

Boosted dark matter from galactic and cosmological semi-annihilation

In scenarios where the dark matter (DM) relic abundance is set by semi-annihilation, two DM particles can produce one dark matter particle and one Standard Model particle. These processes may still occur today in both the Milky Way galaxy and the early Universe, generating a flux of boosted DM particles. We study the resulting signals in direct detection and neutrino experiments for sub-GeV DM masses. For galactic semi-annihilation, we show that for typical cross-section values, the sensitivity of current experiments to the spin-independent DM–proton scattering cross-section can exceed existing limits from cosmic-ray boosted DM by several orders of magnitude. We also compute the cosmological contribution from semi-annihilation in an inhomogeneous high-redshift DM distribution, using a state-of-the-art boost-factor model. We show that this component can enhance the reach of current searches by up to two orders of magnitude and may allow future experiments to probe scattering cross-sections in the femtobarn range for sub-GeV DM.

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