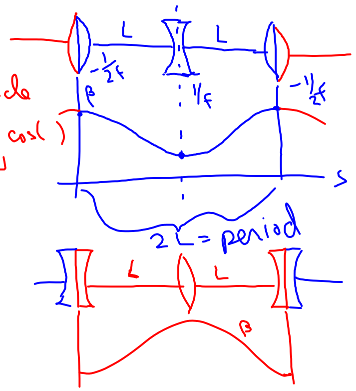
Hints:

(12)

For particle

$x \sim \sqrt{\beta} \cos(\ )$



$$\frac{1}{2}\text{Trace}(F_o d_o) = 1 - \frac{1}{2}\frac{L^2}{F^2}$$

$$= \cos\mu = 1 - 2\sin^2\frac{\mu}{2}$$

(13) Design Orbit $\Rightarrow \begin{pmatrix} x \\ x' \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$

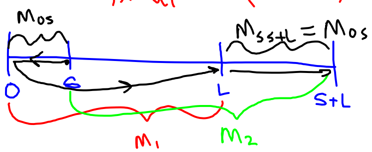
Kick $\Rightarrow \begin{pmatrix} x \\ x' \end{pmatrix} = \begin{pmatrix} 0 \\ \theta \end{pmatrix}$

$x = A\sqrt{\beta}\cos\psi + B\sqrt{\beta}\sin\psi$

x' = derivative

Evaluate x, x' at $s=0$ $(\psi(s=0)=0)$

(14)



$$M_2 = M_{s\,s+L}\, M_1\, M_{s0}$$

$$= M_{0s} M_1 M_{0s}^{-1}$$

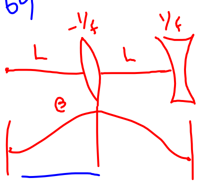
$$(I\cos\mu + J_2\sin\mu) = M_{0s}(I\cos\mu + J_1\sin\mu)M_{0s}^{-1}$$

(15) See Eq. 3.69

(16) Let $s = 0 - L$

$\beta(2L-s) = \beta(s)$

$\alpha(2L-s) = -\alpha(s)$



① Do matrix of FODO drawn above to get $\beta_0, \alpha_0, \gamma_0$

$$\begin{bmatrix}\cos\mu+\alpha_0\sin\mu & \beta_0\sin\mu \\ -\gamma_0\sin\mu & \cos\mu-\alpha_0\sin\mu\end{bmatrix} = M$$

$$\cos\mu = \frac{\mathrm{Tr}\, M}{2} \qquad \alpha\sin\mu = \frac{M_{11}-M_{22}}{2}$$

$$\beta_0 = m_{12}/\sin\mu \qquad \gamma_0 = -m_{21}/\sin\mu$$

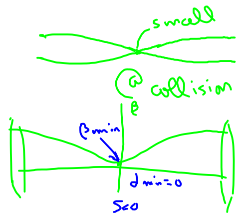
② use problem 14 and $m_{0s} = \begin{pmatrix}1 & s\\ 0 & 1\end{pmatrix}$ to get α, β, γ

for $0<s<L$

③ $$\mu = 2\pi\nu = \int_0^L \frac{ds}{\beta} + \int_L^{2L}\frac{ds}{\beta} = 2\int_0^L \frac{ds}{\beta}$$

symmetry $= \int_0^L \frac{ds}{\beta}$

⑰ Collider



$$\beta(s) = \beta_{min} + \frac{1}{\beta_{min}} s^2$$

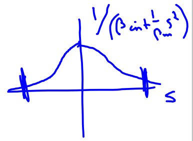
From ⑭

$$\beta = \beta_{min} + m_{12}^2\gamma_{min} - 2\alpha_{min} m_{11} m_{12}$$

$$m = \begin{pmatrix}1 & s\\ 0 & 1\end{pmatrix}$$

$$\alpha_{min} = -\frac{\beta'_{min}}{2} = 0$$

$$\gamma_{min} = \frac{1+\alpha_{min}^2}{\beta_{min}} = \frac{1}{\beta_{min}}$$



$$\Delta\Psi_{\text{interaction region}} = \int\frac{ds}{\beta} = \int_{-\infty}^{\infty}\frac{ds}{\beta_{min} + \frac{1}{\beta_{min}} s^2} = \int_{-\infty}^{\infty}\frac{d(s/\beta_{min})}{1+(s/\beta_{min})^2} = \pi$$