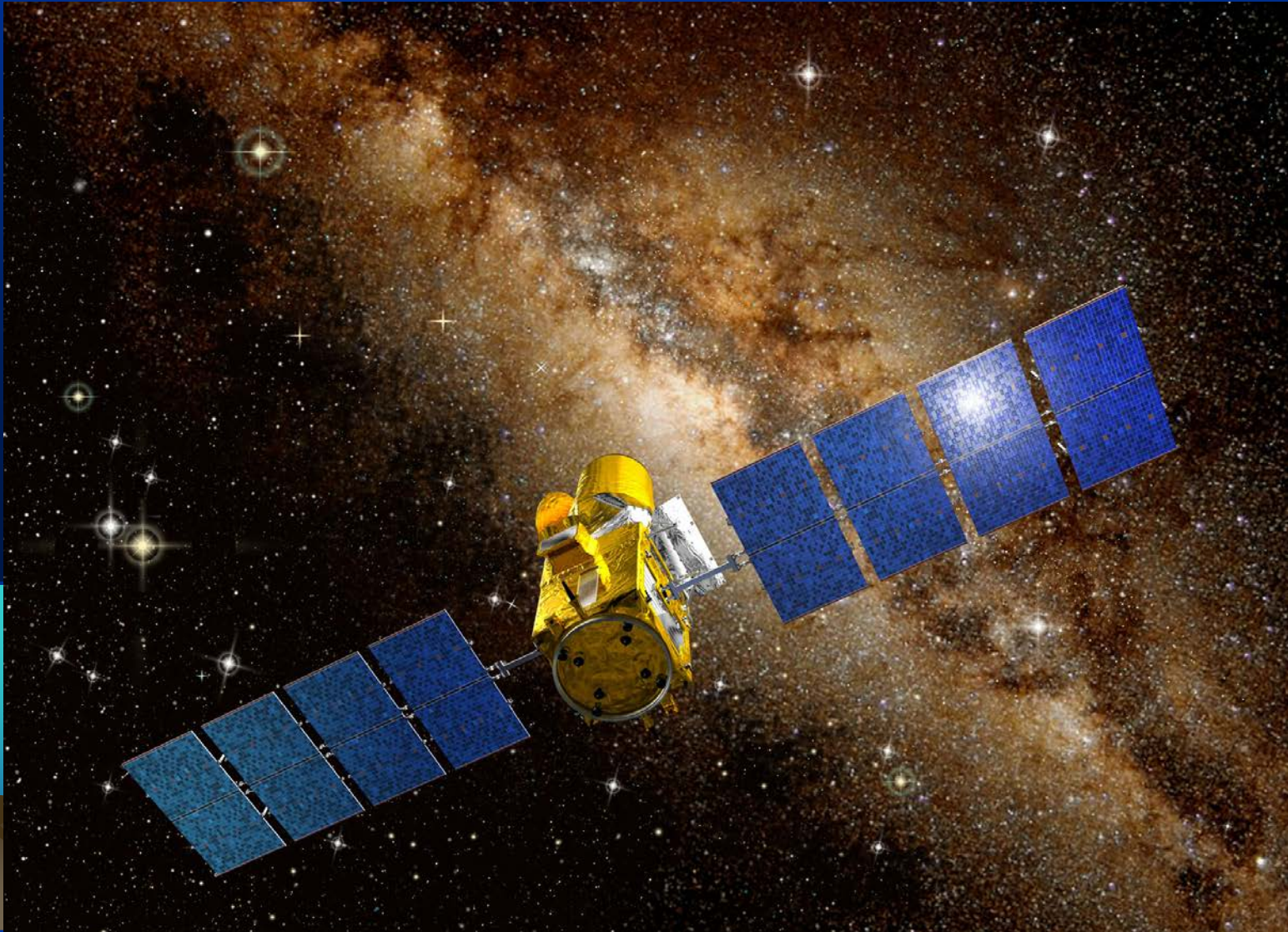


### Ground-based observatories

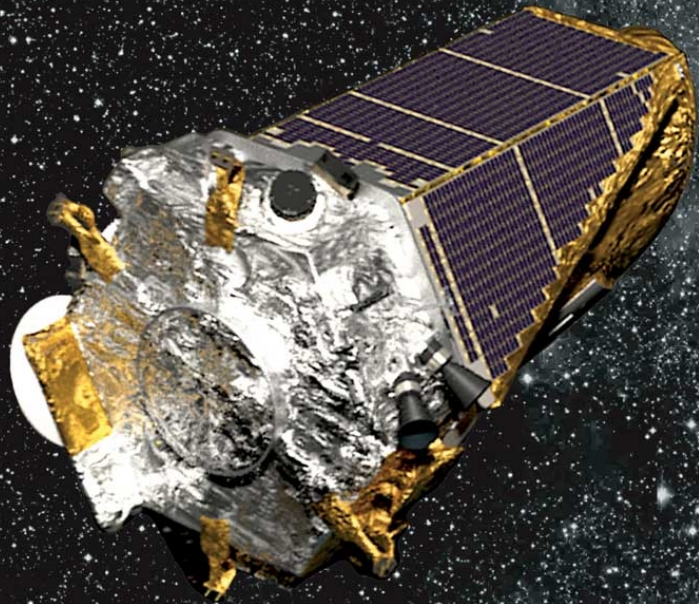
First discoveries of exoplanets in the 1990s opened up the field of exoplanet research. New innovations and discoveries continue to this day



