CS6630 Realistic Image Synthesis

Surface reflection

Steve Marschner

Fall 2022

Reflection overview

Lambertian surfaces

- diffuse reflectance

Specular surfaces

- specular reflectance

Nonlambertian reflection

- BRDF
- hemispherical reflectance

Illumination integrals

- solid angle
- area

Lambertian diffuse reflection

a number between 0 and 1

$$M_r = R_d E_i$$ ← radiant exitance is proportional to irradiance

$$M_r = \int_{H^2} L_r \, d\omega^\perp = \pi L_r$$ ← reflected radiance is constant in all directions

$$L_r = \frac{R_d}{\pi} E_i = k_d \int_{H^2} L_i(\omega) \, d\omega^\perp$$ ← fill in irradiance integral, define k_d

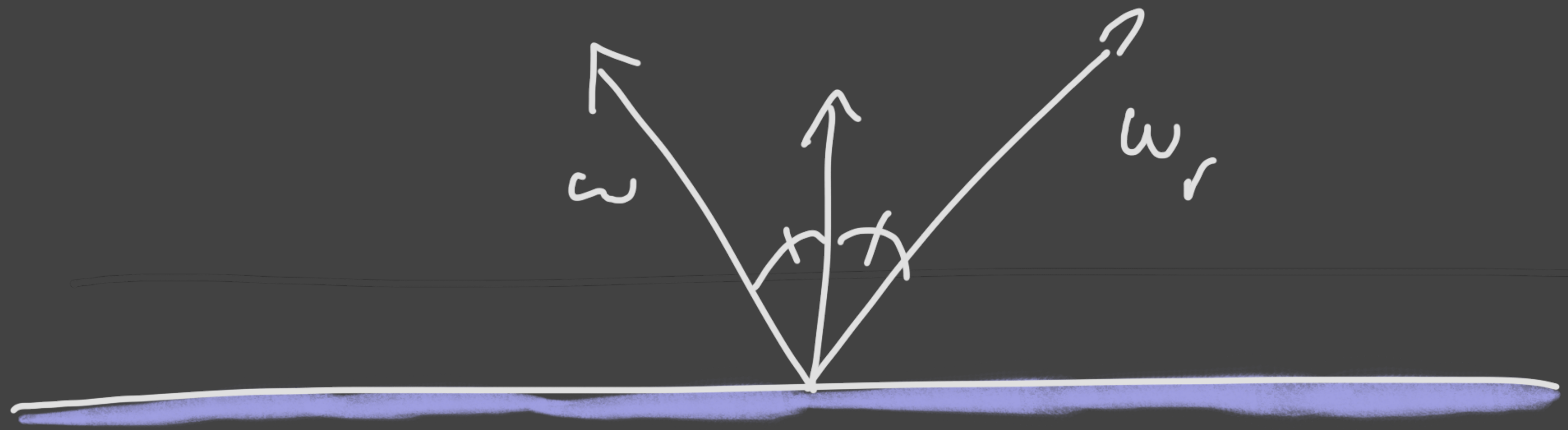
diffuse reflection coefficient can go outside integral
a number between 0 and 1/π

