

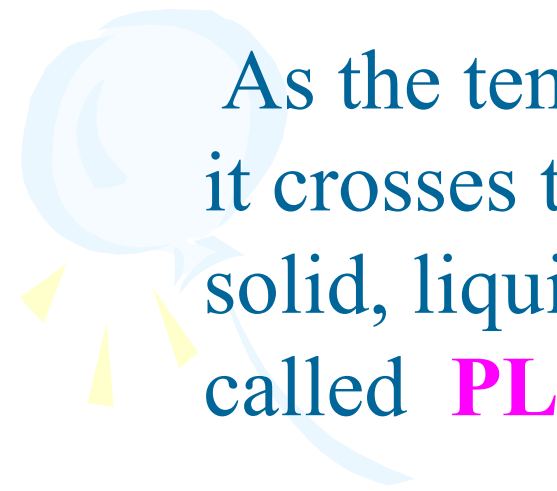


THE SUN (A PLASMA BALL)

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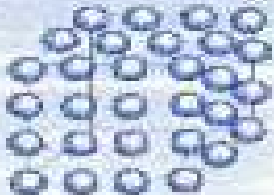


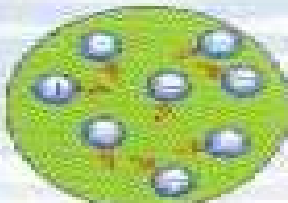


PLASMA- MATTER ON FOURTH STATE



As the temperature of a material is increased, it crosses the first three states of matter, viz, solid, liquid, gas, and reaches the fourth state called **PLASMA**.



Solid	Liquid	Gas	Plasma
<p>Example</p> <p>Ice</p> <p>H_2O</p>	<p>Example</p> <p>Water</p> <p>H_2O</p>	<p>Example</p> <p>Steam</p> <p>H_2O</p>	<p>Example</p> <p>Ionized Gas</p> <p>$H_2 \rightarrow H^+ + H^+ + 2e^-$</p>
<p>Cold</p> <p>$T < 0^\circ C$</p>	<p>Warm</p> <p>$0 < T < 100^\circ C$</p>	<p>Hot</p> <p>$T > 100^\circ C$</p>	<p>Hotter</p> <p>$T > 100,000^\circ C$</p> <p>(> 10 electron Volts)</p>
			
<p>Molecules</p> <p>Fixed in</p> <p>Lattice</p>	<p>Molecules</p> <p>Free to</p> <p>Move</p>	<p>Molecules</p> <p>Free to</p> <p>Move, Large</p> <p>Spacing</p>	<p>Ions and</p> <p>Electrons</p> <p>Move</p> <p>Independently,</p> <p>Large</p> <p>Spacing</p>



EXISTENCE OF PLASMA?

- 99% of the universe is in Plasma state
- Plasma is predominantly present in the Sun, Stars and Interstellar spaces
- Aurora, lightning and welding arcs are also plasmas
- Plasmas exist in neon and fluorescent tubes



