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Probing Dark Matter–Neutrino Interactions through High Energy Neutrino Observations from AGN

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Dark Matter (DM) accounts for a substantial fraction of the universe's mass-energy content, yet its particle nature remains one of the most profound open questions in physics. Neutrinos, with their extremely weak interactions and cosmic reach, offer a unique probe of new physics scenarios involving DM. One intriguing possibility arises in the vicinity of supermassive black holes, where gravitationally induced dark matter overdensities, in other words,"DM spikes", may significantly alter the propagation of high-energy neutrinos emitted by active galactic nuclei (AGN). In particular, neutrino-DM scattering in such dense environments can lead to observable attenuation features in the neutrino flux.

Recent detections of high energy neutrinos from point-like extragalactic sources, most notably the blazar TXS 0506+056 and the radio-loud Seyfert galaxy NGC 1068, by the IceCube Neutrino Observatory present an unprecedented opportunity to search for such effects. In this study, we leverage publicly available IceCube data to jointly analyze these sources and place constraints on the neutrino–DM scattering cross-section. By combining multiple AGN neutrino observations, we enhance our sensitivity to potential deviations from standard astrophysical expectations, offering constraints on dark matter interactions at energy scales far beyond those accessible by terrestrial experiments.

Neutrino Properties

Yes

Neutrino Telescopes & Multi-messenger

Yes. Searches for Neutrino-Dark Matter Interactions in IceCube Data from Active Galactic Nuclei

Neutrino Theory & Cosmology

No

Data Science and Detector R&D

Yes

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