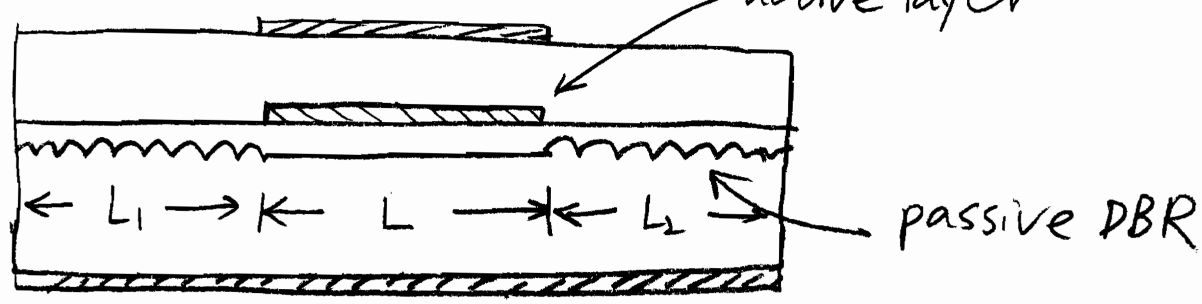
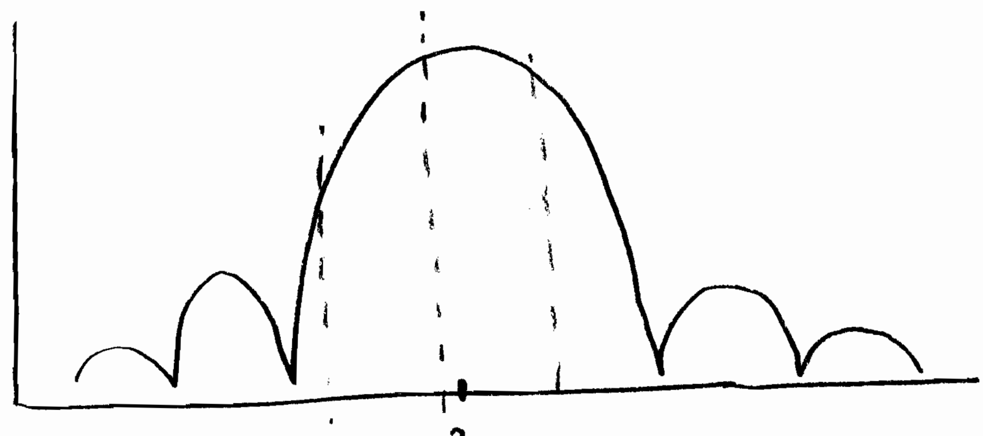
Distributed Bragg Reflector (DBR) Laser

* Optical cavity formed by passive gratings (DBR's)



* Wavelength-dependent reflectivity



- Lasing wavelength $\approx \lambda_{Bragg} = 2 \cdot n_{eff} \cdot \Lambda$
- Exact wavelength is determined by modes
  ↳ With 0.5 mode spacing from the peak reflectivity

Threshold condition:

$$r_1 r_2 e^{i 2 \cdot \beta \cdot L} = 1$$

: round-trip condition for field.

$$\beta = \beta_0 - i \frac{1}{2} (\Gamma g - \alpha)$$

$$r_1 = \sqrt{R_1}\, e^{i\phi_1}$$
$$r_2 = \sqrt{R_2}\, e^{i\phi_2}$$

$$\Rightarrow \quad g_{th} = \frac{1}{\Gamma}(\alpha + \alpha_m) = \frac{1}{\Gamma}\left(\alpha + \frac{1}{2L}\ln\frac{1}{R_1 R_2}\right)$$

$$2\beta_0 L + \phi_1 + \phi_2 = 2m\pi$$

$$r_1 = |r_1| \cdot e^{i\phi_1}$$
$$= \frac{-\kappa^* \sinh S L_1}{\Delta\beta \sinh S L_1 + i S \cosh S L_1}$$

$$\gamma = iS = \sqrt{\delta^2 - |\kappa|^2} = i\sqrt{|\kappa|^2 - \delta^2}$$
$$S = \sqrt{|\kappa|^2 - \delta^2}$$

Note ϕ_1 is a function of β_0 also.

