THE INTERNAL CONSTITUTION OF THE STARS

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CHAPTER XIII

DIFFUSE MATTER IN SPACE

The Temperature of Space.

256. The total light received by us from the stars is estimated to be equivalent to about 1000 stars of the first magnitude. Allowing an average correction to reduce visual to bolometric magnitude for stars of types other than F and G, the heat received from the stars may be taken to correspond to 2000 stars of apparent bolometric magnitude 1·0. We shall first calculate the energy-density of this radiation.

A star of absolute bolometric magnitude 1·0 radiates 36·3 times as much energy as the sun or $1{\cdot}37 . 10^{35}$ ergs per sec. This gives $1{\cdot}15 . 10^{-5}$ ergs per sq. cm. per sec. over a sphere of 10 parsecs ($3{\cdot}08 . 10^{19}$ cm.) radius. The corresponding energy-density is obtained by dividing by the velocity of propagation and amounts to $3{\cdot}83 . 10^{-16}$ ergs per cu. cm. At 10 parsecs distance the apparent magnitude is equal to the absolute magnitude; hence the energy-density $3{\cdot}83 . 10^{-16}$ corresponds to apparent bolometric magnitude 1·0.

Accordingly the total radiation of the stars has an energy-density

$$2000 \times 3{\cdot}83 . 10^{-16} = 7{\cdot}67 . 10^{-13} \text{ ergs/cm.}^3$$

By the formula $E = aT^4$ the effective temperature corresponding to this density is

$$3^\circ{\cdot}18 \text{ absolute.}$$

In a region of space not in the neighbourhood of any star this constitutes the whole field of radiation, and a black body, e.g. a black bulb thermometer, will there take up a temperature of 3°·18 so that its emission may balance the radiation falling on it and absorbed by it. This is sometimes called the "temperature of interstellar space."

It is possible, however, for matter which has strong selective absorption to rise to very much higher temperature. Attention was called to the possible astrophysical importance of this effect by C. Fabry*. Radiation in interstellar space is about as far from thermodynamical equilibrium as it is possible to imagine, and although its density corresponds to 3°·18 it is much richer in high-frequency constituents than equilibrium radiation of that temperature. It is convenient to exhibit this by stating for each wave-length λ an equivalent temperature T_λ such that the actual density

* *Astrophys. Journ.* 45, p. 269.