PHYSICAL SCIENCE
BY NAVEED ANJUM

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UNIVERSE:

The total of all that exists or has existed, both in space and time. Matter and energy, stars, planets, galaxies and contents of intergalactic space(Plasma).

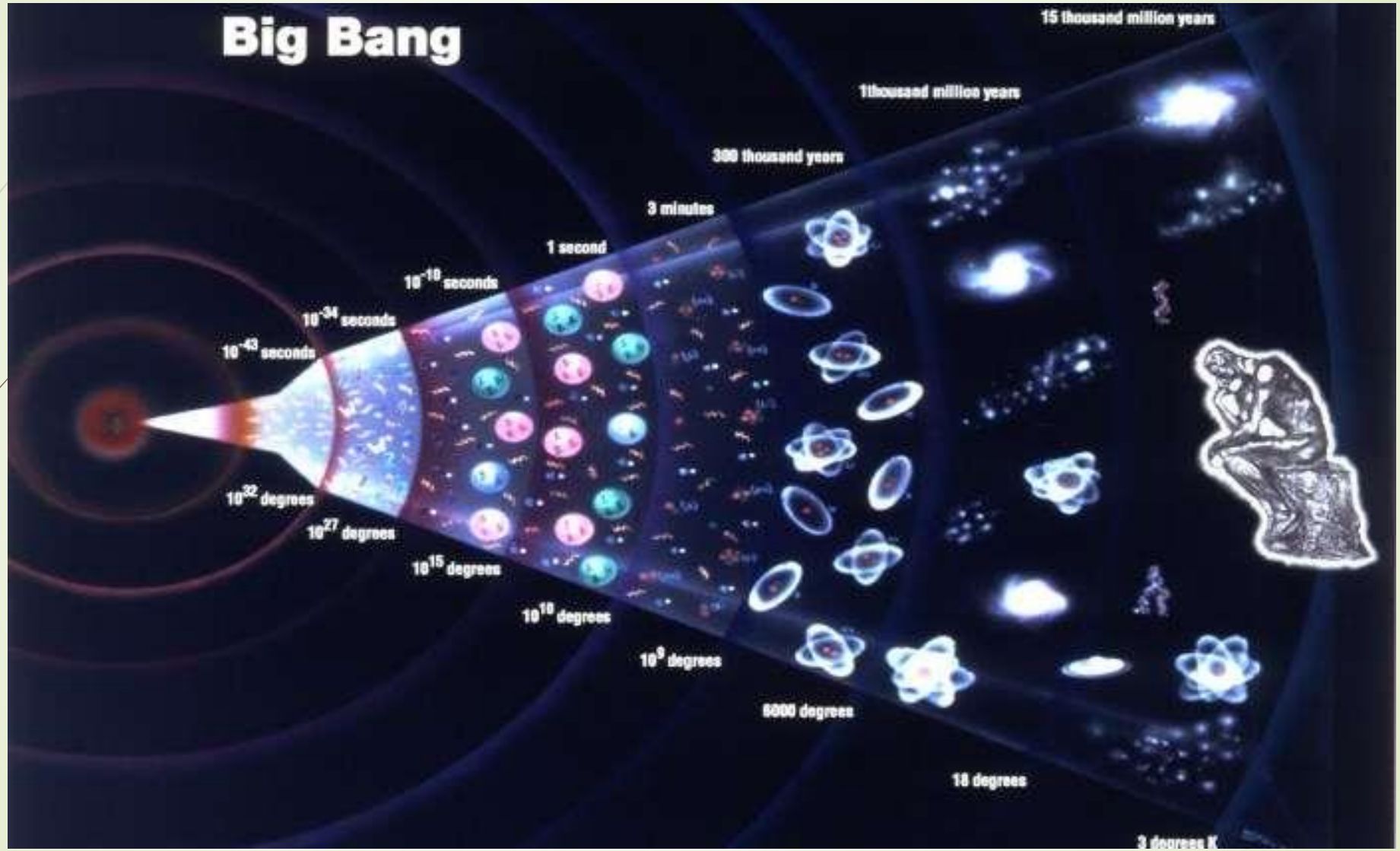
Universe = All Matters + Energy

ORIGIN OF UNIVERSE

1. THE BIG BANG THEORY

- **Big bang, a term coined by Sir Fred Hoyle in 1950.**
- **13.8 billion years ago**
- **Singularity**
- **Released a large amount of energy**
- **Electrons and Protons came into existence**
- **Gravity came into existence**
- **E + P = Hydrogen atoms**
- **Atoms formed nebulas, a group of molecules, which then developed into stars**
- **Temp Drop = 1 bn degree C**

From Singularity to the Existed Universe



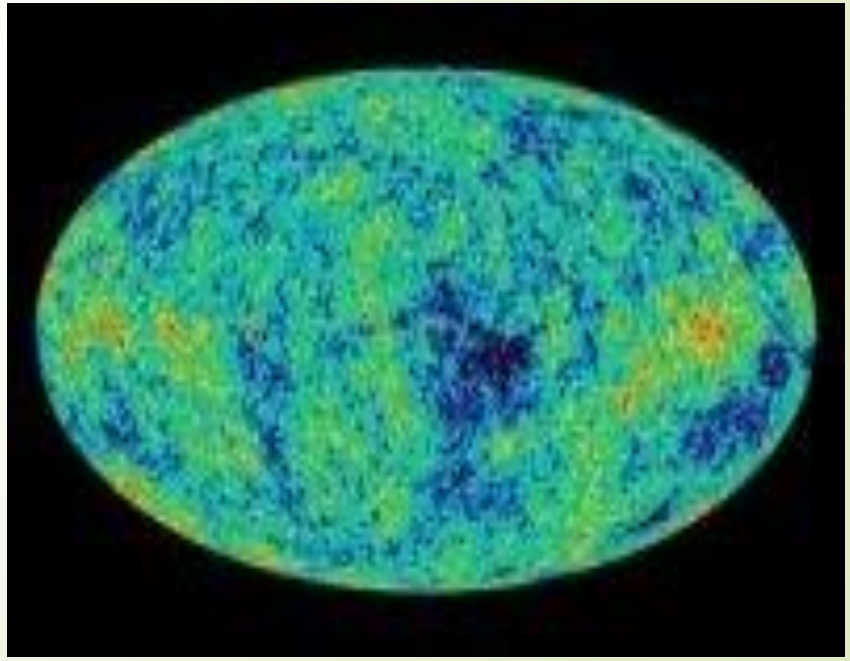
Evidences for the Big Bang

1. Redshift of Galaxies

- The redshift of distant galaxies tells us the Universe is expanding.
- A. RedShift = Light shifts => longer and redder wave length (Moving away)
- B. Blueshift = Shorter and Blue wave length (Moving towards Earth)

