Fermilab

AP-Note-90-006

ACCELERATOR PHYSICS DEPARTMENT

TITLE: γ_T Jump Schemes

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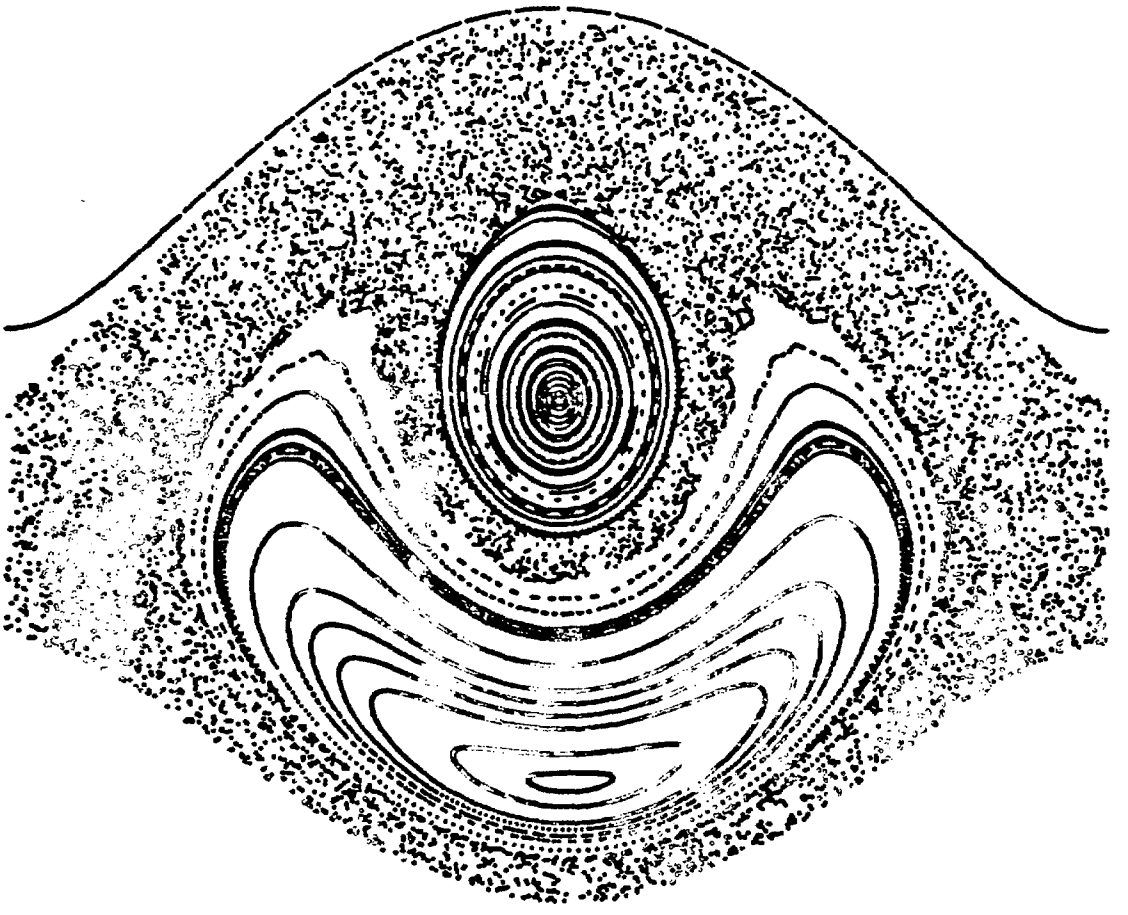


April 6 '90

γ_T jumps

$$\frac{1}{\gamma_T^2} = \alpha = \frac{\int \eta \, d\theta}{C}$$

η - dispersion
C - circumference
$d\theta = \frac{ds}{R}$

- Consider MI-like lattices of 90° FODO cells
- Cells are either completely full or completely empty of dipoles (except $\frac{1}{2}$ full Disp. Sups.)
- Quadrupoles are zero length

$$\frac{1}{\gamma_T^2} = \frac{1}{RC} \int \eta \, ds \sim \langle \eta \rangle$$ average dispersion

- Consider small quadrupole perturbations, δq

$$\eta = \eta_0 + \tilde{\eta}$$ ← perturbation

$$\eta_0'' + K \eta_0 = \frac{1}{R}$$ Normal dispersion

$$\tilde{\eta}'' + K \tilde{\eta} = \delta q \cdot \eta_0$$ Exactly like closed orbit perturbations!!

