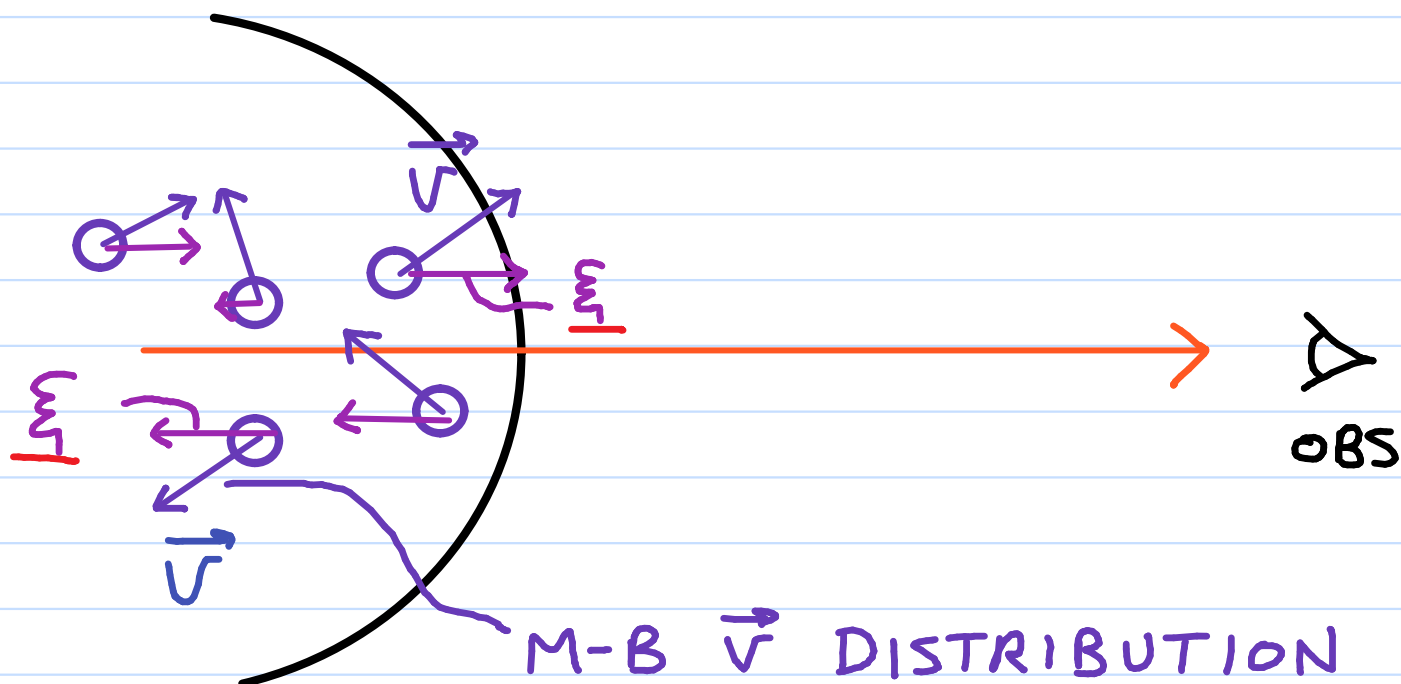


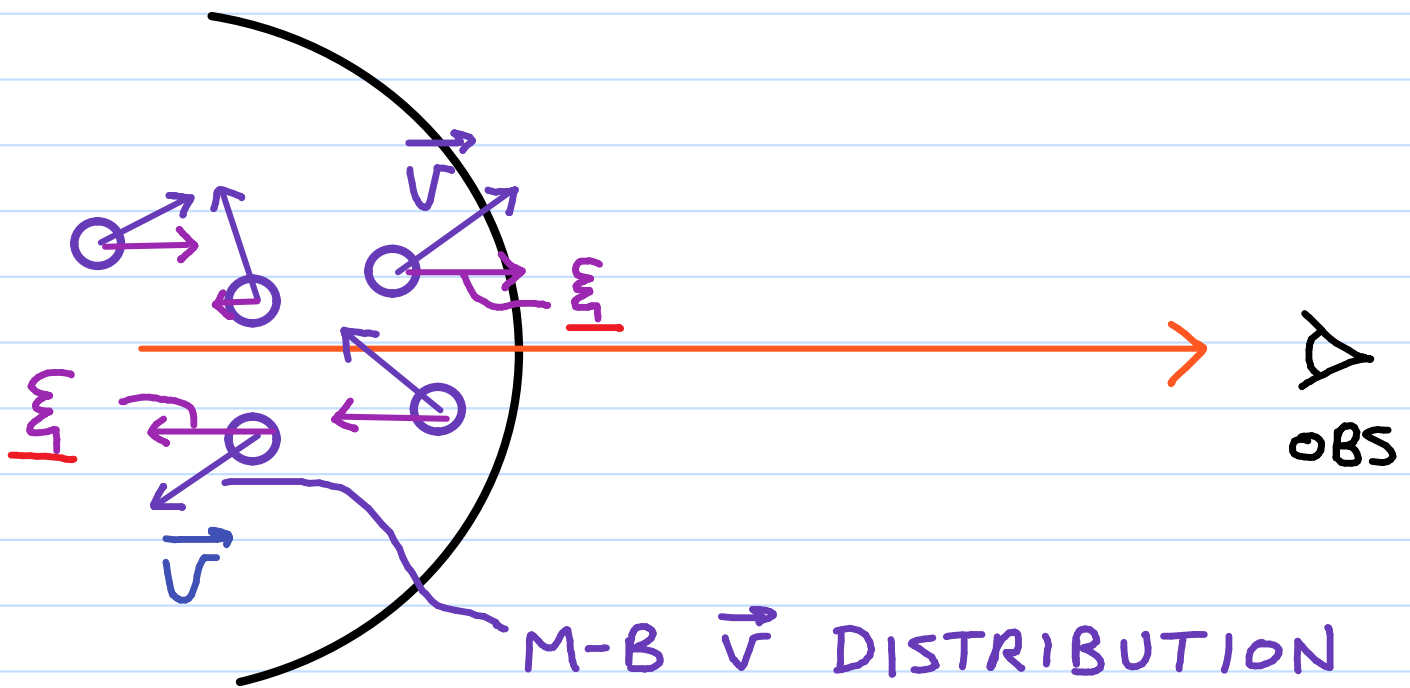
THERMAL LINE BROADENING:



ENSEMBLE OF ABSORBERS
BROADENS LINE

→ ASCRIBE EFFECT TO A
REPRESENTATIVE ATOM

NO NET ϕ_v SHIFT: $\Delta\nu_0 = 0$



IN ATOM'S REST FRAME

- RADIATION & COLLISIONAL DAMPING ONLY:

$$\phi_{v'}^*(v' - v_0') = \frac{\gamma/4\pi^2}{(v' - v_0')^2 + (\gamma/4\pi)^2}$$

$$\rightarrow \underline{\gamma} = \gamma^R + \gamma^C$$

IN STAR'S REST FRAME :

$$\frac{\Delta V}{V'} \equiv \frac{V - V'}{V'} = \frac{\xi}{c}$$

$$\rightarrow \because \xi > 0 \Rightarrow \Delta V > 0$$

→ NO NET ϕ_ν SHIFT : $\nu_0' = \nu_0$

→ FWHM = $\frac{\gamma}{2\pi}$ SMALL $\therefore \nu' \approx \nu_0'$

$$\therefore \frac{\xi}{c} = \frac{V - \nu_0'}{\nu_0'}$$

\therefore TRANSFORMATION : $\nu' \approx \nu - \nu_0 \frac{\xi}{c}$

\therefore FOR SINGLE ATOM:

$$\phi_{\nu'}^*(\nu' - \nu_0') = \phi_\nu^* \left(\left(\nu - \frac{\xi \nu_0}{c} \right) - \nu_0 \right)$$

∴ FOR ENSEMBLE IN STAR'S FRAME:

$$\phi_r(\nu - \nu_0) = \int_{-\infty}^{\infty} \phi_r^* \left(\left(\nu - \frac{\xi \nu_0}{c} \right) - \nu_0 \right) \frac{\eta_\xi(\xi)}{N} d\xi$$

LORENTZIAN 1D M-B DIST

$$\frac{\eta_\xi(\xi) d\xi}{N} = \frac{1}{\xi_0 \sqrt{\pi}} e^{-\xi^2 / \xi_0^2} d\xi$$

- AREA-NORMALIZED GAUSSIAN

$$- \xi_0 \equiv \overline{\xi} = \sqrt{\frac{2kT_{\text{kin}}}{m}}$$

$$\therefore \underline{\text{FWHM}} = 2 \xi_0 \sqrt{\ln 2}$$

$$\text{DOPPLER WIDTH, } \underline{\Delta v_D} \equiv \frac{\xi_0 v_0}{c}$$

$$= \frac{v_0}{c} \sqrt{\frac{2R T_{\text{kin}}}{m}}$$

$$\therefore \phi_v(v-v_0) =$$

$$\frac{1}{\sqrt{\pi} \underline{\Delta v_D}} \int_{v'=0}^{\infty} \frac{(\gamma/4\pi^2) e^{-\left(\frac{\Delta v}{\underline{\Delta v_D}}\right)^2}}{(v'-v)^2 + (\gamma/4\pi)^2} dv'$$

- VOIGT fn

$$\therefore \phi_v(v-v_0) =$$

$$\frac{1}{\sqrt{\pi} \Delta v_D} e^{-\left(\frac{\Delta v}{\Delta v_D}\right)^2} * \frac{\gamma/4\pi^2}{(v'-v_0)^2 + (\gamma/4\pi)^2}$$

- VOIGT fn

VOIGT fn, USEFUL FORM:

$$\phi_\nu(\nu - \nu_0) = \frac{H(a, \nu)}{\sqrt{\pi} \Delta\nu_D}$$

$$\rightarrow \underline{H(a, \nu)} \equiv \frac{\underline{a}}{\pi} \int_{y=-\infty}^{\infty} \frac{e^{-y^2}}{(\underline{\nu - y})^2 + \underline{a^2}} dy$$

$$\rightarrow a \equiv \frac{\gamma}{4\pi \Delta\nu_D}$$

$$\rightarrow \nu \equiv \frac{\Delta\nu}{\Delta\nu_D}$$

$$(y \equiv \xi / \xi_0)$$

CONTRIBUTION OF MICROTURBULENCE:

$$\Delta Y_D = \left(\frac{\xi_0 + \xi_T}{c} \right) V_0$$

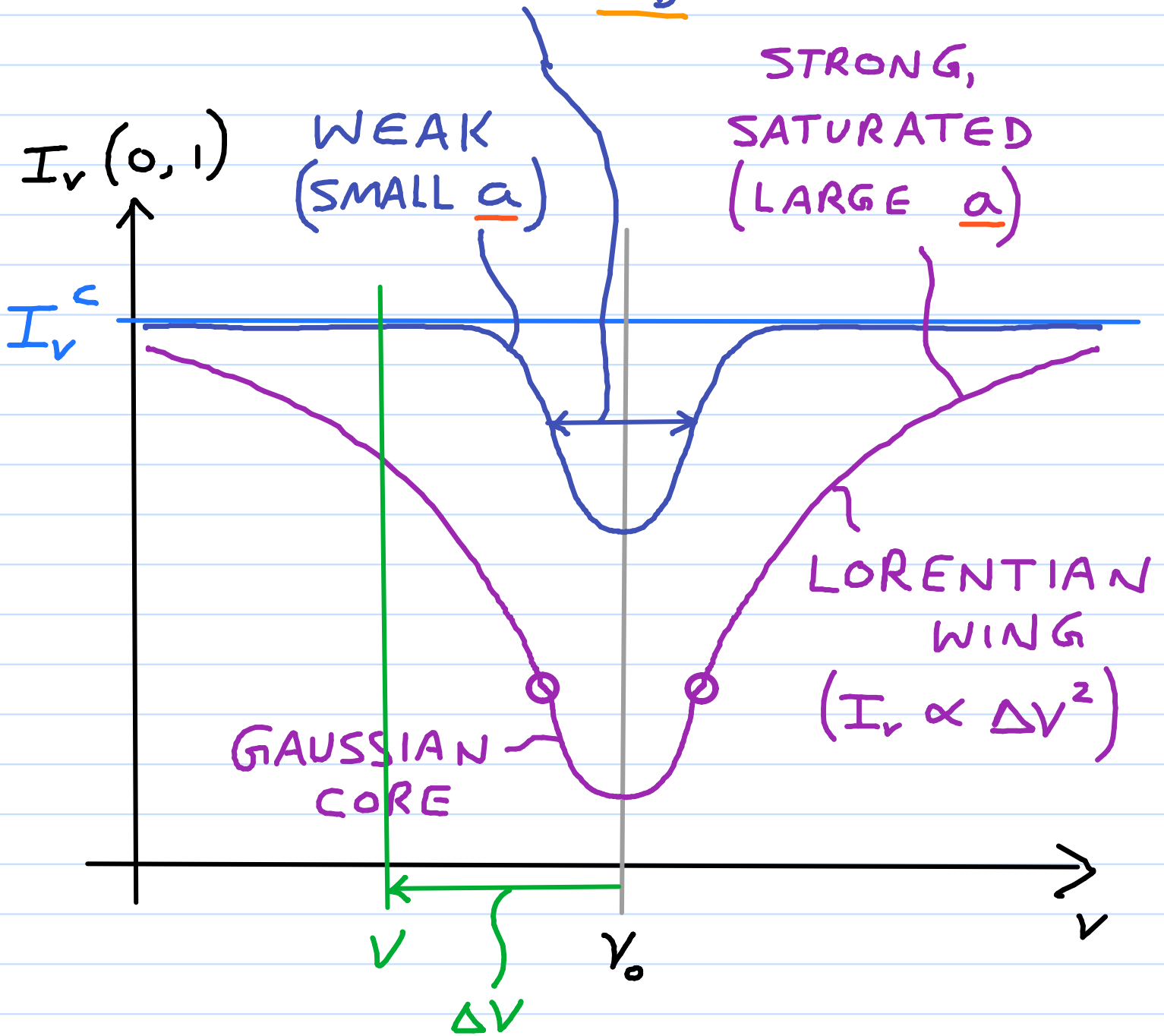
RECALL:

- ξ_T = MICROTURB. ν DISPERSION
- AN INPUT PARAMETER

NORMALLY: $\xi_T \gtrsim \xi_0$

VOIGT LINE PROFILES:

$$FWHM = 2 \Delta \nu_D \sqrt{\ln 2}$$



WEAK LINE: $\alpha_\nu^l / \alpha_\nu^c$ SMALL

STRONG LINE: $\alpha_\nu^l / \alpha_\nu^c$ LARGE