High Energy Physics - Phenomenology

Sommerfeld-Enhanced Annihilation in Dark Matter Substructure: Consequences for Constraints on Cosmic-Ray Excesses

Tracy R. Slatyer, Natalia Toro, Neal Weiner

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In models of dark matter (DM) with Sommerfeld-enhanced annihilation, where the annihilation rate scales as the inverse velocity, N-body simulations of DM structure formation suggest that the local annihilation signal may be dominated by small, dense, cold subhalos. This contrasts with the usual assumption of a signal originating from the smooth DM halo, with much higher velocity dispersion. Accounting for local substructure modifies the parameter space for which Sommerfeld-enhanced annihilating DM can explain the PAMELA and Fermi excesses. Limits from the inner galaxy and the cosmic microwave background are weakened, without introducing new tension with substructure-dependent limits, such as from dwarf galaxies or isotropic gamma-ray studies. With substructure, previously excluded parameter regions with mediators of mass ~1-200 MeV are now easily allowed. For O(MeV) mediators, subhalos in a specific range of host halo masses may be evaporated, further suppressing diffuse signals without affecting substructure in the Milky Way.

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