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A final word on Electroweak WIMPs at future lepton colliders

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Weakly Interacting Massive Particles (WIMPs) are theoretically appealing Dark Matter (DM) candidates. Generalizing the Minimal Dark Matter paradigm, we consider stable DM
candidates within a single SU(2)L n-plet with hypercharge Y.
The hypercharge is constrained by Direct Detection (DD) constraints. It must be 0 for odd n, while non-zero for even n.
For n<6, the thermal masses of the candidates are in the 1 TeV-15 TeV range, making them interesting targets for future muon colliders. The searches possible at lepton colliders are broadly of two types: missing invariant mass (MIM)
or disappearing tracks (DT) searches. The MIM channels look for SM particles (photon, W, Z) recoiling against heavy invisible objects. For low n, low masses the mono-W channel outperforms the mono-photon. For high n, multiple recoils (di-photon, same sign di-W), can enhance the signal-to-noise ratio of the search, making it more robust in presence of systematics.
DT searches instead look for a charged particles decaying, after having hit the innermost layers of the tracker, into a soft, unreconstructed SM charged state (pions or positron/neutrino pair) plus a heavy invisible object. The search is sensitive to the lifetime of the charged particles. For odd n, the lifetime is a robust prediction of the theory. For even n, the lifetime is model dependent. However, the operators that induce the splitting can be probed at DD experiments, leading to an interplay between them and collider searches. We find that for fermions, a 10 TeV muon collider is enough to exclude at 2 sigma models with n<4,
while scalars are harder to probe.

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