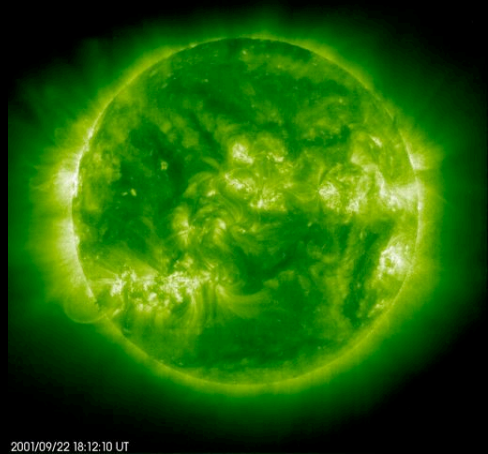
Astronomy

By Noel Schutt

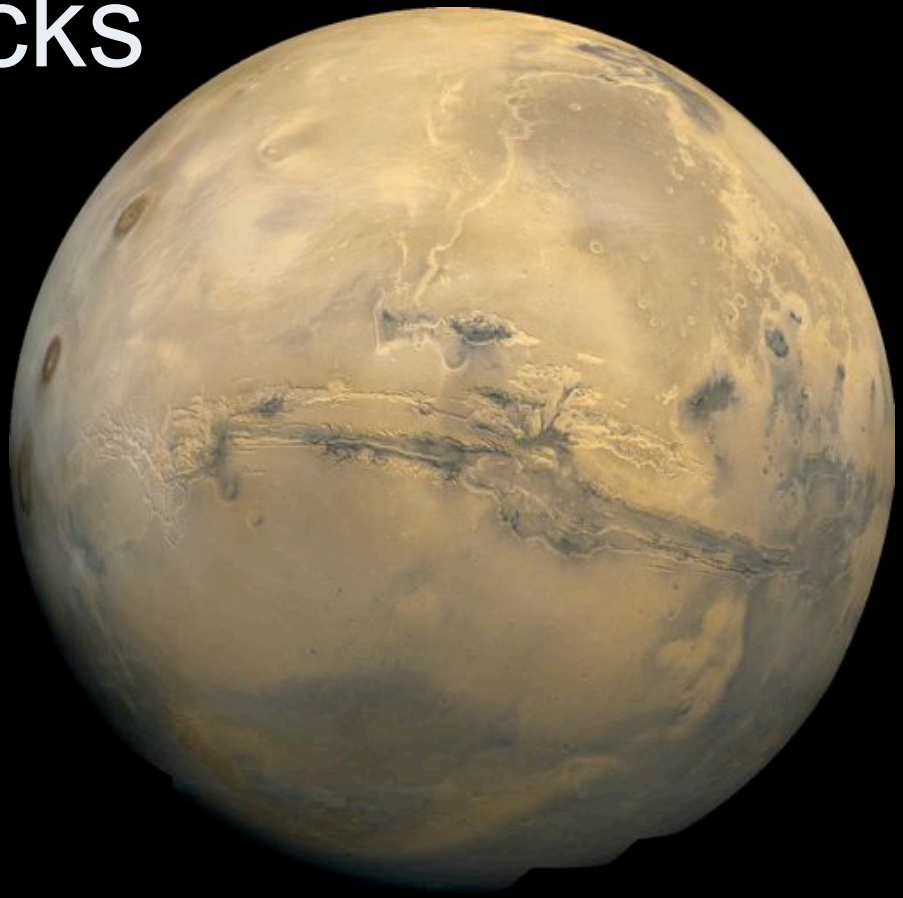
What’s out there?

Gases



Dust

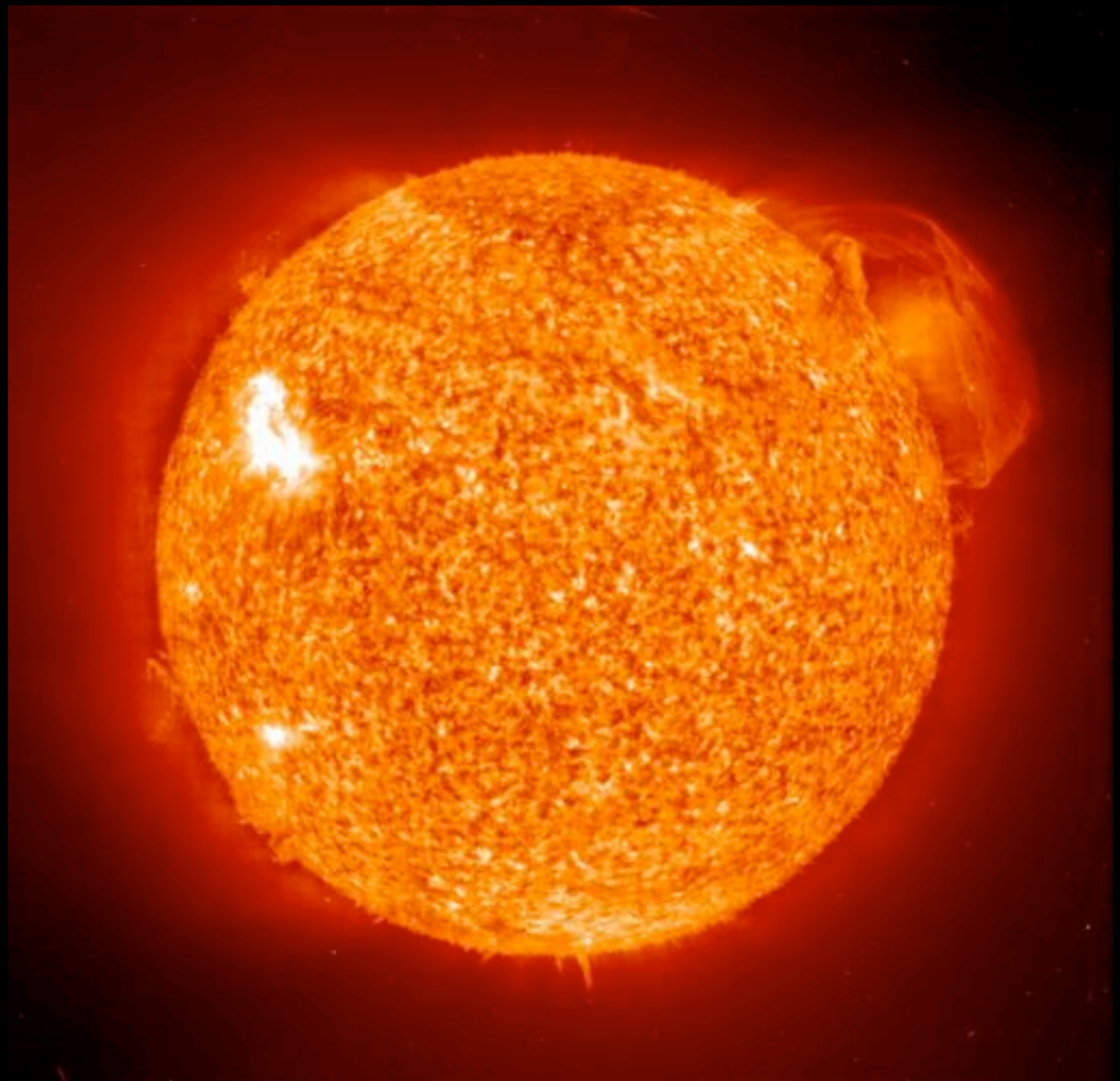
Rocks



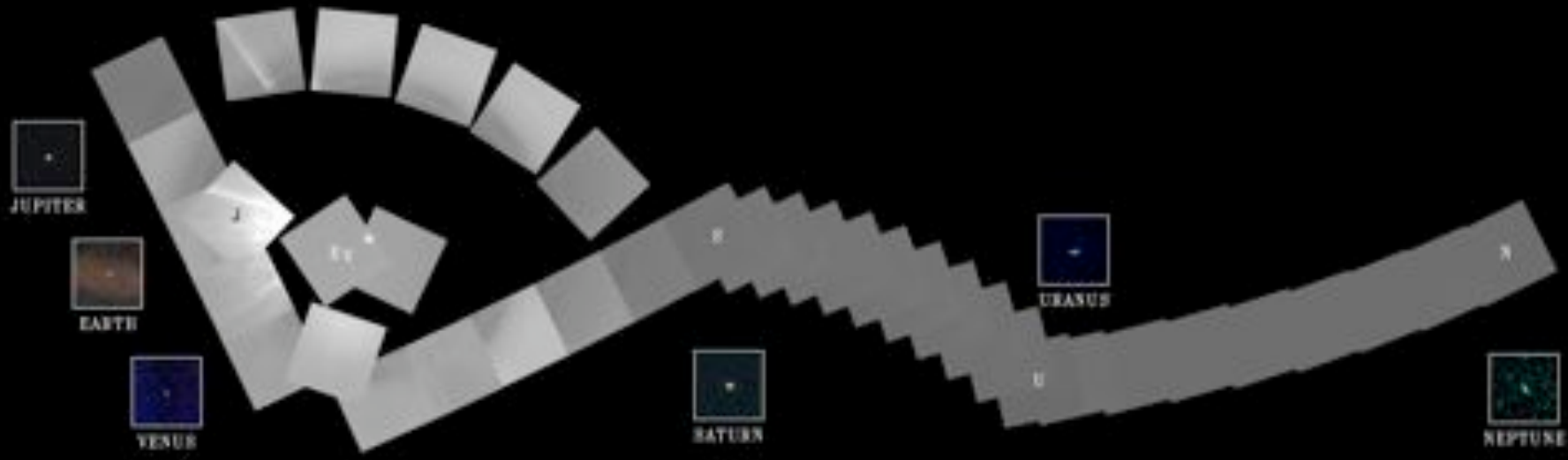
Ice

How the material will be covered

Zooming Out from the Sun



The Solar System



Stars and Nebulae

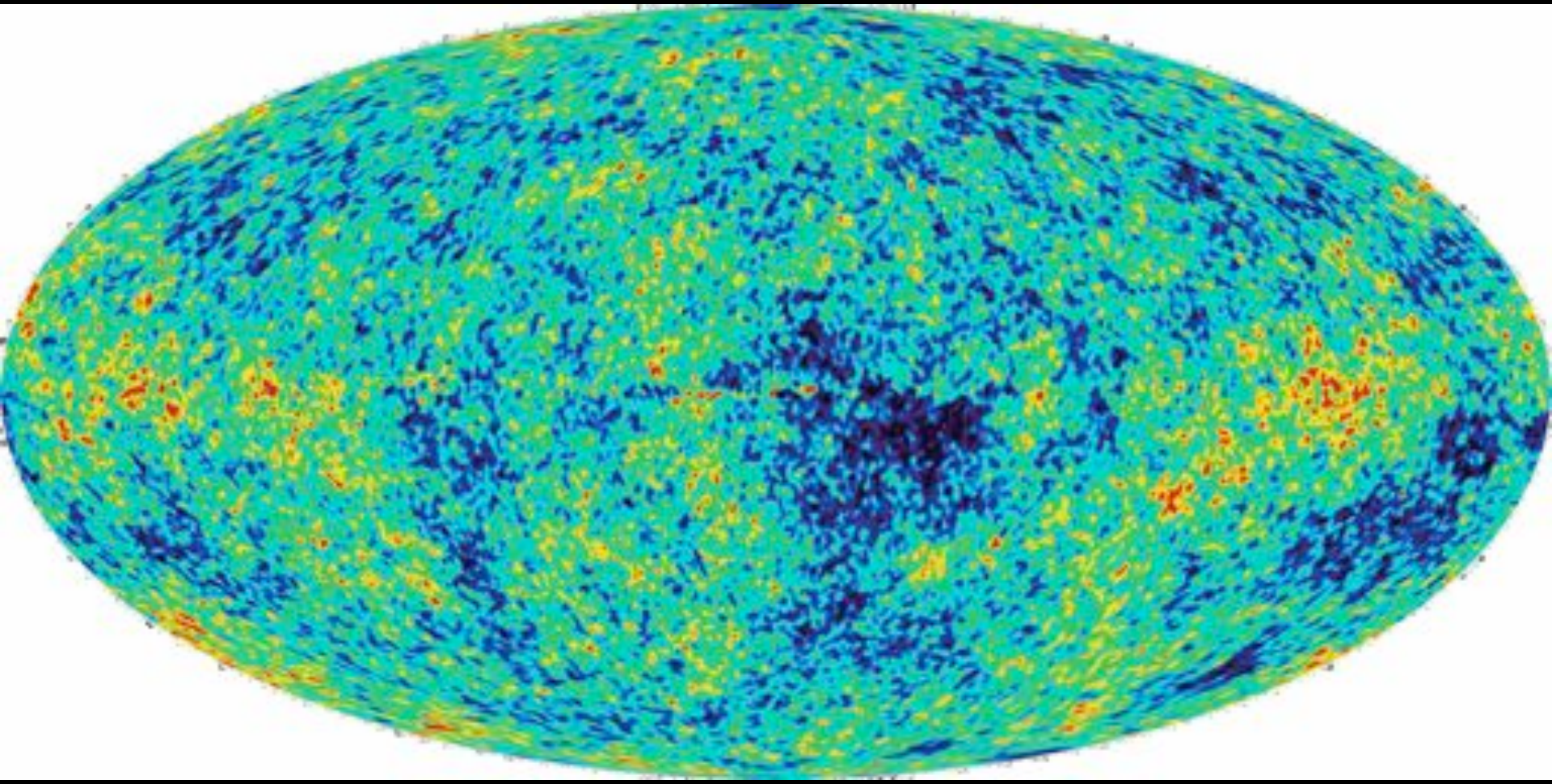

Clusters of Stars


The Galaxy

Other Galaxies

Groups of Galaxies

The Universe



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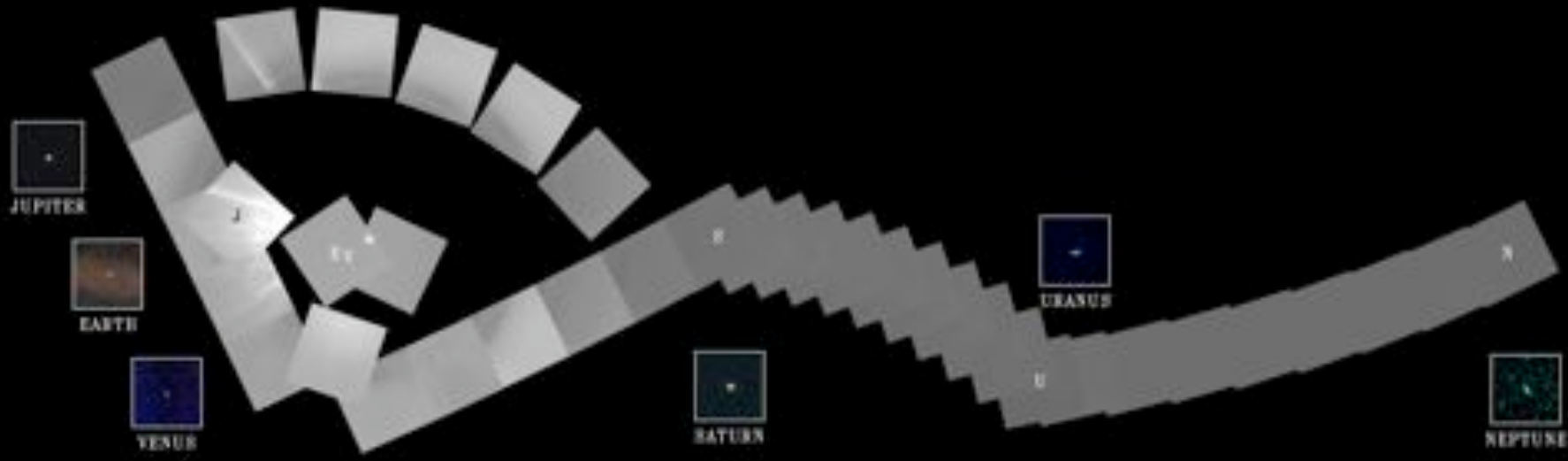
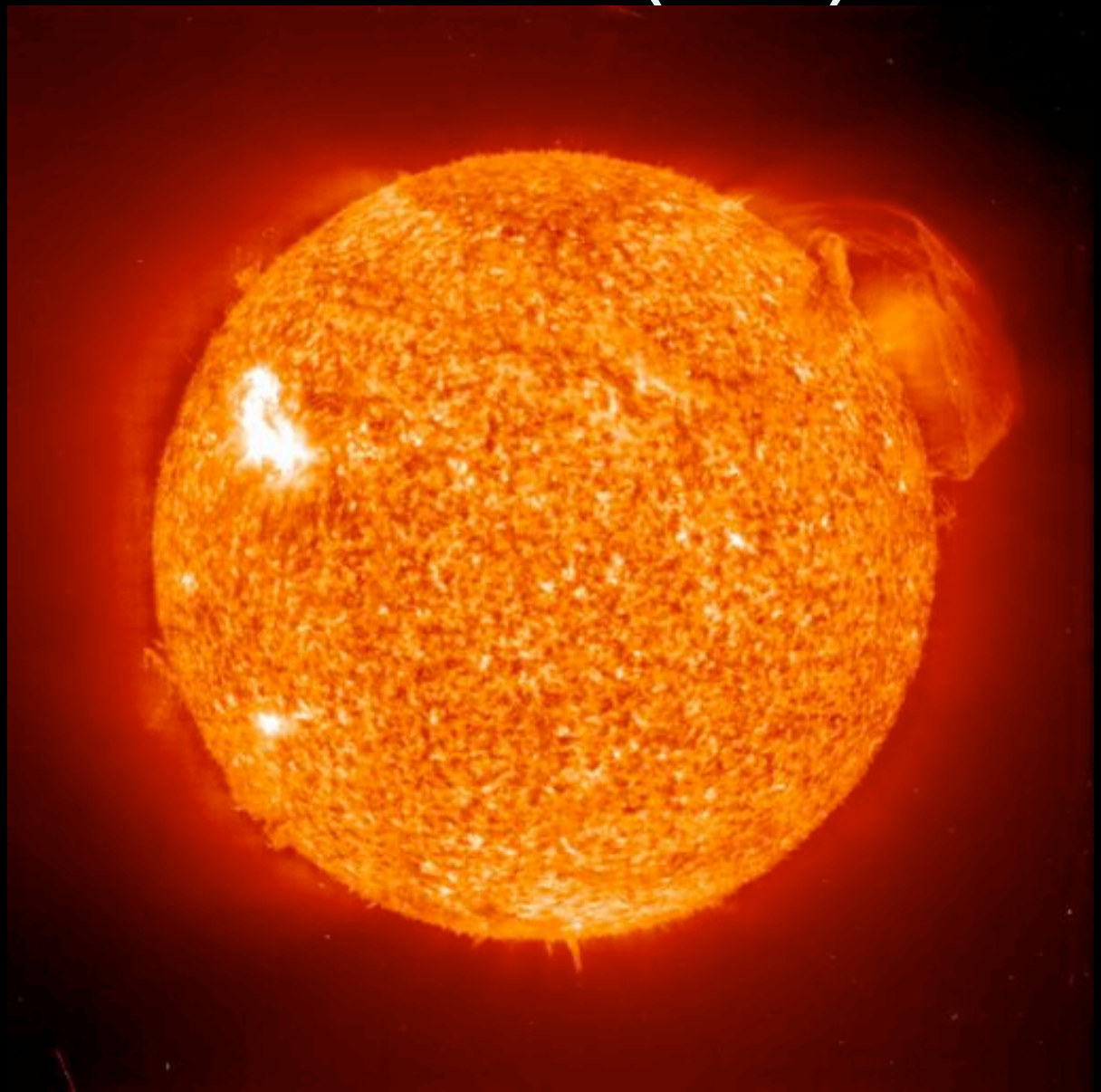
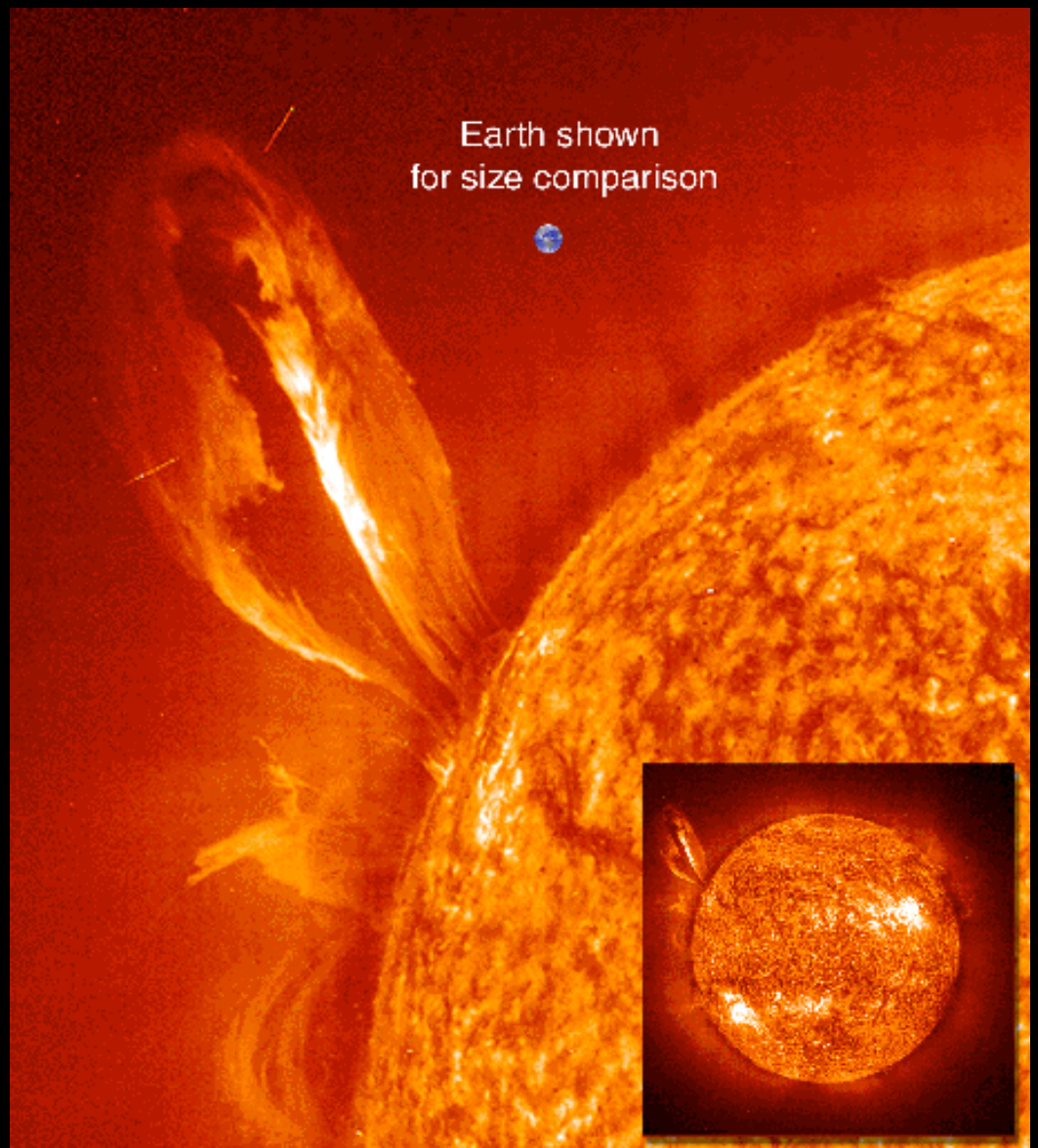


The Sun (Sol)



The Sun



Temperature

Temperature is the average kinetic energy of a group of atoms. How fast are the atoms moving?

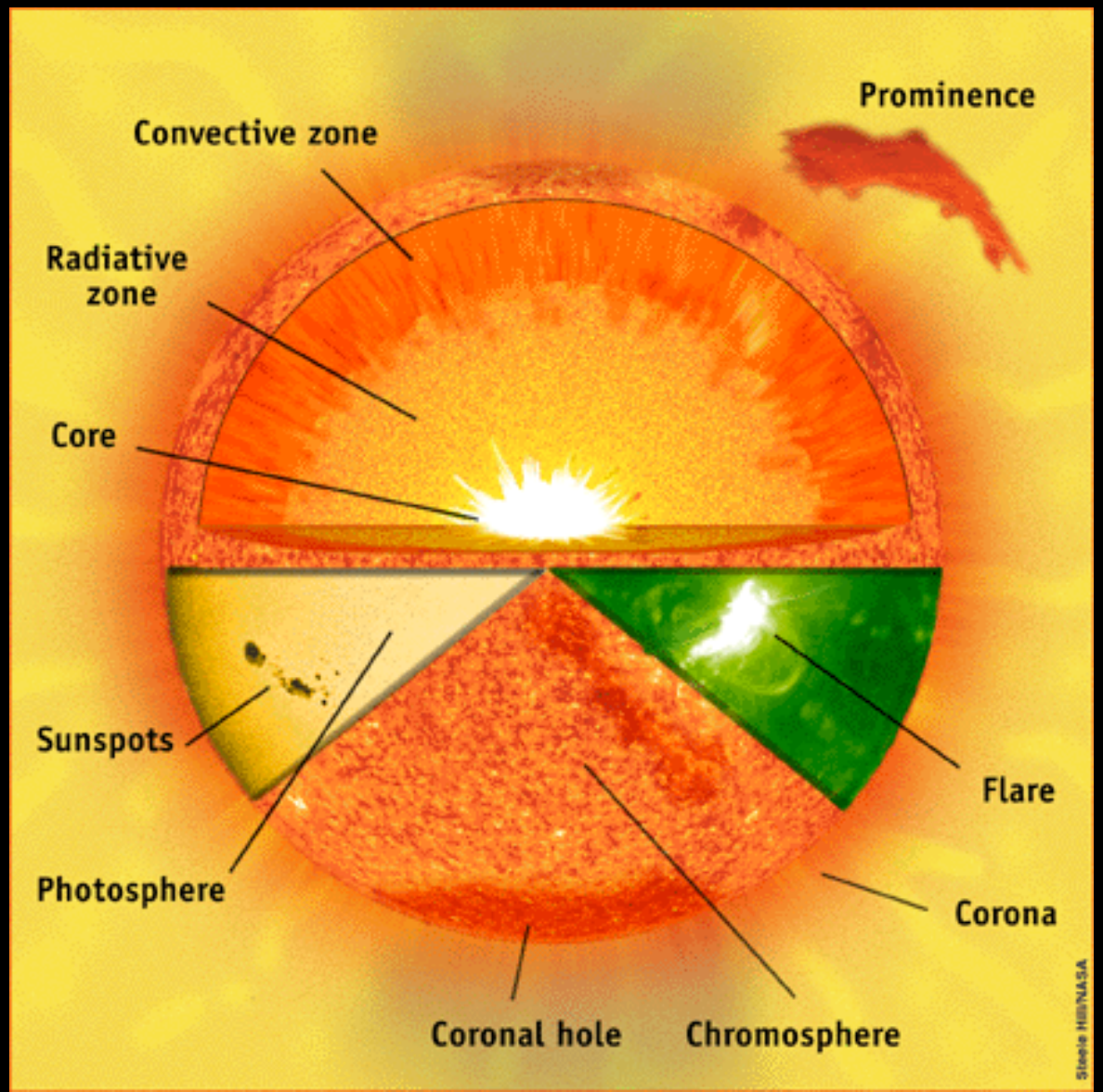
Temperature Scales

Fahrenheit
- Room temp. = 68˚F

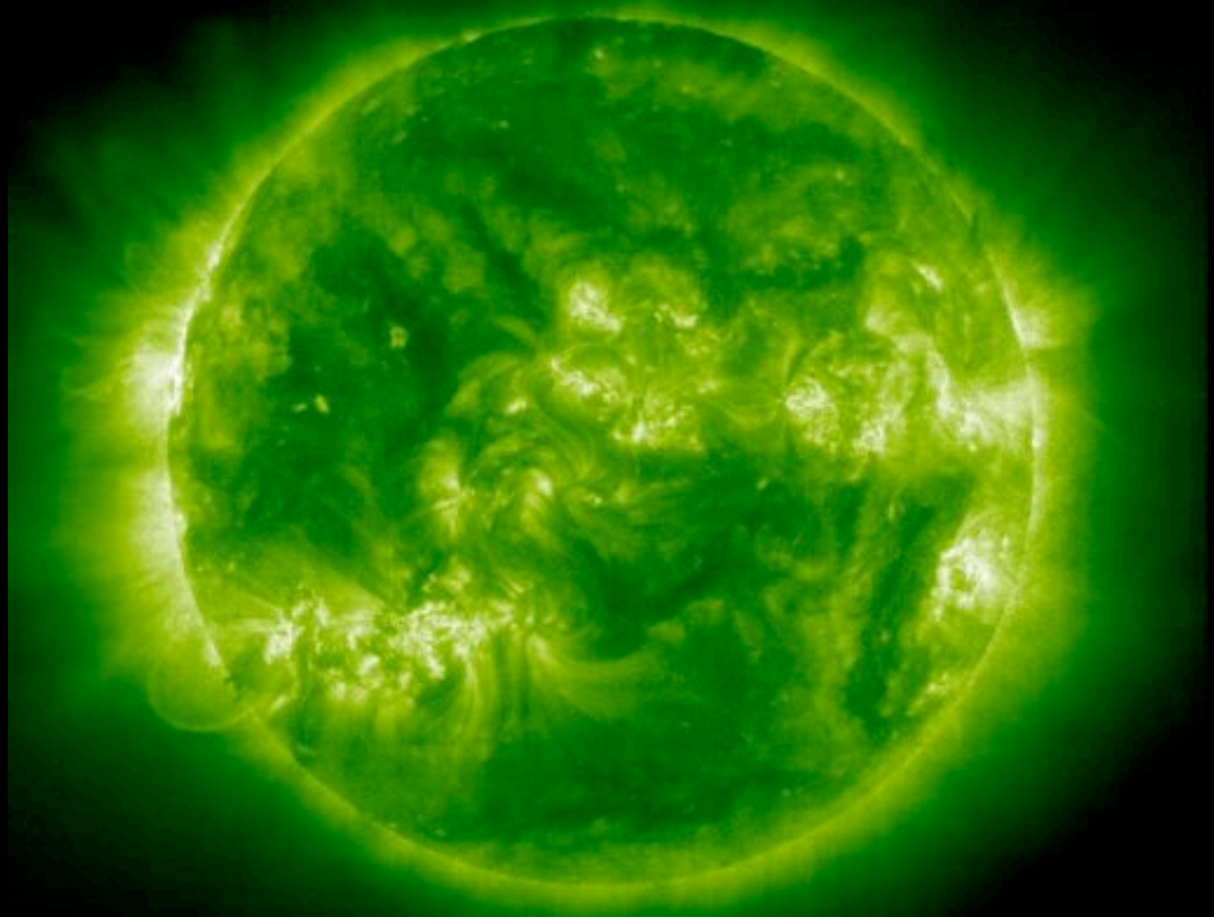
Celsius
- Room temp. = 20˚C

Kelvin
- Celsius + 273.15
- Room temp. = 293.15K

The Sun – Layers



The Sun



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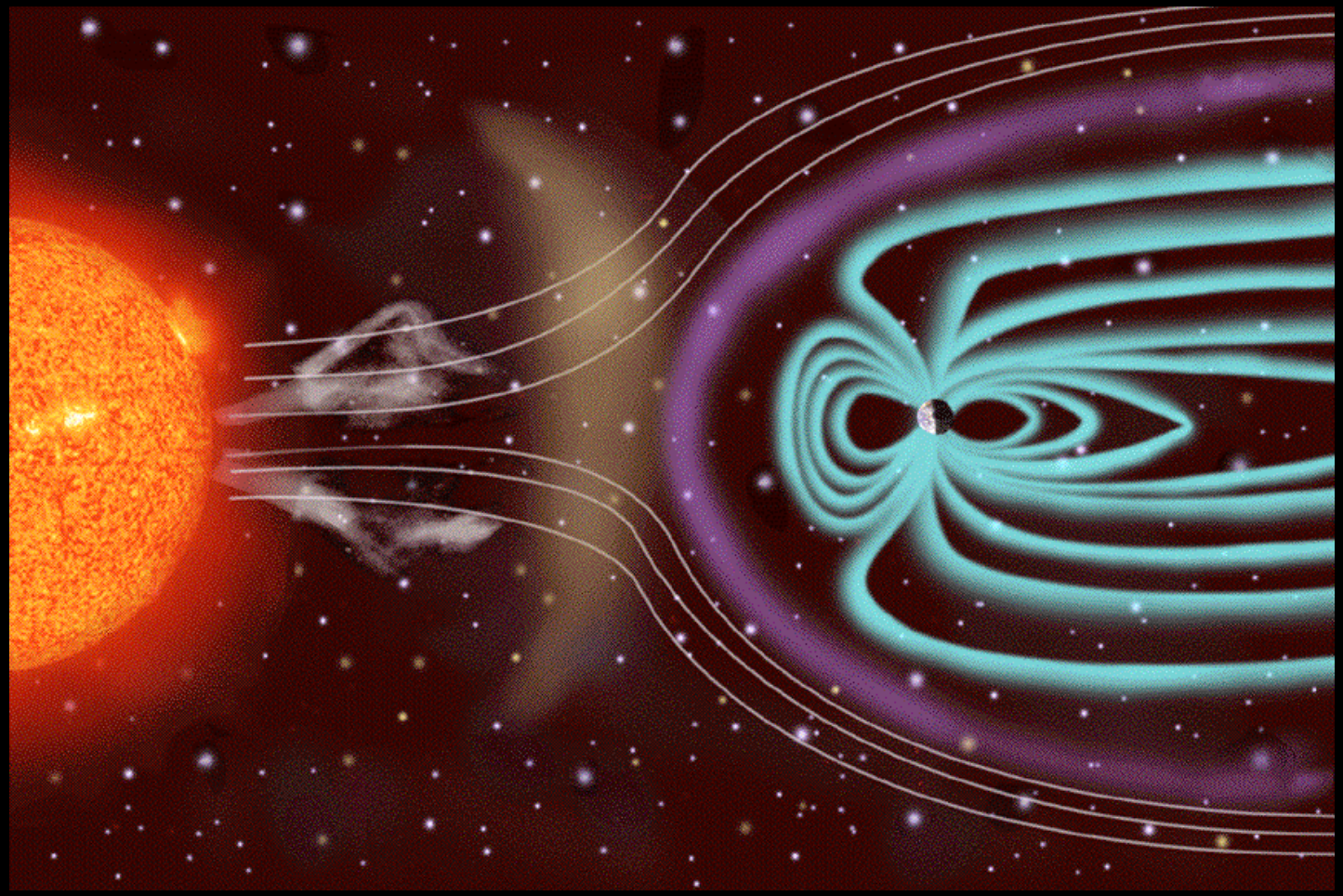
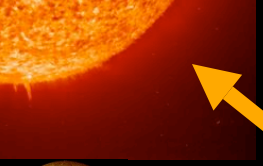
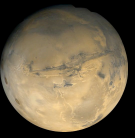
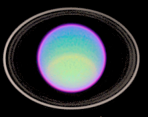