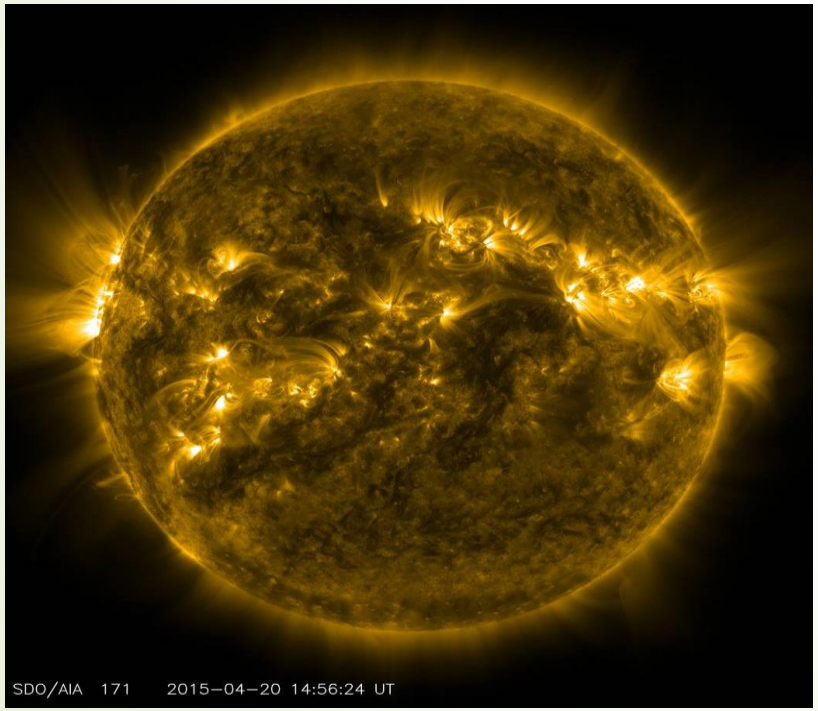
2. Microwave Background

- After Big Bang => Universe was very hot
- As it grew in the size, the heat left a "glow" which fills the entire Universe.
- Detected this glow as microwave light.



3. Mixture of Elements

- Some chemical elements were created soon after the Big Bang.
- Elements like hydrogen and helium.



4. Looking back in time

- Steady State theory
- The Universe does not change much over time.

Future of the Universe (Models)

1. Closed Model

Contracting Universe Theory: Many billion years from now, expansion will stop and universe will contract back upon itself.

2. Flat Model

Steady State Theory: Expansion will slow down but will not collapse upon itself. And it will approach a stable size.

3. Open Model

Expanding Universe Theory: The universe will continue to expand forever.

4. Cyclic Model

Cyclic Universe Theory: Universe will collapse upon itself, then there will be a big bang again, it will expand and will collapse again. This cycle will go on.

THE WHOLE UNIVERSE

1. Known Universe (5%)

Composed of normal matter and normal energy.

- Visible and Invisible (infrared)
- Luminous matter
- Known Properties (Chemical composition)
- The energy can be controlled and utilized
- Space time (1hr-7years)
- Particles (e, p, n)
- Physical laws
- Gnz11 is the farthest galaxy (32 bn light years away)

2. Unknown Universe (95%)

Composed of unknown (dark) matter and unknown (dark) energy.

DARK MATTER

- Non-Luminous matter
- Invisible in nature
- Present within galaxies
- Cosmic glue (produces an attractive force-gravity)
- Can not be utilized

DARK ENERGY

- Energy responsible for expansion/big bang
- Present in between galaxies
- Properties Unknown
- Can not be controlled or utilized

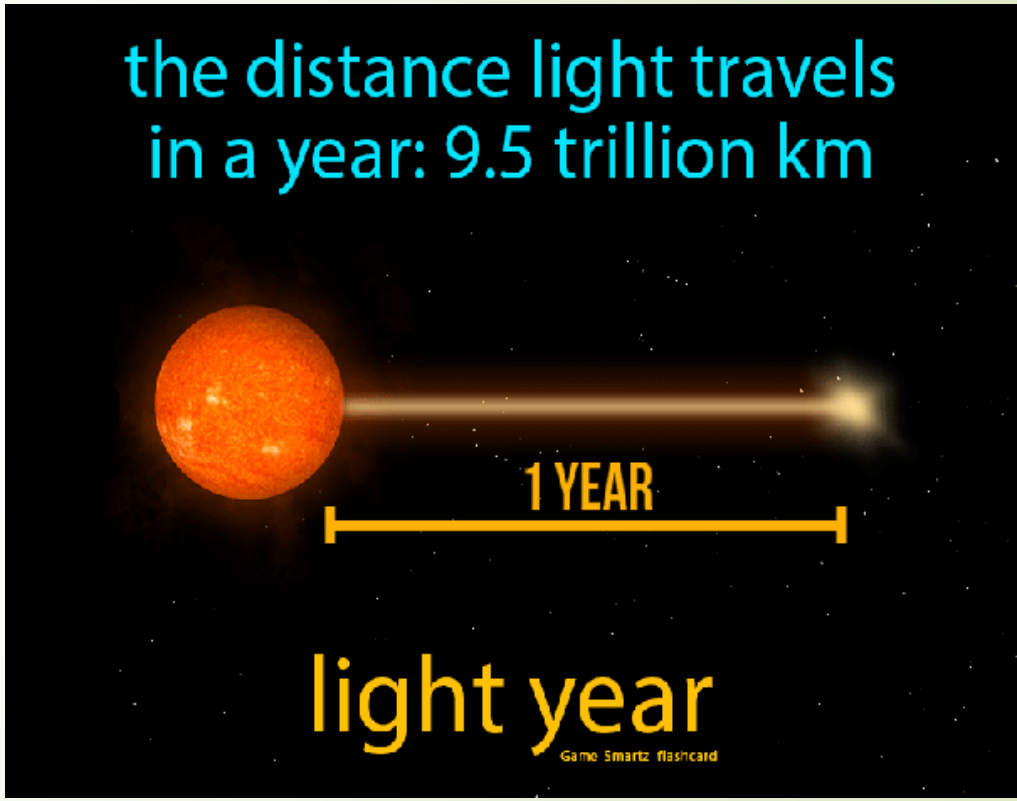
LIGHT YEAR

A light year is an astronomical unit of length informally used to express astronomical distances.

As defined by the International Astronomical Union (IAU), a light-year is the distance that light travels in vacuum in one Julian year (365.25 days)

1 lightyear = 6 trillion miles

One light second is 186,000 miles



GALAXY

- Massive aggregate of hundreds of billions of stars, all gravitationally interacting and orbiting about a common Centre.
- Astronomers estimate that there are 125 billion galaxies in the universe.
- Milky way and Andromeda are examples of galaxy
- Size
- Dwarfs: with a few thousands stars
- Giants: with 100 trillion stars
- Shapes

1. Spiral
2. Elliptical
3. Irregular

1. Spiral galaxies

A spiral galaxy is a disc shaped galaxy, with a bulge at the center and with arms that spiral outwards as the galaxy rotates.

It contains more middle-aged stars along with clouds of gas and dust.

Spiral galaxies are further divided into a, b and c depending on the extent of the unwinding of arms and on relative clarity of the arms & the nucleus.

Milky way is a spiral galaxy.

2. Elliptical galaxies

Elliptical galaxies appear as luminous elliptical discs with a smooth distribution of light.

Brightness decreases from the center.

