Neutrino and its Detection Method

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Abstract:

This review paper will briefly survey the capabilities of current detectors and the old detectors and the detection methods being used now. Then it will cover recent progress in development of neutrino detection techniques as well as prospects for septic future experiments. This paper will also discuss about the neutrinos.

Neutrinos speak to another "window" to the Universe, spreading over a vast scope of vitality. We examine the exploration of neutrino astronomy what's more, center around two vitality administrations. At "lower" energies ('1 MeV), investigations of neutrinos conceived inside the sun, or delivered in associations of astronomical beams with the environment, have permitted the principal undeniable confirmation that neutrinos have mass. At energies commonly one thousand to one million times higher, sources more distant than the sun (both inside the Milky Way and past) are relied upon to create a motion of particles that can be distinguished just through neutrinos.

Introduction:

Neutrinos are the one of the fundamental particles. They have a very special characteristics. A Neutrino is an elementary particles and the only way of interaction for them is subatomic forces and gravity. They are like electrons but they don’t have charge and there mass is also very less. It is electrically neutral and had a very limited interaction with the particles. They can pass through body easily. Neutrinos are present everywhere, in every second more than 200o neutrinos pass through a body without us ever noticing. Most of the neutrinos were created during the Big Bang while others were created or being created by the nuclear reactions inside the Suns, stars and cosmic bodies and some of them also produced by the events in universe like the “colliding of the black holes, gamma ray bursts from the explosion of the stars….” And now we are also producing it artificially in the nuclear reactor.

Despite of being such a common thing it is very difficult to detect. Because of its electrical neutrality and zero rest mass it is very complex to detect the neutrinos and hence, a very large and very sensitive detectors are required. A neutrino with low energy can travel through anything for any distance. Neutrinos only interact via the gravity and the neutral current or the weak interactions.

Neutrino Detector is a simple apparatus used for the detection of the Neutrinos. Neutrinos interact weakly with the other particles because of that the detector need to be large enough to collect the significant amount of the neutrino for the detection. In a neutral current interaction, the neutrino transforms some of its energy and momentum to the targeted by particle while entering and exiting the detector. If the target particle has the sufficient charge and the sufficiently lighted, then while accelerated to the particle it will emit the Cherenkov Radiation, and that radiation can observed easily.

For the detection of the Neutrino we should know how it interacts. Neutrino only interacts via weak interaction. So, following is some of the interactions of the Neutrinos:

a) Neutrino interacts by the elastic scattering on electrons. These interactions are effective at low energy. And basically these interactions are done by Solar Neutrino and the Reactor Neutrino.
b) Neutrino also interact via passing the charged current on proton or nuclei and this method of interaction is also very effective at all low energy.
c) Or Neutrino also interact by passing the neutral current to deuteron or nuclei. This type of interaction is basically done by Solar Neutrino.
d) They also interact by the Inverse Beta Decay method and basically used in the Nuclear Reactor.

They are certain more methods of interaction of Neutrinos. Neutrino are very light and their cross sectional area is very small.

History of Detection of Neutrinos:

Mathematically and theoretically it was first postulated in 1930 by Wolfgang Pauli. It was postulated that time was to explain the beta decay can also conserve energy, momentum and spin.

Further in 1956 the first Neutrino was detected by the Cowan and Reines using the INVERSE-BETA Decay method. In 1962 Laderman and Steinberger discovered different forms of Neutrinos (Tau Neutrino).

In parallel with accelerator searches from '70s underground laboratories have being making progress in neutrino physics

• Solar neutrino flux and spectrum

• Atmospheric neutrino

• Neutrino flavour oscillation

• Neutrino magnetic moment

• Neutrino mass

Source Of Neutrino:

Natural Sources of Neutrinos are Sun and other Stars and they are produced by the beta decay process. Neutrinos are also generated or produced by the Cosmic Rays which is also a natural source. The neutrino produced from the Cosmic rays have high energy and are used in various process. They are also naturally produced by the radioactivity.

Neutrino from the sun and sky are produced by the pp cycle and they are rich in energy spectrum. We know cosmic ray are produced by the high energy protons and nuclei that interact with the atmosphere produce hardronic showers. Neutrino produced from the sky have all its species while the Muon Neutrino are produced by the pion decays.

