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Impact of multi-messenger spectral modelling on blazar-neutrino associations

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Blazars are promising candidates for astrophysical neutrino sources. Multi-messenger lepto-hadronic models based on proton–photon ($p\gamma$) interactions predict spectra that peak at high energies, whereas statistical searches often assume a power-law shape, emphasising lower energies. We investigate how these spectral assumptions impact neutrino–blazar associations by incorporating physically motivated spectra into our Bayesian point-source framework. Using predictions from Rodrigues et al. (2024), we analyse 10 years of IceCube data and identify five candidate sources. Our results show that $p\gamma$ spectra suppress low-energy associations but may enhance high-energy ones. Strong associations then imply that energetic neutrino events likely have much higher true energies than those inferred under a power-law assumption. This is particularly relevant in light of the recent KM3NeT detection of the highest-energy neutrino, reinforcing the need for theory-driven models to interpret multi-messenger signals.

Collaboration(s)

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