USPAS summer 2023, Grad Accelerator Physics

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Homework #5

Beta beat: Hand in the honework about beta beats from yesterday.

Periodic coordinate system (Review): Go through the notes that describe the simplified coordinate system for J and φ and lead to the single resonance Hamilton function. Write a successive list of the main steps and approximations taken to obtain at the single resonance approximation. When is this approximation a good model of a realistic accelerator?

Single resonance approximation (Review): An accelerator with linear optical elements, i.e. dipoles and quadrupoles. Use first order perturbation theory in nonlinear forces Δf to find which resonances can occur in the Hamilton function:
(a) for a circular accelerator with one short sextupole that you approximate as a delta function.
(b) for a circular accelerator with one continuous and constant sextupole strength all around the ring. Approximate the beta function to be also constant around the ring.

Fixed points (Review): Go through the steps of finding a fixed point in the single resonance system. Start with the single resonance Hamiltonian and write a list of the main steps taken to obtain the fixed points and to determine their stability.

Amplitude dependent tune shift: Compute the horizontal tune distribution $\rho(\nu_x)$ for a Gaussian beam with an emittance of $\epsilon = 180$nm when the ring has the tune of $\nu = 0.52$ and there is an octupole of strength 2m^4 with length 1m at a place with β_x of 40m.

Lattice Design #5

Design a tune-adjustment section in your first straight line. It should change the phase advance in the periodic straight FoDos of that line to obtain any desired x and y tunes for the ring, while not creating a beat beat. This means that the matching cells to the dispersion suppressor have to be adjusted simultaneously with changing the phase advance of the straight FoDos.

Alternatively adjust the x and y tunes to your desired values by changing all horizontally focusing quads in the arcs, and all vertically focusing quads in the arcs simultaneously. Check how much beta beat this creates in the periodic FoDos.

Chromaticity correction: Insert sextupoles in each FoDo, next to each quad. Turn on only those sextupoles where there is dispersion and correct the chromaticity by changing all sextupoles simultaneously that are next to horizontally focusing quads. And similarly by changing all those simultaneously that are close to vertically focusing quads.