

LOCAL CHANGE TO I_ν :

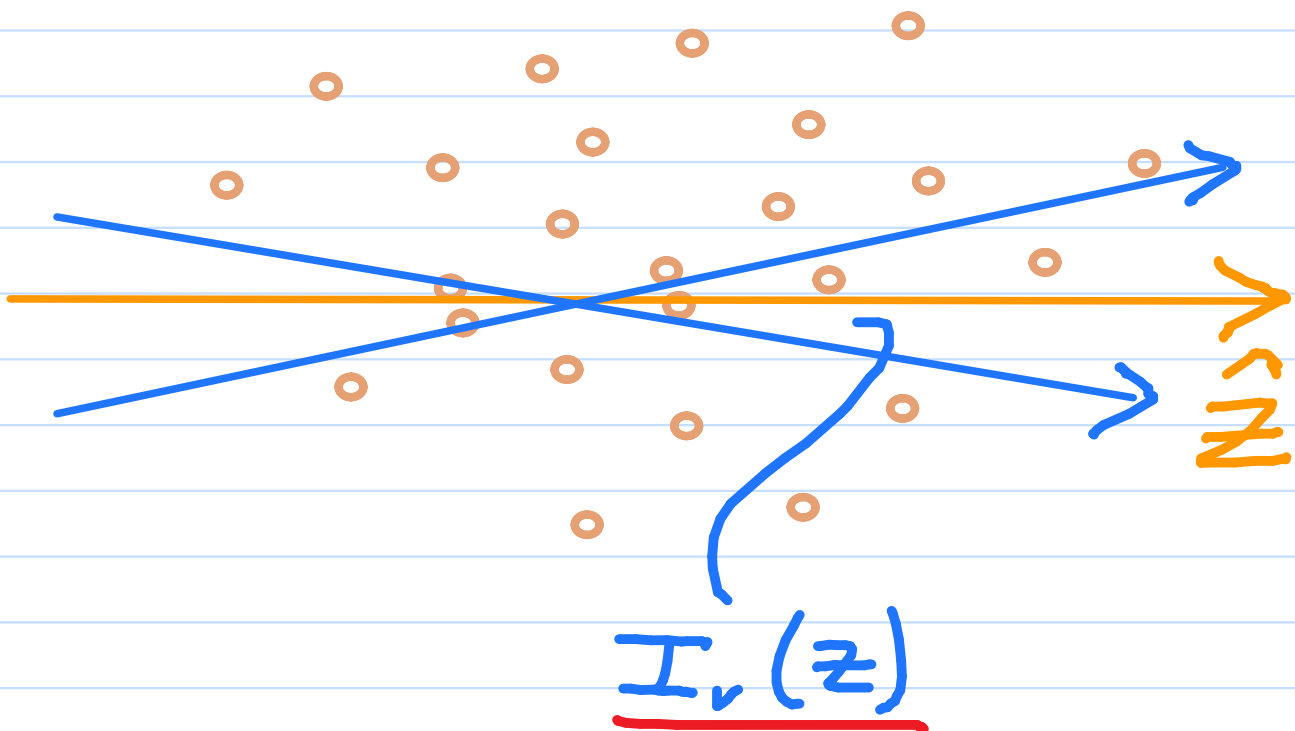
FOR 1D AXI-SYMMETRIC MODEL

RECALL: BEAM IN VACUUM

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

BEAM IN MEDIUM,

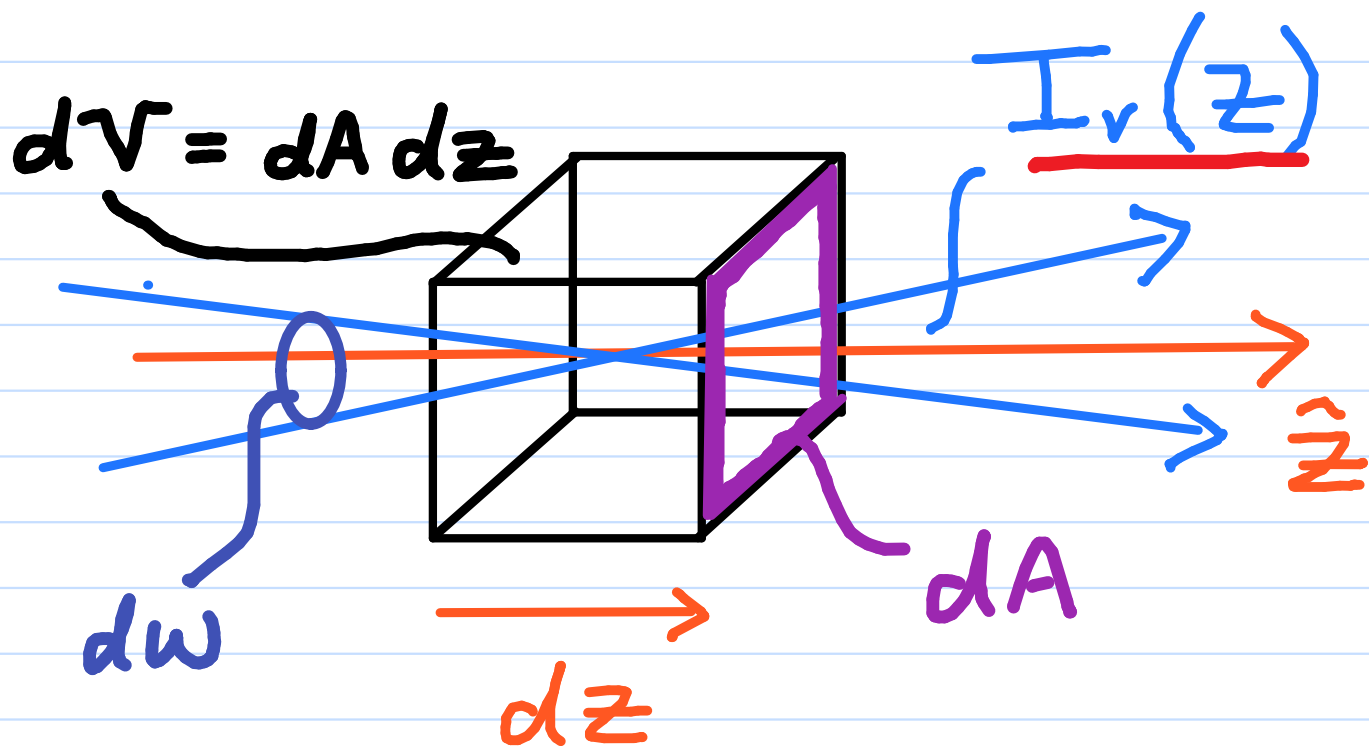
$$I_\nu(z) = f(z)$$



EMISSION:

MONOCHROMATIC VOLUME EMISSIVITY,

$$\underline{j_\nu(z)} \quad (\text{erg/s/cm}^3/\text{STER/Hz})$$