Specular reflection

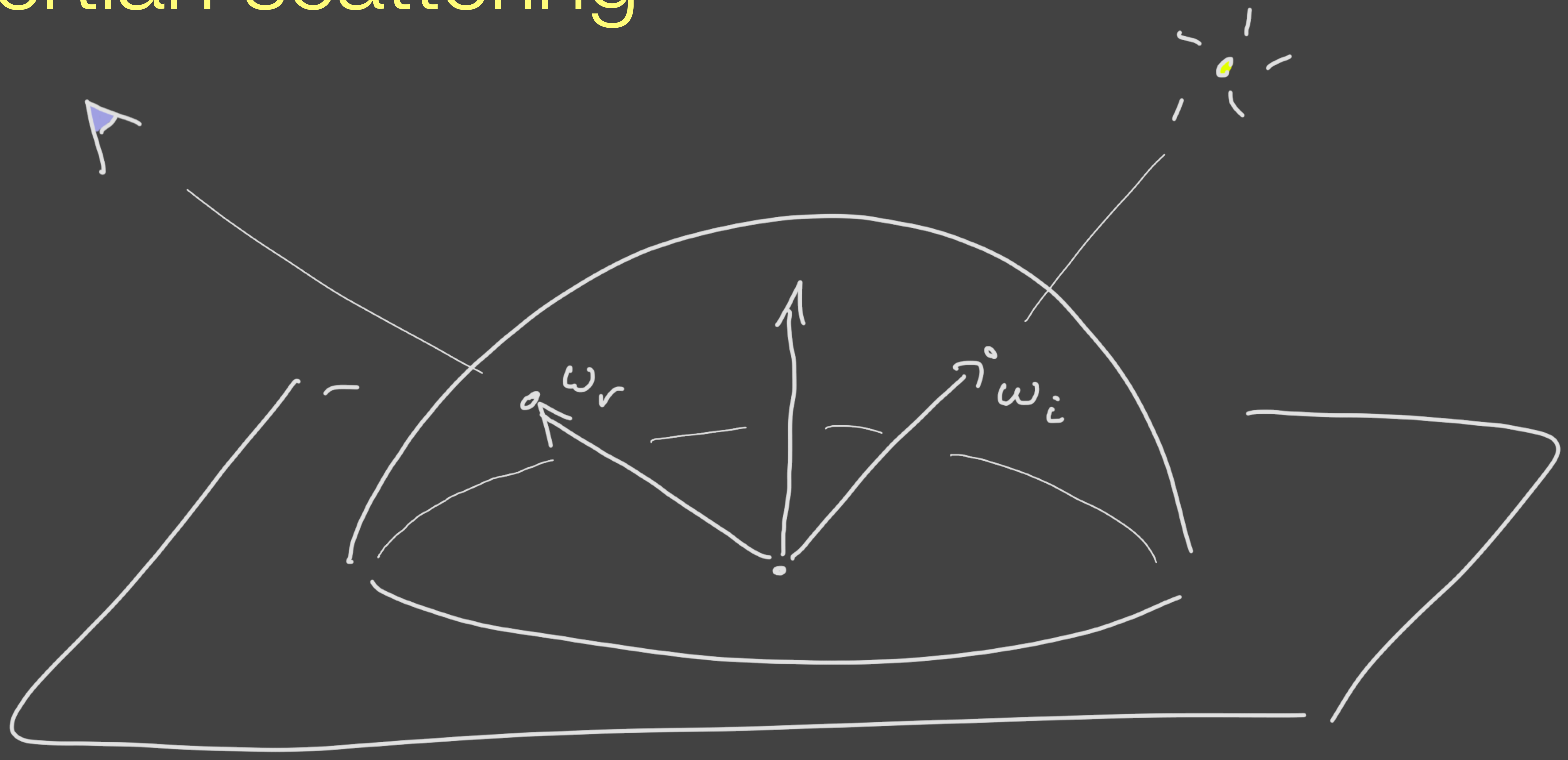
$$L_r(\omega) = R_s\, L_i(\omega_r)$$

↑

a number between 0 and 1



Non-lambertian scattering



$$L_r(\omega_r) = \int_{H^2} f_r(\omega_i, \omega_r)\, L_i(\omega_i)\, d\omega_i^\perp$$

