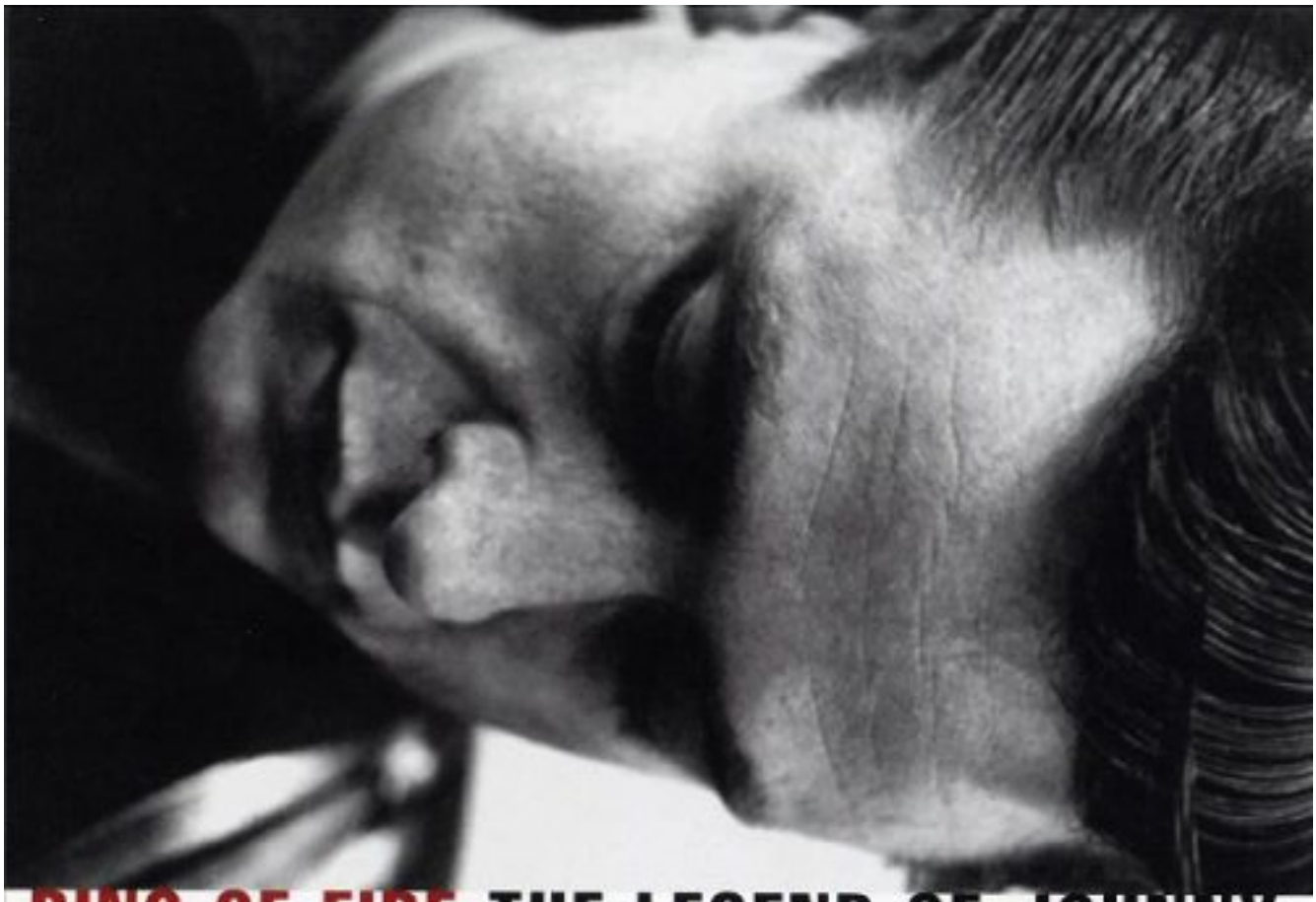
What is the *Ring of Fire*?



RING OF FIRE THE LEGEND OF JOHNNY CASH


7400


RING of FIRE
CHEVROLET


abc


BEST OF
KING OF FIRE

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

Q. What is the Age of Universe? A. About 13.7 billion years (Ga)

Q. How do we know this? A. Intensity vs. Red shift of galaxies

Q. What is the Age of the Solar System? A. 4.56 Ga

Q. How do we know this? A. Radiometric dating of meteorites

Q. How large is the Milky Way? 80,000 light years

Q. What's a light year?

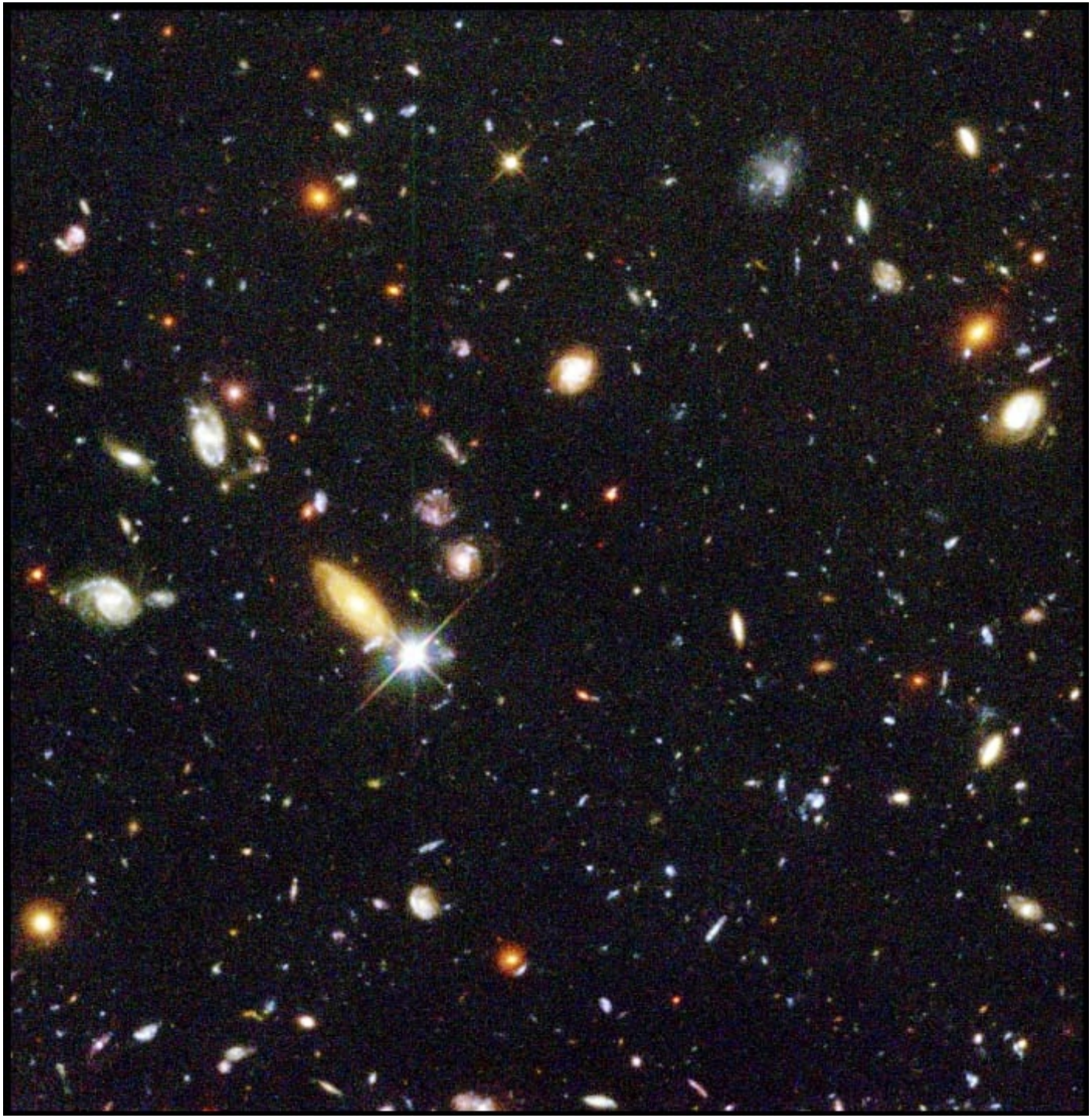
(3 x 10^8 m/s x 365.25 days x 24 hr x 60 min x 60 s = about 9.5 x 10^{15} m)

