

Near-surface shear layer (NSSL) of the Sun

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In news

For the first time, Indian astronomers at the Aryabhata Research Institute of Observational Sciences (ARIES) and the Indian Institute of Science, Bangalore, have presented a theoretical explanation for the existence of the Sun's near-surface shear layer (NSSL).

About the Near-Surface Shear Layer (NSSL)

- The NSSL is the region very close to the visible solar surface, where there is a change in the rotation profile of the Sun.
- It was long known the Sun's equator spins faster than the poles.
- However, a **peek into the internal rotation of the Sun using sound waves revealed the existence of an intriguing layer called near-surface shear layer (NSSL).**
- In NSSL the rotation profile of the Sun changes sharply.
- **This layer exists very close to the solar surface**, where there is an outward decrease in angular velocity.
- The presence of such a layer had been indicated by many researchers in the past based on solar surface observations but the real inference has been provided only after helioseismic measurements.

Key findings of the study

- This work has been published in the journal Monthly Notices of the Royal Astronomical Society.
- In their study, **they have used an equation called the thermal wind balance equation.**
- **It explains how the slight difference in temperature**

between solar poles and equator, called thermal wind term, is balanced by the centrifugal force appearing due to solar differential rotation.

- Most scientists believe that this condition is true only in the interior of the Sun, and it does not hold near the solar surface.
- In this work, the **authors have shown that this belief actually holds near the surface as well.**
- They have noted that if this condition is true near the solar surface, it can explain the existence of NSSL, which is inferred in helioseismology (technique of using sound waves to peek inside the Sun) based observation.

Thermal wind

- The thermal wind is the vector difference between the geostrophic wind at upper altitudes minus that at lower altitudes in the atmosphere.

Helioseismology

- It is a term coined by Douglas Gough.
- It is the study of the structure and dynamics of the Sun through its oscillations. These are principally caused by sound waves that are continuously driven and damped by convection near the Sun's surface.

The modern field is separated into **global helioseismology**, which studies the Sun's resonant modes directly, and **local helioseismology**, which studies the propagation of the component waves near the Sun's surface.

Significance of the study

Understanding NSSL is crucial for the study of several solar phenomena like sunspot formation, solar cycle, and it will also help in understanding such phenomena in other stars.