4.4: Flux

The word "flux" in the context of stellar atmosphere theory differs from the "flux" of standard terminology. The symbol used is F, occasionally but not always printed in a special font. Let us imagine a horizontal surface embedded somewhere in a stellar atmosphere. It is being irradiated from below and above, but rather more from below than from above. Let us concentrate our attention for the time being on the radiation that is coming up from below. The rate of arrival of radiant energy per unit area from below from all directions would, in "standard" nomenclature, have been called the irradiance. After passage through the surface, it would be called the exitance. Now, using the nomenclature of stellar atmosphere theory, we call the rate of upward passage of radiant energy per unit area through a horizontal surface within the atmosphere the *upward* or the *outward flux*. The symbol is F_+ (sometimes printed in a special font), and the SI units would be $\mathrm{W\ m^{-2}}$. Likewise, the rate of passage of radiant energy per unit area from above to below is the *downward* or *inward flux*, F_-. The net upward flux is

$$F = F_+ - F_-. \tag{4.4.1}$$

If you are standing upright, F_+ is the irradiance of the soles of your feet, while F_- is the irradiance of the top of your head. If we measure the spherical angle θ from a downwardly-directed z-axis, then, following equation 1.14.5, we have

$$F_+ = \int_0^{2\pi}\int_0^{\pi/2} I(\theta,\phi)\cos\theta\sin\theta\,d\theta d\phi \tag{4.4.2}$$

$$F_- = \int_0^{2\pi}\int_{\pi}^{\pi/2} I(\theta,\phi)\cos\theta\sin\theta\,d\theta d\phi \tag{4.4.3}$$

$$F = F_+ - F_- = \int_0^{2\pi}\int_0^{\pi} I(\theta,\phi)\cos\theta\sin\theta\,d\theta d\phi, \tag{4.4.4}$$

which is sometimes written for short

$$F = \int_{4\pi} I\cos\theta\,d\omega \tag{4.4.5}$$

or just

$$\int I\cos\theta\,d\omega \tag{4.4.6}$$

At the surface of the star (if there is such a thing!) $F_- = 0$, so that $F = F_+ = \pi I$. This is the same as equation 1.15.2. At the centre of the star, I is isotropic and $F = 0$.