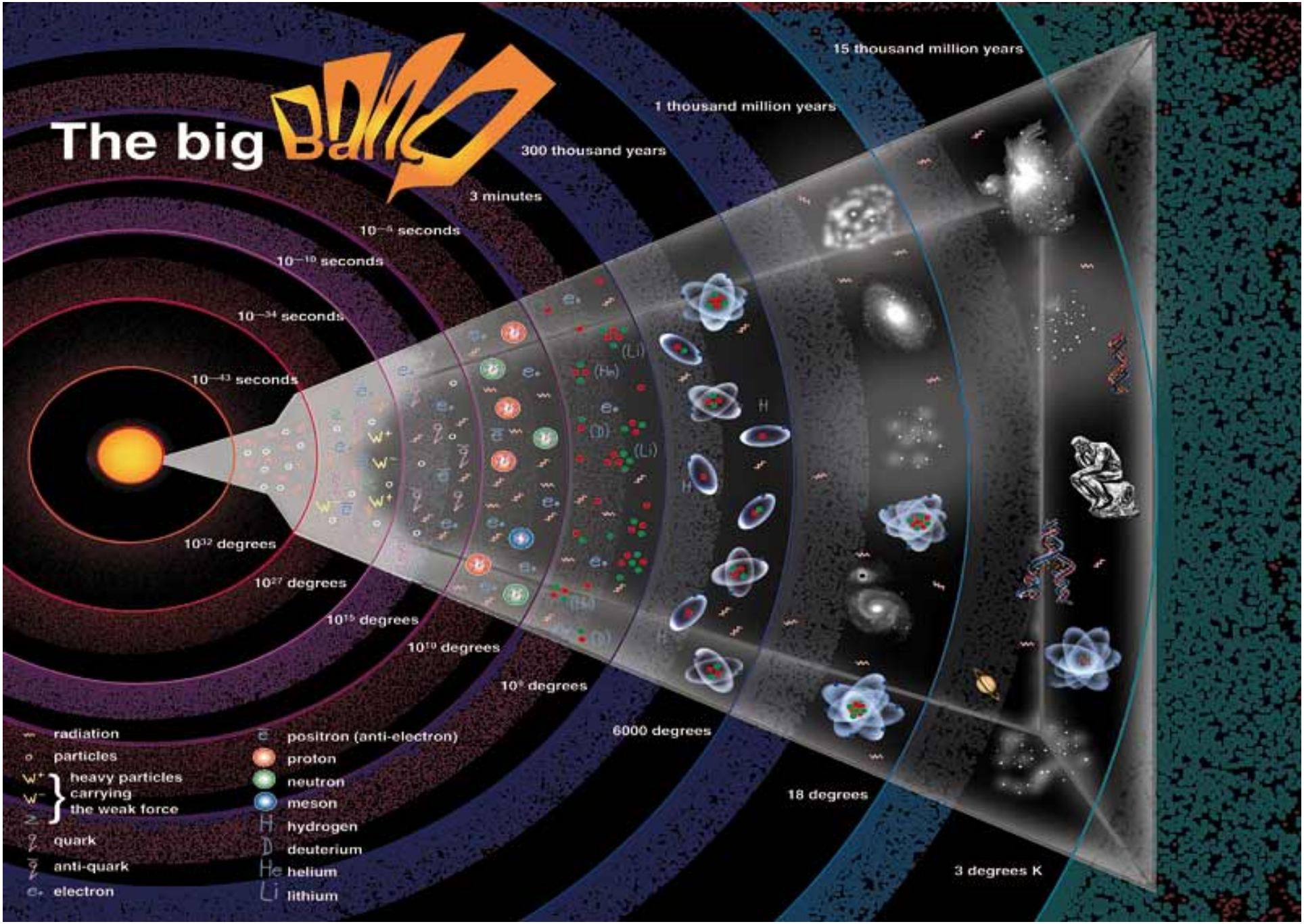
So the Milky Way is 80,000 x 9.5 x 10^{15} m = 7.6 x 10^{20} m = 7.6 x 10^{17} km
= 5 x 10^{17} mi

