INDIA-BASED NEUTRINO OBSERVATORY

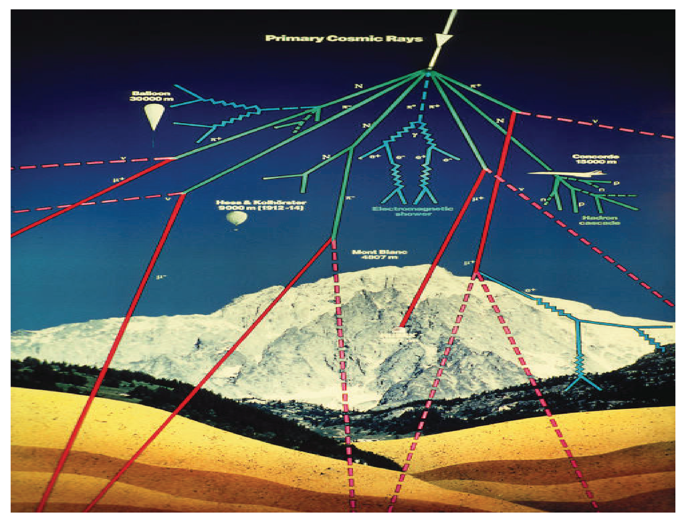
NEUTRINOS AT A GLANCE

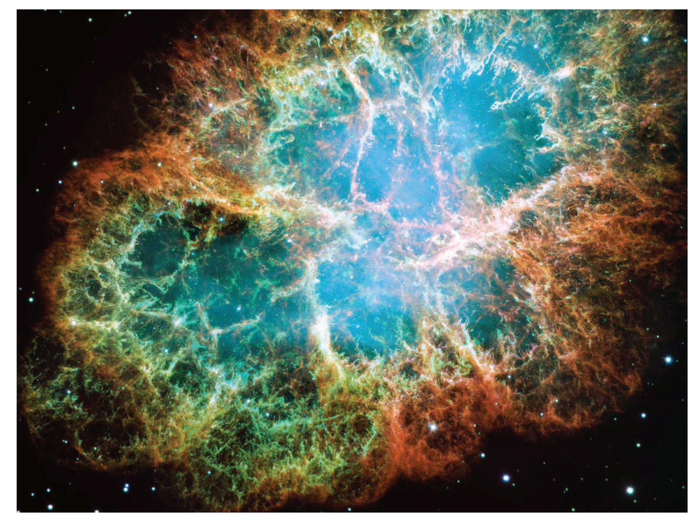
PROPERTIES

Charge	0
Mass	≈0
Spin	½ - Fermion
Types	3 : ν_e , ν_μ , ν_τ
Family	Lepton
Interaction	Weak

- Neutrinos are chargeless, almost massless particles belonging to a class of particles called Leptons.
- They are half-integer spin particles — hence fermions.
- There are three charged leptons, electron, muon and the tau.
- Each such lepton flavour has its own partner neutrino.
- Neutrinos interact weakly and so their detection is extremely difficult. They can easily pass through the earth and come out without any hindrance or deflection!
- Not only that, they can even change their flavour as they travel.

SOURCES





Neutrinos are produced naturally from a wide variety of sources.

Neutrinos from the Sun (called solar neutrinos) are produced due to the thermo-nuclear reaction taking place in the sun's core. These neutrinos have energy in the range of a few MeVs (*).

Cosmic rays are one of the major sources of naturally produced neutrinos. These neutrinos are produced in the earths atmosphere due to nuclear interactions. They have a wide energy ranging from few thousands of MeV to hundreds of thousands of MeV.

Atmospheric neutrinos were first detected in 1965 at the Kolar gold mines in India. The India Based Neutrino Observatory will mainly probe atmospheric neutrinos.

Another interesting source of neutrinos is supernovae. They have an energy of few tens of MeVs.

Neutrinos are also produced artificially from the core of nuclear reactors. Their energy is also in the order of few MeVs.

(*) Million Electron Volt (MeV) is a convenient unit of energy often used in high energy physics. A flying mosquito has an energy of approximately a million million electron volts.