now depends on direction

bidirectional reflectance distribution function now has to go inside integral

Constraints on BRDF

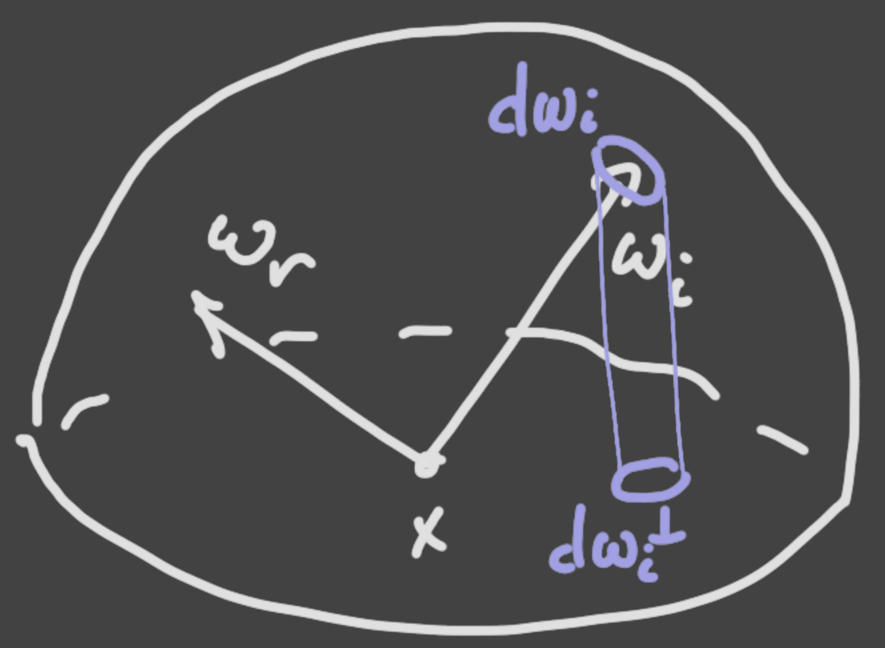
$$f_r(\omega_1, \omega_2) = f_r(\omega_2, \omega_1)$$

← reciprocity (paths can be reversed)

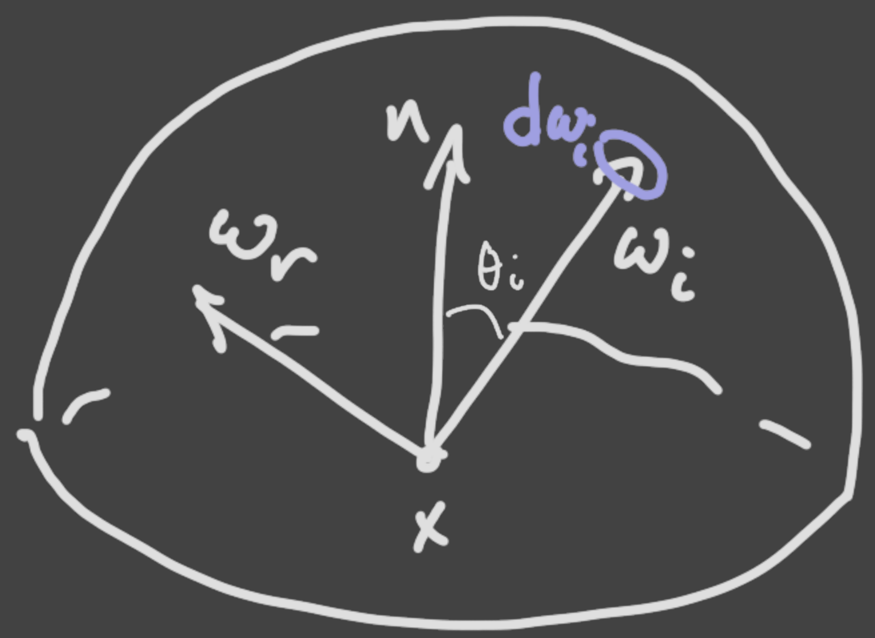
$$\int_{H^2} f_r(\omega_1, \omega_2)\, d\omega_2^{\perp} < 1$$

