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Dark Matter Freeze-out via Catalyzed Annihilation

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We present a new paradigm of dark matter freeze-out, where the annihilation of dark matter particles is catalyzed. We discuss in detail the regime that the depletion of dark matter proceeds via $2\chi \to 2A'$ and $3A' \to 2\chi$ processes, in which χ and A' denote dark matter and the catalyst respectively. In this regime, the number density of dark matter decreases in power-law before freeze-out, rather than an exponential decrease due to Boltzmann suppression, as is the case with classical WIMPs and SIMPs. The paradigm applies for a secluded weakly interacting dark sector with a dark matter in the $\mathrm{MeV} - \mathrm{TeV}$ mass range. It is consistent with constraints from both the Cosmic Microwave Background (CMB) and Big Bang Nucleosynthesis (BBN), and it predicts enhanced signals for indirect detection.

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