Chapter 1: Introduction

Conventional accelerators are based on Courant and Snyders theory of the alternating-gradient synchrotron, developed in 1952. [?] In an AG focusing lattice, particles oscillate transversely with a characteristic tune. Unfortunately, this system is susceptible to coherent resonances which lead to beam loss and halo growth. Thin lens octupoles for Landau damping limit coherent resonances, but introduce unbounded chaotic orbits, leading to particle losses, wall activation and ultimately limited achievable beam intensity.

A novel approach by Danilov and Nagaitsev suggests an integrable but highly nonlinear lattice as an alternative to the standard AG synchrotron. [?] A large amplitude dependent tune spread detunes resonant particles as they gain energy from a system perturbation, making the beam immune to coherent resonances. This nonlinear detuning is also shown to mitigate halo growth, which is driven by a parametric resonance between large-amplitude particles and beam core oscillations. [?]

The fully integrable elliptic potential willl be tested at Fermilab's IOTA ring. [?] Danilov and Nagaitsev also consider the case in which the nonlinear field is purely octupolar. Particles contained in an octupole potential that scales as $V(s) \propto \frac{1}{\beta^3(s)}$

will conserve a single invariant of transverse motion, the normalized Hamiltonian, and particle orbits will be chaotic but bounded. The nonlinear optics program at UMER will test this quasi-integrable lattice by incorporating octupole magnets into the existing ring framework.

Bibliography