Solar System Formation/The Sun

Objective

- 4 Examine the orbital paths of planets and other astronomical bodies (comets and asteroids). Examine the theories of geocentric and heliocentric models and Kepler's laws of motion.
- 5 Examine and diagram the characteristics of meteors, meteorites, meteoroids, asteroids, and comets (including the development and direction of a comet's tail as it orbits the sun).
- 1 Describe the structure, composition, and features of the Sun. (Include flares, ***solar winds***, ***sunspots***, and solar prominences.)
- 2 Identify ***fusion****** of ***hydrogen****** to ***helium****** as the source of the Sun's energy.

ES 4

- The student will investigate and understand the characteristics of the Earth and the solar system. Key concepts include
  - c. characteristics of the ***Sun***, planets and their moons, comets, meteors, and asteroids; and

ES 14

- The student will investigate and understand scientific concepts related to the ***origin and evolution*** of the universe. Key concepts include
  - a. ***nebulae***;
  - b. the origin of stars and star systems;
  - c. stellar evolution;

Enduring Understanding

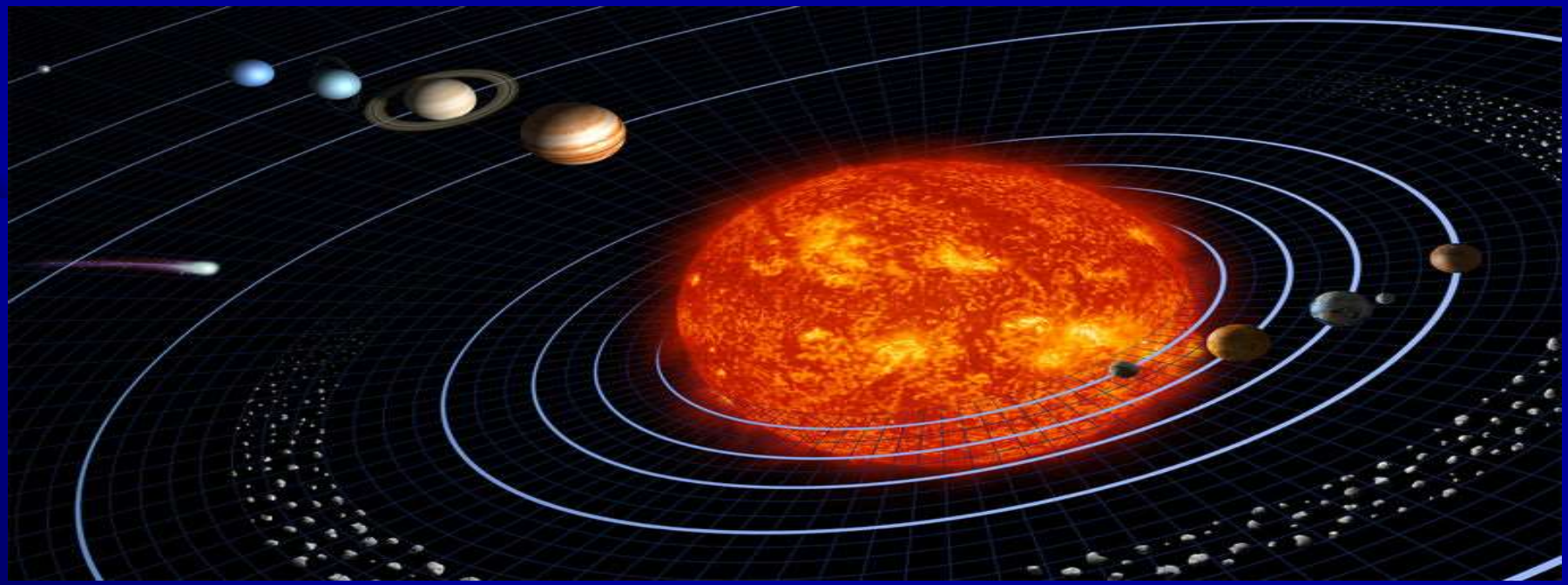
- The Sun has unique features that are ***constantly changing*** and that directly impact the Earth.
- Stars have a ***life cycle*** that is governed by their ***masses and composition*******.

Solar System Formation

- Using Earth-based observations and data from probes astronomers have derived ***theories*** on how the Solar System formed

Solar System Formation

- Stars and planets form from ***clouds of gas and dust**** which exist between the stars that ***collapse and condense**** as a result of ***gravity***** and become concentrated enough to form stars



