LOCAL CHANGE TO I_r:

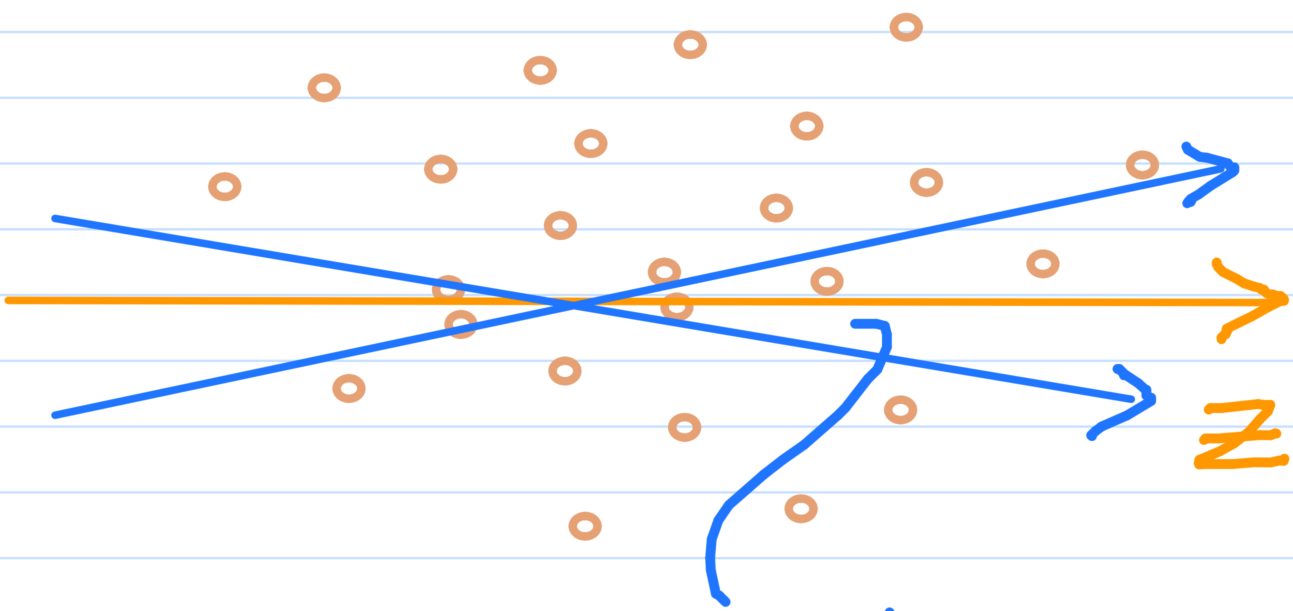
FOR 1D AXI-SYMMETRIC MODEL

RECALL: BEAM IN VACUUM

$$I_r(z) = \text{CONST.}, \text{ ALL } z$$

BEAM IN MEDIUM,

$$I_r(z) = f(z)$$

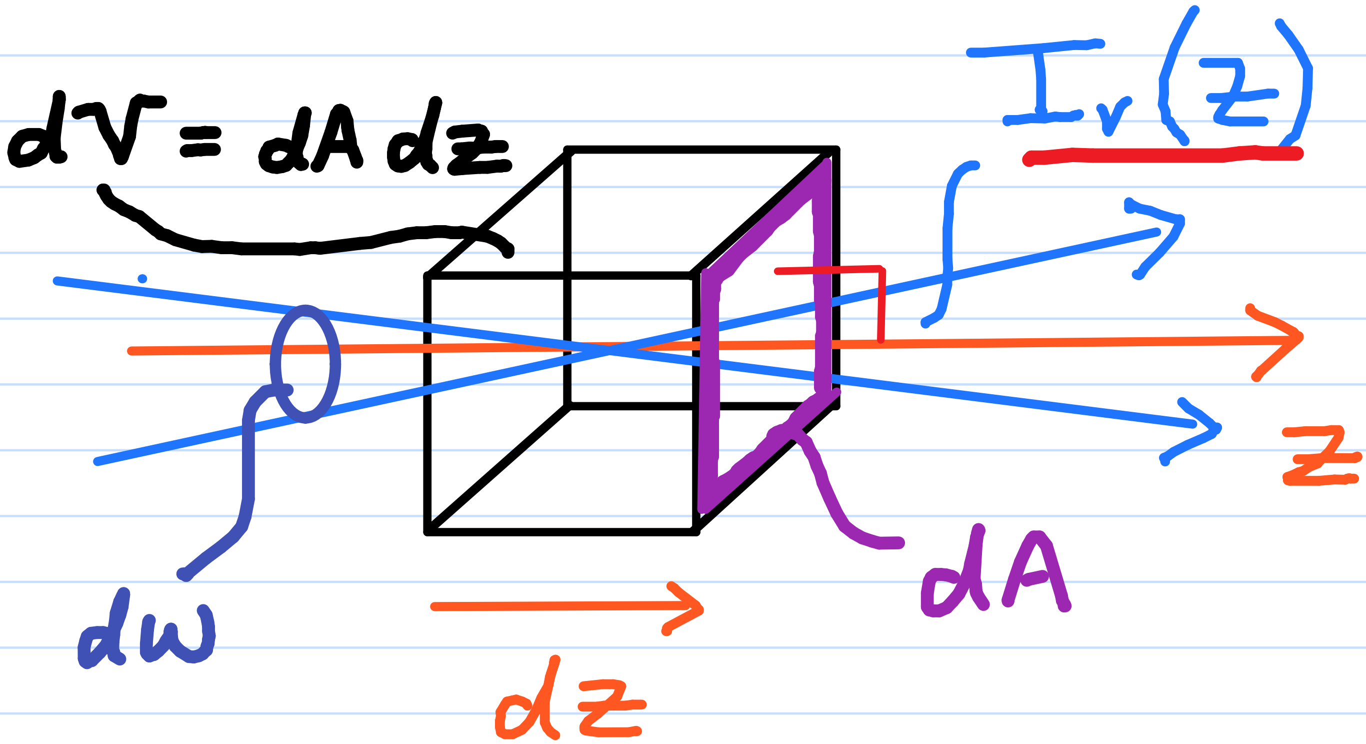


$I_r(z)$

EMISSION:

MONOCHROMATIC VOLUME EMISSIVITY,

$j_\nu(z)$ (erg/s/cm^3/STER/Hz)



$dE_\nu(z) \equiv$ E ADDED TO BEAM IN INTERVALS ν TO $\nu + d\nu$ AND dt (erg)

