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Using M_T2 to Distinguish Dark Matter Stabilization Symmetries

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Abstract:

We examine the potential of using colliders to distinguish models with parity (Z_2) stabilized dark matter (DM) from models in which the DM is stabilized by other symmetries, taking the latter to be a Z_3 symmetry for illustration. The key observation is that a heavier mother particle charged under a Z_3 stabilization symmetry can decay into one or two DM particles along with Standard Model (SM) particles. This can be contrasted with the decay of a mother particle charged under a parity symmetry; typically, only one DM particle appears in the decay chain. In arXiv:1003.0899, some of us studied the distributions of visible invariant mass from the decay of a single such mother particle in order to highlight the resulting distinctive signatures of Z_3 symmetry versus parity symmetry stabilized dark matter candidates. We now describe a complementary study which focuses on decay chains of the two mother particles which are necessarily present in these events. We also include in our analyss the missing energy/momentum in the event. For the Z_3 symmetry stabilized mothers, the resulting inclusive final state can have two, three or four DM particles. In contrast, models with Z_2 symmetry can have only two. We show that the shapes and edges of the distribution of M_T2-type variables, along with ratio of the visible momentum/energy on the two sides of the event, are powerful in distinguishing these different scenarios.

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