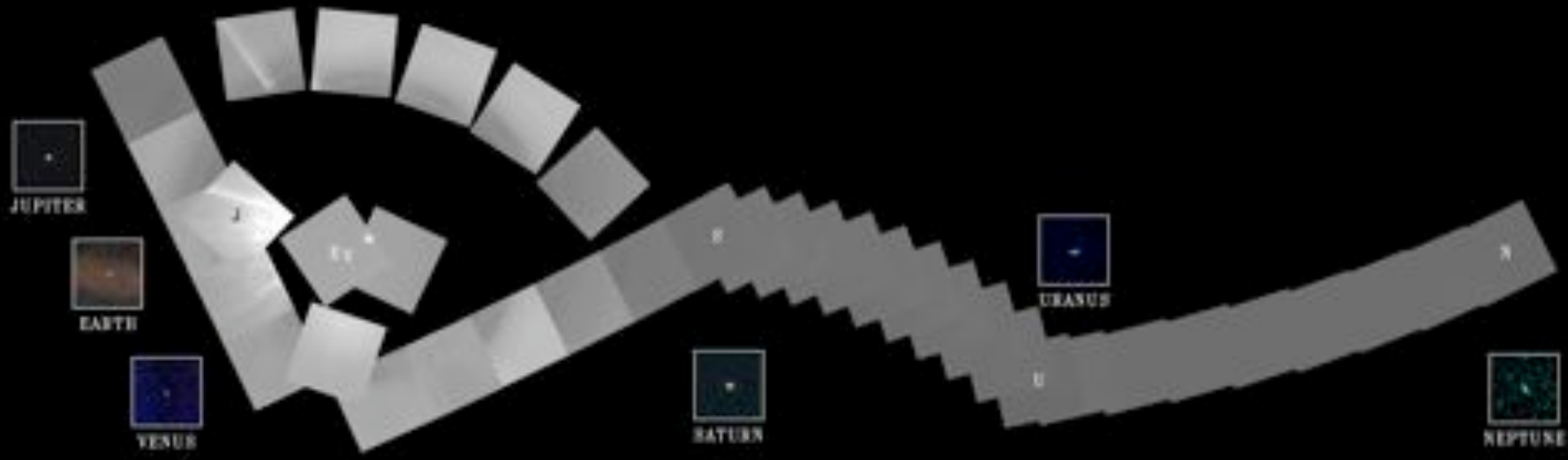


The Sun

Satellites

A satellite is an object that is bound by gravity to a larger object.

Planets

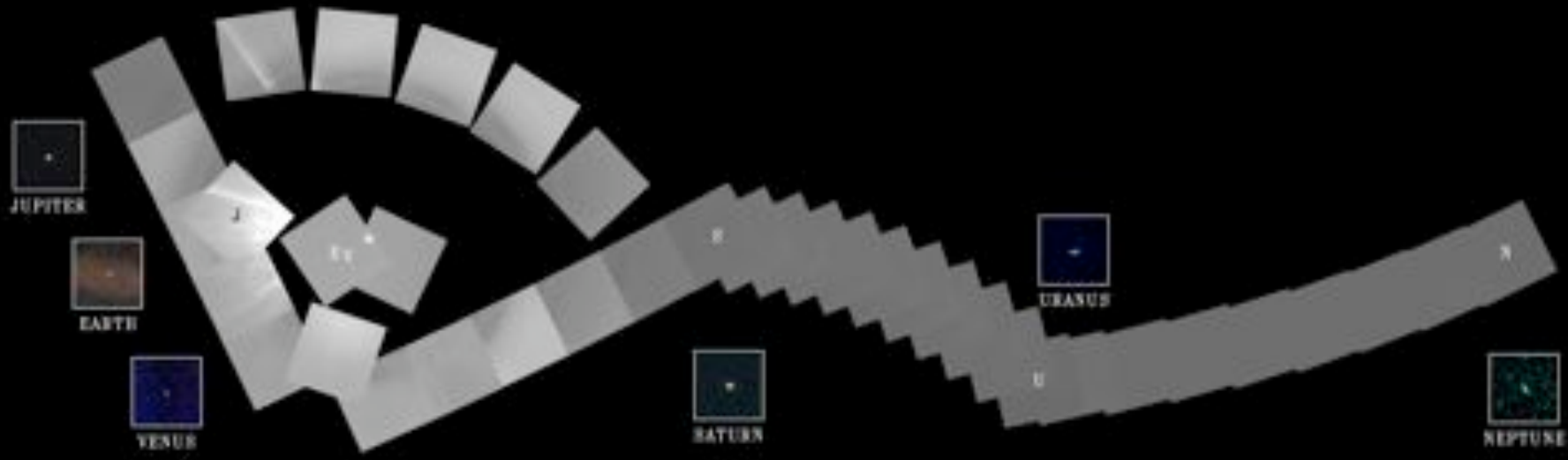


Planets

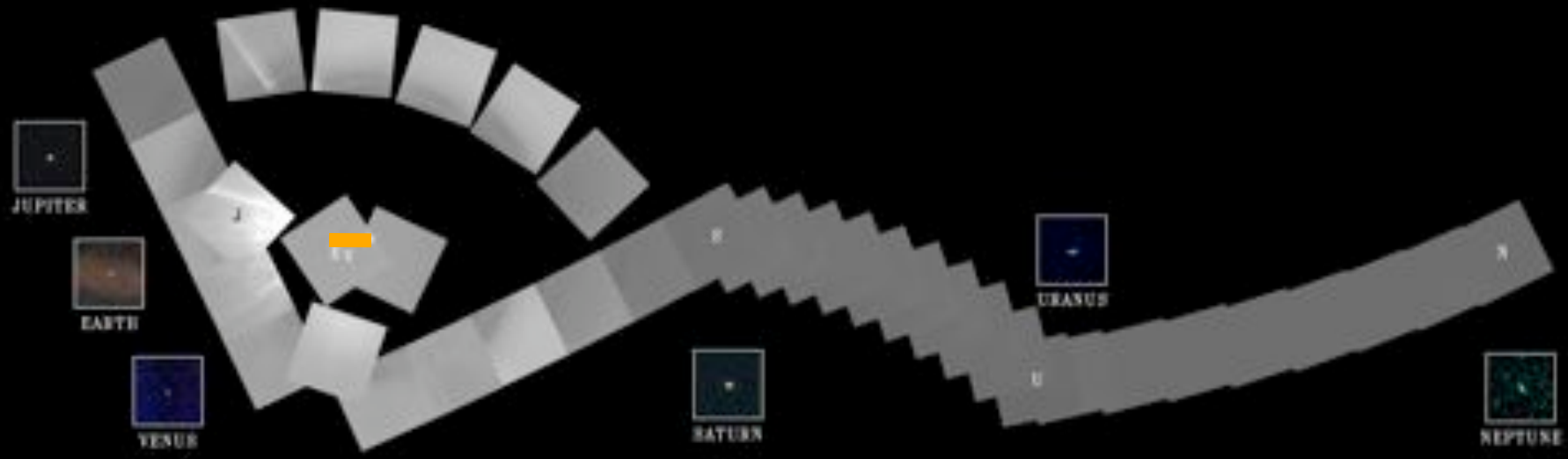
Planets

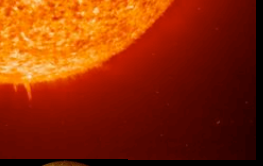
http://www.fourmilab.ch/cgi-bin/uncgi/Solar

Planets

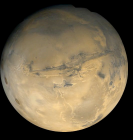


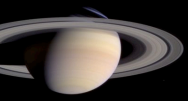
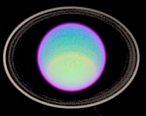
AU – astronomical unit





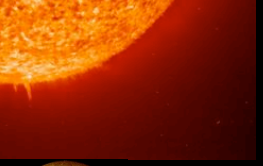




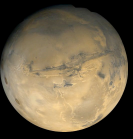



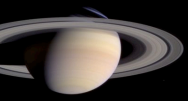
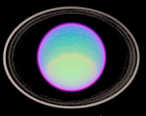
Planets

- The planets (as far as we know) are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.








Planets

- The planets (as far as we know) are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

Planets – Mnemonics

- My very educated mother just served us nine pizzas (or pies.)
- Mary Venus eats marshmallows (and) jelly sandwiches under (the) neighbor's porch. (from Tammy Brown)
- My very eager mother jumped stairs until nails popped. (Made up by Cammy Ulrich and Melissa Smead)
- My very exciting mother just sat under Nancy's poster. (From a book found by Athena Matlock)

  Mary's vicious eyes make Johnny stay up nights, period. (Professor Birkey learned this one in high school)
- My very educated monkey just sat under nine planets. (Made up be Brett Freeman.)

Planets – Mnemonics

- My very educated mother just served us noodles
- Mary Venus eats marshmallows (and) jelly sandwiches under (the) neighbor's . (from Tammy Brown)
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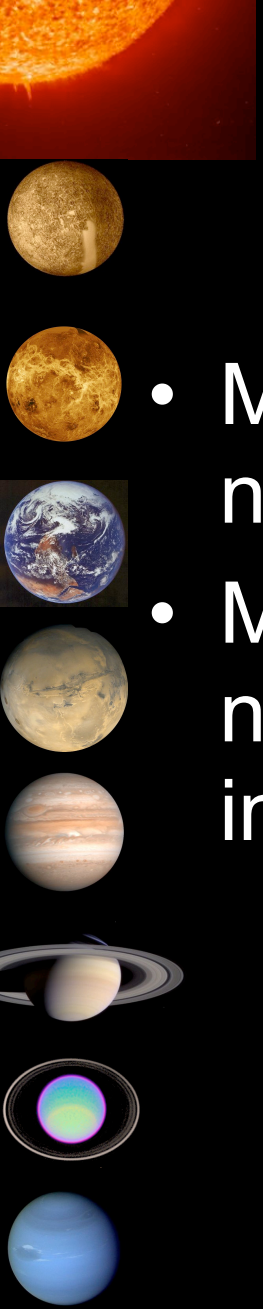
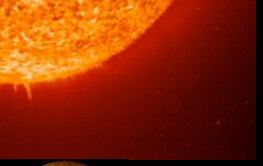
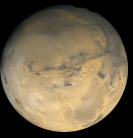


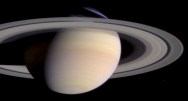
Planets – Mnemonics

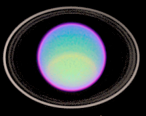
- My very educated mother just served us noodles
- Mary's vicious eyes make Johnny stay up nights. (Professor Birkey learned this one in high school, modified)



Terrestrial Planets

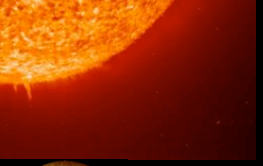


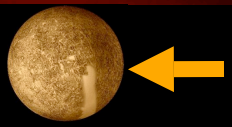


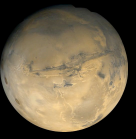


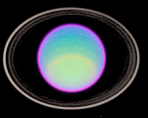
- The first four planets are terrestrial planets. This means that they have a solid surface like Earth. We could stand on them. We have sent probes to land on the surface of several of them.

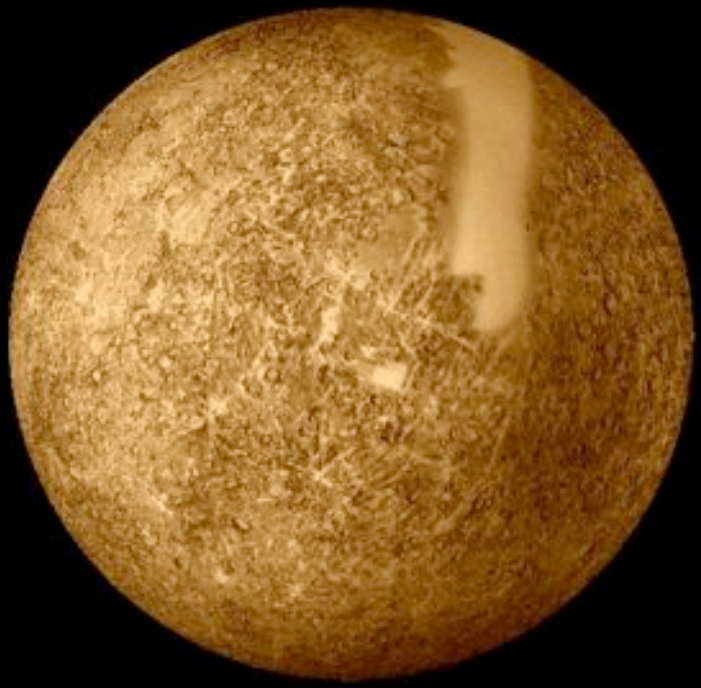
Mercury

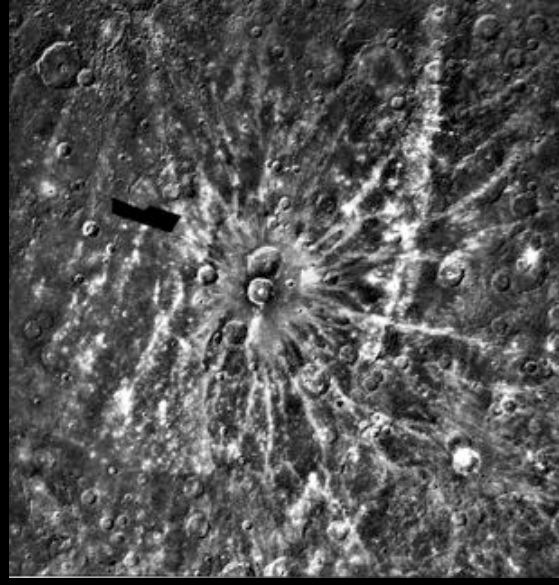


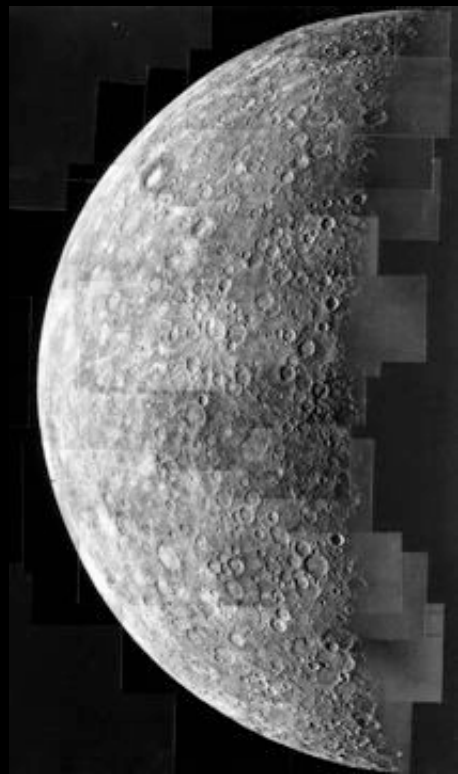




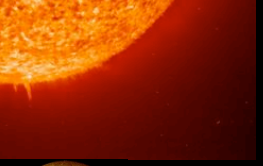


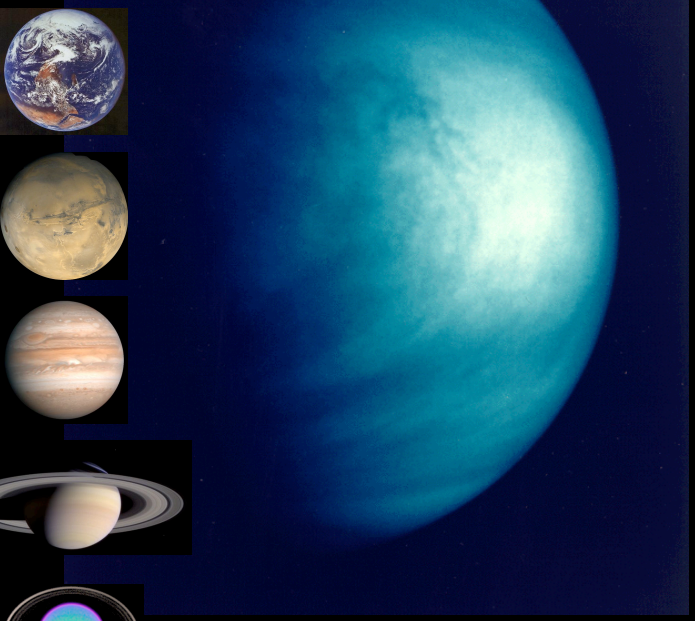


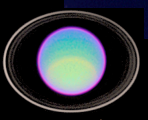




Venus





Earth

"Mostly Harmless"

