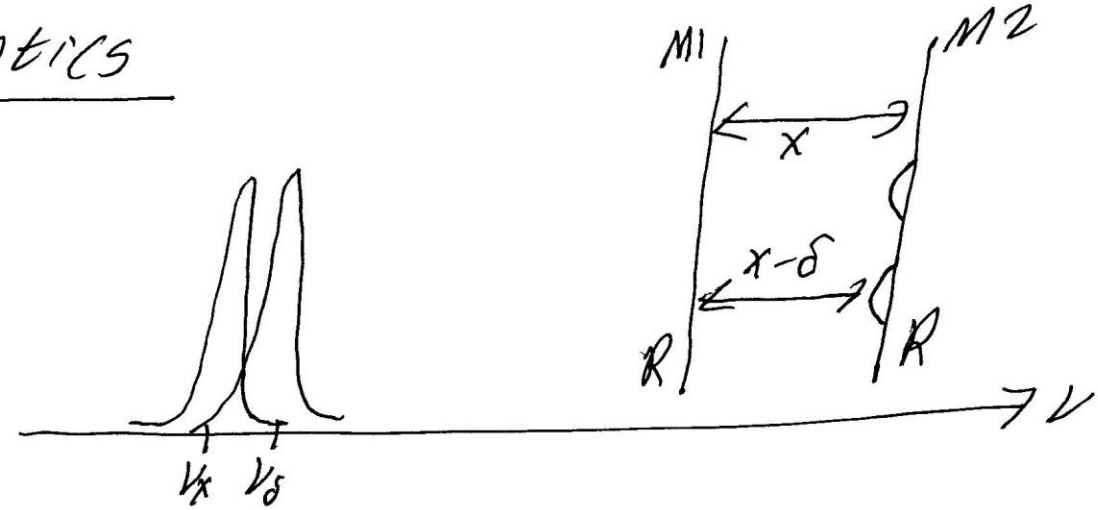
Optics

a.)



$\nu_x - \nu_\delta \sim \Delta\nu_{1/2}$

F = finesse = $\frac{\pi\sqrt{R}}{1-R}$

$$\frac{mc}{2nx} - \frac{mc}{2n(x-\delta)} \sim \frac{\Delta\nu}{F}$$

$$\frac{m\cancel{c}}{\cancel{2n}x} - \frac{m\cancel{c}}{\cancel{2n}(x-\delta)} \sim \frac{\cancel{c}}{\cancel{2n}xF}$$

$$m\left(\frac{1}{x} - \frac{1}{x-\delta}\right) \sim \frac{1}{x}\frac{1}{F}$$

$$m\left(\frac{x-\delta-x}{x^2-x\delta}\right) \sim \frac{1}{x}\frac{1}{F}$$

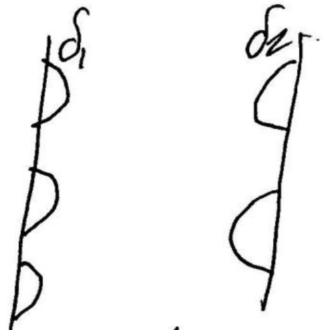
$x^2 >> x\delta$ $\qquad \delta \sim \frac{x}{m}\frac{1}{F}$

$x = \frac{m\lambda}{2}$

$\frac{x}{m} = \frac{\lambda}{2}$

$$\boxed{\delta \sim \frac{\lambda}{2F}}$$

b.)



$\delta_{eff} \sim \sqrt{\delta_1^2 + \delta_2^2}$

if $\delta_1 \sim \delta_2$, then

$\delta_{eff} \sim \sqrt{2}\,\delta$

roughness is often approximated as a Gaussian distribution

C.) "Loss" is no longer dictated by R but rather by phase uncertainty

phase coherence

so we must utilize an effective "R" obtained from the reduced Finesse.

$$g_{th} = \alpha - \frac{1}{x} \ln R$$

get R from measured Finesse, F

$$F = \frac{\pi \sqrt{R}}{1-R}$$

$$\frac{\pi^2 R}{1-2R+R^2} = F^2$$

$$\pi^2 R = F^2 - 2F^2 R + F^2 R^2$$

$$R = \frac{(2F^2+\pi^2) - \sqrt{(2F^2+\pi^2)^2 - 4F^4}}{2F^2}$$

$$R = \frac{(2F^2+\pi^2) - \sqrt{4F^2\pi^2 + \pi^4}}{2F^2}$$

If $F \gg \pi$ (which is always the case in such a situation)

$$R \approx \frac{2F^2 - \sqrt{4F^2\pi^2}}{2F^2}$$

$$R = 1 - \frac{\pi}{F}$$

$$\boxed{g_{th} = \alpha - \frac{1}{x} \ln\left(1 - \frac{\pi}{F}\right)}$$

$$g_{th} = \alpha - \frac{1}{\ell} \ln\left(1 - \frac{\pi}{\frac{\lambda}{2\delta}}\right)$$

$$\boxed{g_{th} = \alpha - \frac{1}{\ell} \ln\left(1 - \frac{2\pi\delta}{\lambda}\right)}$$