2.8: Intensity

The *intensity* of a source in a given direction is the power radiated per unit solid angle about the specified direction, *i.e*.

$$I = dP/d\omega. \tag{2.8.1}$$

The SI units are watts per steradian (W sr^{-1}). The intensity of an element of area is the product of its radiance and its *projected* area., and the intensity of a surface in a given direction is the integral of the radiance over the projected area of the surface. As an example, the shape of an irregularly shaped asteroid can be approximated as a set of connected planar triangular facets; two such facets are shown in figure 1.

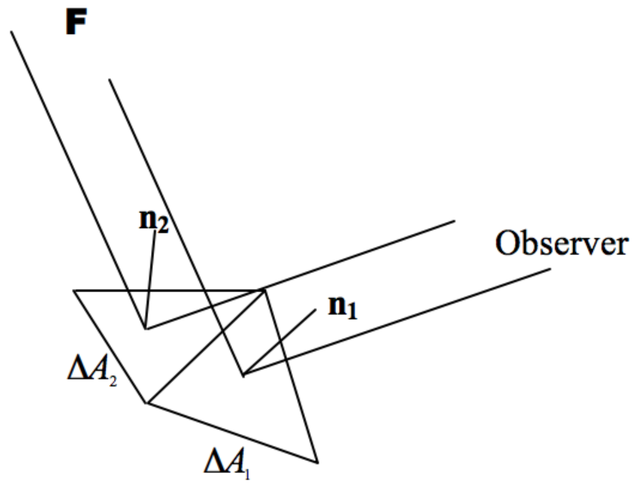

Fig.1.

For each facet of area ΔA_k the contribution to the intensity in the direction of the observer is

$$\Delta I_k = L_{obs,k} \Delta A_k \cos\theta_k \tag{2.8.2}$$

where θ_k is the angle between the surface normal vector $\mathbf{n}_k$ and the (fixed) direction to the observer. The total intensity (in the direction toward the observer) of the asteroid is then

$$I = \sum_{k=1}^{N} \Delta A_k \tag{2.8.3}$$

where N is the total number of facets both irradiated and visible to the observer.

Of particular interest is the intensity of a *sphere* as a function of solar phase angle α. If we consider a sphere of radius α centred in an O*xyz* frame with directional spherical coordinates (Θ, Φ) irradiated from the *x*-direction with flux density **F**, an element of surface area is $\alpha^2 \sin\Theta d\Theta d\Phi$ and its projected area in the direction μ is $\mu\alpha^2 \sin\Theta d\Theta d\Phi$.

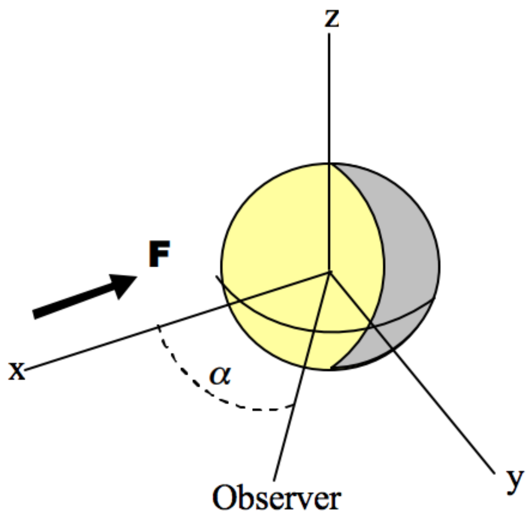

Fig. 2.

The irradiance of a point (α, Θ, Φ) of a point on the surface is $E = \mathbf{F}\mu_0$, where it may be shown that

$$\mu_0 = \sin\Theta\cos\Phi, \tag{2.8.4}$$

and for an observer at phase angle α in the *xy*-plane

$$\mu = \sin\Theta\cos(\alpha - \Phi), \tag{2.8.5}$$

in which case the intensity as a function of phase angle is given by

$$I(\alpha) = \alpha^2\mathbf{F}\int_{\alpha-\pi/2}^{\pi/2}\int_0^{\pi} f_r\mu_0\mu\sin\Theta d\Theta d\Phi. \tag{2.8.6}$$

We will return to this equation, with more detail, in **§9**.