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Gravothermalizing into cannibal stars and primordial black holes

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Very little is known about the universe's history from after the end of inflation until the Big Bang nucleosynthesis (BBN), which spans more than 10^{39} orders of magnitude in time scales. In this work, we show that if there was a long period of matter domination (at least 10^8 scale factors) in this unknown period, and if the particle causing the matter domination has self-interactions, then the matter particles can undergo gravothermal collapse to form primordial black holes (PBHs). We show that $4 \rightarrow 2$ self-annihilations of the particles can form a 'cannibal star' and inhibit collapse to a black hole for some parameter space. For a range of black hole formation efficiency, we find that CMB and BBN constraints on PBHs can rule out significant regions of EMDE parameter space. Thus, we show how PBHs can offer a new window into a pre-BBN universe.

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