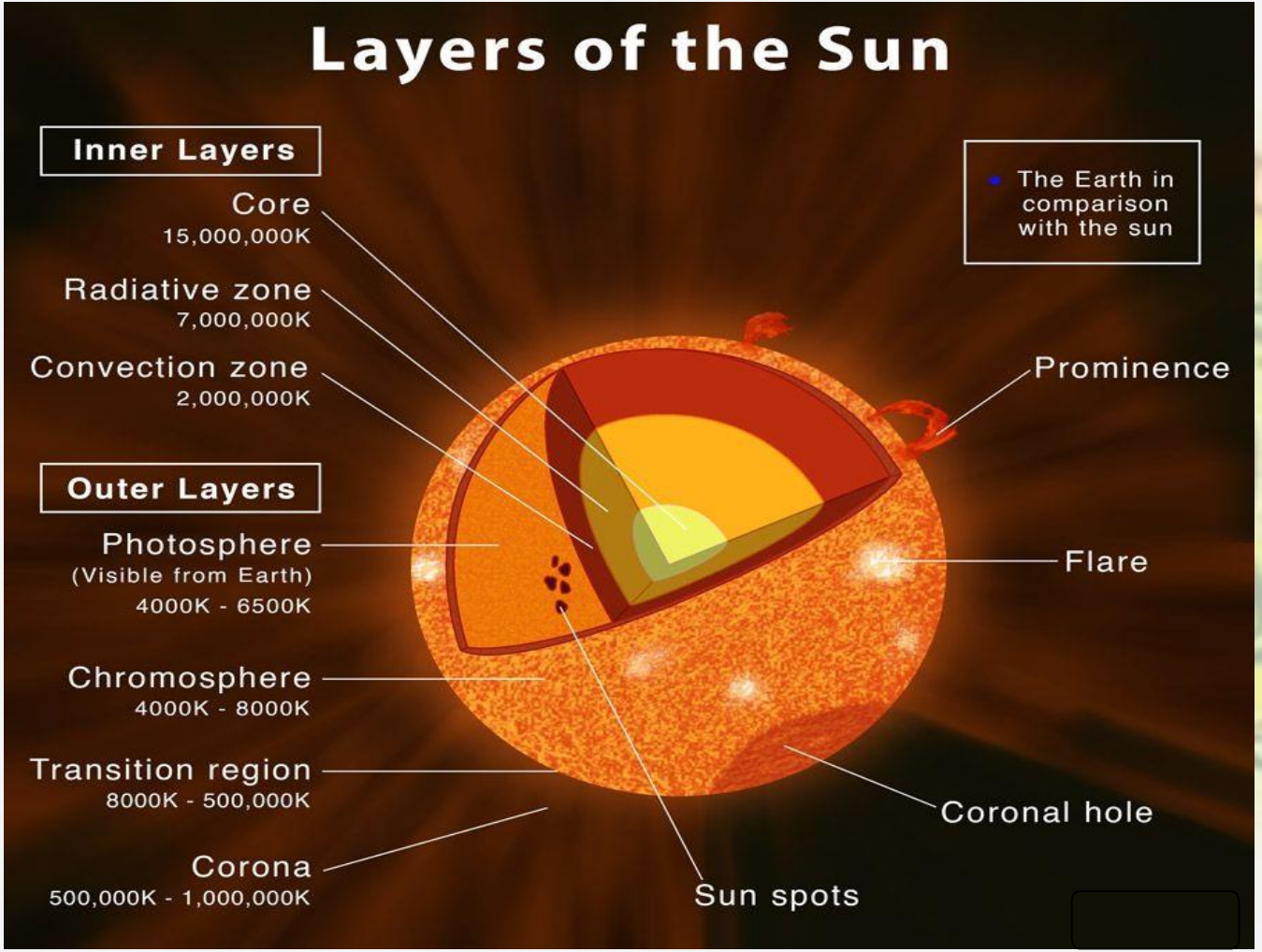
The Sun's Internal Structure and Atmosphere, Solar Wind

How the Sun Formed

1. **Nebula Collapse:** Gravity causes a giant gas and dust cloud (nebula) to collapse, possibly triggered by shockwaves from a nearby supernova.
2. **Protosun Forms:** Most material (99.9%) collapses into the center, getting denser, hotter, and eventually becoming the protosun (pre-star).
3. **Nuclear Fusion:** Once the core gets hot enough, nuclear fusion begins, and the Sun is born.
4. **Protoplanetary Disc:** Remaining material (0.1%) orbits the Sun, forming a flat disc.

