PHYS 690C: Homework, set #3

due date: April 3rd in my mailbox.

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exercise 1: Consider a symmetric quadrupole triplet in the thin lens approximation. In the horizontal plan it consists of a lens of focal lens f separated by a distance d from a lens with focal length $-f/2$ which is separated by d from the third lens that has a focal length f.

1. What are the horizontal and vertical transfer matrix?
2. What are the focal lengths in the two plans?
3. What are the locations of the focal points?
4. Sketch the trajectories for particles starting with $x'_0 = y'_0 = 0$.

exercise 2: The optical system sketched in Fig. 1 makes a translation in x. The system consists of two (opposite polarity) sector dipole magnets with a bending angle Φ and two focusing quadrupoles. You can treat these quadrupoles as thin lenses with same focal length f. The drift spaces between the elements are defined in the Figure. Find the value of f such to make the system achromatic, i.e. such that the dispersion function is zero at the exit of the system.

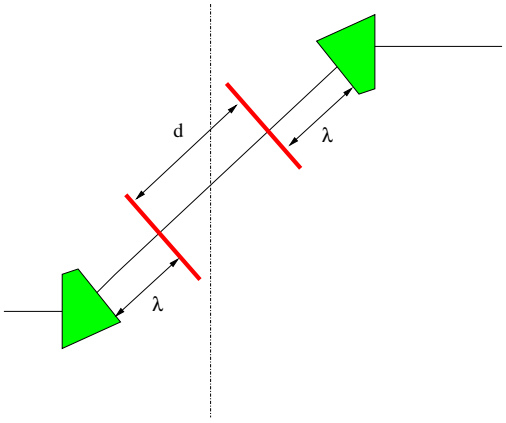

Figure 1: Figure for problem 2. The red lines represent the quadrupole locations.

exercise 3: A FODO lattice is an array of "cells" where each cell consists of a focusing quadrupole with a focal length f, a drift space of length L, a defocusing quadrupole with focal length f, and finally a drift space of length L [FODO is an acronym for **F**ocusing -**O** (0) gradient (i.e. drift) - **D**efocusing -**O** (0) gradient]. The symmetry is easier to see if you start and stop the cell in the middle of the quadrupoles as illustrated in Fig. 2.

1. Compute the 1-cell transfer matrix from the middle of a focusing quadrupole as shown in Fig. 2.

2. What are the α and β in the middle of the focusing quadrupole?

3. What are the α and β in the middle of the defocusing quadrupole?

4. What is the phase advance per half-cell as a function of f/L?

5. Sketch the β-function when the phase advance per half-cell is 60°

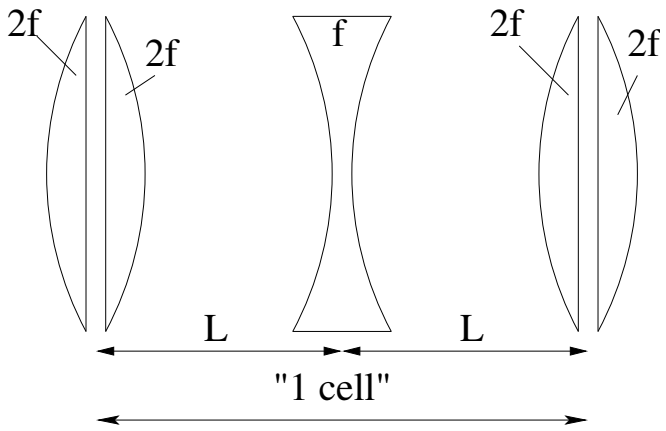

Figure 2: Figure for problem 3.