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

$$\equiv \underline{j_\nu(z)} dV dt d\omega d\nu > 0$$

$$dE_v(z) \equiv \underline{j_v(z)} \overset{dA dz}{dV} dt d\omega dv \quad (1)$$

RECALL:

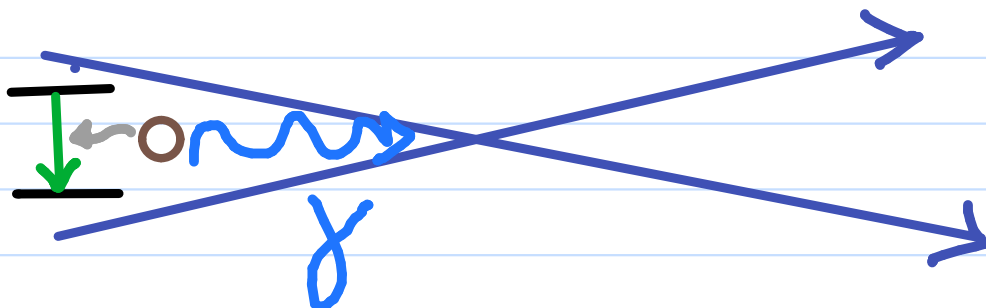
$$dE_v(z) \equiv \underline{I_v(z)} dA dt d\omega dv \quad (2)$$

Eq. (1) & (2):

