Contribution ID: **123** Type: **Invited talk**

Probing AGN jets with high-energy neutrinos

Thursday 16 September 2021 13:30 (30 minutes)

Active galactic nuclei (AGN) with relativistic jets, powered by mass accretion onto the central supermassive black hole of their host galaxies, are the most powerful persistent sources of broadband electromagnetic radiation in the Universe. Despite decades of multi-wavelength observations, there are still several key questions about AGN jet physics that remain open, such as "What is the plasma composition of AGN jets? Are they composed of electrons and positrons or do they contain baryons too?" and "Where and how are gamma-rays produced in jets?" Unlike photons, neutrinos can only be produced in inelastic collisions of relativistic protons or heavier nuclei with radiation or matter. In contrast to gamma-rays and cosmic rays, neutrinos can freely escape their astrophysical sources and travel over cosmological distances without being affected by ambient photon fields and intergalactic magnetic fields due to their extremely rare interactions with matter and radiation. Carrying important information about the physical conditions in their production sites, neutrinos are thereby a unique messenger for understanding how the most powerful and persistent particle accelerators of the Universe work. The detection of a high-energy neutrino (IC-170922A) coincident with an electromagnetic flare from TXS 0506+056 in 2017 and the subsequent discovery of a neutrino excess from the same direction have strengthened the hypothesis that jetted AGN are cosmic neutrino sources. The lack, however, of gamma-ray flaring activity during the latter period challenges the idea of co-spatial production of gamma-rays and neutrinos in jets, suggesting multiple production sites. In this talk, I will present results of widely adopted physical models trying to explain the aforementioned associations, while highlighting the lessons learned and the newly created puzzles. I will conclude with a new proposal linking the neutrino production in AGN jets to periods of enhanced X-ray activity and discuss its testability with IceCube observations.

Abstract field

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Session Classification: Multi-Messenger & Astro-Particle

Track Classification: Multi-Messenger and Astro-particle