Astro 242: Problem Set 8

Due Mar 7

1 Problem 1: Predict the CMB Temperature

- Assume that deuterium forms when the background temperature is $T = 10^9$K. Require that neutron capture be efficient enough to form light elements but not so efficient as to leave no deuterium so that $\langle \sigma v \rangle n_b / H \sim \langle \sigma v \rangle n_b t \sim 1$. (a) With $\langle \sigma v \rangle = 4.6 \times 10^{-20}$ cm^3 s^{-1}, and the age of the universe at $T = 10^9$K (calculated from assuming the photons and neutrinos are the dominant contributors to the Friedmann equation) estimate the baryon density n_b under this condition. (b) Assuming a current baryon number density corresponding to $\Omega_b h^2 = 0.02$, what is the scale factor at $T = 10^9$? (c) What is the temperature of the background today?