# CoRoT (French: Convection, Rotation et Transits planétaires; 2006-2013



# Кеплер 2009-2018; 530506 звезда, 2662 планете



# Milky Way Galaxy

**Kepler Search Space**

← 3,000 light years →

**Sagittarius Arm**

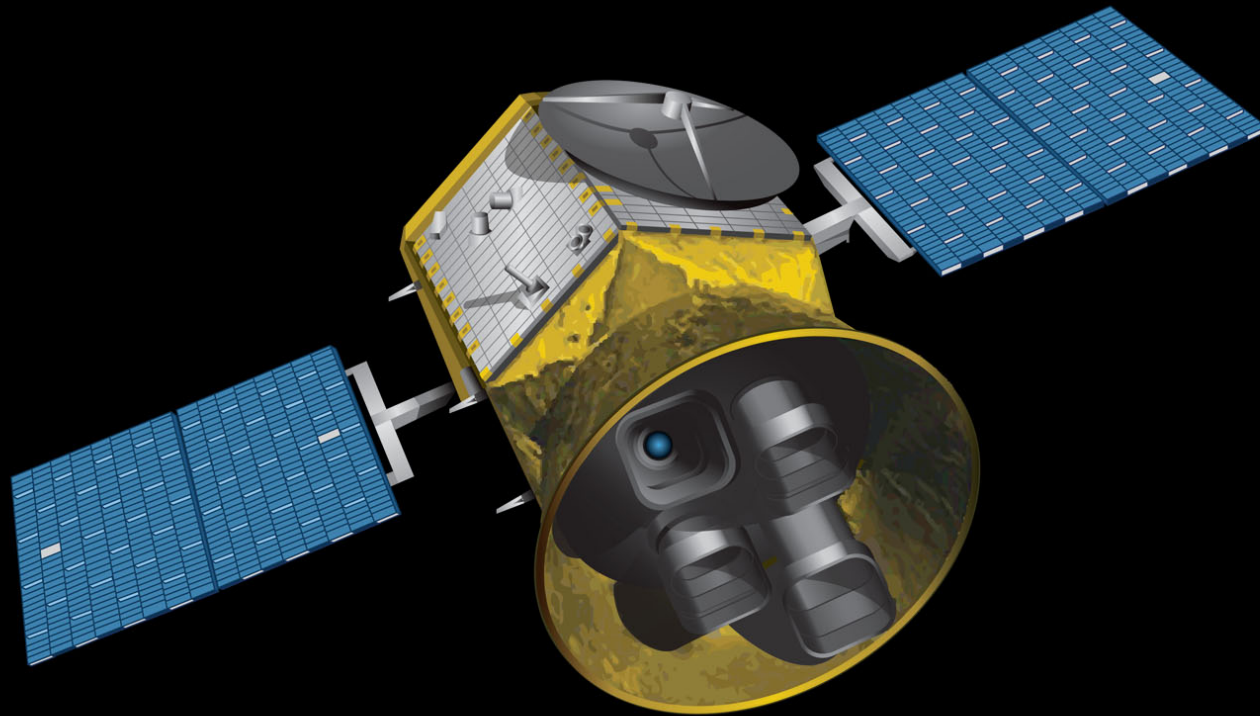


**Sun**

**Orion Spur**

**Perseus Arm**

# Transiting Exoplanet Survey Satellite (TESS - 2018)

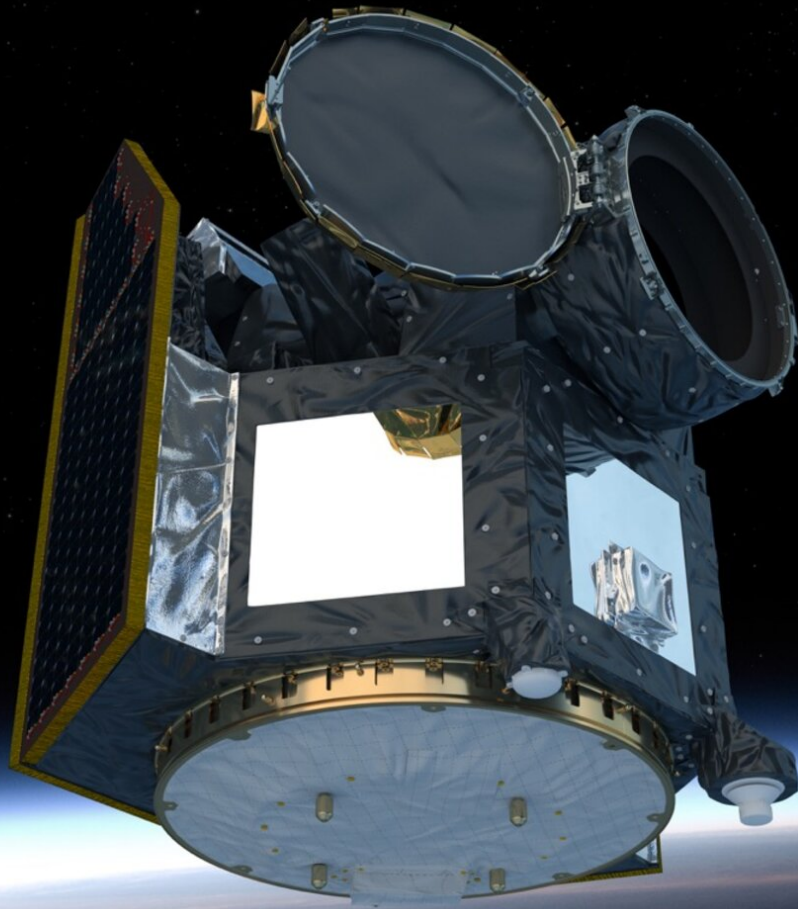


**TRANSITING EXOPLANET SURVEY SATELLITE**

*DISCOVERING NEW EARTHS AND SUPER-EARTHS  
IN THE SOLAR NEIGHBORHOOD*



# Cheops (ESA) CHaracterising ExOPlanet Satellite; 18.12.2019



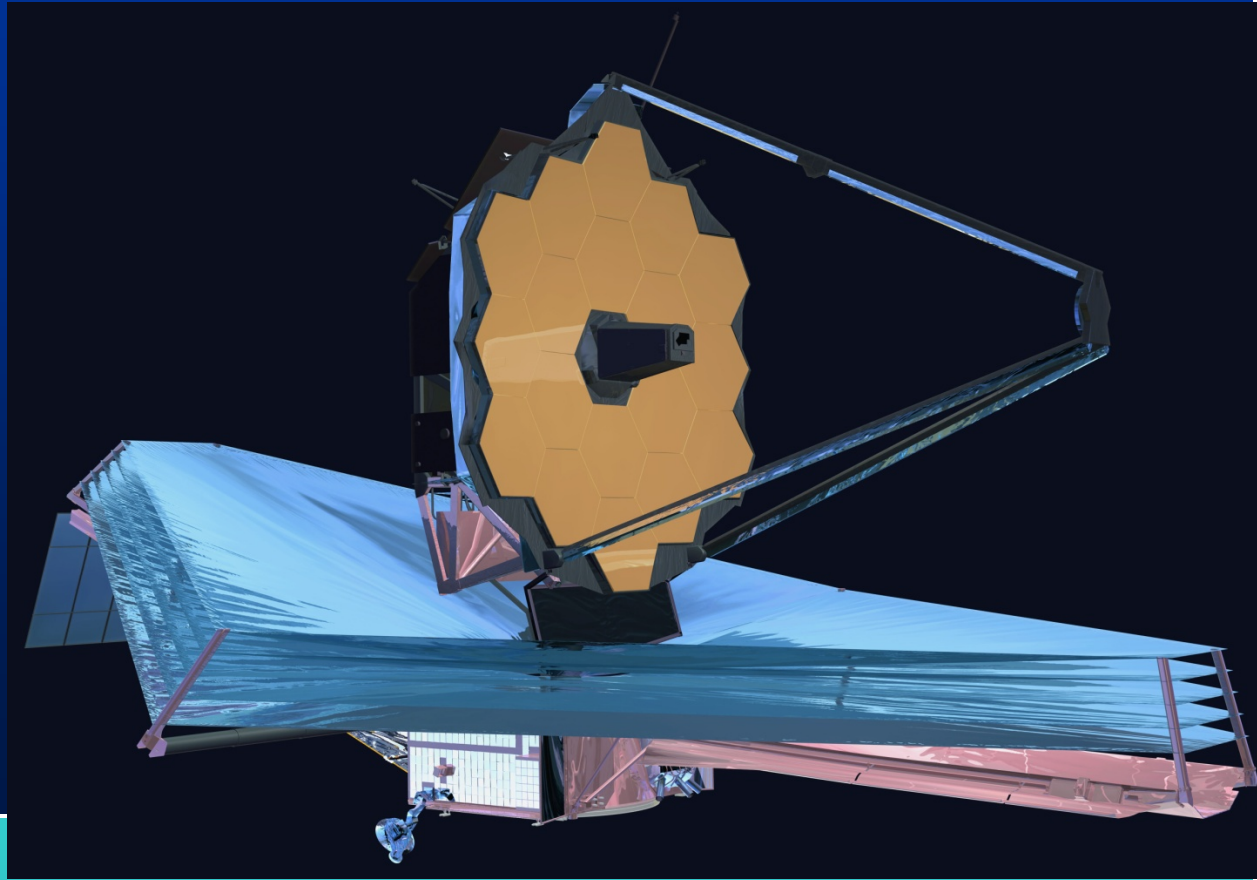
# 24.12.2021 James Webb Space Telescope

6.5 m,  
0.6 – 27  $\mu\text{m}$