Solar System Formation

- This ***cloud**** is called a ***nebula****

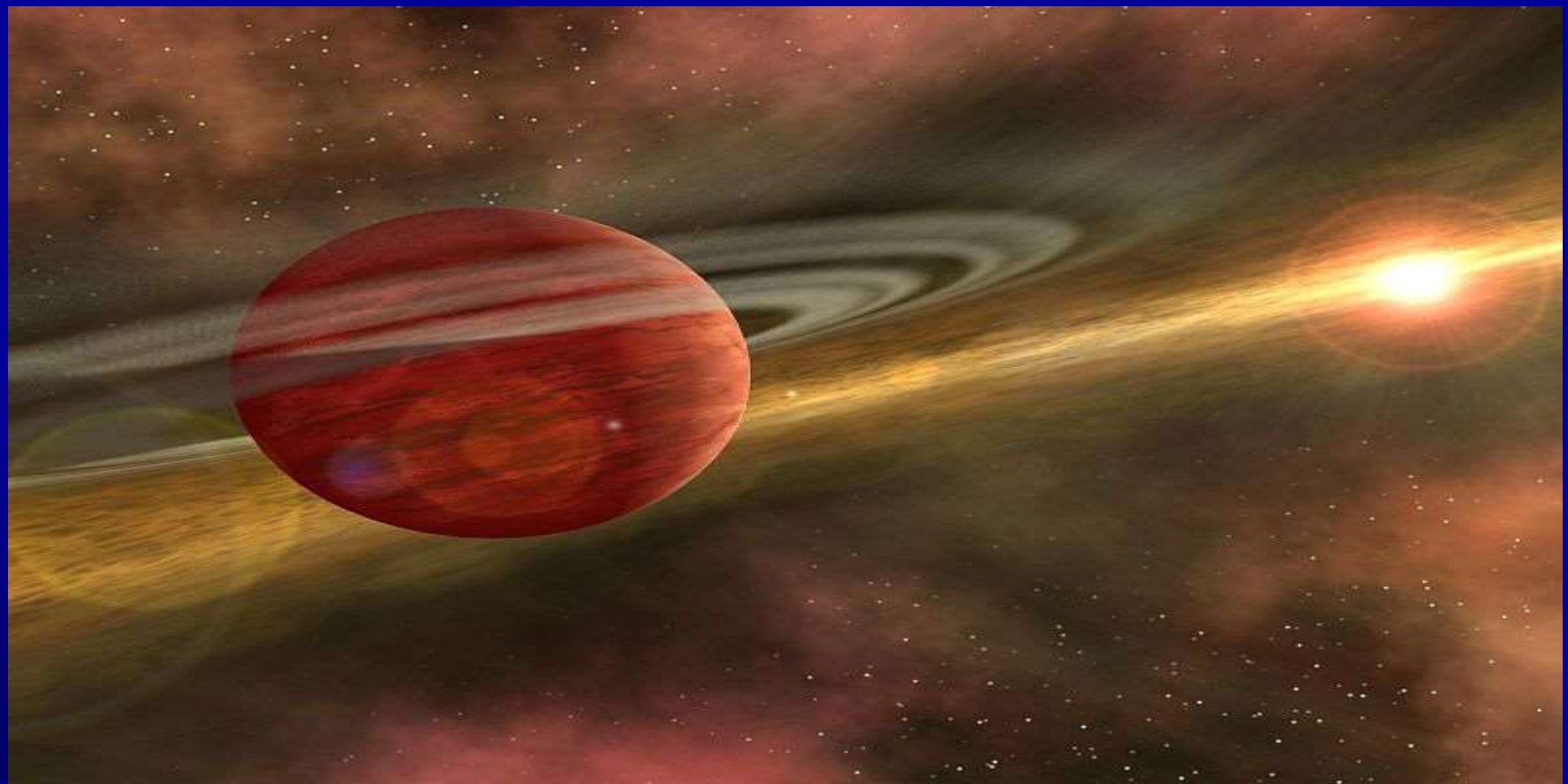
Elephant Trunk nebula

Solar System Formation

- The cloud will spin faster as it contracts similar to what is seen when figure skaters pull in their arms and spin faster

Solar System Formation

- The cloud eventually becomes a ***rotating disk*** with a dense concentration in the center

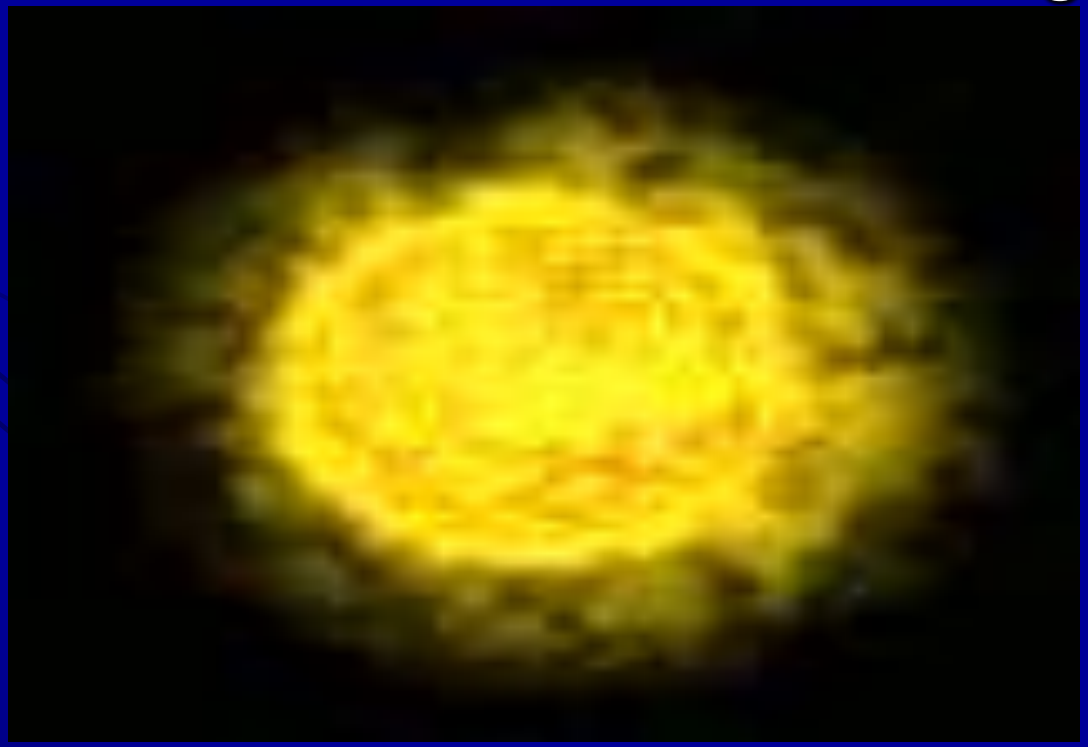


Formation of the Planets

- The ***Solar nebula**** had a dense concentration of gas at the center which eventually concentrated to form the Sun but farther away from the center different substances such as oxides, silicates and iron were able to cool and condense to liquid or solid form ***depending on how far*** they were away from the hotter center

Formation of the Planets

- Tiny grains of condensed material began to accumulate and merge to form larger bodies then collide and stick together



Formation of the Planets

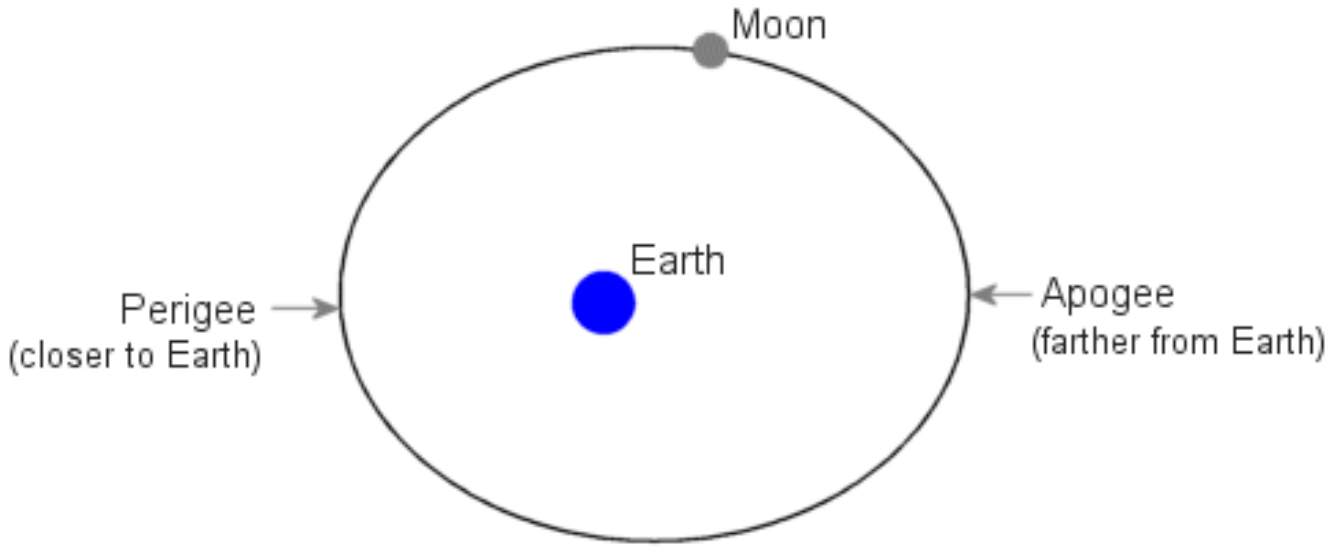
- Eventually these bodies reached hundreds of kilometers in diameter and are called planetesimals that continued to grow through collisions with other objects