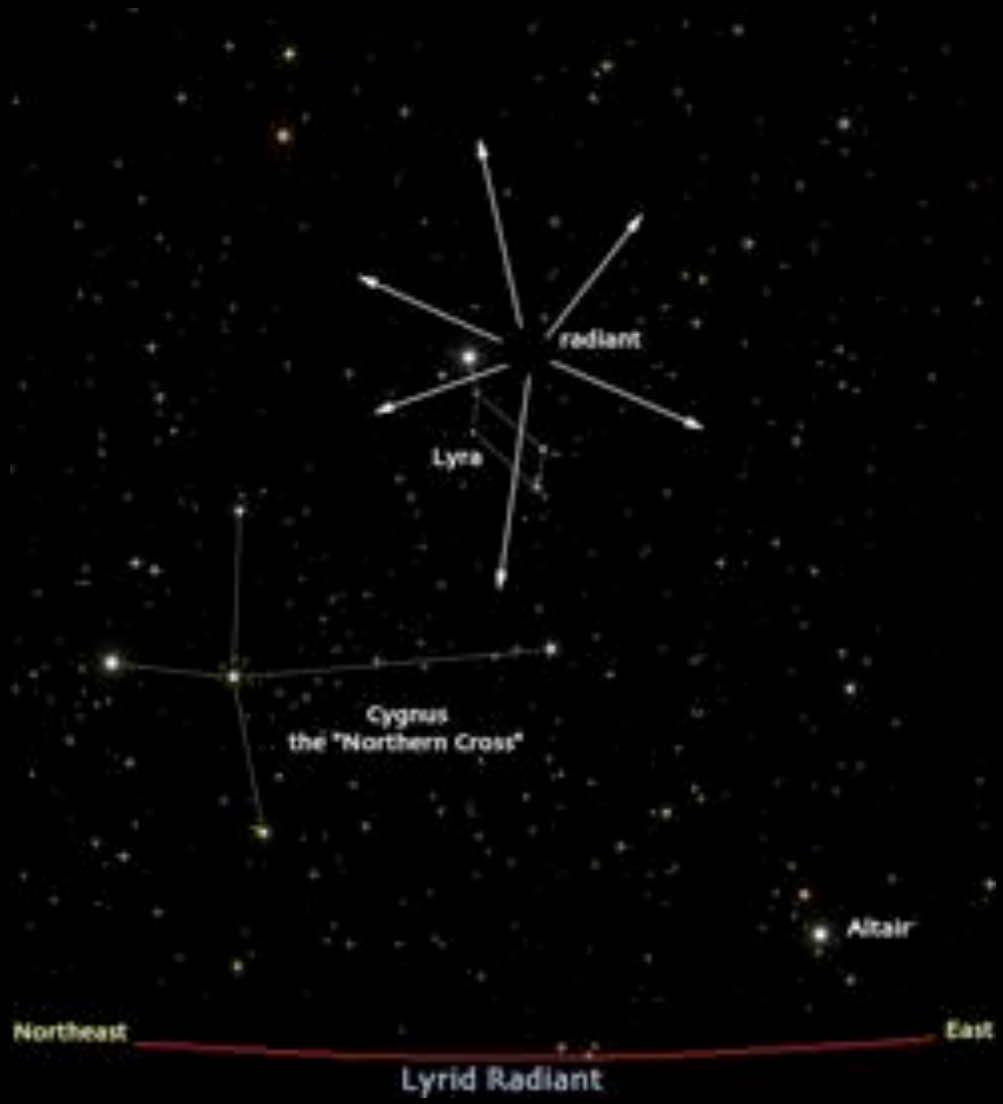
Meteoroids

Meteors

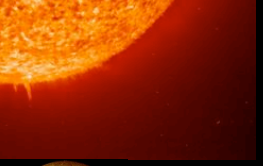
Meteorites

Meteorites

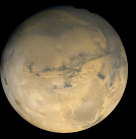
Meteor showers – Lyrids

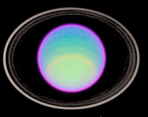


The Moon

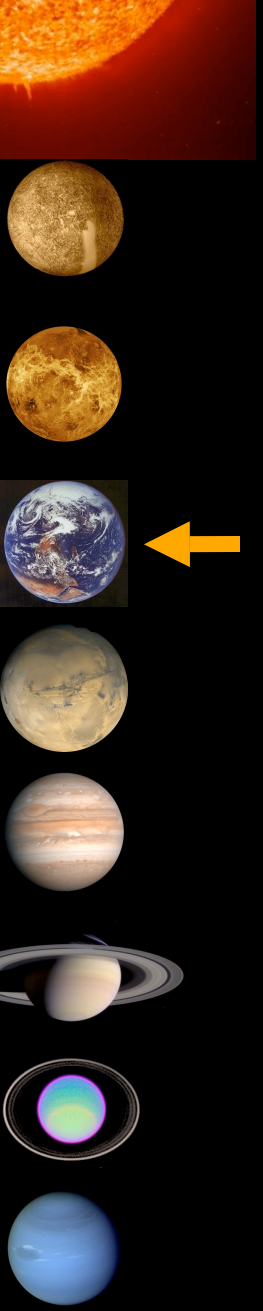




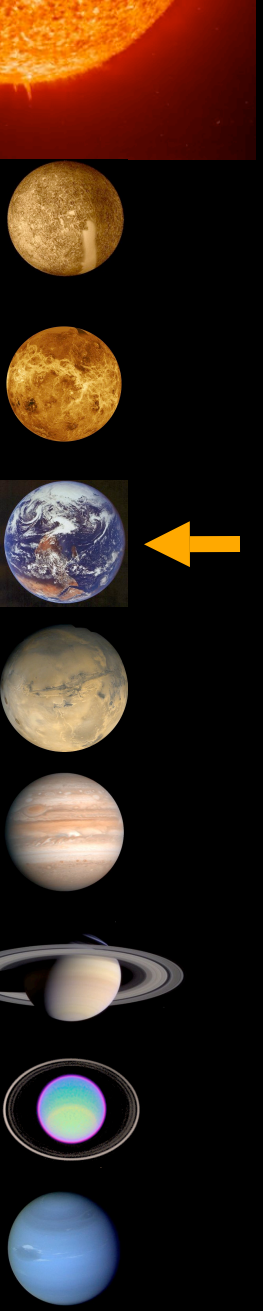



The Moon – Size



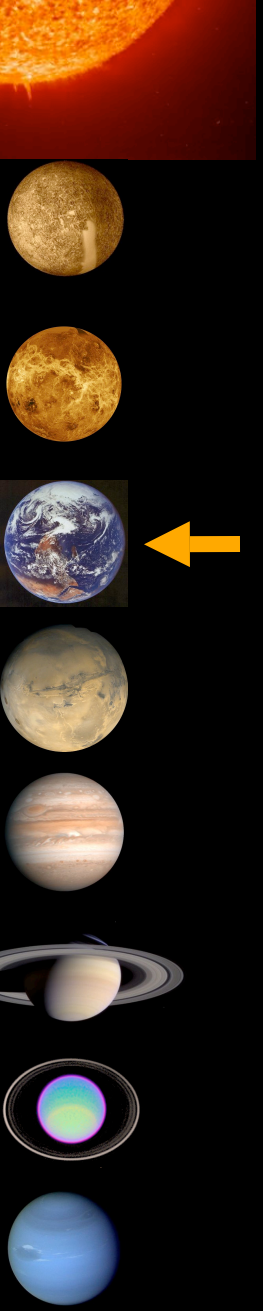
The Moon – Distance



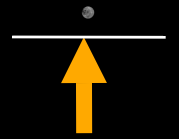
Earth

Moon

The Moon – Distance



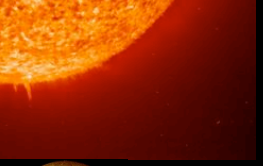
Earth



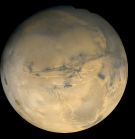
Moon

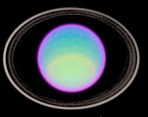
The Moon

The Moon



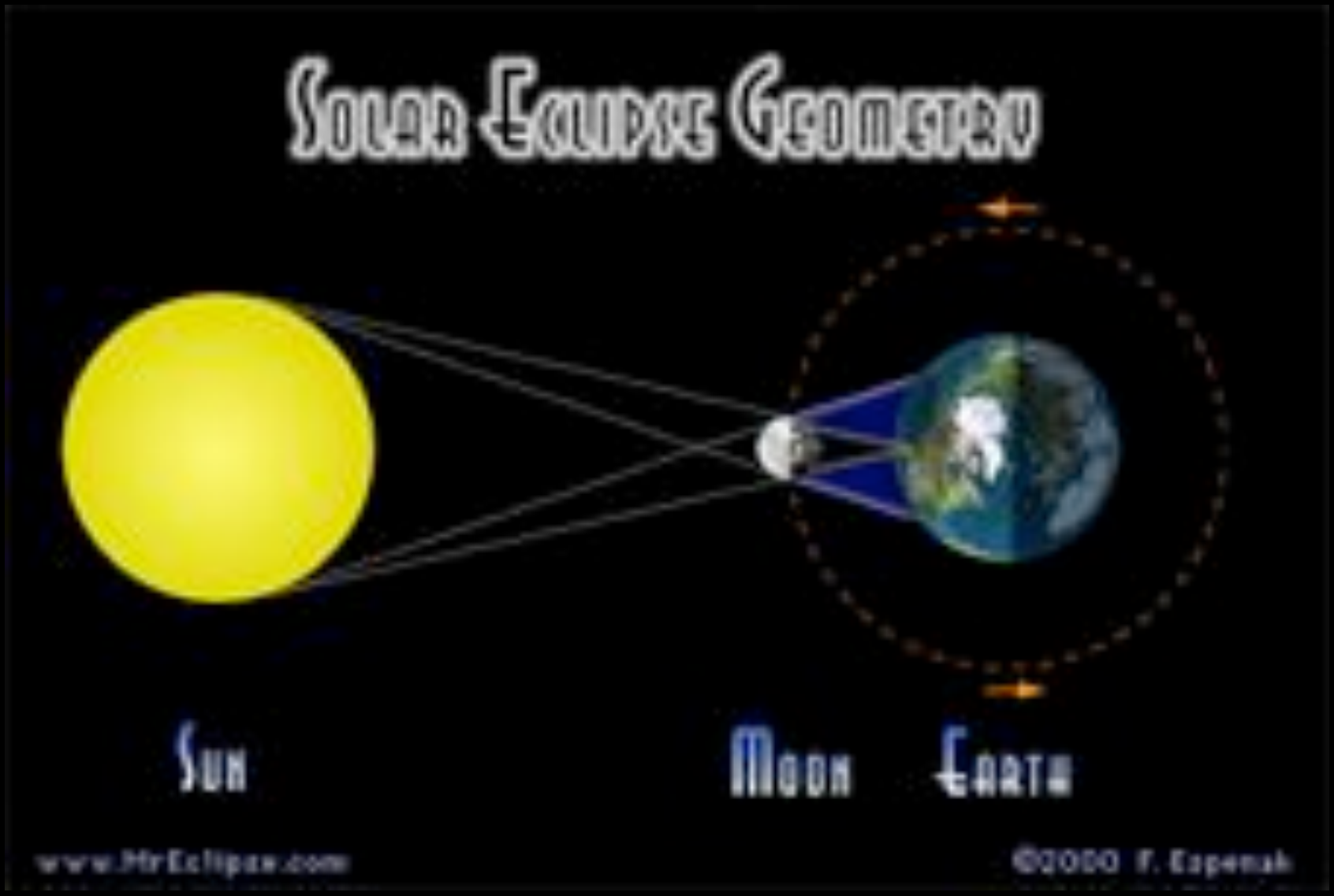





The Moon

Eclipse


Solar Eclipse Geometry
Sun
Moon
Earth
www.MrEclipse.com
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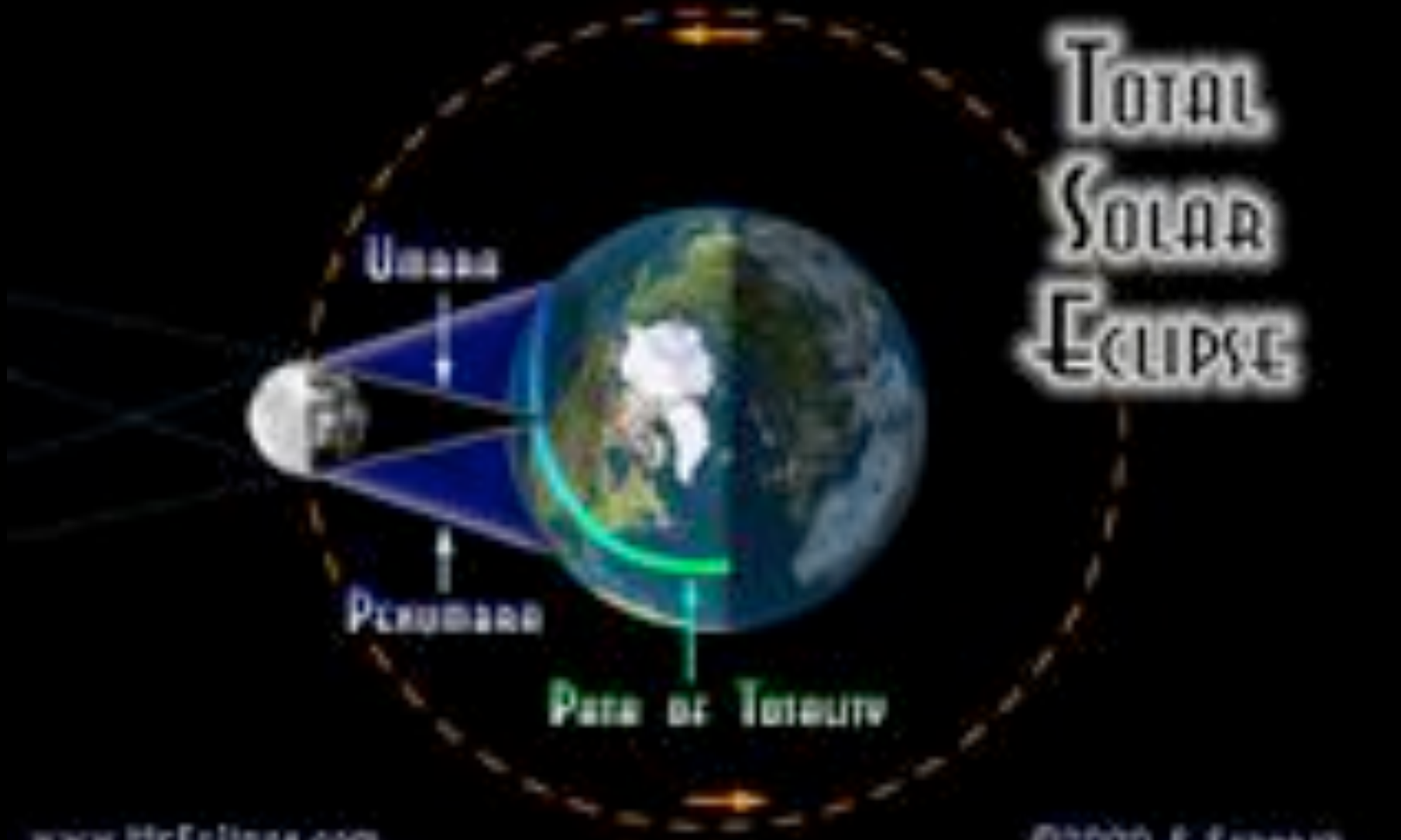
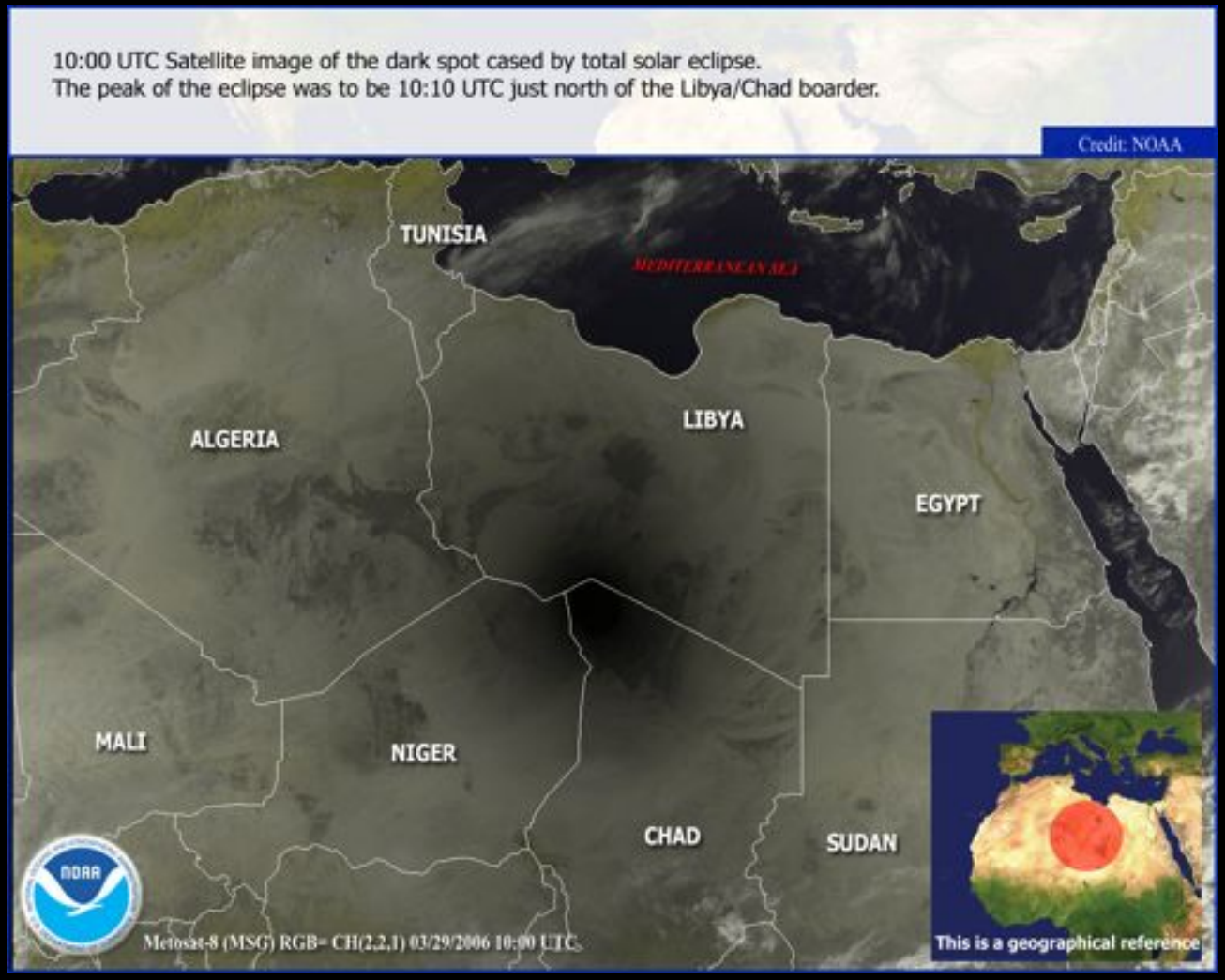
Solar Eclipse

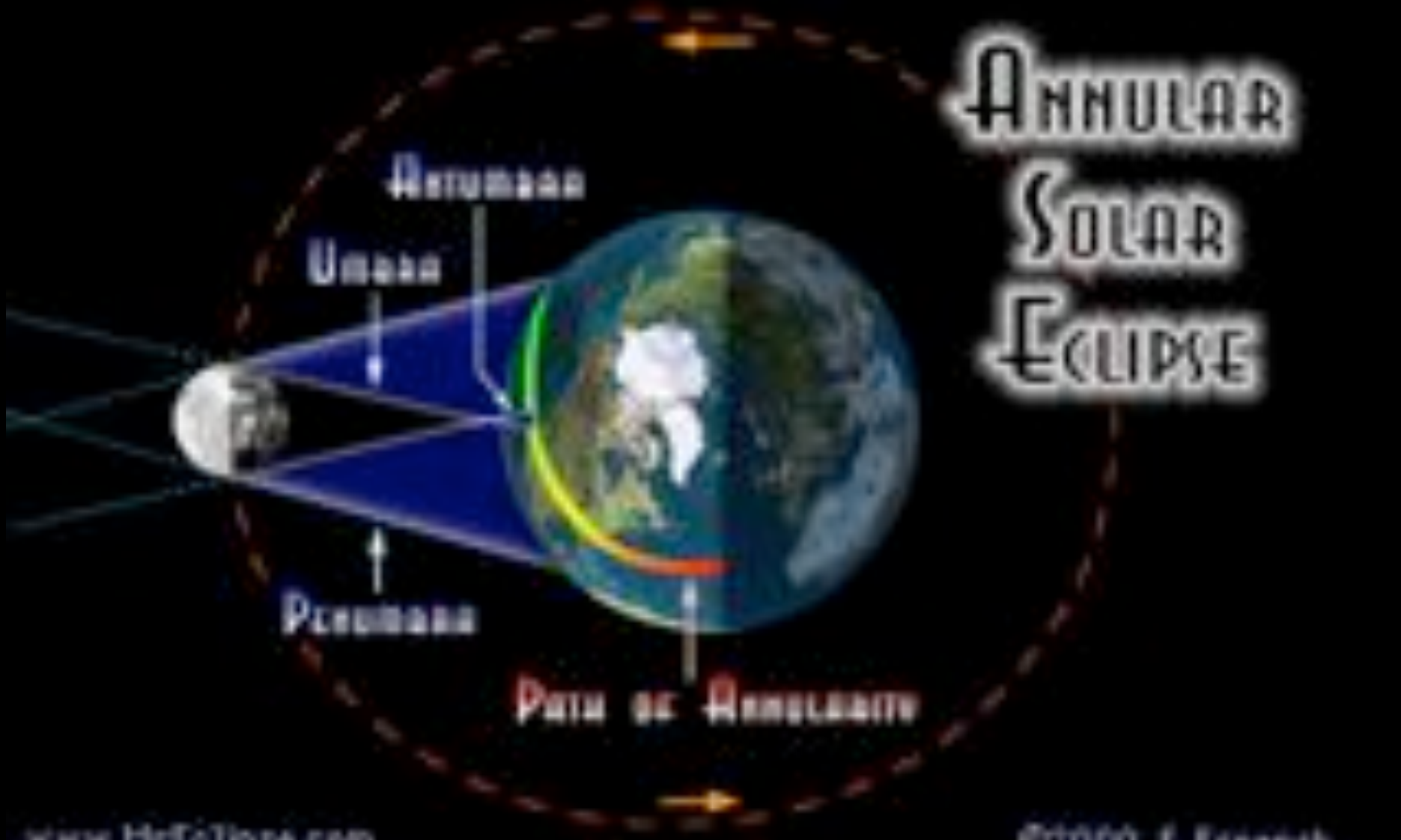
Total Solar Eclipse



Solar Eclipse

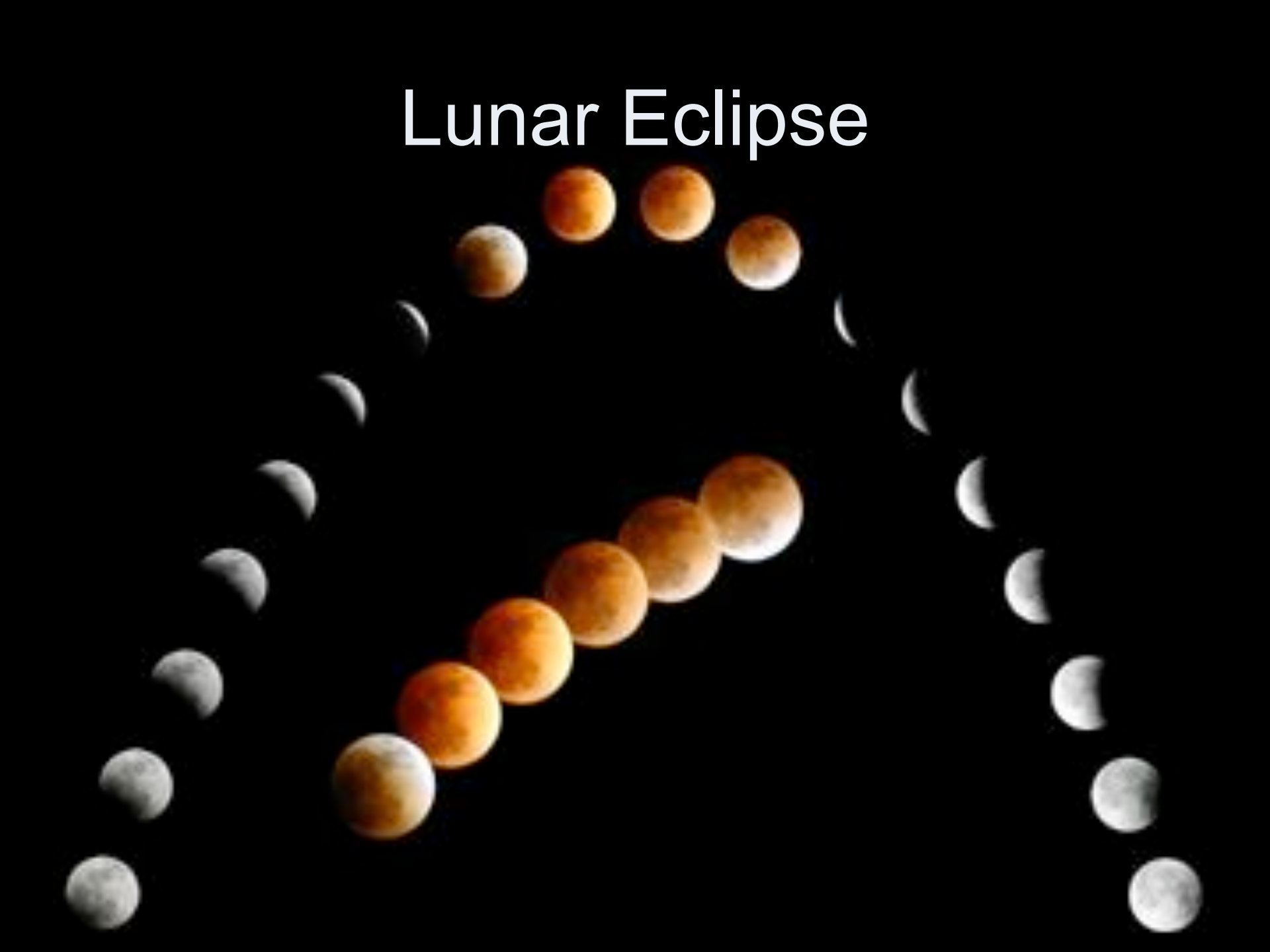


Annular Solar Eclipse

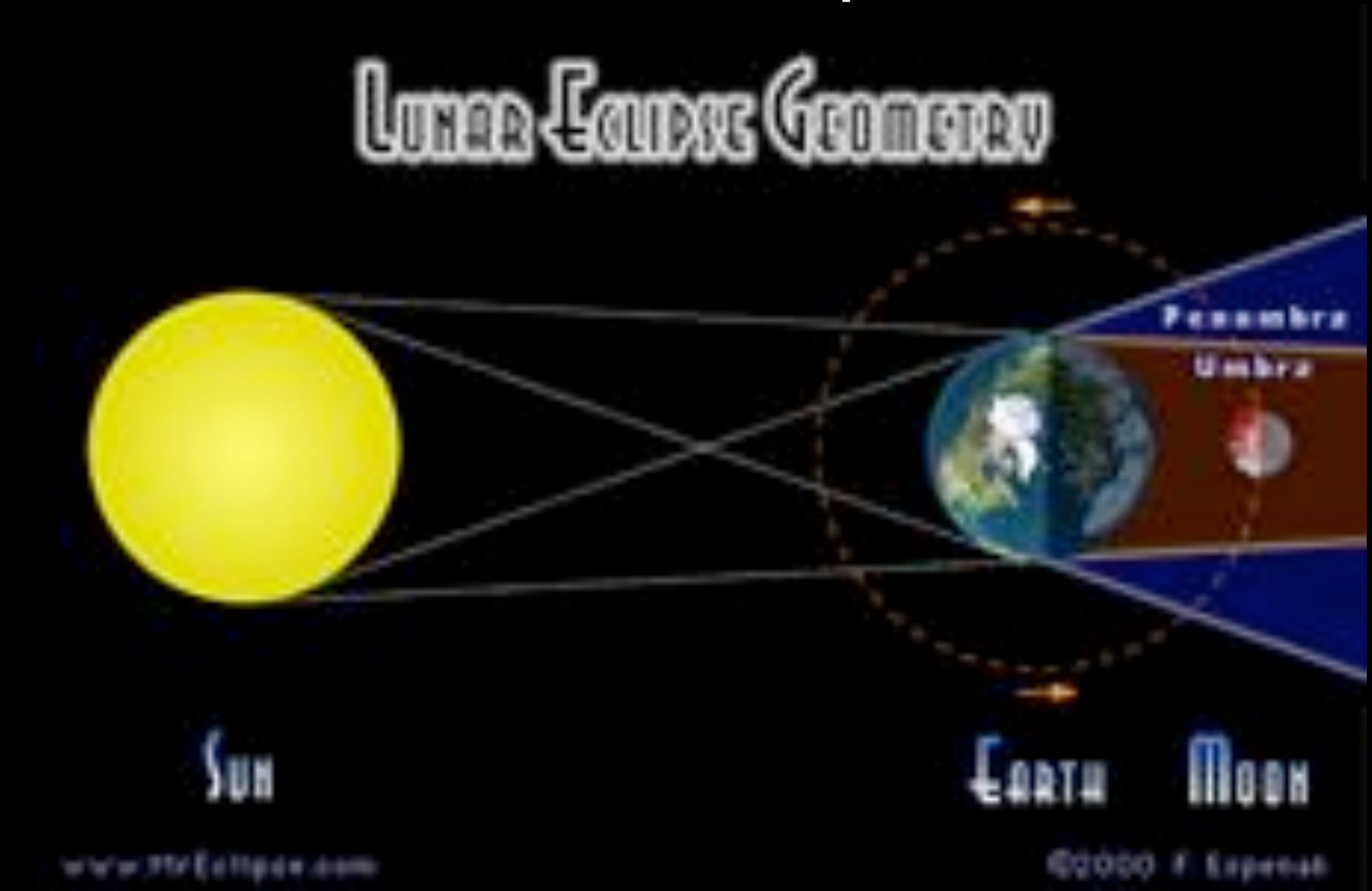


Annular Solar Eclipse

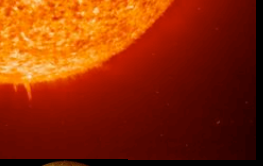
Lunar Eclipse



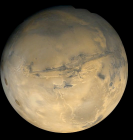
Lunar Eclipse

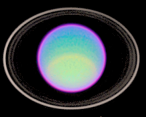


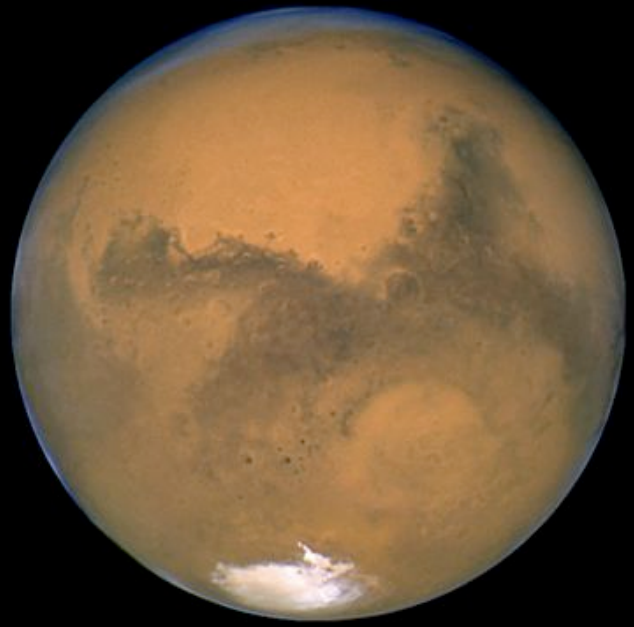
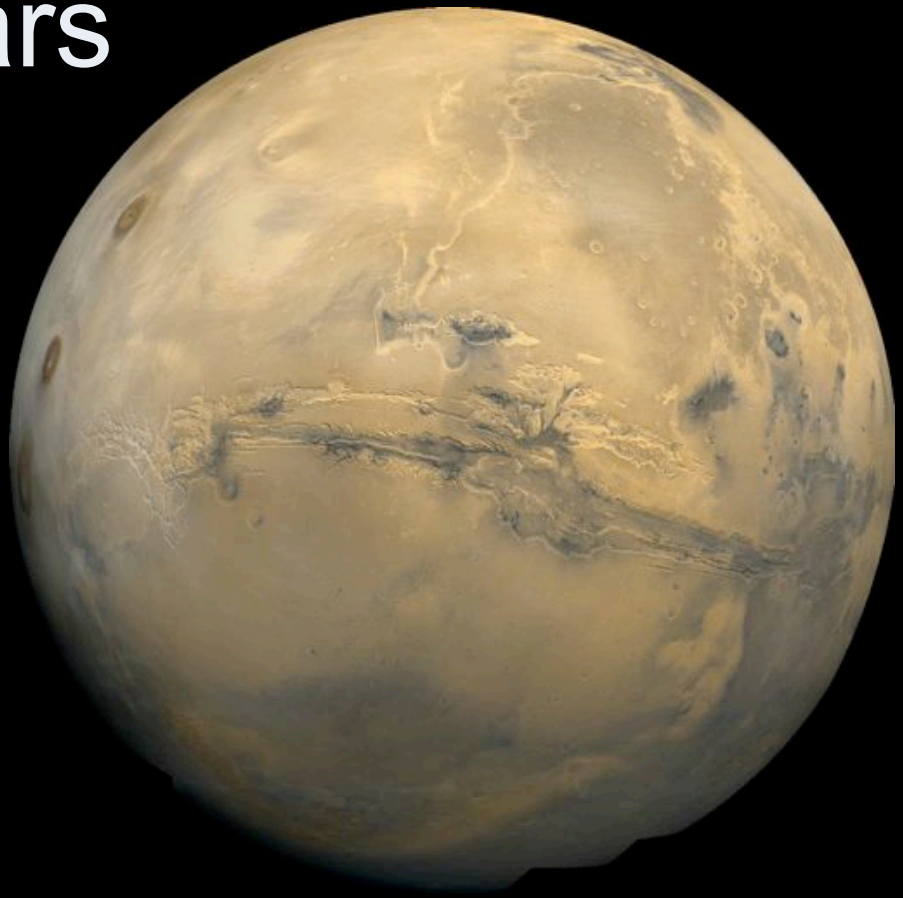
Mars



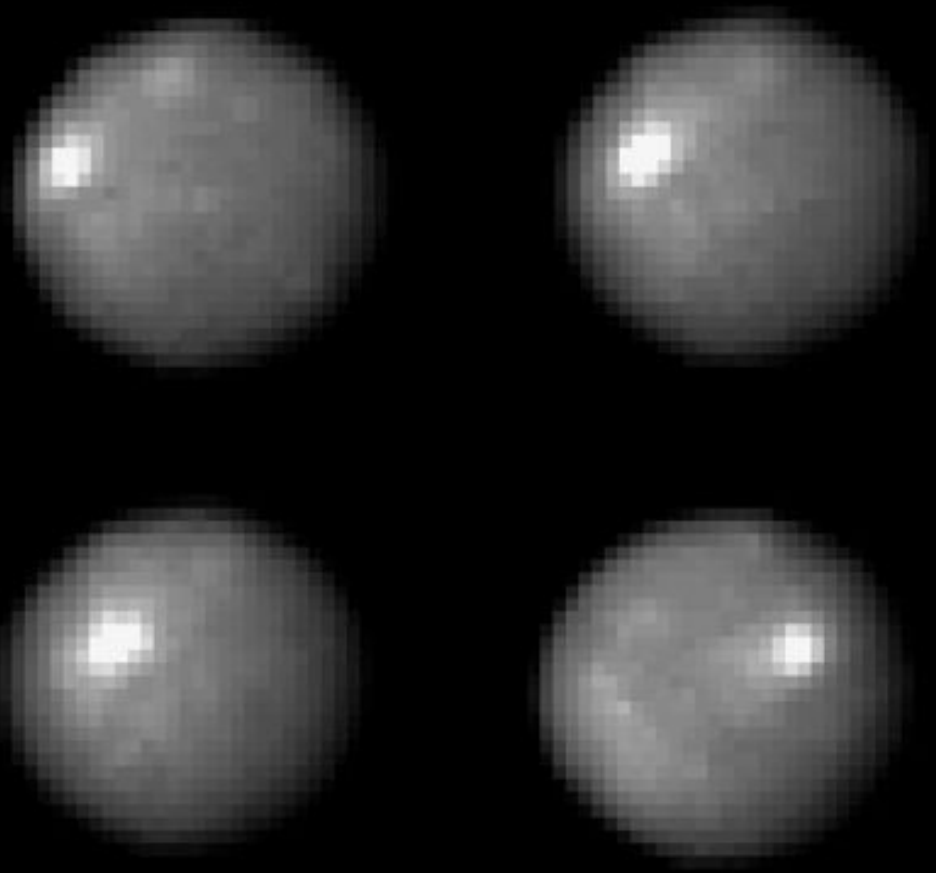




Ceres

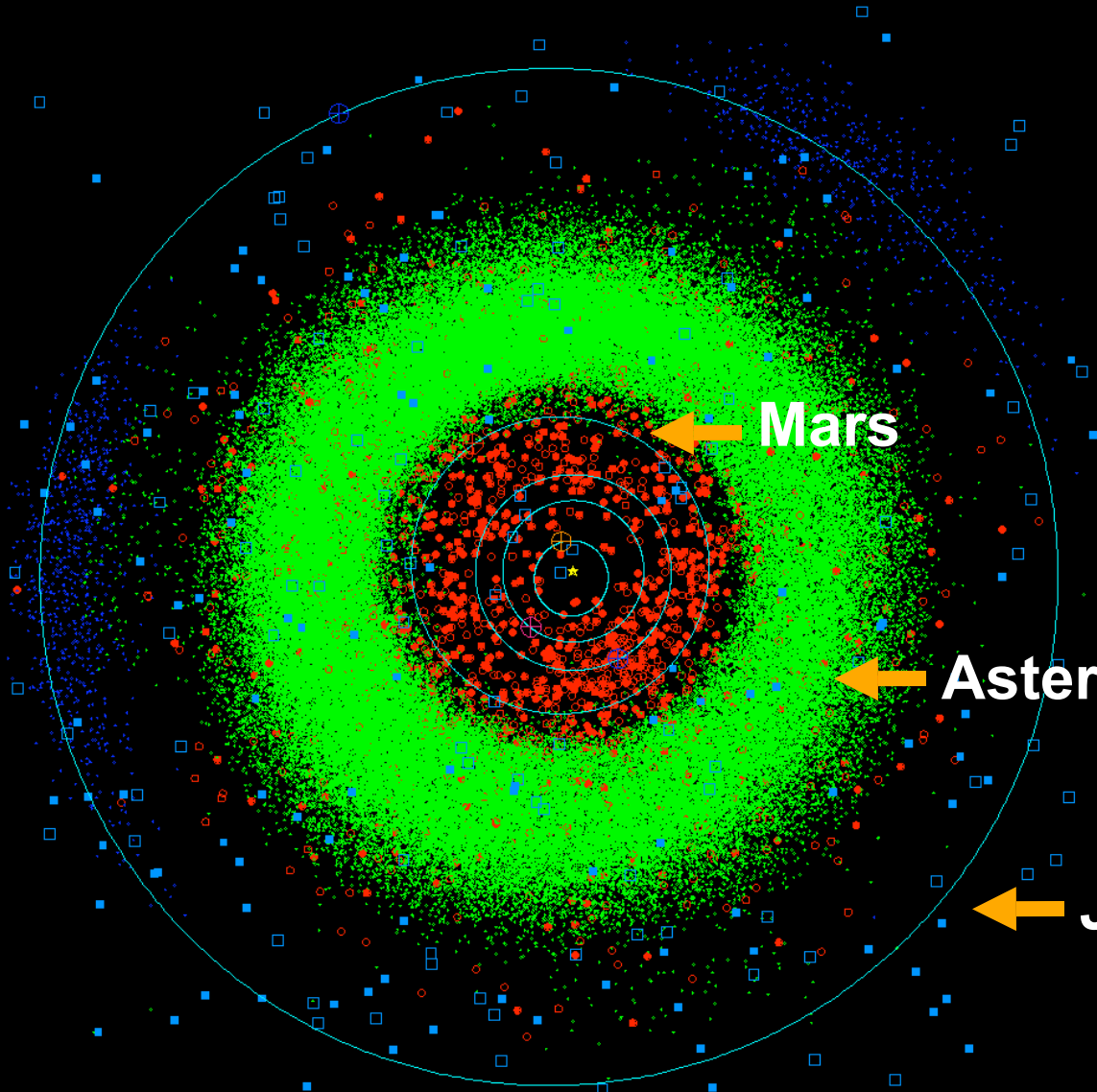


Ceres

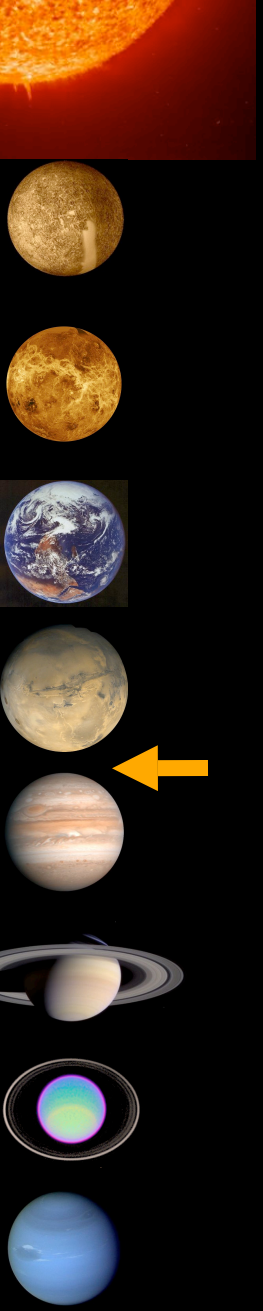
Dwarf Planet

- Orbits around the Sun
- Has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (near-spherical) shape
- Has not cleared the neighborhood around its orbit
- Is not a satellite

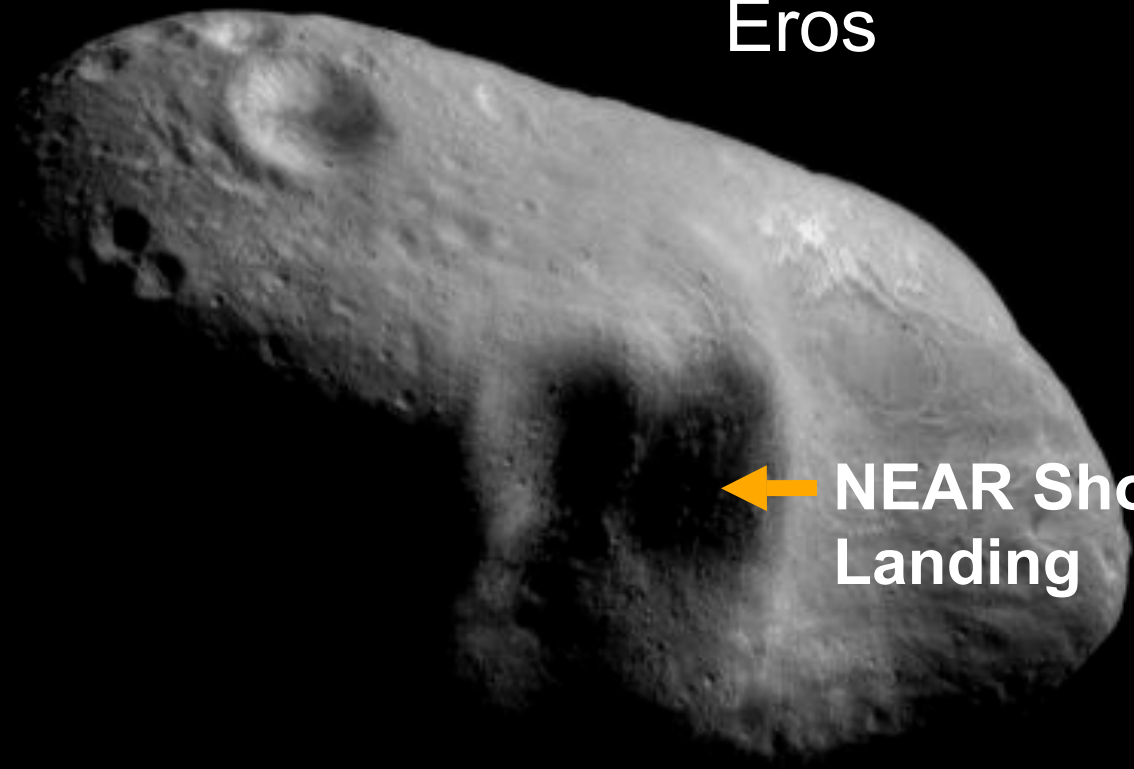
The Asteroid Belt



The Asteroid Belt



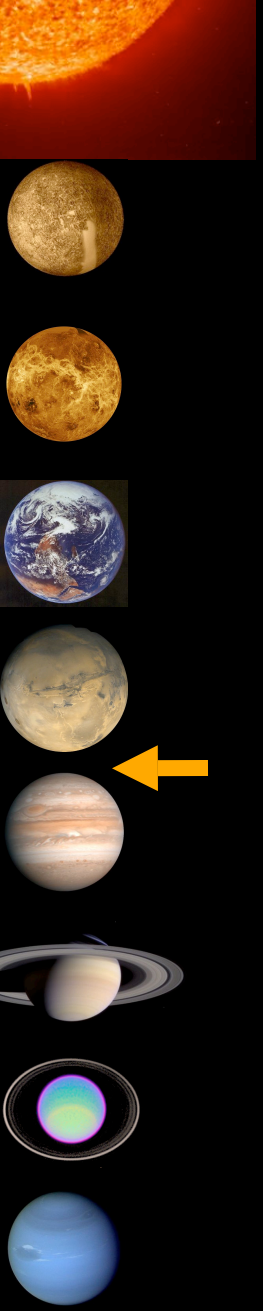
The Asteroid Belt



Eros

NEAR Shoemaker Landing

The Asteroid Belt

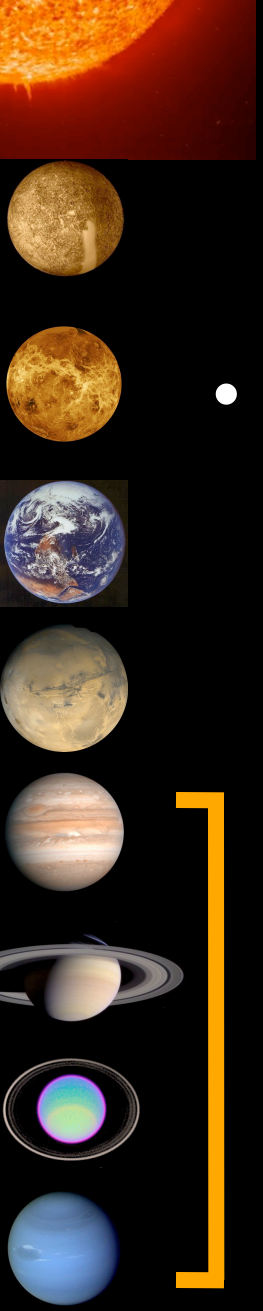


Ida

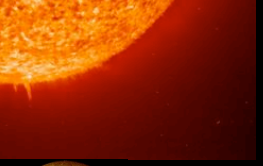
Dactyl

Jovian Planets

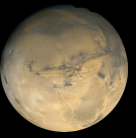
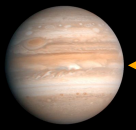
- The next four planets are made of hydrogen and helium gas. These are the Jovian planets (named after Jupiter.)