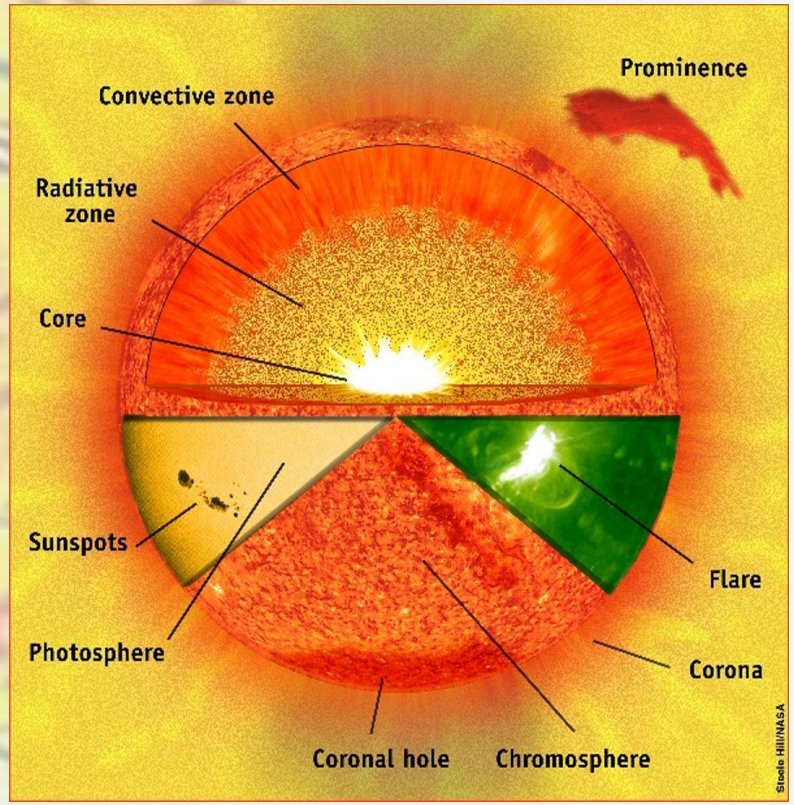
Some Facts about the sun

- Age: 4.6 billion years
- Temperature: 6000 °C on the surface and 16 million °C in the core
- Density: 1.41 times that of water (density of water = 999.97 kg/m^3; earth's overall density is 5.5 times that of water)
- The surface gravity of the Sun is 274 m/s2 (28 times the gravity of the Earth). Comparatively, the surface gravity of the earth and moon are 9.8 m/s2 and 1.62 m/s2 respectively.
- Speed of rotation: 7179.73 km/hrs. Comparatively, earth's rotational velocity is 1675 Km/hrs.
- Period of rotation: 25 days 9 hrs.
- Rotation: counter clockwise (when viewed from a long way above Earth's north pole).
- Mass: equivalent to 3,32,900 Earth masses.
- Composition: 98% of the sun is hydrogen & helium.
- Most of the solar system's mass is in the Sun (~99.8%), with most of the remaining mass contained in Jupiter and Saturn. Although the Sun dominates the system by mass, it accounts for only about 2% of the angular momentum due to the differential rotation within the gaseous Sun.



Key Points:

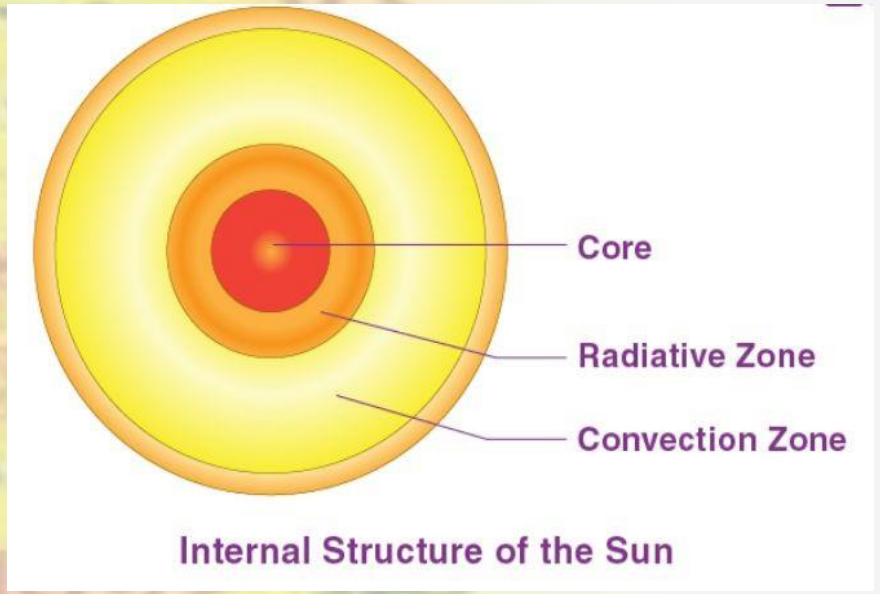
- Energy Flow: Energy created in the core moves outward through the radiative zone and then the convection zone.
- Temperature Gradient: The temperature gets cooler as you move out from the core.



Internal Structure and Atmosphere of the Sun

Layers of the Atmosphere of the Sun (Inner Layer)

- Core:
  - The Sun's heart, where nuclear fusion occurs.
  - Hydrogen fuses into helium, releasing immense energy.
  - Hottest part of the Sun.
- Radiative Zone:
  - Energy travels outward as electromagnetic radiation (light).
  - This process is slower than in the convection zone.
- Convection Zone:
  - Outermost layer of the Sun's interior.
  - Energy moves via rising and falling currents of hot gas (like boiling water).
  - Cooler than the layers below, allowing heavier elements to hold onto some electrons.



Internal Structure of the Sun

Photosphere:

- What it is: The visible surface of the Sun.
- Appearance: Bright and uneven.
- Temperature: Around 6000°C at the outer edge.
- Light: Emits most of the sunlight we see.

Chromosphere:

- Location: Lies above the photosphere.
- Visibility: Difficult to see normally. Visible as a reddish ring during a solar eclipse (when the photosphere is blocked).
- Temperature: Surprisingly, it gets hotter as you move away from the Sun's core.

What are Sunspots?

- Dark, cool patches on the Sun's surface.
- Caused by strong magnetic fields that block some of the Sun's heat and light.

Appearance:

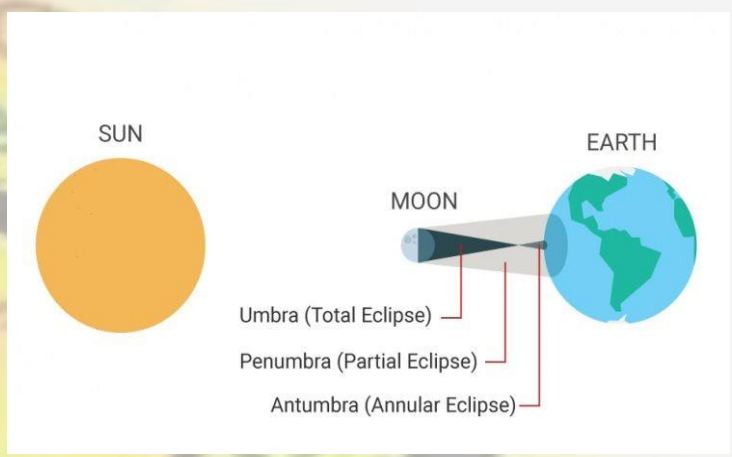
- Umbra: The dark center.
- Penumbra: The lighter surrounding area.