Neutrino Detection Methods:

Anti-neutrinos were first detected in the 1956 by Cowan And Reines near the Savannah River Nuclear Reactor. Two calcium targets were used as the target and the INVERSE BETA DECAY Process was used, Two scinitillation detector were used. And after that many experiments and research work were done. There were different radiochemical methods.

- Neutrino Detection: Radiochemistry
  This method of detection is also known as the Homestake experiment which was perfoemd by the RJ Davies in 1968. In this experiment the targets were 614 tons of clothes cleaner and its goal was to detect the ^{37}Ar atom per day. It was performed 2500 m below the earth.
- Neutrino Detection: WATER CHERENKOV
  Super-Kamiokande
  This process of detection of Neutrino is still used. In this process the scattered electron emits Cherenkov radiation detected by PMTs. In this process the real time detection methods was done. For this process the water tank was put below 1.6km below the ground and around 50k tons of pure water was used for this experiment. And in this experiment there was **1 neutrino interaction every 1.5 hour**. It used the down-up neutrino detection method.
- Cherenkov light is produced when the charged particles like electron or the muons move with the speed of light in that medium. In this detector a large vessel is used which is filled with the large amount of the water or ice surrounded by the photomultiplier tubes. These Cherenkov radiation generally produces the optical shockwave.
- The Sudbury Neutrino Detector uses the 1k tones of the pure heavy water for it process. And this process is also done in a heavy vessel. SNO experiment was done and in that it was basically constitute of the nucleon and nucleus interaction and it was sensitive to the charge and neutral current. Not only the neutrino detection it can also detect the bursting of the gamma ray. In this process al the neutrino flavors equally participate.

- Another MINIBOONE detector uses the mineral oil for its experiment. We know the mineral oil is the natural scintillator. So, it is very usefull in production of the Cherenkov light and scintillation light. It is located 2.5 km in the Mediterrean Sea.

There were other neutrino experiments like

a) Accelerators: In this method high energy protons were used on the target. And the charged pions were extracted by the focusing magnet].
b) Underwater/Ice Neutrino Observatories: It used the UHW neutrino detection method. It was performed 3 to 4 km below the sea. And strings of PMTs were used to detect Cherenkov light produced by up-going neutrinos.
c) Radio Ice Cherenkov detectors used different antennas to detect the Cherenkon radiation from the neutrinos in Antartica.

In 1957 G.A. Askaryan called attention to that ionization furthermore, cavitation along a track of an ionizing molecule through a fluid prompts hydrodynamic radiation. In the 1960s, 1980s, hypothetical and test ponders have been performed on the hydrodynamic radiation of bars and particles navigating densemedia . One generally examined application of this impact is the identification of ultra-high vitality vast, i.e. astrophysical neutrinos. An isotropic motion of such neutrinos is normal from the communication of vast beams of the most elevated energies with the photons of the vast microwave foundation.

While the acoustic identification of such neutrinos in salt arches and in permafrost has additionally been talked about, water and ice are the media in which examinations of the strategy have been pushed the farthest. In the 1970s this thought was talked about inside the DUAvailableMAND1 optical neutrino indicator venture and has been considered regarding Cherenkov neutrino indicator ventures since. The discovery of ultra-high vitality neutrinos is impressively more difficult than the look for high-vitality neutrinos as at present sought after by under-ice and submerged Cherenkov neutrino telescopes. Because of the low anticipated motions, volumina surpassing 100 km should be checked for communications. Be that as it may, the properties of the acoustic strategy consider scantily instrumented clusters with ∼100 sensors/km^3.

Identification of photons as tracers of astrophysical procedures have two essential shortages: (I) they are delicate just to those astrophysical procedures that particularly create unmistakable light (an to a great degree little bit of the whole electromagnetic recurrence range), and (ii) on the grounds that the interstellar medium isn't unfilled, and is fairly a soup of residue (1 proton for each cubic meter by and large), low-vitality microwave photons left over from the Big Bang (400ycm^3), infrared starlight, and so on., the probability of an optical photon entering the interstellar medium from the edge of the Universe and achieving our earthly telescopes without being annoyed, assimilated, or avoided in transit, diminishes with both the vitality of the photon and the separation from Earth to source point. This persuades the look for elective methods for gathering galactic data.