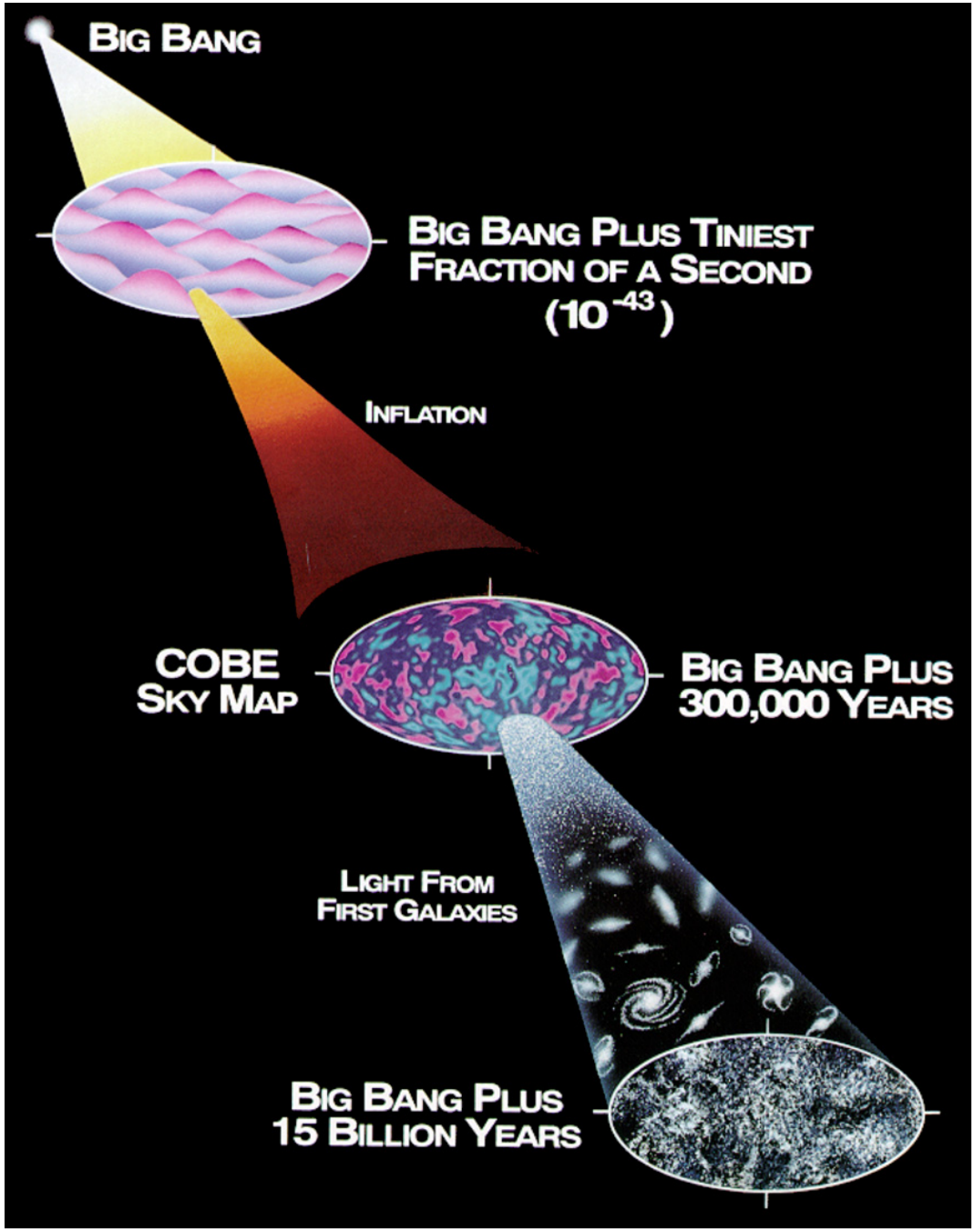
7.6 x 10^{17} km = 760,000,000,000,000,000 km

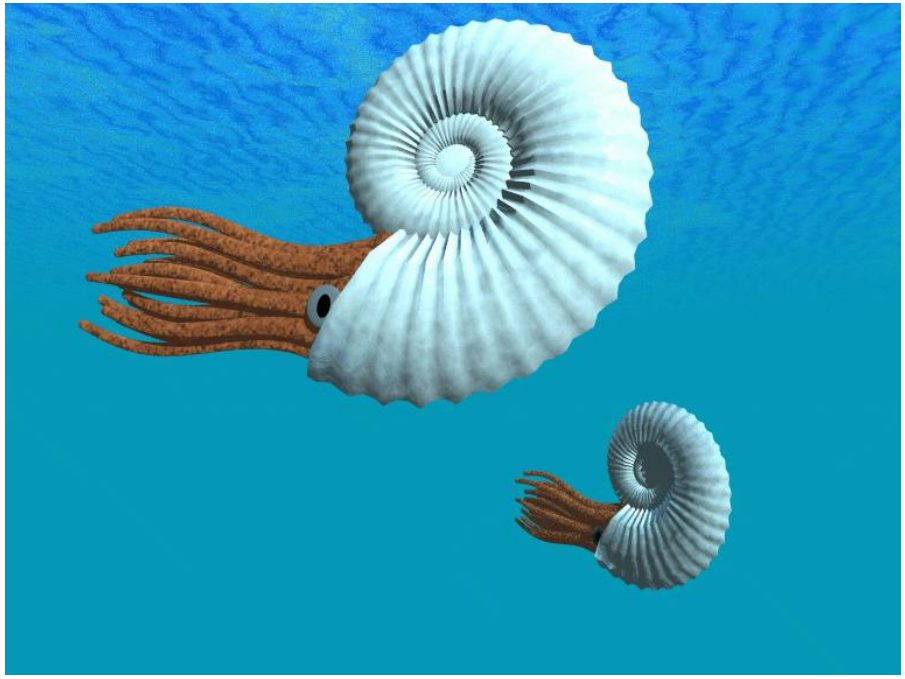
(I have no concept of how big this is)

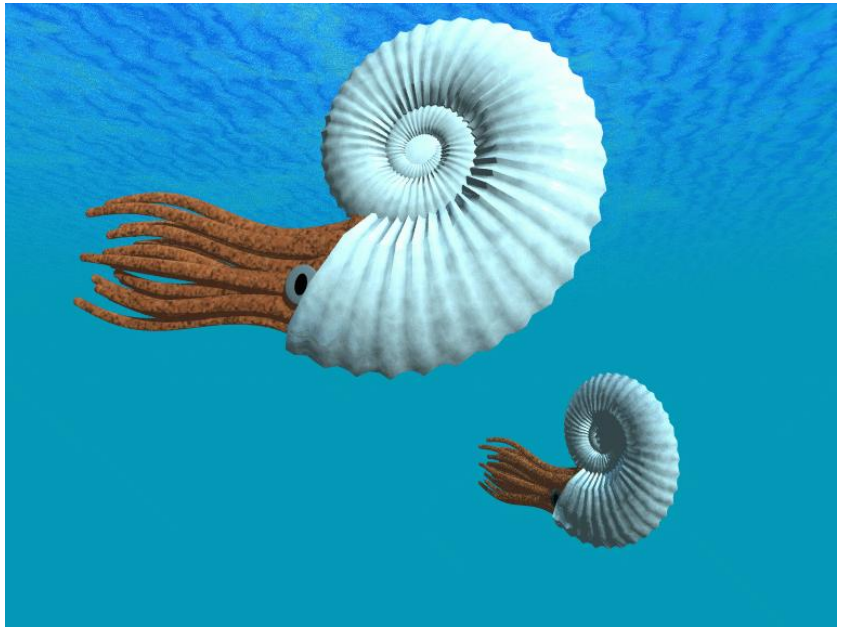
…and the universe is a whole lot bigger than this.