← energy conservation

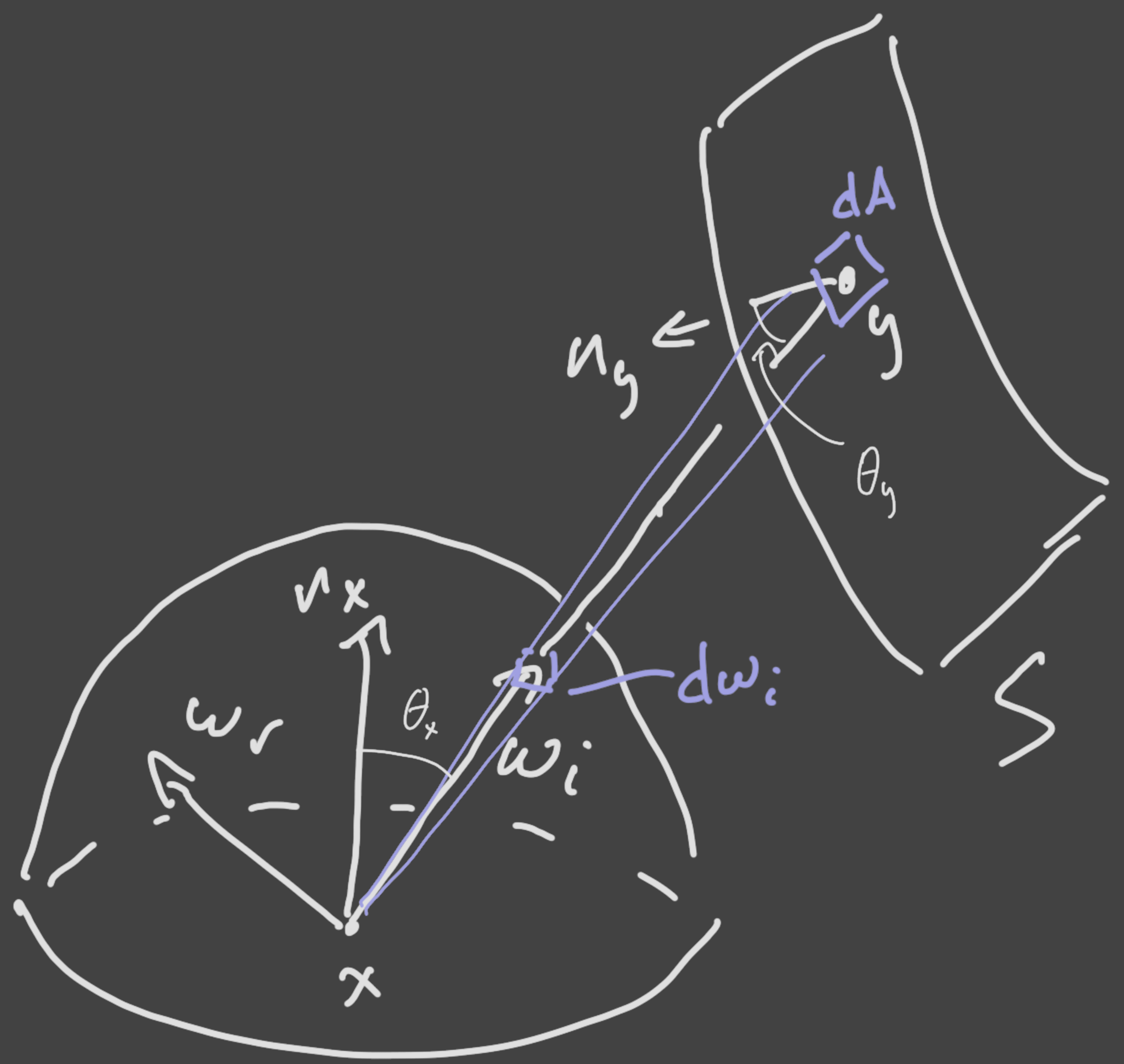
Illumination integrals



$$L_r(\omega_r) = \int_{H^2} f_r(\omega_i, \omega_r)\, L_i(\omega_i)\, d\omega_i^{\perp}$$



$$L_r(\omega_r) = \int_{H^2} f_r(\omega_i, \omega_r)\, L_i(\omega_i)\, \cos\theta_i\, d\omega_i$$



$$L_r(\omega_r) = \int_{S} f_r(\omega_i, \omega_r)\, L_i(\mathbf{y})\, \frac{\cos\theta_x \cos\theta_y}{r^2}\, dA(\mathbf{y})$$