Radiometry
Radiometry

- Read Chapter 4 of Ponce & Forsyth
- Solid Angle
- Irradiance
- Radiance
- BRDF
- Lambertian/Phong BRDF
The solid angle subtended by an object from a point P is the area of the projection of the object onto the unit sphere centered at P.

- Measured in steradians, sr
- Definition is analogous to projected angle in 2D
- If I’m at P, and I look out, solid angle tells me how much of my view is filled with an object
Solid Angle

• By analogy with angle (in radians), the solid angle subtended by a region at a point is the area projected on a unit sphere centered at that point.

• The solid angle subtended by a patch area $dA$ is given by

$$d\omega = \frac{dA \cos \theta}{r^2}$$
Radiance

- Power is energy per unit time

- Radiance: Power traveling at some point in a specified direction, per unit area perpendicular to the direction of travel, per unit solid angle

- Symbol: \( L(x, \theta, \phi) \)

- Units: watts per square meter per steradian: \( \text{w/(m}^2\text{sr)} \)
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\[
L = \frac{P}{(dA \cos \alpha) d\omega}
\]

Power emitted from patch, but radiance in direction different from surface normal
Radiance transfer

What is the power received by a small area $dA_2$ at distance $r$ from a small emitting area $dA_1$?

From definition of radiance

\[
L = \frac{P}{(dA \cos \theta)d\omega}
\]

From definition of solid angle

\[
d\omega = \frac{dA \cos \theta}{r^2}
\]

\[
P = LdA_1 \cos \theta_1 d\omega_{1 \rightarrow 2}
\]

\[
= \frac{L}{r^2} \frac{dA_1 dA_2 \cos \theta_1 \cos \theta_2}{r^2}
\]
Irradiance

- How much light is arriving at a surface?
- Units of irradiance: Watts/m²
- This is a function of incoming angle.
- A surface experiencing radiance $L(x,\theta,\phi)$ coming in from solid angle $d\omega$ experiences irradiance $E(x)$:

$$E(x) = L(x,\theta,\phi)\cos\theta d\omega$$

**Crucial property:**

Total irradiance arriving at the surface is given by adding irradiance over all incoming angles:

$$\int \int L(x,\theta,\phi)\cos\theta d\omega$$

over the hemisphere

$$\int\int_0^{2\pi}\int_0^\pi L(x,\theta,\phi)\cos\theta \sin\theta d\theta d\phi$$