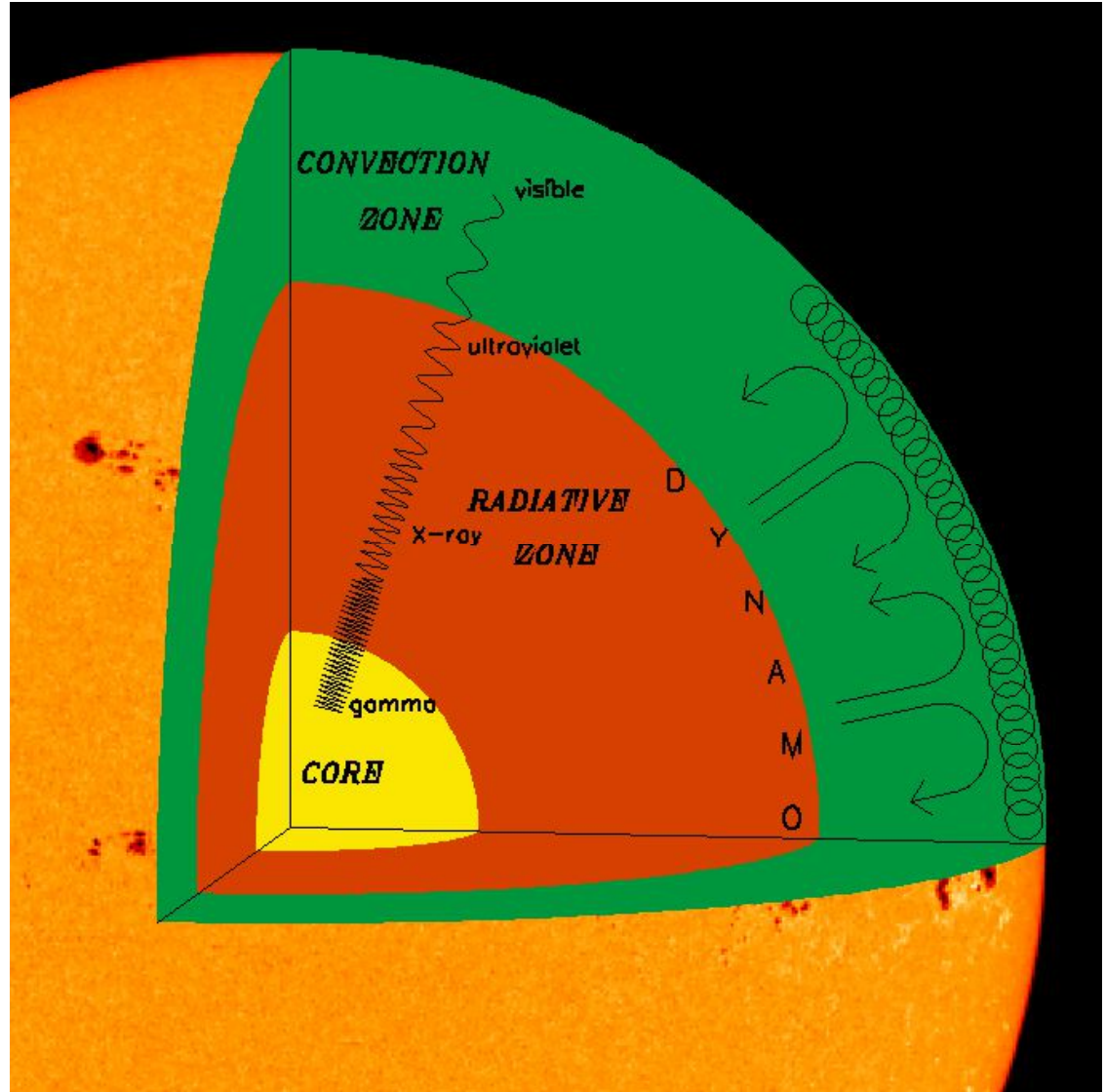
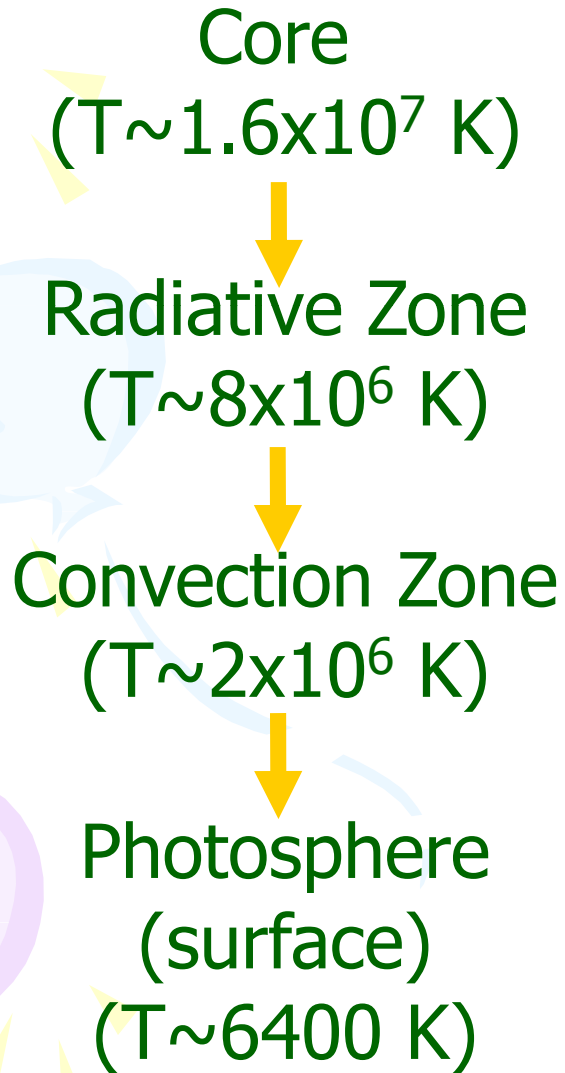
FACTS OF THE SUN

- The Sun is an object of great beauty and fascination
- Like all stars, Sun is a massive ball of Plasmas, which belongs to G2 type star
- Consists 90% of Hydrogen and 10% of Helium, mostly in an ionized state
- The remaining elements are C, N, O contributing about 0.1%

PHYSICAL PROPERTIES OF THE SUN

- Age: 4.5×10^9 Year
- Mass: 1.99×10^{30} Kg
- Radius: 6.96×10^8 m
- Mean Density : 1.4×10^3 kg/m³
- Mean distance from Earth: 1.5×10^{11} m
- Surface gravity (g_{sun}): 274 m/sec²
- Effective temperature: 5785 K

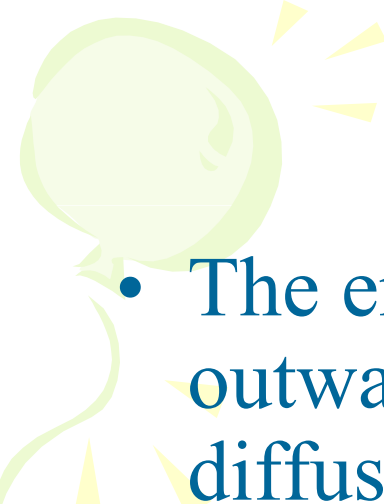


SOLAR INTERIOR



A decorative graphic on the left side of the slide features a stylized sun with yellow rays at the top, a light blue balloon in the middle, and a light purple balloon at the bottom. The sun and balloons are connected by thin, curved lines.