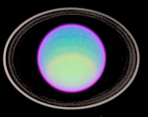


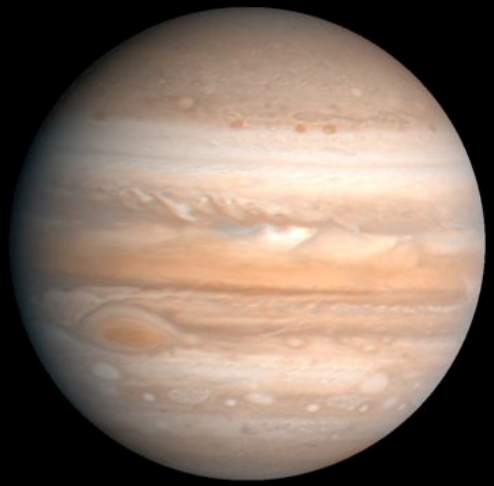
Jupiter



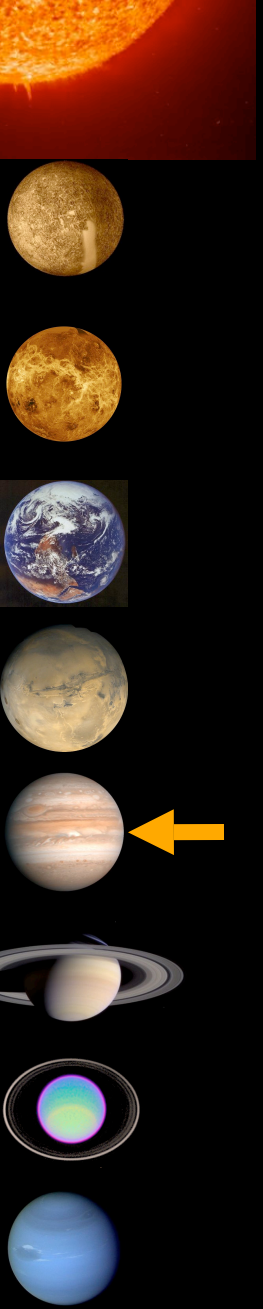


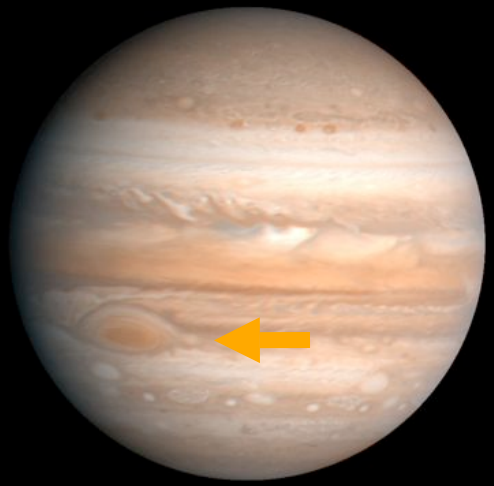





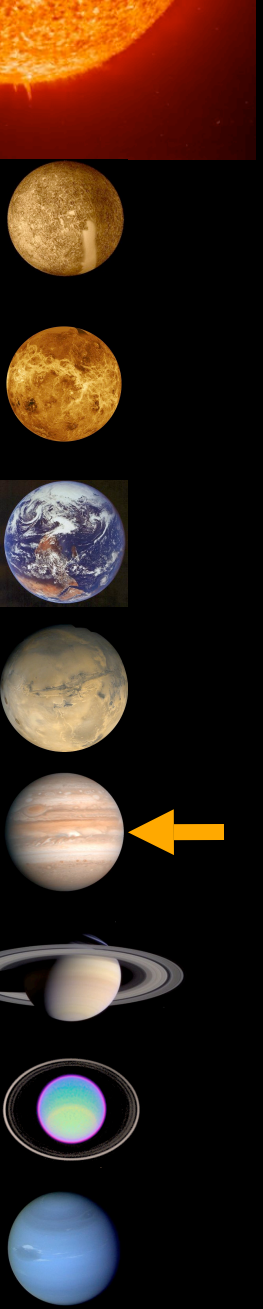
Jupiter



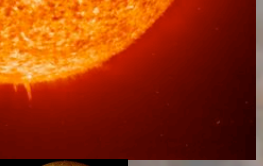


Great Red Spot

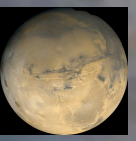
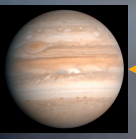
Jupiter – Galilean Moons

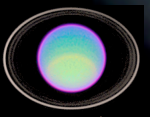


Jupiter –
Galilean Moons

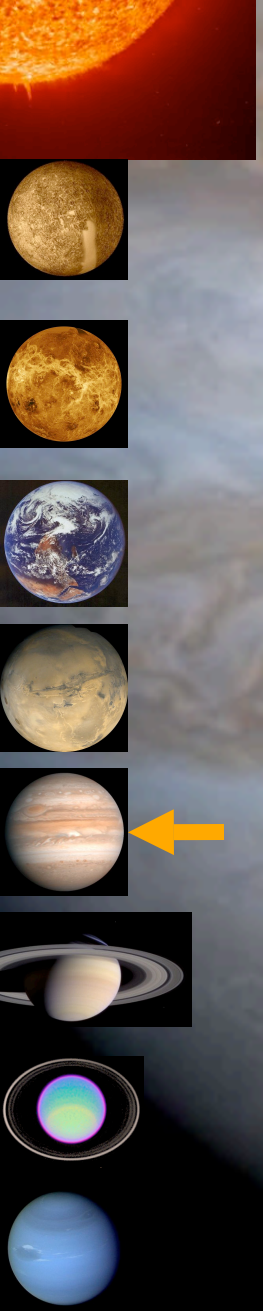






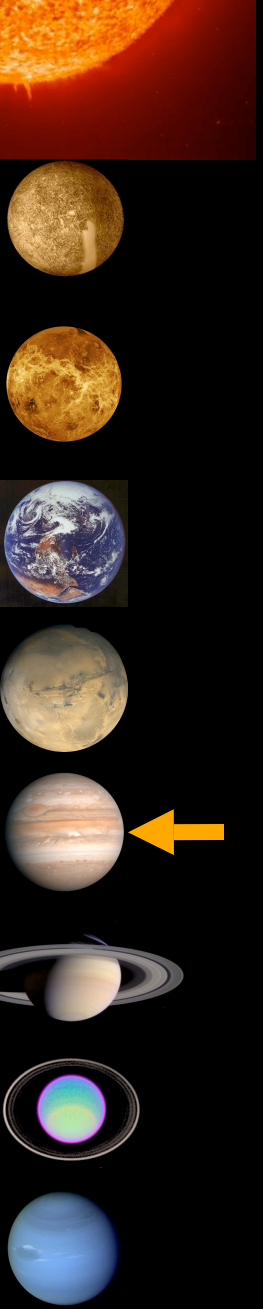

Jupiter – Galilean Moons

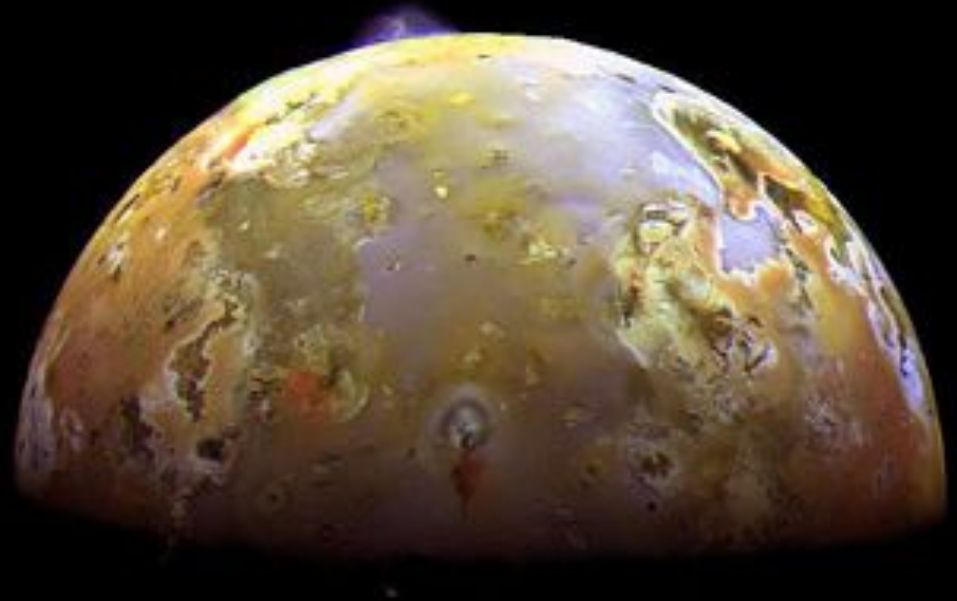


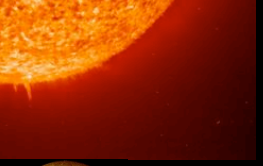
lo's shadow

lo

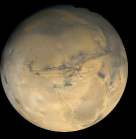
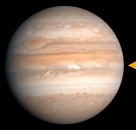
Jupiter – Io

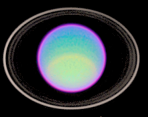




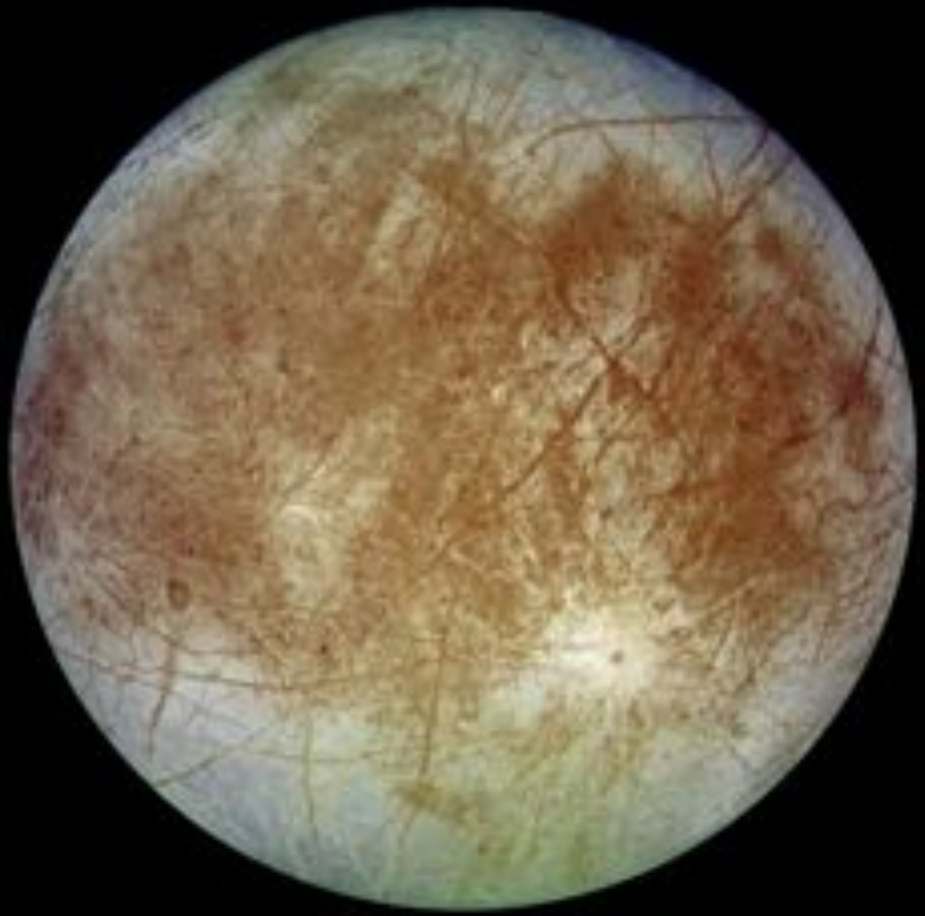




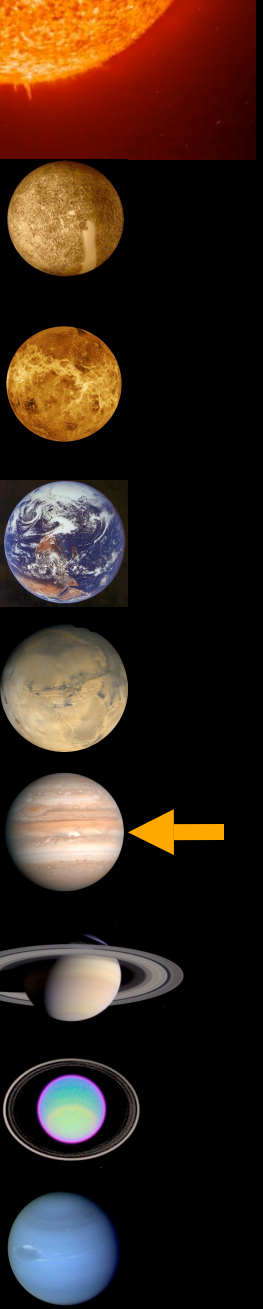



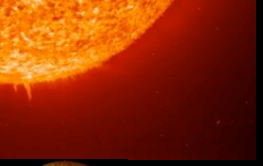



Jupiter – Europa

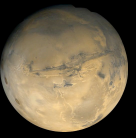
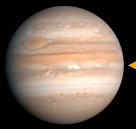


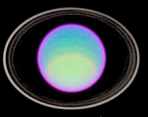
Jupiter – Ganymede





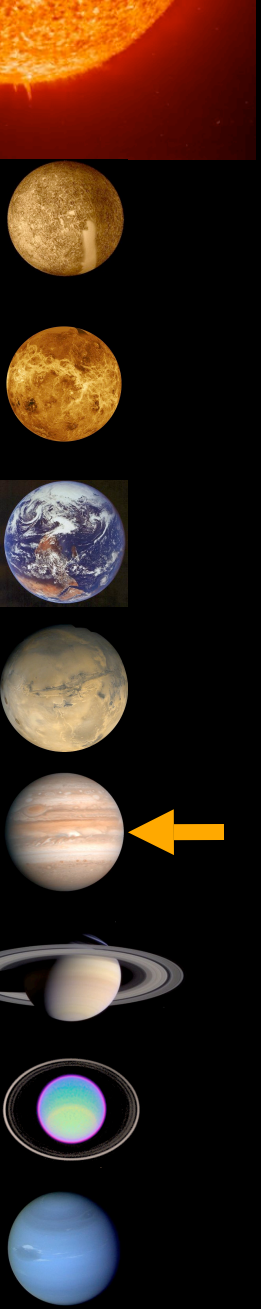


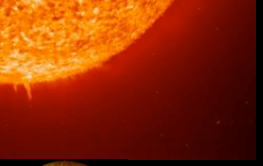



Jupiter – Callisto

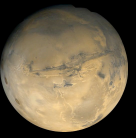
Jupiter – Rings

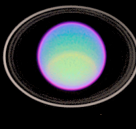


Saturn





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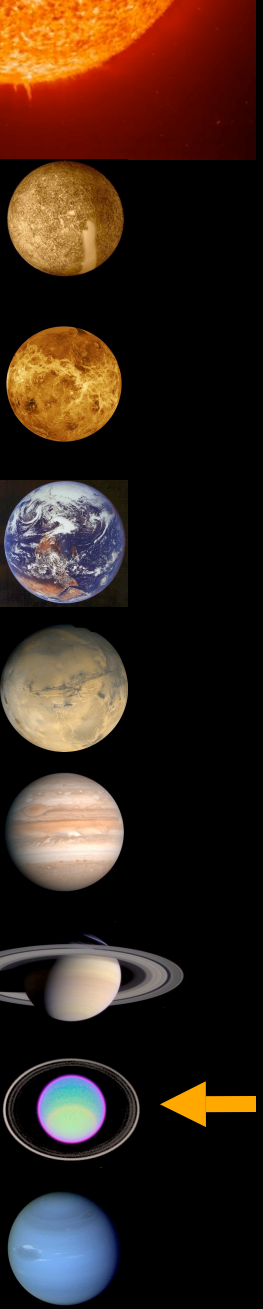
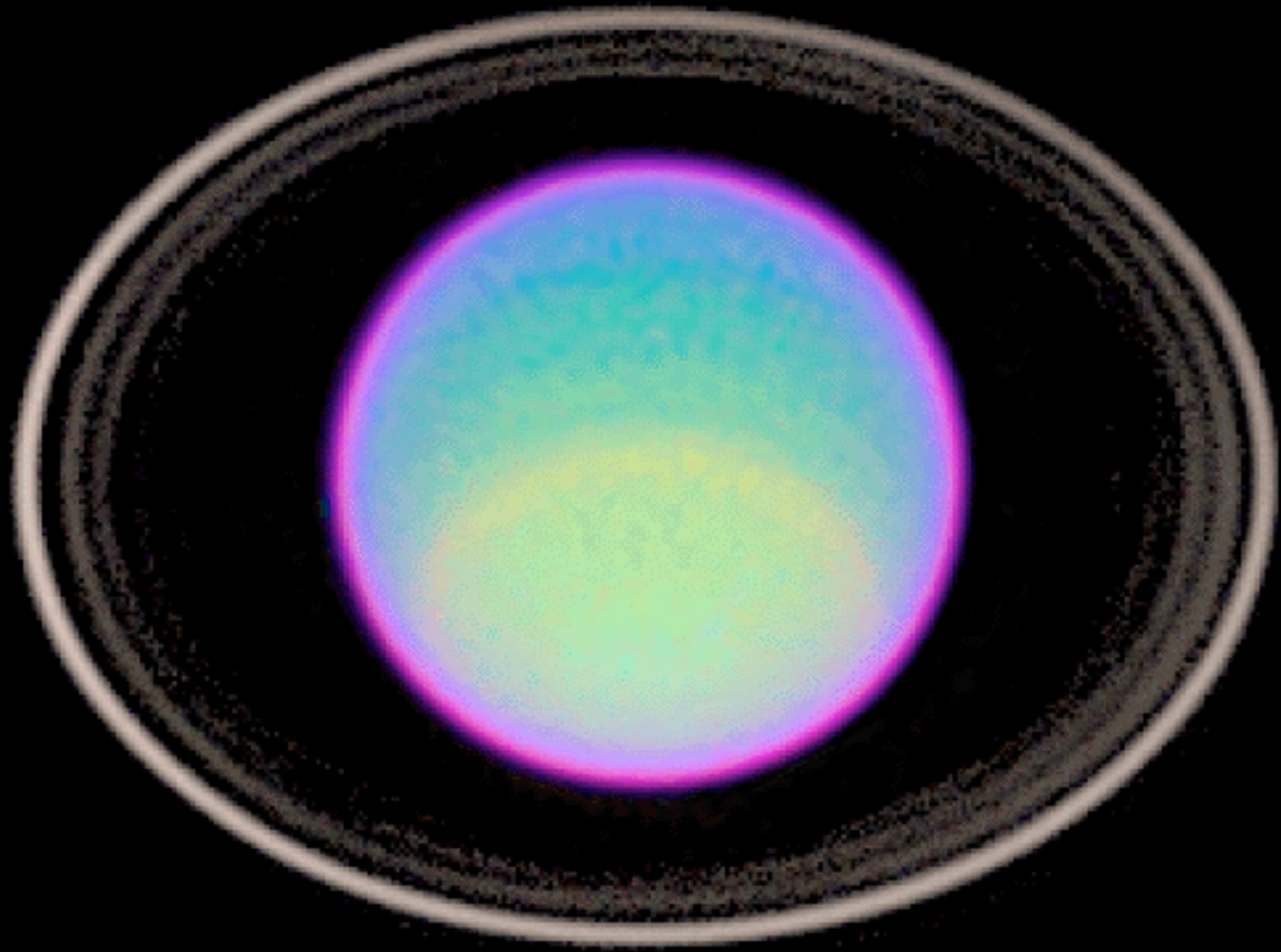
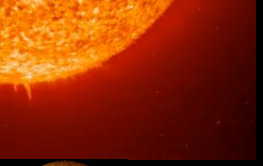
Uranus

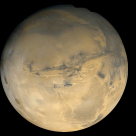


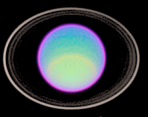
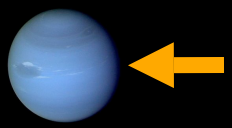


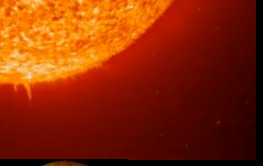
Neptune



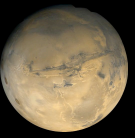


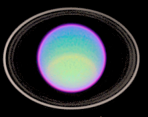
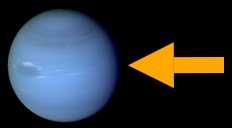




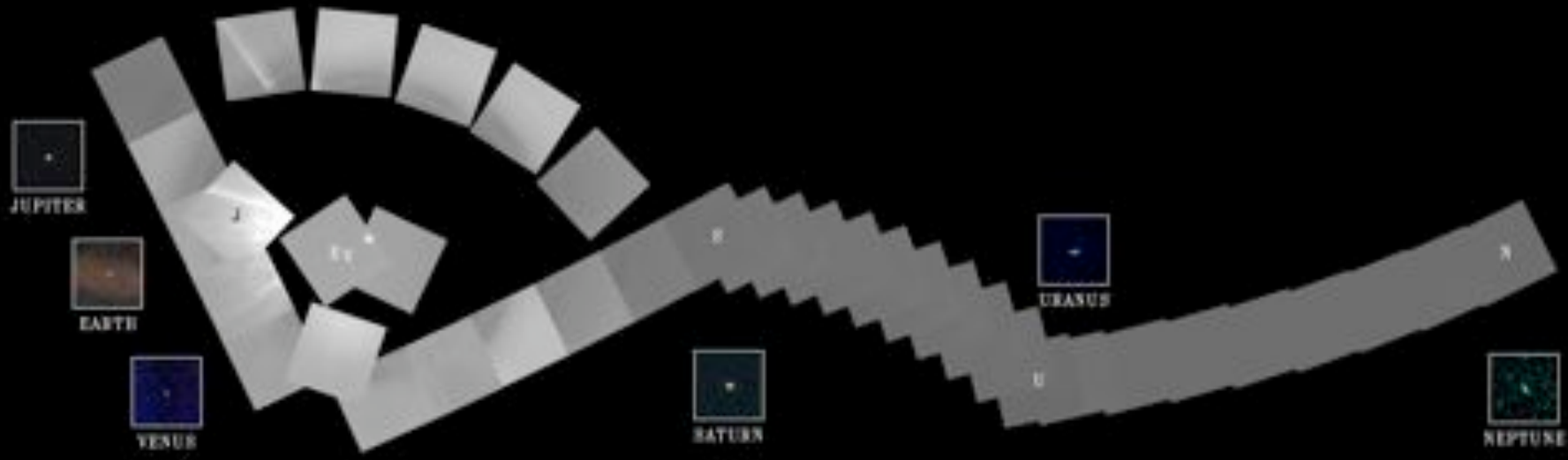




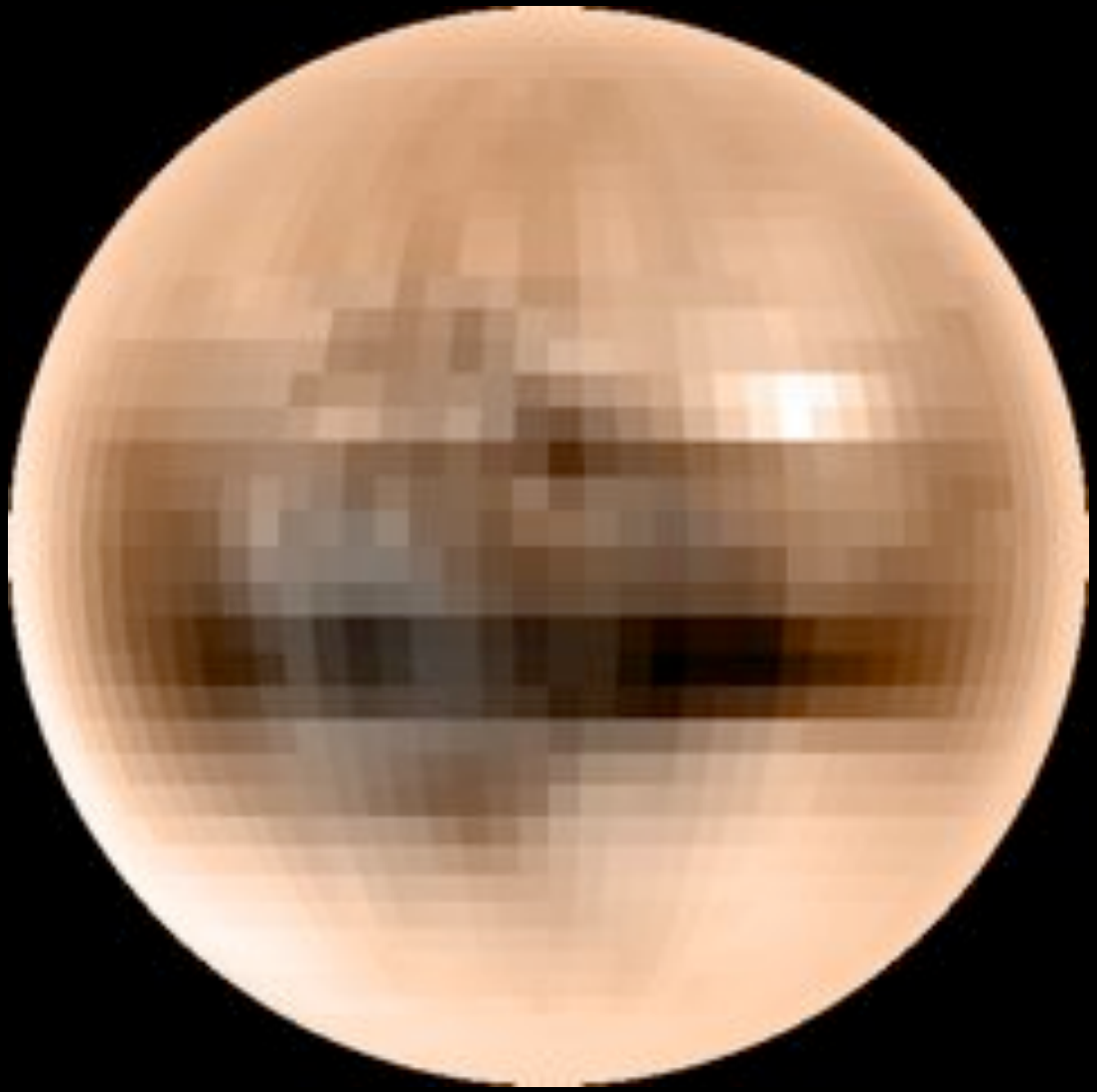




Neptune

Planets



Pluto

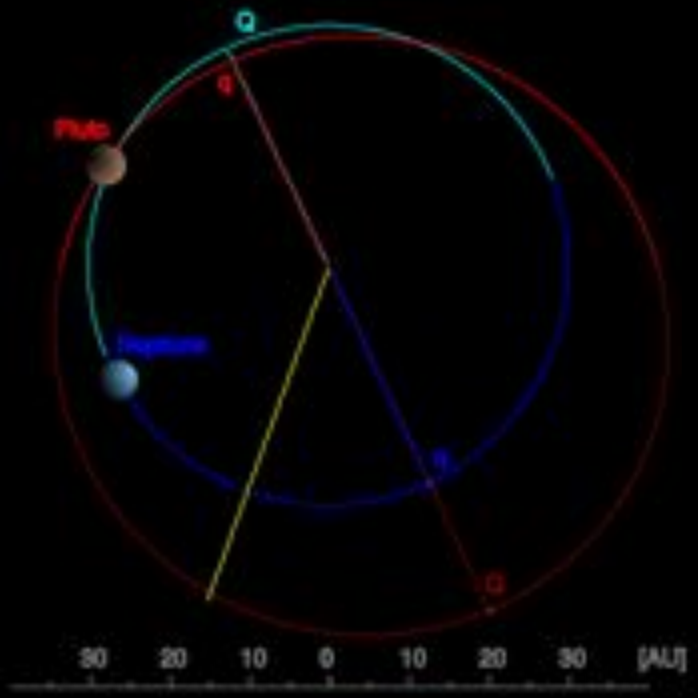


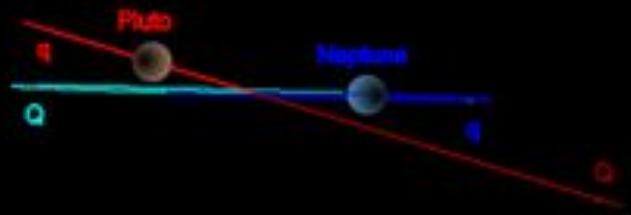
Dwarf Planet

- Orbits around the Sun
- Has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (near-spherical) shape
- Has not cleared the neighborhood around its orbit
- Is not a satellite

