Contribution ID: **1183** Type: **Talk**

Extreme Relativistic Beaming in Neutrino-Associated Blazars

Tuesday 22 July 2025 14:35 (15 minutes)

Blazars have emerged as prominent sources of high-energy neutrinos, with multiple IceCube events linked to them in recent years. A growing body of observational evidence suggests that relativistic beaming is a crucial factor in neutrino emission from these extreme astrophysical accelerators. In this work, we conduct a statistical investigation of this connection by analyzing jet geometry, kinematics, and Doppler and Lorentz factors of neutrino-coincident blazars. These quantities are measured at parsec scales through VLBA observations within the MOJAVE program.

Additionally, we present a remarkable individual case of the blazar 1424+240, which is associated with one of the most significant peaks in the IceCube stacked neutrino all-sky map. Its VLBA polarization image, stacked over 20 years, reveals a jet observed from within its opening cone, maximizing relativistic beaming and reinforcing the link between neutrino production and jet orientation.

Our findings indicate that high-energy neutrinos are predominantly emitted along the jet's axis, suggesting that their parent PeV-scale protons exhibit relativistic bulk motion. This implies that neutrino production occurs at sub-parsec scales, where the jet has already undergone substantial acceleration. These results offer a crucial insight into the physical conditions necessary for neutrino generation in blazars.

Collaboration(s)

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Session Classification: NU

Track Classification: Neutrino Astronomy & Physics