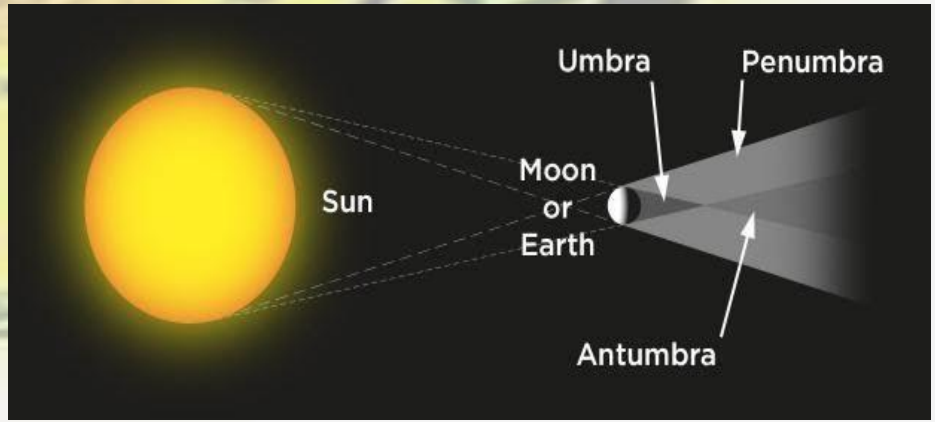
Characteristics:

- Temporary: Can last from days to months.
- Linked to solar activity: More sunspots often mean the Sun is more active.

Potential Impact on Earth

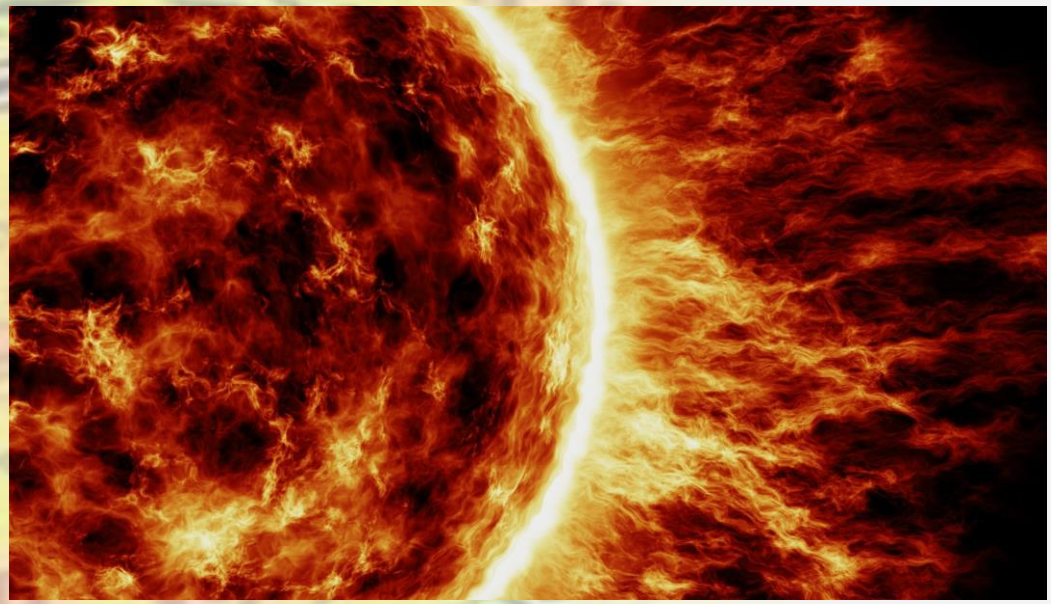
- When there are few or no sunspots, the Sun might become slightly cooler (around 1%).
- This could have minor effects on Earth's climate, but is not the primary driver of long-term climate change.





The Sun's Corona

- What it is: The outermost layer of the Sun's atmosphere, located above the Chromosphere.
- Visibility: Appears as a glowing white halo during a total solar eclipse.