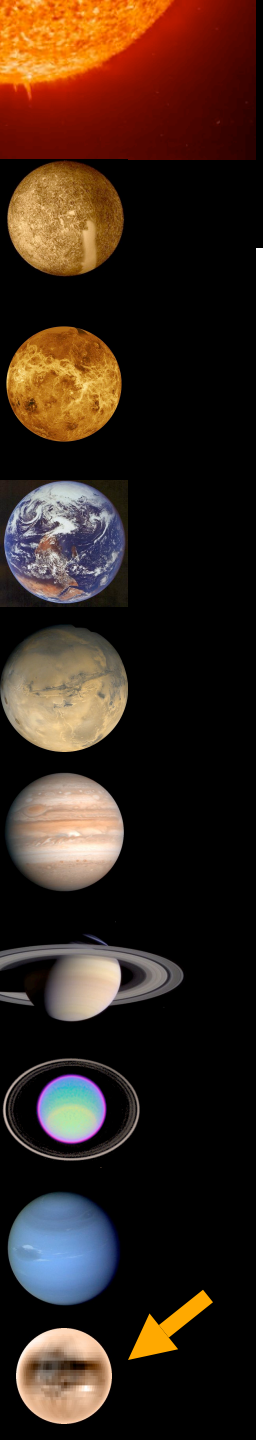
Pluto and Charon

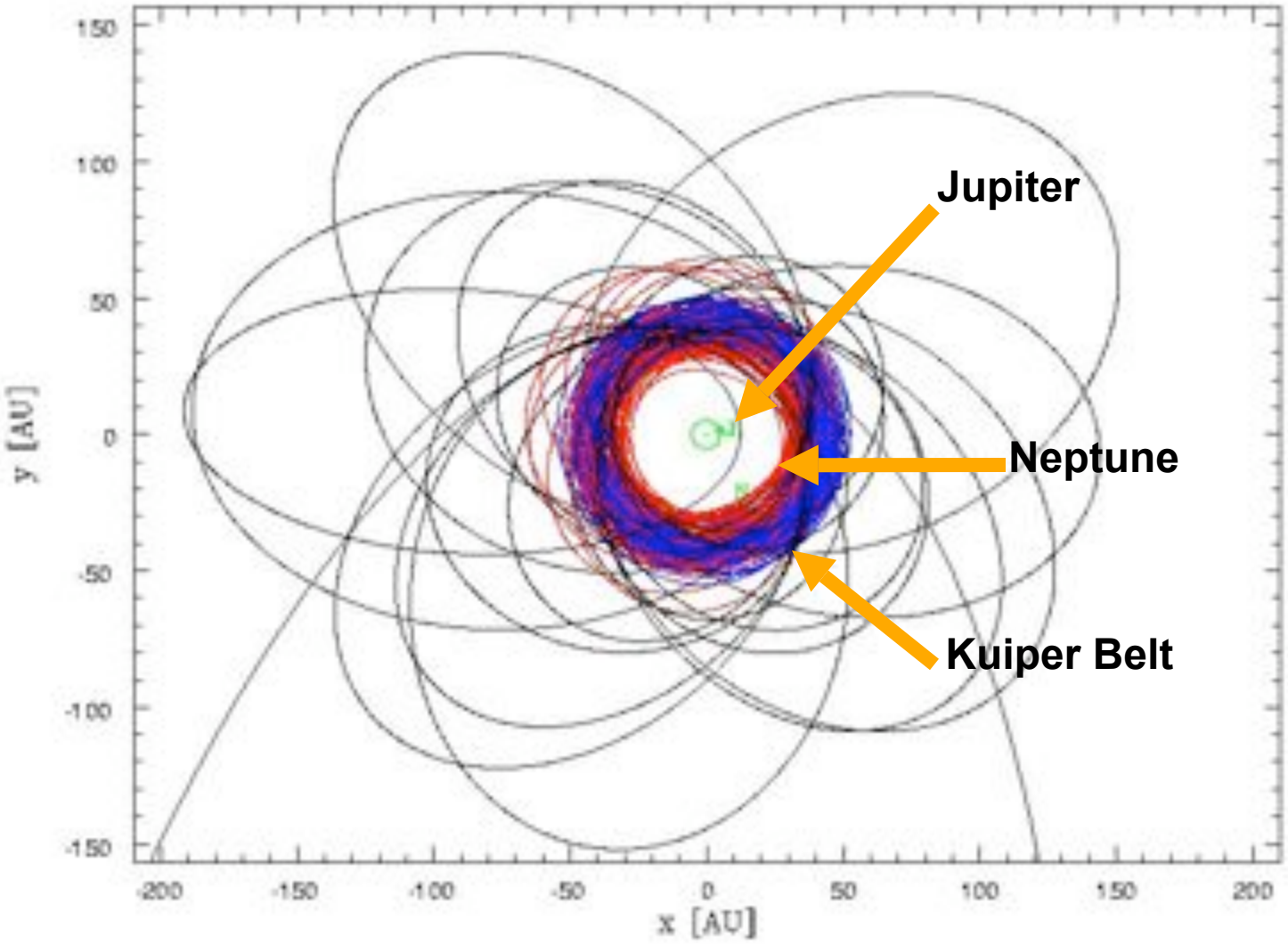
Pluto





Kuiper Belt

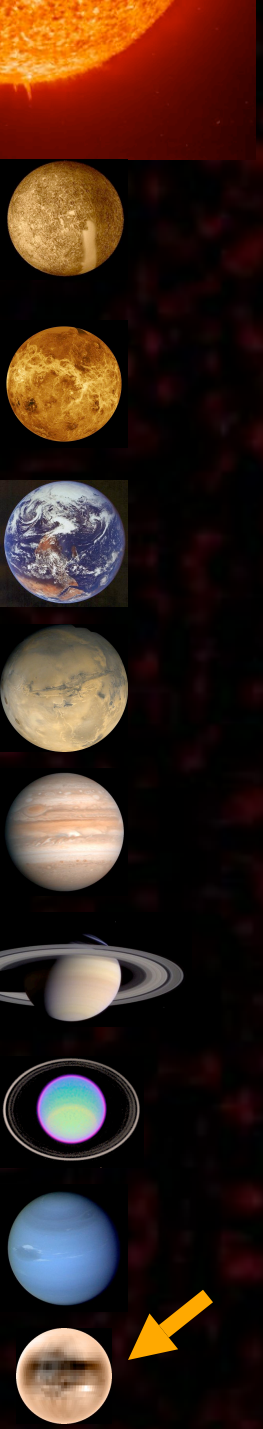



Jupiter
Neptune
Kuiper Belt
y [AU]
x [AU]
150
100
50
0
-50
-100
-150
-200
-150
-100
-50
0
50
100
150
200

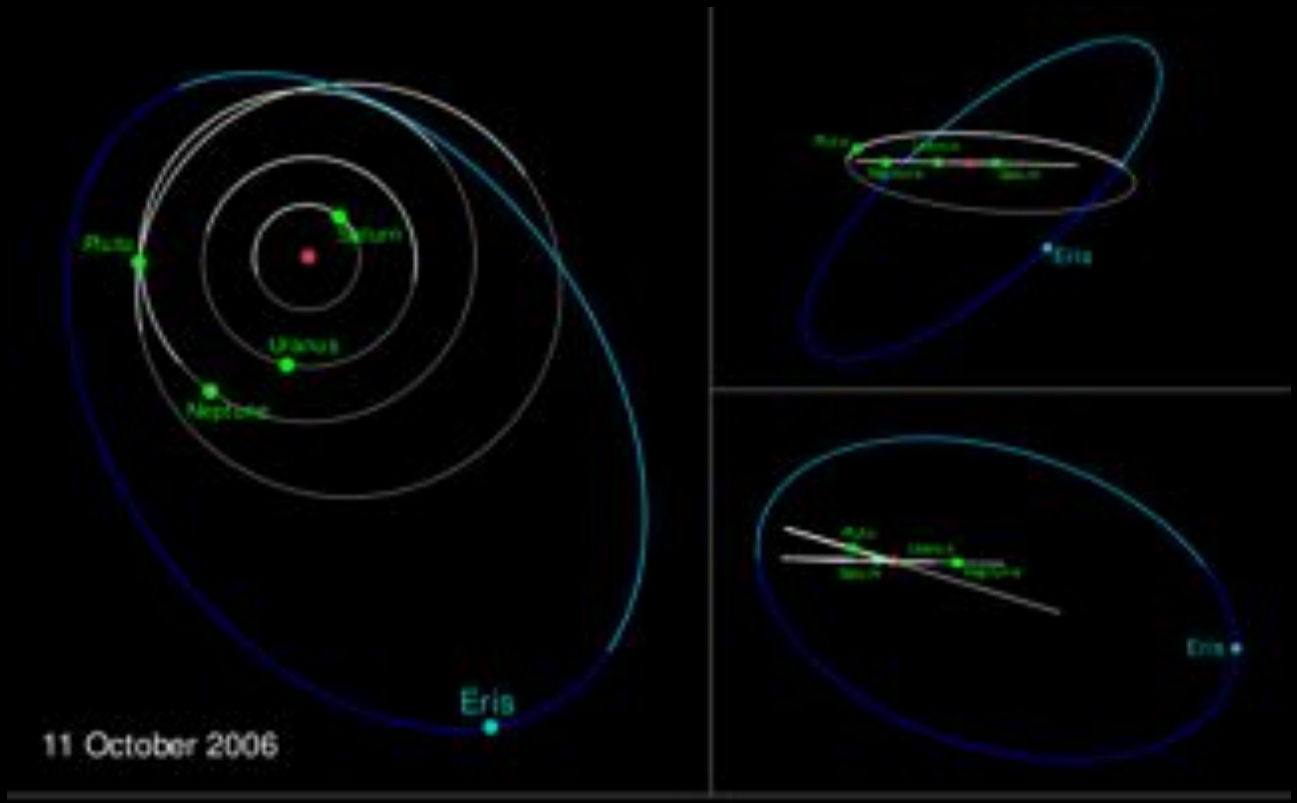
Kuiper Belt


Sedna
800-1100 miles
in diameter
Quaoar
(800 miles)
Pluto
(1400 miles)
Moon
(2100 miles)
Earth
(8000 miles)

Eris



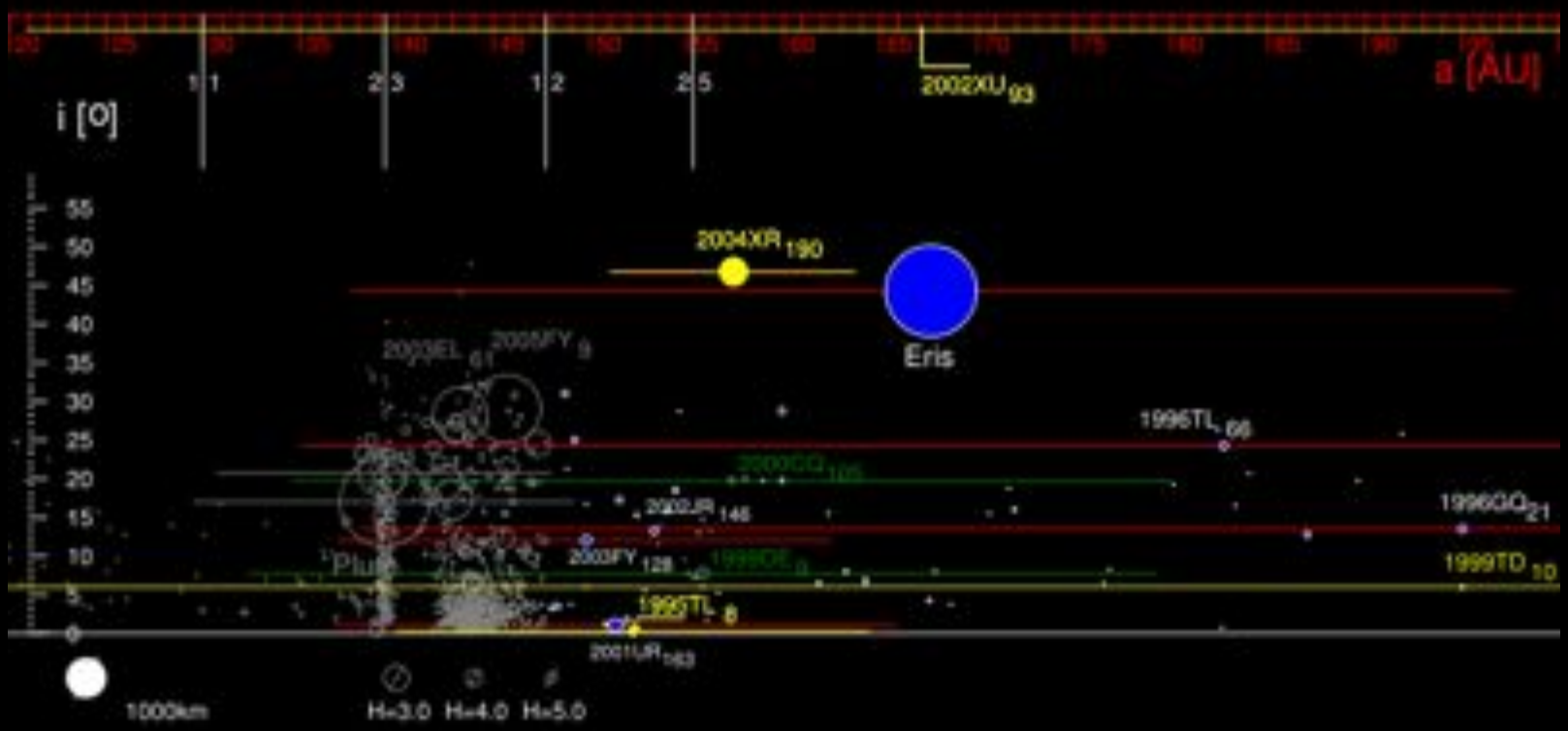
Eris



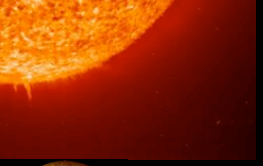
Orbit of Eris
(136199 Eris)

Perihelion: 37.77 AU
Aphelion: 97.56 AU
Eccentricity: 0.44
Inclination: 44°
Orbital period: 557 years

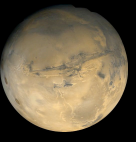
Scattered Disk

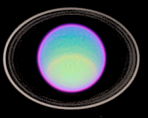


Comets



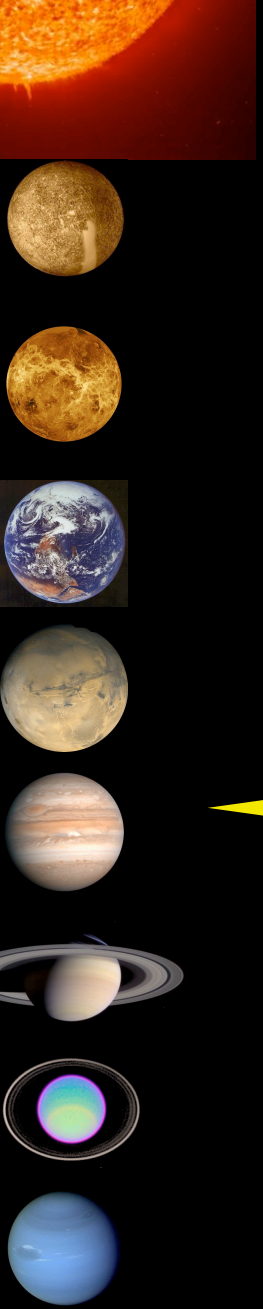


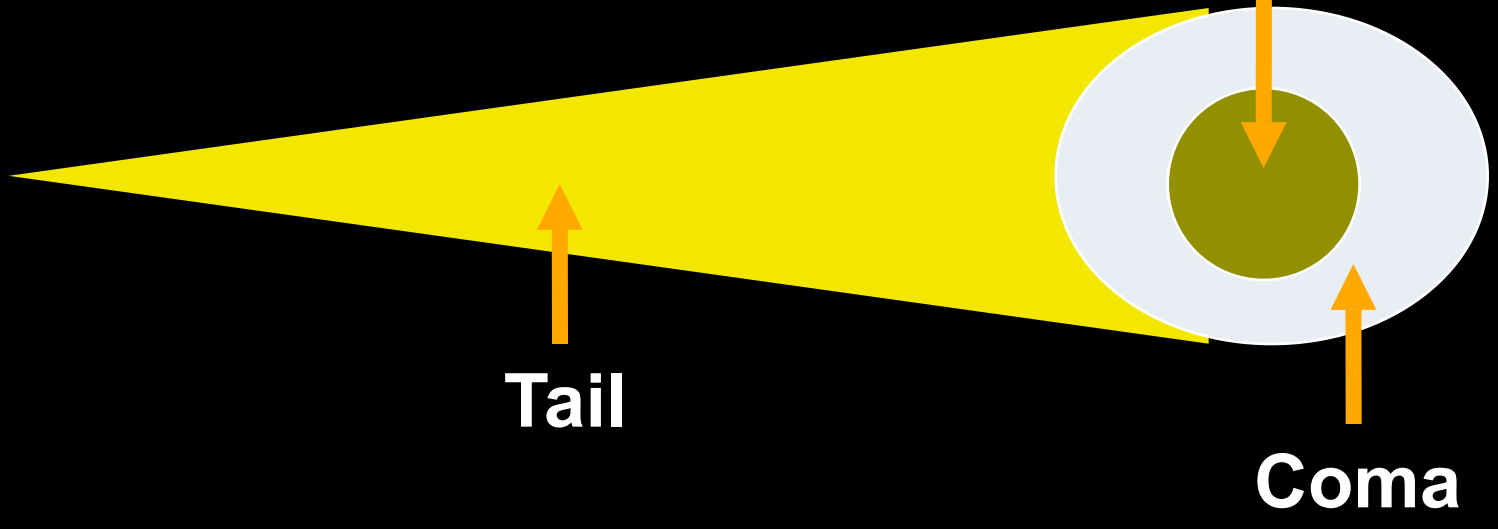



Comets

Comets





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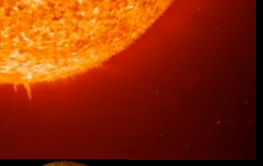
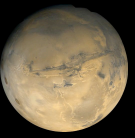
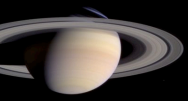
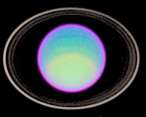
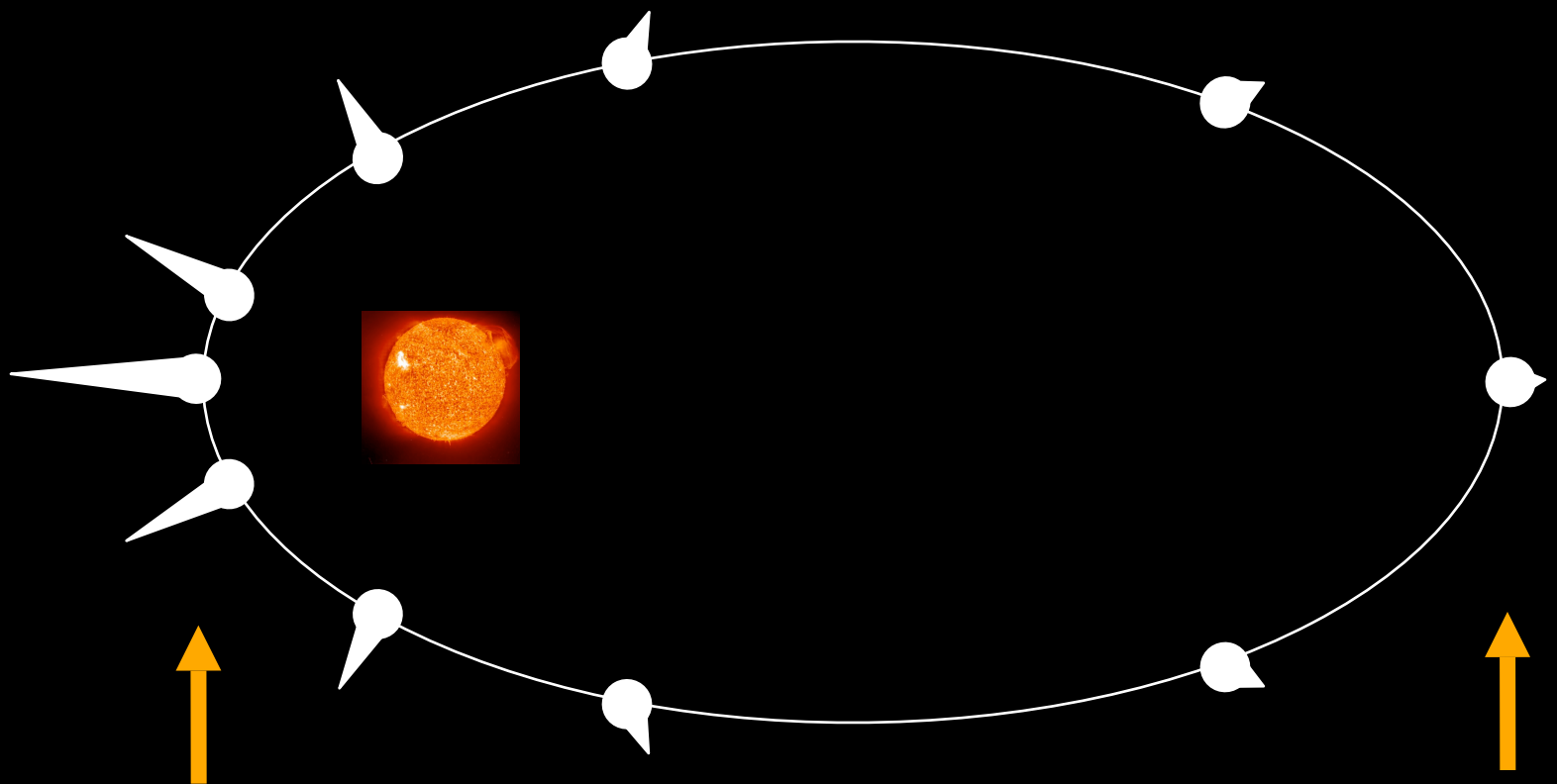