The big Bang
15 thousand million years
1 thousand million years
300 thousand years
3 minutes
10^{-6} seconds
10^{-10} seconds
10^{-34} seconds
10^{-43} seconds
10^{32} degrees
10^{27} degrees
10^{15} degrees
10^{10} degrees
10^{8} degrees
6000 degrees
18 degrees
3 degrees K
radiation
particles
heavy particles carrying the weak force
quark
anti-quark
electron
positron (anti-electron)
proton
neutron
meson
hydrogen
deuterium
helium
lithium


BIG BANG
BIG BANG PLUS TINIEST FRACTION OF A SECOND (10^{-43})
INFLATION
COBE SKY MAP
BIG BANG PLUS 300,000 YEARS
LIGHT FROM FIRST GALAXIES
BIG BANG PLUS 15 BILLION YEARS



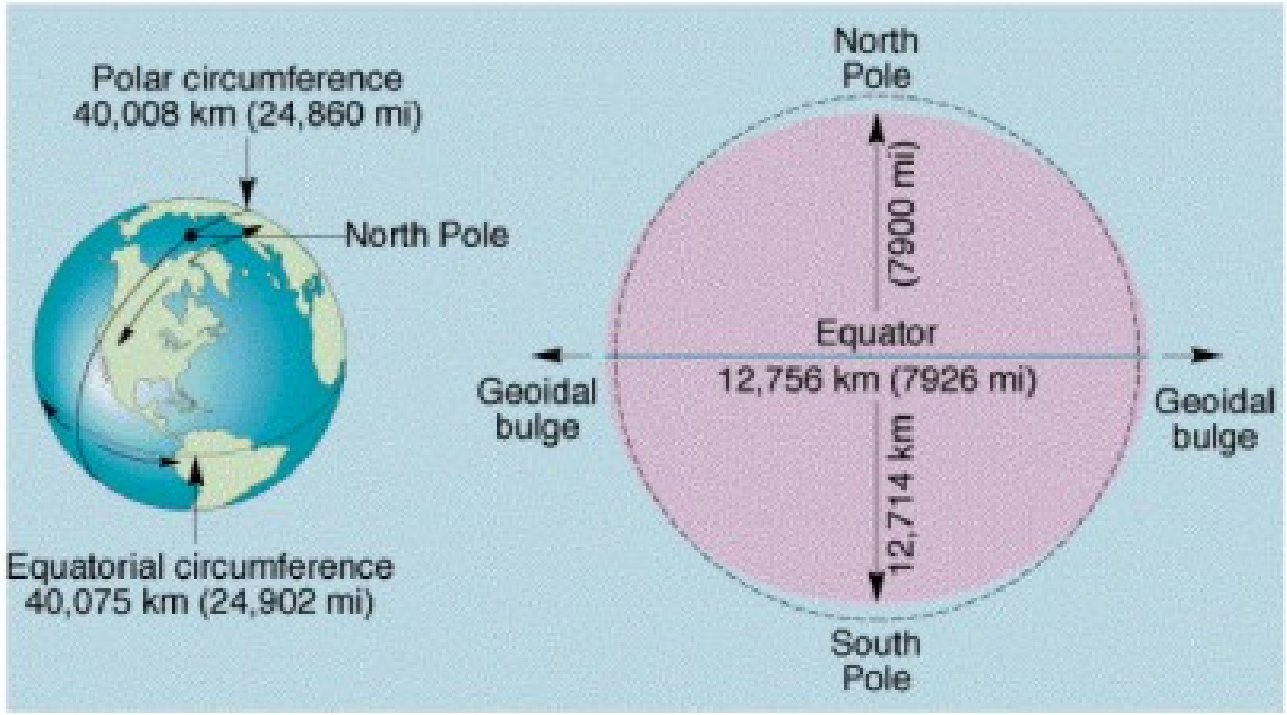


Q. What is the Shape of Earth? Layered Oblate Spheroid

Flattening is 1/297 - Poles (6357), Equator (6378)
→ 21 km difference in Radius

….Like amusement park rides.

Average radius for a non-rotating Earth = 6371 km.



Earth is Layered according to DENSITY:

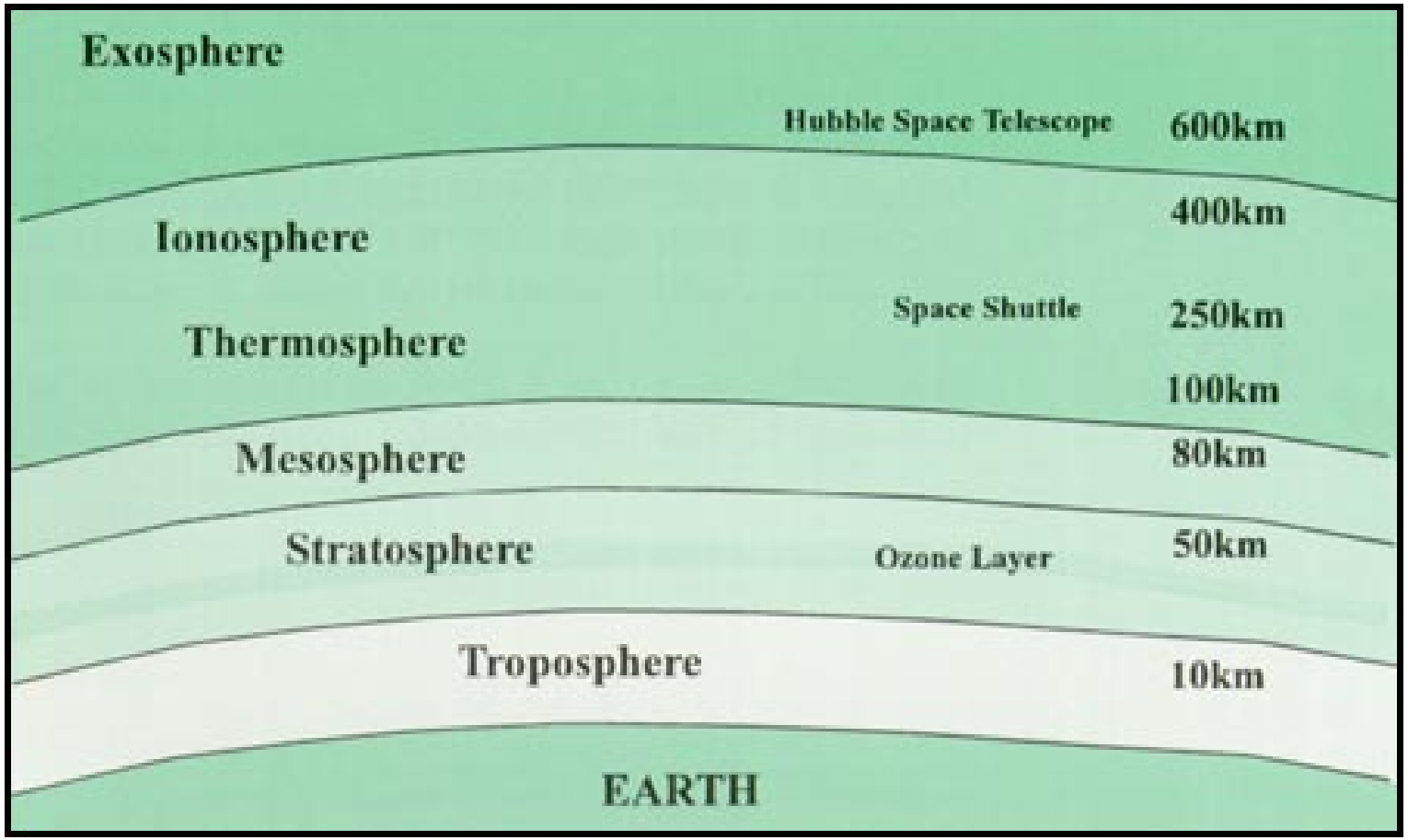
Geosphere (Core, Mantle, Crust)

Hydrosphere

Atmosphere

Also: Cryosphere, Biosphere, Magnetosphere

Atmosphere:


Exosphere
Hubble Space Telescope
600km
400km
Ionosphere
Space Shuttle
250km
Thermosphere
100km
Mesosphere
80km
Stratosphere
Ozone Layer
50km
Troposphere
10km
EARTH

What are the most abundant gases in the atmosphere?

Composition (moles):

N_2 - 78.1%
O_2 - 20.9%
Ar - 0.93%
H_2O - 0.1%
CO_2 - 0.039% (increasing)
Ne - 0.0018%

Hydrosphere: 98% in Oceans
2% streams, lakes, groundwater, glaciers

71% of Earth's surface is covered with water.

If Earth were a perfect sphere, it would be covered with 2.25 km of water.

Biosphere: Extends from the seafloor and deep crust, to the tops of mountains and the atmosphere.

3 - 30 millions species; 1.5 million identified

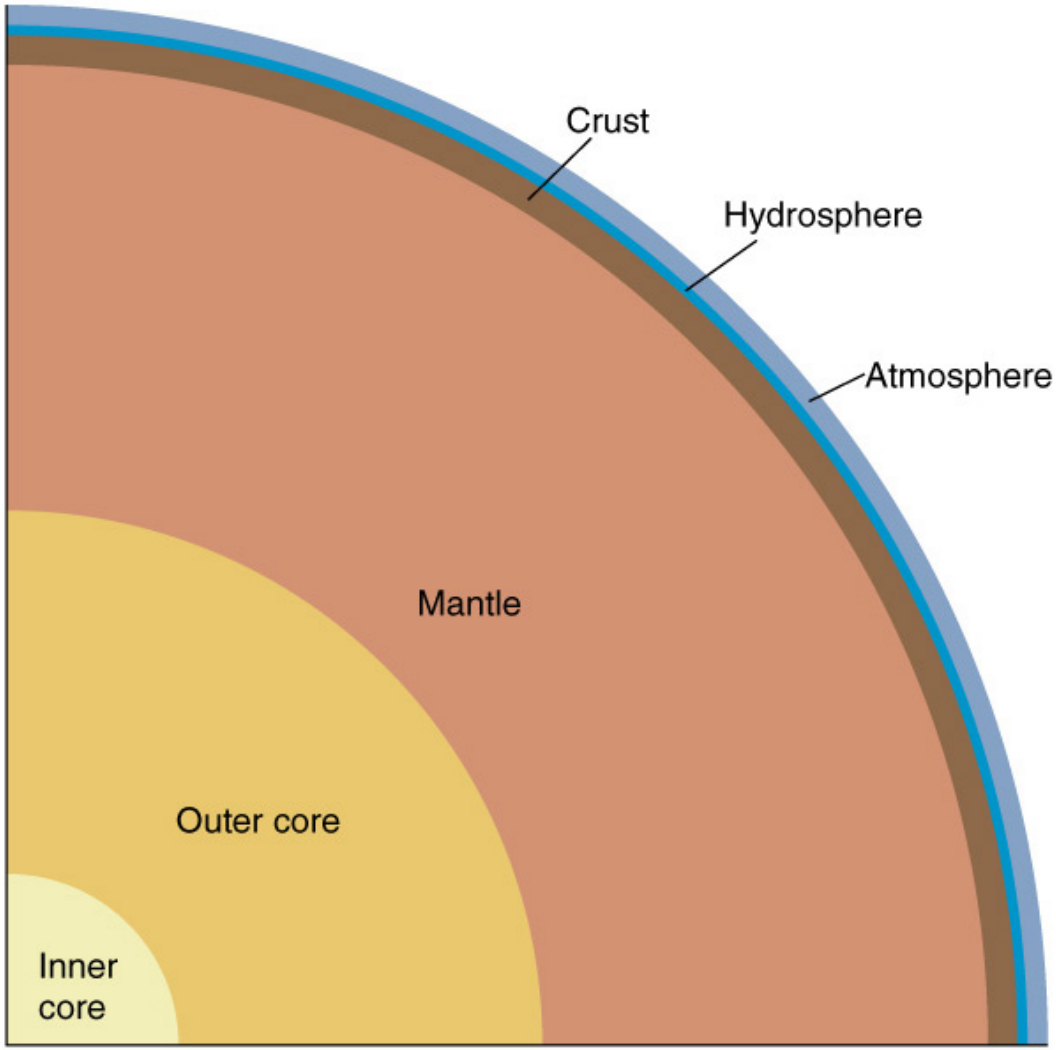
VERY significant geological agent (Ex: atmosphere, weathering)

