$D = D_{material} + D_{waveguide}$

↓ yerçekimi bağlı

$\lambda \to 0 \Rightarrow D = 0$

$D = S \Delta\lambda$

↓ dispersion slope

$S = \left(\frac{2\pi c}{\lambda^2}\right)^2 \frac{d\beta_2}{d\omega} + \left(\frac{4\pi c}{\lambda^3}\right) \beta_2$

$S = \frac{dD}{d\lambda}$

$B L |S| (\Delta\nu)^2 < 1$

σ_λ

$\sigma = \sqrt{(\sigma_0^2 + \sigma_D^2)}$

↓ output pulse width

fiber Losses

Beer-Lambert Law

$\frac{dP}{dz} = -\alpha P$

$\frac{P_{out}}{P_{in}} = e^{-\alpha L}$

confinement factor

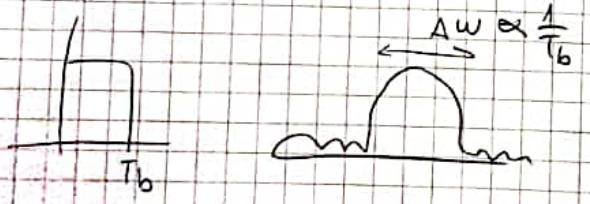
$$\Gamma = \frac{P_{core}}{P_{total}} = 1 - e^{\frac{-2a^2}{w^2}}$$

group velocity dispersion

$$v_g = \left(\frac{d\beta}{dw}\right)^{-1} = \frac{c}{n_g}$$

$$\bar{n_g} = \bar{n} + w\frac{d\bar{n}}{dw}$$

$$\Delta T = L\beta_2 \Delta w \quad \rightarrow \quad \beta_2 = \frac{d^2\beta}{dw^2}$$



$$\Delta w = -\frac{2\pi c}{\lambda^2}\Delta\lambda$$

$$\Delta T = D L \Delta\lambda = \frac{d}{d\lambda}\left(\frac{1}{v_g}\right)\Delta\lambda$$

Dispersion factor

$$D = -\frac{2\pi c}{\lambda^2}\beta_2 = \frac{d}{d\lambda}\left(\frac{1}{v_g}\right)$$

$B_L|D|\Delta\lambda < 1$

$B\Delta T < 1$

→ propagation constant

$$b = \frac{\beta/k_0 - n_2}{n_1 - n_2} = \frac{\bar{n} - n_2}{n_1 - n_2}$$

$V < 2.4$ single Mode fiber

$$V = \left(\frac{2\pi}{\lambda}\right) a\, n_1 \sqrt{2\Delta}$$

→ yarıçap

→ $n_1 - n_2$

$$k_0 = \frac{2\pi f}{c} = \frac{\omega}{c} = \frac{2\pi}{\lambda}$$

$n_1 > \bar{n} \geq 2$

# of modes $\frac{V^2}{2}$

beat length $L_B = \frac{\lambda}{B_m}$ $\quad B_m = |\bar{n}_x - \bar{n}_y|$

↓ degree of birefringence

$$E_x = A\, e^{-\frac{\rho^2}{w^2}} e^{j\beta_z}$$

$a_m = \pi w^2$ mode area

Spot size $\frac{w}{a} \approx 0.65 + 1.619\, V^{-\frac{3}{2}} + 2.879\, V^{-6}$

$n_1 \simeq n_2 \Rightarrow \quad NA = n_1 \left(2 \frac{(n_1 - n_2)}{n_1} \right)^{1/2}$ $\quad \Delta = \frac{n_1 - n_2}{n_1}$

$$\Delta T = \frac{n_1}{c} \left(\frac{L}{\sin \phi_c} - L \right) = \frac{L n_1^2}{c} \Delta$$

(longest path)

$v = \frac{c}{n_1}$ speed of propagation

$v = \frac{c}{\sqrt{\varepsilon_{r1}}} \rightarrow n_1$

$\Delta T < T_b = 1/B$ olmalı

$$BL < \frac{n_2 c}{n_1^2 \Delta}$$

$B \Delta T < 1$

$\frac{\Delta T}{L} = \frac{n_1 \Delta^2}{8L}$ Grond index fiber

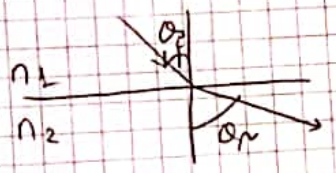
$BL < \frac{8c}{n_1 \Delta^2}$

Fiber Optic

0.2 dB/km

%1 after 100km

$n_1 > n_2$



$\theta_r > \theta_i$

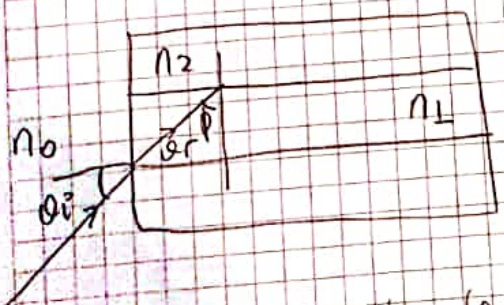
Step index fiber

$$n_0 \sin\theta_i = n_1 \sin\theta_r$$

$$\sin\phi_c = \frac{n_2}{n_1}$$

$\phi < \phi_c \Rightarrow$ refraction

θ_r büyük olmalı



$$\underbrace{n_0 \sin\theta_i}_{(NA)} = n_1 \cos\phi_c = (n_1^2 - n_2^2)^{1/2}$$