Leftovers

- There is a great deal of ***interplanetary debris*** that for various reasons was unable to join up with any other bodies
- The planetesimals between Jupiter and Mars are known as the ***asteroid belt****** remain there because of Jupiter's gravity


Apogee
Perigee
2004-12-26
405,363 km
29.94 arc-min
Altitude @ 77.81°
2004-07-02
357,448 km
33.66 arc-min
Altitude @ 21.72°

The Moon's orbit around Earth is an ellipse. One side (perigee) is closer to Earth than the other (apogee).

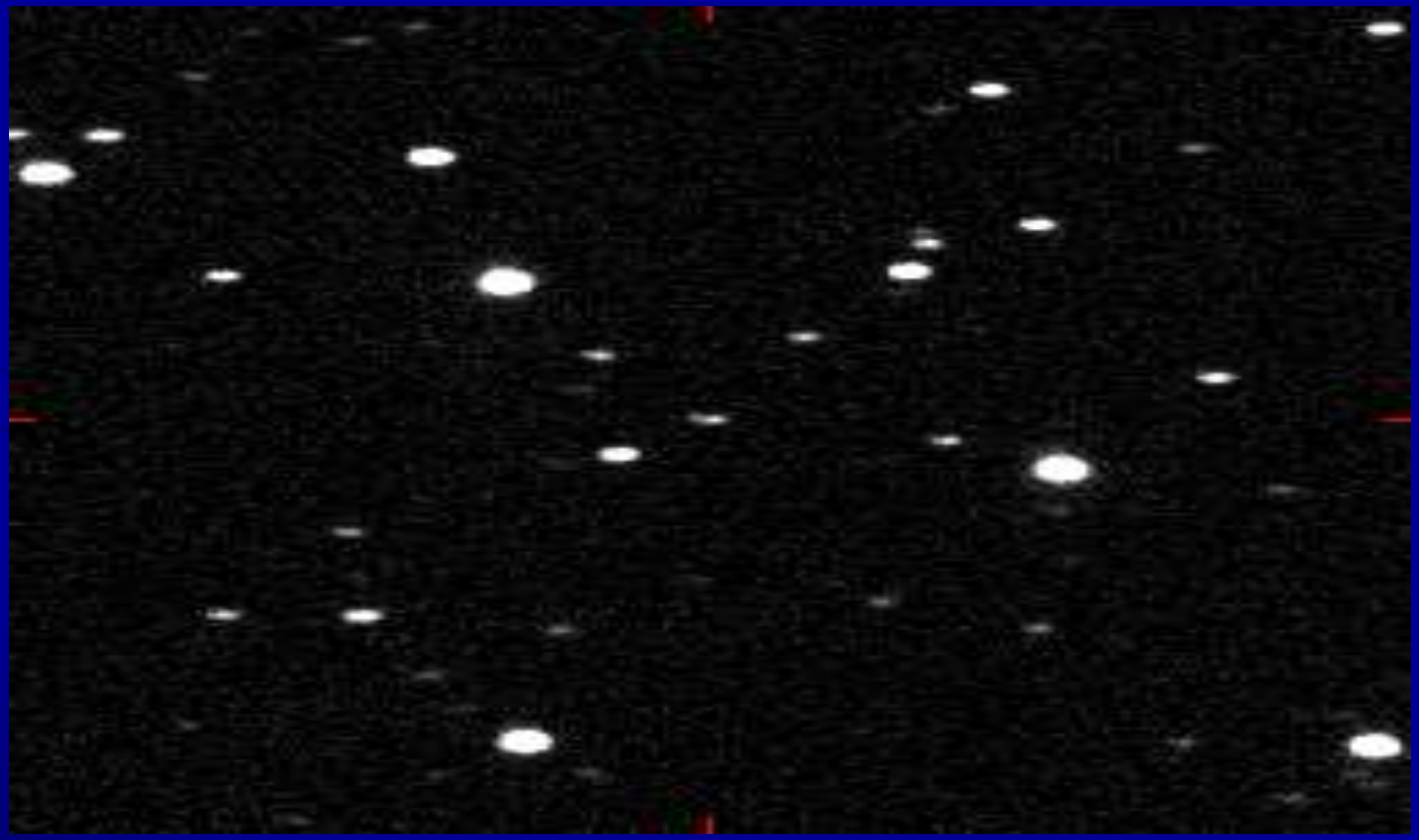


Apogee? Perigee? Can't remember which is which? An old astronomer's trick: The "a" in "apogee" stands for "away."

Note: In this diagram, the eccentricity of the Moon's orbit is exaggerated for clarity.

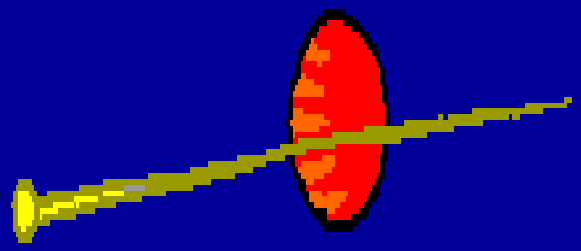
Asteroids and Comets

- ***Asteroids*** range from a few km to over 100 km in diameter



Asteroids and Comets

- ***Comets*** are small ***ice and rock bodies*** with highly eccentric orbits. They can be seen when they come close enough to the Sun (3 AU) for the material to ***evaporate*** and we see the sunlight reflect off of the gas and dust particles