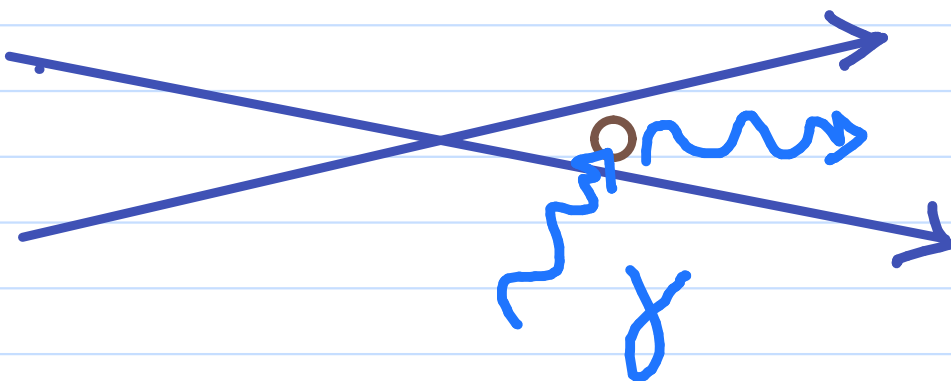
$$\therefore \boxed{dI_v(z) = \underline{j_v(z)} dz} > 0$$

TWO TYPES OF PROCESS CONTRIBUTE TO j_ν :

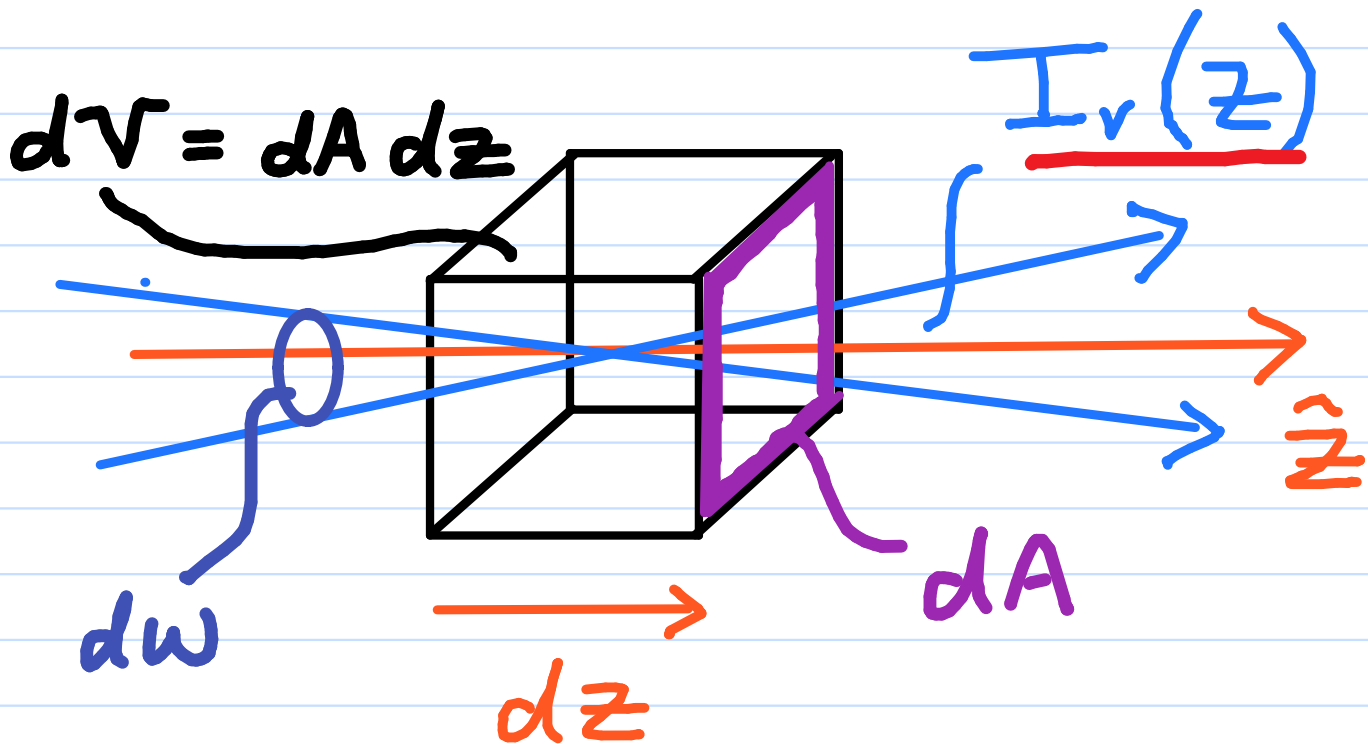
1) THERMAL γ CREATION:



2) γ SCATTERING:



EXTINCTION:



RECALL:

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

MONOCHROMATIC MASS EXTINCTION,
 $K_v(z)$ (cm^2/g)

