Recitation 12
Week of 5 December 2011

Topics Covered on Exam 3:

- Inside an event horizon – positivists, idealists, cosmic censorship conjecture, naked singularities, why it is worth studying and predictions
- Exotic Matter
- Horizon Area Increase Theorem (what causes horizon’s to increase?), Entropy and the 2nd Law of Thermodynamics
- Hawking Radiation and formula

\[ t = \left( \frac{8.407 \times 10^{-26} \text{ sec}}{\text{gm}^3} \right) M^3 \]

Time it takes for a black hole of mass, \( M \), to evaporate due to Hawking Radiation

- Wormholes and Wormhole Time machines - including those in Contact, The Black Hole, Star Trek DS( and Star Trek (2009)- stability, appearance, practicality
- Homogeneity and Isotropy of the Universe
- Expansion of the Universe, Hubble’s Law and the Hubble Constant

\[ V = H_0 D \quad \text{where} \quad H_0 = 20 \, \text{km/sec/Mly} \]

(recall: Doppler Shift)

\[ V = c \left( \frac{\lambda}{\lambda_0} - 1 \right) \quad \text{or} \quad \lambda = \lambda_0 \left( 1 + \frac{V}{c} \right) \]

- Models of the universe – a.k.a. the works of Einstein, Friedman, Robertson, Walker, Lemaitre, Gamow and others
- The people who contributed to our understanding of our universe – Hubble, Penzias and Wilson, Ryle et al.
- The Cosmological constant
- The Big Bang - Observational Evidence
- Inflation
- The model of our Universe and why we believe it
Problems:

1. Say we were able to contact a species in another universe similar to ours. They reported that the Hubble constant in their universe was one half the Hubble constant in our universe.
   a) Using their value of the Hubble constant, what is the age of their universe?
   b) By what factor is their universe older than our universe?

2. You are home for Winter Break strike up a conversation with an old friend about all the cool stuff you learned about the universe in AST 102. Your friend has recently seen a special talking about the Cosmic Microwave Background Radiation. Help your friend reach a better understanding of the universe by explaining some things they did not quite understand.
   a) They explain, “So I understand the CMBR has been measured to be very uniform corresponding to emission from a blackbody with a uniform temperature of about 4000 K. But what I don’t get is how a hot (4000 K) body would have emission peaking at such a long wavelength. How can this be?”
   b) “I also heard that the Cosmic Microwave Background is virtually isotropic, meaning that it looks pretty much same in any direction we look. How can this radiation that surrounds us in far away parts of the universe be so similar?”