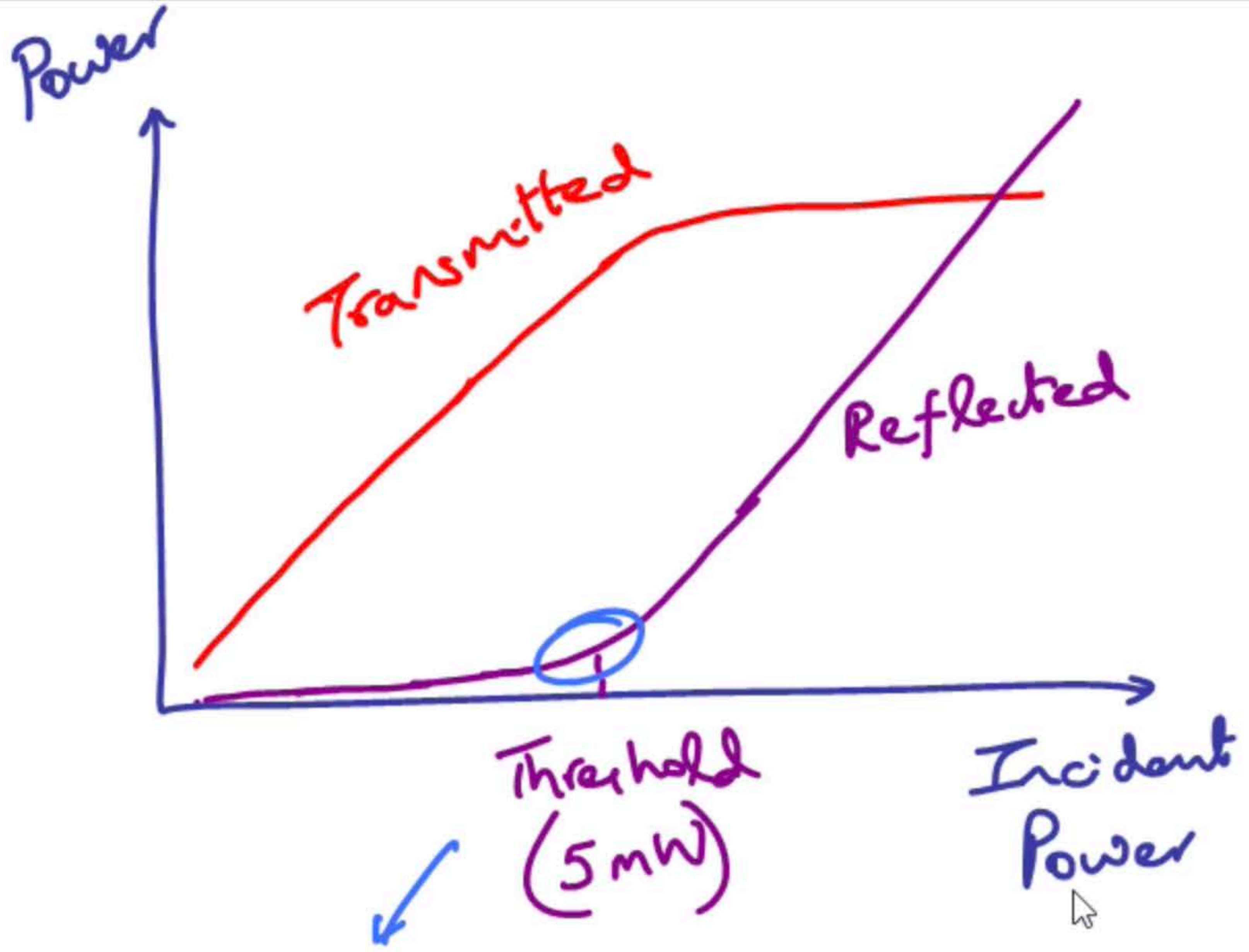