-Настанак  
галаксија, звезда,  
протопланетарних  
и планетарних  
система

- екзопланете

-Порекло живота



# ПЛАТОН 2026 Planetary Transits and Oscillations of stars, or PLATO,



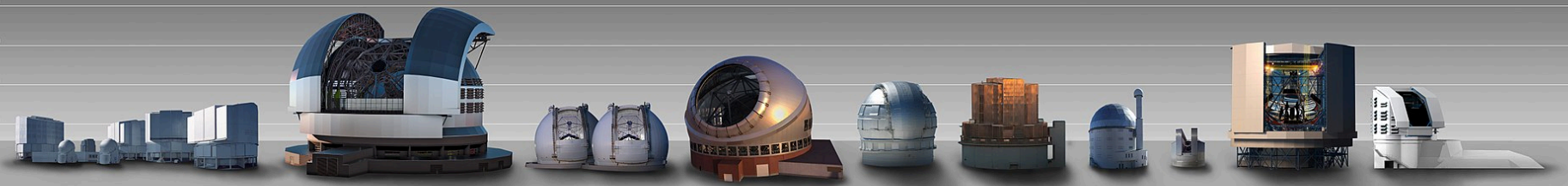
100 m

80 m

60 m

40 m

20 m



Very Large Telescope

Extremely Large Telescope

Keck Telescope

Thirty Meter Telescope