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

MONOCHROMATIC OPTICAL DEPTH,
 $T_v(z)$

RECALL:

$$dT_v(z) = \alpha_v(z) dz = \rho(z) K_v(z) dz$$

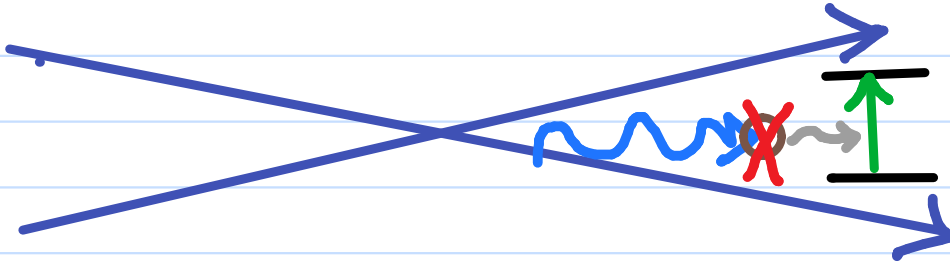
FOR A PURE EXTINCTION MEDIUM:

$$K_v = \frac{\alpha_v}{\rho} = \frac{n\sigma_v}{\rho}$$

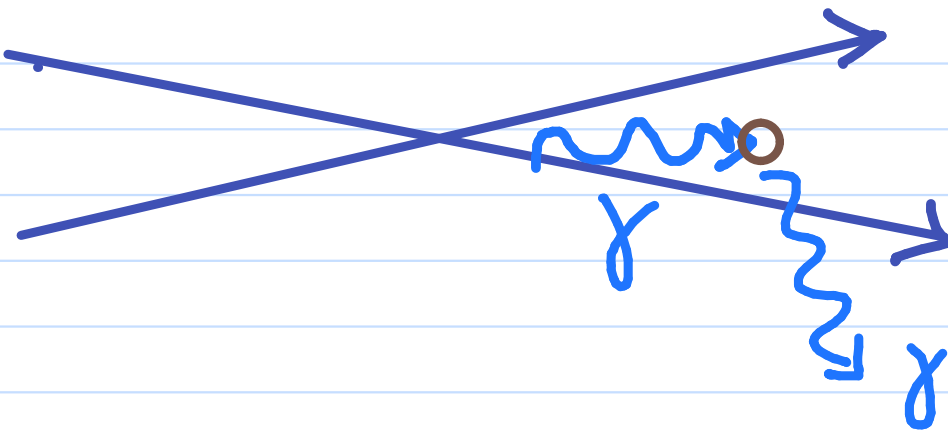
$$\begin{aligned} dI_v(z) &= -\alpha_v(z) \underline{I_v(z)} dz \\ &= \underset{\uparrow}{-} K_v(z) \rho(z) \underline{I_v(z)} dz < \underline{0} \end{aligned}$$

TWO TYPES OF PROCESS CONTRIBUTE TO K_v :

1) THERMAL γ DESTRUCTION:

