PHY306 QUESTIONS FOR SMOOT ET AL 1992

Answer all questions. Some questions may require you to consult other sources: if so, remember to reference the sources used in standard style (see the Department's web page on "Plagiarism and Collusion" for instructions on referencing). Always use your own words, unless there is justification for a brief direct quote—if there is, use quotation marks. This exercise counts 5% towards your total module mark.

1. Smoot et al. explain that they measure the CMB at three wavelengths, 9.5, 5.7 and 3.3 mm, "chosen to be ... near the CMB maximum." Assuming a temperature of 2.74 K, what is the expected peak wavelength of the CMB? Why is it important to measure at multiple wavelengths? [2]

2. One of the two dominant features of the CMB temperature variation is a dipole anisotropy of about 10^{-3} in the direction $l = 265°$, $b = 48°$. Explain carefully what a "dipole anisotropy" is, and how this one is produced. [2]

3. Smoot et al. comment that much of the observed quadrupole signal in the data is probably of Galactic origin. One of the pieces of evidence they cite in support of this is that the quadrupole component Q_1 aligns very well with a cosec $|b|$ behaviour. Why might you expect this behaviour if the signal originates in the Galactic disc? [Hint: think about the path length through a disc of thickness h viewed at an angle b from a point in the central plane of the disc.] [2]

4. The emission from the Galactic plane is said to be dominated by synchrotron emission, free-free emission and dust emission. Explain how each of these components generates microwave radiation, and comment on the quoted frequency dependences. [6]

5. Discuss the implications of the results of this paper for cosmological models. Why is this result not sensitive to the overall curvature of the universe? [3]