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Pre-inflationary bounce : using two fields

While the inflationary paradigm is considered to be the most successful early universe paradigm, explaining the observations, it suffers from many issues, including the singularity problem. The classical bouncing paradigm, being the most popular alternative, on the other hand, is capable of solving the singularity problem, but often is unable to be in line with the observations. In this work, we propose a model where the bounce occurs prior to the onset of the conventional inflationary scenario, such that the bounce evades the initial singularity problem while the pivot scale leaves the Hubble horizon in the inflationary era, thus preserving the observational consistency. To achieve such a scenario, we construct the simplest Lagrangian consisting of two scalar fields, where the first one (ϕ) is canonical, responsible for the inflationary scenario, whereas the auxilliary field (χ) with a negative kinetic energy term helps achieve the bounce. Keeping that in mind, we, first construct such a model with the chaotic and starobinsky inflationary model, which then we generalize for any inflationary model. In order fto preserve observational consistency, the Universe should be fully governed by slow-roll dynamics when the pivot scale crosses the horizon, so it is important to choose the value of field ϕ at the time of onset of inflation in a way that the inflationary expansion phase lasts for at least 50-60 efolds. As a result, the perturbations will be ensured to behave similarly to slow-roll inflation, enabling our bouncing model to satisfy the observational constraints, whereas, the effect of bounce, however, might be observed at higher cosmological scales (modes smaller than pivot scale), and this may even be confirmed from the non-Gaussianity parameter. (This work is currently outside of its current scope, so we reserve the work for future endeavours.) However, such construction can not avoid the ghost instability, which later we show that, this issue can even be mitigated (not entirely) by considering the coupling function between two scalar fields.

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