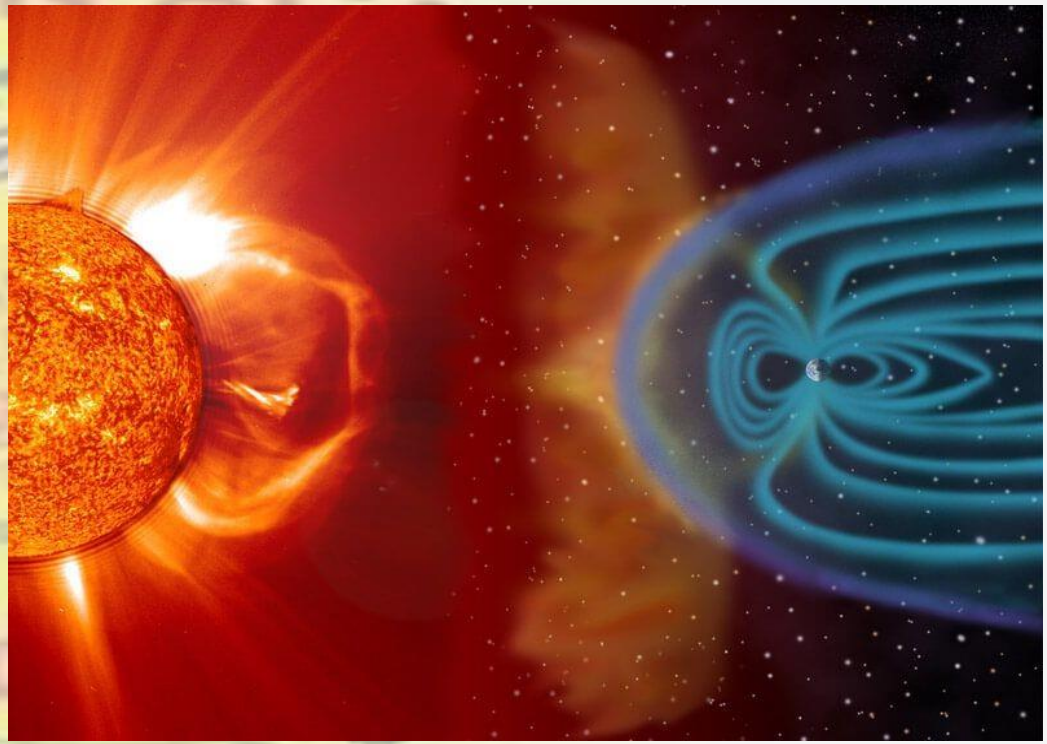


Solar Flares

- What they are: Sudden bursts of energy from the Sun's surface due to magnetic disturbances.
- Appearance: Appear as bright flashes of light.
- Temperature: Incredibly hot, reaching temperatures between 10 and 20 million degrees Celsius.

What is the solar wind?

- A stream of extremely hot, charged particles (electrons and protons) flowing out from the Sun.
- It travels at incredibly high speeds (up to 900 km per second).

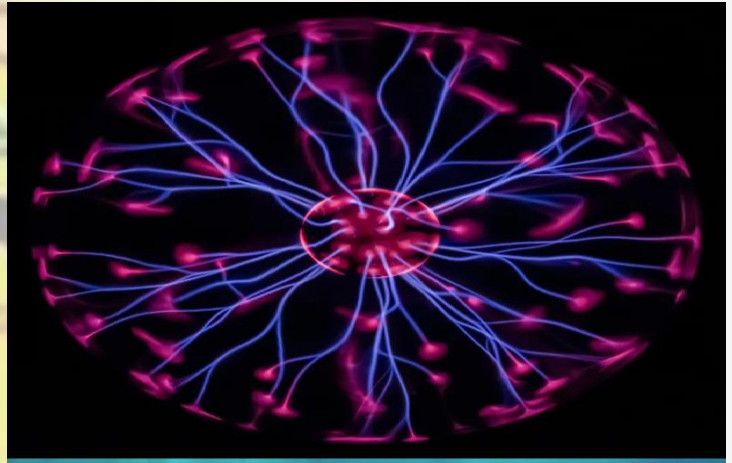


Key points:

- Made of plasma: This means the atoms in the solar wind are superheated, causing them to split into charged particles.
- Origin: The Sun's outer atmosphere (the corona).

Plasma: The Fourth State of Matter

- What it is: Superheated gas where atoms have lost some of their electrons, creating a mix of charged particles (ions) and electrons.
- Everyday examples:
  - Lightning bolts
  - Electric sparks
  - The glow inside neon signs



Aurora: Lights in the Sky

- What it is: A beautiful light show in the sky, mostly seen near the Earth's poles (North Pole =Aurora Borealis, South Pole =Aurora Australis).
- How it happens:
  - Charged particles from the Sun (solar wind) get pulled in by Earth's magnetic field.
  - These particles crash into gases in our atmosphere, making them glow.