Composition of Crust (%):

	Weight	Moles	Volume
Oxygen	47.2	61.7	93.8
Silicon	28.2	21.0	0.9
Aluminum	8.2	6.4	0.5
Iron	5.1	1.9	0.4

Composition of Whole Earth (weight %):

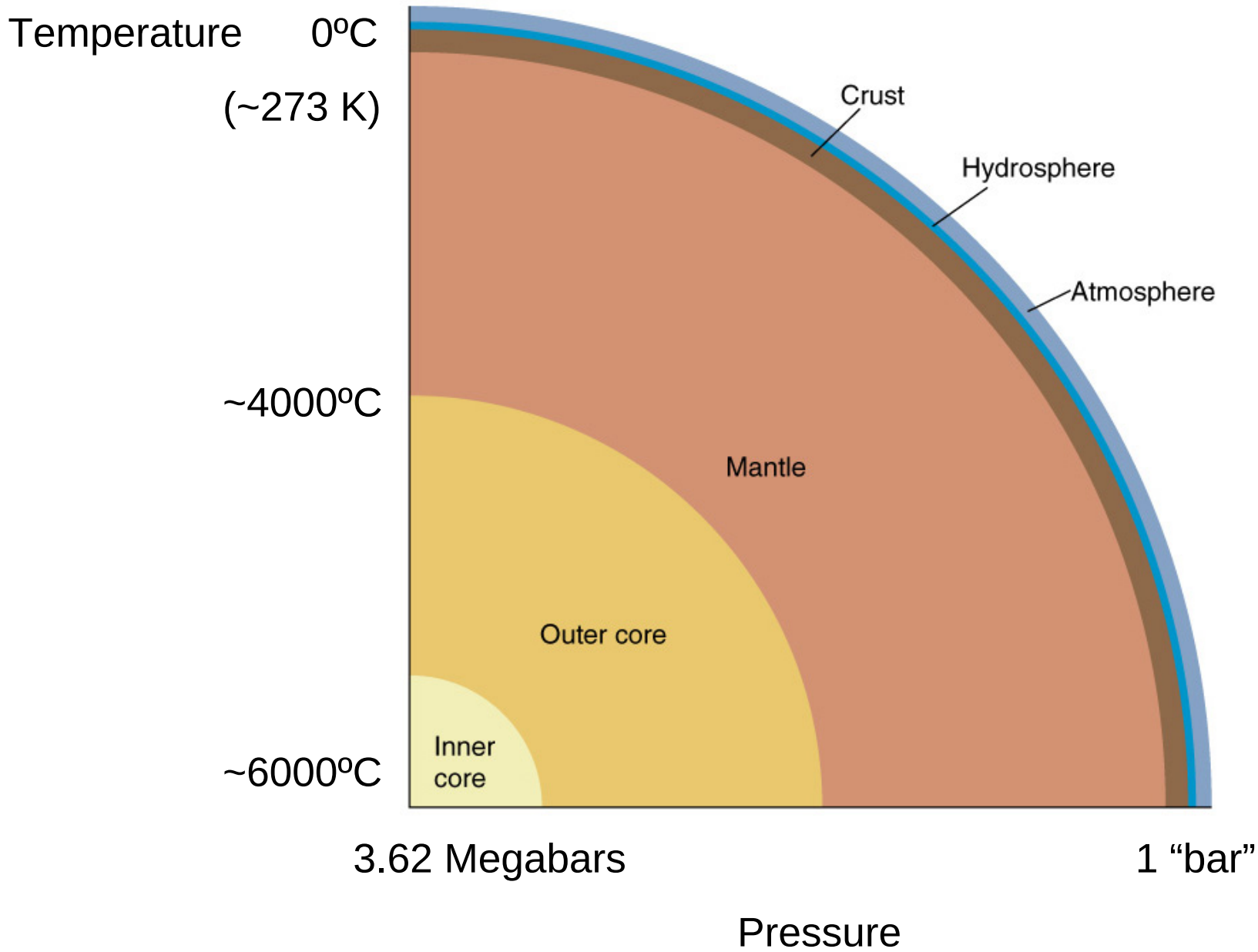
Iron	35
Oxygen	30
Silicon	15
Magnesium	13
Nickel	2.4



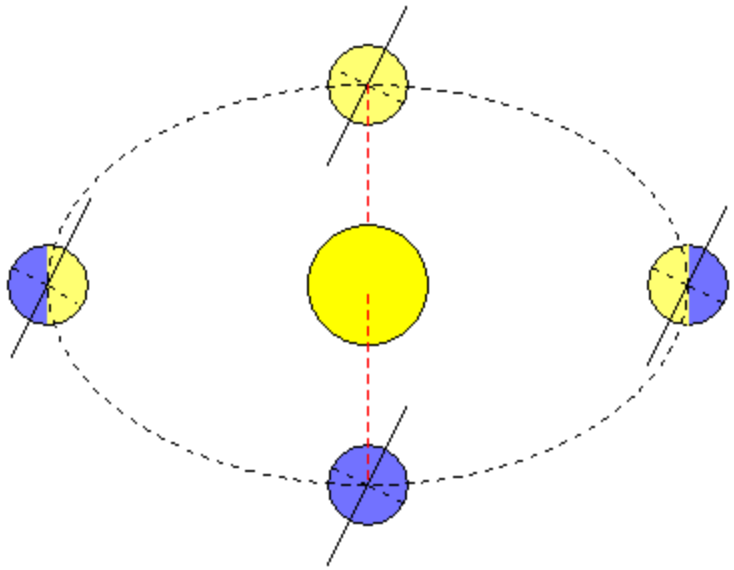
The mean density of Earth is 5.52 gm/cm^3.

