Question Sheet: Radiation

1. At what wavelengths will the following lines be observed? (i) Line emitted at 5000 A by a star moving toward us at 100 km s^{-1}. (ii) The Ca^{+} line ($\lambda = 3970A$) emitted by a galaxy receding at 90,000 km s^{-1}.

2. Assume that Saturn subtends an angular diameter of $\sim 17''$ at the Sun. Let its distance from both the Earth and the Sun be considered to be 9.5 AU. If the light received from Saturn is 0.86×10^{-11} that received from the Sun, compute the reflection coefficient of Saturn's surface. Note that Saturn is known to shine primarly by reflection, since its moons cast a shadow on the surface when they pass between the planet and the Sun.

3. Show that the total luminous power P intercepted by Earth is

$$P = \pi R_{\rm Earth}^2 (L_\odot / 4\pi r^2) \ , \tag{1}$$

where $R_{\rm Earth}$ is the radius of Earth, $L_\odot = 3.9 \times 10^{33}$ erg/s the luminosity of the Sun and r the distance of the Earth from the Sun (1.50×10^{13} cm).

Taking into account the rotation of the Earth, what is the average energy flux $\bar{f}$ incident on Earth? Assume that only 61 percent of $\bar{f}$ is absorbed by Earth, the other 39 percent being reflected from cloudtops, the ground and the oceans. The former flux of light heats the surface to an average temperature T, and the Earth reradiates this energy effectively as a black body. Compute T. Is your answer reasonable? What explains the discrepency between T and the observed average temperature of 290 K?

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