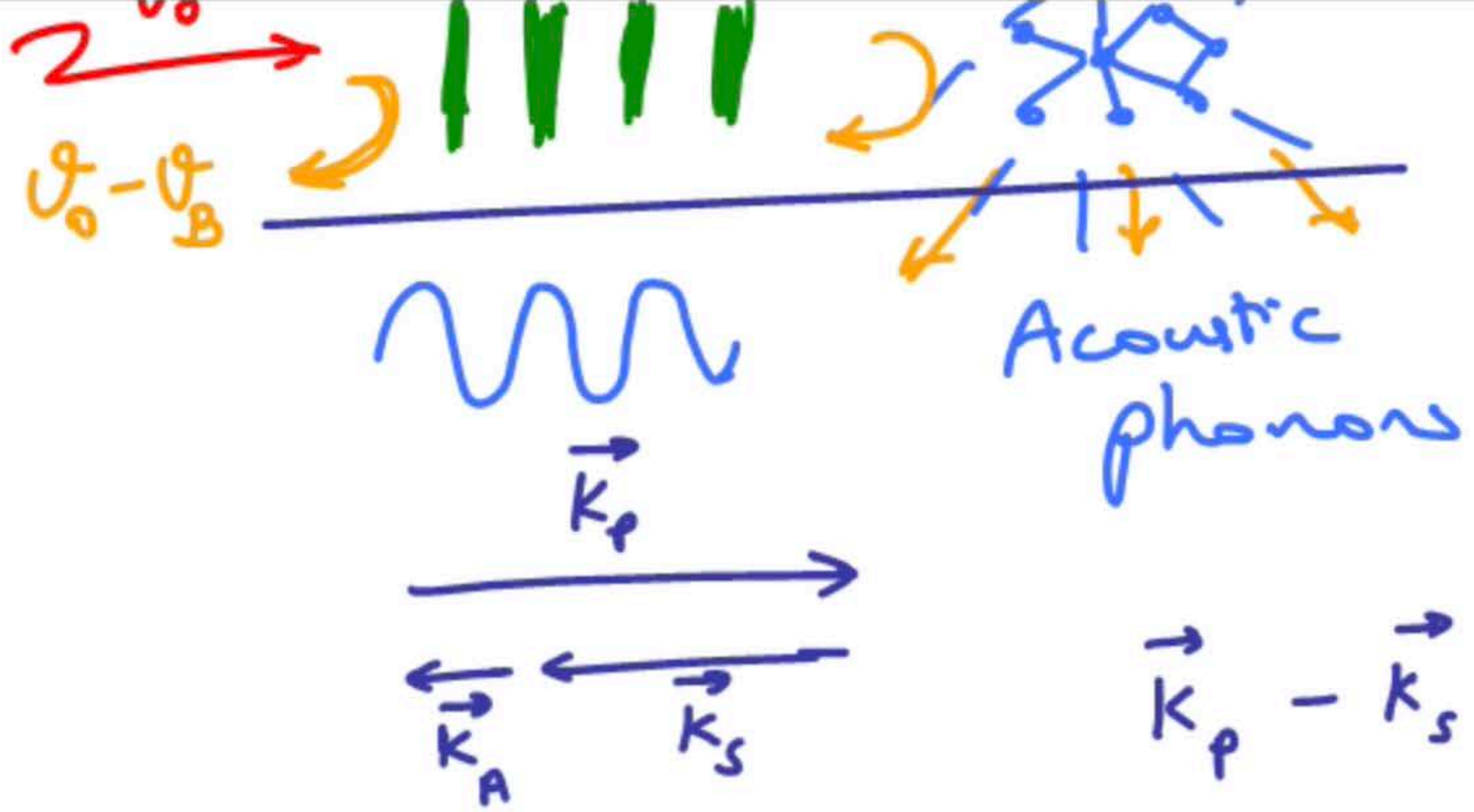



