5.8: Source function in scattering and absorbing atmospheres

Suppose that at some point in a stellar atmosphere the mean specific intensity per unit frequency interval surrounding it is J_ν. If all of the radiation arriving at that point is isotropically scattered, the emission coefficient j_ν will simply be $\sigma(\nu)J_\nu$. But from equation 5.6.1 we see that in a purely scattering atmosphere, the ratio of j_ν to $\sigma(\nu)$ is the source function. Thus we see that, for an atmosphere in which the extinction is due solely to scattering, the source function is just

$$S_\nu = J_\nu. \tag{5.8.1}$$

If on the other hand the extinction is all due to absorption, we have $S_\nu = j_\nu/\alpha(\nu)$. If we multiply top and bottom by dx, the numerator will be dI_ν, the increase in the specific intensity in a distance dx, while the denominator is the absorptance in a layer of thickness dx. Thus the source function in a purely absorbing atmosphere is the ratio of the specific intensity to the absorptance. But this ratio is the same for all surfaces, including that of a black body, for which the absorptance is unity. Thus in an atmosphere in which the extinction is due solely to absorption, the source function is equal to the specific intensity (radiance) of a black body, for which we shall use the symbol B. For a purely absorbing atmosphere, we have

$$S_\nu = B_\nu. \tag{5.8.2}$$

In an atmosphere in which extinction is by both scattering and absorption the source function is a linear combination of equations 5.8.1 and 5.8.2, in proportion to the relative importance of the two processes:

$$S_\nu = \frac{\alpha(\nu)}{\alpha(\nu)+\sigma(\nu)} B_v + \frac{\sigma(\nu)}{\alpha(\nu)+\sigma(\nu)} J_\nu \tag{5.8.3}$$