SOLAR INTERIOR

- The Sun's interior is shielded from our view, the surface layers can only be seen.
- The interior is divided into three regions namely the **core**, **radiative** or **intermediate zone** and **convective zone**.
- The **core** contains only half the mass of the Sun, but it generates 99% of the energy. Its central temperature is more than enough for **Thermo-Nuclear Fusion Reaction**.

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- The energy from the core is slowly transferred outwards across the **Intermediate zone** by diffusion.
 - Convection is the dominant means of energy transport in the **convection zone**.
 - According to **Dynamo Theory**, this is the region where the Sun's magnetic field is generated.
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SOLAR ATMOSPHERE

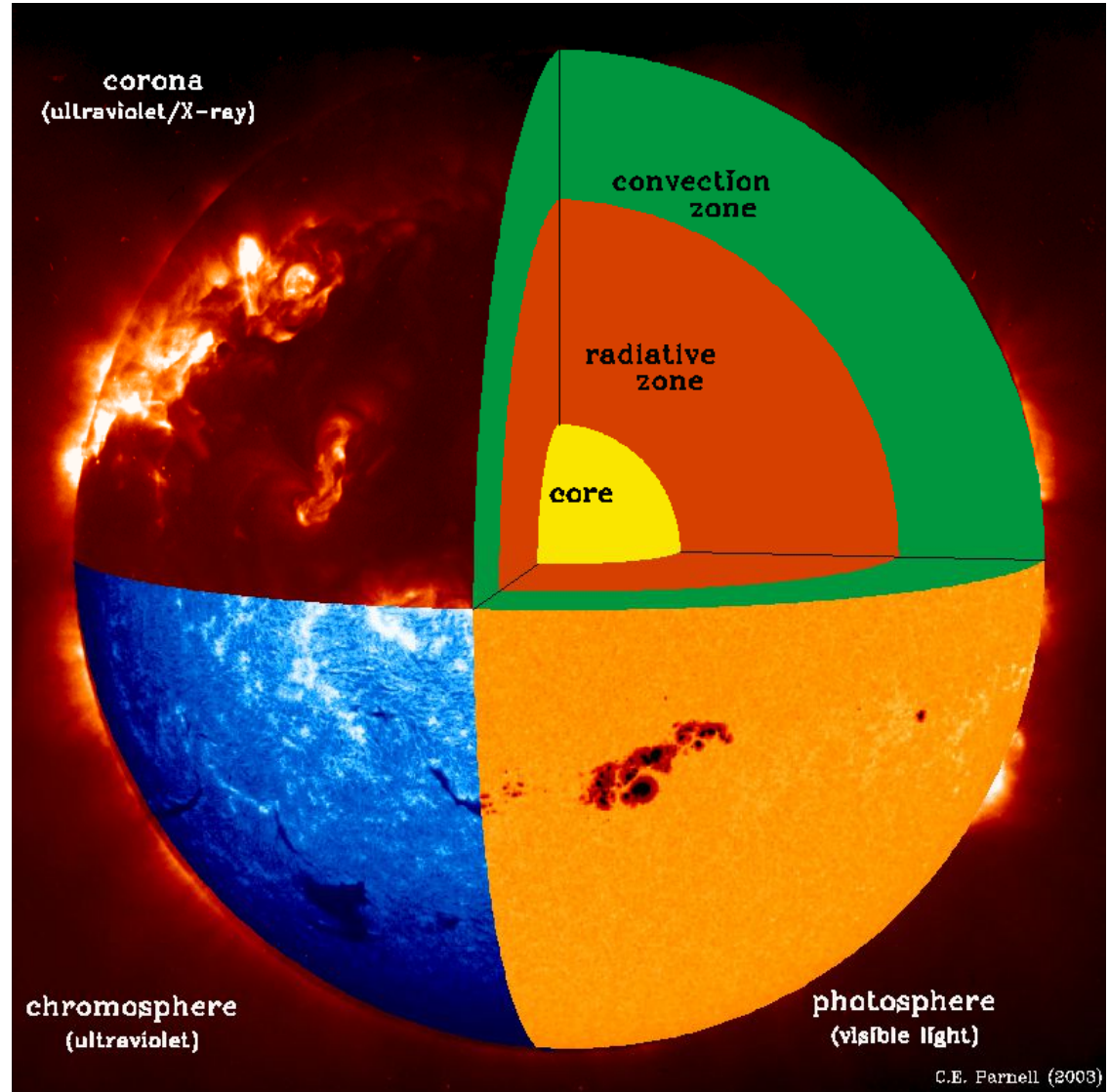
Photosphere
($6600\text{ K} > T > 4300\text{ K}$)



Chromosphere
($4300\text{ K} < T < 10^6\text{ K}$)