If source is highly coherent




$$\vec{k}_p - \vec{k}_s = \vec{k}_A$$

If $|k_p| \simeq |k_s|$ $\quad 2|k_p| = |k_A|$

$$2 \cdot \frac{\cancel{2\pi}}{\lambda_p} n_{eff} = \frac{\cancel{2\pi}\,\nu_B}{V_A}$$

$n_{eff} \simeq 1.5$

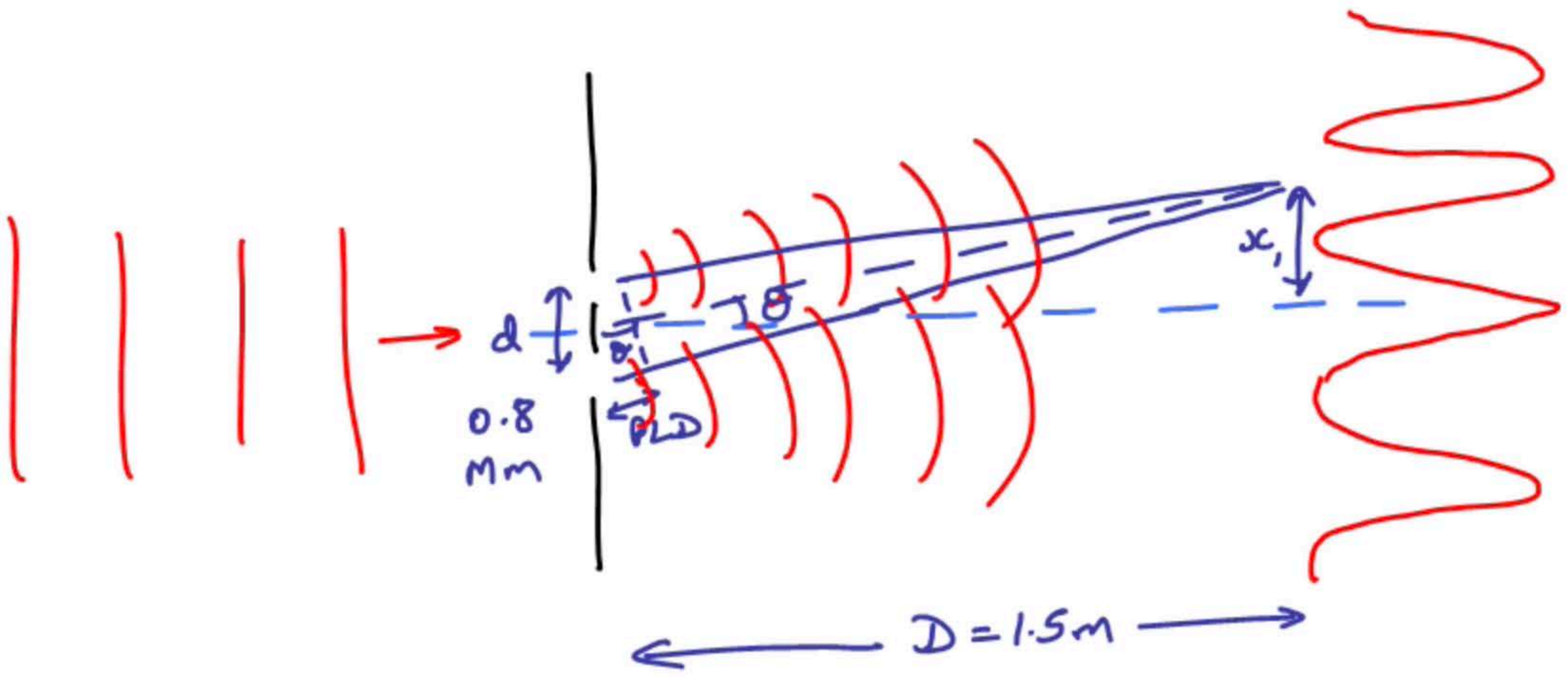
$V_A = 6$ km/s

$\lambda_p = 1.5\ \mu m$

$\Rightarrow \nu_B = 12$ GHz

$$\boxed{\nu_B = \frac{2 n_{eff} V_A}{\lambda_p}}$$

## Example 2: Can you discriminate different colours using Young's double slit?




$\lambda_{red} = 650$ nm

$\lambda_{orange} = 600$ nm

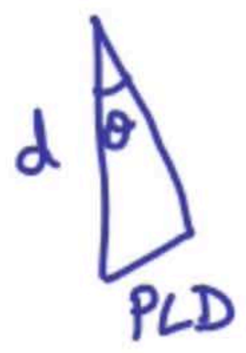
$x_1^r = D\tan(\theta_r)$

$= \underline{1.218 \text{ mm}}$

$x_1^o = \underline{1.125 \text{ mm}}$

$x_1^r - x_1^o = 93\ \mu m$

$\text{slit width} = \dfrac{x_1^r - x_1^o}{2} = \underline{46.5\ \mu m}$




$\sin\theta = \dfrac{PLD}{d}$

$PLD = d\sin\theta$

$\phi_1 - \phi_2 = 2\pi m$

$\dfrac{\cancel{2\pi}}{\lambda} n\, d \sin\theta_m = \cancel{2\pi} m$ (Constructive interference)

For $m = 1$ $(n = 1)$ $\theta_1^r = \sin^{-1}\left(\dfrac{\lambda_r}{d}\right) = \sin^{-1}\left(\dfrac{0.65\times10^{-6}}{0.8\times10^{-3}}\right) = 0.8$ mrad

Energy Conservation

$\omega_1 + \omega_2 = \omega_3 + \omega_4$

Momentum Conservation

$\vec{k}_1 + \vec{k}_2 = \vec{k}_3 + \vec{k}_4$

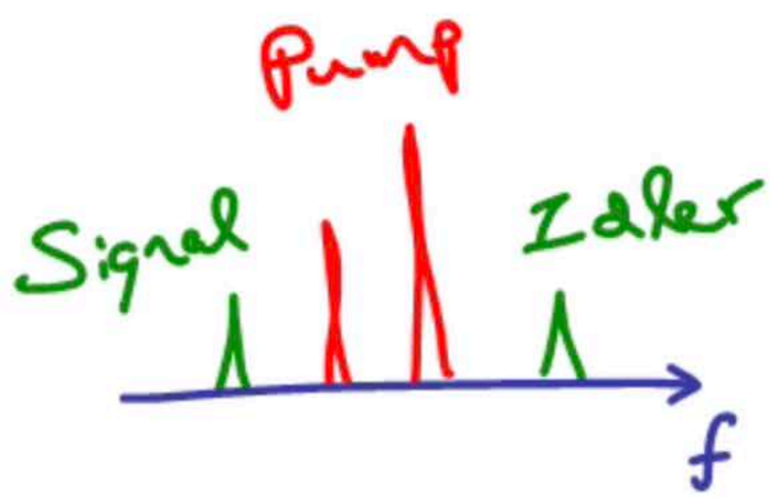
$$\begin{array}{l} E(\omega_1) \rightarrow \\ E(\omega_2) \rightarrow \\ E(\omega_3) \rightarrow \end{array} \boxed{\chi^{(3)}} \rightarrow \begin{array}{l} \omega_1 + \omega_2 + \omega_3 \\ \omega_1 - \omega_2 - \omega_3 \\ \vdots \end{array}$$

