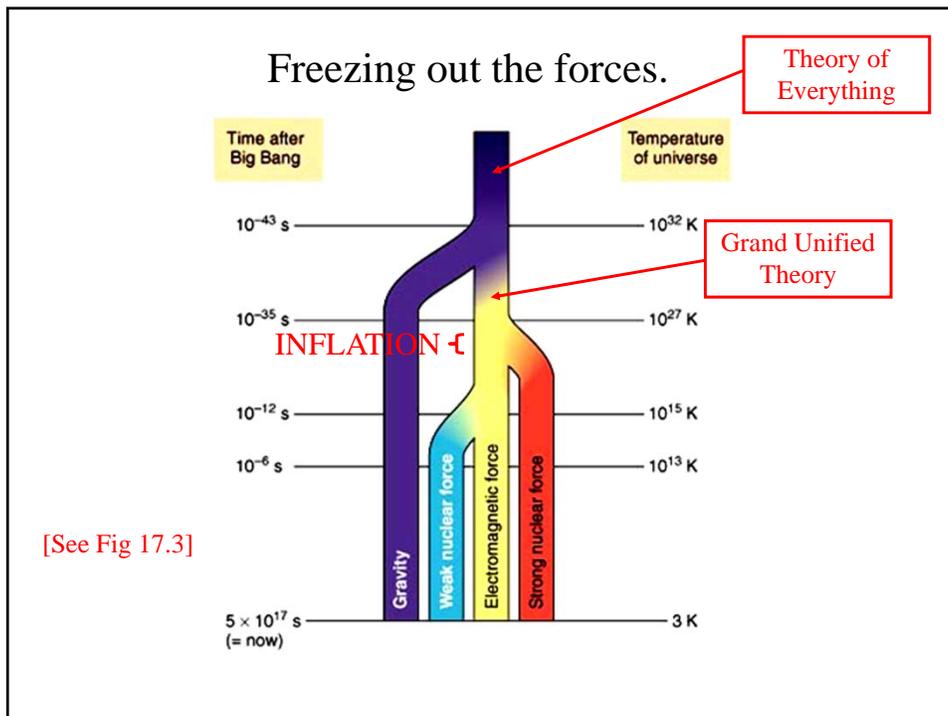
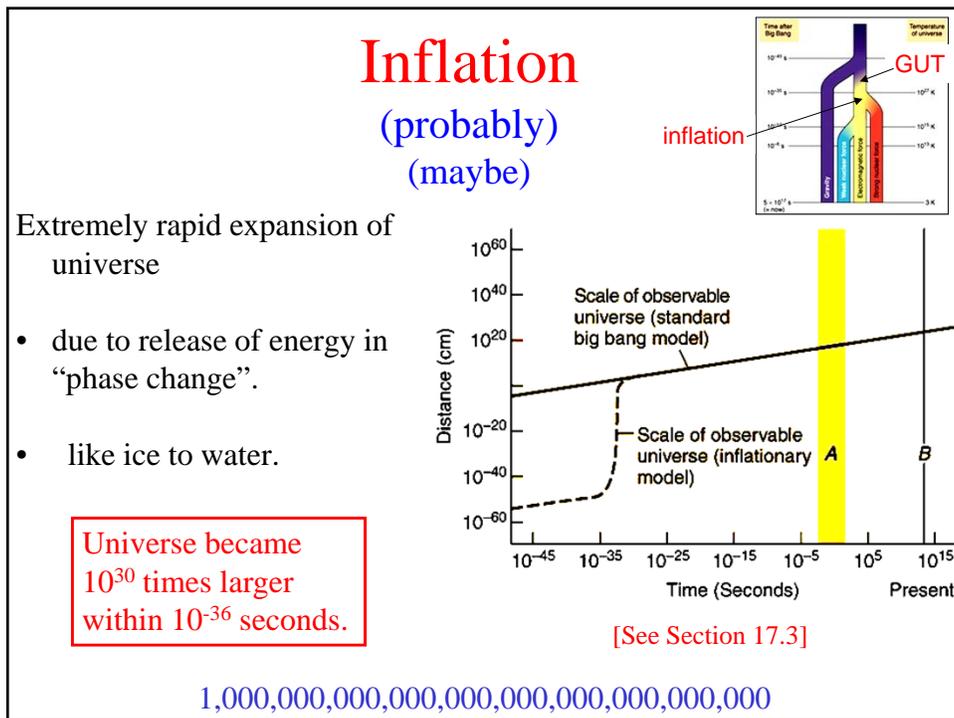