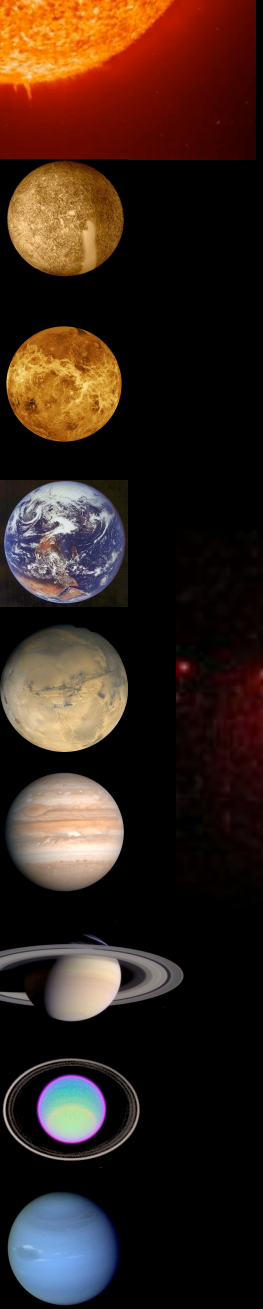


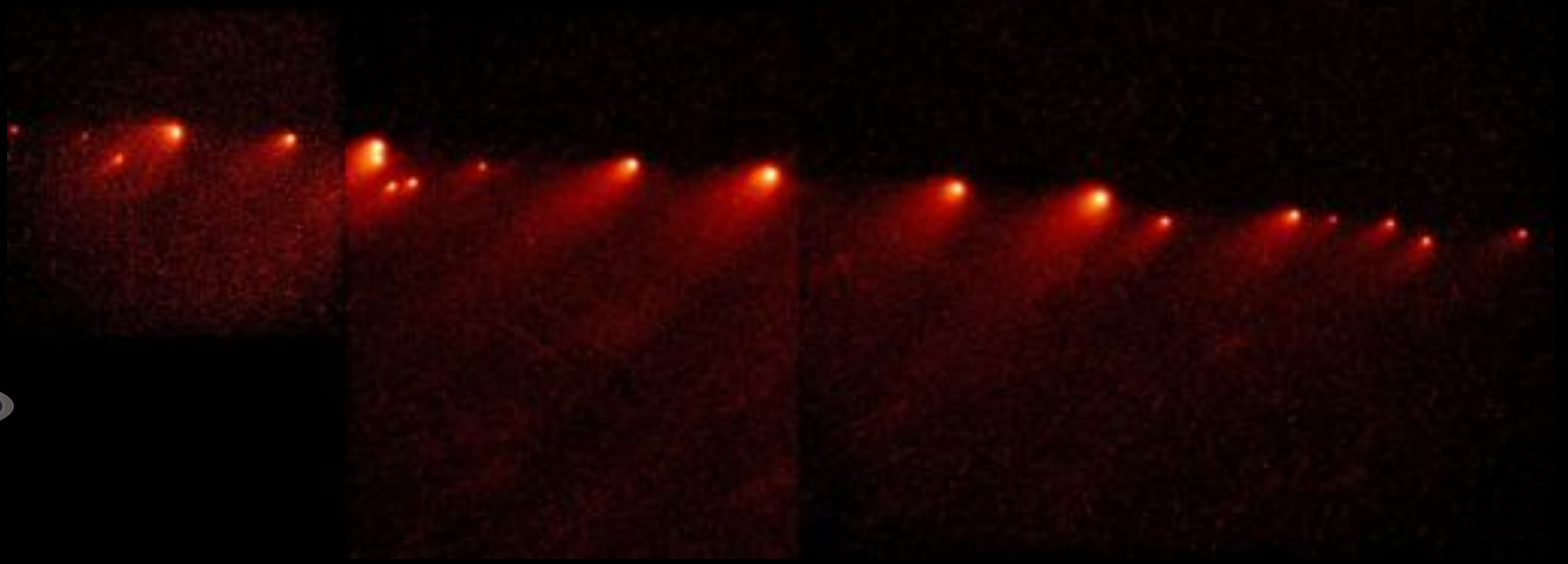


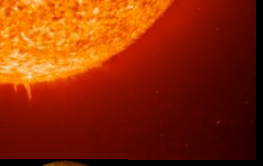



Comets

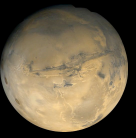


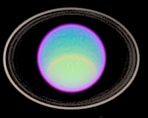


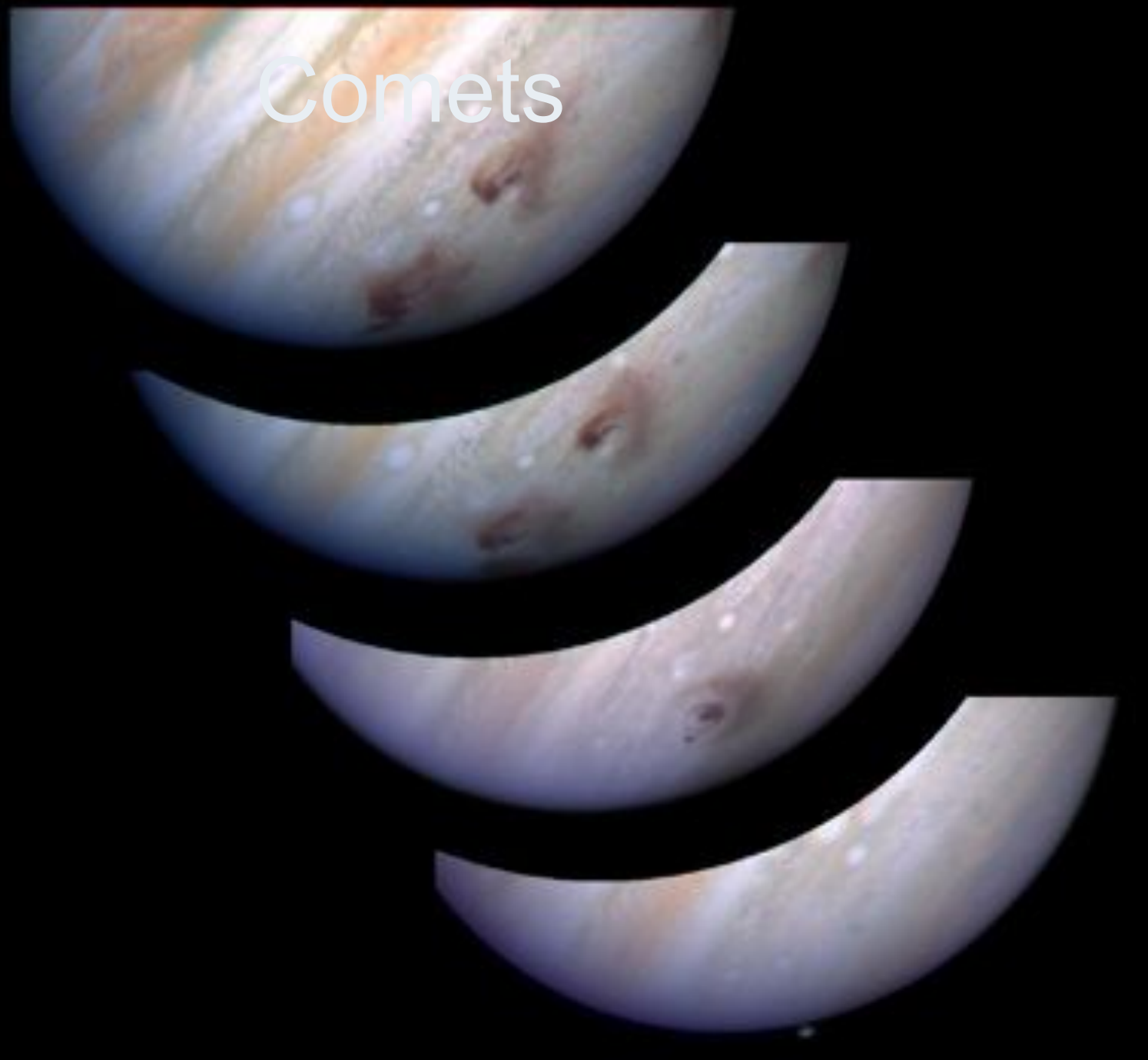
Comets



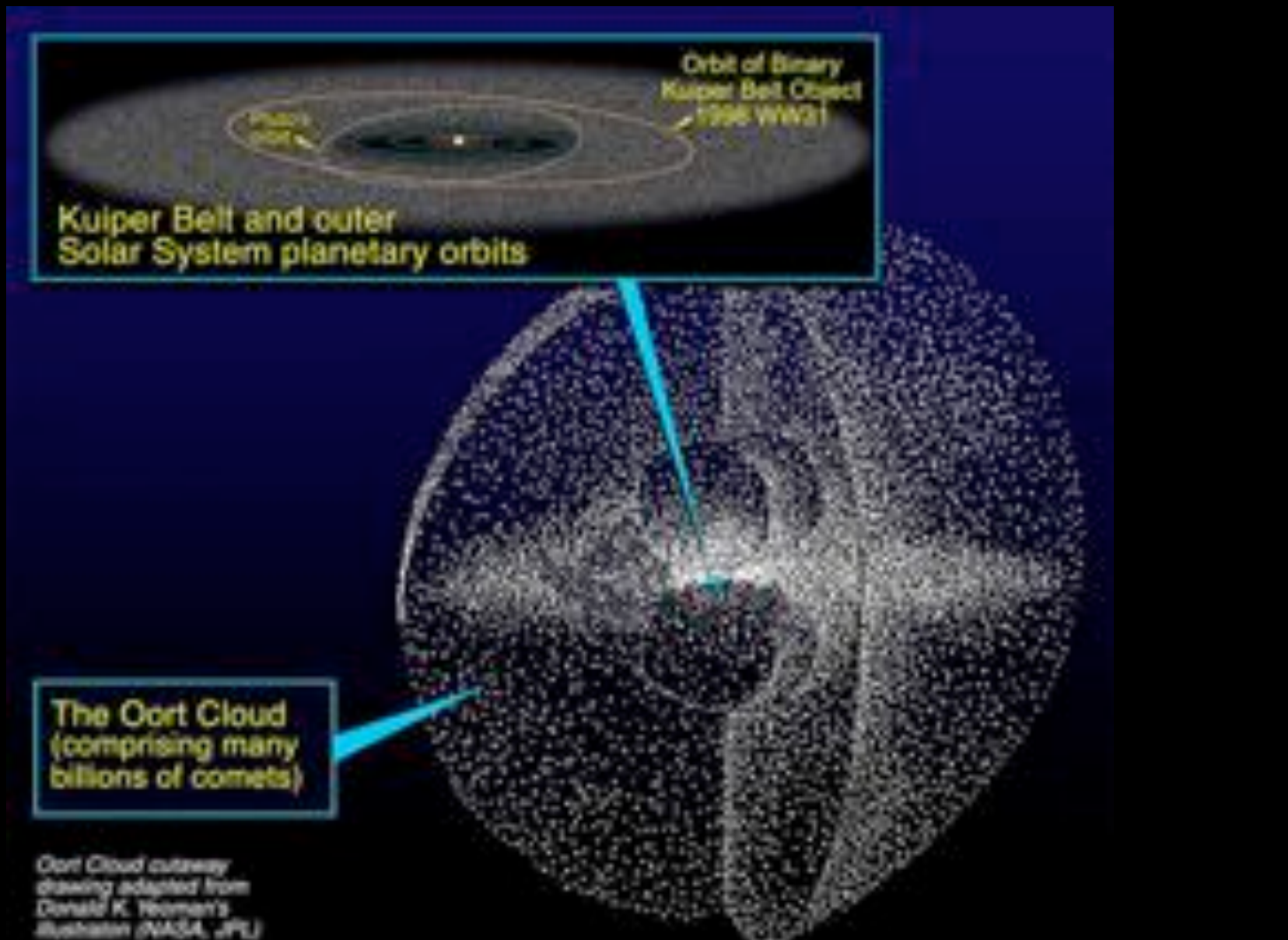






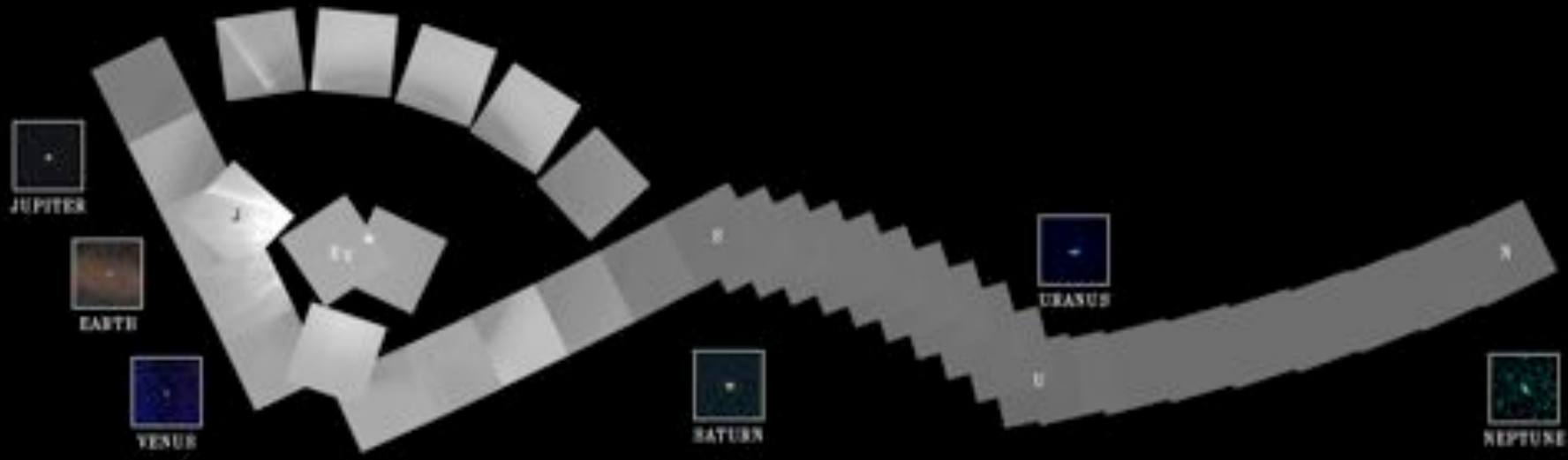
Oort Cloud


Orbit of Binary
Kuiper Belt Object
1998 WW31
Kuiper Belt and outer
Solar System planetary orbits
The Oort Cloud
(comprising many
billions of comets)
Oort Cloud cutaway
drawing adapted from
Donald K. Yeoman's
illustration (NASA, JPL)

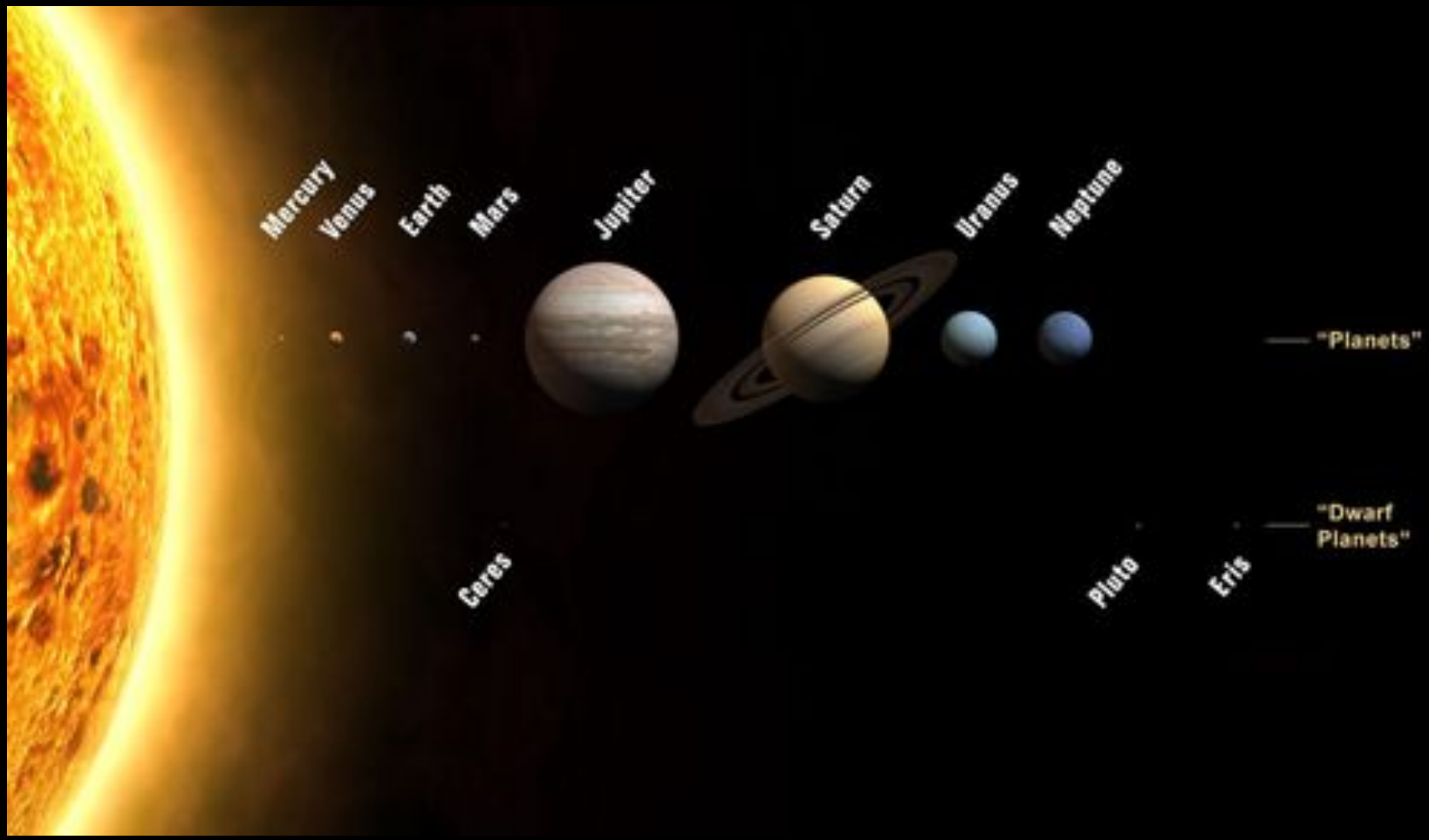
Trans-Neptune Objects

- Kuiper Belt
- Scattered disk
- Oort Cloud

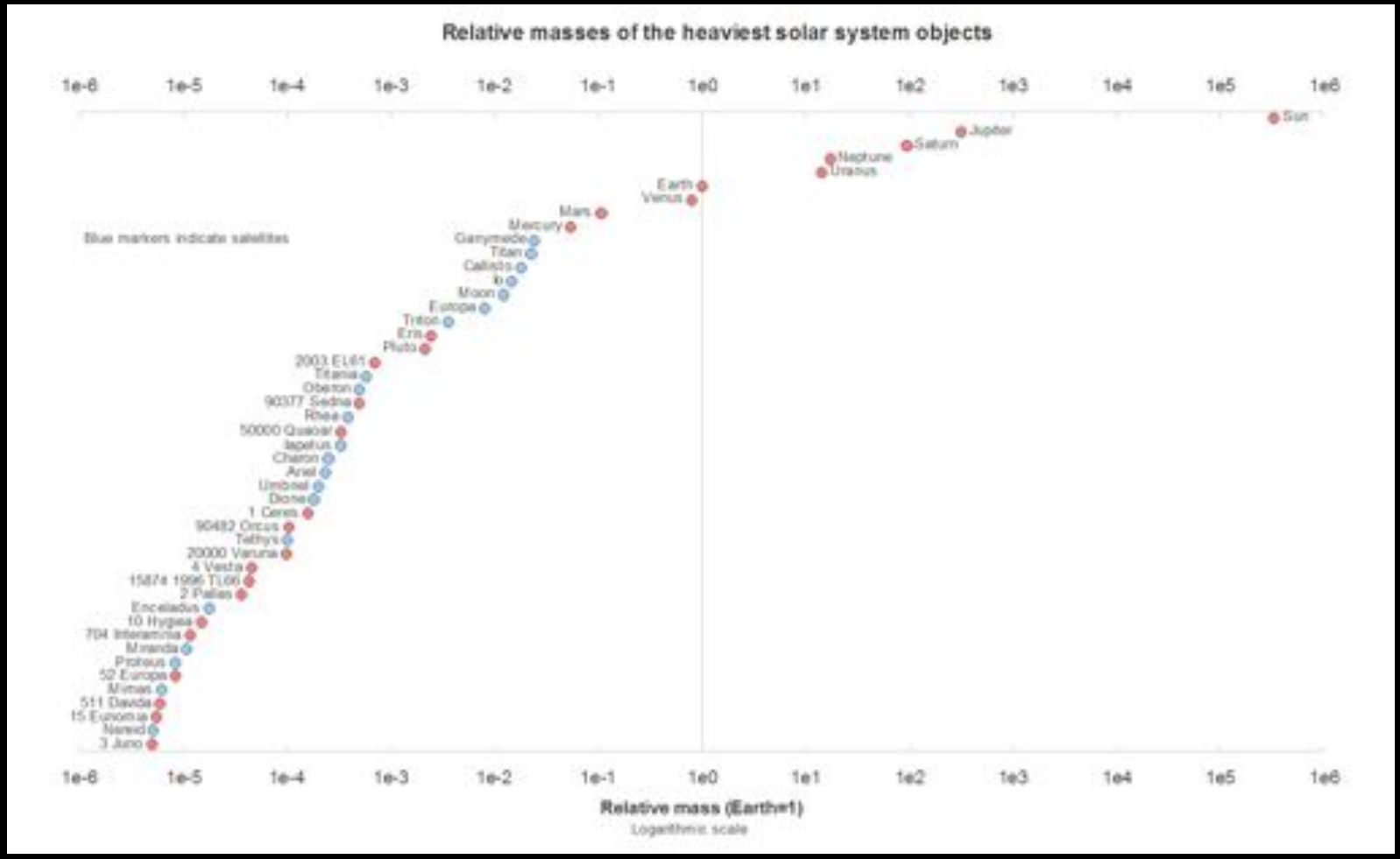
The Solar System



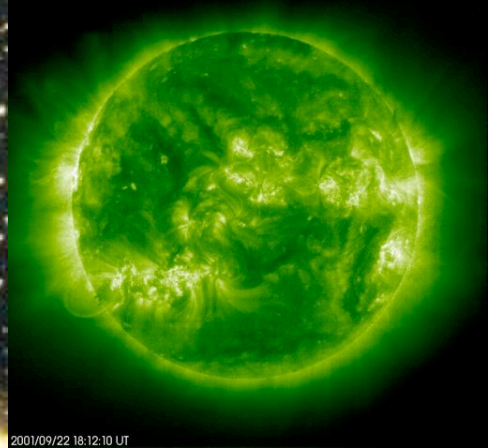
The Solar System



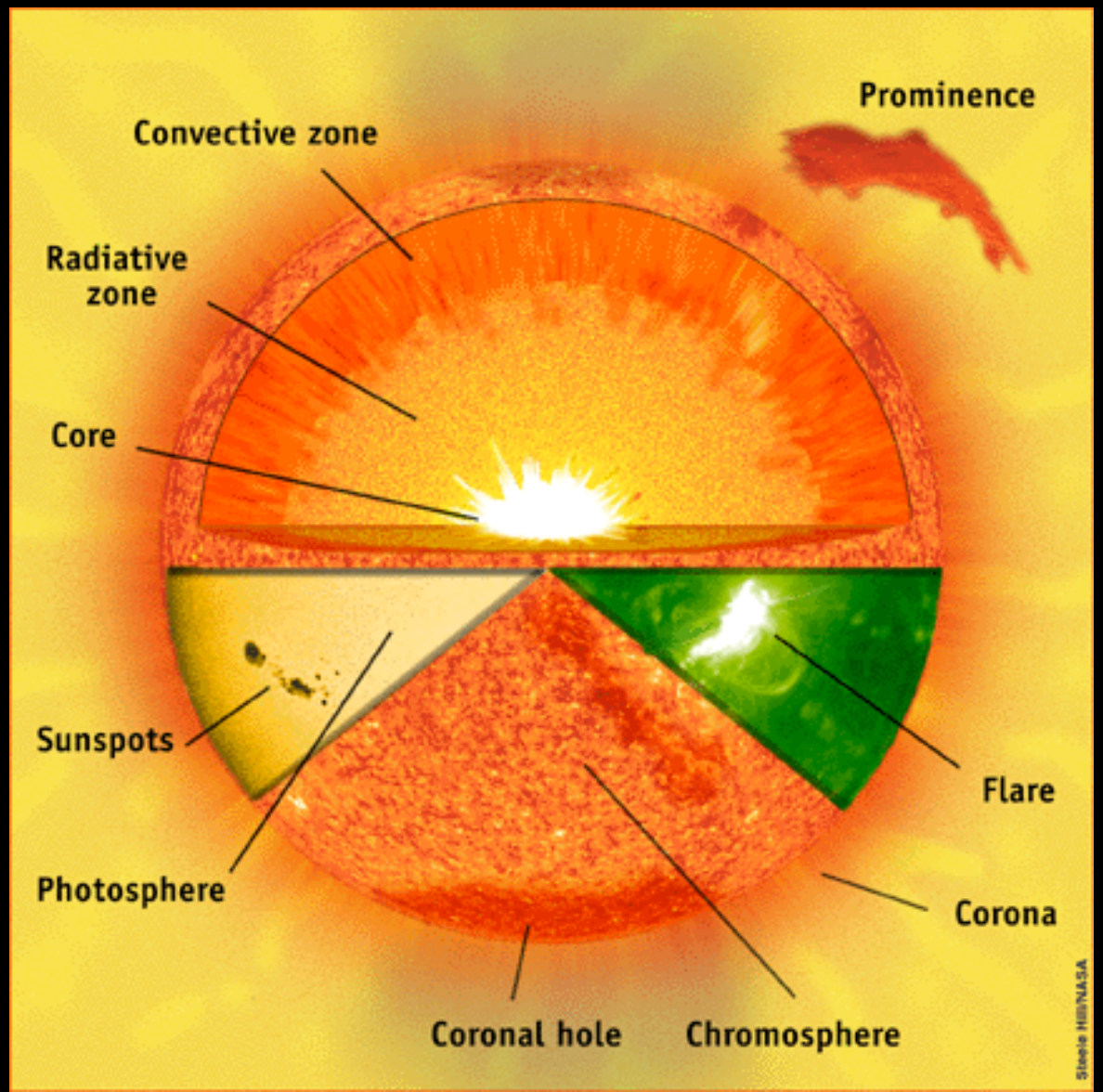
The Solar System



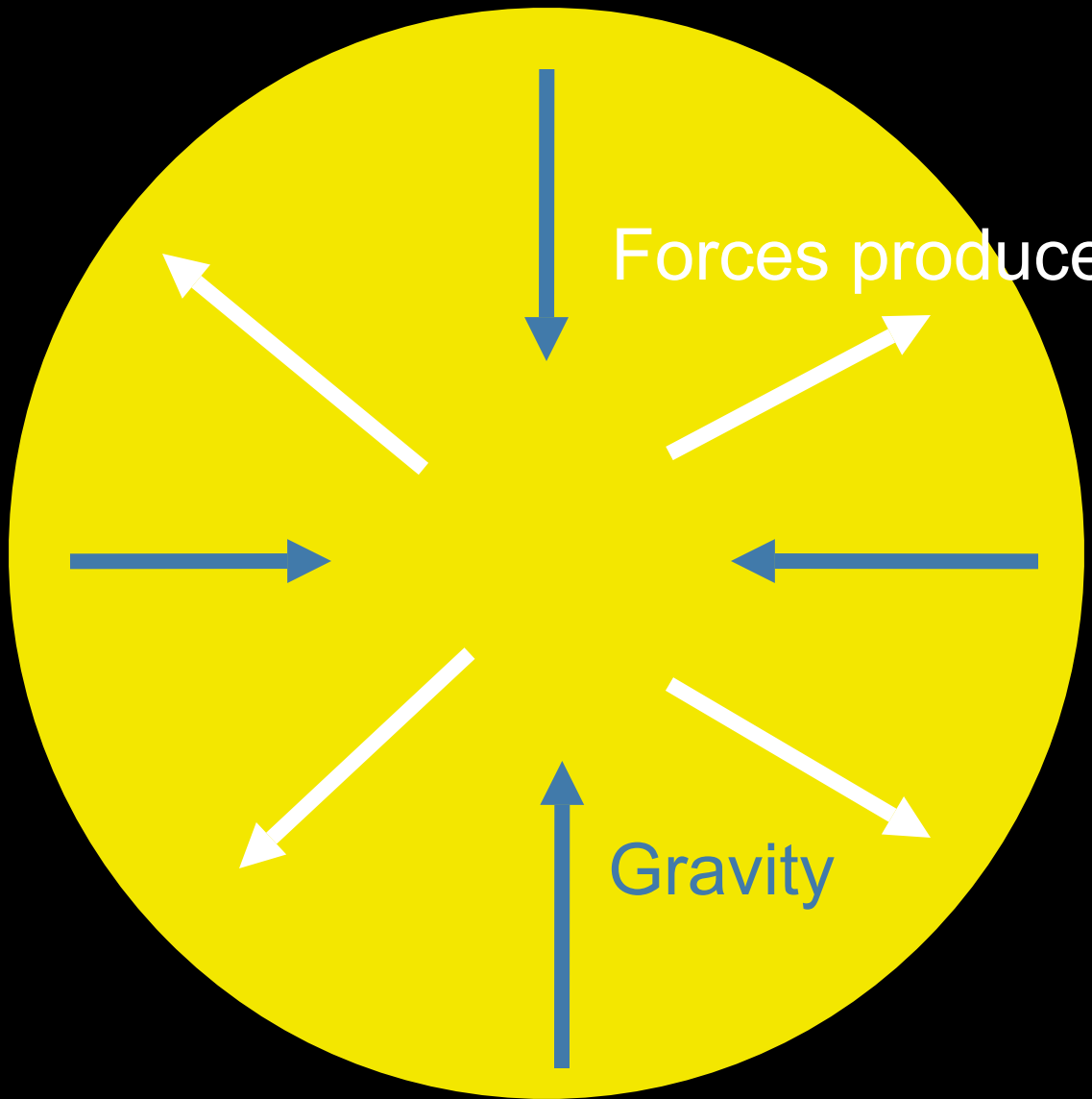
Stars



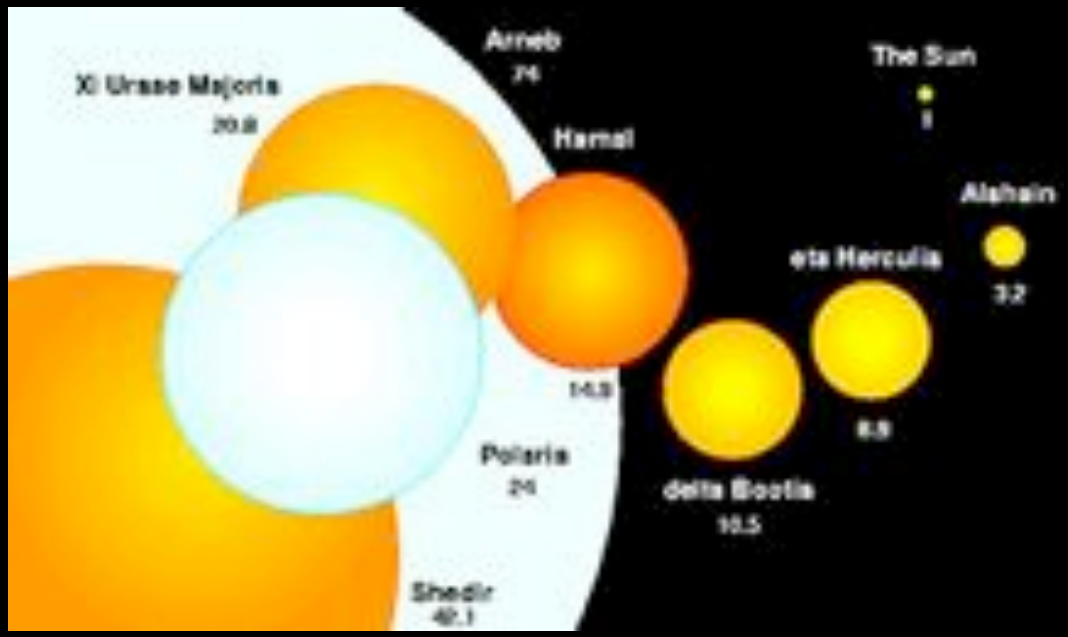
The Sun – Layers



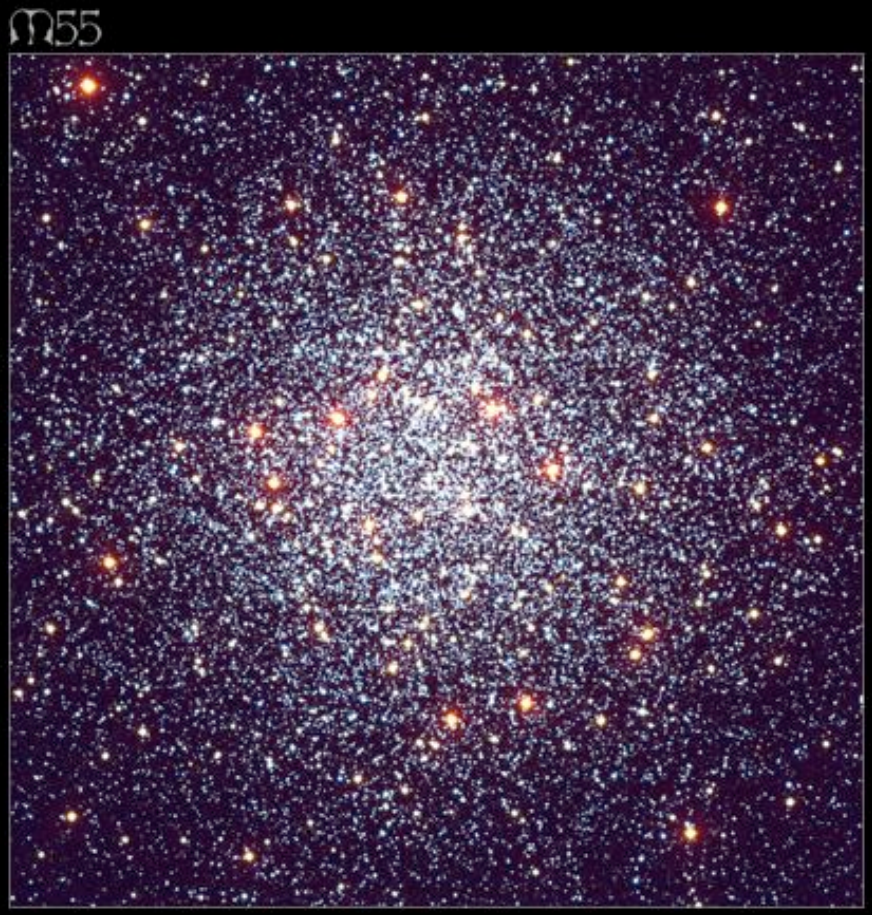
Stars – Balancing Act

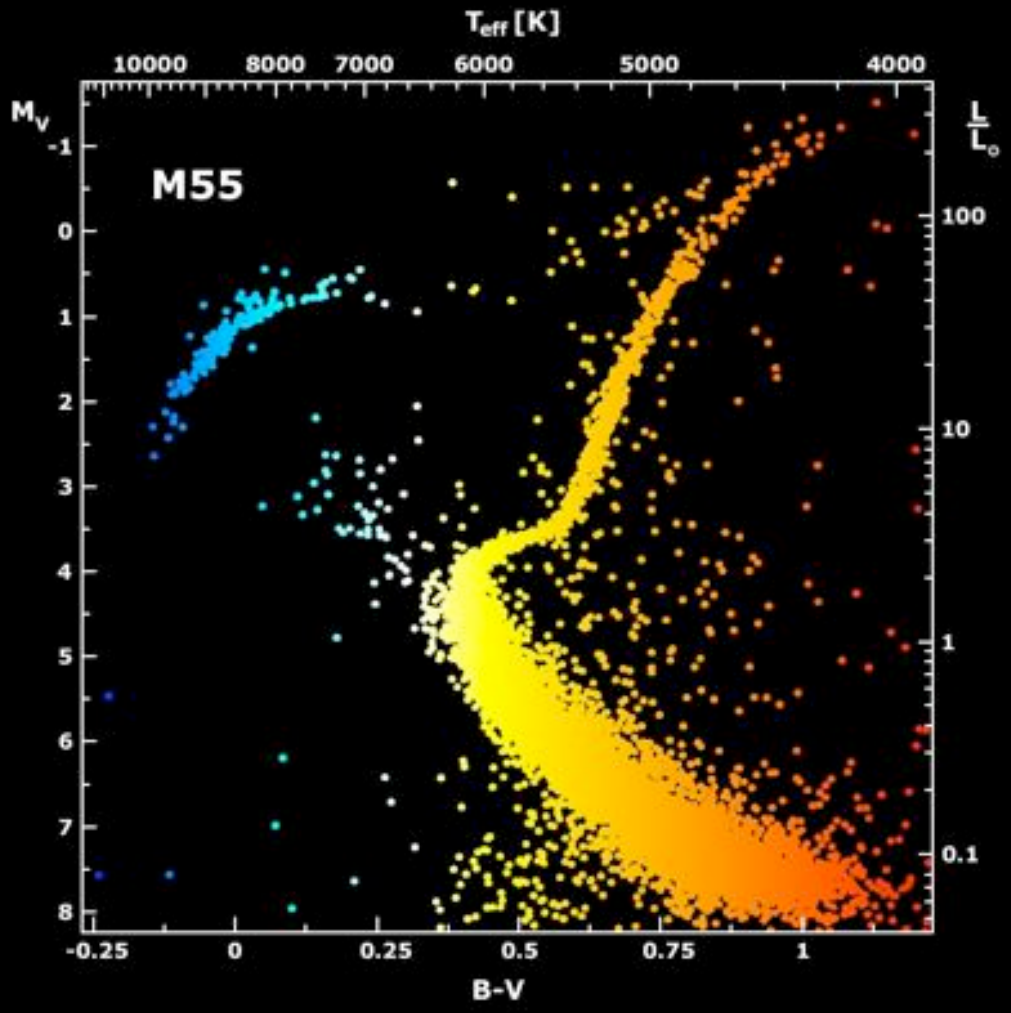


Star Size

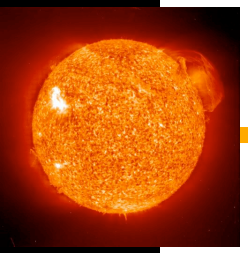

Xi Ursae Majoris
Arneb
Hamal
The Sun
Alphain
eta Herculis
3.2
Polaris
delta Bootis
Shedir