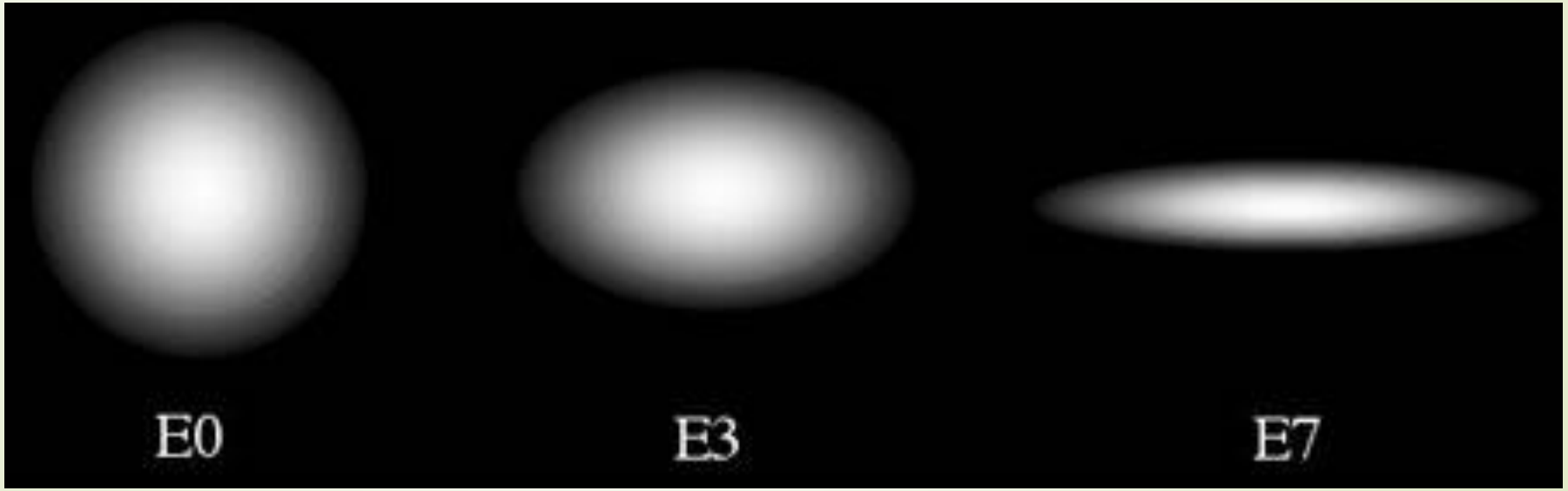
Contains older stars with very little dust & gas.

Elliptical galaxies are further divided into

E-O (face on as circular discs)

E-3 (oval shaped)

E-7 (edge on galaxy)



3. Irregular galaxies

Irregular galaxies have undefined and indefinite structure.

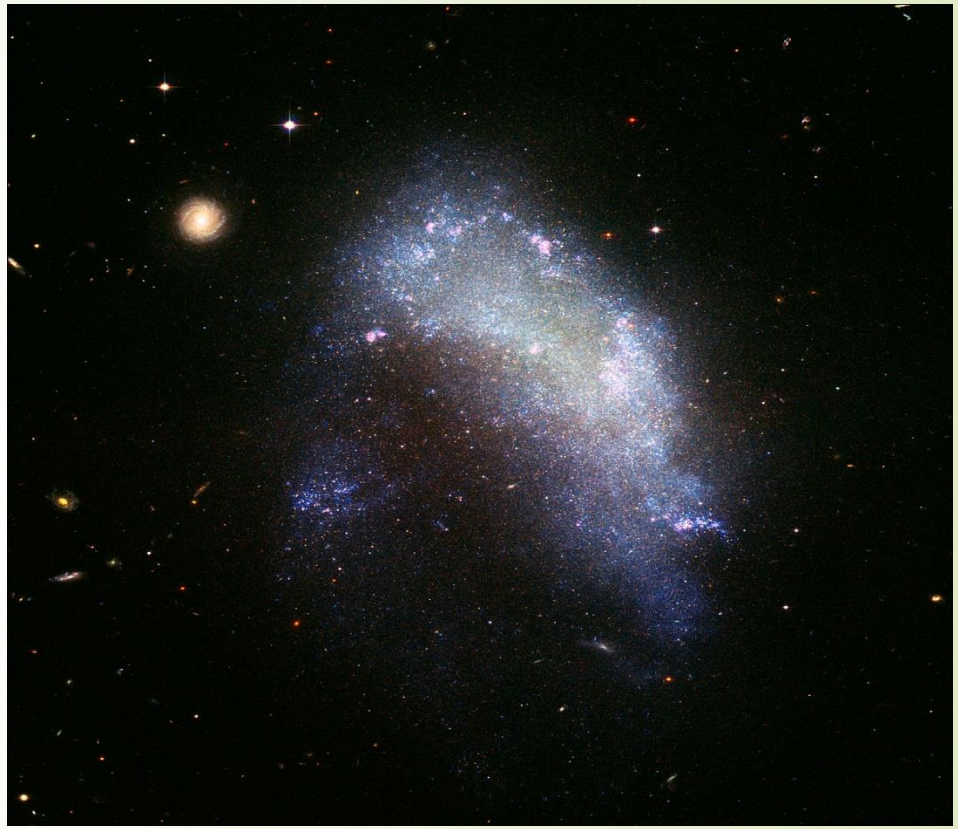
Irregular galaxies have lots of young stars with dust and light.

Irregular galaxies do not have distinct shape because they are in the gravitational influence of other galaxies.

Irregular galaxies are divided into

Irr- I

Irr-II



Milky Way

- Large, disc-shaped
- Includes Earth's Solar System and about 200-400 bn other stars, in which most of them are visible
- Diameter = 100,000 light years (Light-year is the distance light travels in one year)
- Earth's Solar System distance from center = 30,000 light years
- Sun rotation = 250 million years
- Spiral – Bugle in the center and with arms
- Nearest galaxy = Andromeda
- The Region occupied called Galactic Plane

Major Arms: 1. Pursues 2. Sagittarius 3. Centaurs 4. Cygnus Arm

Minor Arms: 1. Orion Spur/arm

Solar System

- Made of Planets, Dwarfs, satellites, Asteroids, meteoroids, Comets
- Elliptical/Egg Shaped
- Sun contains more than 99% of the solar system mass
- 4.5 bn years old
- Formed out of solar nebula (a huge cloud of gas)

