General Astronomy - Spring 2007
Home work #12 - Due May 4

1. What is the Copernican principle?

That we do not occupy a special place in the Universe, and, more generally, that the Universe is homogeneous when examined on sufficiently large scales.

2. If the Hubble constant were found to be 120 km/s/Mpc, what would be the critical density of the Universe?

The critical density is given by

$$\rho_C = \frac{3}{8\pi G} H_0^2$$

For the commonly accepted value of the Hubble constant of $H_0^2 = 72$ km/s/Mpc, the critical density is $\rho_C = 9.7 \times 10^{-27}\,\mathrm{kg\,m^{-3}}$. For a value of 120 km/s/Mpc, the new value of ρ_C would be

$$\rho_C = (9.7 \times 10^{-27}\,\mathrm{kg\,m^{-3}}) \left(\frac{120}{72}\right)^2 = 2.7 \times 10^{-26}\,\mathrm{kg\,m^{-3}}$$

3. When the Universe was 0.1 seconds old, there were no protons. Explain why.

The Universe was too hot for protons to exist. The very high kinetic energies of the quarks which make up protons overwhelmed the attractive force which binds quarks into protons.

4. How were the photons in cosmic microwave background produced?

The photons we see as the cosmic microwave background were produced when the Universe changed from being opaque to being transparent. This occurred at a temperature around 3740 K when the ionized plasma of separate electrons and protons combined into Hydrogen atoms.

5. How can dark energy be distinguished from normal matter?

Dark energy causes the expansion of the Universe to accelerate. All normal forms of matter and energy cause the expansion to decelerate.