HOMEWORK

1. CONSIDER A SCALAR FIELD IN DE-SITTER.

$$S = \frac{1}{2}\int \sqrt{g}\, g^{\mu\nu}\partial_\mu\phi\,\partial_\nu\phi = \frac{R_{dS}^2}{2}\int d\eta\, d^3k \left[(\partial_\eta\phi)^2 - k^2|\phi_k|^2\right]$$

a) CHECK THAT $\phi_k \sim (1-ik\eta)e^{ik\eta}$ ARE SOLUTIONS TO THE CLASSICAL EQUATIONS.

b) WRITE ϕ IN TERMS OF CREATION & ANNIHILATION OPERATORS, COMPUTING THE PROPER NORMALIZATION

c) FIND $\langle \phi_k \phi_k \rangle$ AT LATE TIMES

d) CHECK THAT $[\phi_k, \eta\partial_\eta\phi_{-k}] \to 0$ AS $\eta k \to 0$

HOW FAST DOES IT DECREASE?

2. ASSUME THAT THE REHEATING TEMPERATURE IS $T \sim 10^{16}$ GeV & THAT WE HAVE RADIATION DOMINATION EVER SINCE.
HOW MANY e-FOLDS DO WE NEED TO EXPLAIN THE UNIFORMITY OF THE UNIVERSE?

3. $\langle \varphi\varphi \rangle \propto \frac{1}{\varepsilon\theta_*}\frac{H_*^2}{M_{Pl}^2}$ $\qquad \langle \gamma\gamma \rangle \sim \frac{H_*^2}{M_{Pl}^2}$

$\eta_* k \sim 1 \sim e^{t_* - t} k$

FIND THE "TILT" OF THE TENSOR SPECTRUM. IN TERMS OF ε

SCALAR TILT $\equiv k\partial_k \langle \varphi\varphi \rangle$ $\qquad$ TENSOR TILT $\equiv k\partial_k \langle \gamma\gamma \rangle$

$$\varepsilon \equiv \frac{1}{2}\left(\frac{M_{Pl}V'}{V}\right)^2 \qquad \eta \equiv \frac{M_{Pl}^2 V''}{V}$$