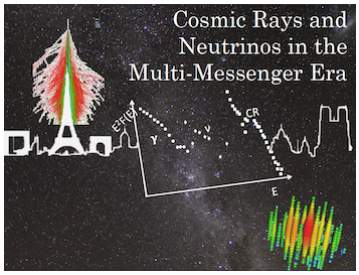

ID de Contribution: **68** Type: **Poster**

Search for multiple flare neutrino emission with 10 years of IceCube data

After more than 100 years since their discovery, cosmic rays (CRs) are still one of the most intriguing open questions in astrophysics. Different astrophysical objects, such as black holes in active galaxies, gamma-ray bursts, supernova shocks, etc., have been proposed as sources of high-energy CRs, but any scientific attempt to track back the sites of their production and acceleration is intrinsically limited by the deflection of these charged particles in galactic and intergalactic magnetic fields. Hints of a cosmic accelerator might come from the detection of a flux of high-energy photons or neutrinos that are expected to be produced by the interactions of CRs with the ambient matter and radiation in the vicinity of a potential source. While the photon horizon is limited by electromagnetic interactions, neutrinos weakly interact across the universe and only change flavour due to oscillations, turning out to be excellent messengers to study cosmic accelerators.

After 10 years of operation, IceCube, the largest neutrino telescope ever built, has the first hints of such sources. Recently published investigations of a catalog, comprising 110 known gamma ray emitters, observed a cumulative excess at 3.3σ-level in the time-integrated flux emitted in 10 years by four of these potential sources in the northern sky (declination $\delta \geq -5^{\circ}$), namely the starburst galaxy NGC 1068 (also reported as the most significant northern spot in a time-integrated all-sky search), the blazar TXS 0506+056 and the BL Lacs PKS 1424+240 and GB6 J1542+6129.

This poster illustrates the methods and the results of a time-dependent follow up of that investigation. A new multiple flare algorithm is developed and firstly applied to this analysis to search for possible multiple flaring emissions from the same direction across 10 years of IceCube data. It turns out that at the location of TXS 0506+056, a well known blazar in the multimessenger sector, this algorithm identifies two notable and independent flares. Moreover, this time-dependent follow-up confirms at a significance of 3σ-level the excess observed in the northern sky by the aforementioned time-integrated search. Four sources are mainly responsible for the time-dependent excess: three (NGC 1068, TXS 0506+056, GB6 J1542+6129) are the same responsible for the time-integrated excess too, and a fourth, M87, is characterised by a clear time-dependent signature with 3 signal-like neutrinos in a 4-minute time window. M87 is also found to be the best individual source in the northern sky with a pre-trial significance of 3.3σ, that becomes 1.7σ post-trial after correcting for the look-elsewhere effect. No interesting results are found in the southern sky, where the sensitivity of IceCube is degraded by the overabundant background of atmospheric muons.

Related session

Neutrino source observations

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