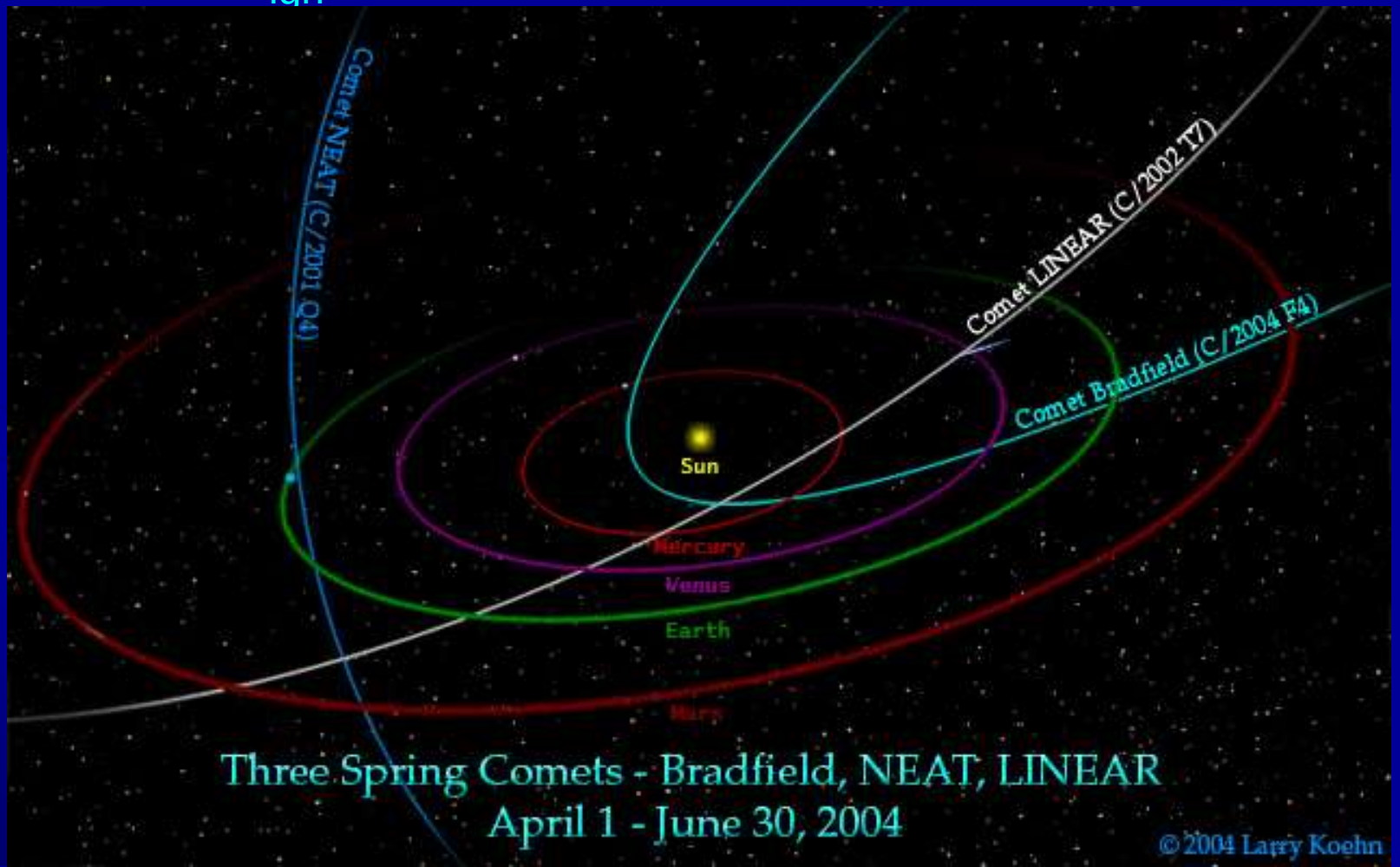


http://www.skyandtelescope.com/about/pressreleases/3305731.html?page=1&c=y

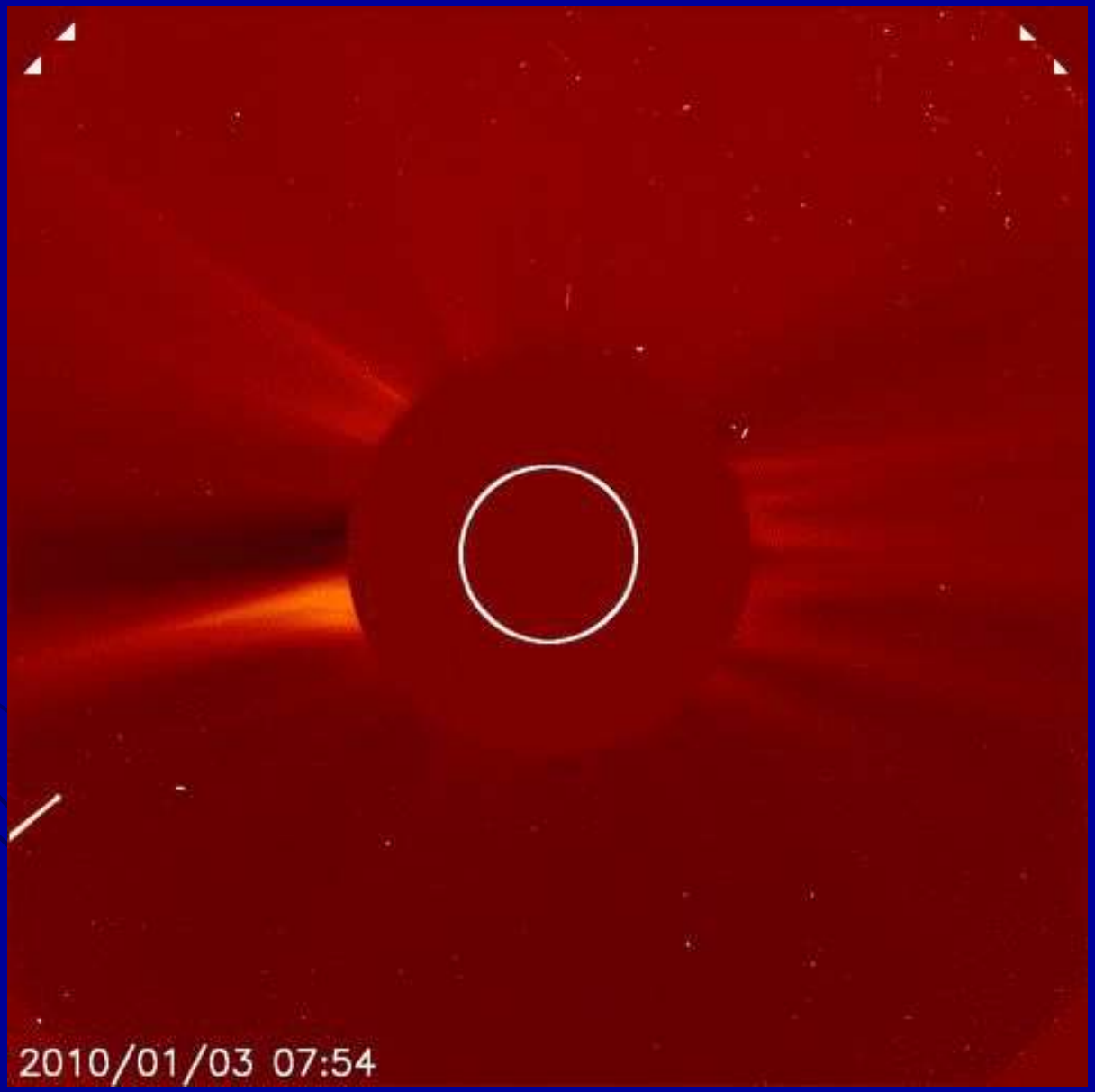
http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&fileitem=3309&catfilter=452

