Accelerator Physics Homework #3

1. We have a ring consisting of N simple FODO cells. Assume that the drifts are completely filled with bending sector magnets; that is,$ N\left(2θ\right)=2π$, where $θ$ is the bend of the magnet in one drift. Show that the dispersion in the middle of the quads is

(hint: start by showing $\frac{L}{2f}=sin\frac{μ}{2}$ and use this to simplify the matrix that we derived in the lecture. You may greatly simplify the problem by invoking symmetry to show that D’=0 at the ends of the cell and then solving for D)

1. Recall that the expansion of a normal sextupole (Lecture 2, p. 15) is given by

so an offset in *x* will produce a linear slope in $B\_{x}$ vs *y*. Use this to calculate the chromaticity in the non-bend plane ($ξ\_{y}$), in terms of $\left(Bρ\right),β\_{y},D\_{x}$, and $S≡B''l$.

1. Show (trivally) that for our simple FODO lattice, the maximum and minimum $β$ functions will be the same in the other plane, but that the locations will be reversed; that is, $β\_{y,min}$ will be at the location of $β\_{x,max}$ and $β\_{y,max}$ will be at the location of $β\_{x,min}$.
2. Based on the previous result, we see that a small quadrupole placed at the location of $β\_{x,max}$ will effect the tune in both planes, but it will have the maximum effect on $ν\_{x}$ and the minumum effect on $ν\_{y}$ of any location. To control the tunes in our N-FODO ring, we install two “families” of “trim” quads next to the main quads, one family next to all the quads which focus in the horizonal plane and one family next to all the quads which focus in the vertical plane [[1]](#footnote-1). All N trim quads in each family have the same strength

where the *F* and *D* denote whether they are near the magnets which focus or defocus, respectively, in the horizontal plane.

* 1. Calculate the tune changes $∆ν\_{x}$ and $∆ν\_{y}$ as a function of $β\_{max},β\_{min},q\_{F}$ and $q\_{D}$.
	2. Write an expression for the required $q\_{F}$ and $q\_{D}$ to make a change $∆ν\_{x}=∆ν$ and $∆ν\_{y}=0$
	3. Repeat for $∆ν\_{y}=∆ν$ and $∆ν\_{x}=0$

1. Or equivalently, we can think of this as a small trim current which we can make independently on the two types of quads. [↑](#footnote-ref-1)