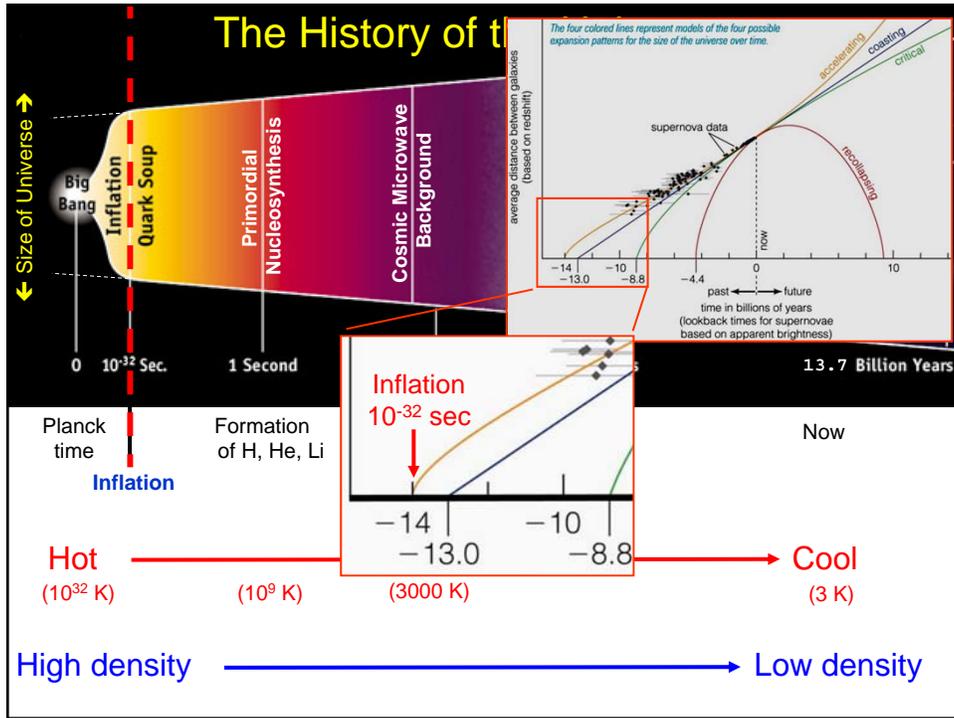