Four-wave mixing

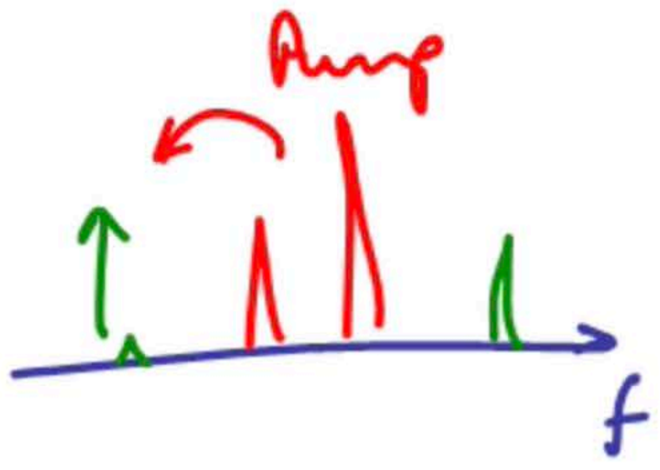
Self Phase Modulation / Kerr effect

Stimulated Raman Scattering

Stimulated Brillouin Scattering

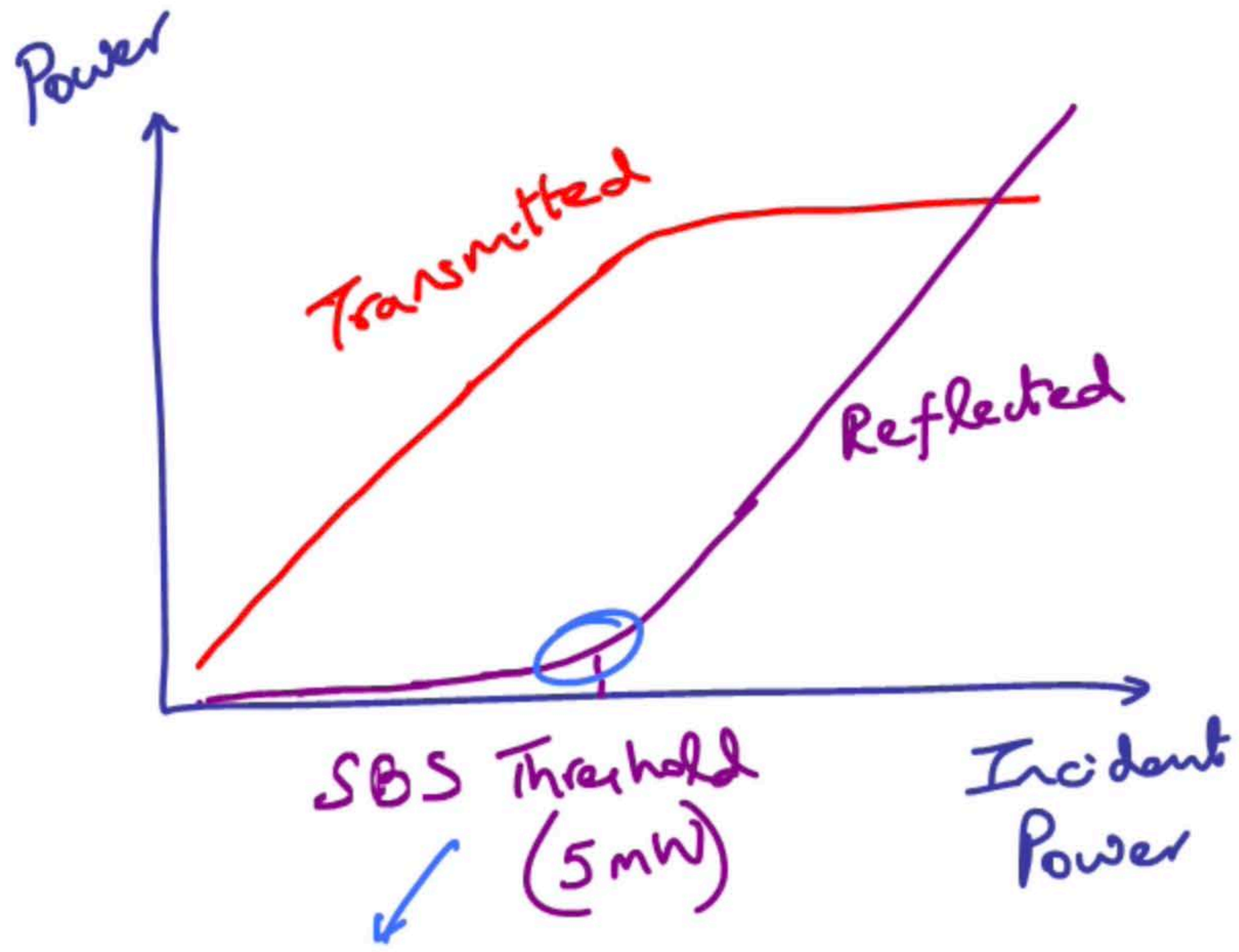



Wavelength Conversion

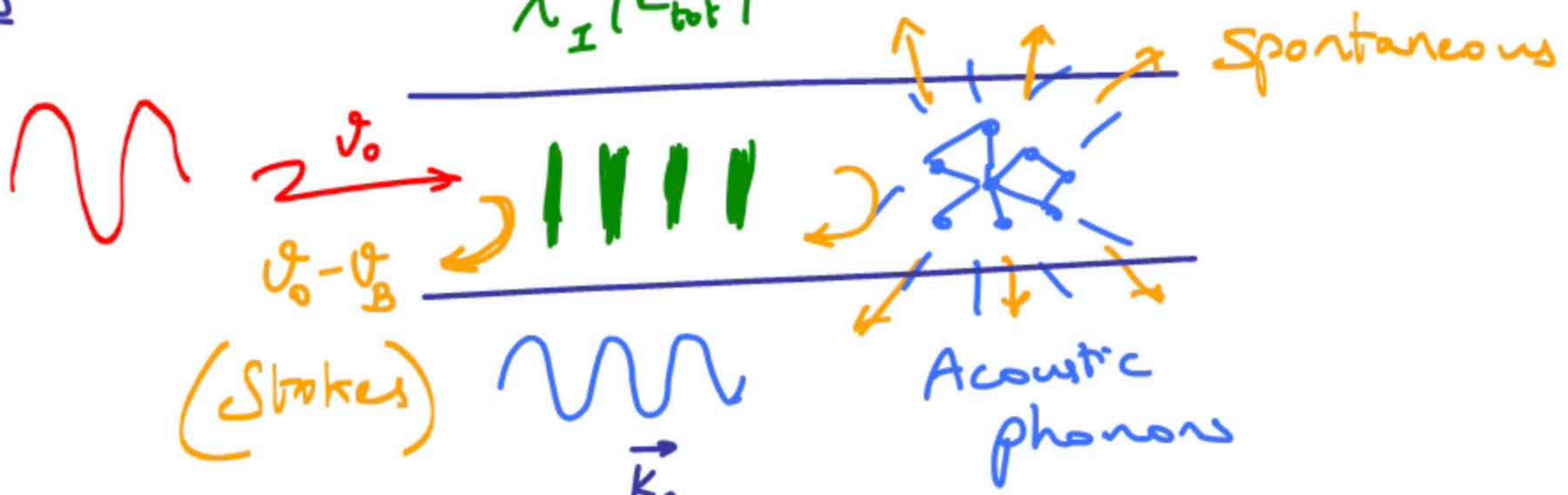


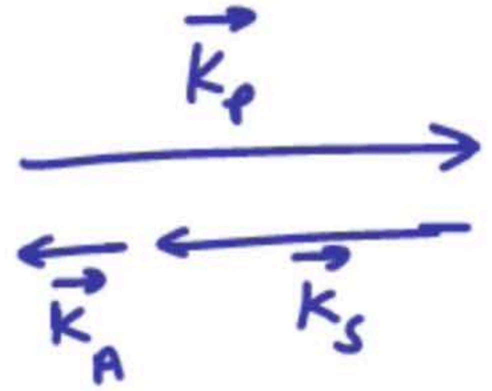

Parametric Amplification

# Stimulated Brillouin Scattering




$\chi^{(3)}_I |E_{tot}|^2 \rightarrow$ Electrostriction




$$\vec{k}_p - \vec{k}_s = \vec{k}_A$$

If $|k_p| \simeq |k_s|$ $\quad 2|k_p| = |k_A|$

$$2 \cdot \frac{\cancel{2\pi}}{\lambda_p} n_{eff} = \frac{\cancel{2\pi}\, \nu_B}{V_A}$$