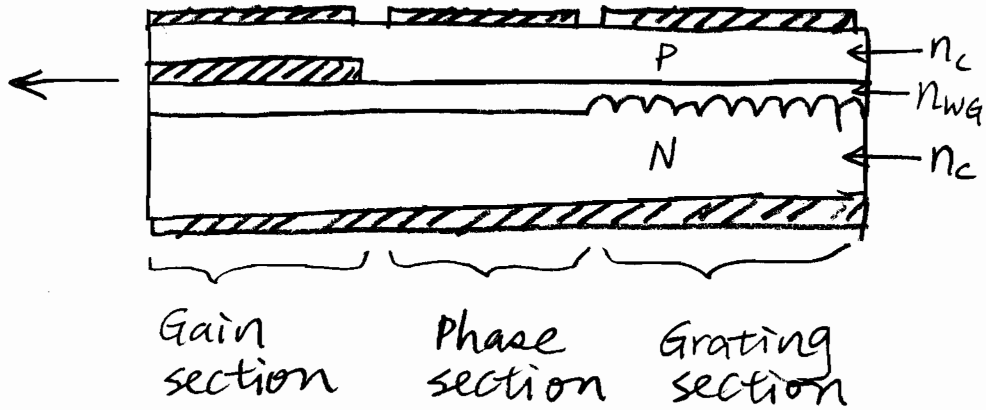
$$\frac{d\phi_1}{d\beta} = 2 \cdot L_{eff,1}$$

Likewise $\frac{d\phi_2}{d\beta} = 2 \cdot L_{eff,2}$

$$\Rightarrow \quad 2\beta_0 (L + L_{eff,1} + L_{eff,2}) = 2m\pi$$

* Mode spacing is determined by
active section length + effective grating lengths

* A unique benefits of DBR → Tunable laser



$$\lambda_{Bragg} = 2 \cdot n_{eff} \cdot \Lambda$$

↑ effective index of grating section.

$$n_{eff} = \Gamma \, n_{WG} + (1-\Gamma)\, n_c$$

n_{WG} can be changed by injecting carriers (called free-carrier plasma effect)

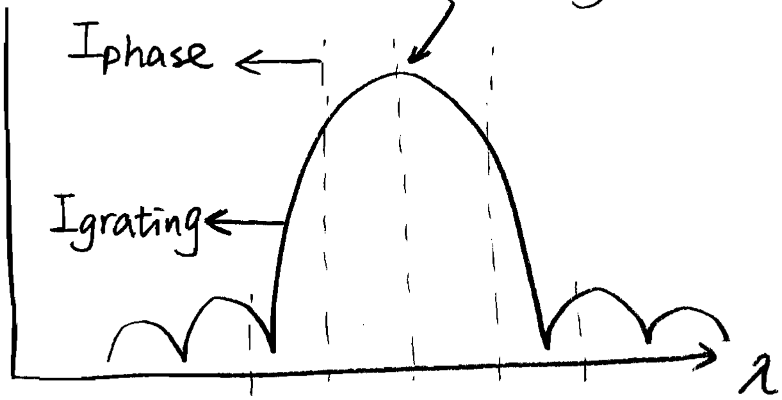
Typically

$$\frac{dn}{dN} = -10^{-20} \ cm^3$$

e.g. $\Delta N = 10^{18} \ cm^3$

$n \rightarrow n - 0.01$

$\frac{\Delta n}{n} \sim 0.1\%$ to 1%

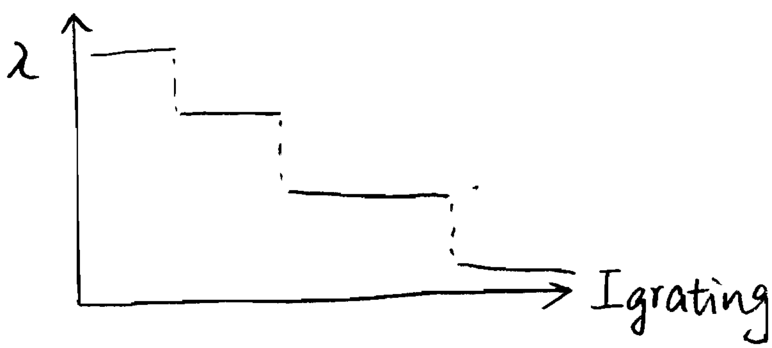


Increasing grating section current (Igrating) moves reflectivity curve to shorter λ side, but does not change mode position much

⇒ discrete tuning (step ≅ mode spacing)

Increasing phase section current (Iphase) moves modes to shorter λ side, but does not change the reflectivity curve

⇒ continuous tuning with $\Delta\lambda_{max}$ = mode sp.



⇒ Combining Igrating and Iphase

⇒ Continuous tuning over a large range