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Gravitational SIMPs

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We study the impact of thermalization and number-changing processes in the dark sector on the yield of gravitationally produced dark matter (DM). We take into account the DM production through the s-channel exchange of a massless graviton both from the scattering of inflatons during the reheating era, and from the Standard Model bath via the UV freeze-in mechanism. By considering the DM to be a scalar, a fermion, and a vector boson we show, in a model-independent way, that DM self-interaction gives rise to a larger viable parameter space by allowing lower reheating temperature to be compatible with Planck observed relic abundance. As an example, we also discuss our findings in the ontext of the $\mathbb{Z}_2$-symmetric scalar singlet DM model.

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