$$\boxed{\nu_B = \frac{2 n_{eff} V_A}{\lambda_p}}$$

$n_{eff} \simeq 1.5$

$V_A = 6$ km/s

$\lambda_p = 1.5\ \mu m$

$\Rightarrow \nu_B = 12$ GHz

If source is highly coherent

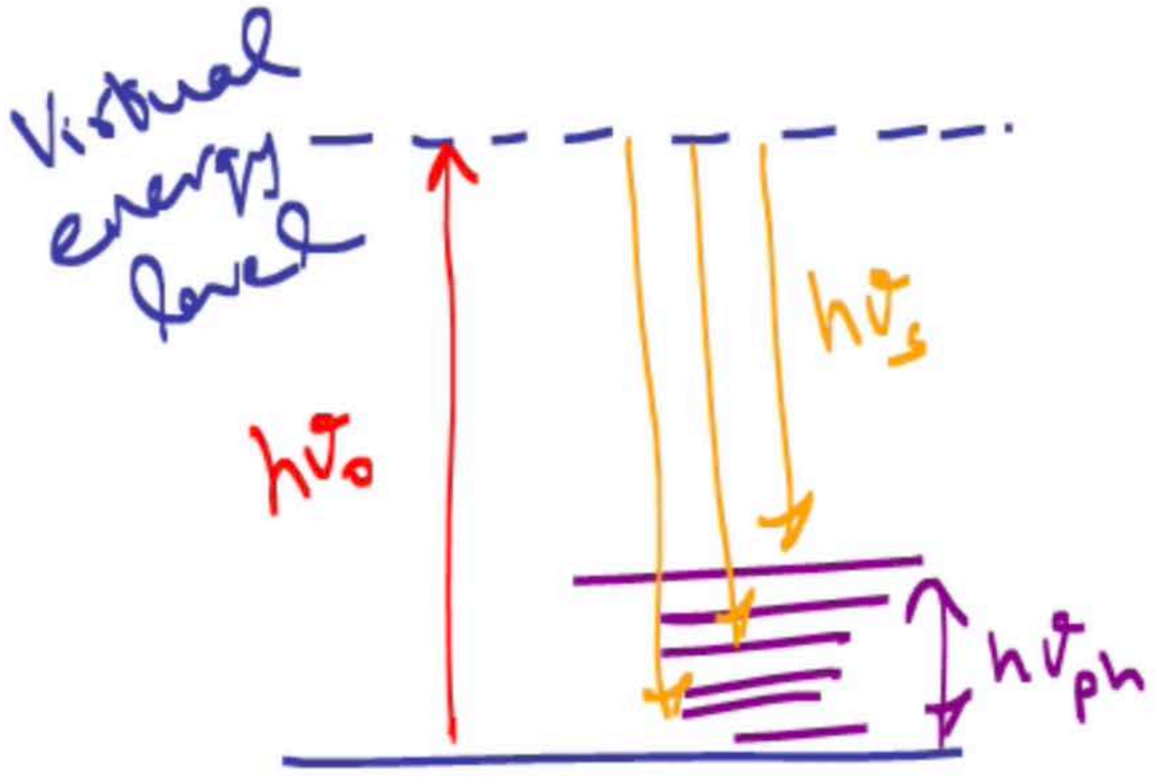
Optical Communications

Optical Sensing

# Stimulated Raman Scattering

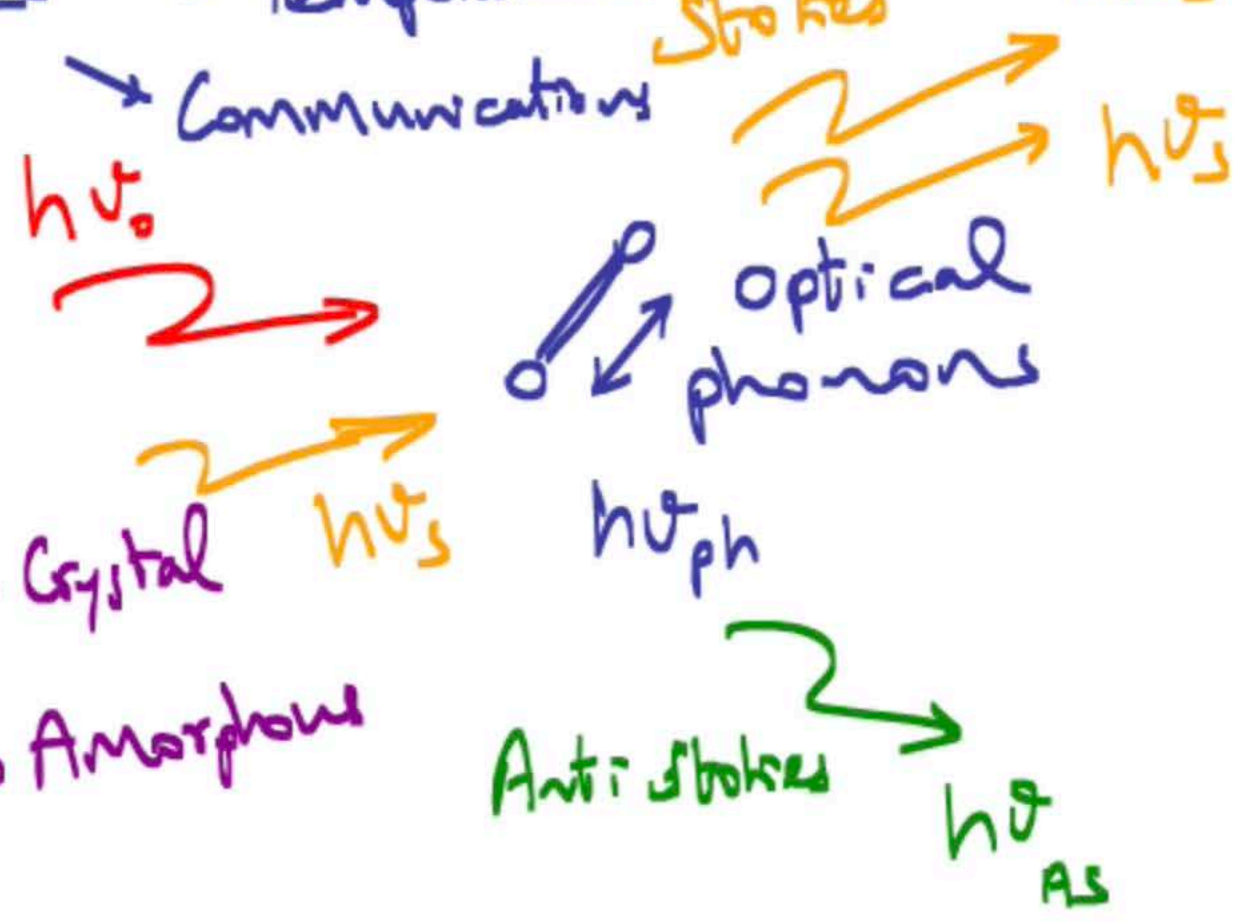
→ Spectroscopy
→ Temperature
→ Communications

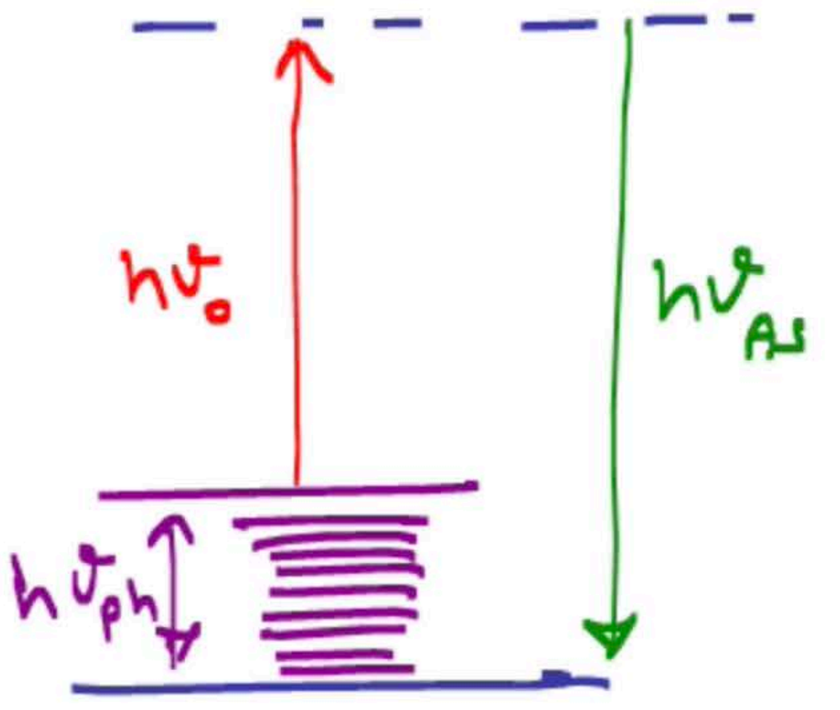
(Amplification)




Narrow → Crystal

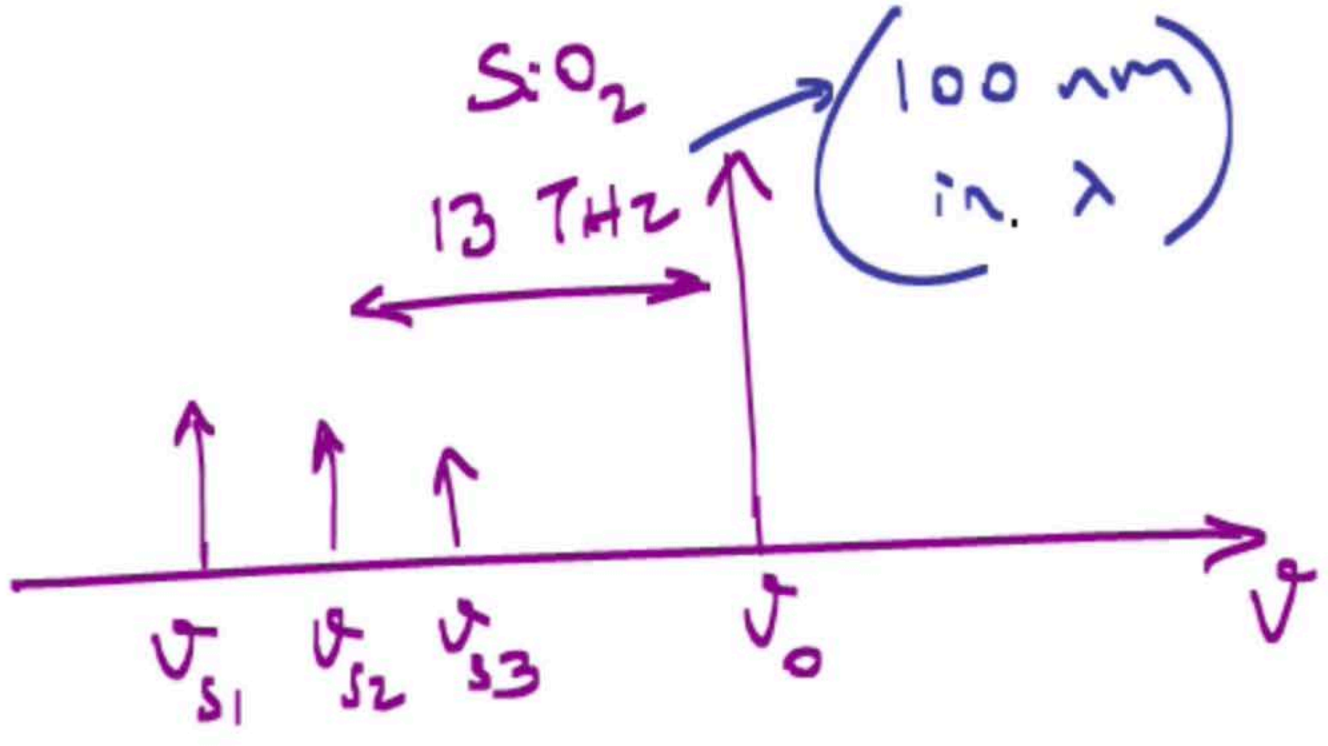
Broad → Amorphous



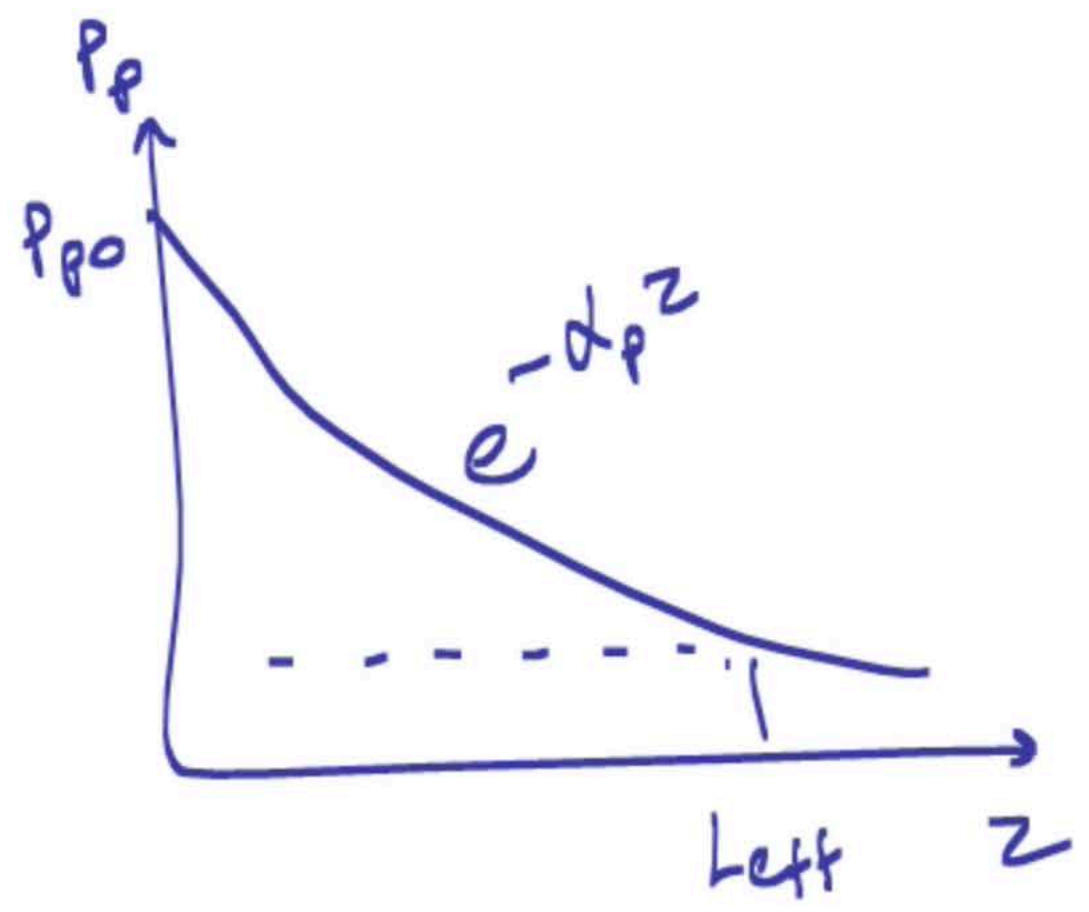




Stokes scattering

$(10^{-7})$




$$R = \frac{P_{AS}}{P_s} = \left(\frac{\lambda_s}{\lambda_{AS}}\right)^4 \exp\left(-\frac{h\nu_{ph}}{k_B T}\right)$$




SRS Attenuation

$$\frac{dP_s}{dz} = g_R \frac{P_p}{A_{eff}} \cdot P_s - \alpha_s P_s$$

Amplifier gain $G_R = \exp\left(\frac{g_R}{A_{eff}} P_{p0} \cdot L_{eff}\right)$

To achieve 20 dB gain,

$g_B = 6 \times 10^{-11}$ m/W

$g_R = 6 \times 10^{-14}$ m/W

$L_{eff} = 20$ km

$A_{eff} = 50\ \mu m^2$

$P_{p0} = \underline{0.2\ W}$