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Weyl-Starobinsky inflation

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In Starobinsky inflation with a Weyl squared Lagrangian $-\alpha C^2$, where alpha is a coupling constant, we study the linear stability of cosmological perturbations on a spatially flat Friedmann-Lemaître-Robertson-Walker background. In this theory, two dynamical vector modes are propagating as ghosts for $\alpha > 0$. This condition is required to avoid tachyonic instabilities of vector perturbations during inflation. The tensor sector has four propagating degrees of freedom, among which two of them correspond to ghost modes. However, the tensor perturbations approach constants after the Hubble radius crossing during inflation, and hence the classical instabilities are absent. In the scalar sector, the Weyl curvature gives rise to a ghost mode coupled to the scalaron arising from the squared Ricci scalar. We show that two gauge-invariant gravitational potentials, which are both dynamical in our theory, are subject to exponential growth after the Hubble radius crossing. There are particular gauge-invariant combinations like the curvature perturbations whose growth is suppressed, but it is not possible to remove the instability of other propagating degrees of freedom present in the perturbed metric. This violent and purely classical instability present in the scalar sector makes the background unviable. Furthermore, the presence of such classical instability makes the quantization of the modes irrelevant, and the homogeneous inflationary background is spoiled by the Weyl curvature term.