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Search for Boosted Dark Matter at ProtoDUNE

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We propose, for the first time, the potential of physics opportunities at the ProtoDUNE detectors in the context of dark matter physics. More specifically, we explore various experimental signatures at the cosmic frontier, arising in boosted dark matter scenarios, i.e., relativistic, inelastic scattering of boosted dark matter often created by the annihilation of its heavier component which usually comprises of the dominant relic abundance. Although features are unique enough to isolate signal events from potential backgrounds, vetoing a vast amount of cosmic background is rather challenging as the detectors are located on the ground. We argue, with a careful estimate, that such backgrounds nevertheless can be well under control via performing dedicated analyses after data acquisition. We then discuss some phenomenological studies which can be achieved with ProtoDUNE, employing a dark photon scenario as our benchmark dark-sector model.

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