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Decaying Dark Matter at IceCube and its Signature in High-Energy Gamma-Ray Experiments

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Observations of high-energy astrophysical neutrinos in IceCube have opened the door to multi-messenger astronomy, by way of which questions in particle physics could be explored through a combination of IceCube data and optical experiments such as Fermi-LAT. However, the origin of these astrophysical neutrinos is still largely unknown. Among the tensions that still need to be addressed, for example, is the excess of neutrinos observed in the energy range of 40-200 TeV, a contribution that could come from heavy dark matter decay. The dark matter decay hypothesis can be tested through comparisons with gamma-ray data, because a coincident gamma-ray flux is expected to accompany the neutrino flux that IceCube observes. However, gamma-rays become heavily suppressed for sources dominating in particular energy ranges. In the case of the Galactic center, the γ-sky is partially opaque in the (0.1-10) PeV range. This is due to properties of the traversed medium, which can generally consist of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field. These significantly alter the initial spectrum through intermediate processes such as absorption and Inverse-Compton scattering, giving rise to anisotropy and energy features in the final spectrum that reaches telescopes on Earth. The existence of competing photon background models, moreover, complicates estimates of dark matter constraints. In this presentation, we address these questions by studying the impact that these different models have on indirect measurements of heavy dark matter decay. I present my predictions for galactic, inverse-Compton, and extragalactic gamma-ray spectra undergoing attenuation by different backgrounds.

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Dark matter

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