SUN

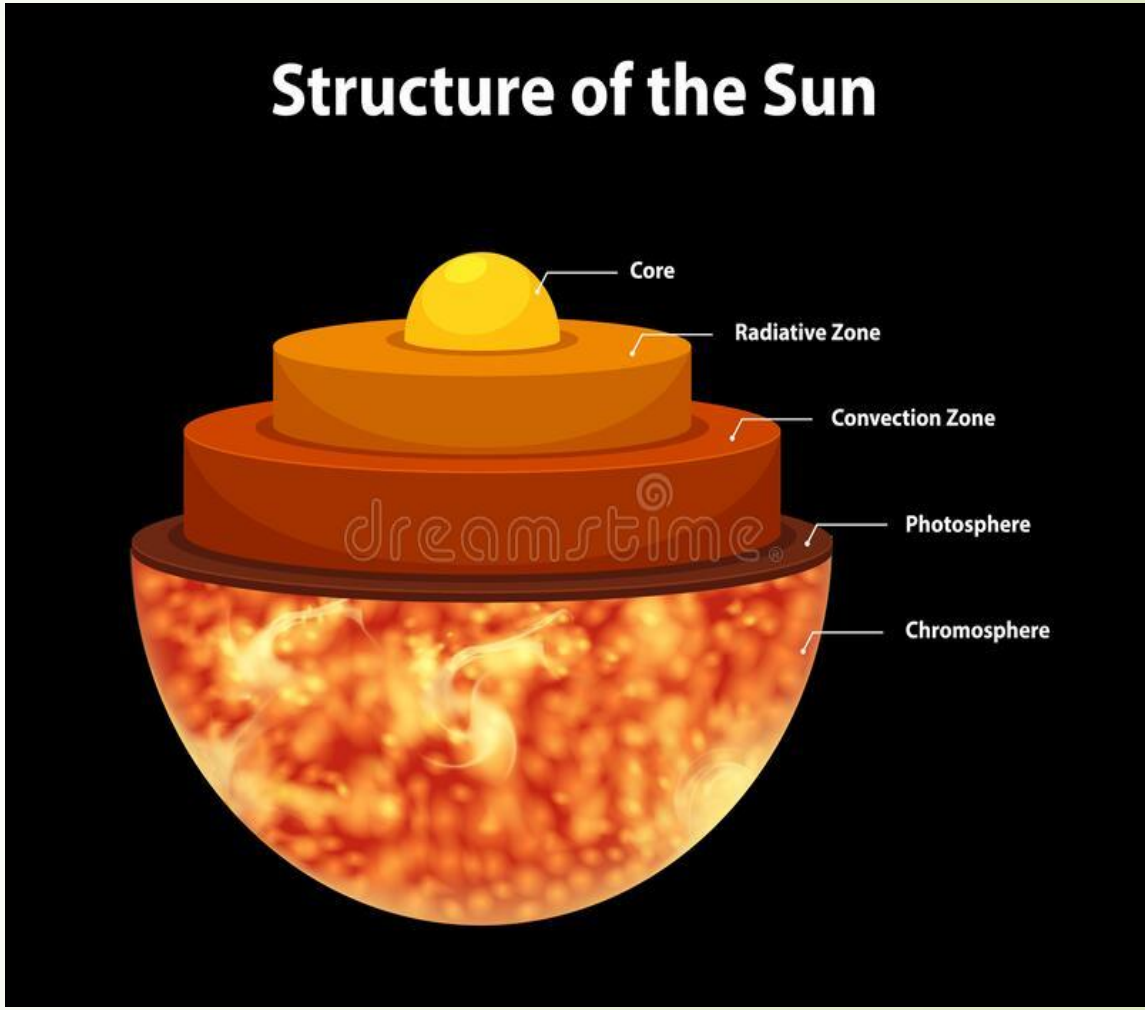
- Closest star, lies in milky way galaxy, yellow dwarf star and of medium size.
- 4.5 billion years old
- Scientists predict it will die after 4.5 billion years.
- Diameter is 870,000 miles, 1.4 million kms
- Mass of sun is 1.989 × 10^30 kg and 330,000 times of earth.
- Composed of 90% H2, 8% He, 2% heavy metals
- Density 1.41 g/cm3
- Temperature is 5778 K (9932 F)
- Temperature at core is 15 million degree Celsius
- Mean distance from the earth 149-150 million km or 93 million miles.
- Sun has very active and large magnetic field

SUN

- Sun rotates around its axis in 25-35 days (25 at the equator and 35 at the poles)
- Sun rays reach the earth in 8 minutes and 20 seconds.
- The minimum distance between the sun and the earth is known as perihelion and maximum distance is called aphelion.
- Sun is moving around the center of the galaxy at a velocity of 220 km/s. It completes its one revolution in 250 million years and this time taken is known as cosmic year .

SUN

- **Star:** Composed of Hydrogen and Helium
- **Reaction:** Nuclear Fusion
- **Regions of Sun:** 1. Interior
  2. Solar Atmosphere
  3. Visible Surface
- **INTERIOR:** 1. Core
  2. The radiative zone
  3. The convective zone
- **VISIBLE SURFACE:** Photosphere
- **SOLAR ATMOSPHERE:** 1. Chromosphere
  2. Corona



The Core

- Central part; Hottest
- Reactor (Fusion Reaction in four stages)
  1. Two Hydrogen nuclei or Protons collide to produce deuterium --- produce a positron
  2. Positron collides with an electron to produce two photons
  3. The deuterium nucleus collides with another proton to form helium-3
  4. Two helium-3 nuclei collide to produce helium-4
- 25% of solar radius
- Density: 150 times of water's density
- Temperature: 15 million degree Celsius, which is almost 3000 time higher than at the surface.
- Pressure: 340 billion times the atmospheric pressure on Earth's surface

The Interior Part of Sun

The Radiative Zone

- Energy from core carried out through this layer by photons as thermal radiation.
- Hot, dense and highly ionized
- Temperature: 2 to 7 million degree Celsius
- It is about 75% hydrogen and 24% helium.
- Occupies roughly 45% of the Sun's radius

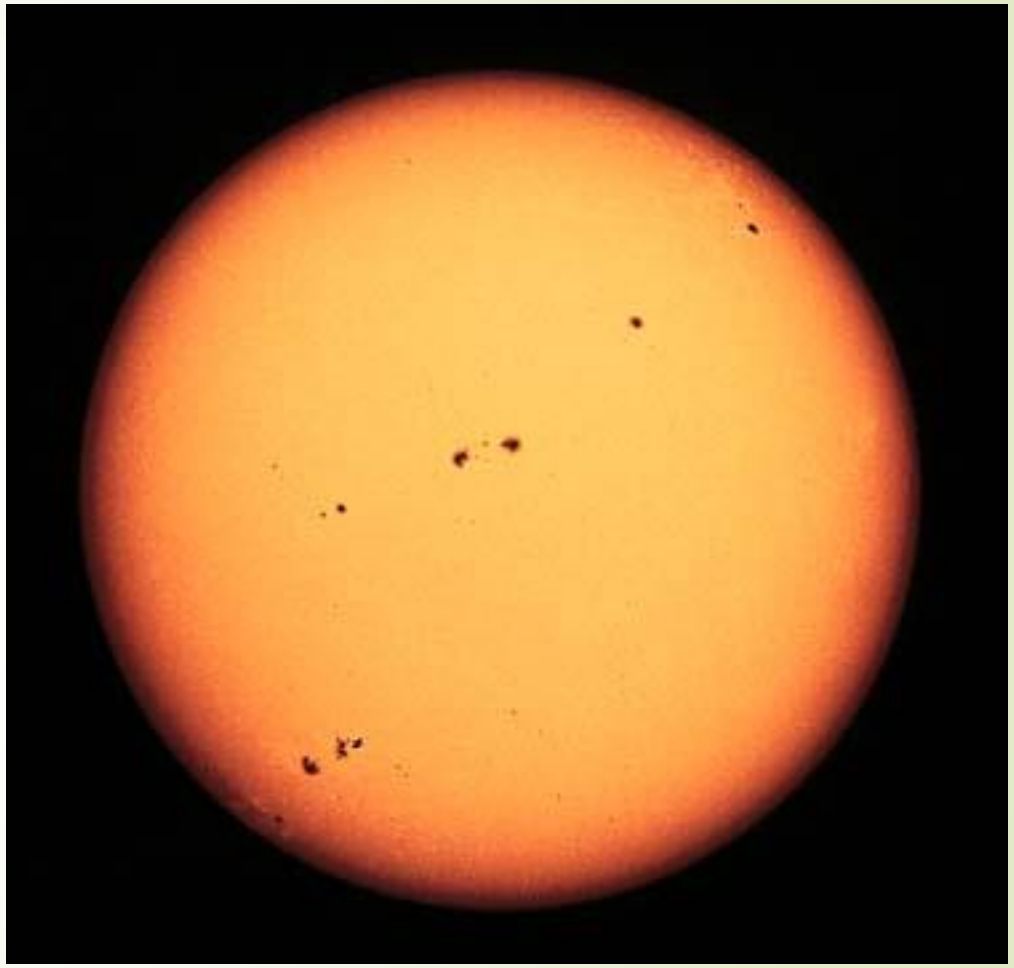
The Convective Zone

- Dominant mode of energy flow by thermal convection (Heat Transfer)
- Not dense or hot enough
- Once the material cools off at the surface, it plunges downward to the base of the convective zone to absorb more heat from the top of the radiative zone and repeat the cycle.

