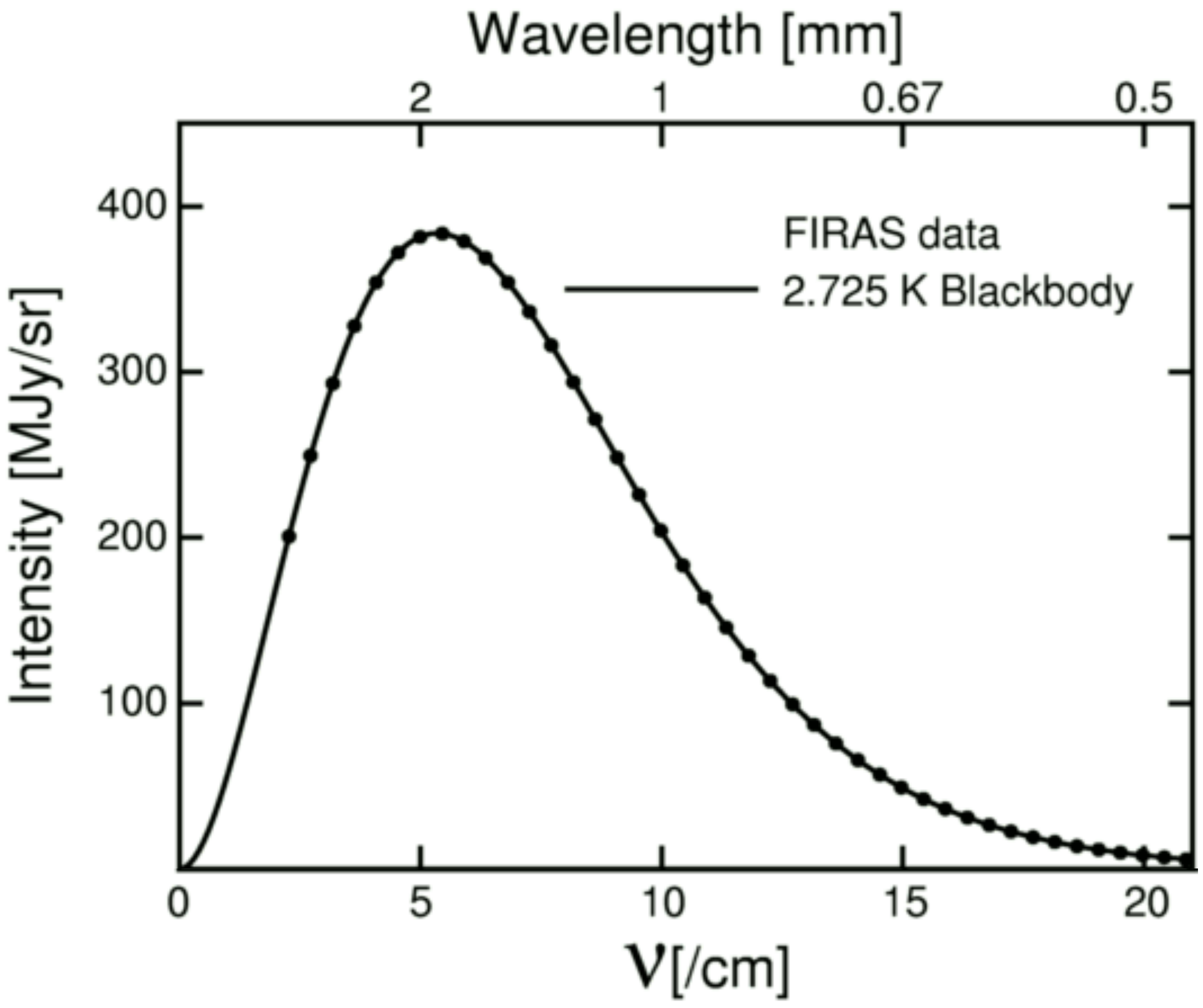
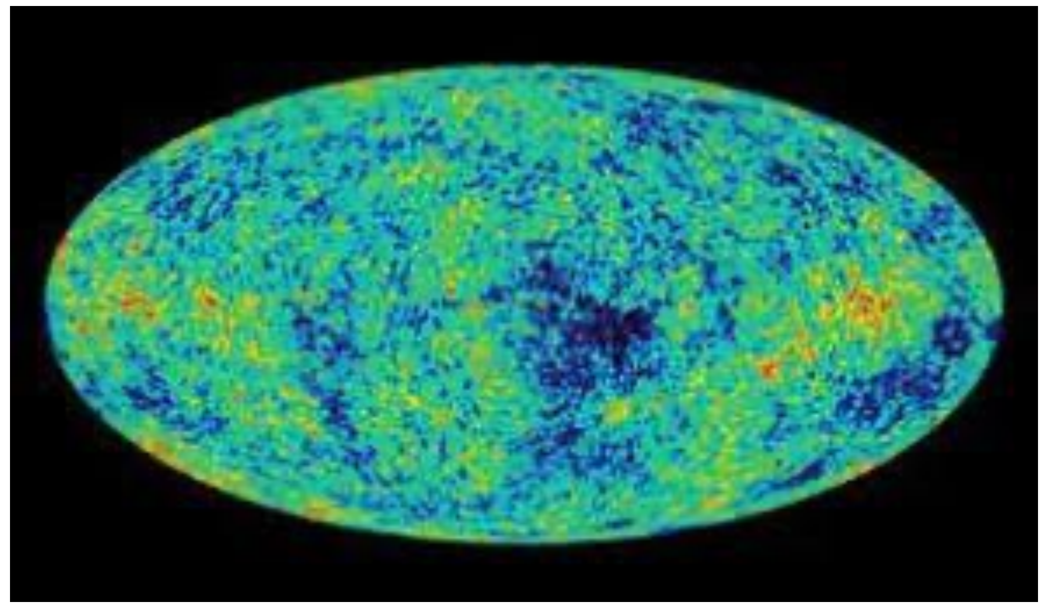
The cosmic microwave background





The intensity proportional to :

$$I \propto \frac{\nu^3}{e^{h\nu/k_B T} - 1}$$

The frequency is ν and $h\nu = \hbar\omega$

Problem 1. The most energetic frequency interval and wavelength interval

(a) The energy density can be written

$$u = \int_0^\infty d\omega \, \frac{du}{d\omega} \tag{1}$$

where $du/d\omega$ is the energy per frequency interval $d\omega$. Using a graphical means show $du/d\omega$ is maximum for $\hbar\omega = 2.82kT$. What is the energy of a photon with this frequency for a black body of 6000K, which is approximately the surface temperature of the sun.

(b) The energy density can be written

$$u = \int_0^\infty d\lambda \, \frac{du}{d\lambda} \tag{2}$$

where $du/d\lambda$ is the energy per wavelength inteval $d\lambda$. Find $du/d\lambda$, and using a graphical method find the wavelength where $du/d\lambda$ is maximum. (You should find $\lambda \simeq 4.9hc/kT$.) What is this wavelength in nm for a black body of 6000K, which is approximately the surface temperature of the sun.