General Relativity Ph236b

Problem Set 6

Due: In class, February 14, 2005

Suggested Reading: "Theory of CMB Polarization," P. Cabella and M. Kamionkowski, http://arxiv.org/abs/astro-ph/0403392.

1. Exercise 8 in the suggested reading.

2. From the discussion in Section 7 of the suggested reading, show that the intensity pattern $I_\nu(\theta,\phi)$ can always be written as

$$I_\nu(\theta,\phi) \propto \frac{1}{e^{h\nu/kT(\theta,\phi)}-1};$$

   in other words, show that angular variations in the intensity always appear as angular variations in the temperature. (Note that the factor $dh/d\nu$ on the right-hand side of the first of Eqs. (105) should be $dh/d\eta$.)

3. Exercise 11 (the first one in the suggested reading, on page 22).

4. Exercise 11 (the second one in the suggested reading, on page 25). You should begin, as suggested, there, by first showing that the 1σ cosmic-variance error with which each C_l^{TT} can be measured is $\sqrt{2/(2l+1)}C_l^{\mathrm{TT}}$. To do this, you will need simply to know that each a_{lm} is chosen from a Gaussian distribution with variance $\langle |a_{lm}|^2\rangle = C_l^{\mathrm{TT}}$.