

Neutrinos

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A neutrino is a **subatomic particle** that is very similar to an electron, but has **no electrical charge and a very small mass**, which might even be zero. Neutrinos are one of the most abundant particles in the universe. Of the four fundamental forces in the universe, **neutrinos only interact with two – gravity and the weak force**, which is responsible for the radioactive decay of atoms.

Features of Neutrinos

- They have very little interaction with matter and hence they are incredibly difficult to detect.
- Nuclear forces treat electrons and neutrinos identically; neither participate in the strong nuclear force, but both participate equally in the weak nuclear force.
- Particles with this property are termed **leptons**. In addition to the electron (and its antiparticle, the positron), the charged leptons include the **muon** (with a mass 200 times greater than that of the electron), the **tau** (with mass 3,500 times greater than that of the electron) and their anti-particles.
- Having nearly no mass, the neutrinos zip through the cosmos at **almost the speed of light**.

Significance of Neutrinos

- Just as archaeologists study broken clay pieces to construct a story about the society that produced them, physicists examine neutrinos to learn more about the **events and processes from which these subatomic particles have their origins**.
- Neutrinos play a role in many fundamental aspects of our lives:

- . they are produced in nuclear fusion processes that power the sun and stars
- . they are produced in radioactive decays that provide a source of heat inside our planet
- . they are produced in nuclear reactors
 - Neutrinos are believed to be a vital ingredient in a star's **supernova process**. These explosions spread heavy elements throughout space, elements that are needed to create the universe we live in.
 - Neutrinos also provide a tool to **study the structure of nucleons (protons and neutrinos)**, to learn how matter evolved from simple particles into more complex composites of particles, creating everything around us.

India Based Neutrino Observatory

- The India-based Neutrino Observatory (INO) Project is aimed at building a world-class underground laboratory with a rock cover of approx. 1200 m for **non-accelerator based high energy and nuclear physics research**.
- The project includes construction of an underground laboratory and associated surface facilities at **Pottipuram in Bodi West hills of Theni District** of Tamil Nadu.
- It also includes construction of an **Iron Calorimeter (ICAL) detector** for studying neutrinos, consisting of 50000 tons of magnetized iron plates arranged in stacks with gaps in between where Resistive Plate Chambers (RPCs) would be inserted as active detectors.
- The proposed magnetized ICAL detector will **detect the atmospheric neutrinos and antineutrinos over a wide range of energies and path lengths**.