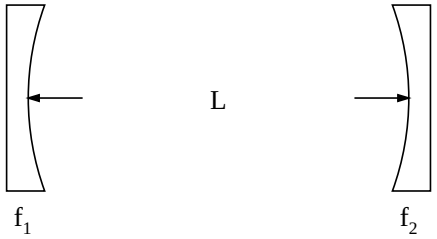
1 Öldulengdarval í geislaholum

1.1 Lengdarhættir



Krafa um styrkjandi samliðun milli umferða í holinu gefur:

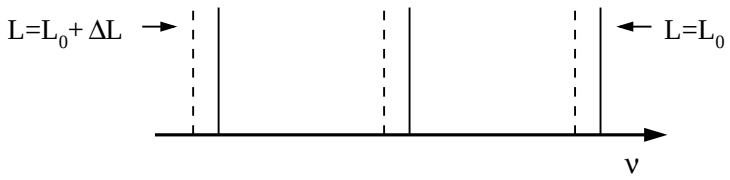
$$L = q\,\frac{\lambda}{2} \qquad q \text{ heil tala}$$

$$\Longrightarrow \qquad \nu \;=\; q\,\frac{c}{2L} \;=\; q\,\Delta\nu$$

$\Delta\nu$ free spectral range

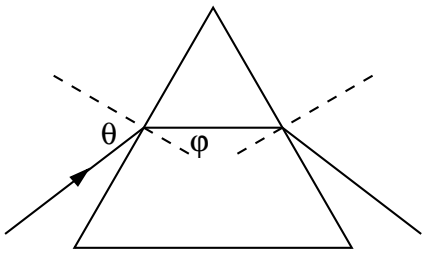
Lengdarhættir eru jafndreifðir í tíðni. Fínstilling á tíðni fæst með breytingu á lengd holsins.

$$d\nu \;=\; -q\,\frac{c}{2L}\,\frac{dL}{L} \;=\; -q\,\frac{c}{2L}\,\frac{dL}{q\lambda/2} \;=\; \Delta\nu\,\frac{dL}{\lambda/2}$$



1.2 Aðgreining lengdarhátta

Prisma



$$\theta \;=\; \theta_B$$

$$\Longrightarrow \qquad \cos\theta \;=\; \sin\varphi$$

Fyrri skilflötur:

$$sin\theta \;=\; (n+\Delta n)\sin(\varphi+\Delta\varphi_1) \;\simeq\; (n+\Delta n)(\sin\varphi+\Delta\varphi_1\cos\varphi)$$

$$\Longrightarrow \qquad \Delta\varphi_1 \;=\; -\frac{\Delta n}{n}\,\tan\varphi \;=\; -\frac{\Delta n}{n^2}$$

Seinni skilflötur: $\Delta\varphi_2 \;=\; -\Delta\varphi_1$

$$\sin(\theta+\Delta\theta) \;=\; (n+\Delta n)\sin(\varphi+\Delta\varphi_2)$$

$$\sin\theta + \Delta\theta\cos\theta \;=\; (n+\Delta n)(\sin\varphi + \frac{\Delta n}{n^2}\cos\varphi)$$

$$\Longrightarrow \qquad \Delta\theta \;=\; \frac{\Delta n}{n}\cot\varphi + \Delta n \;=\; 2\Delta n$$

$$\frac{d\theta}{d\lambda} \;=\; 2\,\frac{dn}{d\lambda} \qquad\qquad \frac{d\theta}{d\nu} \;=\; 2\,\frac{dn}{d\nu}$$

NaCl við 10μm: $\frac{dn}{d\lambda} = 5\cdot 10^{-3}/\mu$m

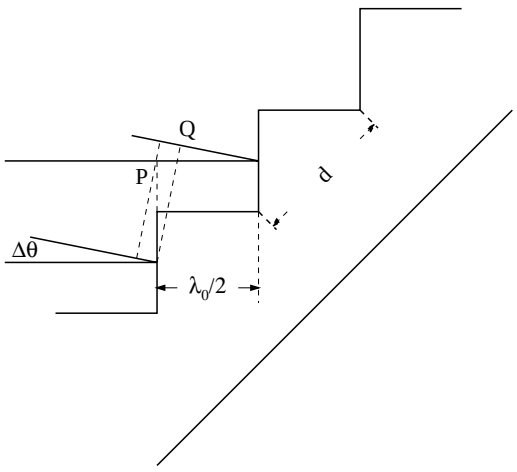
$$\frac{dn}{d\nu} \;=\; \frac{dn}{d\lambda}\frac{d\lambda}{d\nu} \;=\; -\frac{dn}{d\lambda}\frac{\lambda^2}{c} \;=\; 1.5\cdot 10^{-15}/\text{MHz}$$

$$\frac{d\theta}{d\lambda} \;=\; 10^{-2}\text{rad}/\mu\text{m}$$

Setjum L=30cm $\qquad\Longrightarrow\qquad$ $\Delta\nu = \frac{c}{2L} = 500$MHz

$$\Delta\theta \;=\; -7.5\cdot 10^{-13}\text{rad}$$

Speglunargreiða



Í Littrow-stöðu greiðu speglast geisli með öldulengd λ_0 í sjálfan sig. Geisli með öldulengd $\lambda_0+\Delta\lambda$ speglast í stefnuna $\Delta\theta$ vegna víxlunar milli hlutgeisla frá mismunandi þrepum.

$$\lambda_0+\Delta\lambda = |PQ|$$

$$= \frac{\lambda_0}{2}(1+\cos\Delta\theta) - \sqrt{d^2-(\lambda_0/2)^2}\,\sin\Delta\theta$$

Til fyrstu gráðu er

$$\Delta\theta \;=\; -\frac{\Delta\lambda}{\sqrt{d^2-(\lambda_0/2)^2}}$$

$$\Longrightarrow\; \frac{d\theta}{d\lambda} \;=\; -\frac{1}{\sqrt{d^2-(\lambda_0/2)^2}}$$

Við $\lambda_0 = 10\mu$m og $d = \frac{1}{150}$mm fæst $\quad\frac{d\theta}{d\lambda} \;=\; 0.23\text{rad}/\mu\text{m}$.