Latitudinal Variation in Sun's Rotation Speed

Source: PIB

Why in News?

Recently, **Indian astronomers** have mapped variation in the **Sun's rotation** speed from its **equator to its poles** for the first time.

- The study used 100 years of daily solar observations from the **Kodaikanal Solar Observatory, Tamil Nadu.**

What are the Key Findings of the Study?

- **Sun's Chromospheric Rotation Mapped:** Astronomers have successfully mapped the variation in the rotation speed of the **Sun's chromosphere** for the **first time.**
  - The chromosphere is a **thin layer of plasma** that lies **between** the Sun's visible surface **(the photosphere)** and the **corona** (the Sun's upper atmosphere).
- **Differential Rotation of the Sun:** The Sun's **equator** spins much **faster** than its poles. It takes the equatorial region only about **25 days** to complete one rotation, while the **poles take 35 days.**
  - The Sun's **equator** rotates at **13.98 degrees per day**, while at **80 degrees latitude,** the rotation rate slows to **10.5 degrees per day**.
- **Contribution of Kodaikanal Solar Observatory:** Using **solar plages** and **network cells** from the observatory's records of 100 years, astronomers could measure the Sun's rotation speeds across **all latitudes.**
  - **Plages** are **brighter regions** with weaker magnetic fields. They are found in the **chromosphere** and are 3 to 10 times larger than sunspots.
  - **Network cells** have weaker magnetic fields and are slightly larger than individual **sunspots** but smaller than sunspot groups.
  - Unlike sunspots, **plages and networks are always present** on the Sun's surface, helping scientists study the rotation rate even at the poles.
    - **Sunspots** are areas that appear **dark on the surface of the Sun**. They appear dark because they are **cooler** than other parts of the Sun's surface.
- **Significance of the Findings:** Understanding this differential rotation is essential as it is behind the **solar dynamo**, the **11-year solar cycle**, and its periods of intense activity that even produce **magnetic storms** on Earth.

Note:

- **Richard Carrington**, an English astronomer in the **19th century**, first discovered **differential rotation** by observing **sunspots**.
- However, sunspots are mostly limited to **latitudes below 35 degrees** and are not suitable for high-latitude rotation measurements.

What are the Key Facts About the Sun's Atmosphere?

- The Sun’s atmosphere consists of **multiple layers,** each with distinct **characteristics and temperatures:**
    - **Photosphere:** The **visible surface** of the Sun, marking the **boundary** between the interior and the atmosphere.
    - **Chromosphere:** An **irregular layer** above the photosphere where the temperature rises from **6000°C to about 20,000°C.**
    - **Transition Region:** A thin and very irregular layer of the Sun’s atmosphere that **separates** the **hot corona** from the much cooler **chromosphere.**
    - **Corona:** The Sun’s **outer atmosphere**. It is **much hotter** than the underlying chromosphere or photosphere.
- **Beyond the corona** lies the **solar wind**, which is an outward flow of **charged particles (plasma)** originating from the corona.
    - The solar wind extends **far into space** affecting planetary atmospheres and causing phenomena like the **auroras on Earth**.

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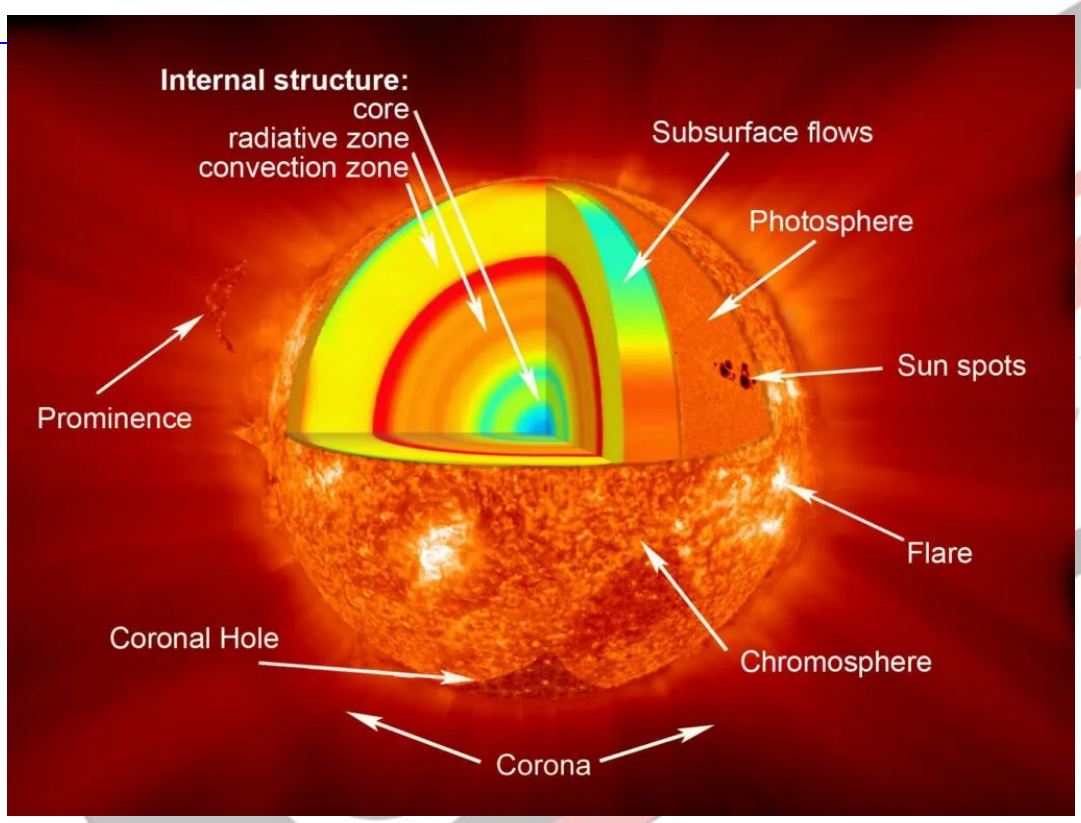

About Kodaikanal Solar Observatory

- It is operated by the **Indian Institute of Astrophysics (IIA)** is located in the Palani range of hills in Southern India.
    - IIA is an autonomous institute of **Department Of Science & Technology.**
- It was established to study the **Sun’s impact on Earth’s atmosphere** and better understand **monsoon patterns**.
- Solar observations at this observatory over **more than 100 years** provide one of the **longest continuous series** of solar data.
- One of the major milestones was the discovery of the **Evershed Effect** in **1909**, which is related to the **movement of gases in the solar atmosphere**.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. Electrically charged particles from space travelling at speeds of several hundred km/sec can severely harm living beings if they reach the surface of the Earth. What prevents them from reaching the surface of the Earth? (2012)

(a) The Earths' magnetic field diverts them towards its poles

(b) Ozone layer around the Earth reflects them back to outer space.

(c) Moisture in the upper layers of atmosphere prevents them from reaching the surface of the Earth

(d) None of the statements (a), (b) and (c) given above is correct

Ans: (a)