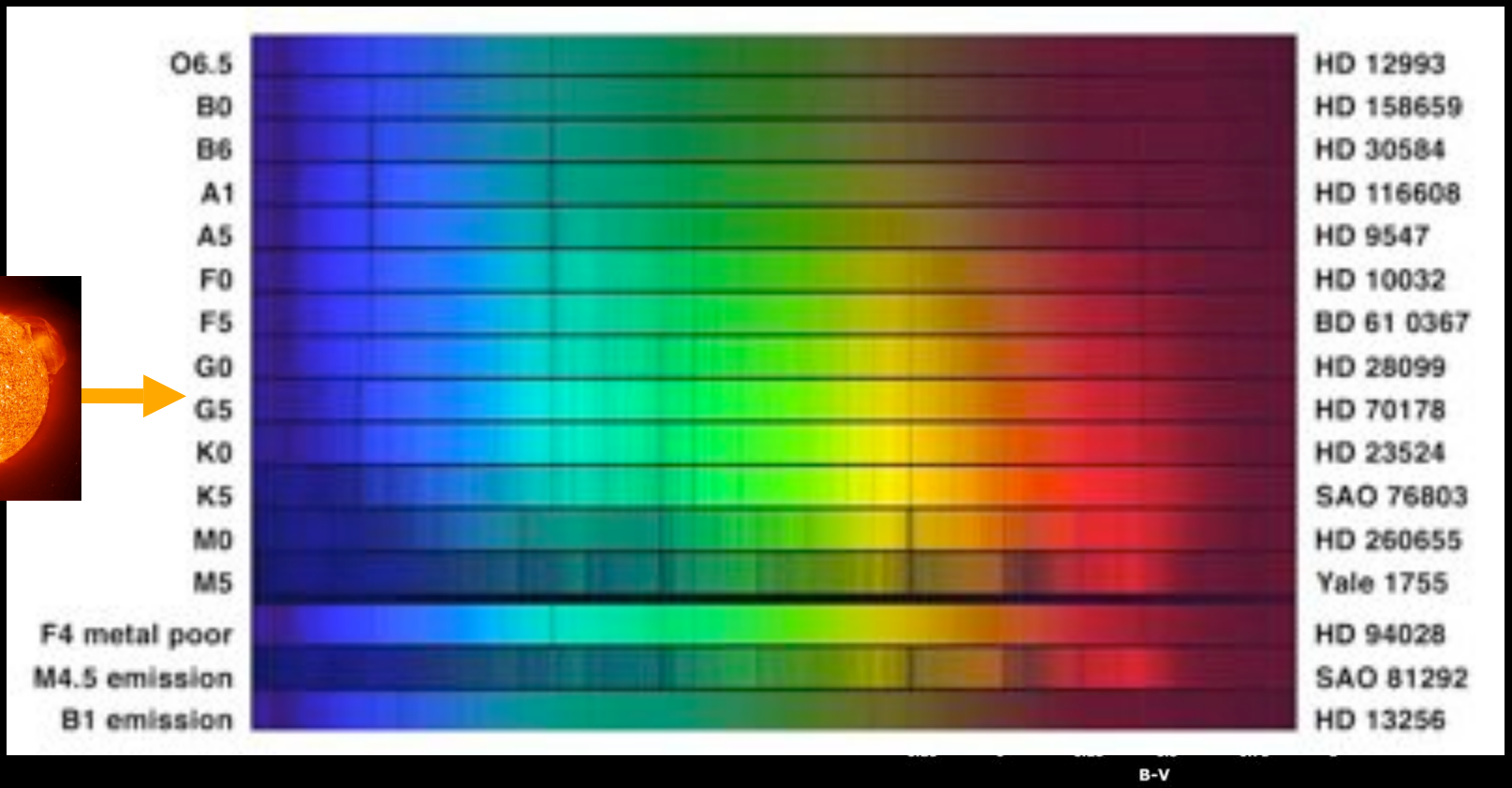
Star Color / Temperature



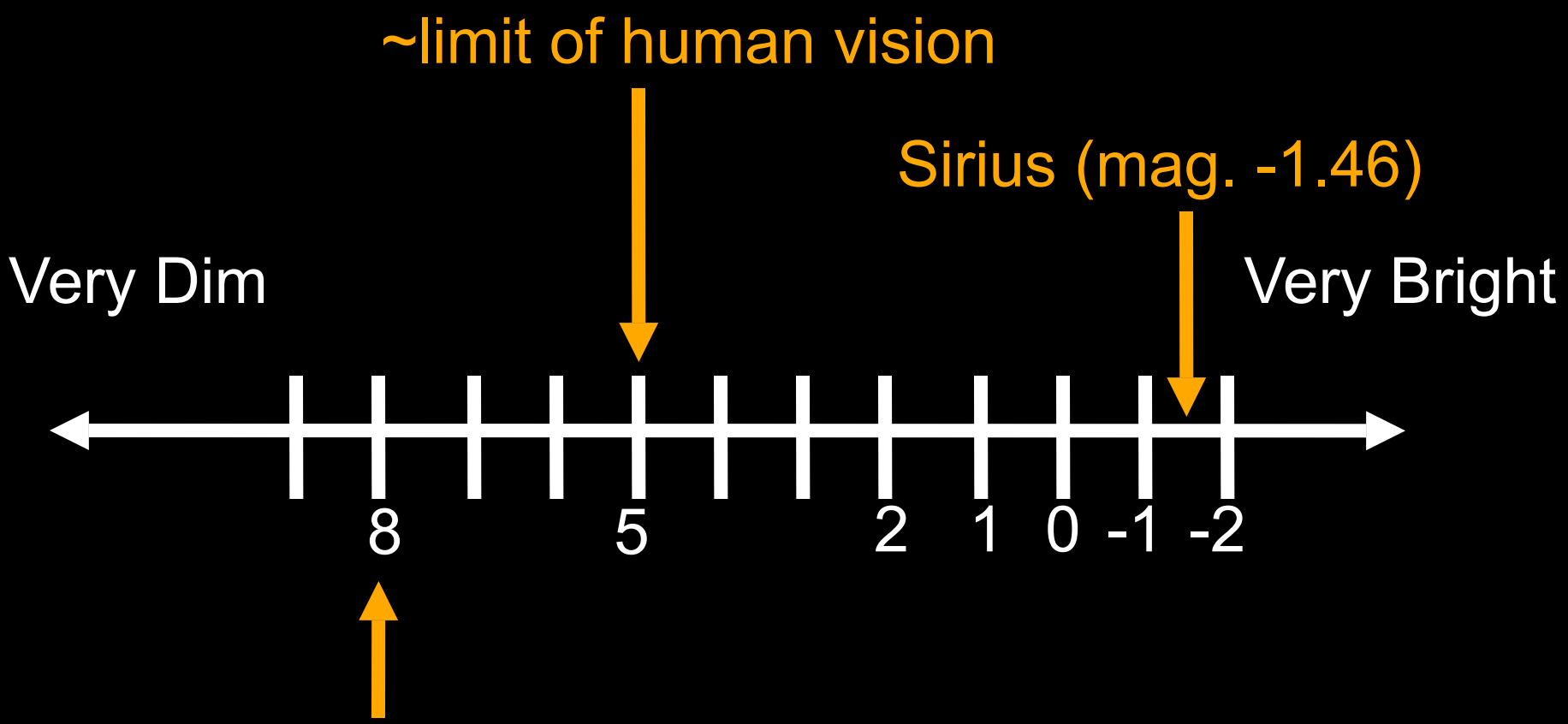


Star Color / Temperature

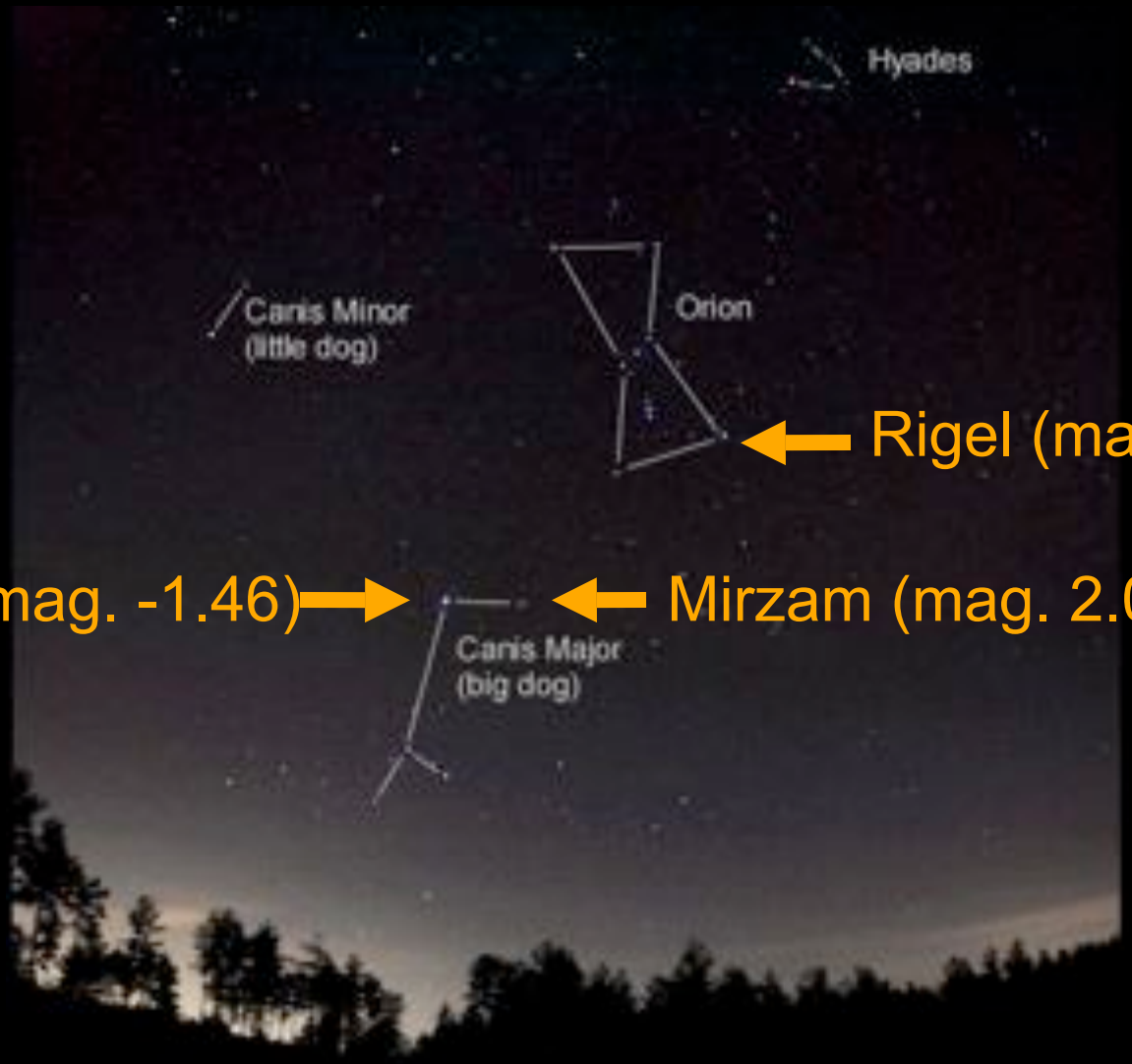




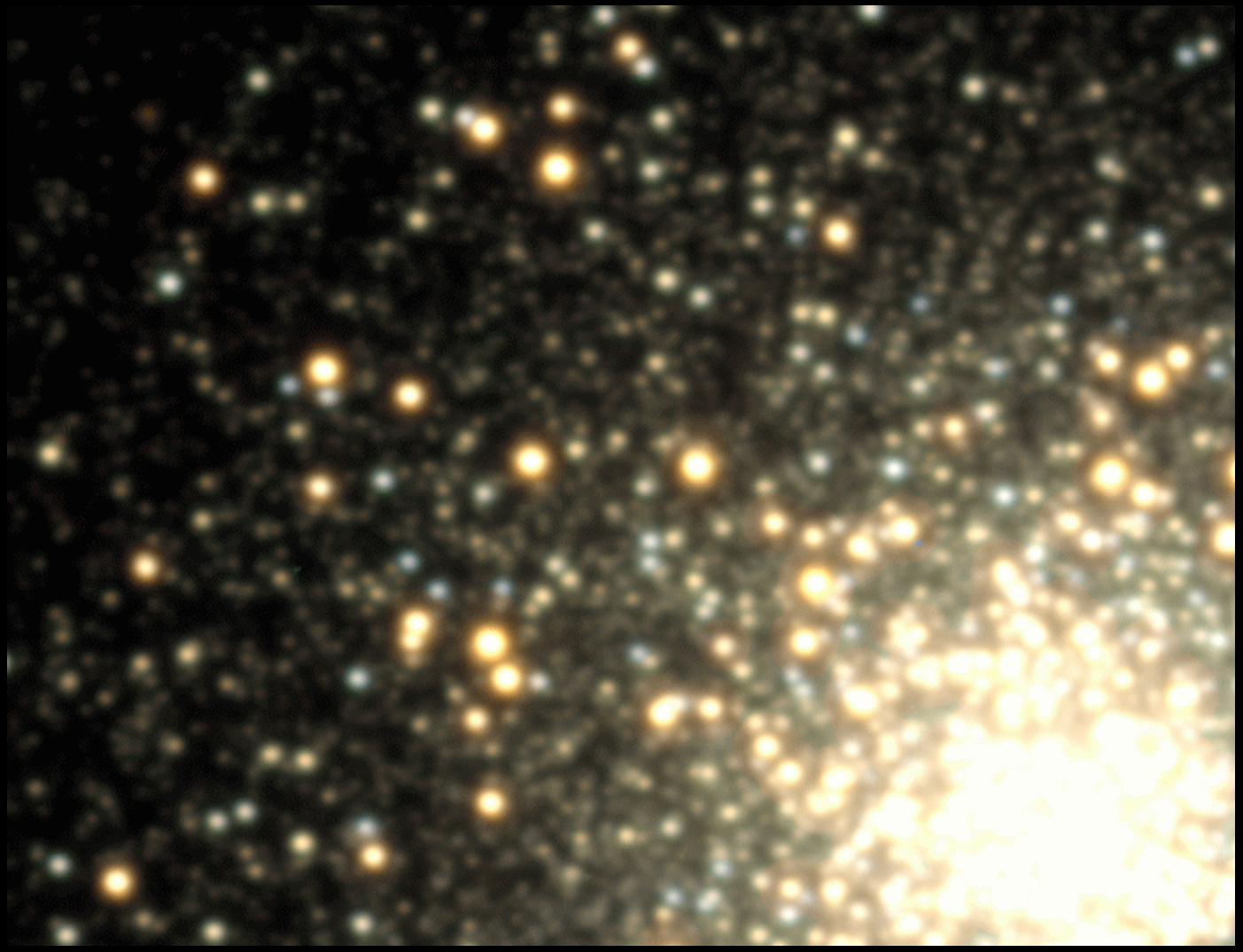
Star Brightness (Magnitude)



Star Brightness



Variable Stars



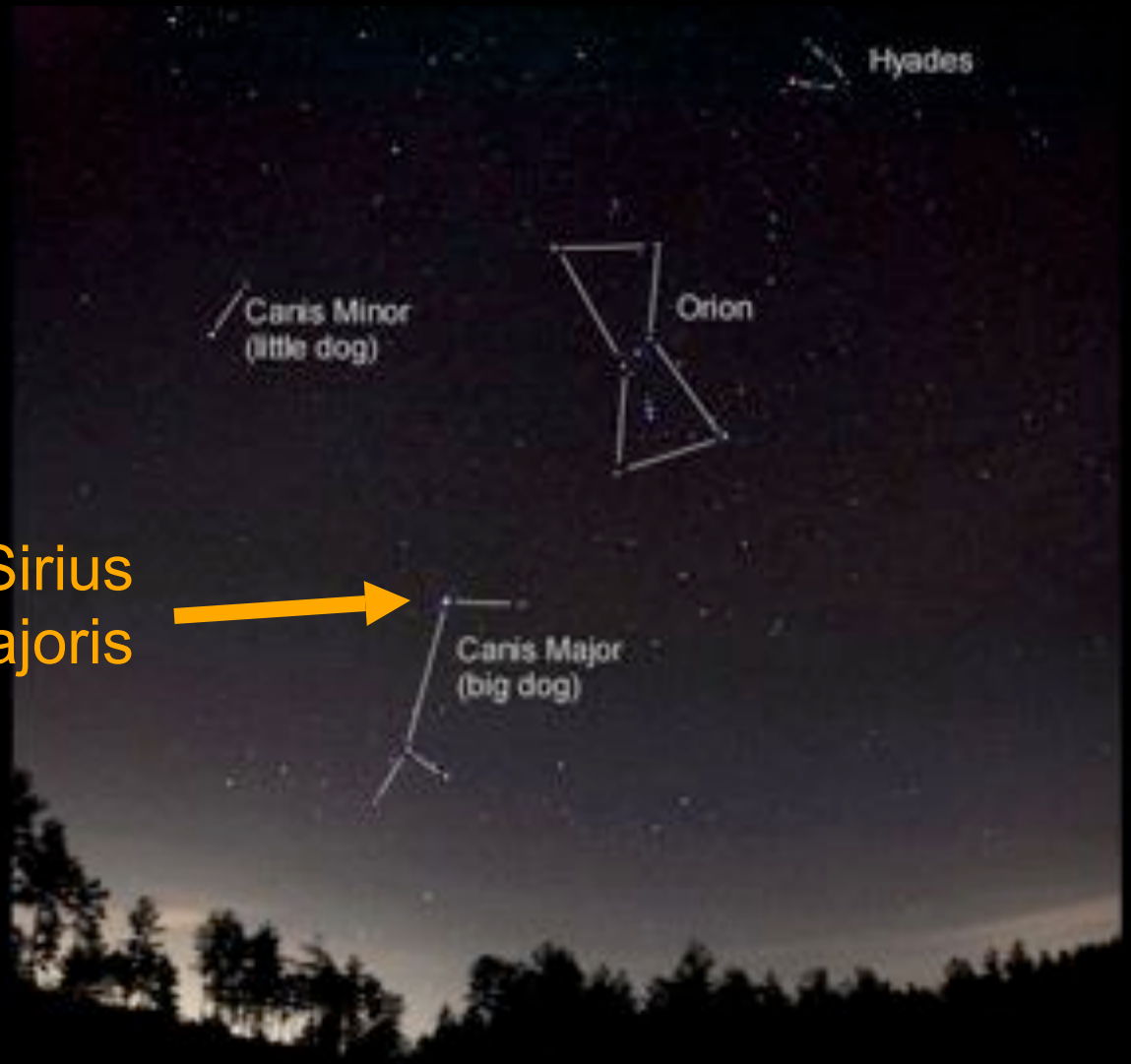
Variable Stars

- Pulsing Stars
- Eclipsing Binaries

Star Names

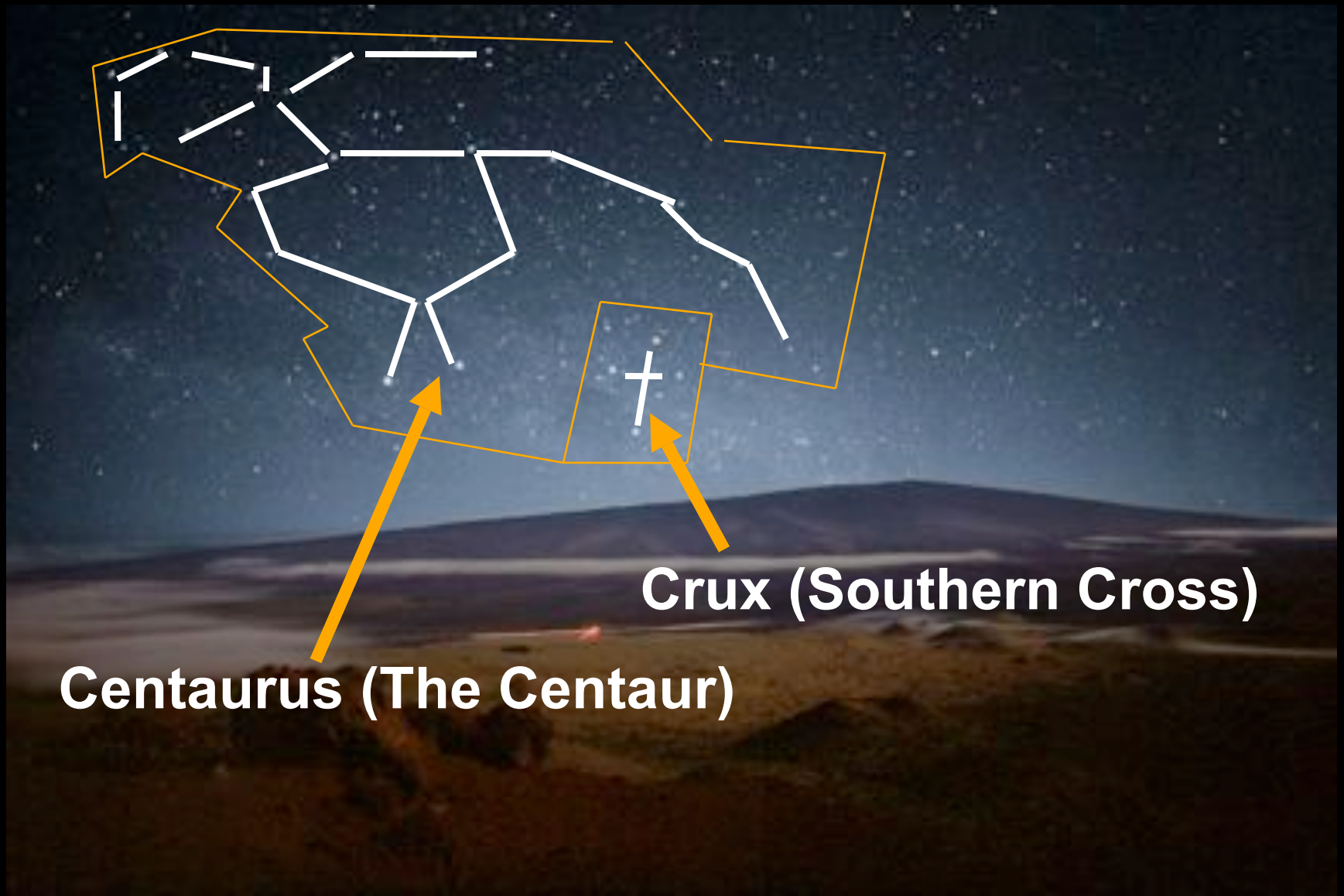
- Proper (Greek or Arabic names)
- Bayer Letters
  - Use Greek letters to designate stars in a constellation by brightness
  - α is brightest, β is second brightest, &c.
- Flamsteed numbers for stars without proper names, or Bayer Letters

Star Names

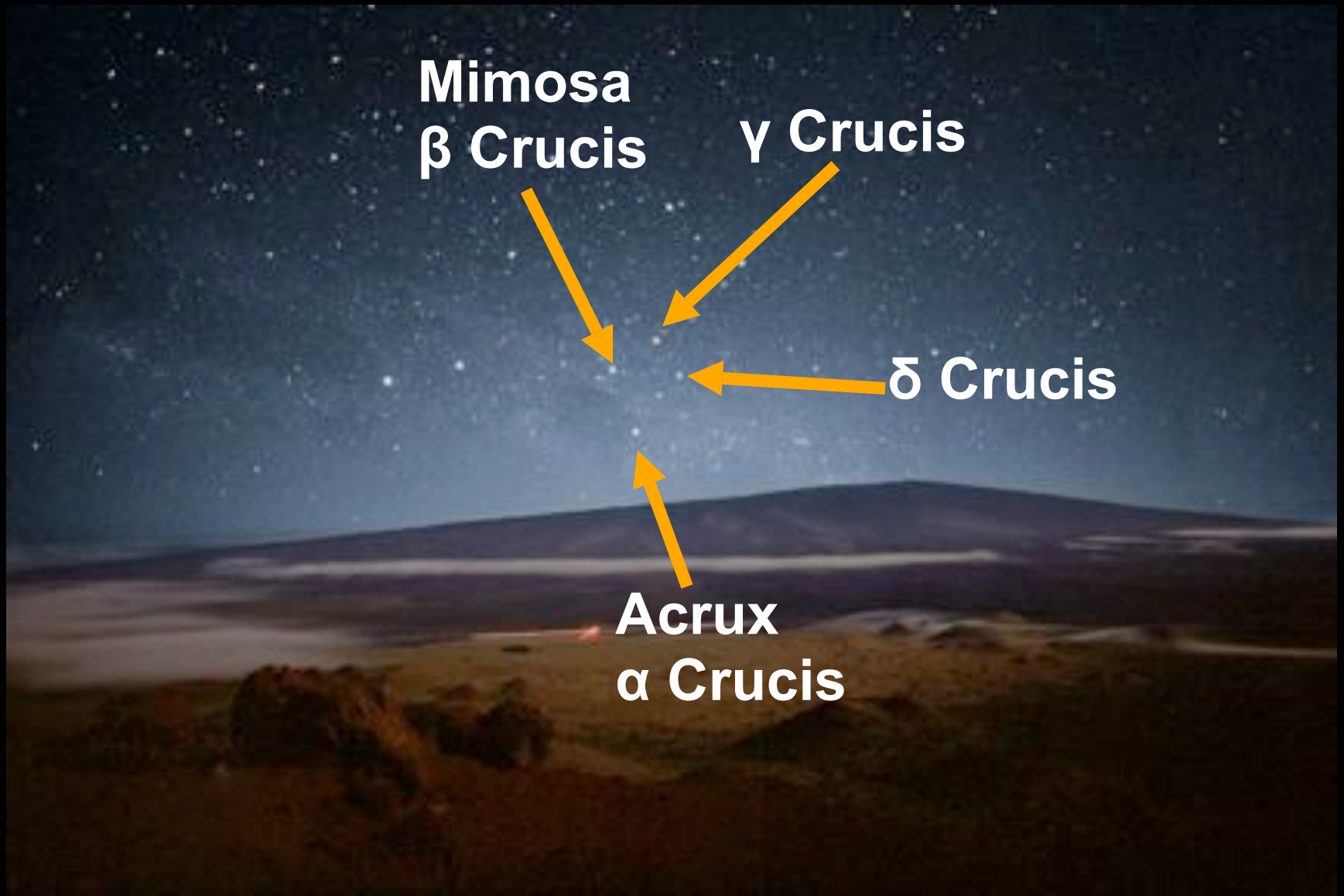


Sirius
α Canis Majoris

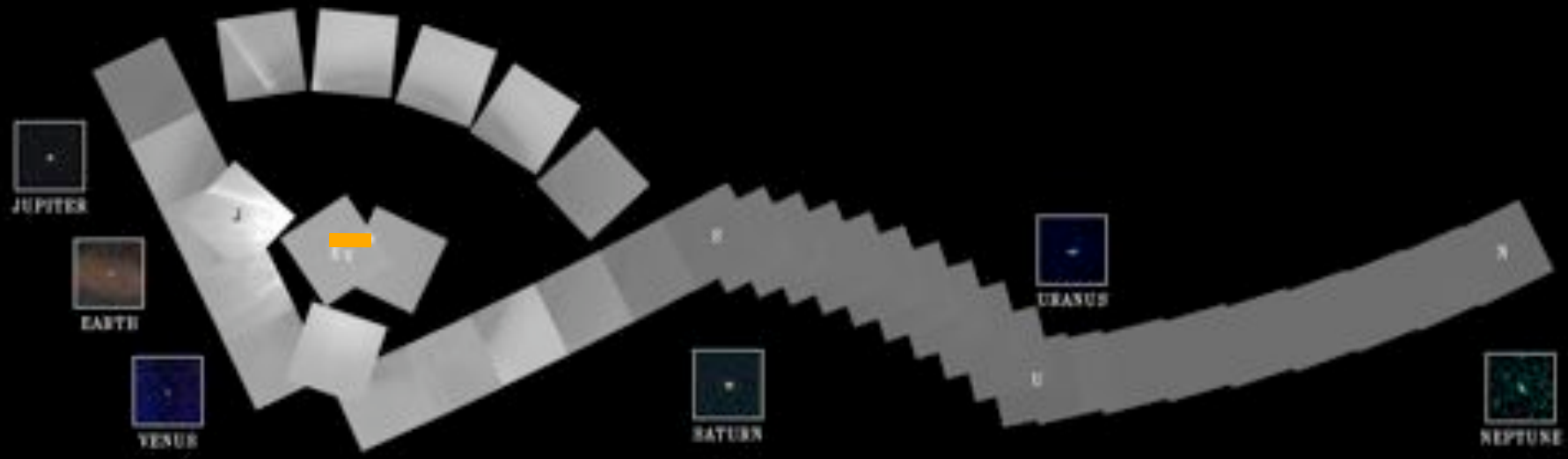
Stars



Stars



AU – astronomical unit



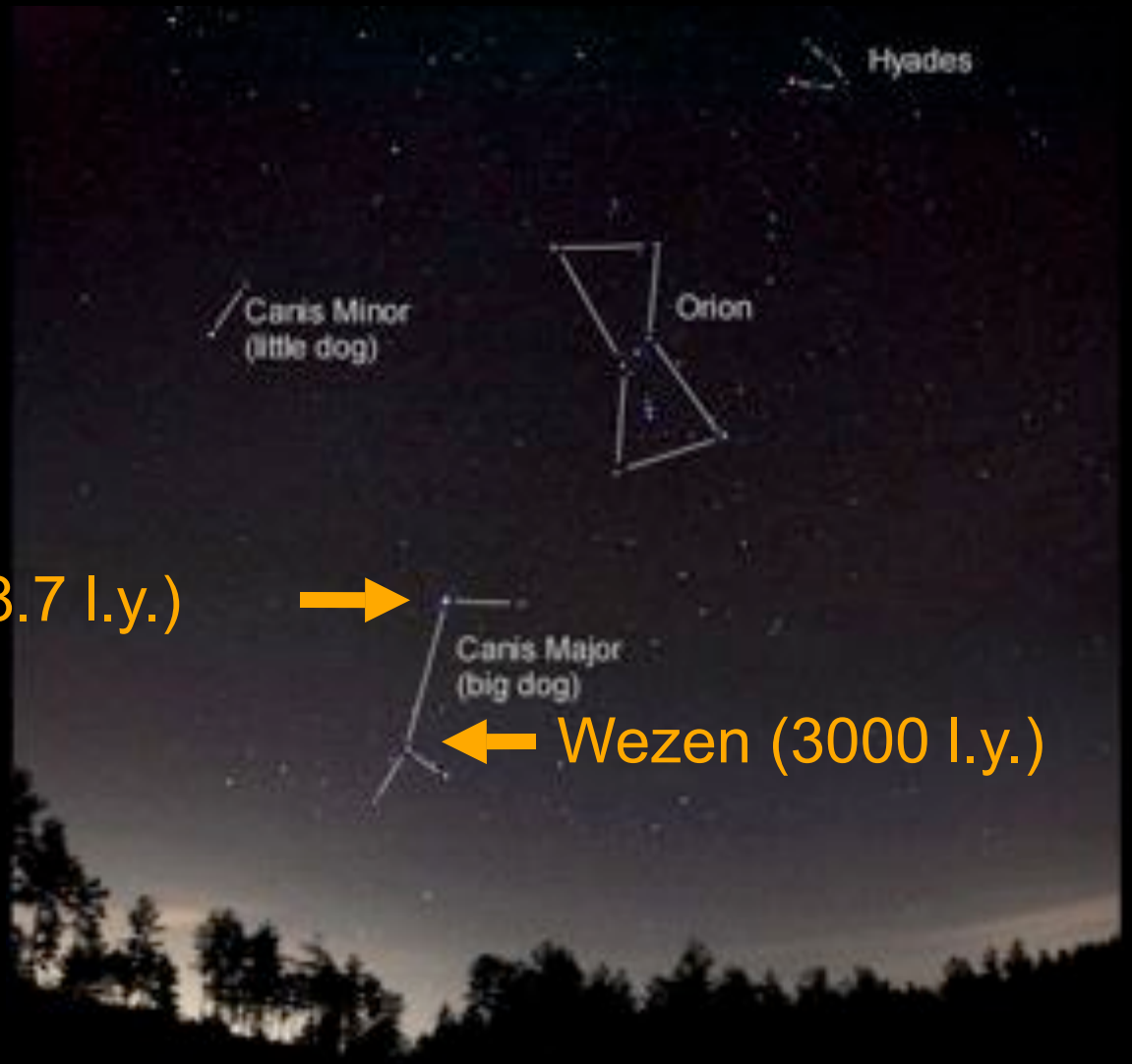
Light year (l.y.)