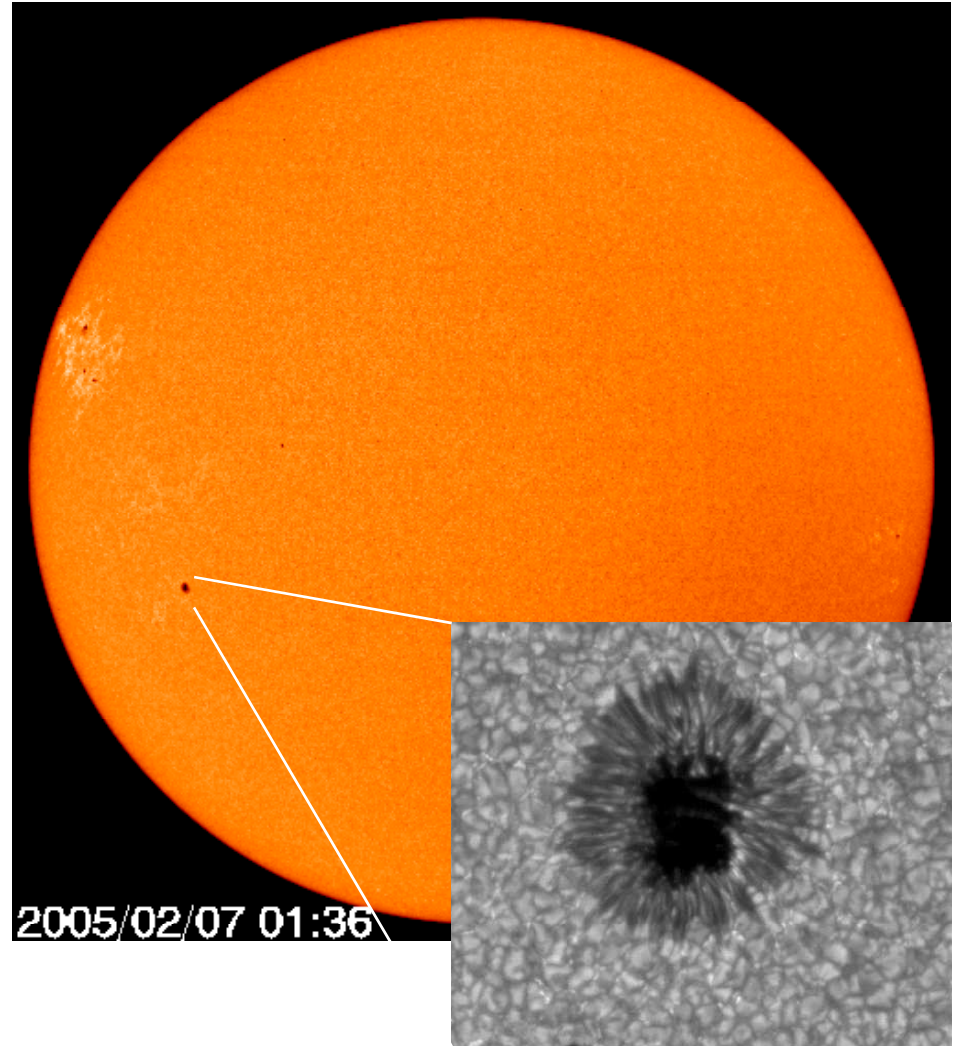


Corona
($T > 10^6\text{ K}$)



