Collision-Less Shock Waves

Why in News?

Recently researchers have found that Collision-less shock waves could be the cosmic engines driving subatomic particles in space to extreme speeds.

- **Shock waves** – Are waves that can transmit waves at faster than the speed of sound through the atmosphere.
- **Plasma** – The shock waves are born in plasma, a gas of charged particles that can conduct electricity and interact with magnetic fields.
- **Collision less shock waves** – When the solar wind hits Earth's magnetic field, it creates special kinds of shock waves called "collision-less shock waves."
- **Occurrence** – Collision-less shock waves occur throughout the universe including:
  - Near pulsars and magnetar
  - In accretion disks around black holes
  - During supernova explosions
  - In interstellar and intergalactic media
- **Key characteristics** – Formation in low-density plasmas where particles rarely collide.
- Unlike regular shock waves, Collision less shock waves transmits energy transmission through electromagnetic forces.
- Capability to accelerate particles to relativistic speeds (close to light speed).
- **Natural particle accelerators** – The researchers discovered that these shock waves act like natural particle accelerators, *capable of boosting electrons to enormous speeds*.
- Using data from NASA satellites, they observed electrons reaching up to 86% of light speed near Earth.
- **Electron injection problem** – This discovery helps solve what scientists call the "electron injection problem" which explains how *electrons get their initial boost* before being accelerated to even higher energies in space.

  The electron injection problem is the scientific term for the mystery of how electrons gain energy in outer space.

- **Implications for Cosmic Rays** –Cosmic rays could be generated due to similar interaction of planetary electrons (earth magnetosphere particles) with the Stellar winds (similar to solar wind).

Reference

The Hindu | Collision-less shock waves



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