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Constraints on the very early universe from WIMP dark matter

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We investigate the relic density n_\chi of non-relativistic long-lived or stable particles \chi in non-standard cosmological scenarios. We calculate the relic abundance starting from arbitrary initial temperatures of the radiation-dominated epoch, and derive the lower bound on the initial temperature T_0 \geq m_\chi/23, assuming that thermally produced \chi particles account for the dark matter energy density in the universe; this bound holds for all \chi annihilation cross sections. We also investigate cosmological scenarios with modified expansion rate. Even in this case an approximate formula similar to the standard one is capable of predicting the final relic abundance correctly. Choosing the \chi annihilation cross section such that the observed cold dark matter abundance is reproduced in standard cosmology, we constrain possible modifications of the expansion rate at T \sim m_\chi/20, well before Big Bang nucleosynthesis.

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