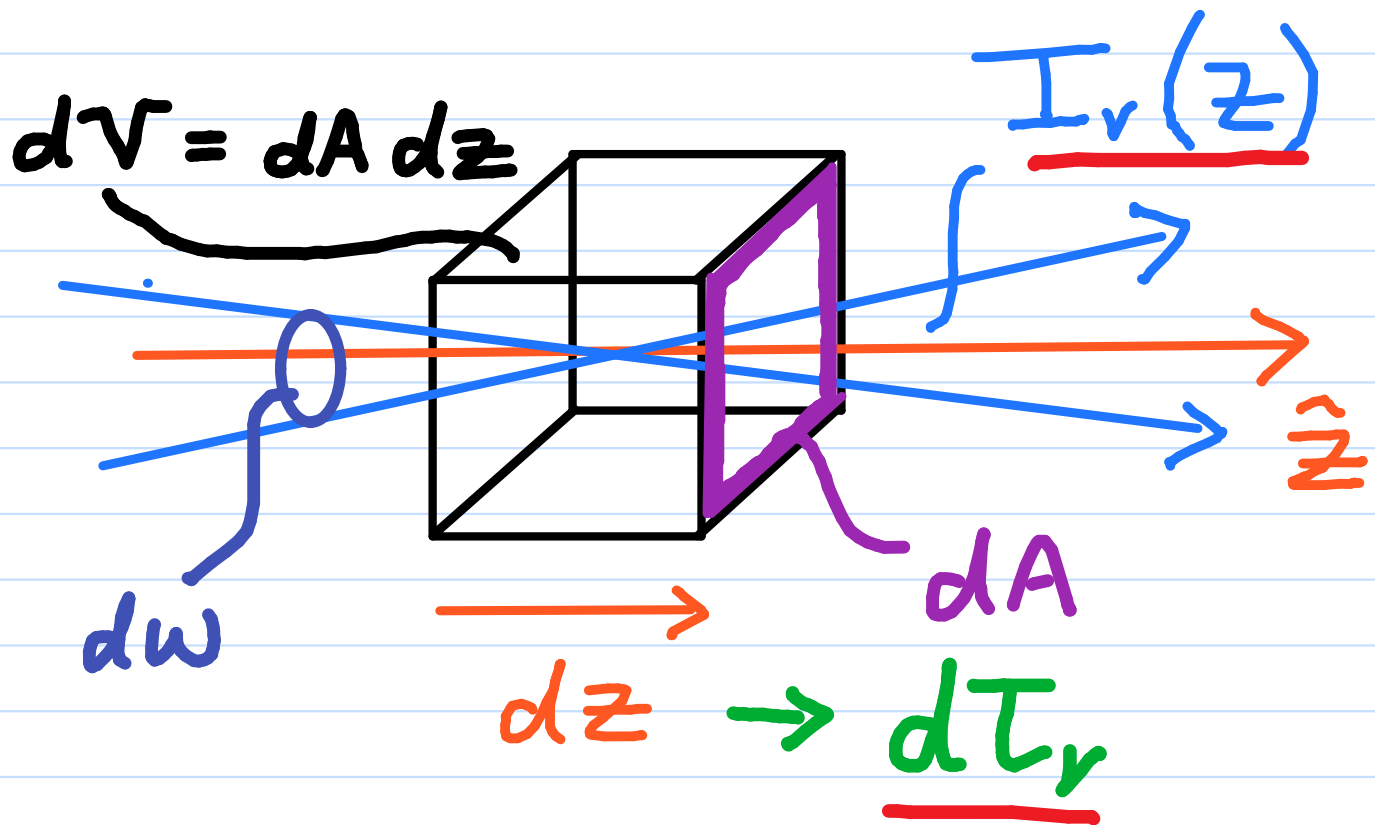


2) γ SCATTERING:



MONOCHROMATIC SOURCE FUNCTION,

$$S_\nu \quad (\text{erg/s/cm}^2/\text{STER/Hz})$$



$S_\nu = \text{INCREASE, } dI_\nu, \text{ DUE TO } j_\nu \text{ ONLY}$

PER UNIT T_ν ALONG BEAM:

$$\therefore S_\nu(z) \equiv \frac{dI_\nu(z)}{dT_\nu(z)} = \frac{j_\nu(z) dz}{\alpha_\nu(z) dz}$$

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

MICROSCOPIC SOURCES OF j_ν & K_ν :

i) CONTINUUM ("BACKGROUND") SOURCES,
 j_ν^c & K_ν^c :

- BROAD BAND

a) THERMAL SOURCES

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

PHOTO-IONIZATION: K_ν^c

PHOTO-RECOMBINATION: j_ν^c

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

BREMSTRAHLUNG (BRAKING RADIATION)

BREM. γ -ABSORPTION: K_v^c

BREM. γ -EMISSION: j_v^c

b) SCATTERING SOURCES:

THOMSON SCATTERING
FROM FREE e^- s

RAYLEIGH SCATTERING
FROM ATOMS & MOLECULES

• SCATT. EXTINCTION: K_v^c

• SCATT. EMISSION: j_v^c

2) LINE SOURCES: j_ν^l & K_ν^l
- MOSTLY NARROW-BAND

THERMAL & SCATTERING SOURCES:

BOUND-BOUND (b-b) SOURCES:

PHOTO-EXCITATION: K_ν^l

PHOTO-DE-EXCITATION: j_ν^l

TOTAL j_ν & K_ν :

$$\begin{aligned} \underline{K_\nu(z, \nu)} &= \sum_{\underline{b-f}} K_\nu^c(z, \nu) + \sum_{\underline{f-f}} K_\nu^c(z, \nu) \\ &+ \sum_{\text{THOM. RAYL.}} K_\nu^c(z, \nu) + \sum_{\underline{b-b}} K_\nu^l(z, \nu) \end{aligned}$$

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

NARROW $\Delta\nu$ RANGE:

