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Generalizing Minimal Dark Matter: Millicharge or Decay

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The Minimal Dark Matter (DM) framework classifies viable DM candidates that are obtained by simply augmenting the Standard Model of particle interactions with a new multiplet, without adding new ad hoc symmetries to make the DM stable. The model has no free parameters and is therefore extremely predictive; moreover, recent studies singled out a Majorana $SU(2)$ quintuplet as the only viable candidate. The model can be constrained by both direct and indirect DM searches, with present time gamma-ray line searches in the galactic center being particularly sensitive. It is therefore timely to critically review this paradigm and point out possible generalizations. We propose and explore two distinct directions. One is to abandon the assumption of DM electric neutrality in favor of absolutely stable, millicharged DM candidates. We explicitly study a few examples, and find that a Dirac $SU(2)$ triplet is the candidate least constrained by indirect searches. Another possibility is to lower the cutoff of the model, which was originally fixed at the Planck scale, to allow for decays of the DM quintuplet. We analyze the decay spectrum of this candidate in detail and show that gamma-ray data constrain the cutoff to lie above the GUT scale.

Experimental Collaboration

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