

Monday, November 26, 2007

Vilenkin Part II

Agenda

- Announce:
 - Project “Reports” due Thursday
 - Read Part III
- Review the Big Bang
- Part II

Review

- How do we “look back” in time?
- Where do the particles come from?
- What’s the horizon problem?
- What does inflation solve?
- What evidence do we have for inflation?
- What problems remain w/ inflation?
- What aspects of all this are mostly universally accepted?

Review: Structure Formation as understood in Inflation

- Scalar field (inflaton) gets random, quantum “kicks”
 - In some places, kick ends inflation earlier
 - In some places, kick ends inflation later
- Kicks move scalar field small distance on its path rolling down hill
- Kicks are small compared to the force rolling the field down the hill
- Therefore:
 - Everywhere ends inflation at about the same time
 - Places kicked backward have small “density perturbation” with larger density than average

Eternal Inflation

- When field is at the top of the hill, different regions of space will get to the steep part at different times
 - Some regions stop inflating *long* before others...this contrasts with small perturbations of structure formation
 - Regions where inflation ends, called island universes
 - Separated from other islands from still inflating regions
 - Inflation always occurring somewhere
 - We live in one such island universe
 - Inflation has ended
 - False vacuum energy decayed into heat & particles...Big Bang
 - If we could somehow see beyond our horizon (can't), would find inflating regions with other island universes beyond

Crazy fanciful ideas

- Need some false vacuum that has never been observed
- Most models use a scalar field never observed
- Fair amount of freedom specifying the hill that it gets to roll down
- Possibly predicts existence of other universes we have no hope of observing
- But...

Discovery of Acceleration of Universe

- In 1998, two teams examined distant supernova and measured
 - How far away they are
 - How fast they're moving
- Measured the expansion of the universe for very distant times
- Expected to see slow down from gravity
- Instead, *both* teams observed...speed up!

Universe & Dark Energy

- Supernova data supports idea of a cosmological constant
- Further supported by CMBR analysis and other
- 70% of Universe is so-called dark energy

Structure of Eternal Inflation

- Outer regions of island universe continue inflating forever
- From within an island universe, this "forever inflation" appears as infinite in space
- "whole" universe can be finite or infinite

Strange Implications of Eternal Inflation

- An infinite number of island universes
- Each island universe contains a finite amount of information/# of states
- Hence, multiple copies of our Universe can be found!