$D(\beta, \alpha)$ and $R(\beta, \alpha)$, respectively. Once these are known

$$G(\beta, \alpha) = B(\beta, \alpha) + D(\beta, \alpha) + R(\beta, \alpha) \tag{20.27}$$

#### 20.5.3.1 Direct irradiance

Straightforward geometrical considerations lead to

$$B(\beta, \alpha) = B \max(0, \cos\theta_S) \tag{20.28}$$

where $B$ is the direct irradiance falling on a surface perpendicular to the sun's rays, and $\cos\theta_S$ is the angle of incidence between the sun's rays and the normal to the surface, given by equation (20.9). $B$ can be obtained from the corresponding value on a horizontal surface

$$B = \frac{B(0)}{\cos\theta_{ZS}} \tag{20.29}$$

Note that when the sun is illuminating the back of the surface (for example, during all morning on a vertical surface oriented to the west) $|\theta_S| > \pi/2$. Then, $\cos\theta_S < 0$ and $B = 0$. This way, the factor $\max(0, \cos\theta_S)$ reflects that the irradiance incident on the back surface of PV modules is normally not utilised.

#### 20.5.3.2 Diffuse irradiance

We can assume that, when the sun is occulted, the sky is composed of elemental solid angles, such as $d\Omega$ (Figure 20.14) from which a diffuse radiance $L(\theta_Z, \psi)$ is emanated towards the horizontal surface. The term radiance is taken to mean the flux of energy per unit solid angle crossing a surface normal to the direction of the radiation. It is expressed in W/m$^2$.steradian.

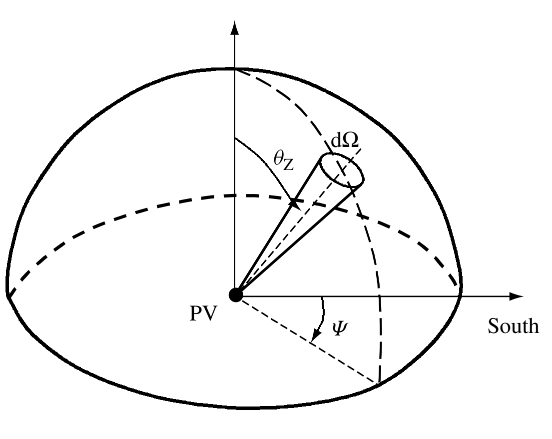


**Figure 20.14** Angular co-ordinates, $\theta_Z$ and $\psi$, of an elemental solid angle of the sky