σ = cross section (depends on λ, material)

$$\Delta \text{Prob}_{abs} = \frac{n_{mol}}{Vol} \cdot \sigma \cdot \Delta s = \frac{\rho}{m_{mol}} \cdot \sigma \cdot \Delta s$$

Mean free path: $\Delta s = \ell = \frac{m_{molec}}{\rho \cdot \sigma}$

Opacity: $\ell = \frac{1}{\kappa_\lambda \rho}$, $\kappa_\lambda = \frac{\sigma}{m_{molec}}$

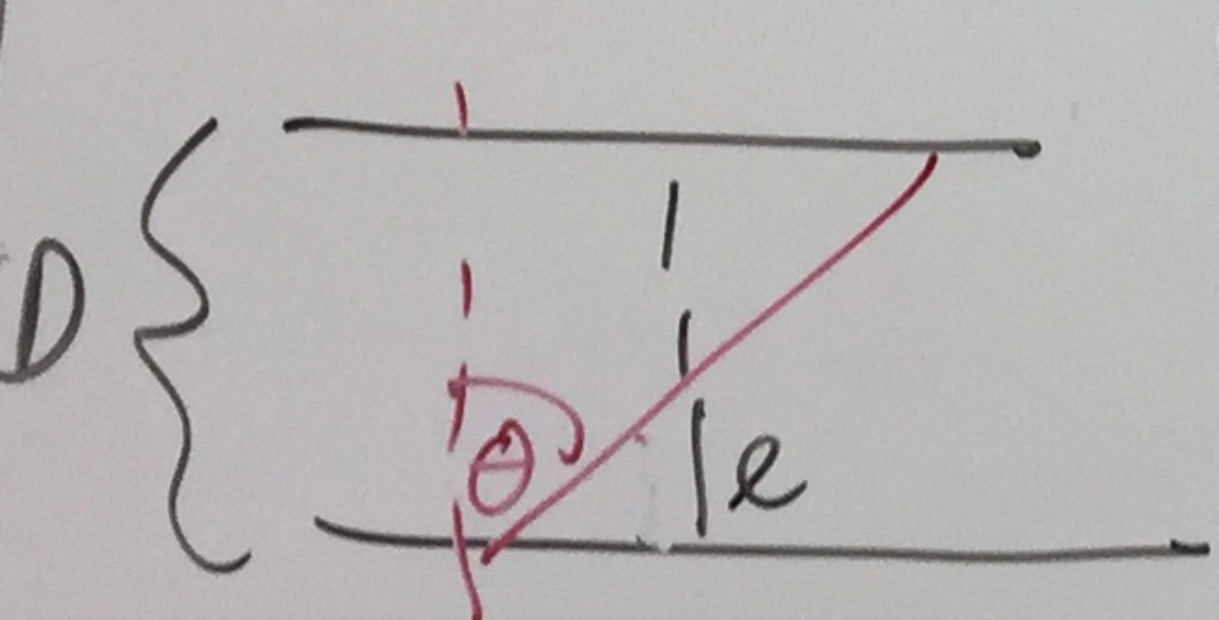
$\langle \kappa_\lambda \rangle_\lambda = \bar{\kappa}$