Asteroids and Comets

http://www.windows.ucar.edu/tour/link=/comets/comet_model_interactive.html&edu=high



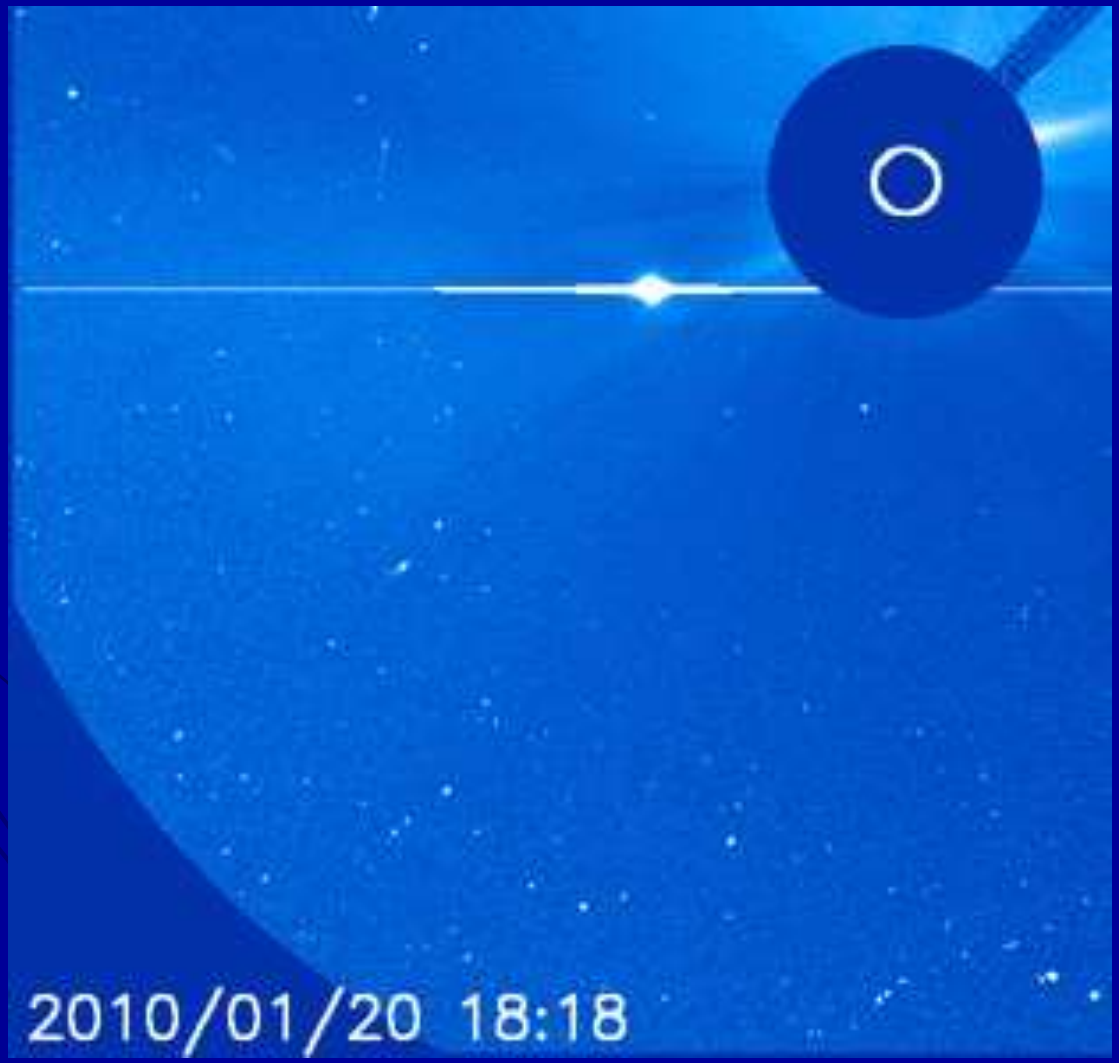
bright comet approaching the sun and then disintegrating.



The Solar and Heliospheric Observatory (SOHO) has a good view of the comet's death plunge:

Venus →

Comet →



The Sun

- The Sun is the largest and most massive object in the Solar System. It would take 109 Earths lined up to cover it's diameter and ***330,000 Earths*** to match it's mass. It holds ***99 percent*** of the entire mass of the Solar System therefore controls the motions of all the bodies therein. It is composed largely of ***H*** gas.
- http://hypnagogic.net/sim/Sim/hr3/HRdiagram.html
- http://hypnagogic.net/sim/#xtrasol

