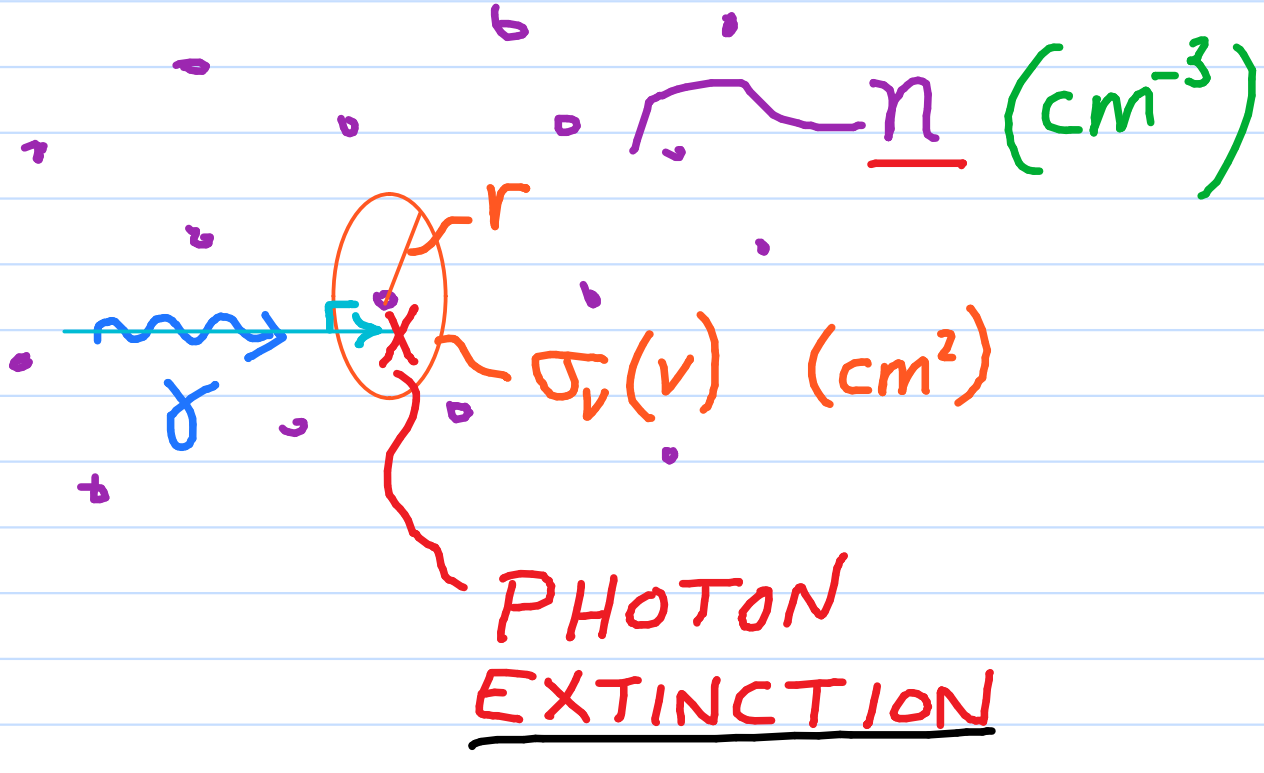
OPACITY & OPTICAL DEPTH:

- INTERACTION OF GAS AND RADIATION

MONOCHROMATIC INTERACTION CROSS-SECTION FOR PHOTONS (γ) AND GAS PARTICLES,

$\sigma_\nu(\nu)$ (cm^2)

- ν = FREQUENCY (Hz)