$$\tilde{\eta} = \delta q \cdot \eta_{oe} \sqrt{\beta_e \beta} \cdot \sin(\phi - \phi_e)$$ Local perturbat

OR

$$\tilde{\eta} = \delta q \cdot \eta_{oe} \sqrt{\beta_e \beta} \cdot \frac{\cos(\pi Q - |\phi - \phi_e|)}{2 \sin(\pi Q)}$$ Global closed

AND $$\Delta\left(\frac{1}{\gamma_T^2}\right) = \frac{1}{RC} \int_{ARCS} \tilde{\eta} \quad \sim \langle \tilde{\eta} \rangle$$

THAT IS ① WANT A D.C. DISPERSION PERTURBATIO

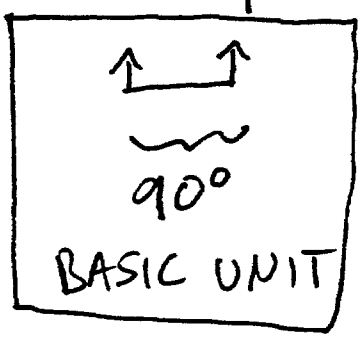
② CAN USE SIMPLE VECTORS

FOUR CONDITIONS

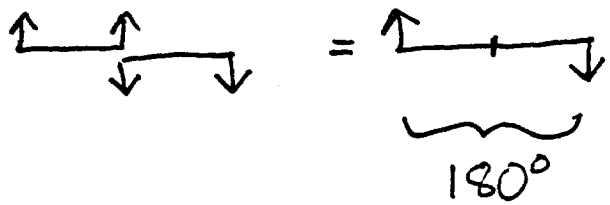
1) $\langle \tilde{\eta} \rangle$ IS large !!
2) $\frac{\Delta\beta}{\beta} \sim \sum \delta q \beta \sin(2\phi) = 0$ "outside" perturbed regio
3) $\Delta Q \sim \delta q \beta = 0$
4) $\tilde{\eta} \sim \sum \delta q \cdot \beta \cdot \eta_0 \sin(\phi) = 0$ "outside"

$\boxed{\text{OR}}$ η_{MAX} be as small as possible

* No $\frac{\Delta\beta}{\beta}$ perturbation if δq are paired

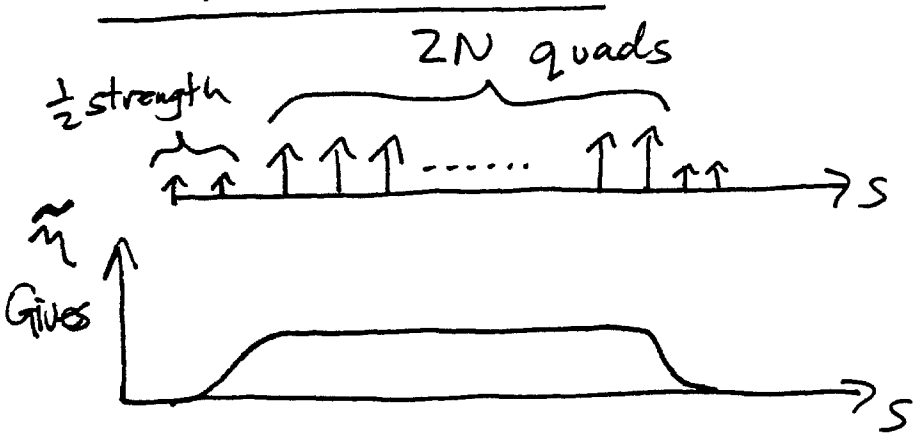


e.g.



