

Exercises (Inflation/GUTs)

- 1) Show that in Standard Big Bang Cosmology, there was no causal contact among regions in the CMB sky separated by about 2° ^{(or more).} Note that the CMB was emitted about 350,000 years after the Big Bang. The age of the universe is ~ 13 billions years.
- 2) Consider the gauge symmetry $H \equiv SU(4)_c \times SU(2)_L \times SU(2)_R$ which displays ^{electric} charge quantization. The fermions of each generation belong in the representations $(4, 2, 1)$ and $(\bar{4}, 1, 2)$ respectively. [Note that there are 16 (15+1) chiral fields per generation; the model predicts a SM singlet often referred to as a right handed neutrino.]
- a) Use simple arguments to show that the smallest monopole charge is two Dirac units.
Are exotic states possible in this setup?
- b) Suppose H is embedded in $SO(10)$ GUT, such that $SO(10) \rightarrow H \rightarrow \text{Standard Model}$.
~~Prove~~ Show that the breaking of $SO(10)$ to H also produces monopoles?

3) Consider $m^2 \phi^2$ chaotic inflation such that $m \sim 10^{13} \text{ GeV}$.

Suppose ϕ decays into fermions via the Yukawa coupling

$g \bar{\psi} \psi \phi$, with $g \sim 10^{-3}$.

Show that the reheat temperature after inflation

is of order 10^{13} GeV .