

Introductory Astronomy

Week 8: Cosmology

Clip 12: Inflation

Inflation

- A solution proposed by Guth 1980
- In early times $t \sim 10^{-36}$ s exponential expansion by many orders of magnitude
- Our particle horizon is small part of preinflation horizon
- Entire observable universe was inside preinflation horizon
- Exponential inflation drives Ω to one

$$H^2(\Omega - 1) = \frac{kR_0c^2}{a^2}$$

- Relics diluted by inflation

Inflating the Universe

- How to turn Λ on and then off?
- Tunable vacuum energy density occurs in GUTs
- As universe cools can get trapped in false vacuum triggering inflation
- At the end of inflation decay reheats universe
- Problems at the end of inflation resolved by new inflation in which inflationary era is slow roll to damped oscillations
- Chaotic inflation replaces phase transition with quantum fluctuation

Eternal Inflation

- Recent theoretical ideas favor **eternal inflation**
- Universe has **large** vacuum energy – expands exponentially
- Small regions can reach vacua with **smaller** vacuum energy.
- These small regions undergo **inflation** with subsequent **decay** to state with zero (or small) vacuum energy
- Expanding **less** than rest of space – disappear
- Leads to many **disconnected** patches: multiverse

Is This Real?

- Exponential inflation can freeze fluctuations whose size inflated outside horizon
- These form seeds for structure formation leading to clusters and galaxies
- Models predict structure of perturbations leading to predictions for inhomogeneity