Q. This is almost double the density of rock at the surface. Why?

A. Iron core; Compression


Temperature
0ºC
(~273 K)
~4000ºC
~6000ºC
Crust
Hydrosphere
Atmosphere
Mantle
Outer core
Inner core
3.62 Megabars
1 “bar”
Pressure

Q. Why are there seasons?

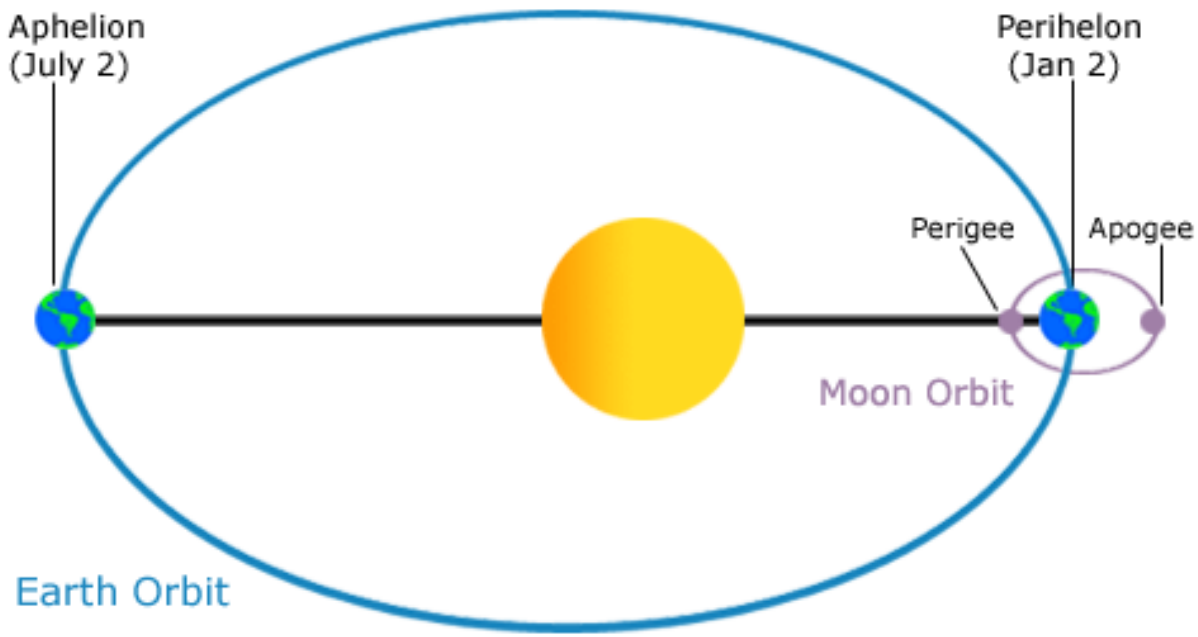


A. Rotation: Earth's axis of rotation is tilted by 23.5º with respect to the ecliptic.

Revolution: All orbiting objects follow elliptical paths.

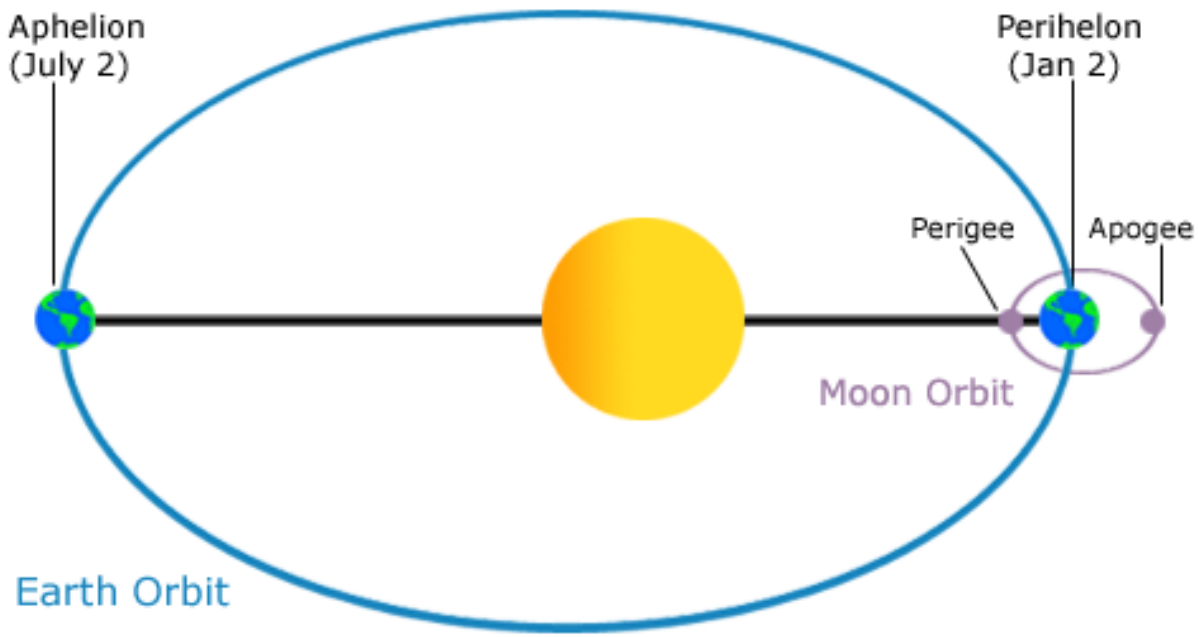
Q. How do the solar eclipses prove this?

A. Total vs. Annular eclipses



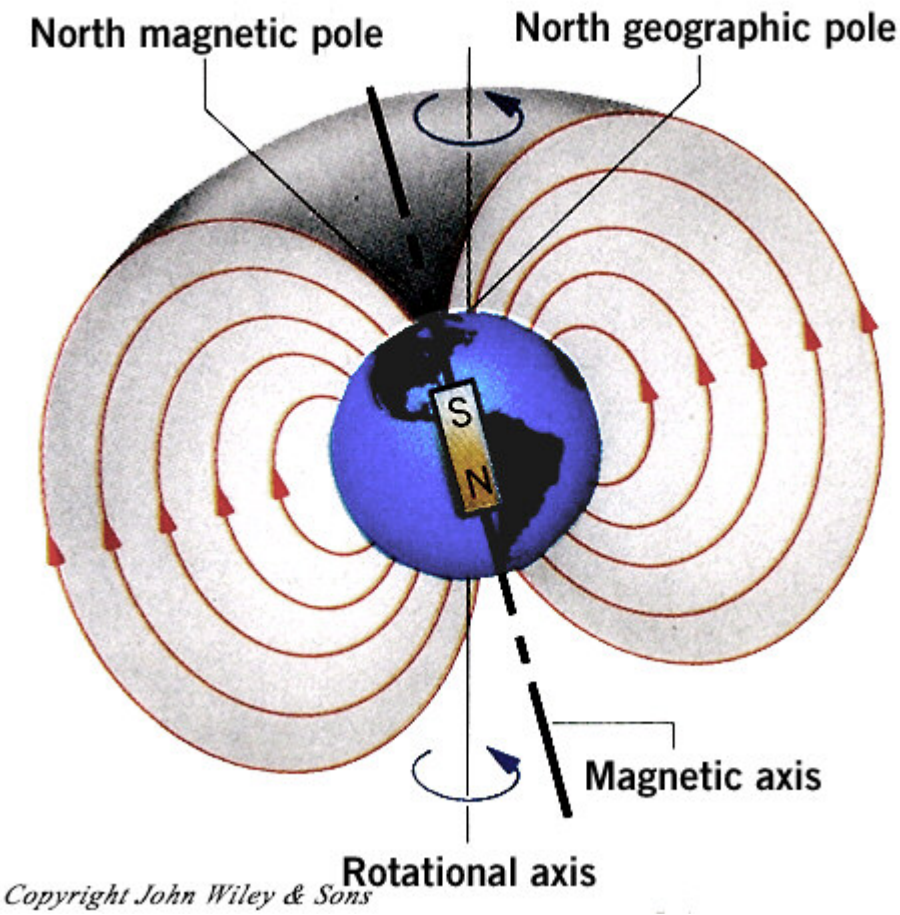
Earth's elliptical orbit is *NOT* related to the change of seasons.
(Earth is closest to the Sun around Jan. 2 !!!!)

