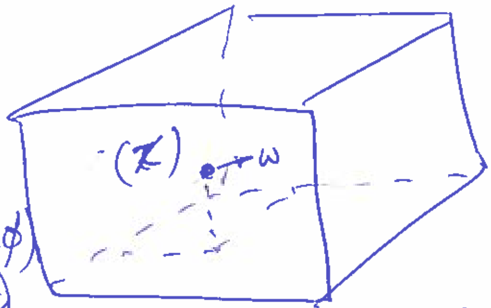
~~Hacking~~ Physics for Realistic CG

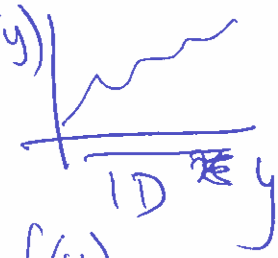
Radiance $\longrightarrow L(x, \omega)$ $\quad (L(x,\omega,\lambda))$

$W/m^2 sr$

~~directional~~

$x \to 3$, $\omega \to 2$ $\Rightarrow$ 5D



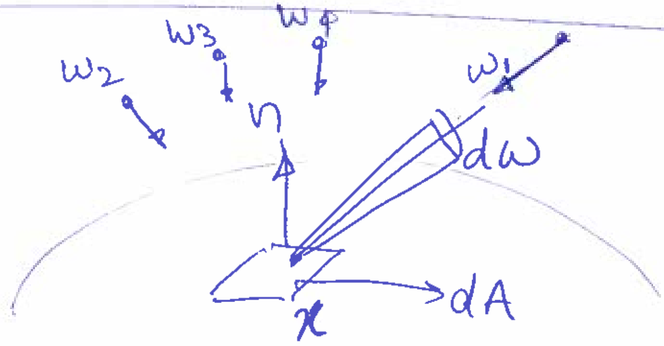


$f(y)$

Irradiance $E(x)$

W/m^2

~~not dn~~



$L(x, \omega_1)$

$(\omega \cdot n)_\perp = \begin{cases} 0 & \text{if } (\omega \cdot n) < 0 \\ \omega \cdot n & \text{otherwise} \end{cases}$

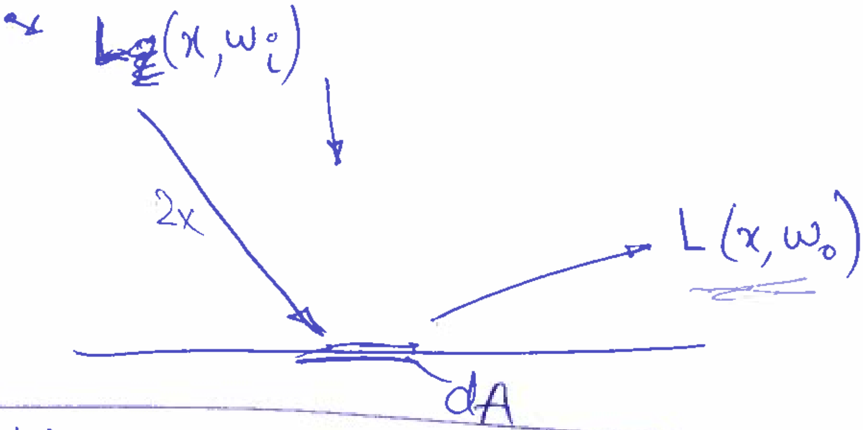
$$E(x) \approx L(x,\omega_1) \cdot d\omega \cdot (\omega \cdot n)_\perp$$

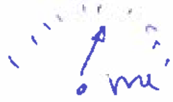
$$= \sum_{i=1}^{4} L(x,\omega_i)(\omega_i \cdot n)_\perp \, d\omega$$

$$E(x) = \int_{\Omega} L(x,\omega)\,(\omega \cdot n)_\perp \, d\omega$$

W/m^2 $\qquad \frac{W}{m^2 sr}$ $\qquad sr$

integrate over ω $\quad \frac{W}{m^2}$





Approximations

Reflection is linear

$dE_i(x)$ [$E(x) \propto L(x, w_o)$
due to
$L(x, w_i)$]

we know that $dE_i(x) = ?$ in terms of $L(x, w_i)$

$= L(x, w_i)(w_i \cdot n) \cdot dw$

& we know

$$\frac{L(x, w_o)}{dE_i(x)} = \boxed{f(w_i, w_o)}$$

material property

mirror $f(w_i, w_o) = 1$ only if w_i & w_o is refl of w_i

Diffuse object

$f(w_i, w_o) = k$

regardless of w_i & w_o

$f(\omega_i, \omega_o)$ → material property

function

dimensionality

$\Omega \times \Omega$

$2 + 2 = 4$

Bidirectional Reflectance Distribution Function

BRDF

Also depends on $\underline{x}$! $\;\underline{}$ 3D — 7D function

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Also depends on λ — 8D function