Gran Telescopio Canarias

Subaru Telescope

South African Large Telescope

New Technology Telescope

Giant Magellan Telescope

Large Synoptic Survey Telescope

140 M

120 M

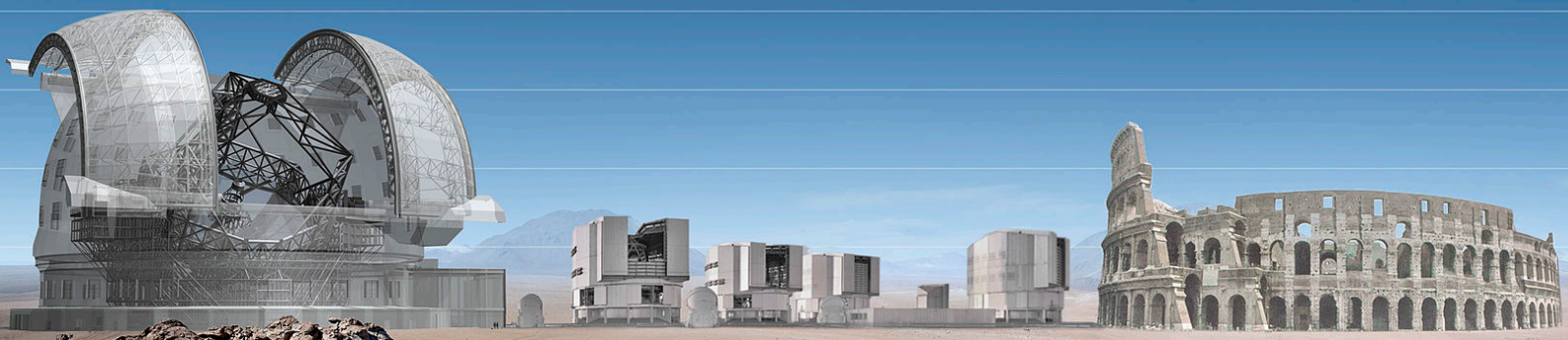
100 M

80 M

60 M

40 M

20 M

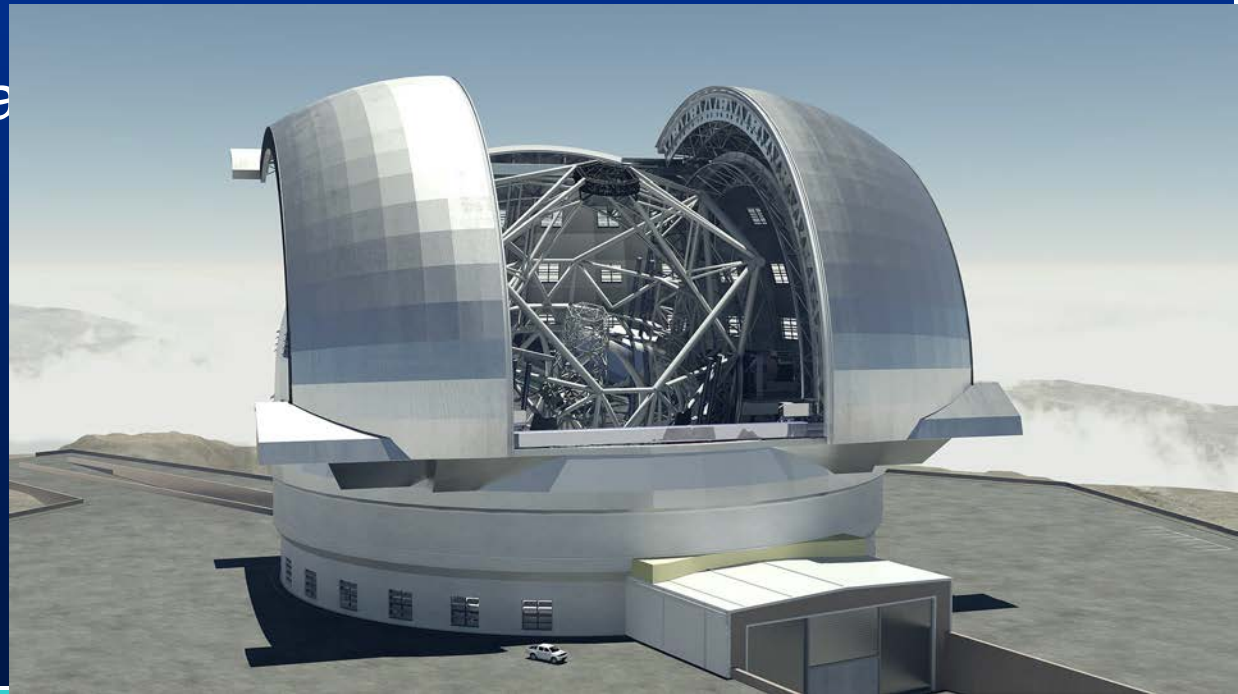


# ELT-Extremely Large Telescope 39 m, 2027, 0.4 – 21 $\mu\text{m}$

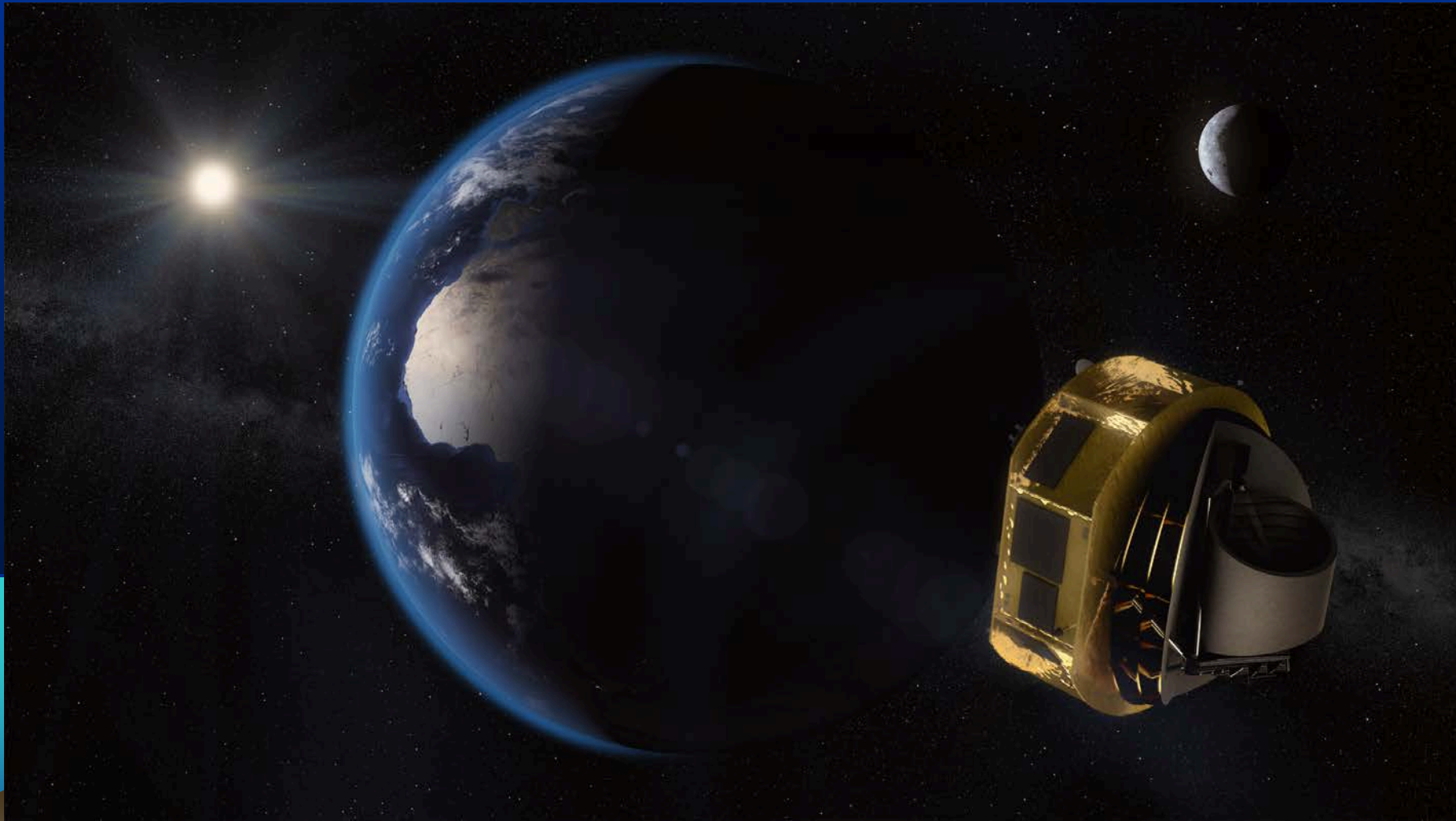
-Слике егзопланета  
у настањивим  
зонама

-Карактеристике  
атмосфере  
егзопланета

-ТРАГАЊЕ ЗА  
ЗНАЦИМА  
ЖИВОТА



# 2029 АРИЕЛ Atmospheric Remote-sensing Infrared Exoplanet Large-survey (ARIEL),



# КОСМИЧКА СРБИЈА

Око звезде МОРАВА окреће се планета  
ВЛАСИНА



# ХВАЛА НА ПАЖЊИ

