Detection of Most Energetic Neutrino

Source: TH

Scientists detected the **highest-energy neutrino** using the **KM3NeT (Cubic Kilometre Neutrino Telescope) observatory** in the **Mediterranean Sea.**

- It was 30 times more energetic than any previously observed, **1015 times more energetic than photons**, and **10,000 times more powerful** than particles from the **Large Hadron Collider,** the world's largest particle accelerator.

Cubic Kilometre Neutrino Telescope (KM3NeT): KM3NeT is an under construction **European research facility** in the **Mediterranean Sea** that studies **neutrinos.**

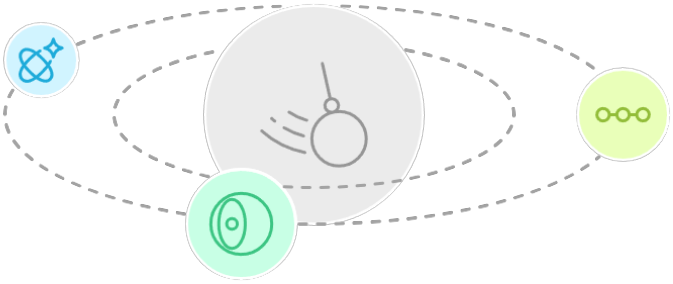
- It's designed to **detect neutrinos from distant sources** and from Earth's atmosphere.

Note: India's Neutrino Observatory project is proposed to be set up at Pottipuram village in Theni (Tamil Nadu) in a 1,200-metre-deep cave.

What are Neutrinos?

- **About:** Neutrinos, often called **"ghost particles",** are electrically neutral, nearly massless subatomic particles that rarely interact with matter.
  - This allows them to **travel vast distances** through stars, planets, and galaxies **without being deflected by magnetic fields,** making them reliable "cosmic messengers."
- **Sources of Neutrinos:**
  - **Natural Sources: Sun** (solar neutrinos), **Nuclear reactions in stars, supernovae**, and **cosmic rays.**
  - **Artificial Sources:** Nuclear reactors, radioactive decay and particle accelerators.
  - **Big Bang Neutrinos:** Remnants from the early universe, contributing to cosmological studies.
- **Types/Flavors of Neutrinos:**

Types/ Flavors of Neutrino



Electron Neutrino
Associated with electrons and produced in nuclear fusion and beta decay

Muon Neutrino
Linked to muons, produced in cosmic ray interactions

Tau Neutrino
Associated with tau particles, observed in accelerators and astrophysical events

- Neutrinos undergo **oscillation** (change from one flavour to another) while traveling due to **quantum mixing**.

- **Significance in Astrophysics:**
  - Neutrinos, unlike cosmic rays, **travel undisturbed**, making them c**rucial for tracing high-energy astrophysical events.**
  - Scientists detect neutrinos using **deep-sea or ice observatories** that capture **Cherenkov radiation (a detectable flash of light)** from rare interactions.

FUNDAMENTAL

Neutrinos are fundamental particles, which means that—like quarks and photons and electrons—they cannot be broken down into any smaller bits.

ABUNDANT

Of all particles with mass, neutrinos are the most abundant in nature. They're also some of the least interactive. Roughly a thousand trillion of them pass harmlessly through your body every second.

ELUSIVE

Neutrinos are difficult but not impossible to catch. Scientists have developed many different types of particle detectors to study them.

OSCILLATING

Neutrinos come in three types, called flavors. There are electron neutrinos, muon neutrinos and tau neutrinos. One of the strangest aspects of neutrinos is that they don't pick just one flavor and stick to it. They oscillate between all three.

NEUTRINOS ARE...

LIGHTWEIGHT

Neutrinos weigh almost nothing, and they travel close to the speed of light. Neutrino masses are so small that so far no experiment has succeeded in measuring them. The masses of other fundamental particles come from the Higgs field, but neutrinos might get their masses another way.

DIVERSE

Neutrinos are created in many processes in nature. They are produced in the nuclear reactions in the sun, particle decays in the Earth, and the explosions of stars. They are also produced by particle accelerators and in nuclear power plants.

MYSTERIOUS

Neutrinos are mysterious. Experiments seem to hint at the possible existence of a fourth type of neutrino: a sterile neutrino, which would interact even more rarely than the others.

VERY MYSTERIOUS

Scientists also wonder if neutrinos are their own antiparticles. If they are, they could have played a role in the early universe, right after the big bang, when matter came to outnumber antimatter just enough to allow us to exist.

UPSC Civil Services Examination Previous Year Question (PYQ)

Q. In the context of modern scientific research, consider the following statements about 'IceCube', a particle detector located at South Pole, which was recently in the news: (2015)

1. It is the world's largest neutrino detector, encompassing a cubic kilometre of ice.
2. It is a powerful telescope to search for dark matter.
3. It is buried deep in the ice.

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (d)