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Decay of heavy dark matter at future ultra-high-energy neutrino telescopes: enhanced potential of joint energy and angular analysis

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Upcoming neutrino telescopes will have an unprecedented sensitivity to ultra-high-energy (UHE) neutrinos, above 10 PeV. This achievement will allow to test physics beyond the Standard Model at a very high energy scale, including the decay of heavy dark matter particles. Previous works acknowledged this possibility, showing that the total number of detected events will allow to set competitive bounds on dark matter lifetime in the mass range above 10 PeV. We adopt a detailed modeling of the radio array at IceCube-Gen2 to investigate how these bounds are improved by a full spectral and angular analysis of the detected events. In the case of non-existence of heavy dark matter, an angular analysis strengthens the projected bounds, due to the characteristic signal anisotropy towards the Galactic center; in the case of its existence, such an anisotropy may provide a signature allowing discrimination between UHE neutrinos from dark matter and those of astrophysical origin.

Primary authors: FIORILLO, Damiano (Niels Bohr Institute, Copenhagen); BUSTAMANTE, Mauricio (Niels Bohr Institute, Copenhagen); VALERA, Victor (Niels Bohr Institute, Copenhagen); WINTER, Walter (DESY Zeuthen)

Presenter: FIORILLO, Damiano (Niels Bohr Institute, Copenhagen)

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