The Sun

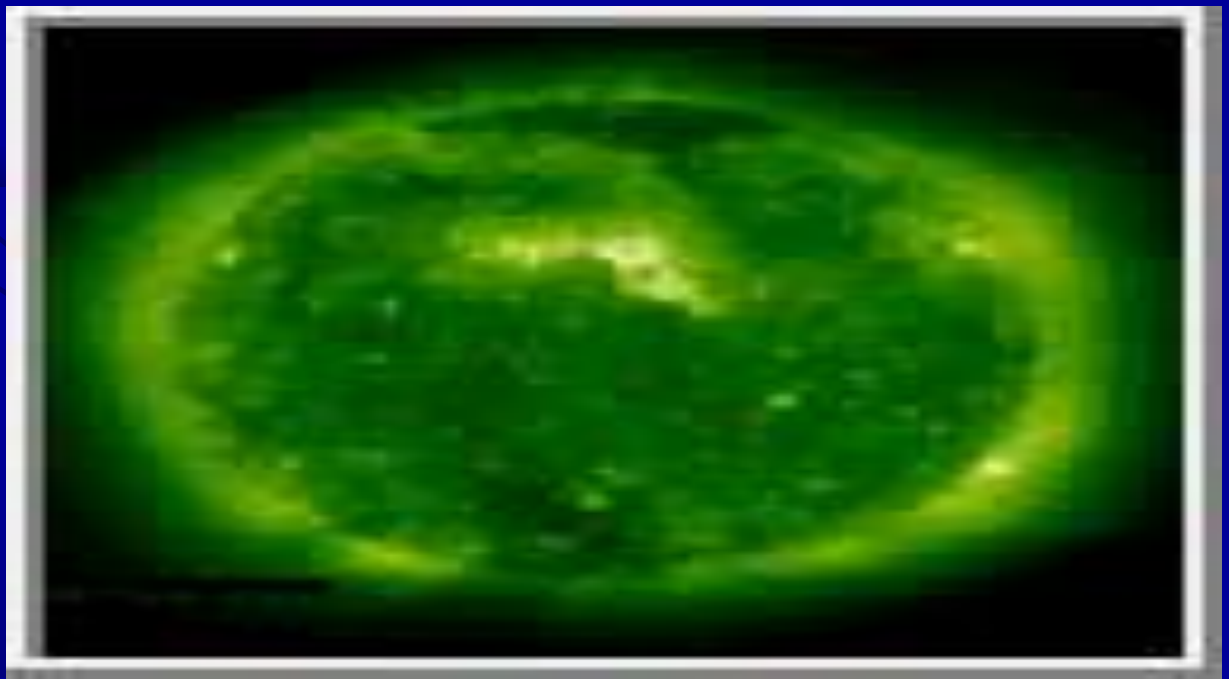
- ***Photosphere*** the lowest layer of the atmosphere and is the visible surface because it emits the most visible light
  - Average temperature of the photosphere is 5800 K