- Observatory open house: 9-11PM this Fri/Sat evenings
 - Only if the sky is clear.
- Please.. rate this course (2 surveys):
 - <http://rateyourclass.msu.edu>
 - ISB/ISP Post-Course Survey
 - Angel > ISB/ISP Surveys > Surveys tab > Spring 2012 Post-course Survey folder
 - Complete by midnight Friday April 27 for 3 extra-credit pts.
 - I will not see your answers.
- Study guide for final now available on web.
 - + use study guides for Midterms 1-3
- Review Session: Thursday May 3, 12:30, this room.
- **Final Exam: Friday May 4, 10AM - noon**
 - BPS 1410 (the usual classroom).
 - 51 questions, 1/3 cumulative, 2/3 over material since Midterm 3.
 - **SIT IN YOUR USUAL ASSIGNED ROW!**

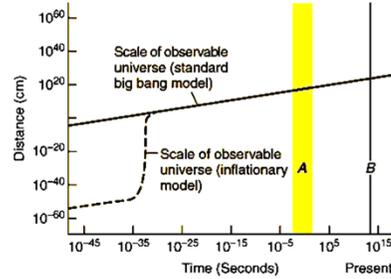
Office hours:
 Kristen (TA):
 - today 11:10-12:10
 - Wed 4-5
 Me:
 - Tu 2-3
 - or by appointment



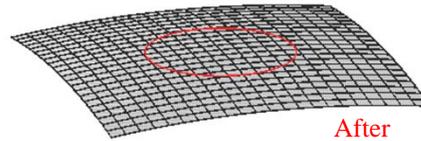


What does inflation predict for geometry of present universe?

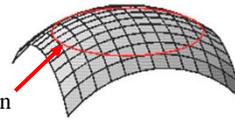
Universe became 10^{30} times larger within 10^{-36} seconds.



- Answers question: *Why* is the universe flat?
 - It is bound to look that way over the small portion we can see.
- Solves other “problems” too.

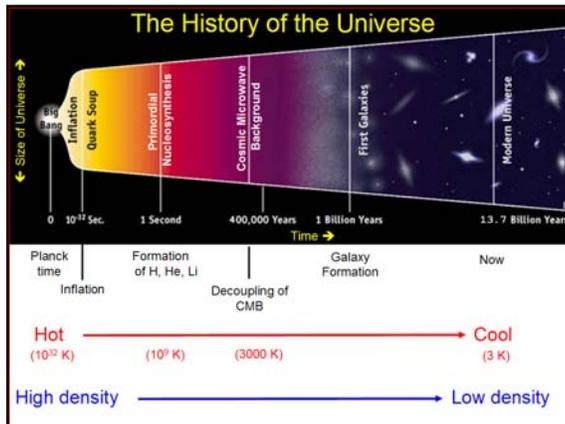


After Inflation



Before Inflation

Red circle = horizon

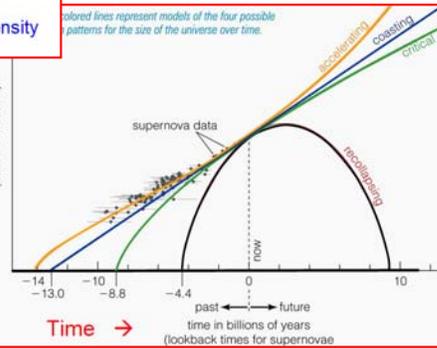


IT WILL EXPAND FOREVER

(or at least almost forever)

Scale Factor $R(t)$

average distance between galaxies (based on redshift)



The End of the Universe

Continued expansion, forever... (we think).

- 10^{10} yrs. Current age of universe. (13.7 billion yrs)
- 10^{14} yrs. Stars use up last nuclear fuel.
- $10^{14} - 10^{37}$ yrs. Degenerate Era
 - 88% white dwarfs, 10% brown dwarfs, 2% neutron stars + black holes.
- $10^{37} - 10^{100}$ yrs: Black Hole Era
 - Degenerate stars have disappeared through proton decay (maybe)
 - Dark matter annihilated (??????)
 - Only black holes left, but they also evaporate.
- After 10^{100} yrs: Dark Era
 - Essentially nothing left except hugely redshifted CMB photons.

wild
speculation



(See *Sky & Telescope* magazine, August 1998)

What's outside the Universe?

- Other universes, not intersecting with our Universe??
- Some magic numbers:
 - At $t = 1$ second, our Universe defined by:
 - Ratios of
 - Energy Density. Matter:Kinetic-energy:Cosmological-constant-energy.
 - Numbers of particles. Photons:Normal-matter:Dark-matter
 - Amplitude of density fluctuations $\sim 10^{-5}$
 - Imprinted by Planck Time: ratios of physical constants.
 - Example: electrostatic force 10^{36} x stronger than gravitational force.
 - Different values in other universes?
- **Anthropic Principle:** our particular universe is suitable for us to live in because otherwise we would not be alive to know about it.