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Gravothermalizing into 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, which spans more than 10^{39} orders of magnitude in time scales. In this work, we show that if during this unknown period there was a long period of matter domination by a massive scalar field, and if the particle causing the matter domination has moderate self-interactions, the matter particles can undergo gravothermal collapse to form exotic states as primordial black holes (PBHs), boson stars, and cannibal stars. We found that for some choice of parameters, our model can predict an amount of PBHs surviving until today comparable to dark matter. For an optimistic estimate of PBH abundance, we also find that PBHs with masses less than 10^9 g can reheat the universe before BBN. From the bounds on the PBH abundance, we also constrain the models of massive scalar fields in a large range of parameters.

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