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Inelastic dark matter with vector mediators}

Inelastic dark matter (iDM) is an appealing scenario for light thermal dark matter, since its relic abundance is set by coannihilation and it can evade cosmic microwave background (CMB) radiation bounds, as well as direct and indirect detection. Among its possible realizations, the dark photon mediator with fractional mass splittings $\Delta \sim 0.1$–0.4 has been extensively studied, leaving little viable parameter space. Thus, in this work, the iDM model is extended to general vector mediators associated with a $U(1)_Q$ gauge symmetry, including $B - L$, $B - 3L_\tau$ and $L_\mu - L_\tau$, and its relic density is computed by solving the full system of coupled Boltzmann equations. Furthermore, the study explores the regime of small mass splittings Δ, where the coannihilation approximation is no longer valid and the decays of the heavier dark state are suppressed, together with mediator-to-dark-matter mass ratios $R = m_{Z_Q}/m_1 > 3$. Finally, the resulting thermal targets are contrasted with current limits and projected sensitivities from experiments such as NA64, BaBar, Belle II, FASER, and LDMX, in order to identify regions of parameter space that remain unexplored.
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