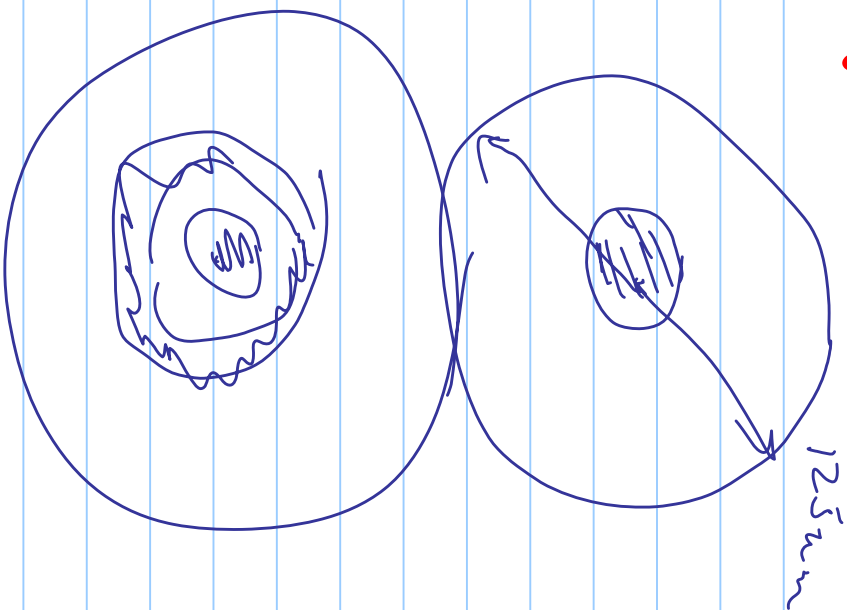
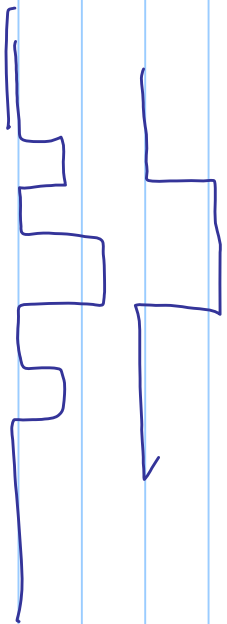
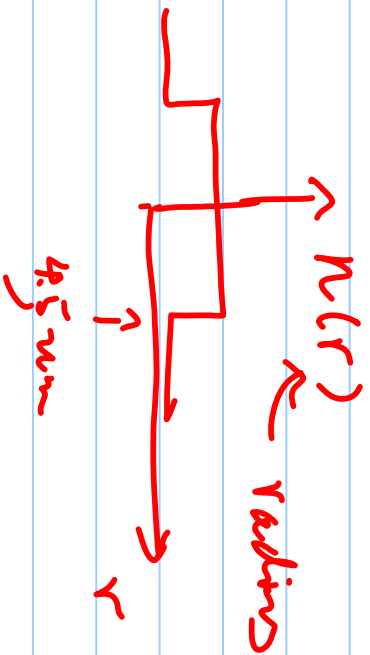


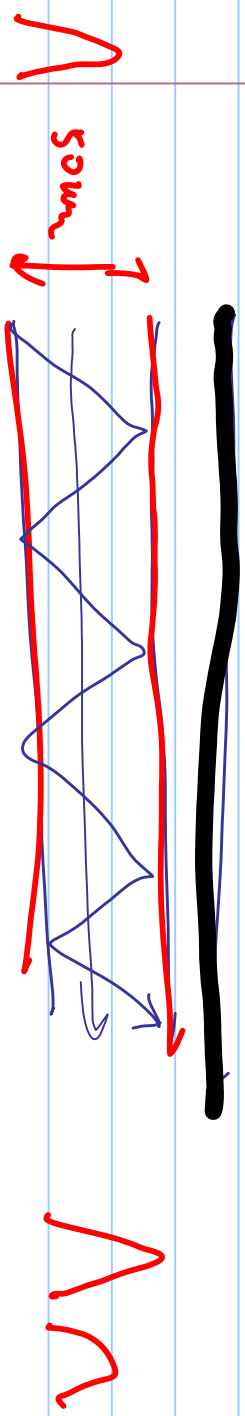
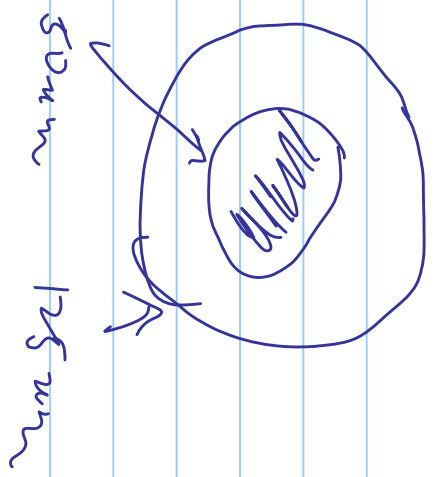
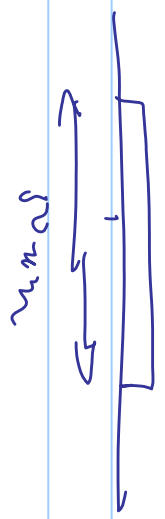


