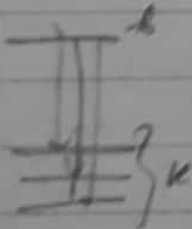
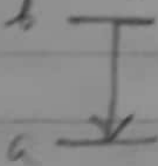


Pressure and thermal broadening

Result



$$\Gamma = \frac{h}{\tau_{ab}}$$

$$\Gamma = \frac{h}{\tau_b}$$

$$\tau_{ab}^{-1} = W_{ab}^{st}$$

$$\tau_b^{-1} = \sum_k W_{kb}^{st} = \sum_k \tau_{kb}^{-1}$$

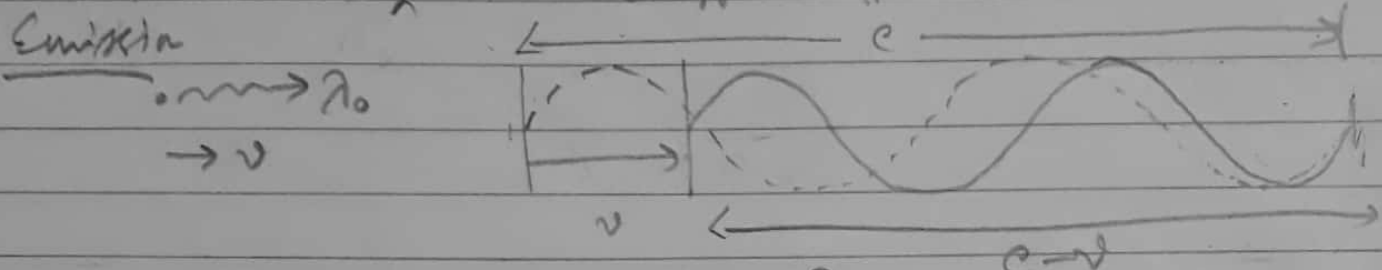
$\Gamma_{total} =$ sum of Γ of all possible decay process.

Example: Pressure broadening

If W_p is the total # of transitions send out from state "b" due to collision then $\Gamma = h(W_p + \dots)$

Thermal broadening: in gas phase

Thermal motion of atoms lead to modification of ω of the emitted ^{as well as scattered light} due to Doppler effect:



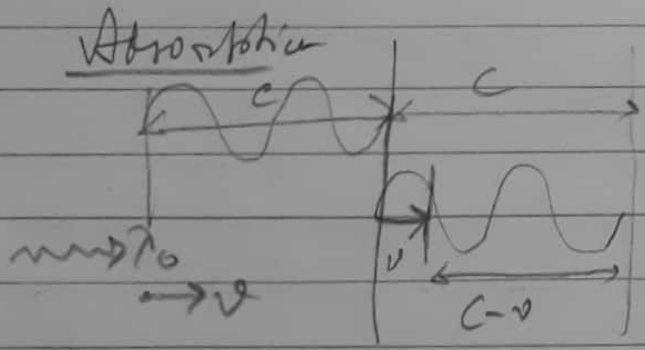
$$\therefore \frac{\lambda}{\lambda_0} = \frac{c-v}{c} \quad \left. \vphantom{\frac{\lambda}{\lambda_0}} \right\} \lambda = \lambda_0 \left(1 \mp \frac{v}{c}\right)$$

$$\Rightarrow \frac{\lambda}{\lambda_0} = \frac{c+v}{c} \quad \left. \vphantom{\frac{\lambda}{\lambda_0}} \right\} \omega = 2\pi \frac{c}{\lambda} = \frac{2\pi c}{\lambda_0 \left(1 \mp \frac{v}{c}\right)}$$

$$= \frac{\omega_0}{\left(1 \mp \frac{v}{c}\right)}$$

$$\approx \omega_0 \left(1 \pm \frac{v}{c}\right)$$

+ for $\hat{k} \parallel \hat{v}$
- for $\hat{k} \parallel -\hat{v}$



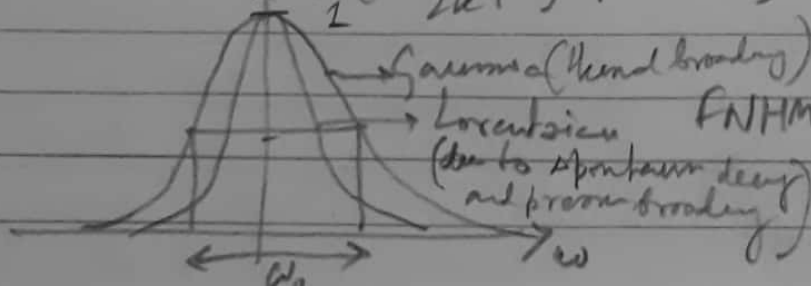
$$\Rightarrow v = \left(\frac{\omega - \omega_0}{\omega_0}\right) (\pm c)$$

$$= \pm c \frac{(\omega - \omega_0)}{\omega_0}$$

$$dN(v) = N_0 \exp\left(-\frac{Mv^2}{2kT}\right) dv$$

↑
at $v=0$

$$\Rightarrow I(v) = I(v=0) \exp\left(-\frac{Mv^2}{2kT}\right) = I(\omega_0) \exp\left[-\frac{Mc^2(\omega - \omega_0)^2}{2kT \omega_0^2}\right]$$



$$\text{FWHM } \Delta\omega = \frac{2\omega_0}{c} \left[\frac{2kT \ln 2}{M} \right]^{1/2}$$