Quick notes on
Light Propagation

Zach Meisel
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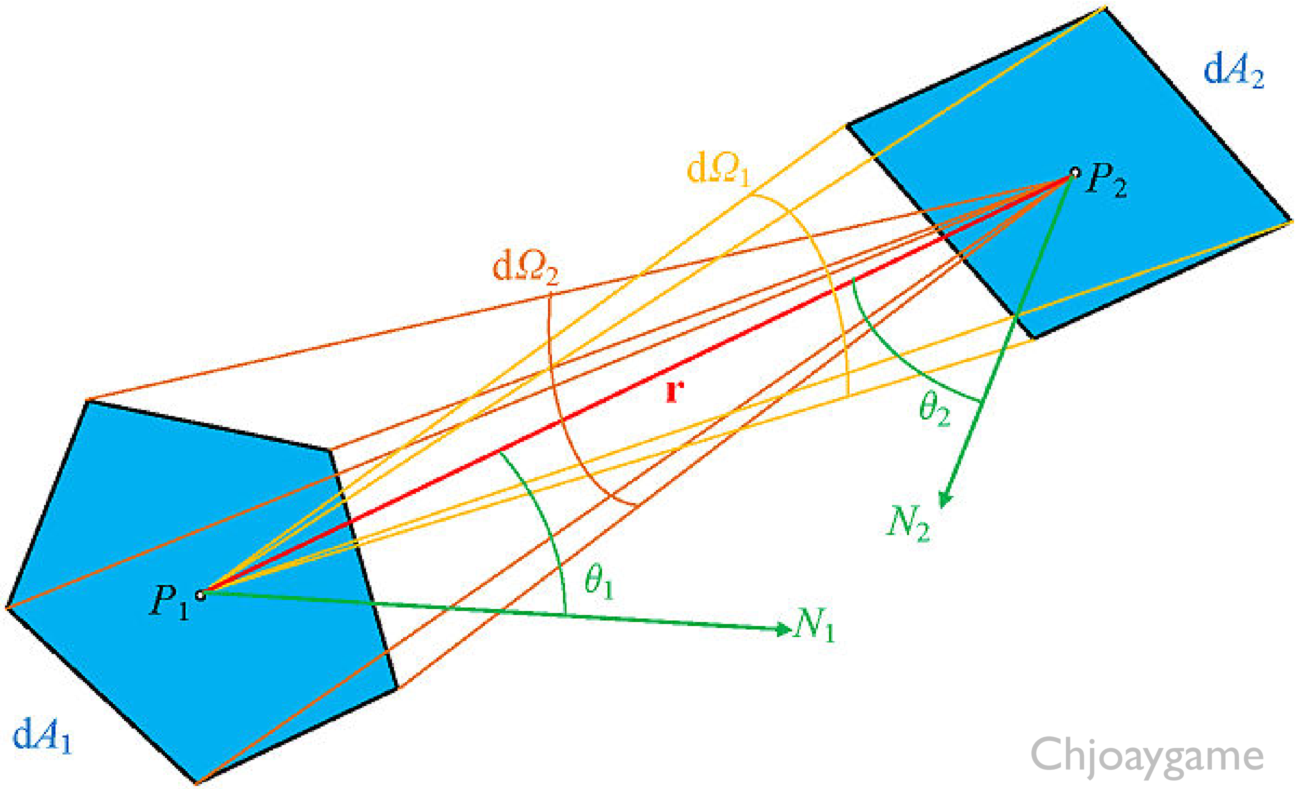
Let there be light

- Light is comprised of quanta, known as photons,
- Each carry **energy** $E = h\nu$,
  where h is Planck's constant and ν is the frequency
- Frequency is related to wavelength via $\lambda\nu = c$, where c is the speed of light
- A light source will have an angular extent (described by solid angle Ω)
  and an energy distribution (known as the spectrum)
- **Luminosity:** energy per unit time released from a light source [W]
- **Flux**: energy per area and unit time some distance from a light source [Wm^{-2}]
  - $F = L/(4\pi d^2)$
- **Intensity** (also known as Spectral Radiance): energy per unit time and unit solid angle and unit projected angle and unit wavelength [$Wsr^{-1}m^{-2}nm^{-1}$]
  emitted by a light source or collected/reflected from a light source