Methodology:

There are two expansive classes of locators used to perform these tests: radiochemical measure and constant water Cherenkov locators. Radiochemical gadgets utilize a vat of fluid containing iotas that neutrinos can render radioactive, and, after a certain timeframe (on the request of multi month), the radioactive iotas are cleared out of the fluid and tallied. This gives a gauge for the aggregate episode transition of neutrinos, coordinated over the timeframe being referred to, and with no learning of the vitality or heading of the communicating neutrino. A few investigations, including one that has been running for more than 30 years, have utilized the radiochemical system.

Interestingly, water Cherenkov gadgets identify every individual neutrino communication "progressively," which implies that the connection is distinguished when it occurs (not up to multi month later, as with radiochemical gadgets), and they can likewise make a precise assurance of the neutrino vitality and bearing. In this way, ongoing gadgets create a more extravagant informational index, making conceivable a significantly more definite investigation of sun oriented and barometrical neutrinos.There are two ongoing Cherenkov gadgets at present taking information: the SuperKamiokande ;superk/) explore in Japan and the Sudbury Neutrino Observatory (SNO) test in Canada. The SuperKamiokande identifier is a 50-kiloton light-water Cherenkov gadget covered under a mountain in a functioning zinc mine in the Japanese Alps. It utilizes roughly 11,000 photomultiplier tubes in a tube shaped geometry to identify the Cherenkov light discharged by electrons.

These electrons transmit Cherenkov light since they have been hit sufficiently hard by neutrinos to obtain speeds surpassing that of light in water. (Light moves slower in media, for example, water than it does in vacuum, so charged particles can move quicker than photons in these media. At the point when this occurs, the charged molecule radiates a stun wave of purported Cherenkov light, much like a supersonic plane produces a sound stun wave or "sonic boom.") SuperKamiokande additionally identifies the Cherenkov light radiated by upward-going charged muons created by environmental neutrino collaborations in the earth just underneath the locator and in the indicator volume itself. In the late spring of 1998, SuperKamiokande reported persuading proof for neutrino motions (and thus neutrino mass) by utilizing upward-going muons and high-vitality electrons delivered by climatic neutrinos. The SNO has been outlined principally to think about sunlight based neutrinos. SNO is covered in a functioning nickel mine in northern Ontario, Canada.

It utilizes around 10,000 photomultiplier tubes in a round geometry and is likewise touchy to Cherenkov light. What makes the SNO analyze one of a kind is that it uses one kiloton of substantial water, D_2O, as a target. Through an assortment of communication systems, this grants SNO to make isolate high-rate estimations of the motion of electron neutrinos and the motion of all neutrino flavors. SNO can in this way make a standard sun oriented model-autonomous estimation that may give us the main decisive proof of sun based neutrino motions in the years to come. At a to somedegree higher vitality extend (normal of Active Galactic Cores, g-beam blasts, and so on.), the occurrence transition of neutrinos is impressively littler on account of the trouble in delivering such high-vitality neutrinos, and furthermore the expanded separation to the source with respect to the lower-vitality neutrinos delivered by the Sun.

Correspondingly, the measure of the locator must be to some degree bigger. The AMANDA test at the South Pole utilizes chilly polar ice as the neutrino target (comparable to the spotless water of SuperKamiokande, or the D_2O of the SNO). To get calculable occasion rates, AMANDA ought to be roughly 100 times the span of SuperKamiokande. Like SuperKamiokande and SNO, phototubes recognize the Cherenkov light created by the section of a charged molecule coming about because of a neutrino connection in the objective material (here, the South Polar ice). Inside the last a few months, AMANDA has watched their first neutrinos (at energies roughly 10– 100 times bigger than those ordinary of SuperKamiokande), recognizing 17 "gold-plated" neutrino associations.

Redesigns of AMANDA in the following quite a long while ought to build up it as a chief neutrino astronomy office in the following decade. All physical indicators have the advantage over radiochemical indicators of giving provoke identification of occasions. They as a rule have too an advantage in affectability. Their burden is their need of separation against foundation occasions of all sorts. An perfect physical indicator ought to recognize the versatile diffusing of neutrinos by cores, since this process has a bigger cross-segment than the inelastic processess what's more. The versatile diffusing cross-segment is given by a indicator working with this cross-segment, what's more, utilizing a overwhelming component Drukier and Stodolsky were the first to propose a physical finder in which the backlash vitality of a core in a flexible neu-trino disseminating occasion is distinguished. They call their plan "boloraetric", since it identifies the aggregate vitality saved in the finder by a neutrino association.

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