NEUTRINO FLUX

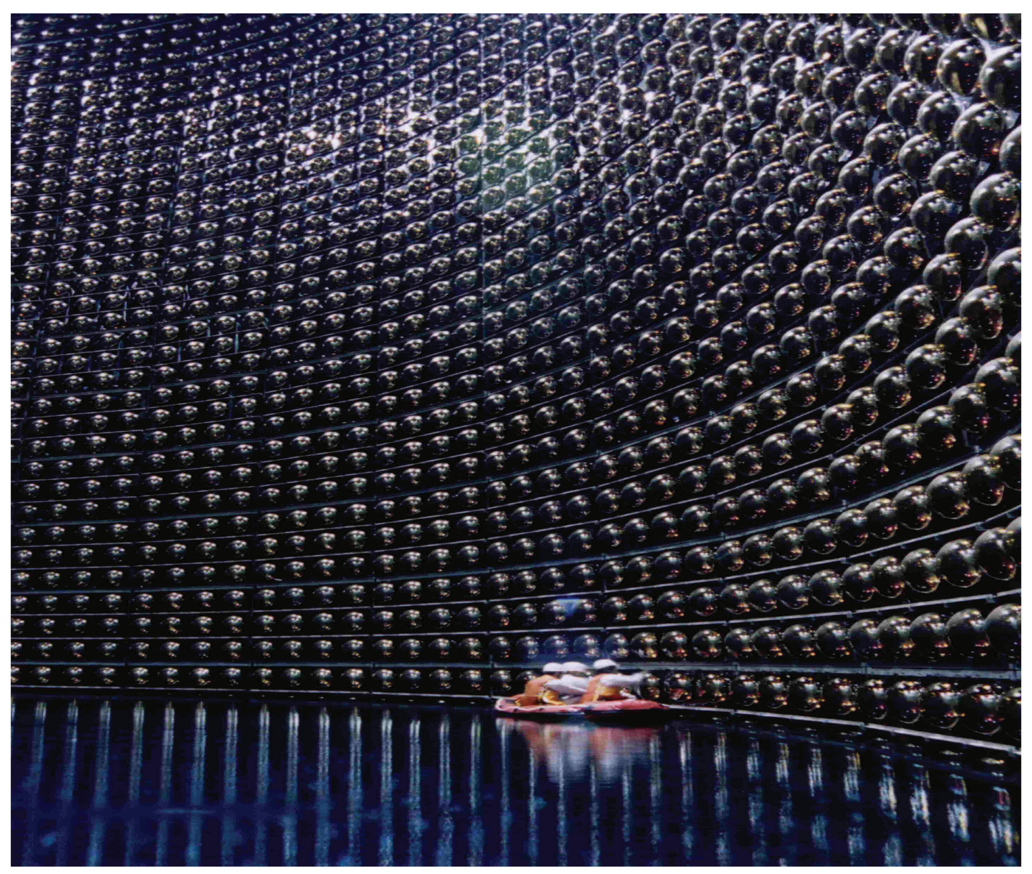
Neutrinos are everywhere.

They come from the Sun, they come from the atmosphere.

Keep your hands open and every second approximately 12000 billion of neutrinos will pass through and you never ever feel them.

