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Effects of the modification of gravity on the production of primordial black holes

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The enhancement of the spectrum of primordial comoving curvature perturbation $\mathcal{R}$ can induce the production of primordial black holes (PBH) which could account for part of present day dark matter.
As an example of the effects of the modification of gravity on the production of PBHs, we investigate the effects on the spectrum of $\mathcal{R}$ produced by the modification of gravity in the case of G-inflation, deriving the relation between the unitary gauge curvature perturbation ζ and the comoving curvature perturbation $\mathcal{R}$, and identifying a background dependent enhancement function $\mathcal{E}$ which can induce large differences between the two gauge invariant variables. We use this relation to derive an equation for $\mathcal{R}$, showing for the presence of a momentum dependent effective sound speed (MESS), associated to the intrinsic entropy which can arise in modified gravity theories, in agreement with the model independent MESS approach to cosmological perturbations.

When ζ is not constant in time it is different from $\mathcal{R}$, for example on sub-horizon scales, or in models exhibiting an anomalous super-horizon growth of ζ, but since this growth cannot last indefinitely, eventually they will coincide.
We derive the general condition for super-horizon growth of ζ, showing that slow-roll violation is not necessary.
Since the abundance of PBHs depends on the statistics of the peaks of the comoving density contrast, which is related to the spectrum of $\mathcal{R}$, it is important to take into account these effects on the PBHs abundance in modified gravity theories.

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