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

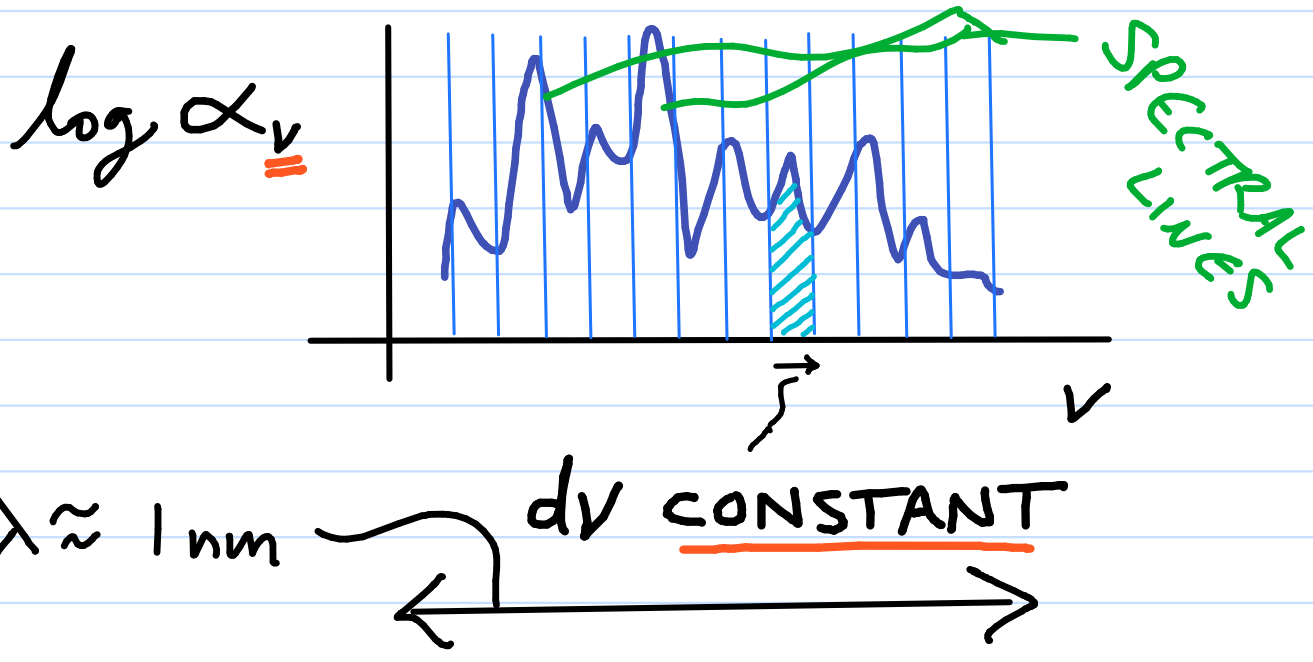
FOR A GAS THAT EXTINGHISHES ONLY:

$$\alpha_\nu(\nu) = n\,\sigma_\nu(\nu)$$

n: cm^{-3}, $\sigma_\nu(\nu)$: cm^2

("LINEAR EXTINCTION")

$\alpha_\nu(\nu)$: A CONTINUOUS ν DISTRIBUTION:

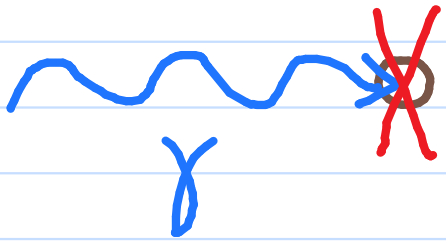


MONOCHROMATIC MASS EXTINCTION COEFFICIENT, $K_\nu(\nu)$ (cm^2/g)

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

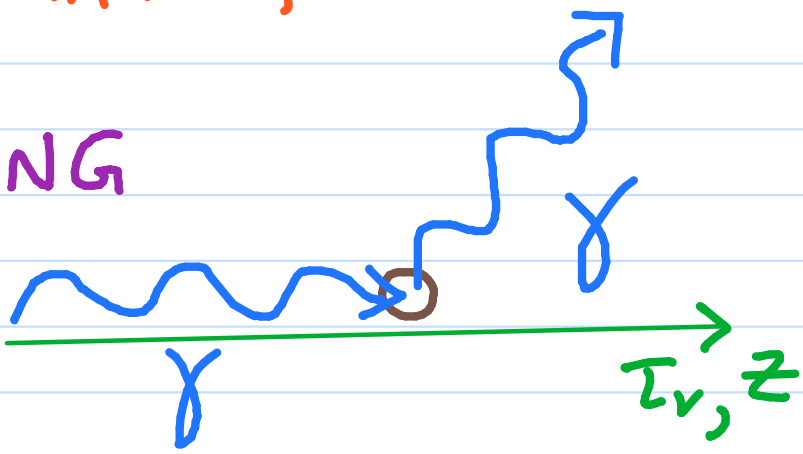
2 TYPES OF EXTINCTION:

1) THERMAL DESTRUCTION



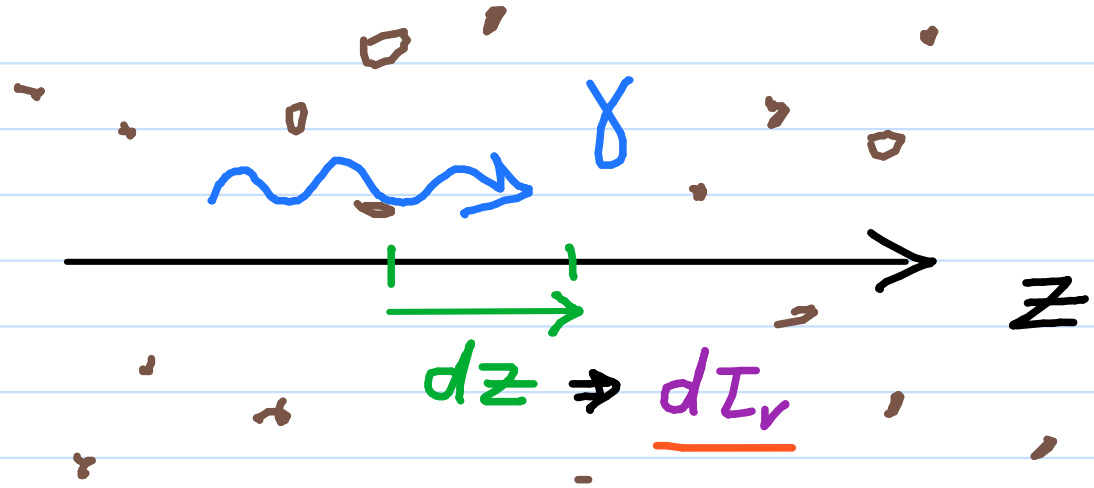
-eg. PHOTO-EXCITATION, -IONIZATION

2) SCATTERING



-eg. THOMSON-, RAYLEIGH-SCATTERING

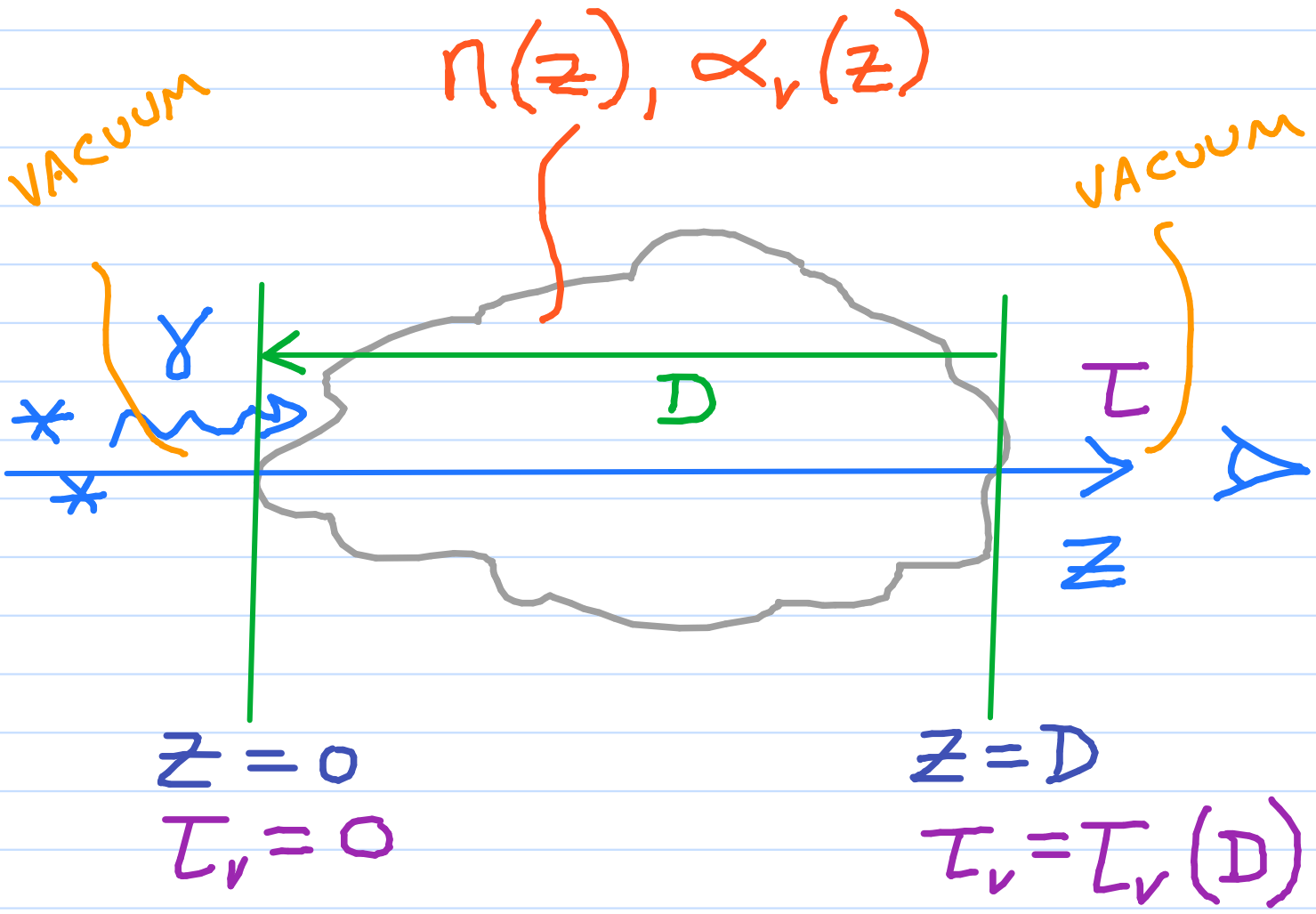
MONOCHROMATIC OPTICAL DEPTH ALONG A γ PATH, $\tau_\nu(\nu)$



$$d\tau_\nu(z) \equiv \alpha_\nu(z)\, dz$$
$$= \kappa_\nu(z)\rho(z)\, dz$$

(UNIT LESS)

