Klaus' Question

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Klaus' question.

- Klaus asked Yannis a great question on Monday:
- When will you finish choosing options?
- Frozen spin idea came out of BNL E821.
- $E \approx aBc\beta\gamma^2$. $a_\mu = 0.0011659 \ldots$
- $\frac{d\vec{S}}{dt} = \vec{d} \times \left(\vec{E} + \underline{\vec{v} \times \vec{B}}\right)$
- At Heidelberg Lepton-Moments Conf. "What about D". $a_D = -0.18$.
- $\mu \to evv$.

Muon → Deuteron

- Ed asked me if I would like to go to Gronigen, NL for polarized Deuteron beam time. I said yes!
- Ed asked me if I would like to go to Julich, Germany for polarized Deuteron beam time. I said yes!
- Had a great time!
- I stopped when the FNAL muon g-2 experiment was approved.
- Moving the magnet, beam-spin dynamics systematics, etc.

Deuteron → Proton

- Yannis asked me what about the proton?
- $E \approx aBc\beta\gamma^2$
- Proton has a huge anomaly! We would like zero anomaly.
- Use all electric ring at the magic energy.
- Proton polarimeter fom peaks at magic energy = 233MeV!
- Took a vote.
- Decided to do proton first.

All Electric → Hybrid

- The all-electric ring has a very annoying requirement.
- Stray radial magnetic field must be very small.
- Yannis said how about electric bending and magnetic focusing?
- Stray radial magnetic field means the average radial magnetic field is not zero on the ideal design orbit.
- However, it is zero on the closed orbit.
- Much, much relaxed requirement.

Answer to Klaus' question.

- I don't think there is another permutation for Yannis to come up with.
- This is it!

Extra

Symmetries

- CW/CCW.
- Very symmetric ring: 24-fold symmetry.
- Radial and longitudinal polarization.
- Alternate quadrupole polarities.
- For E821 and E989, we found systematics that weren’t in the CDR.
- We understood them.
- If you understand them, you are done.
- Must get down to the level of sensitivity to find the real systematics.

closed orbit deviates from the ideal orbit,

$$\frac{d^2x}{ds^2} + k(s)x = -\frac{\Delta B}{B\rho} \equiv F(s). \tag{3.2}$$

Since the field error is in the dipoles, ΔB depends on s, *but not on* x. The Courant-Snyder transformation yields

$$\frac{d^2\eta}{d\phi^2} + \nu^2\eta = \nu^2\beta^{3/2}F(\phi). \tag{3.3}$$

The Green function method gives the periodic solution

$$\eta(\phi) = \frac{\nu}{2\sin(\pi\nu)}\int_{\phi}^{\phi+2\pi}\beta^{3/2}F(\phi')\cos[\nu(\pi+\phi-\phi')]\,d\phi' \tag{3.4}$$

as long as $\nu \neq$ integer. We see that if $\nu =$ integer, then the closed orbit $\to \infty$, i.e. even a small field error ΔB will cause a large closed orbit distortion. Since small errors ΔB are always present, this makes it undesirable to choose a tune close to an integer.