The Photosphere

- Visible surface of the Sun
- Lies between Sun's interior and the solar atmosphere
- Average temperature: 5800 - 6000K
- 400km thick
- Dense enough to smit plenty of light but not so dense that the light can not escape.
- Sunspots: 1. Typical size of spots is similar to the size of the Earth.
  2. These regions are cooler than average, so they look darker than the surrounding hotter region.

  3. With higher Magnetic Field



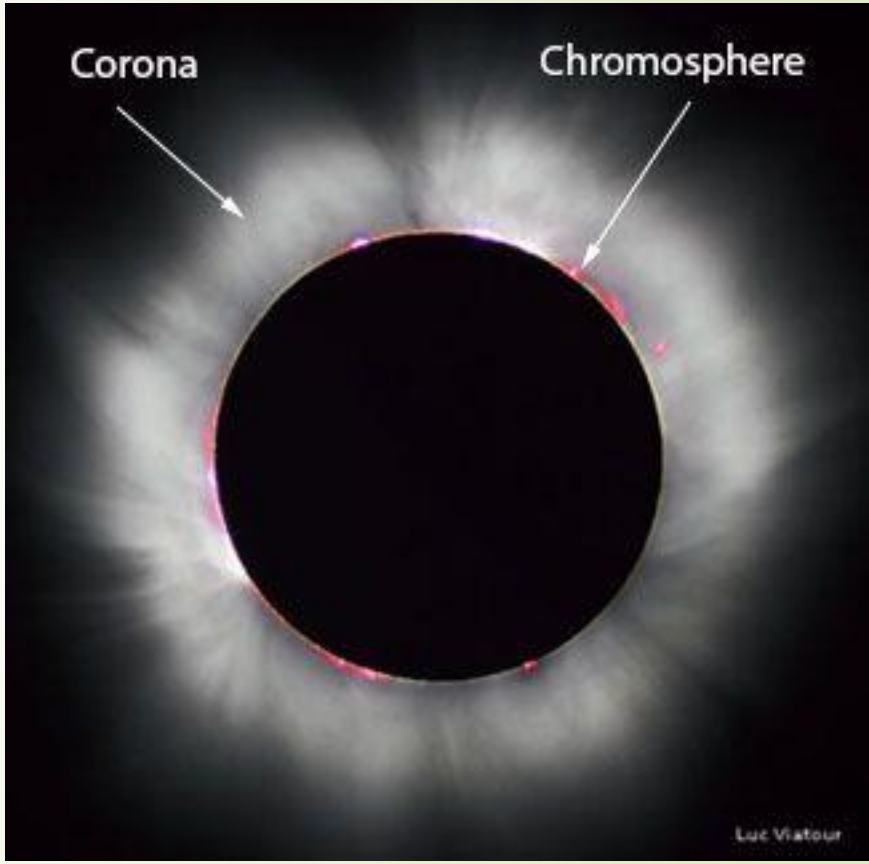
The Solar Atmosphere

Chromosphere

- Lower Region
- Bright Red (viewed during solar eclipse): Appears red because hydrogen atoms are in excited state and emit radiations in visible spectrum near red part.
- Thin transition region where temperature rises sharply between chromos
- Temperature from 6000 to 50,000 centigrade.

Corona

- Outer most region
- Hotter than photosphere (a million degrees Celsius or higher)
- Magnetized waves of plasma could carry huge amounts of energy



PLANETS: (Wanderers)

Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune

1. Terrestrial/Inner/Inferior

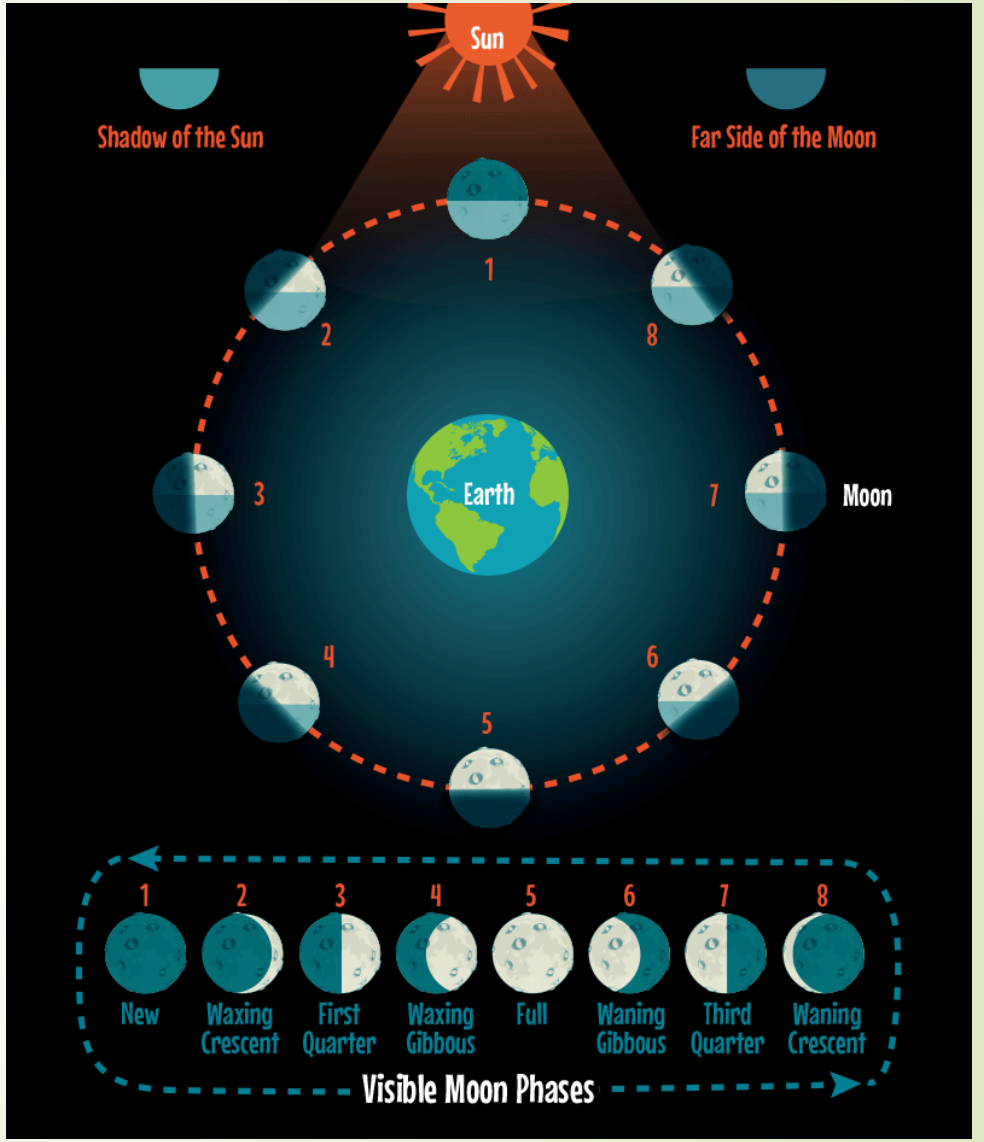
- Mercury, Venus, Earth and Mars
- Close to Sun
- Small masses and radii
- Rocky-Solid surface (Metallic core)
- High Densities
- Slow Rotation (Speed)
- Weak magnetic field
- No Rings
- Few moons
- Carbon dioxide and nitrogen

2. Jovian/Gaseous Planets

- Jupiter, Saturn, Uranus and Neptune
- Far from Sun
- Large masses and radii
- Gaseous surface (Molten rock core)
- Low densities
- Fast Rotation (Speed)
- Strong magnetic field
- Many rings
- Many moons
- Hydrogen, helium and ammonia

MOON (EARTH'S ONLY NATURAL SATELLITE)

- All natural satellites that orbit planets are called moon
- Our moon named *Luna* is fifth largest moon in the solar system
- Diameter 3474 km
- Mass 7.34767309 × 1022 kilograms
- Density 3.34 g/cm^3
- Average distance b/w moon & earth 384,400km
- Orbital period of moon around earth 27 days and 7 hours (actual).
- Same time is taken by the moon to rotate around its axis.
- Gravity is 1/6th of earth's gravity.
- Average surface temperature during the day is 107 degree Celsius and at night -153 degree Celsius.
- No atmosphere but negligible amount of inert gases.