However, it *IS* related to ice ages and sea level changes.
(more later!)



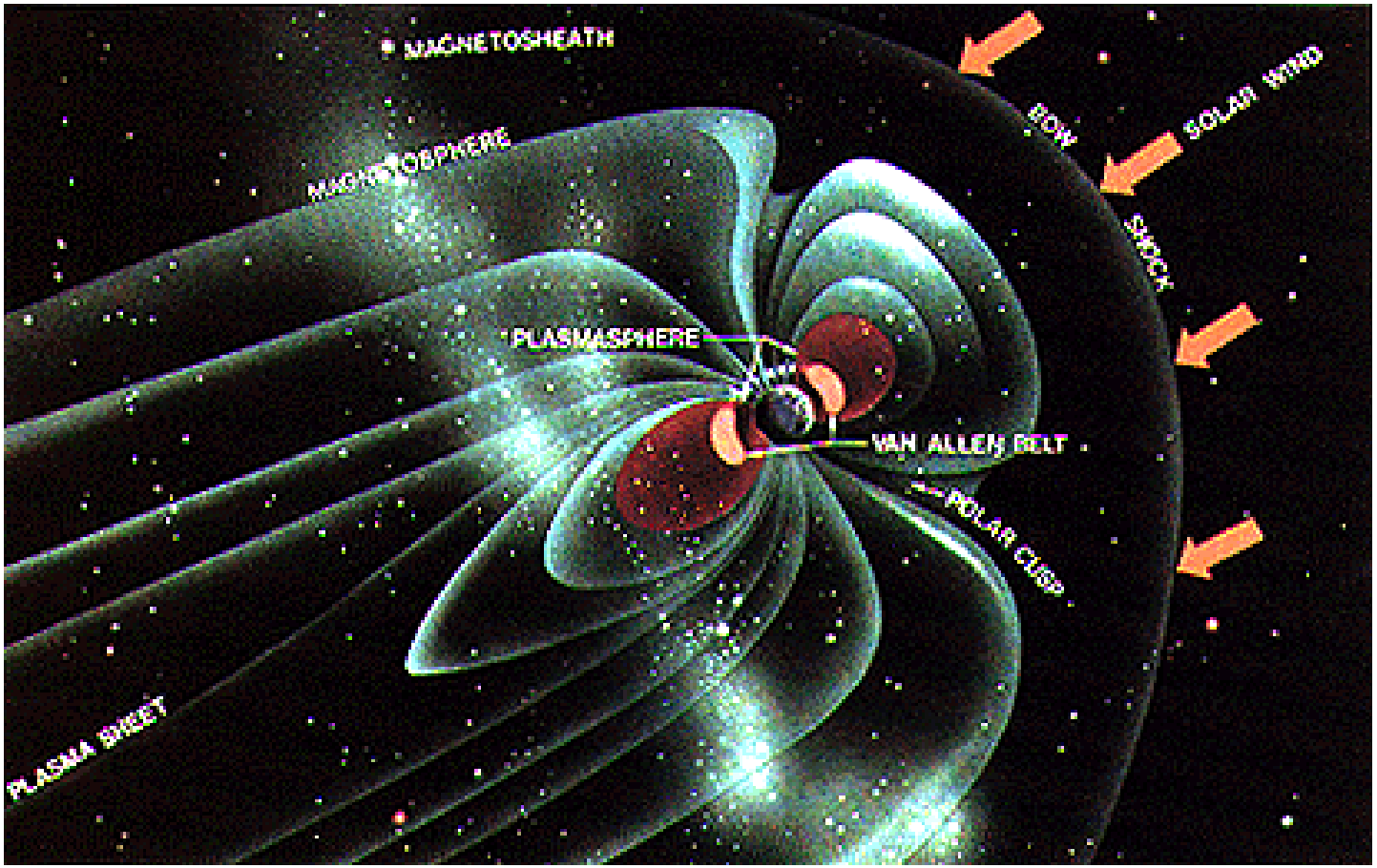
The average distance from Earth to the sun is about 150 million km.

>> Because light travels $3x10^8$ m/s, this is 500 s, or 8 1/3 minutes.



Earth's magnetic field *LOOKS LIKE* it is from a tilted, offset, wandering, bar magnet in its core. (But it *isn't*!!)

Fluid flow (convection) of liquid iron in Earth's outer core creates the magnetic field. → Magnetohydrodynamo



The magnetosphere protects us from ionized particles of solar wind.

Q. What phenomenon is related to some of these ionized particles reaching Earth?

A. Aurora

("Northern Lights")

It could be much worse.

(Go see "*The Core*")

Major “players” in the story of Earth’s evolution:

(1) 1st Law of Geology: Rocks Fall Downhill (Gravity)

- Controls LAYERING, MINERAL PHASES

(2) 1st Law of Geophysics - Heat “rises” (Thermodynamics, thermal expansion, gravity)

Heat flows from hot regions to cold regions (therefore up and out of the Earth).

Major Story Lines:

1) Earth is COOLING DOWN as fast as it can.

>> Radiation (Surface)

>> Conduction (Crust)

>> Convection (Interior)

2) Simultaneous increase in complexity (Life!!!)

3) Uniformitarianism (Cyclical Process) vs. Catastrophism - (one-time events)

4) Plate Tectonics (Radioactivity driven) vs. Erosion (Sun driven) Entropy

→ The surface is the battlefield.

→The Fossil Ammonite from the Himalayas is a “mortar shell” from the battle.

5) Temperature vs. Pressure

(Ex: Earth's Core is about 6000°C, but still SOLID!!)