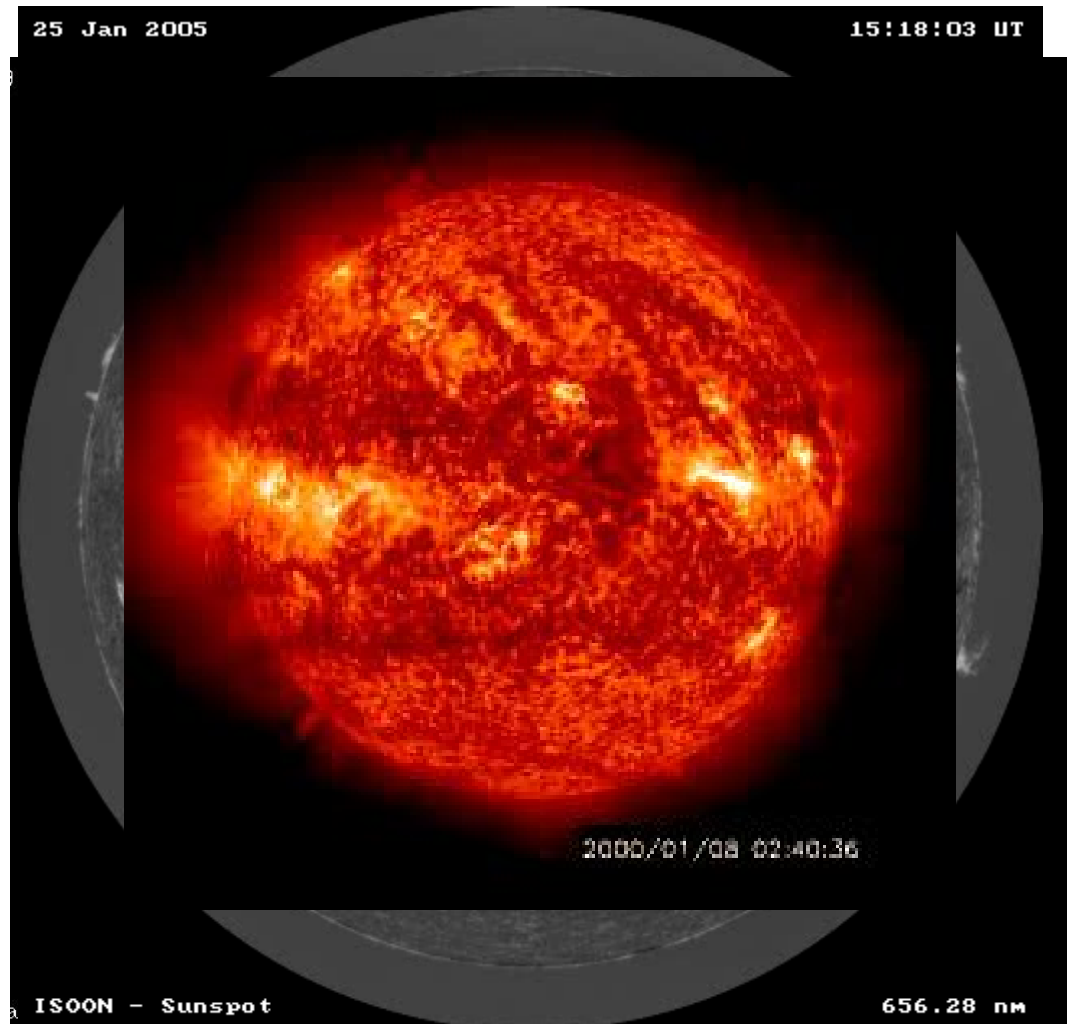
PHOTOSPHERE

- $T \sim 6600\text{-}4300\text{ K}$
- $\rho \sim 10^{-8}\text{th of water}$
- $P \sim 10^{-2}\text{th of atmosphere}$
- $H \sim 100\text{ km}$
- Visible light images reveal sunspots
- Magnetograms reveal surface magnetic fields



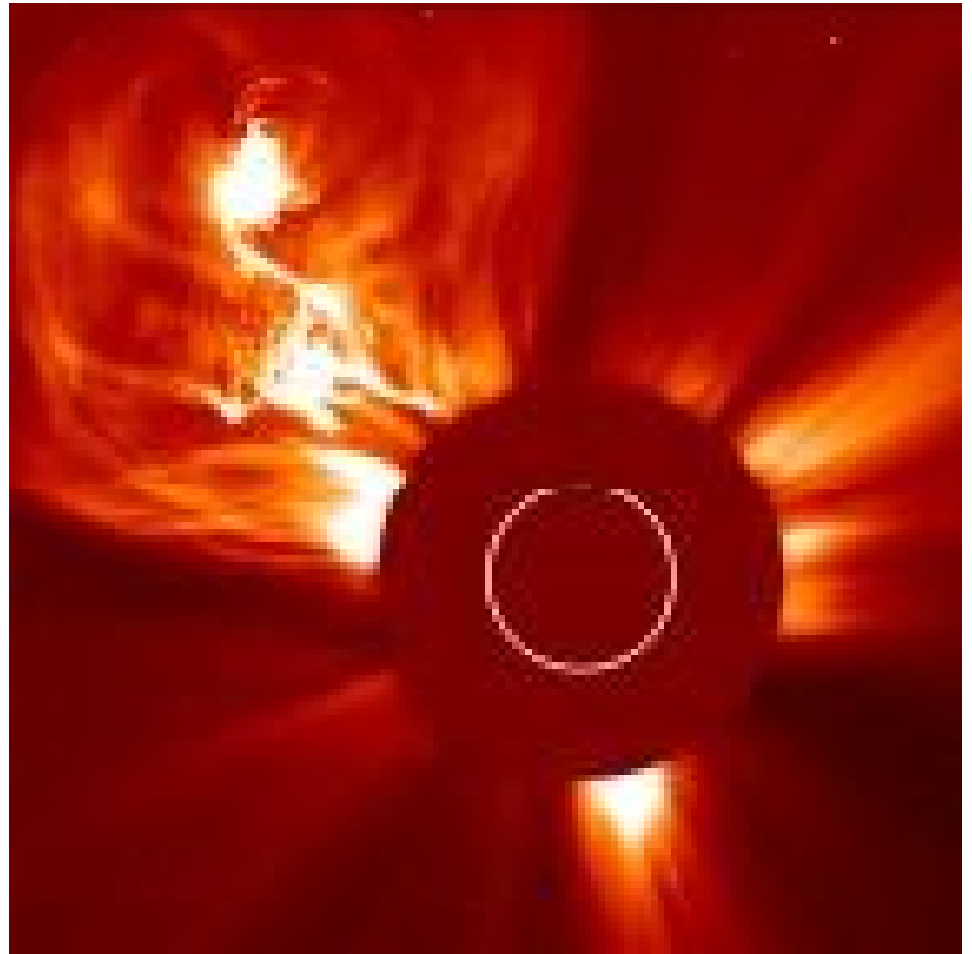
CHROMOSPHERE

- $4300 \text{ K} < T < 10^6 \text{ K}$
- $\rho \sim 10^{-8} - 10^{-14}$ less than water
- $P \sim$ not much!
- $H \sim 2500 \text{ km}$
- Observed in many wavelengths, e.g.,
 - Ca II K
 - H alpha
 - 304 \AA