Planet	Distance from the Sun (million km)	Period of Revolution Round the Sun	Period of Rotation on own Axis	No. of Satellites	Mass Time of Earth	Other Details
Mercury	57.9	88 days	58 days 15h and 30 min	0	0.055	Nearest to the Sun, Smallest and fastest planet
Venus	108.2	224.7 days	243 days and 14 hours	0	0.815	Brightest, Hottest, Closest to Earth and earth twin planet
Earth	149.6	365.25 days	23 h, 56 min and 40 sec	1	-----	Most dense planet, watery planet
Mars	227.9	687 days	24 h, 37 min and 22 sec	2	0.108	--------
Jupiter	778.3	12 days	9 h, 50 min and 30 sec	79 Ganyme de	317.9	Largest Planet, Largest no. of satellites and smallest day
Saturn	1427	30 days	10 h & 14 min	82	95.2	Least Dense
Uranus	2869.6	84 days	16 h & 10 min	27	14.6	-------
Neptune	4496.6	165 days	18 h	14	17.2	Coldest, slowest to move around the sun and largest year

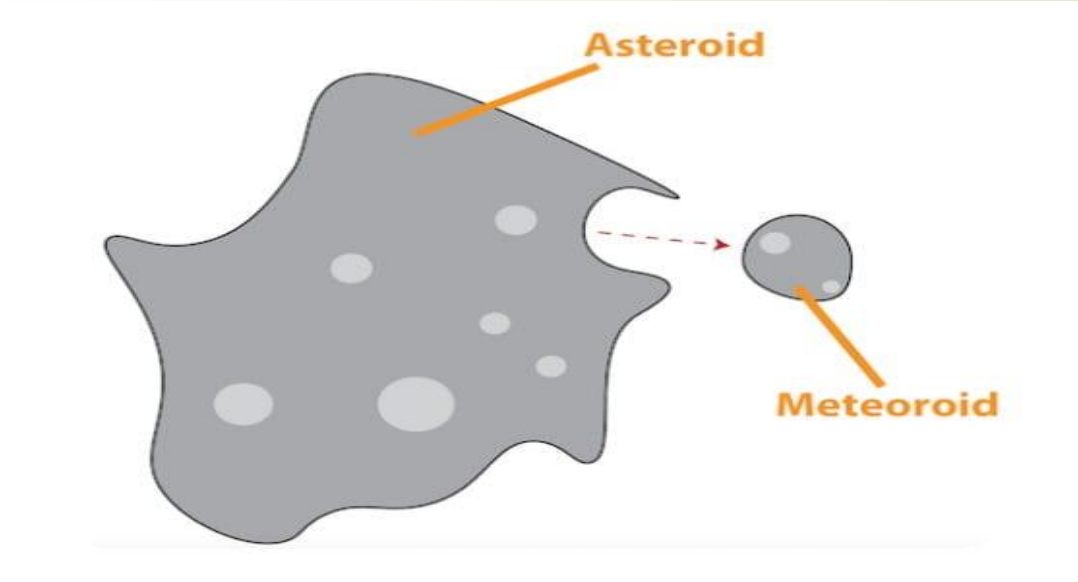
Some Important Definitions

1. Asteroid

- A small rocky object that orbits the Sun
- Diameter: From 100m to 1000km
- Largest asteroid is Ceres (D=950km)
- Irregular in shape and surface cover with Craters (a bowl-shaped depression
- Found in the main asteroid-belt (btw Mars and Jupiter)

2. Meteoroid

- Segment of rock or iron that orbit the Sun
- Originate from comets and asteroids
- **Meteor:** If a meteoroid enters to earth's surface (Shooting stars)
- **Meteorite:** A fragment that survives to hit the ground



3. Comet

- Cosmic snowballs of frozen gases, rock, and dust that orbit the Sun
- Long Tail (made of dust and ionized gas) always point away from the Sun
- Tail length: 250 million km
- Visible when near the Sun
- The current number of known comets is: 3,743
- Halley's Comet: Periodic comet orbits around the Sun

4. Constellation:

- Group of visible stars within a particular region of the night sky forming various shapes and pattern.

LUNAR ECLIPSE

1. Penumbral Eclipse:

- Moon in penumbra
- Rarely visible from earth as there is slightly change of color of the moon.

2. Partial Eclipse:

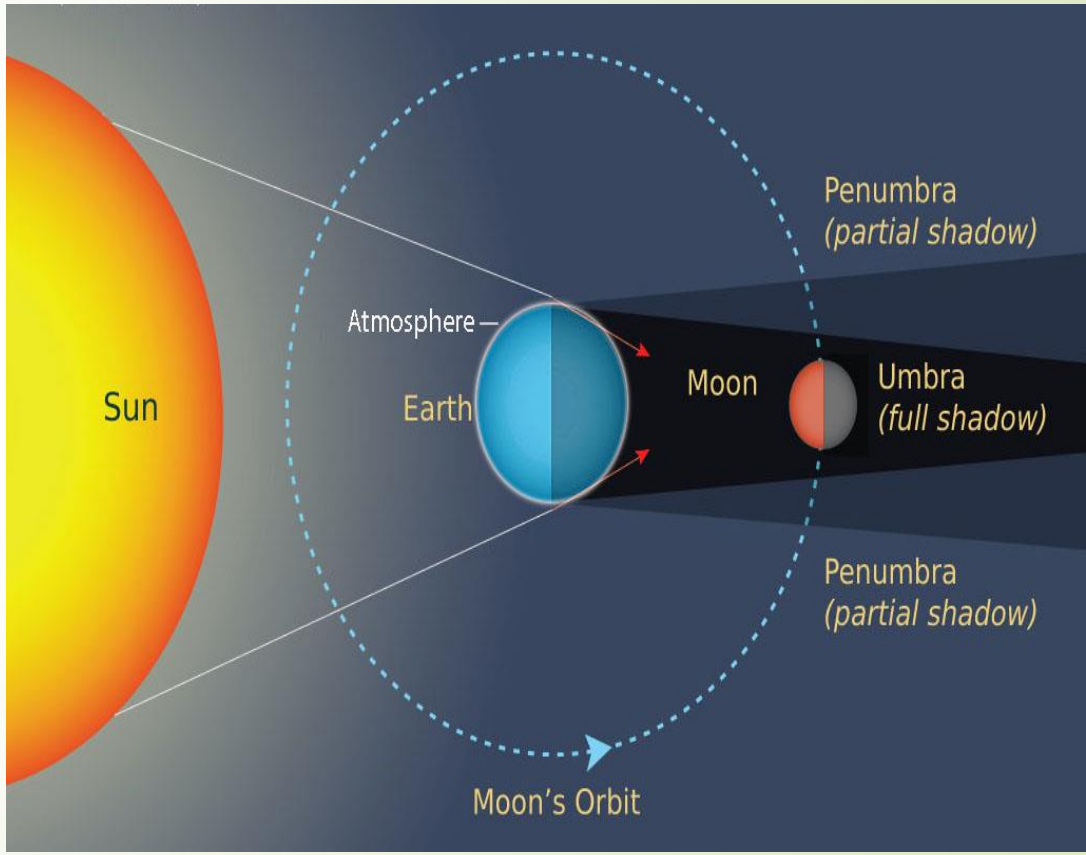
- Moon in between penumbra and umbra
- Moon slightly obscured (conceal)