- The **distance** light travels in a year
  - Distance NOT time
- Light travels at 300 000 km/s
  - 669 600 000 mi/hr
- 5 870 000 000 000 miles/year
  - 9.5 trillion km/year

Light year (l.y.)

- The **distance** light travels in a year
  - Distance NOT time
- Light travels at 300 000 km/s
  - 669 600 000 mi/hr
- 5 870 000 000 000 miles/year
  - 9.5 trillion km/year
- Really, really, really far.

Star Distance



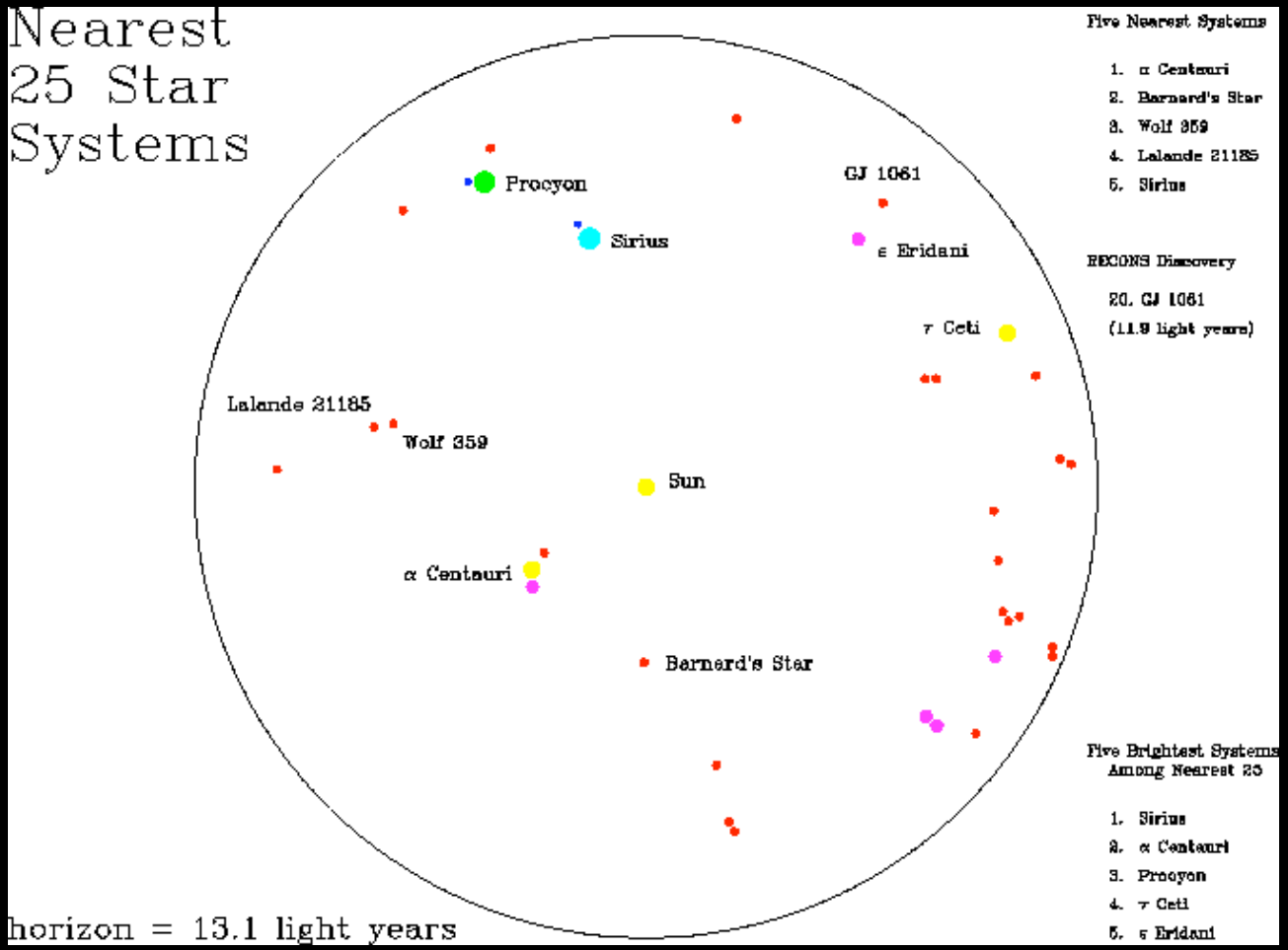
Star Distance

- Parallax can be used to determine the distance of stars to about 100 l.y.

Star Distance: Cepheid Variables

- Oscillates between two sizes.
- Oscillation period of apparent brightness is directly related to intrinsic brightness.
- Used as “cosmic yardstick”

Nearby Stars

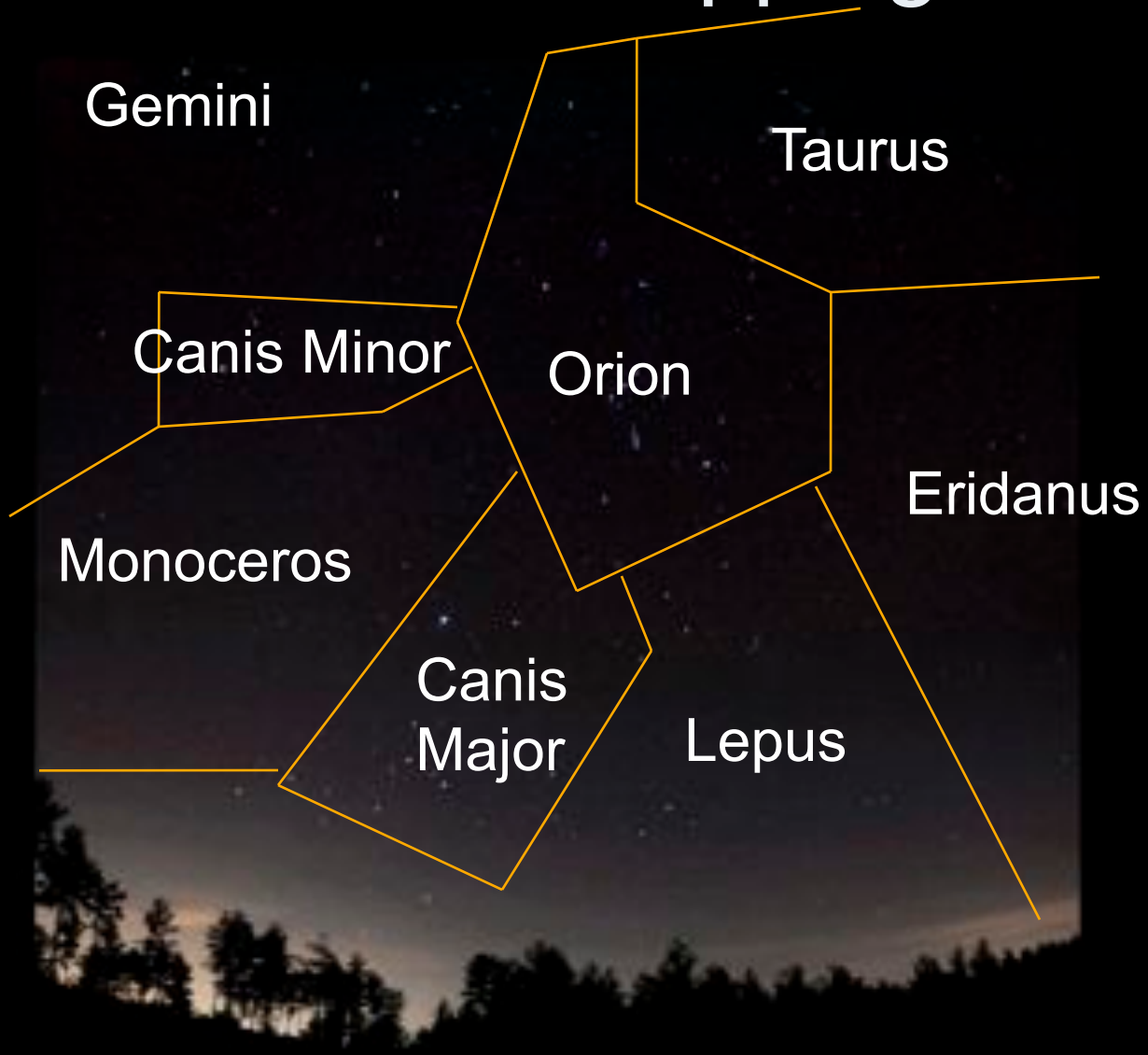


Stars

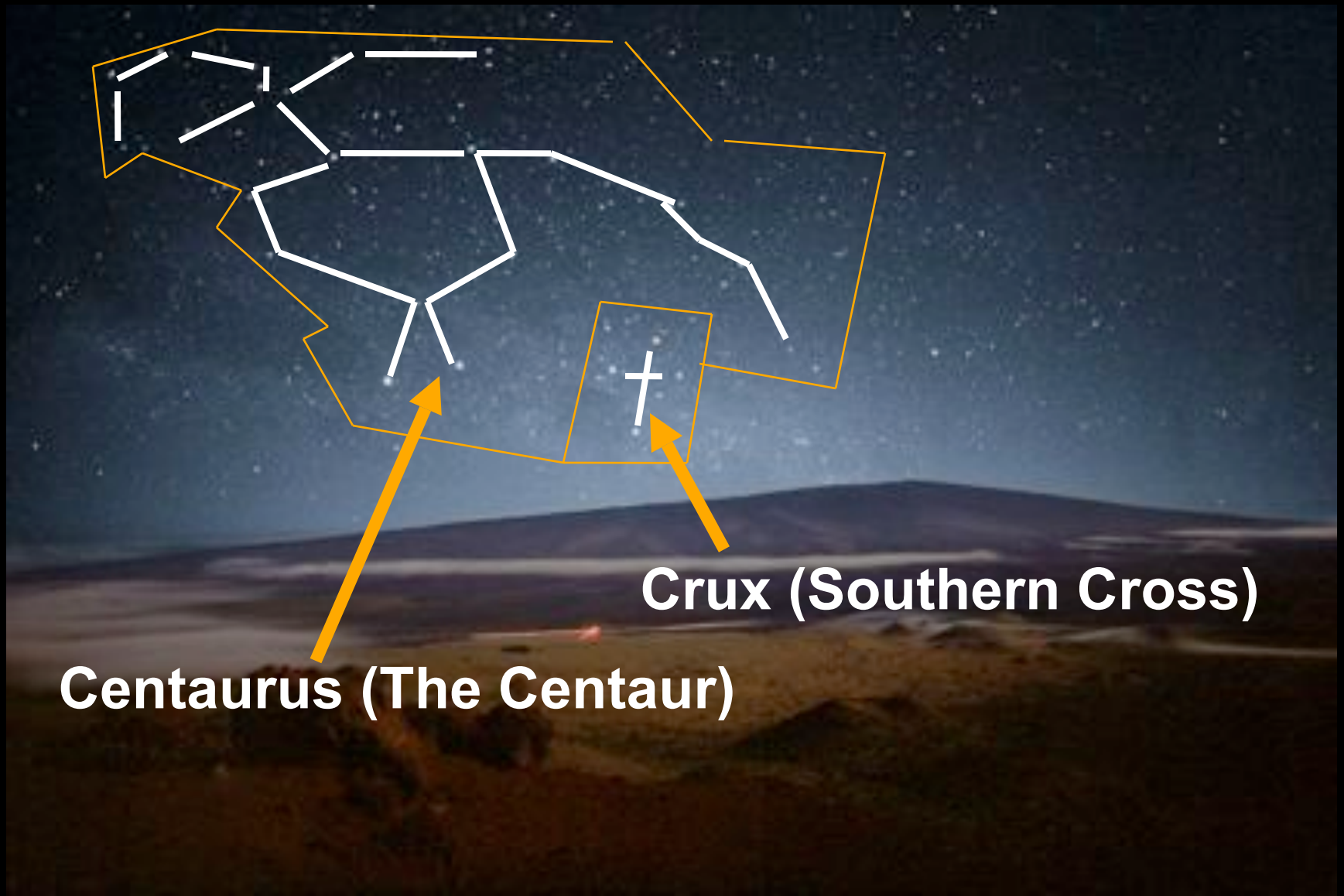
Stars

Constellations – Mapping the Sky

Constellations – Mapping the Sky



Constellations – Mapping the Sky



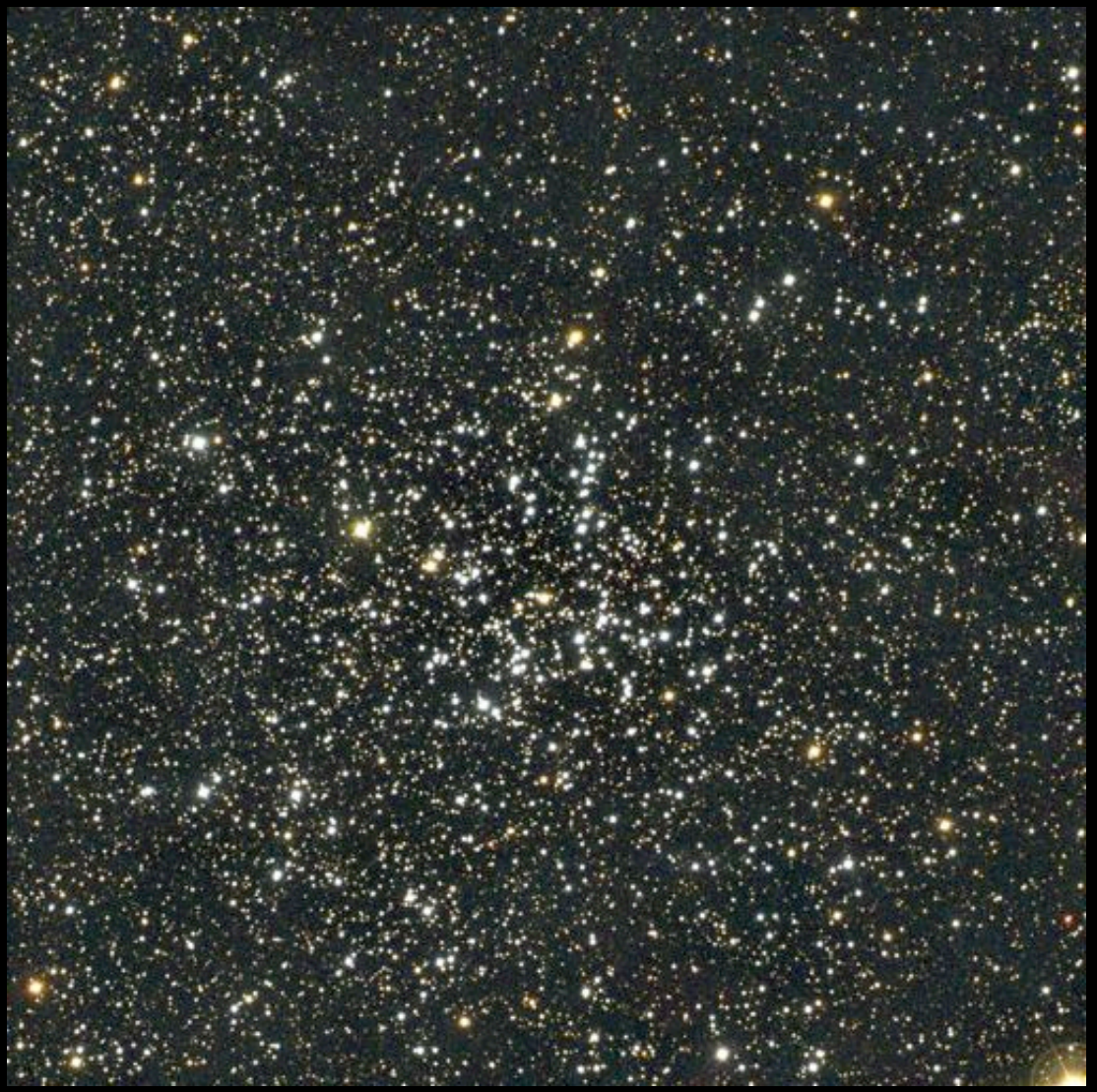
Nova or Supernova

Nova or Supernova

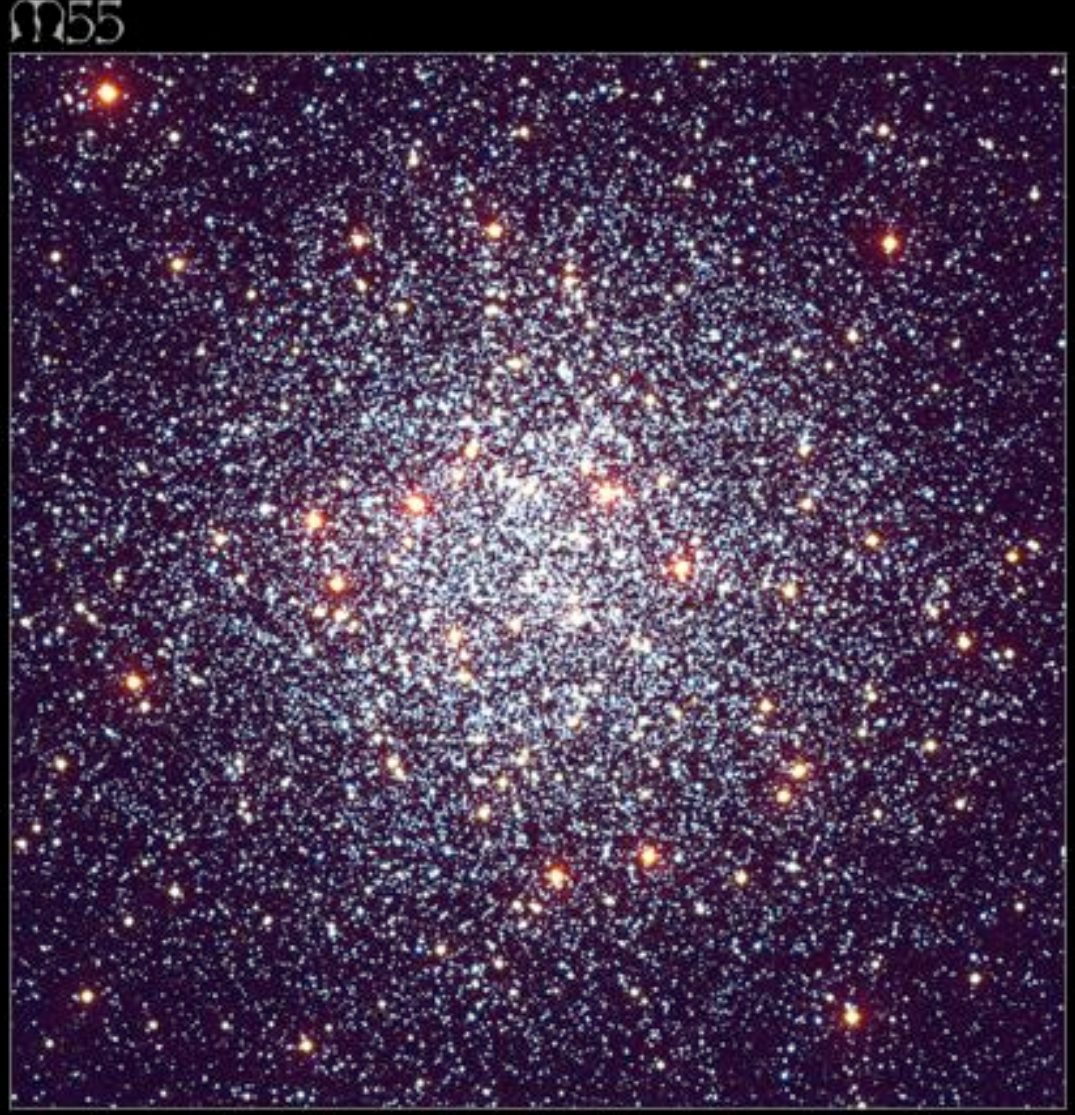
Double and Multiple Stars

- Optical Doubles
- Binaries
- Multiple Stars

Open Clusters



Globular Clusters



Nebulae

- Dust clouds in space

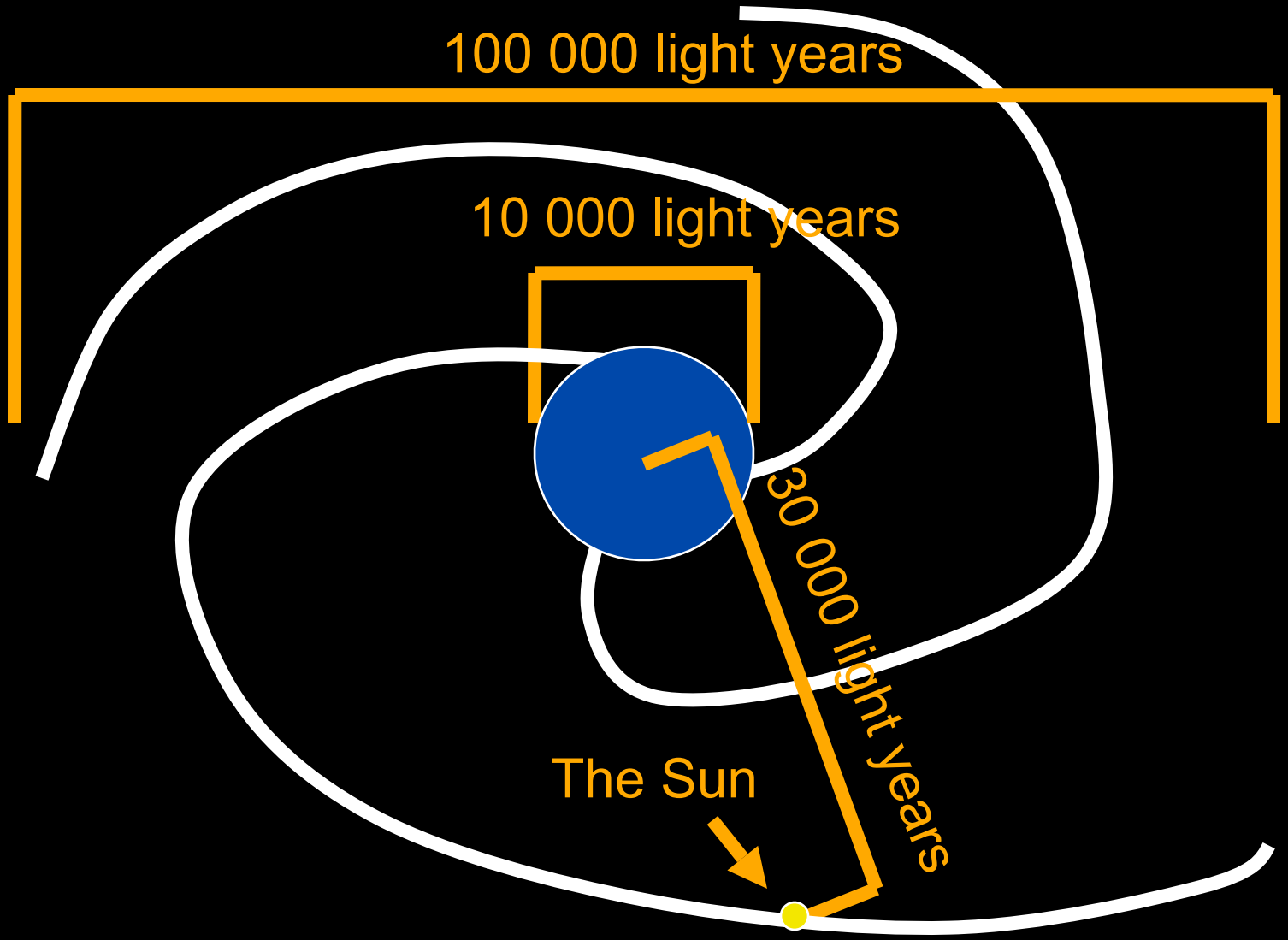
Bright Nebulae

Dark Nebulae

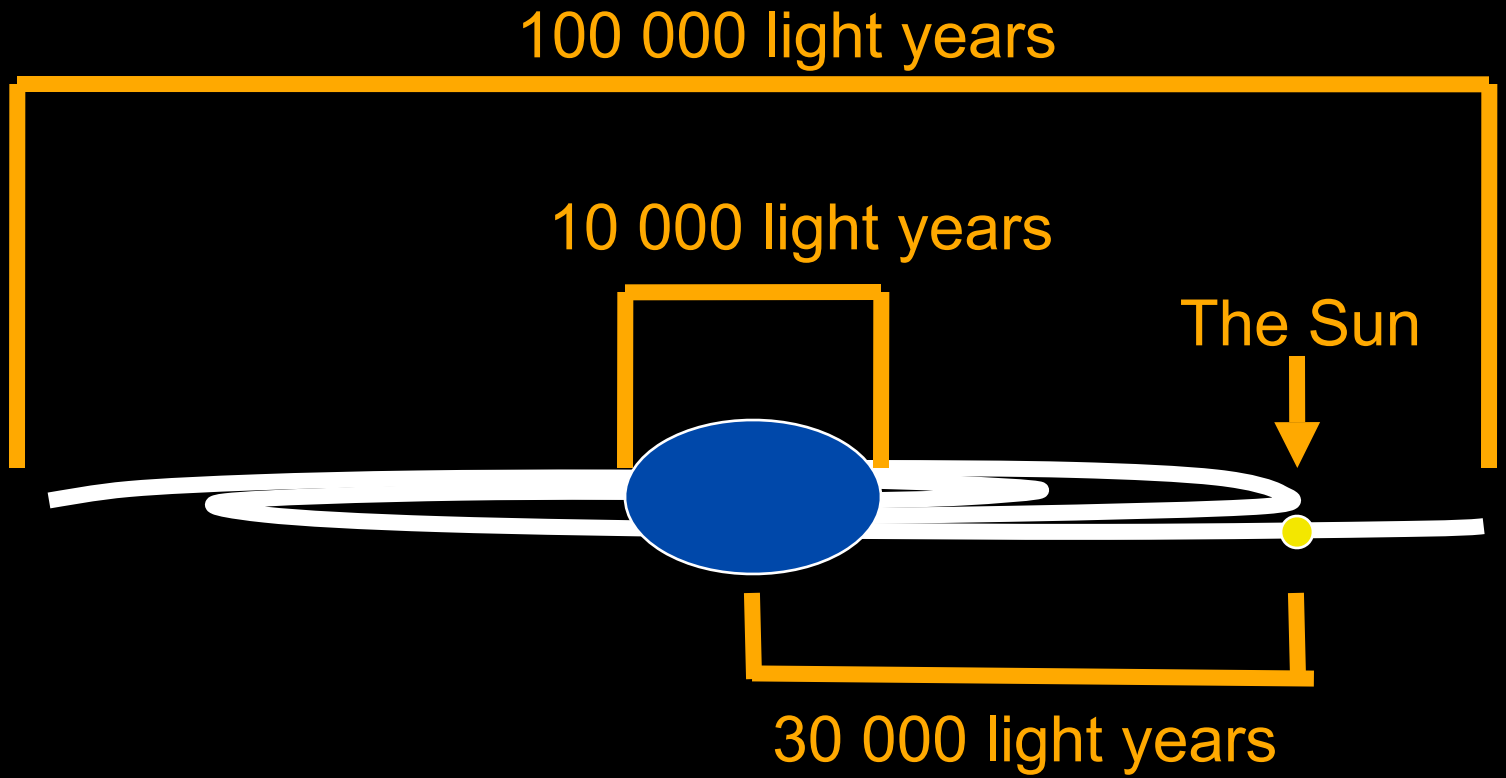
Planetary Nebulae


The Milky Way

The Milky Way – Top View



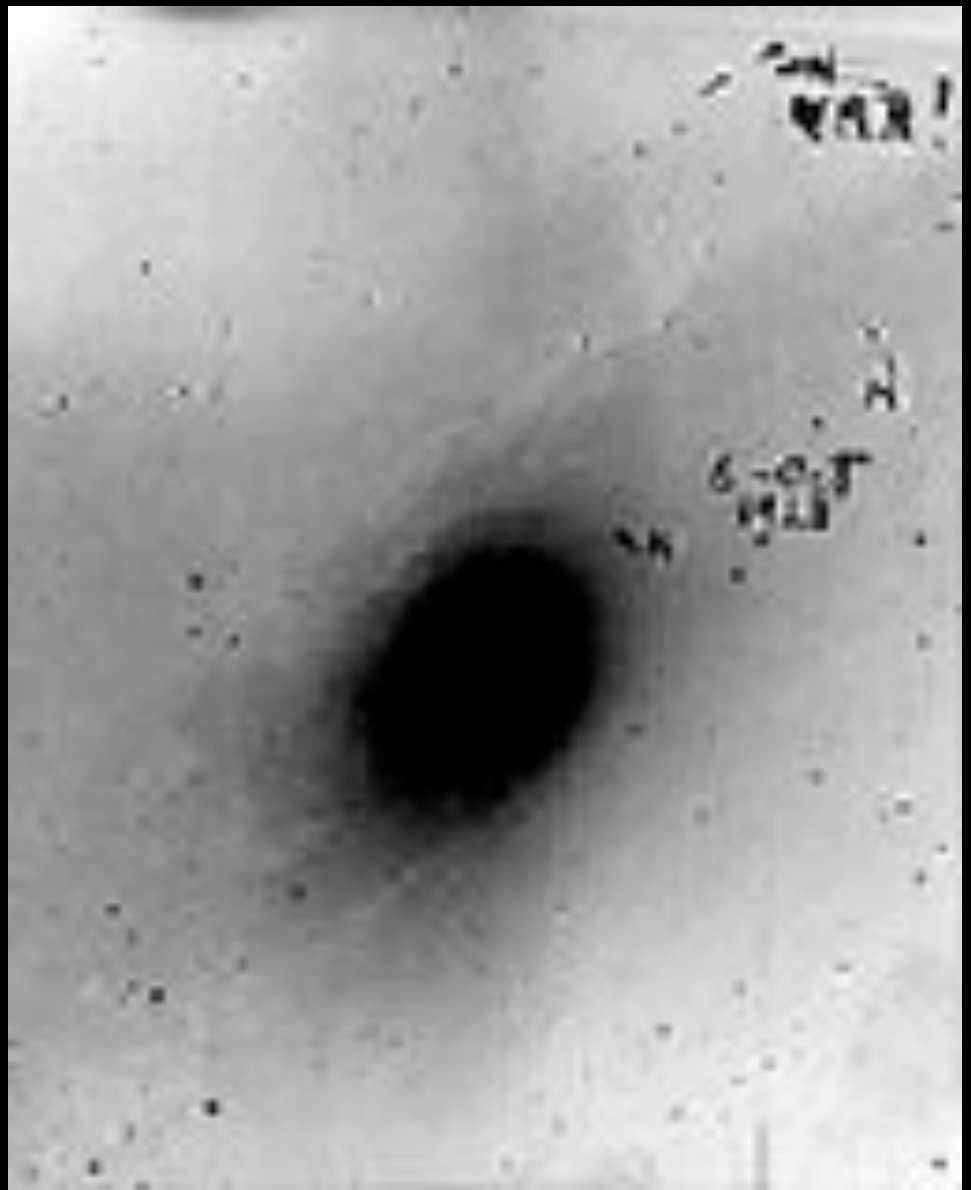
The Milky Way – Side View




The Andromeda Galaxy


The Milky Way

Hubble




The Milky Way
SMC
LMC

Galaxies


The Andromeda Galaxy

Irregular Galaxies

Elliptical Galaxies

Spiral Galaxies

Barred Spiral Galaxies

The Local Group

Hickson Compact Group 87

Hubble Heritage

PRC99-31 • Space Telescope Science Institute • Hubble Heritage Team (AURA/STScI/NASA)

Galaxies Galore

Galaxies Galore

The Universe