Long–lived primordial black holes in running-mass inflation model

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Abstract

The Cosmic Microwave Background (CMB) data naively allows for a large spectrum on small scales ($\theta < 0.3^\circ$), i.e. a spectrum few orders of magnitude above $\mathcal{P}_{\mathcal{R}_c} \simeq 10^{-9}$, evaluated at horizon exit. One can, however, place an upper limit on smaller scale spectrum by taking into account astrophysical and cosmological constraints on black holes. If this spectrum is in fact close to this upper limit, then the situation allows for 'large' fluctuations; large enough to collapse into black holes, known as Primordial Black Holes. We assume that the fluctuations which sourced the PBHs are also generated during inflation, specially towards the end of inflation. Among inflation models, we focus on the running-mass model, a type of inflationary model which emerges naturally in the context of supersymmetric extension of the Standard Model. The model is of the single-field type, but nevertheless it has relatively strong scale-dependence (running) of the spectral index. Former studies on this model showed that this model because of large positive running spectral index can produce high density fluctuations in the early Universe but the recent data of 7-year WMAP prove that the mean value of the running spectral index in negative. So we revisit this model and we show that with introducing a new parameter (the running of running), this model is still "good" for PBHs formation with mass larger than 10^{15} g, which are candidate for Cold Dark Matter.