$$\equiv j_\nu(z)\, dV\, dt\, d\omega\, d\nu > 0$$

$$dE_\nu(z) \equiv \underline{j_\nu(z)}\,\underset{dA\,dz}{\underline{dV}}\,dt\,d\omega\,d\nu \qquad (1)$$

RECALL:

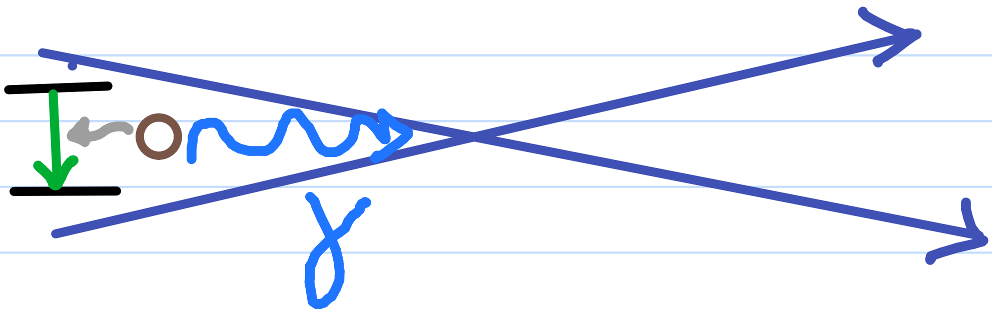
$$dE_\nu(z) \equiv \underline{I_\nu(z)}\,dA\,dt\,d\omega\,d\nu \qquad (2)$$

Eqs. (1) & (2):

$$\therefore \boxed{dI_\nu(z) = \underline{j_\nu(z)}\,dz} > 0$$

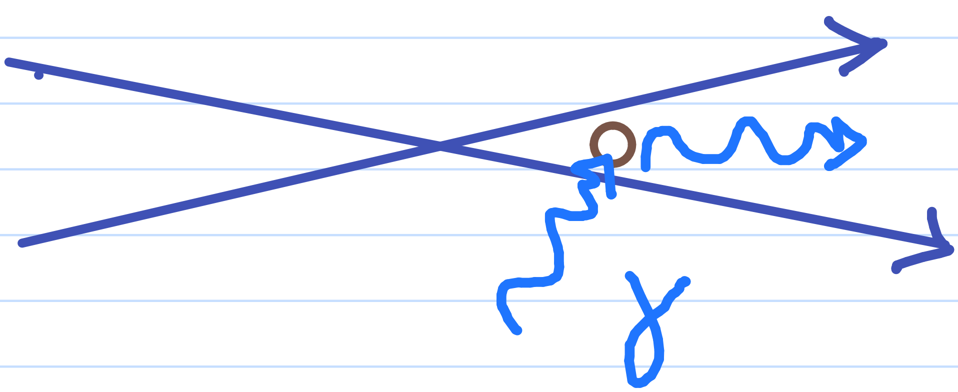
TWO TYPES OF PROCESS CONTRIBUTE TO j_ν:

1) THERMAL γ CREATION:



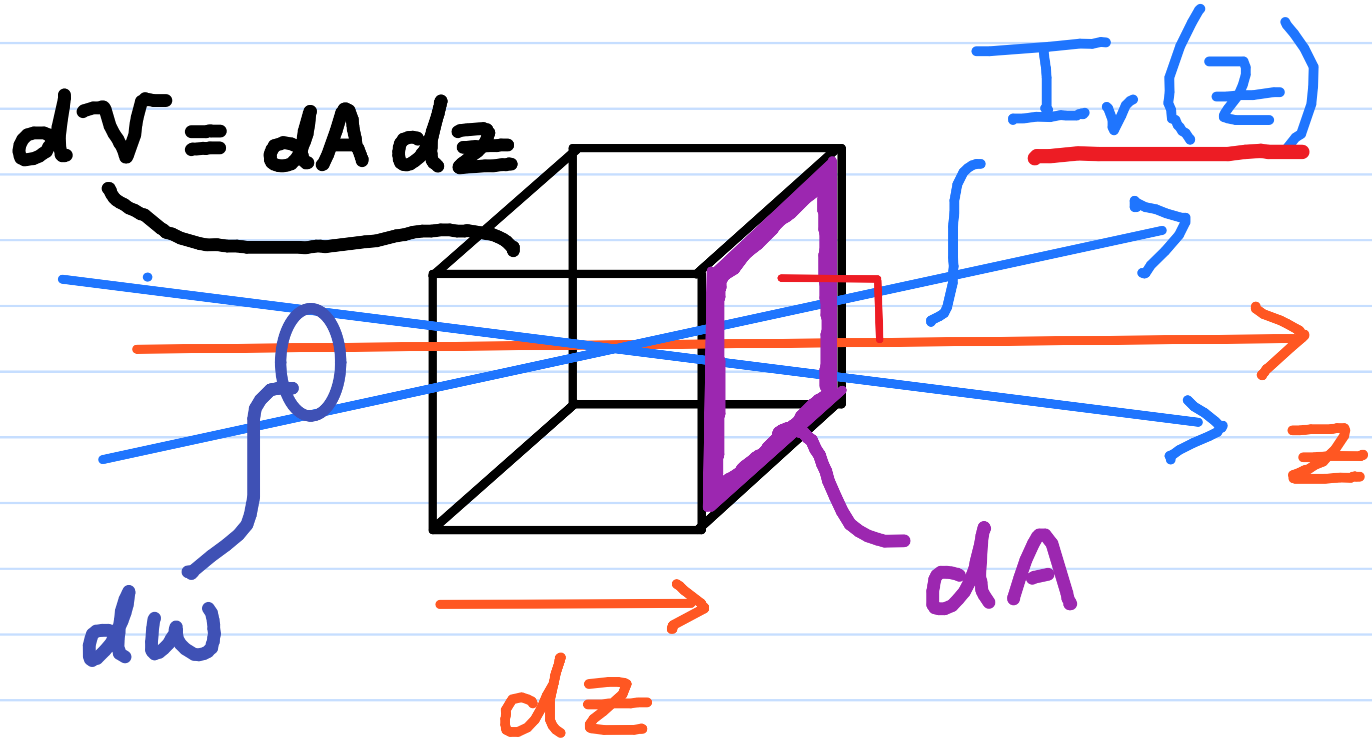
E.g. PHOTO-DE-EXCITATION
PHOTO-RECOMBINATION

2) γ SCATTERING:



E.g. THOMSON, RAYLEIGH SCATTERING

EXTINCTION:



RECALL:

MONOCHROMATIC VOLUME EXTINCTION, $\alpha_\nu(z)$ (cm^{-1}) ("LINEAR EXTINCTION")

MONOCHROMATIC MASS EXTINCTION, $K_\nu(z)$ (cm^2/g)

MONOCHROMATIC EXTINCTION CROSS-SECTION, σ_ν (cm^2)

