

## 219T Assignment - Week 9

**Reading Assignment Abbreviations:** L= Liddle; **H&H** = Hawley & Holcomb; **JL** = Jones & Lambourne

**Topic: Structure in the Universe**

**Reading:**

L: A5.1-3; **H&H:** 15, starting at p. 447; **JL:** Ch. 6.6-7

**On the Course Links page:**

Intro to the CMB

Boomerang Image

Large Scale Structure (numbers refer to those in upper right – NOT lower right, beginning with 8- )  
1-20; 50-end

**A. PROBLEMS** Answer the following questions and explain all your steps.

1. When the universe grows to twice its current size, what will the temperature of the background radiation be?
2. What is the significance of the dipole anisotropy in the cosmic microwave background?
3. For the dipole anisotropy, the fractional increase in temperature,  $\Delta T/T$  is equal to  $-v/c$ , where  $v$  is our speed. Justify this relation using expressions for Wien's Law and the Doppler shift.
4. Why is it important to find small-scale anisotropies in the cosmic microwave background?

**H&H:** 15.1, 2, 4

**B. ESSAY – 3-4 pages**

Compare what we learn about cosmology from studying galaxies (and their constituent stars) with what we learn from the cosmic background radiation. Are both approaches necessary, i.e. could we know all that we know now by studying only one or the other? Why or why not?