Neutrinos

Prelims (GS - I) – *Current events of national and international importance | General Science.*

Mains (GS - III) – *Science and Technology- developments and their applications and effects in everyday life.*

Why in News?

The AMoRE experiment in South Korea has reported not finding evidence of neutrino less double beta decay, imposing stringent limits on this elusive subatomic event.

- **Neutrinos** – They are the 2nd-most abundant subatomic particle in the universe, after photons, the particles of light.
- They were produced in abundant amounts during the Big Bang event.
- They are produced in radioactive decay, when massive stars explode, and when cosmic rays strike the earth's atmosphere.
- They are also made during nuclear fusion; the sun alone is responsible for flooding every square centimetre on the earth with 60 billion neutrinos each second.
- These particles are also extraordinarily hard to catch because they interact very weakly and very rarely with matter.
- **Weight –** Unknown.
- **Types –** It come in three flavours, or varieties, and the differences between the squares of their masses is known, but not the individual masses themselves.
- **Anti-Particle-** A subatomic particle having the same mass as a given particle but opposite electric or magnetic properties.
- If two of them meet, they will annihilate each other in a flash of energy.
- **Majorana particle** – It is a type of fermion that, gets its mass through a *self-interaction mechanism* that does not involve the Higgs field.

Higgs field gives mass to fundamental particles such as electrons and quarks. Particles gain mass by interacting with the Higgs field and the strength of the interaction is proportional to mass of the particle.

- **Key feature** – *Majorana fermions must be their own antiparticle*. where the particle and its anti-particle are identical.
- Since antiparticles typically have opposite electric charges to their corresponding particles, Majorana fermions *can only be neutral particles.*
- **Majorana hypothesis** – As a result, neutrinos are often considered as potential candidates for being Majorana particles, since they are neutral.
- This has led to several experiments attempting to find evidence of Majorana neutrinos

through neutrino less double beta decay.

- **Double beta decay** – It typically involves a nucleus emitting 2 protons, 2 electrons and 2 anti-neutrinos.
- **Neutrino less Double Beta Decay (0νββ) –** It is a rare nuclear process *where two neutrons decay into two protons and emit two electrons*, but no anti-neutrinos are produced.
- For **0νββ** to occur, neutrinos must be their own **anti-particle**.
- Here the neutrino emitted by one neutron is absorbed as an anti-neutrino by the other neutron, allowing the decay to proceed *without emitting an anti-neutrino*.
- **Significance –** If 0νββ is observed, it would prove that neutrinos are Majorana particles, because such a decay can only happen if neutrinos and anti-neutrinos are the same.
- Ongoing experiments like the **AMoRE experiment** aim to detect 0νββ by looking for the distinct energy signatures and confirming if neutrinos are indeed Majorana particles.

Reference

[The Hindu | Neutrinos]