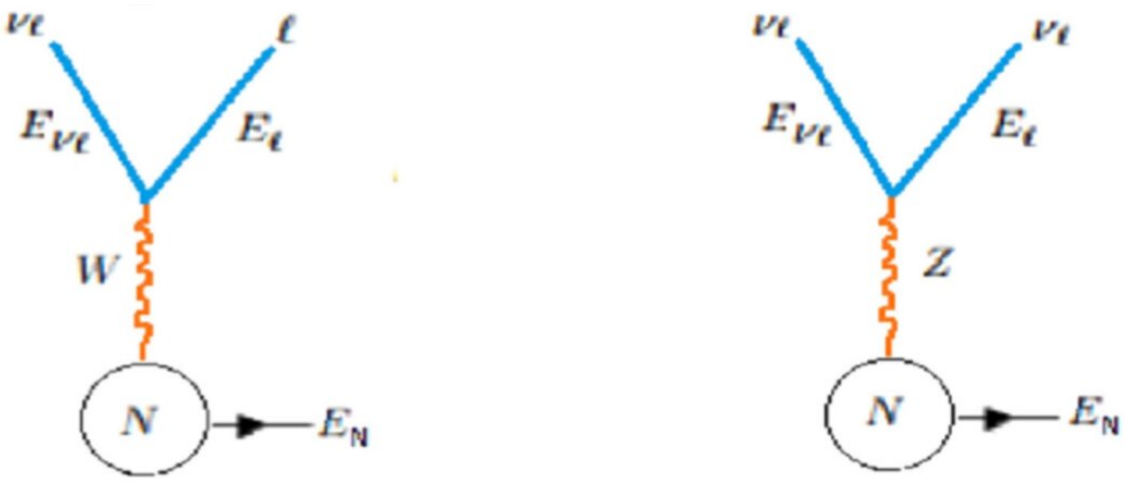
Probing high-energy neutrinos associated with a blazar

August 29 2022, by Clare Sansom



Diagrams for charged(left) and neutral (right) currentneutrino-nucleon interaction.Conservation of energy requiresEν= Eℓ+ EN. Time flow isfrom left to right. Credit: *The European Physical Journal Plus* DOI: 10.1140/epjp/s13360-022-02792-7

Studying a high-energy neutrino that was observed by the IceCube Neutrino Observatory at the South Pole and that is believed to be intergalactic in origin has yielded some intriguing "new physics" beyond the Standard Model

The subatomic particles called neutrinos, are believed to be ubiquitous

throughout the universe but are very difficult to detect. Now, Moroccan astrophysicist Salah Eddine Ennadifi and his co-workers, published a paper in *The European Physical Journal Plus* that describes the first known observation of intergalactic, high-energy neutrinos and probes new neutrino-related physics beyond the Standard Model of Particle Physics.

Neutrinos are puzzling particles; they are similar in many ways to electrons, but have no charge and no, or a very tiny mass. Scientists have suggested many astrophysical bodies as neutrino sources, but only two such sources have been studied: our Sun, and a single supernova (Supernova 1987A).

Neutrinos interactions are rare and can only be observed in a large volume of transparent material, which in practice means water or ice. The IceCube Neutrino Observatory (or telescope) at the South Pole consists of a cubic kilometer of clear, pure and stable ice that acts as a neutrino detector. Ennadifi and his colleagues, from Mohammed V University, Rabat, Morocco, are members of the international IceCube Collaboration.

In this paper, Ennadifi and his co-workers report the detection, by the IceCube telescope, of a high-energy neutrino that is associated with an astrophysical object called a blazar (a quasar with a relativistic jet). This is thought to have an energy of about 300 TeV (300 trillion electron volts) and the blazar associated with it is thought to be about 4 billion light years from Earth. If this is correct, it would fit the definition for a "truly astrophysical neutrino."

High-energy neutrinos like this one, although very rare, are useful tools for studying so-called "new physics" beyond the Standard Model. The researchers were able to give it an estimated mass, which itself goes beyond the Standard Model as that includes only massless neutrinos.

They conclude that high-energy neutrinos from cosmic sources are likely to yield more "surprising" insights and to our further revising our understanding of the forces of nature.

More information: Adil Belhaj et al, Probing new physics scale from TXS 0506+056 blazar neutrinos, *The European Physical Journal Plus* (2022). DOI: 10.1140/epjp/s13360-022-02792-7

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