

The Little Neutrino

One of the most basic curiosities of any of us is to understand the origin and formation of terrestrial as well as extra terrestrial objects such as stars, planets, earth as well as everything we see around including ourselves. Scientists have found that everything in the universe is made up of a small number of basic building blocks called elementary particles, governed by a few fundamental forces. High Energy Physics experiments are built typically to study these particles, their constituents and interaction among them. These particles can be studied using mainly the following two sources.

1. Accelerators: Accelerators are huge machines which can speed up particles to very high energies before smashing them into other particles or targets. Around the points where the *smashing* occurs, scientists build experiments which allow them to observe and study the collisions. By accelerating and smashing particles, physicists can study internal structure of these particles or create new particles, revealing the nature of the interactions between them. It costs a lot of money to build and operate these machines and therefore, there are very few accelerators exist in the world.
2. Cosmic rays: Cosmic rays pass through our body every second, regardless of where we are. Cosmic rays are *free* and can be thought of poor man's accelerators gifted by God! They consist of particles created when high energy atomic nuclei coming from outer space collide with the atoms at the top of the earth's atmosphere. Such particles are not just electrons, protons and neutrons, but also other kinds of particles.

Neutrino is one such particle. Neutrinos are electrically neutral. They are not affected by electromagnetic forces but by weak sub-atomic force which has shorter range compared to electromagnetic force. Hence they can pass through great distances in matter without interacting. They were believed to be mass less for many years but recent experiments have shown that they do possess mass. We still don't know the exact mass of neutrinos. We however know that there exist three basic types of neutrinos and they may transform or *oscillate* from type to another under some conditions.

Indian Neutrino Observatory (INO) collaboration, comprising of a large number of Indian research Institutions and Universities, is planning to build a huge detector to study many unknown properties of neutrinos. The detector, whose volume will be about $18,500 \text{ m}^3$, will use about 100,000 tons of iron and 27,000 indigenously built

particle sensors each of 4 m^2 in area. The detector will be housed inside a set of giant caverns located about 1 km below Nilgiri mountain range near Ooty.

The particle sensors, called Resistive Plate Chambers (or RPCs) are fabricated with commonly used materials, such as thin glass sheets and poly-carbonate materials. In fact, we will use about $100,000 \text{ m}^2$ of glass to fabricate the sensors. They can *clock* particle interactions in the detectors to better than a billionth of a second. All this needs a lot of money and hard work by a number of scientists, engineers, technicians etc. The experiment will cost about 700 crore rupees to build. All this takes for studying the little Neutrino!