

Sommerfeld Effect and Bound State Formation in Simplified Dark Matter Models

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The existence of a dark matter (DM) model with a rich dark sector could be the reason why WIMP DM has evaded its detection so far. For instance, colored co-annihilation naturally leads to the prediction of heavier DM masses. Moreover, non-perturbative effects such as Sommerfeld corrections and bound state formation must be considered in order to accurately predict the DM relic abundance. In the context of simplified t-channel DM models with a colored mediator, we demonstrate the importance of correctly considering these non-perturbative effects for inferring the viable model parameters in an accurate manner. We find that parts of the parameter space thought to be excluded by direct detection experiments and LHC searches remain still viable. Additionally, we illustrate that long-lived particle searches and searches for bound-state resonances at the LHC can play a crucial role in probing such a model.

Finally, we demonstrate how future direct detection experiments will be able to close almost all of the remaining windows for DM produced via the freeze-out mechanism, making it a highly testable scenario.

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