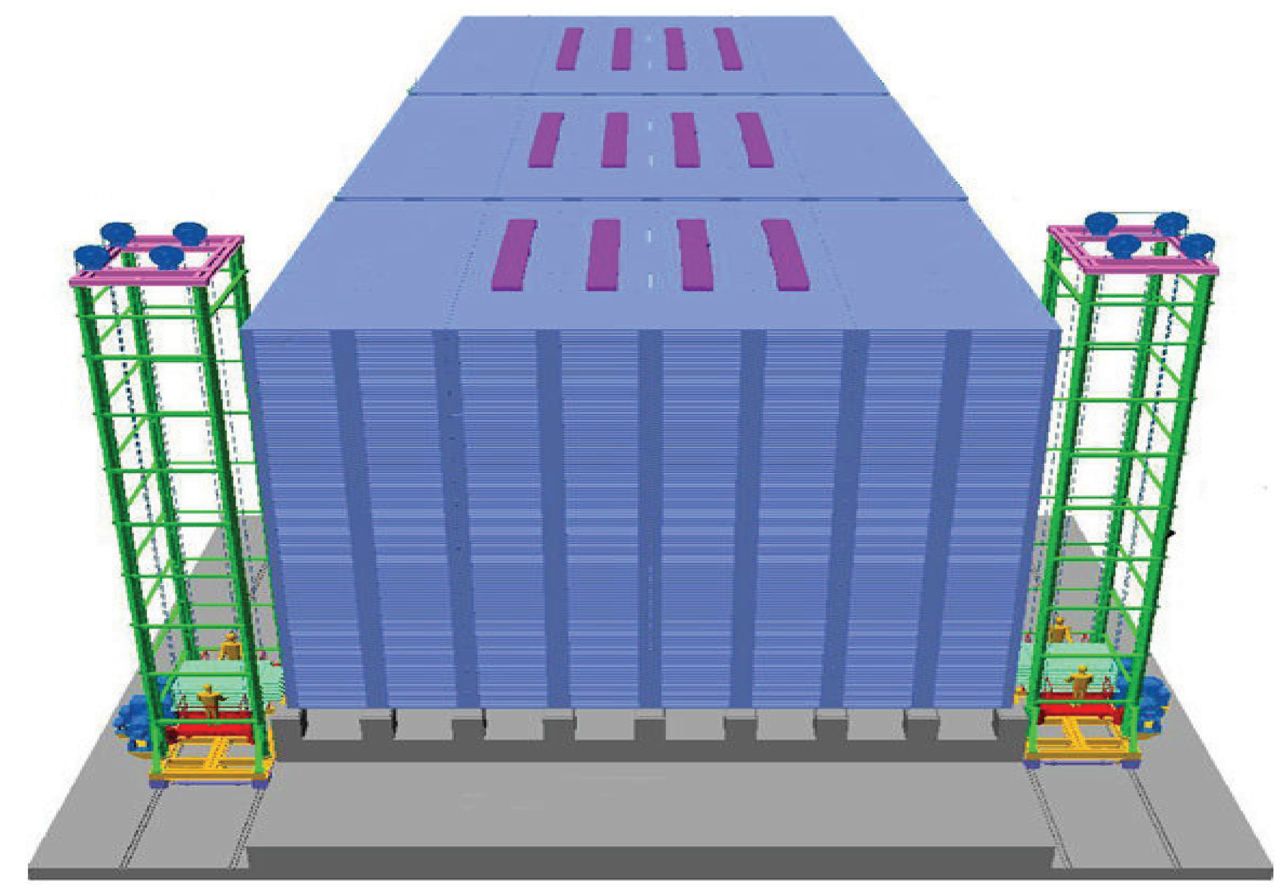
These are the neutrinos that the ICAL detector will detect.

DETECTION IN EXPERIMENTS



The Super Kamiokande

IceCube Neutrino Observatory



The Proposed ICAL detector for INO

Many experiments have detected neutrinos. These detectors are usually placed underground in order to prevent cosmic rays and other disturbances from affecting their detection.

Also, the detector has to be big in order to sense a significant amount of neutrinos. The Super-Kamiokande detector in Japan is a tank containing 50000 tons of pure water. The signal is collected by about 13000 photomultiplier tubes which detects the emission of Cerenkov light when neutrinos interact.

The IceCube Observatory uses the same mechanism of Super-Kamiokande to detect neutrinos. Here, the ice-sheet at the South Pole is used instead of the water tank.

The Iron Calorimeter (ICAL) detector at INO is quite different from the above two detectors. It uses gaseous detectors called Resistive Plate Chambers (RPC) placed between iron layers. Neutrinos interact with the iron and as a result charged particles are emitted which leave signals in the RPCs. A total of 27000 RPCs and 50000 tons of iron will be used. A magnetic field is generated by coils wound around the iron. The uniqueness of this experiment is its capability to differentiate between positively and negatively charged particles, which allows a study of very interesting phenomena.