for dispersion effects

* <u>SIMPLE SOLUTION</u>



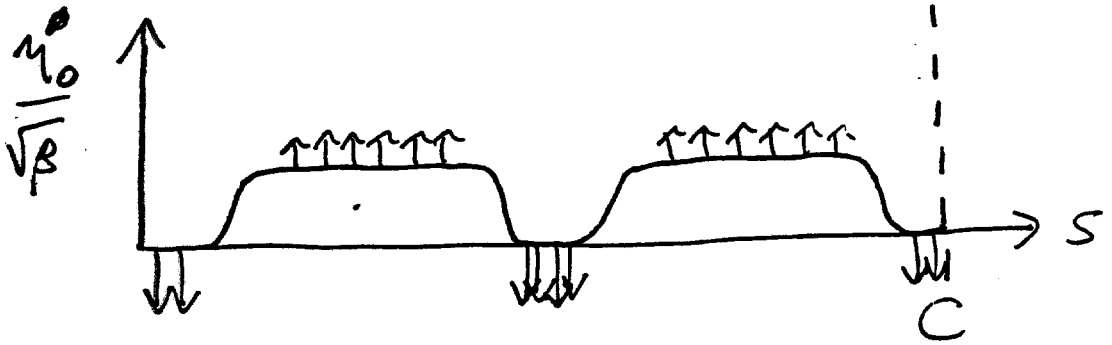
DC offset,
No large peaks,
localised !!

<u>BUT</u> ACCUMULATES LARGE TUNE SHIFT

$$\Delta\gamma_T \approx 1 \Rightarrow \Delta Q \approx 1$$

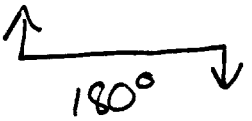
$$\frac{\frac{\Delta\gamma_T}{\gamma_T}}{\frac{\Delta q}{q}} \approx 1.5 \Rightarrow 3\% \text{ perturbation: } \gamma_T = 20 \rightarrow 19$$

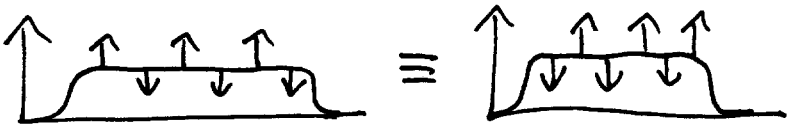
* CAN COMPENSATE IN $\eta_0 = 0$ STRAIGHTS



<u>But is not completely attractive</u> ????

(where is the expense? magnets? PS's? cables?)

* In <u>idealized</u> lattice,  has $\Delta\gamma_T = 0$

By symmetry 

* Situation is like a pendulum:

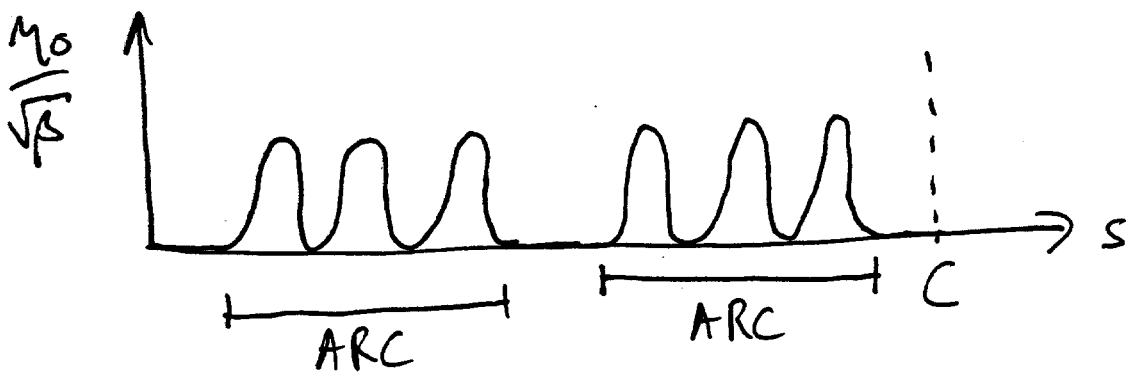
Want to maintain a d.c. angle ($\langle\tilde{\eta}\rangle > 0$) by equal numbers of +ve and -ve kicks

<u>CAN'T BE DONE, WITH</u>
- local solution
- 'smooth' η_0
- smooth bending

* <u>non local solution?</u> don't want to depend on Q

* <u>Non smooth η° ?</u>

example, remove dispersion suppressors!



- No obvious strong solution (proof?)
- η_{MAX} is doubled (or more)

* <u>Non smooth bending?</u> remove dipole(s) every N'th cell - as in Imaginary γ_T
- instead of emphasising $\gamma_T^2 < 0$, emphasise $\Delta\gamma_T$ sensitivity

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$\boxed{\text{IS REMOVAL OF TUNE PERTURBATION IN THE STRAIGHTS } \underline{\underline{\text{SO}}} \text{ BAD ?}}$