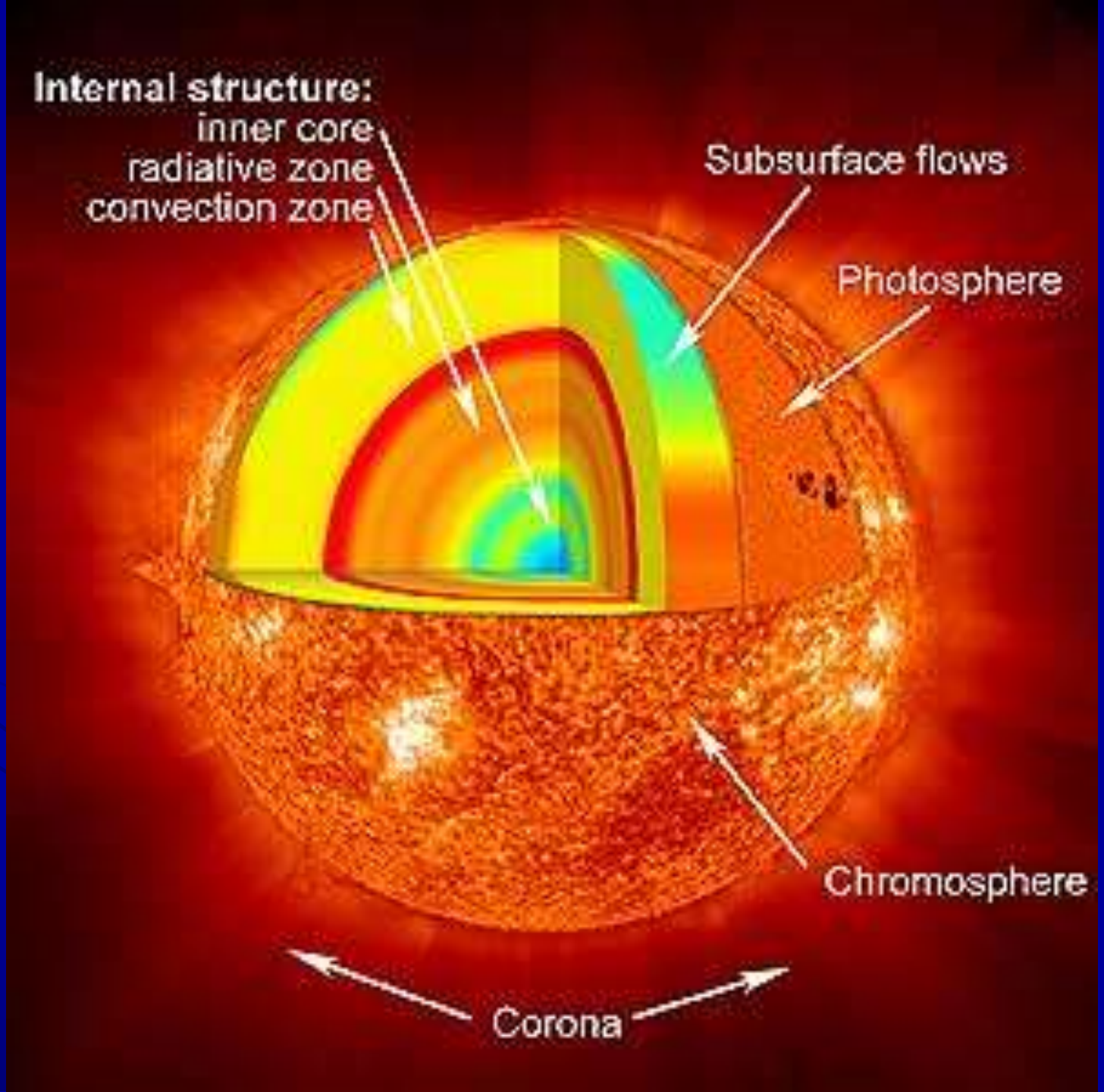
The Sun

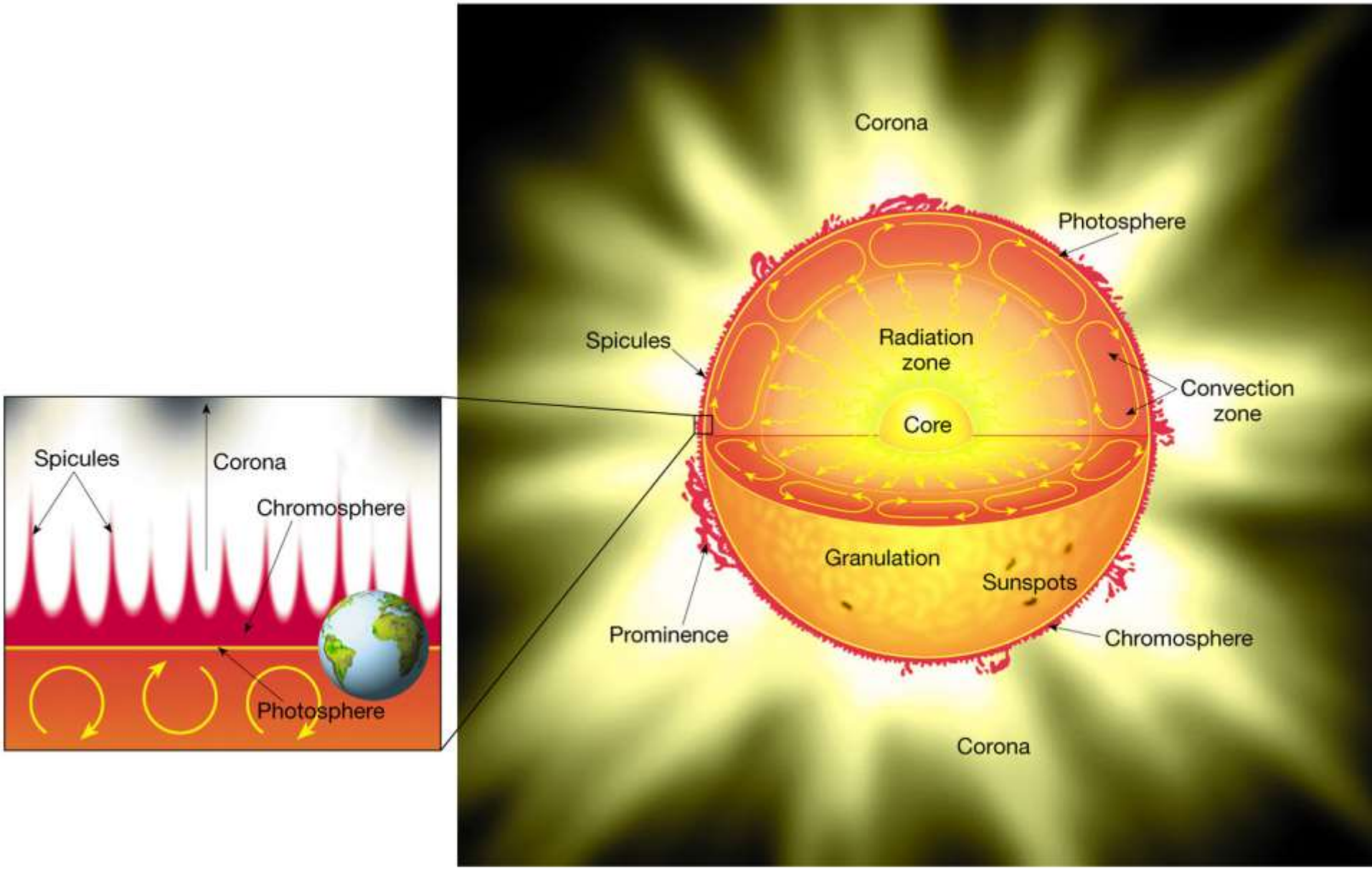
- ***Chromosphere*** is the next layer and is 2500km thick
  - Temp. is nearly 30,000 K at the top and is only visible during a solar eclipse when the photosphere is blocked

The Sun

- ***Corona*** is the top and hottest layer (1-2 million K) and can only be seen when the photosphere is blocked by special filters or the Moon during an eclipse

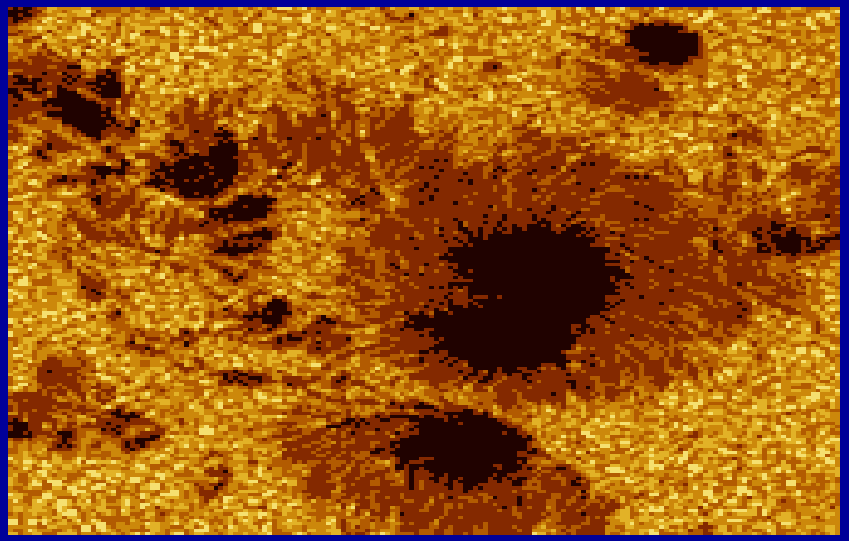



Internal structure:
inner core
radiative zone
convection zone
Subsurface flows
Photosphere
Chromosphere
Corona


Spicules
Corona
Chromosphere
Photosphere
Corona
Photosphere
Spicules
Radiation zone
Convection zone
Core
Granulation
Sunspots
Prominence
Chromosphere
Corona

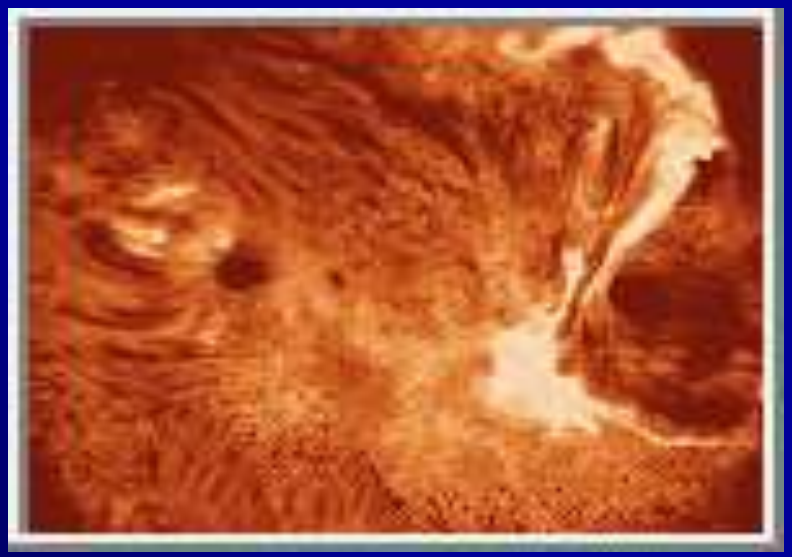
Solar Activity

- ***Sunspots*** are ***dark spots*** on the photosphere they are believed to be caused when the Suns' ***intense magnetic fields*** poke through the photosphere and typically last two months



