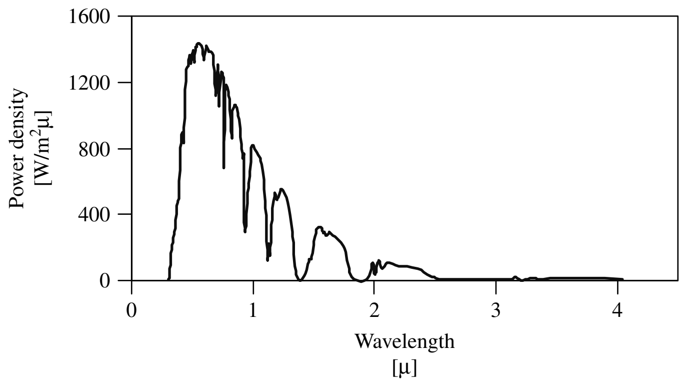

Figure 20.9 *AM* 1.5 solar spectrum, for an irradiance $G = 1000$ W/m^2

When solar radiation enters the Earth's atmosphere, not only the irradiance but also the spectral content is affected. Figure 20.9 shows the *AM* 1.5 spectrum, which is considered for standard test of PV devices. Figure 16.1 shows other spectra for comparison. In general, increasing air mass displaces the solar spectrum towards the red. This is why the sky becomes so nice at nightfall.

Of course, PV devices are sensitive to the spectrum, as discussed in Chapters 3, 9, 12 and 16. However, this is of little importance from the PV engineering point of view, compared to changes in total radiation incident on the PV modules. Because of that, in what follows, we will omit the detailed treatment of the spectral composition of sunlight. Additional comments will be given later on in this chapter.

20.4 SOLAR RADIATION DATA AND UNCERTAINTY

The amount of global radiation that reaches the receiver is extremely variable. On the one hand, even the extraterrestrial radiation experiences regular daily and yearly variations due to the apparent motion of the sun. These variations are predictable and can be theoretically determined just by geometrical considerations. For example, the extraterrestrial irradiance over a horizontal surface is given by

$$B_0(0) = B_0\varepsilon_0 \cos\theta_{ZS} \tag{20.14}$$

which when integrated over the day, leads to [6]

$$B_{0d}(0) = \frac{T}{\pi} B_0\varepsilon_0 \left[-\frac{\pi}{180}\omega_S \cdot \sin\delta \cdot \sin\phi - \cos\delta\cos\phi\sin\omega_S \right] \tag{20.15}$$

where T is the day length, that is, 24 h. The monthly average of this quantity, named $B_{0dm}(0)$, is of particular practical importance. Obviously

$$B_{0dm}(0) = \frac{1}{d_{n2} - d_{n1} + 1} \sum_{d_{n1}}^{d_{n2}} B_{0d}(0) \tag{20.16}$$