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Discovering Minimal Dark Matter at Muon Colliders

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Minimal Dark Matter models extend the Standard Model by incorporating a single electroweak multiplet, with its neutral component serving as a candidate for the thermal relic dark matter in the Universe. These models predict TeV-scale particles with sub-GeV mass splittings Δ. Collider searches aim at producing the charged member of the electroweak multiplet which then decays into dark matter and a charged particle. Traditionally, these searches involve signatures of missing energy and disappearing tracks. Due to the small size of Δ, the transverse momentum of this charged particle is too soft to be resolved at hadron colliders. In this talk, I show that a Muon Collider is capable of detecting these soft charged decay products, providing a means to discover TeV thermal relics with an almost degenerate charged companion. Our technique also facilitates the determination of Δ, allowing for a comprehensive characterization of the dark sector. Our results indicate that a 3 TeV muon collider will have the capability to discover the highly motivated thermal Higgsino-like dark matter candidate as well as other scenarios of Minimal Dark Matter featuring larger multiplets whose neutral component corresponds to a fraction of the total dark matter in the Universe. This study highlights the potential of a muon collider to make significant discoveries even at its early stages of operation.

Mini Symposia (Invited Talks Only)

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