CORONA

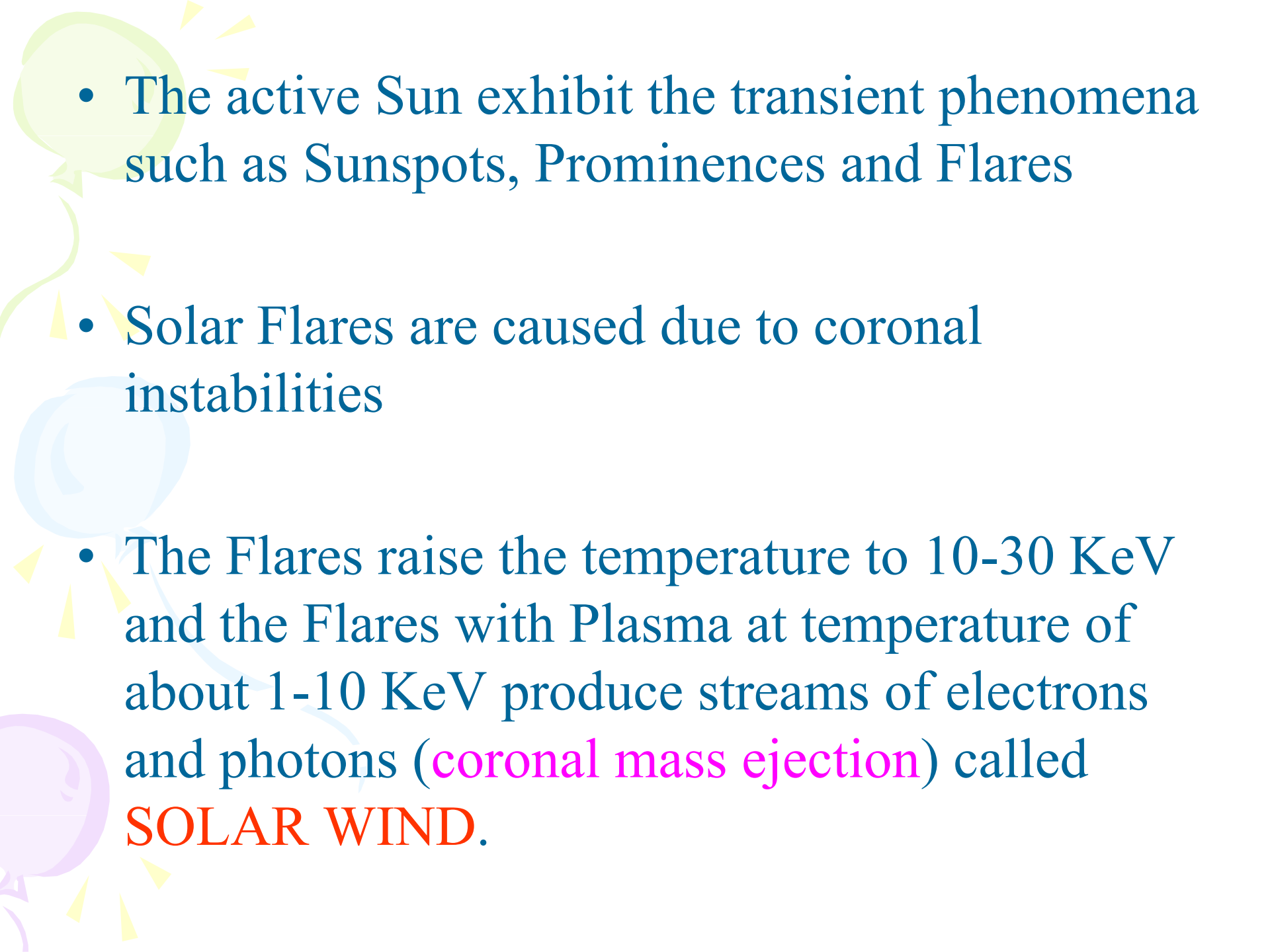
- $T > 10^6$ K (low corona)
- $\rho < 10^{-14}$ less than water
- $P \sim$ even less!
- H - to Earth & beyond!
- Observed in
 - EUV ($T \sim 10^6$ K)
 - Soft X-ray ($T > 2 \times 10^6$ K)
 - Visible (white) light





SOLAR FEATURES

- Traditionally, solar phenomena have been divided into two classes, QUIET and ACTIVE.
- The Quiet Sun is viewed as a static, spherically symmetric ball of Plasma.
- The properties depend on radial distance from the centre and whose magnetic field is negligible.

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- The active Sun exhibit the transient phenomena such as Sunspots, Prominences and Flares
 - Solar Flares are caused due to coronal instabilities
 - The Flares raise the temperature to 10-30 KeV and the Flares with Plasma at temperature of about 1-10 KeV produce streams of electrons and photons (**coronal mass ejection**) called **SOLAR WIND**.