3. Total Eclipse:

- Entire moon passes through the umbral region
- Moon is totally obscured

Note: Occur only on full moon

*** Moon light to reach earth takes 1.3sec**



SOLAR ECLIPSE

Always occurs at new moon

1. Total Eclipse

Moon completely covers the sun light

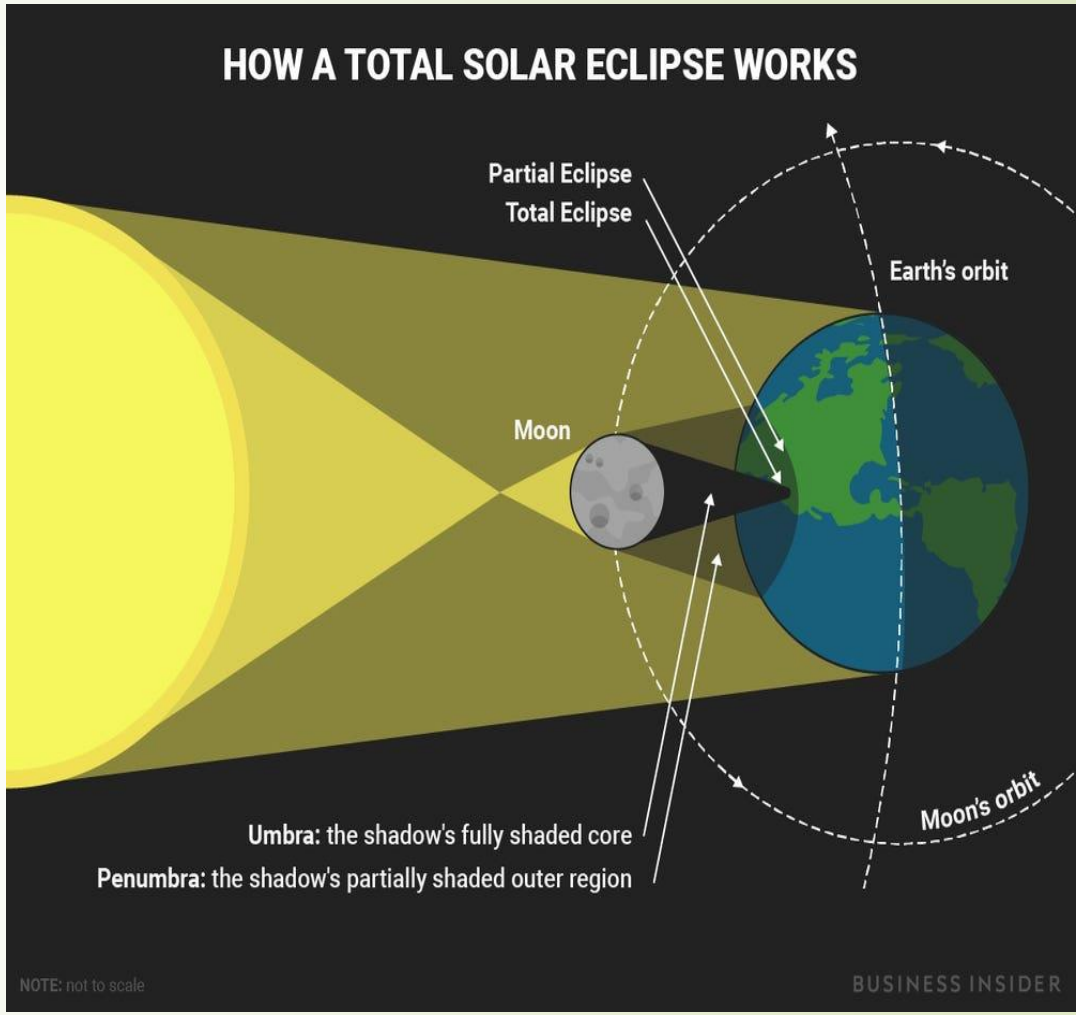
2. Partial Eclipse

Earth, moon and sun do not align in a perfectly straight line. The moon only partially covers the disc of the sun.