Ex: Photosphere of sun

$\rho \simeq 0.2 \cdot 10^{-3} \frac{kg}{m^3}$

$\bar{\kappa} \simeq 0.03 / \frac{kg}{m^2}$

$\ell \approx 160\,km$



Optical depth
$\tau = D/\ell$

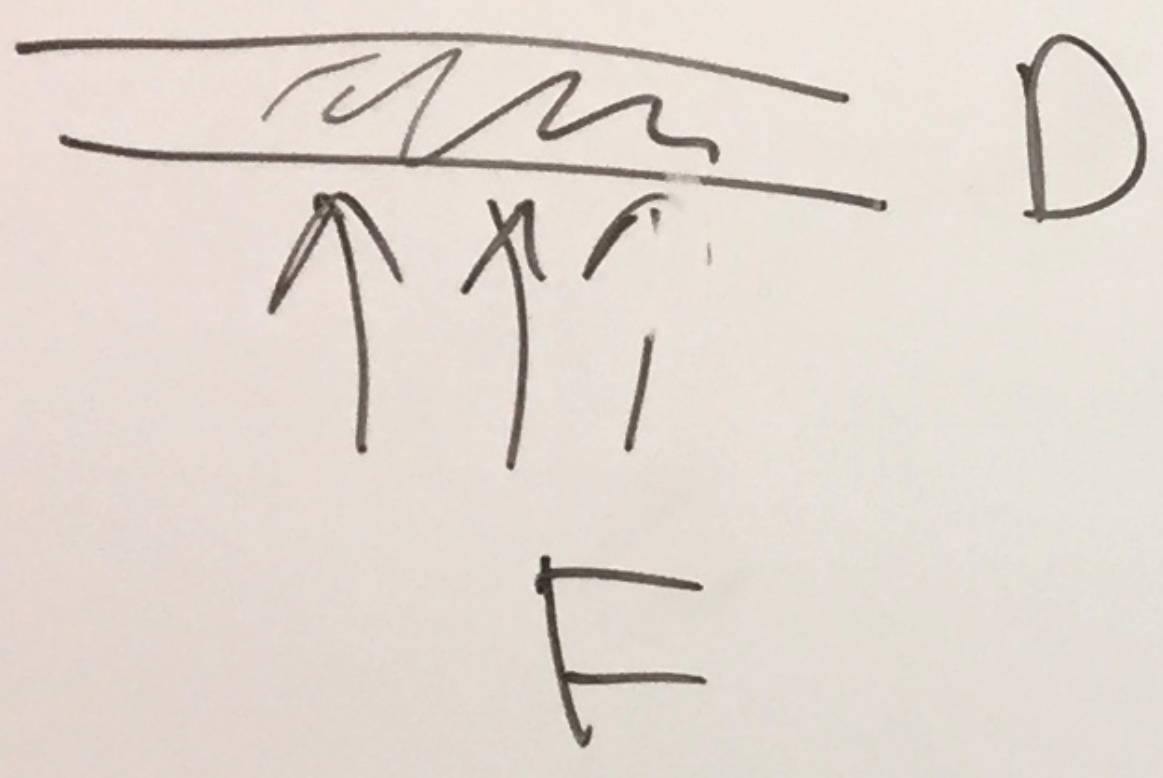
$$I(D) = I_0 \cdot e^{-\tau}$$

$$\tau = D \cdot \rho \cdot \bar{\kappa}$$

Eddington Luminosity:

Energy Flux density

Momentum flux $\left(\frac{Mom.}{time \cdot area}\right) = \frac{F}{c}$ $(E_\gamma = p_\gamma \cdot c$



fraction absorbed $= \rho \cdot \bar{\kappa} \cdot D$

$\Longrightarrow$ Pressure $= \frac{F}{c} \rho \cdot \bar{\kappa} \cdot D$

Pressure Force on some area $A = \frac{F}{c} \cancel{\rho} \bar{\kappa} \cdot \cancel{D} \cdot \cancel{A}$

Grav. " " " " " $= \frac{G \cdot M}{r^2} \cdot \cancel{\rho \cdot D \cdot A}$

Limit of stability: $\bar{\kappa} \frac{F_{max}}{c} = \frac{GM}{r^2}$

$F_{max} = \frac{GMc}{\bar{\kappa} r^2}$

$$L_{max} = 4\pi r^2 F_{max} = \frac{4\pi GMc}{\bar{\kappa}} = \frac{4\pi GM m_{molec} c}{\sigma}$$

n many cases, $\sigma = \sigma_E$ (Thompson)

$$E_{pot\,grav}^{Sphere} = -\frac{3}{5} \frac{GM^2}{R}$$

$\frac{1}{2}$ of this can be radiated away

$p = uud$

$n = udd$

$p \rightarrow n + e^+ + \nu_e$

$n \rightarrow p + e^- + \bar{\nu}_e$

Weak IA