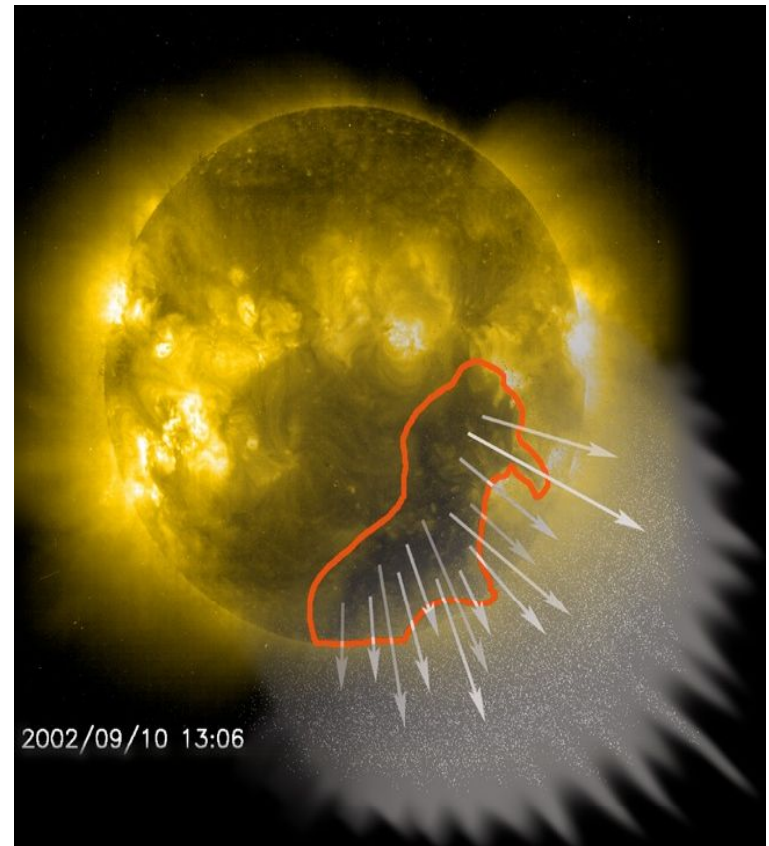


CORONAL FEATURES

- The skylab satellite pictures reveal many interesting facts about Corona.
 - i) Coronal Hole
 - ii) Coronal Loops
 - iii) Prominences
 - Iv) Solar Flares....etc

CORONAL HOLE

- The magnetic field is predominantly open at some regions, appear relatively dark, known as Coronal Holes.
- Here the Plasma is flowing outward to give the Solar Wind.



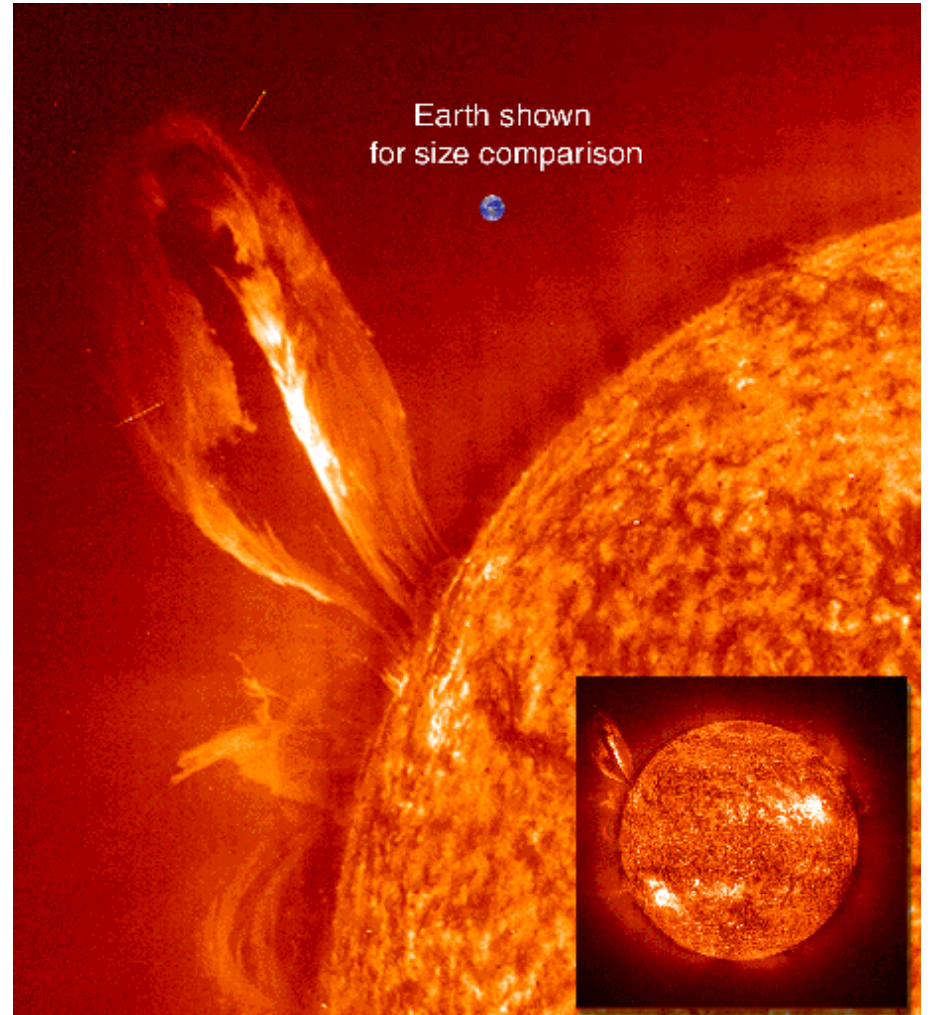


CORONAL LOOPS

- In regions where the magnetic field is mainly closed cause the myriads of “coronal loops”
- Clearly observed through TRACE (Transition Region And Coronal Explorer)

