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Thermal Dark Matter with Low-Temperature Reheating

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We explore the production of thermal dark matter (DM) candidates (WIMPs, SIMPs, ELDERs and Cannibals) during cosmic reheating. Assuming a general parametrization for the scaling of the inflaton energy density and the standard model (SM) temperature, we study the requirements for kinetic and chemical DM freeze-out in a model-independent way. For each of the mechanisms, up to two solutions that fit the entire observed DM relic density exist, for a given reheating scenario and DM mass. As an example, we assume a simple particle physics model in which DM interacts with itself and with SM through contact interactions. We find that low-temperature reheating can accommodate a wider range of couplings and larger masses than those permitted in the usual instantaneous high-temperature reheating. This results in DM solutions for WIMPs reaching masses as high as 10^{14} GeV, whereas for SIMPs and ELDERs, we can reach masses of 10^{13} GeV. Interestingly, current experimental data already constrain the enlarged parameter space of these models with low-reheating temperatures. Next-generation experiments could further probe these scenarios.

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