Solar Activity

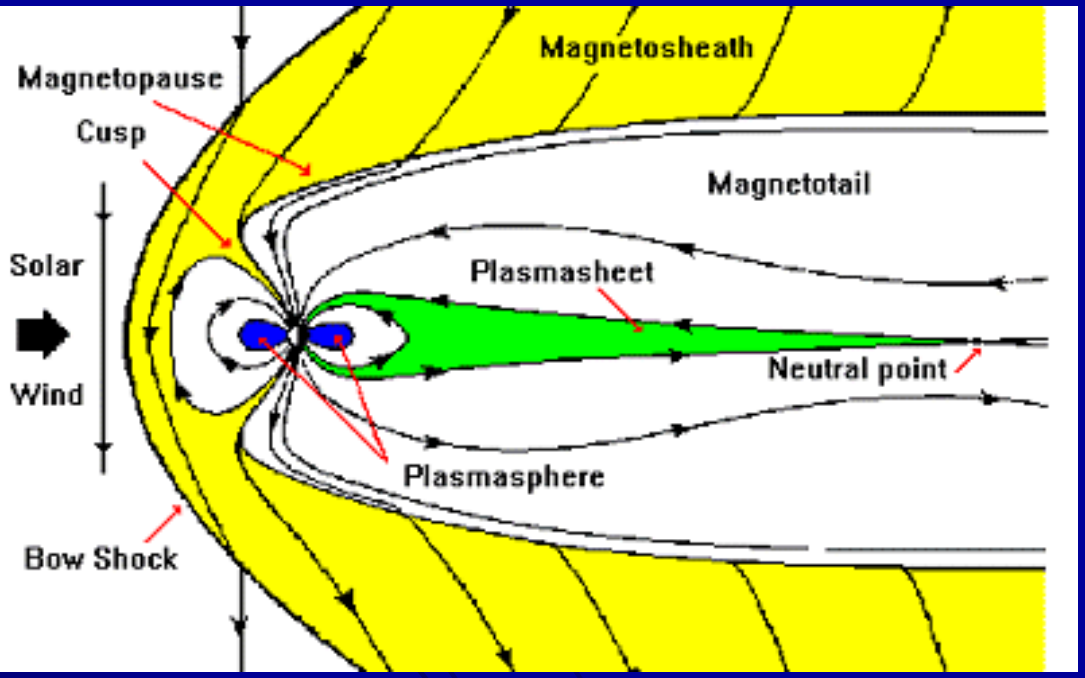
- ***Solar Flares*** are ***violent eruptions*** of particles and radiation from the Sun's surface that are then carried to Earth by the ***solar wind*** and interfere with ***communications***

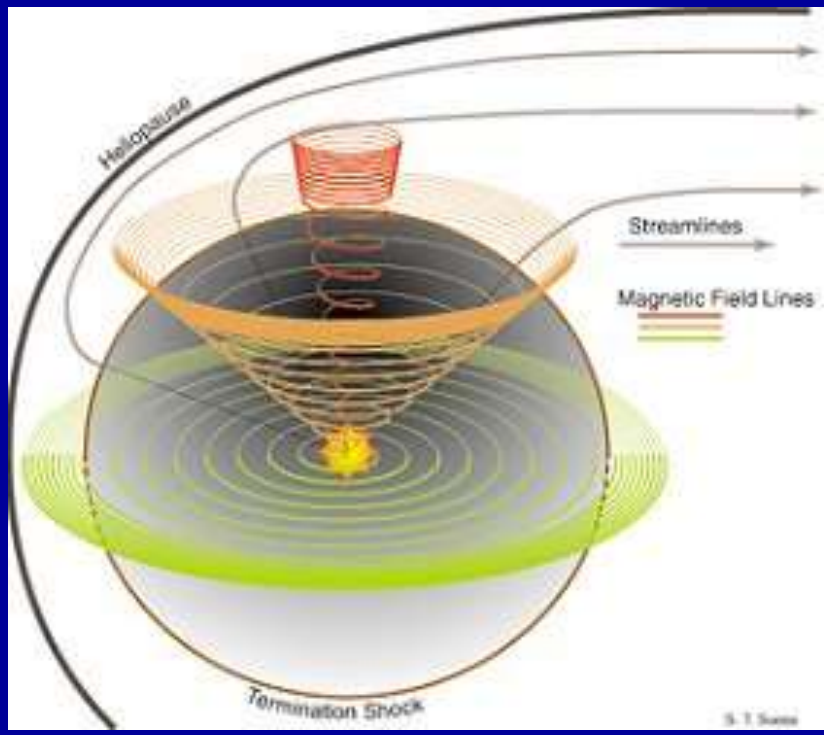


Solar Activity

- ***Prominences*** are ***arcs of gas*** ejected from the chromosphere

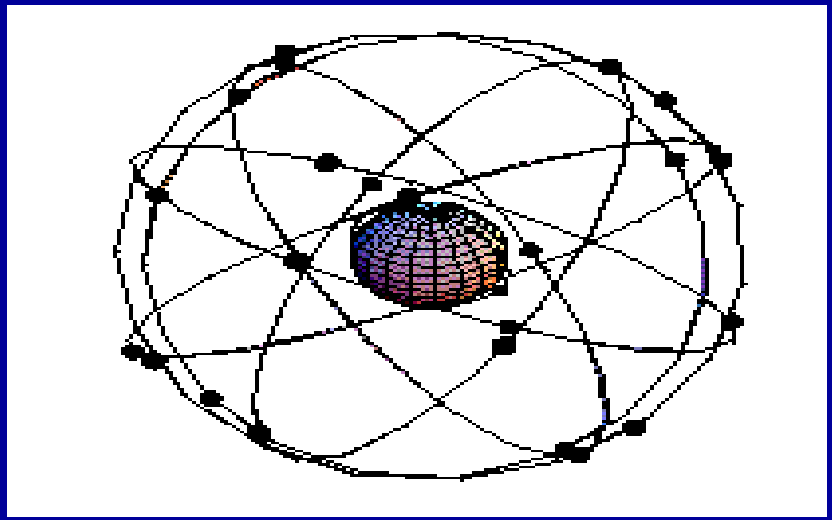
The Interplanetary Magnetic Field





The Sun's Energy

- In the core the pressure and temperature is so intense ***nuclear fusion****** occurs. Fusion is the ***combining of lightweight nuclei*** into heavier nuclei and releases an incredible amount of energy. This is the opposite of nuclear fission which is the splitting of heavy atomic nuclei into smaller, lighter nuclei.



The Sun's Energy

- The energy of the Sun is derived from the fusion of ***H into He*******
- The Sun is about ***halfway*** through it's life cycle with another ***5*** billion yrs left to go