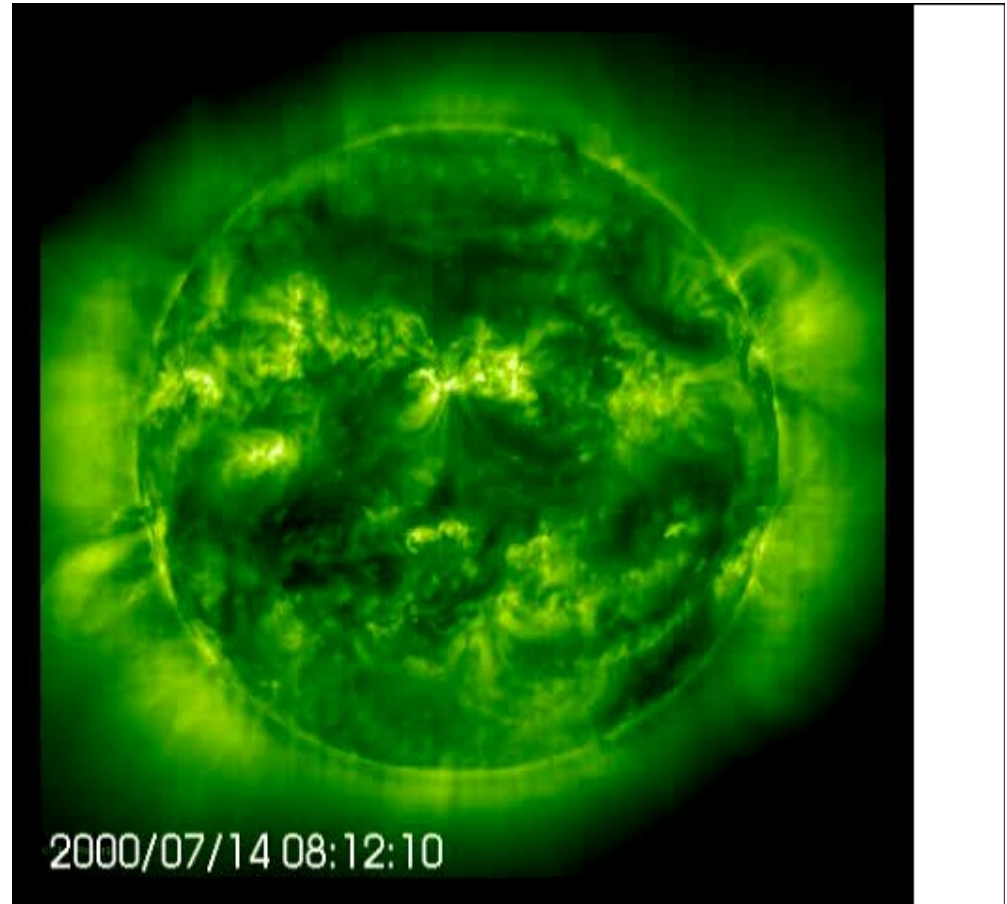
PROMINENCES

- Cool, dense plasma confined in vertical sheets
- Lifetimes:
days-months



SOLAR FLARES



- Sudden, impulsive, intense, large-scale, heating events
- Very energetic:
from 10^{22} - 10^{25} J
- Lifetimes: hours





PLASMA-APPLICATIONS

HOME

- 
- high efficiency lighting(plasma arc lamps)
 - manufacturing of semiconductors for home computers
 - TVs and electronics
 - flat panel displays
- 



BUSINESS

- Sterilisation of medical tools
- Surface cleaning
- Processing of plastics
- Spraying of materials
- Chemical analysis
- Electronics, flat panel displays



TRANSPORTATION

- Plasma spraying of surface coating for temperature and wear resistance
- Treatment of engine exhaust compounds
- Ion thrusters for space flight
- High intensity lighting in head lamps

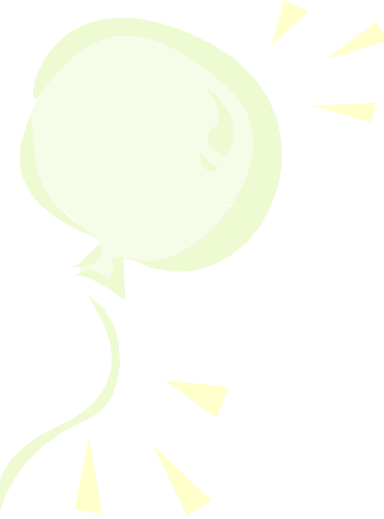


STERILISATION

- Plasma systems are used for surface cleaning and sterilisation for food, medical and other applications
- Kills bacteria, fungi, viruses and spores in minutes
- Non-hazardous to environment
- No radiation damage to materials

DISPOSAL OF HOSPITAL WASTE

- Plasma pyrolysis of disposing millions of tonnes of hospital wastes integrates the thermochemical properties of plasma with pyrolysis process
- The process uses extremely high temperatures of plasma arc in an oxygen stained environment to completely decompose waste materials into simple molecules (organic matter gets reduced to 99%)
- Does not leave any harmful residues



THANK YOU