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Opening the Parameter Space of sub-GeV Inelastic Dark Matter through Parity Violation

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Sub-GeV dark matter has emerged as a compelling alternative to the conventional WIMP paradigm, particularly in light of persistent null results from standard searches. However, candidates with s-wave annihilation in this mass range are strongly constrained by indirect-detection bounds. Inelastic dark matter scenarios offer a natural mechanism to evade these constraints, especially when the excited state is sufficiently long lived. In this talk, I present a detailed analysis of pseudo-Dirac inelastic dark matter interacting through a dark photon, with particular emphasis on the phenomenological consequences of parity violating interactions.

Parity violation generically induces small diagonal couplings that can substantially modify the late-time abundance of the excited state. An accurate determination of this population is therefore crucial for consistently evaluating experimental constraints. To this end, I solve the integrated Boltzmann equation governing the excited-state fraction, including up- and down-scattering with electrons, dark sector conversion processes, and the thermal evolution of the dark sector.

Using the resulting excited-state abundance, I reassess constraints from indirect and direct detection, self-interactions, and collider searches. I find that parity violating interactions can reopen broad regions of parameter space that would otherwise be excluded in parity conserving scenarios, particularly for keV–MeV mass splittings. Finally, I discuss the prospects for testing these scenarios in future experiments, with particular attention to the sensitivity of LDMX.

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