Homework 3

January 21, 2020

Problem 1. (10 pts)

Fill in the following Table for different accelerators

Table 1: Parameters for Accelerators

	NSLS II	LHC	FRIB
Type	Ring	Ring	π rotation
Energy	3 GeV	7 TeV	E_k =150 MeV / Nuclei
Species	Electron	Proton	$^{238}_{78+}U$
Dipole Type	NC	SC	
Bending Field [T]	0.4	8.3	
Dipole length [m]			9

Problem 2. (10 pts)

We use M to represent the 1-D linear betatron transfer map of a piece of lattice. Given the condition that the lattice has mirror symmetry with respect to its mid-point, please find the requirement on the transfer matrix M.

Problem 3. (10 pts)

For a FODO cell, if the focal length of two short quadrupole are f_L and $-f_D$, find the stable condition of the transfer matrix when $f_L = \alpha f_D$.

Problem 4. (20 pts)

Please show that the following statement for a matrix that satisfy symplectic condition:

- If M is symplectic, so does M^{-1}.
- If M and N is symplectic, so does MN
- For 1-D case the symplectic condition just becomes: $\det(M) = 1$
- If λ is eigenvalue of a symplectic map M, so does λ^{-1}.

Problem 5. (Optional)

Consider a 2-D Hamiltonian system, (x, x', y, y'). From the symplectic condition, please find out how many free parameters can the 4-D transfer map have. In general, for a N-D system, how many free parameters are there in the transfer map?