Specific Radiative ***Intensity***

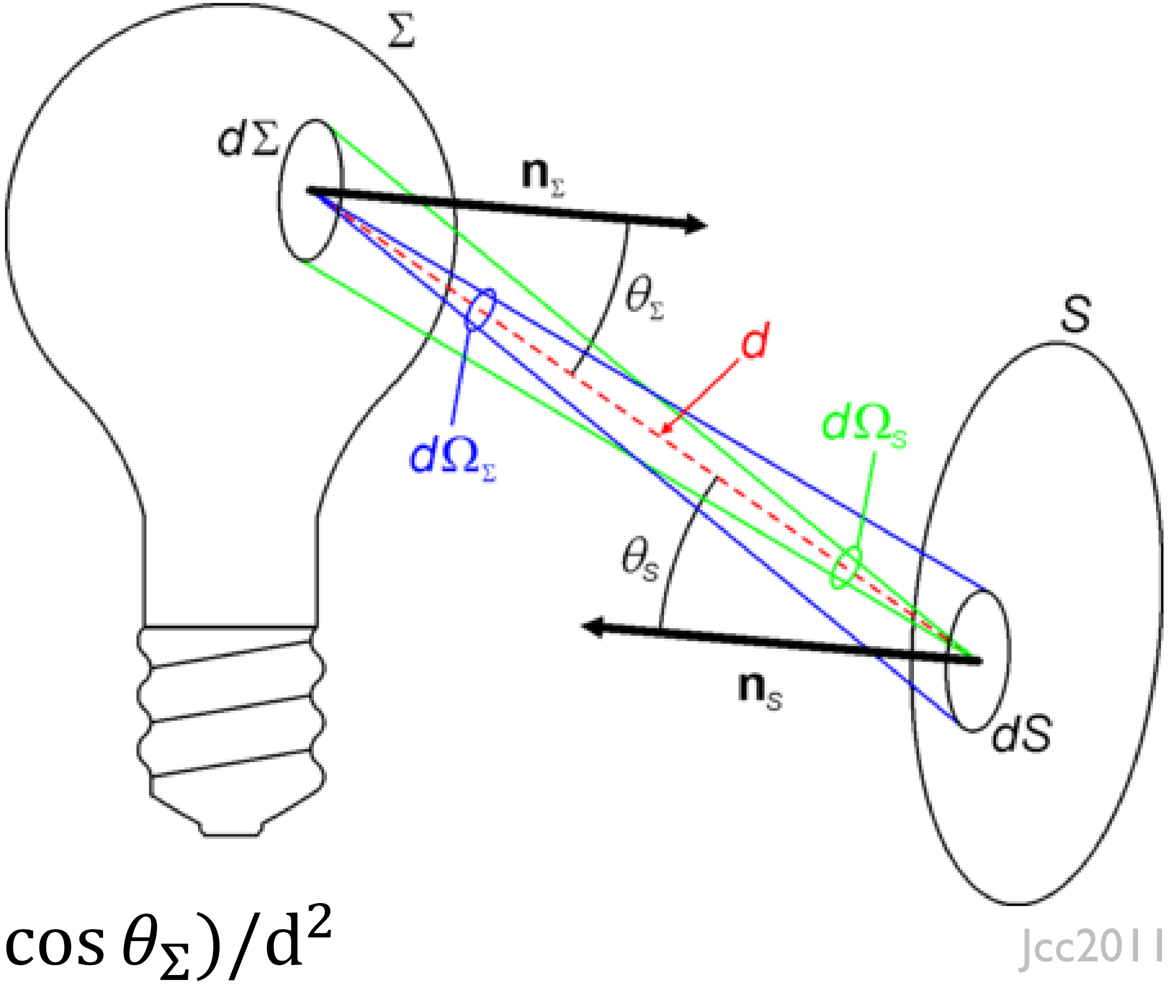
- Uses the ray picture of light (vs wave picture):
  - Photons propagate along straight lines
  - Because we need to quantize continuous space somehow, each ray corresponds to a cone of light with a small solid angle $d\Omega$ about some direction
- Intensity about point P1:
  $I(P1) = dE/(\cos\theta_1\, dA_1 d\Omega_1 d\lambda dt)$,
  where $\cos\theta_1\, dA_1$ is the projected area.
  The differentials are meant to note a small slice in energy/time/angle/area.



Etendue

(you too can be fancy and pronounce this properly: https://www.youtube.com/watch?v=65nnLn26w7Y)

- Geometric property of a light cone
  - Product of the source area and solid angle
    …sort of how spread-out the light is
- Conserved in free space, meaning $dG = dA \cos\theta \, d\Omega$ is constant.
  - Proof:
    - $d\Omega_\Sigma = (dS \cos\theta_S)/\mathrm{d}^2$
    - $d\Omega_S = (d\Sigma \cos\theta_\Sigma)/\mathrm{d}^2$
    - $dG_S = dS \cos\theta_S \, d\Omega_S = dS \cos\theta_S \, (d\Sigma \cos\theta_\Sigma)/\mathrm{d}^2$
    - $dG_\Sigma = d\Sigma \cos\theta_\Sigma \, d\Omega_\Sigma = d\Sigma \cos\theta_\Sigma \, (dS \cos\theta_S)/\mathrm{d}^2 = dG_S$



- Why care? This means intensity is conserved from source to detector