702.

Problem 49.3 (RHK)

Calculate the wavelength of the maximum spectral radiancy and identify the region of the electromagnetic spectrum to which it belongs for each of the following: (a) *The* 2.7-K *cosmic background radiation, a remnant of the primordial fireball*. (b) *Human body*, *assuming a skin temperature of* 34^0C. (c) *A tungsten lamp filament at* 1800 K. (d) *The Sun*, *at an assumed surface temperature of* 5800 K. (e) *An exploding thermo nuclear device*, *at an assumed fireball temperature of* 10^7 K. (f) *The universe immediately after the Big Bang*, *at an assumed temperature of* 10^{38} K. *We may assume cavity radiation conditions throughout*.

Solution:

The wavelength λ_{max} at which spectral radiation emitted at temperature *T* has its maximum is given by the Planck's formula

$$\lambda_{max} = \frac{2898\ \mu m.K}{T}$$

We will use this result for answering (a) to (f).

(a) $\lambda_{max} = \frac{2898\ \mu m.K}{2.7\ K}$ =1.073 mm, microwave region

(b) $\lambda_{max} = \frac{2898\ \mu m.K}{307\ K}$ = 9.439 μm, far infra red

(c $\lambda_{max} = \frac{2898\ \mu m.K}{1800\ K}$ = 1610 nm, infra red

(d) $\lambda_{max} = \frac{2898\ \mu m.K}{5800\ K}$ = 499.6 nm, visible

(e) $\lambda_{max} = \frac{2898\ \mu m.K}{10^7\ K} = 2898\ 10^{-44}$ m = 289.8 pm,

gamma ray

(f) $\lambda_{max} = \frac{2898\ \mu m.K}{10\ K} = 2898\ X\ 10^{44}$ m, ultra-gamma ray

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