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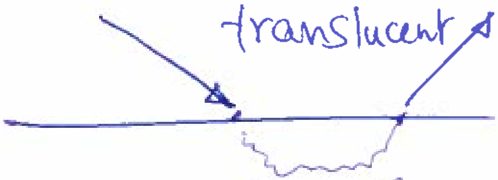
opaque

8D BRDF ✓

translucent



8D ~~BRDF~~

$$L(x,\omega_o) = \int f(\omega_i,\omega_o)\cdot dE_i(x)$$

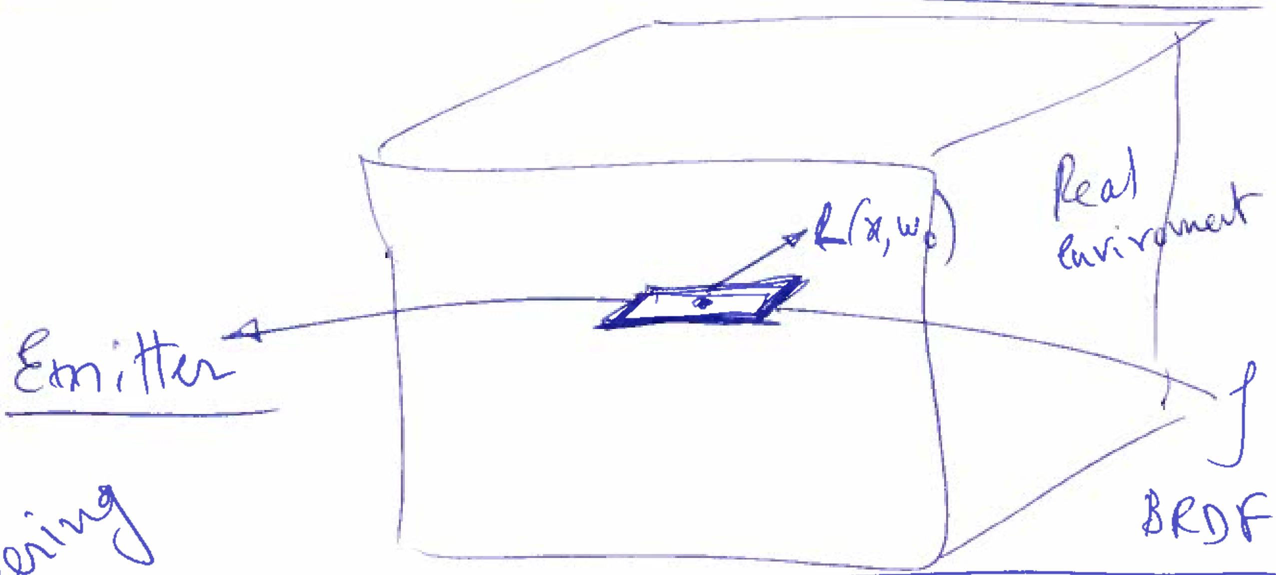
$$= \int f(\omega_i,\omega_o)\cdot L(x,\omega_i)(\omega_i\cdot n)_+ \cdot d\omega_i$$

$$\underline{L(x,\omega_o)} = \int_\Omega \underline{L(x,\omega)}\, f(\omega_i,\omega_o)(\omega_i\cdot n)\,d\omega$$

outgoing or refl. radiance

incident radiance

Reflectance Integral



The Rendering Equation

$$L(x,\omega_o) = L_e(x,\omega_o) + \int L(x,\omega)\, f(\omega,\omega_o)(\omega\cdot n)_+\, d\omega$$

Type

$$l(u) = e(u) + \int l(u,v)\cdot K(u,v)\cdot dv$$

Fredholm's Integral equation (2nd kind)