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Hunting the Neutrino Blazar Candidates and Neutrino Emission Mechanism

The location of gamma-ray-emitting region in blazars has been an open issue for several decades and is still being debated. We use a large sample of gamma-ray-loud FSRQs with available spectral energy distributions and employ a so-called "seed photon factor approach"to locate the γ-ray production region. We principally ascertain that the GeV emission originated far beyond the broad-line region (BLR) and close to the molecular dusty torus (DT)—farther out at parsec scales from the central black hole, which supports a far-site scenario for γ-ray blazars. We probe the idea that inverse Compton scattering of infrared seed photons is happening in the Thomson regime. We also suggest that our method can also indicate the location of neutrino emission, in consideration of the neutrinos and γ-rays being cospatially produced within the same region. We compute the predicted neutrino energy for the overall sample and find εν for two frameworks of far-site scenario and near-site scenario are comparable with »1 PeV, satisfying our general expectation that blazars are optimal production factories for PeV–EeV energy neutrinos in the extra-galactic γ-ray sky.

In the study of the correlations between IceCube-detected neutrino events and γ-ray properties of blazars, we recognize the inherent challenges posed by the limited detection of neutrinos. In this work, we explore few-shot learning to deal with the class imbalance and few-shot issues presented in the incremental version of the 12 yr Fermi-LAT γ-ray source catalog (4FGL_ DR3). Specifically, we train a triplet network to transform the blazars with neutrino emission (NBs) and nonblazar samples into an embedding space where their similarities can be measured. With two-way three-shot learning, 199 out of 3708 blazars without neutrino emission (non-NBs) are considered as the potential blazars emitting neutrinos (NBCs for short), with a similarity score against NBs exceeding 98%. Moreover, the Kolmogorov–Smirnov test supports our identification of NBCs.

Collaboration(s)

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