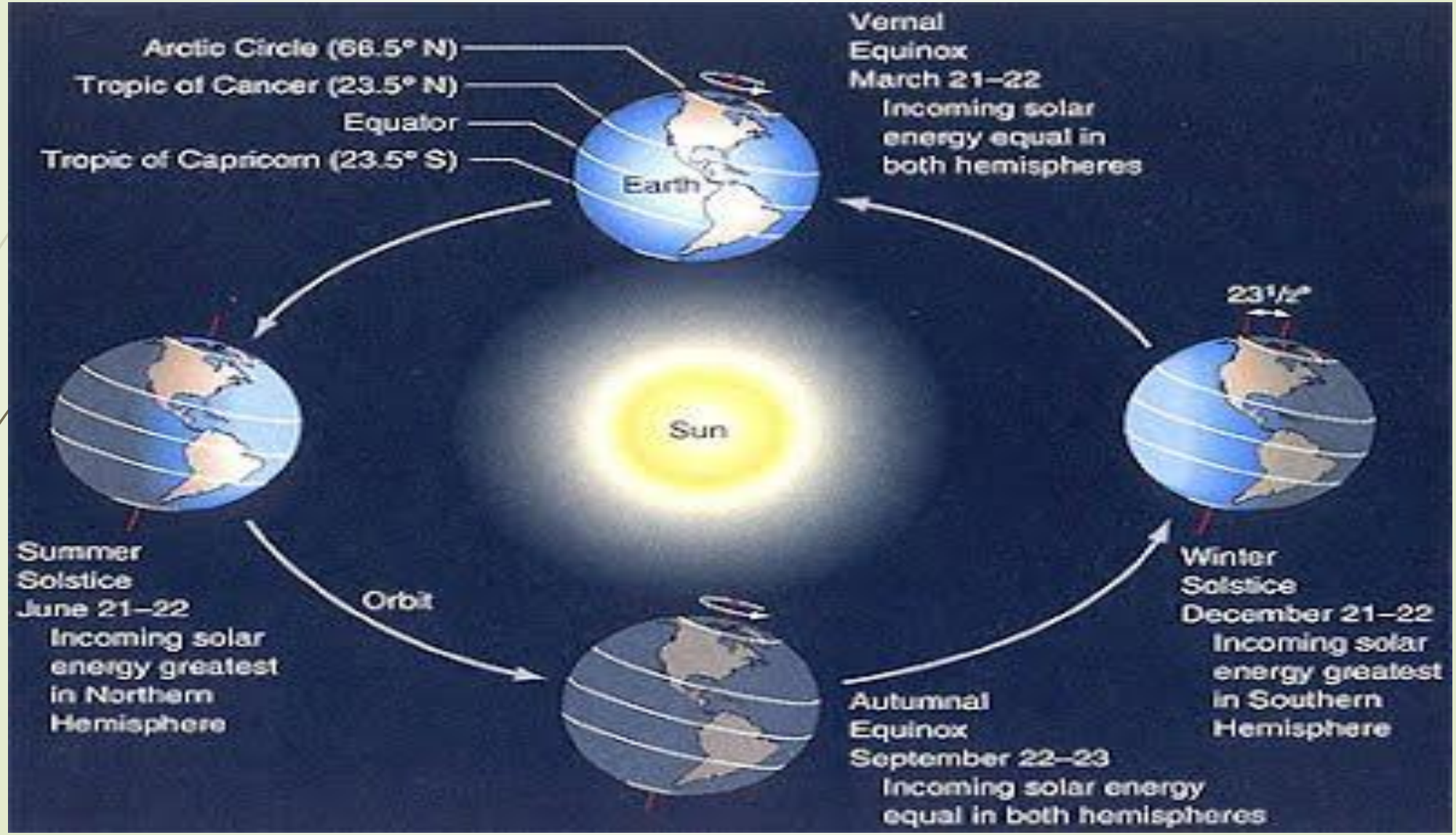
3. Annular Eclipse

The moon appears smaller than the sun

The Sun remains visible

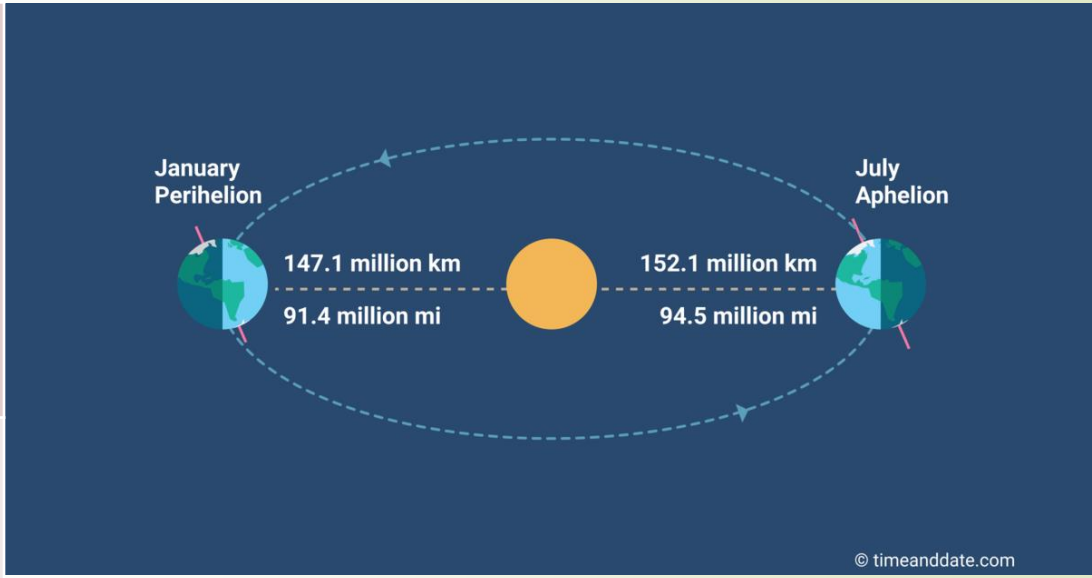


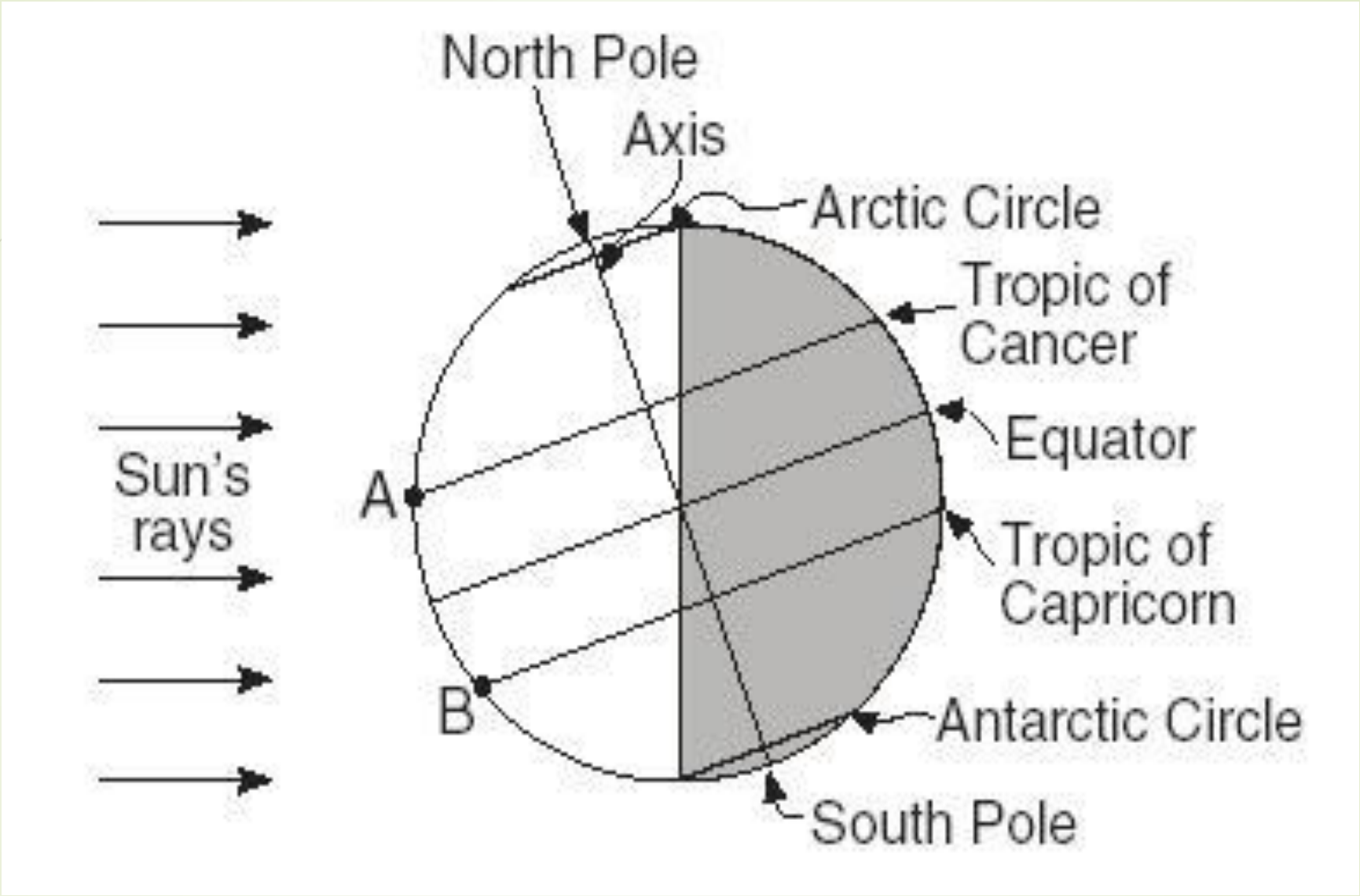
DAY/NIGHT and Their Variation



Aphelion and Perihelion

Perihelion	Aphelion
Perihelion is where the Earth is closest to the Sun (91.4 million miles, or 147 million kilometers)	Aphelion is when our planet reaches its farthest point from the Sun (94.5 million miles, or 152 million kilometers)
This occurs around January 3 every year	This occurs around July 4
The closest point to the Sun in a planet's orbit is called perihelion	The furthest point is called aphelion




North Pole
Axis
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
South Pole
Sun's rays
A
B