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

The measurement of ultra-high energy starting event neutrinos in the TeV-PeV range in IceCube has afforded us with the possibility of answering questions through multimessenger efforts in astroparticle physics. However, the origin and nature of these astrophysical neutrinos is still largely unresolved. Among existing tensions, 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 has been studied extensively through comparisons with gamma-ray data, due to the fact that a coincident gamma-ray flux is expected to accompany the neutrino flux that IceCube observes. Diffuse gamma-ray data has placed strong constraints that rule out the dark matter hypothesis for IceCube's observations. However, gamma-rays become heavily suppressed for sources dominating in particular energy ranges. This is due to properties of the traversed medium, which generally consists of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field, the first of which, in particular, is very difficult to measure and thus involves many uncertainties. In this work, we elaborate on previous dark matter decay results by considering the impact that the EBL could have on predicted gamma-ray spectra for dark matter. We present limits on galactic and extragalactic dark matter decay by comparing our calculations to Tibet 2021 data and Fermi-LAT diffuse data, featuring uncertainties among different EBL models that could have implications for existing limits.

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