

Astro 321: Inflation 3 Final Project

Exact Equations

Write a code to solve the exact equations of motion in the background and linear perturbation theory. For the background $\phi(\mathbf{k}, \eta) = \phi_0(\eta) + \phi_1(\mathbf{k}, \eta)$

$$\ddot{\phi}_0 + 2\frac{\dot{a}}{a}\dot{\phi}_0 + a^2V' = 0, \quad (1)$$

and for the perturbations

$$\ddot{u} + \left(k^2 - \frac{\ddot{z}}{z}\right)u = 0 \quad (2)$$

where $u = a\phi_1$ and

$$z = a\frac{\dot{\phi}_0}{(\dot{a}/a)} \quad (3)$$

Given the chaotic inflation example given in the last problem set, compare the slow roll and exact predictions for the background rolling and Δ_ζ^2 .

Extra credit: work out the same for power law inflation

$$V(\phi) = V_0 \exp\left(-\sqrt{\frac{2}{p}}\phi/M_{\text{pl}}\right) \quad (4)$$

where $M_{\text{pl}} = 1/\sqrt{8\pi G}$. An exact solution for the background exists. See Liddle & Lyth's book for details.