MONOCHROMATIC OPTICAL THICKNESS, $\tau_\nu(z=D)$:



$$\tau_\nu(D) = \int_{z=0}^{D} \kappa_\nu(z)\,dz = \int_0^D K_\nu(z)\rho(z)\,dz$$

$\tau_\nu(D) < 1$: OPTICALLY THIN

$\Rightarrow$ TRANSPARENT

$\tau_\nu(D) \gg 1$: OPTICALLY THICK

$\Rightarrow$ OPAQUE

V-AVERAGED MEAN OPACITIES:

$$\overline{\alpha} = \frac{\int_{\nu=0}^{\infty} W(\nu)\,\alpha_\nu(\nu)\,d\nu}{\int_{\nu=0}^{\infty} W(\nu)\,d\nu} \quad (cm^{-1})$$

WEIGHT f_n

$$\overline{\kappa} = \frac{\overline{\alpha}}{\rho} \quad (cm^2/g)$$

"GRAY" OPACITY: $\alpha_\nu(\nu) = \overline{\alpha}$

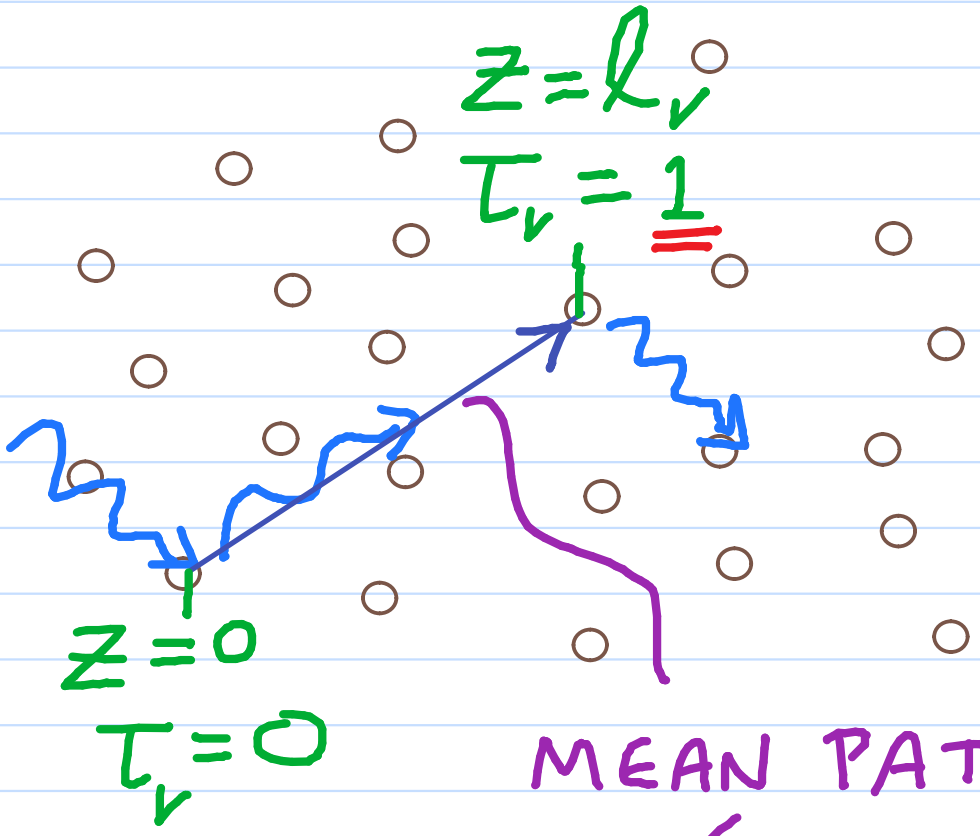
GRAY τ-SCALE:

$$d\tau = \overline{\alpha}(z)\,dz = \overline{\kappa}(z)\rho(z)\,dz$$

$$\Rightarrow \tau(z) = \int_0^z \overline{\alpha}(z)\,dz$$

- eg. ROSSELAND OPTICAL DEPTH, τ_{ROS}

MONOCHROMATIC MEAN-FREE-PATH, ℓ_ν (cm):



$$\tau_\nu \equiv \int_{z=0}^{\ell_\nu} \alpha_\nu(z)\, dz = 1$$