# Standard Single-Mode fiber



# Intermodal Dispersion

Multi mode fiber



Differential mode Dispersion

DMM

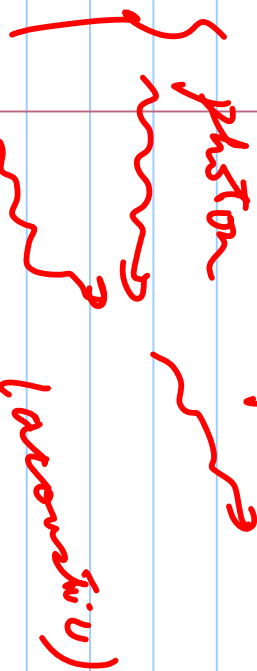
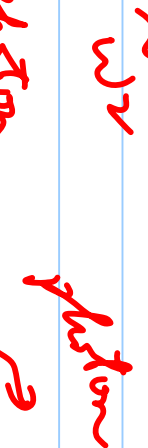
# Nonlinear Effect:

Scattering      Refraction  
(12)

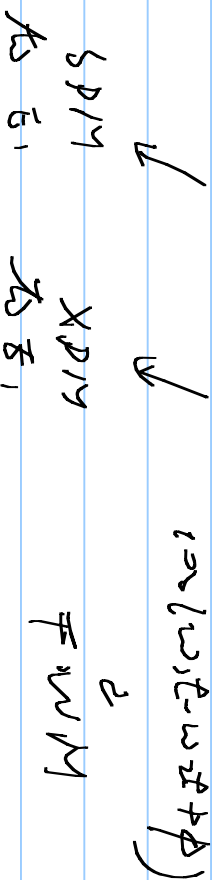
$$n_1 \omega_1 \quad \omega_2 \quad \omega_3$$

photon      photon      photon

$$n_1 \approx n_0 + n_2 \frac{P}{A_{eff}}$$



$$\epsilon = |\epsilon_1|^2 + |\epsilon_2|^2 + 2|\epsilon_1||\epsilon_2|$$

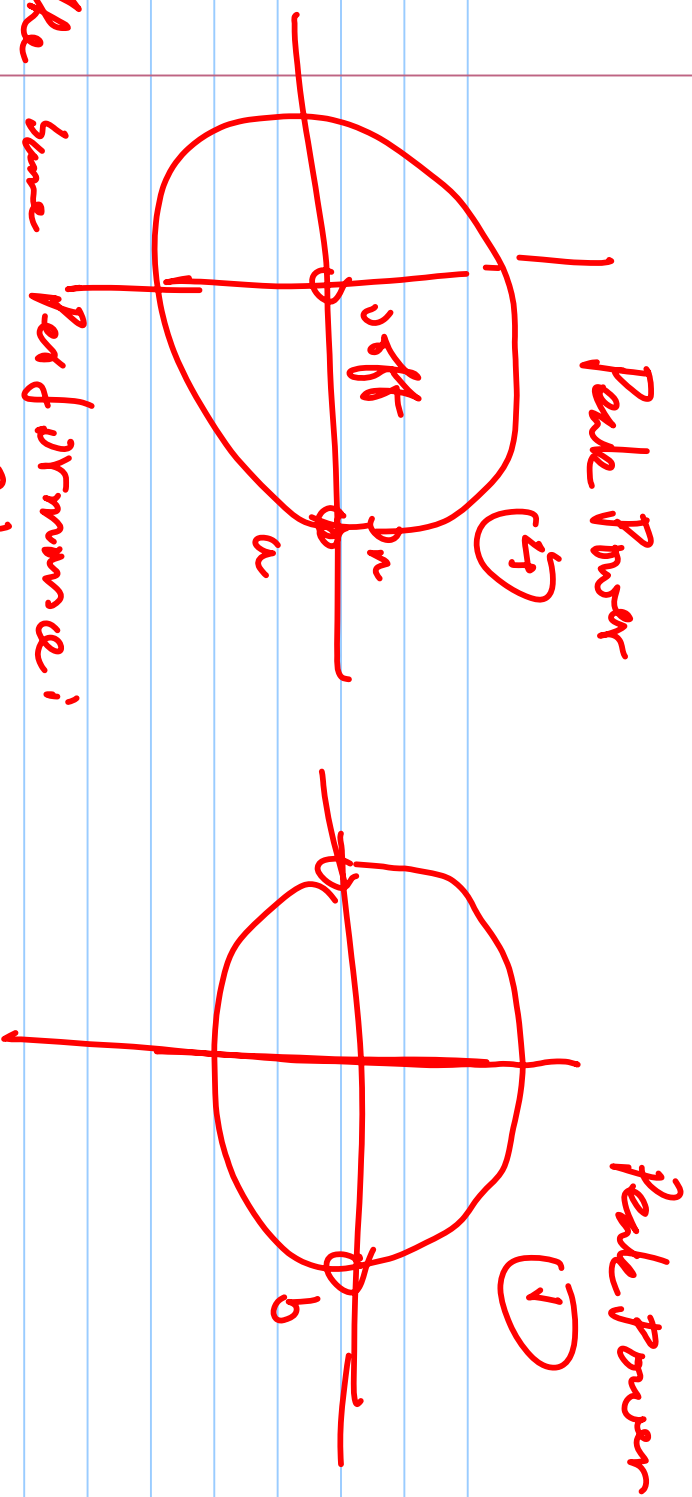


Stimulated Raman Scattering

$$S_{R_r} \approx P_{\text{sig}}$$

If you want to detect a signal,  
you need  $N_s$  photons/bit,

$$P = \frac{N_s h\nu}{T} \leftarrow \underline{\text{bit interval}}$$



The same Per of DRmin a:

$$a = 2b$$

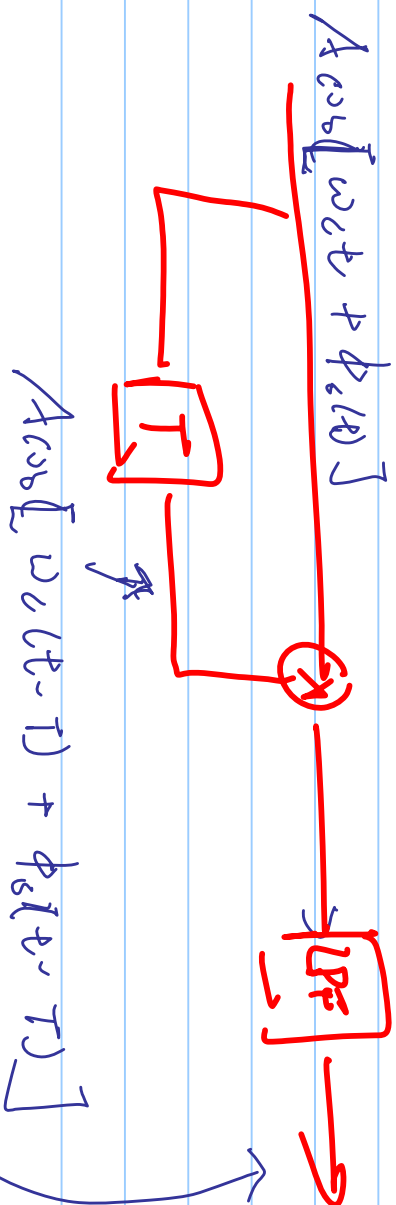
$$P_{\text{avg}} = \frac{1}{2} a^2 + \frac{1}{2} 0^2 = \frac{a^2}{2} = \underline{\underline{2b^2}}$$

$$P_{\text{DRK}} = b^2$$

Disclaimer: All things are wrong

Phase Error:

DPSK Rx:



$\omega_c T \text{ mod } 2\pi = \theta$

$$A^2 \cos[\omega_c T + \phi_s(t) - \phi_s(t-T)]$$

Phase error

$$\theta, \pi$$

$$\omega_c \sim 190 \text{ THz} = 1.9 \times 10^{14} \text{ Hz}$$

$$\theta = \theta_1 + \theta_2$$

$$\theta_1, \theta_2$$

independent;

$$P_{\theta}(x) = P_{\theta_1}(x) \otimes P_{\theta_2}(x)$$

↖ separation.

$$F \Downarrow F'$$

$$\psi_{\theta_1}(x) \quad \psi_{\theta_2}(x) \quad \Leftarrow \text{characteristic functions}$$

$$\psi_{\theta}(x) = \psi_{\theta_1}(x) \psi_{\theta_2}(x)$$