MONOCHROMATIC OPTICAL DEPTH, $\tau_\nu(z)$

RECALL:

$$dI_\nu(z) = \alpha_\nu(z)\,dz = \rho(z)\,K_\nu(z)\,dz$$

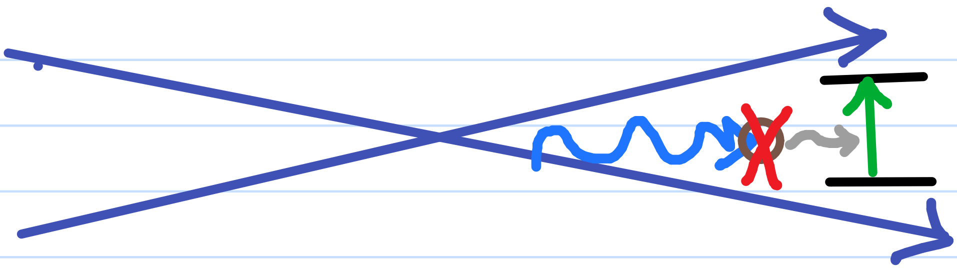
FOR A PURE EXTINCTION MEDIUM:

$$K_\nu = \frac{\alpha_\nu}{\rho} = \frac{n\sigma_\nu}{\rho}$$

$$dI_\nu(z) = -\alpha_\nu(z)\,I_\nu(z)\,dz$$
$$= -K_\nu(z)\,\rho(z)\,I_\nu(z)\,dz \;\; < 0$$

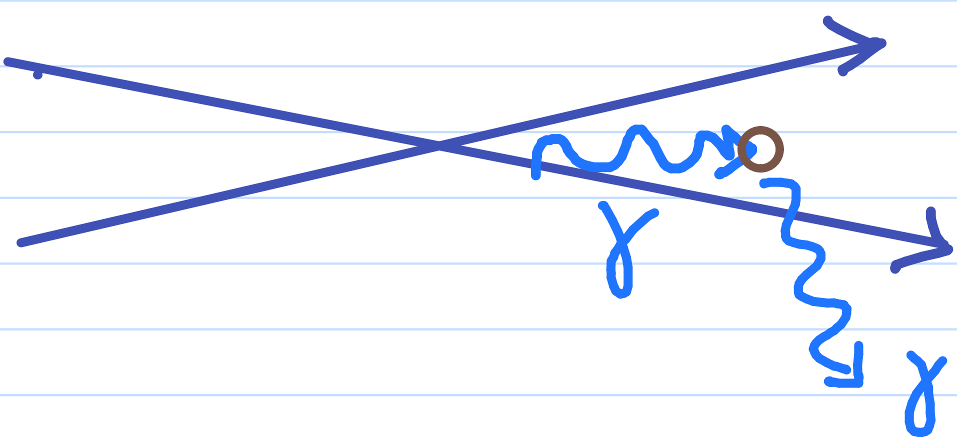
TWO TYPES OF PROCESS CONTRIBUTE TO K_ν :

1) THERMAL γ DESTRUCTION:



Eg. PHOTO-EXCITATION
PHOTO- IONIZATION

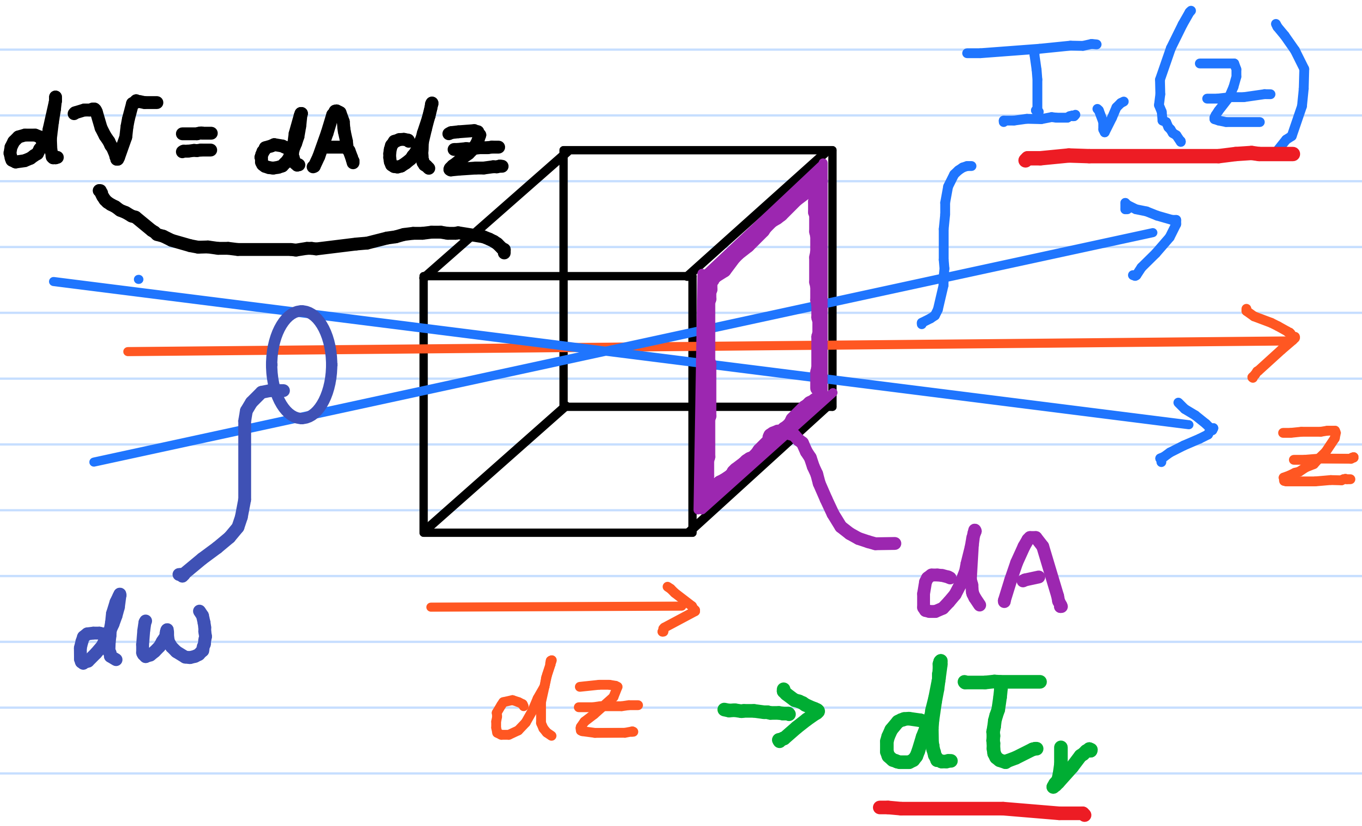
2) γ SCATTERING :



Eg. THOMSON, RAYLEIGH SCATTERING

MONOCHROMATIC SOURCE FUNCTION,

S_ν (erg/s/cm²/STER/Hz)



S_ν = INCREASE, dI_ν, DUE TO j_ν ONLY PER UNIT τ_ν ALONG BEAM:

$$\therefore \quad S_\nu(z) \equiv \frac{dI_\nu(z)}{d\tau_\nu(z)} = \frac{j_\nu(z)\,\cancel{dz}}{\alpha_\nu(z)\,\cancel{dz}}$$

$$= \frac{j_\nu(z)}{\alpha_\nu(z)} = \frac{j_\nu(z)}{\kappa_\nu(z)\,\rho(z)}$$

MICROSCOPIC SOURCES OF j_ν & κ_ν:

1) CONTINUUM ("BACKGROUND") SOURCES, j_ν^c & κ_ν^c:

- BROAD BAND

a) THERMAL SOURCES

i) BOUND-FREE (b-f) SOURCES:

PHOTO-IONIZATION: κ_ν^c

PHOTO-RECOMBINATION: j_ν^c

ii) FREE-FREE (f-f) SOURCES:

BREMSTRAHLUNG (BRAKING RADIATION)

BREM. γ-ABSORPTION: κ_ν^c

BREM. γ-EMISSION: j_ν^c

b) SCATTERING SOURCES:

THOMSON SCATTERING
FROM FREE e^-s

RAYLEIGH SCATTERING
FROM ATOMS & MOLECULES

- SCATT. EXTINCTION: κ_ν^c
- SCATT. EMISSION: j_ν^c

2) LINE SOURCES: j_ν^{ℓ} & κ_ν^{ℓ}

- MOSTLY NARROW-BAND

THERMAL & SCATTERING SOURCES:

BOUND-BOUND (b-b) SOURCES:

PHOTO-EXCITATION: κ_ν^{ℓ}

PHOTO-DE-EXCITATION: j_ν^{ℓ}

TOTAL j_ν & K_ν :

$$K_\nu(z,\nu) = \sum_{b-f} K^c_\nu(z,\nu) + \sum_{f-f} K^c_\nu(z,\nu)$$

$$+ \sum_{\substack{\text{THOM.}\\ \text{RAYL.}}} K^c_\nu(z,\nu) + \sum_{b-b} K^l_\nu(z,\nu)$$

THEN: $j_\nu(z,\nu) = K_\nu(z,\nu)\,\rho(z)\,S_\nu(z,\nu)$

NARROW $\Delta\nu$ RANGE: