15.4.4 The Nishita-Nakamae model of sky light

The most natural light is commonly called **daylight** and is generally rendered by a combination of ambient light and directional light (sun). This approach does not correspond to reality as explained by Nishita and Nakamae (1986), who propose another approach. Daylight is modeled as a combination of direct sunlight (directional light) and **skylight**. Skylight is considered as emanating from the sky dome which surrounds the earth. The sky dome is treated as a hemisphere of very large radius. As the intensity of skylight (skylight luminance) is not uniform, Nishita and Nakamae divide the sky dome into bands, which themselves do not necessarily have uniform luminance.

The illuminance at a given point in the scene is a combination of light from the sky and light reflected from the ground and/or surrounding objects. Interreflection of light between objects in the scene must also be considered.

For unobstructed sky, the illuminance at a point **P** is calculated with the following assumptions:

1. **P** is considered as the center of the dome and the center of the coordinate system
2. The coordinate system is also defined so that **P** is in the XY-plane, which is horizontal
3. The XY-plane is also the base of the sky dome of radius r
4. N-band sources are defined by cutting the hemisphere by planes, including the X-axis
5. A band source k is characterized by its angle of elevation Ω_k (see Fig.15.11) and its width $2\Delta\delta$
6. Each band may be subdivided into sky elements; such an element has a constant luminance and may be considered as a point source $\mathbf{P}_s$
7. $\mathbf{P}_s$ is measured by two angles: the angle α from the X-axis to the sky element and the angle Ω from the XY-plane to the sky element

The illuminance $E_k(\alpha)$ due to the band source k between 0 and α may be calculated as follows:

1. For uniform sky (constant sky luminance L_0):

$$E_k(\alpha) = 0.5\, d_k (\alpha - \cos\alpha \sin\alpha) L_0 \tag{15.54}$$

with

$$d_k = \cos(\delta_k - \Delta d) - \cos(\delta_k + \Delta d) \tag{15.55}$$

2. For non-uniform sky :

$$E_k(\alpha) = d_k \int_0^\alpha L(\alpha,\delta_k) \sin^2\alpha \, d\alpha \tag{15.56}$$

where $L(\alpha,\delta_k)$ is the sky luminance at $\mathbf{P}_s$.

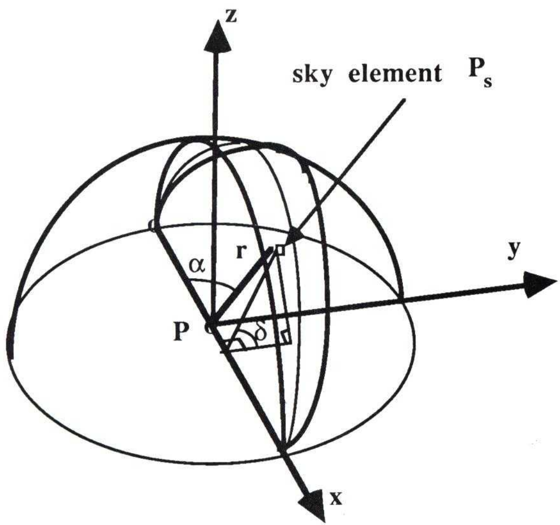

Fig.15.11. Model of the distribution of sky luminance

For obstructed sky, the illuminance by the source in the visible region between α_1 and α_2 is calculated as $E_k(\alpha_2) - E_k(\alpha_1)$. An algorithm for calculating the visible parts of the sky is described by Nishita and Nakamae (1986).

To take into account reflected light, Nishita and Nakamae assume that the illuminance of each face F is uniform. Therefore, the illuminance may be obtain by substituting L_0 in Eq. (15.54) to the luminance of F.