Accelerator Physics and Technology Seminar

Universal Model of Thin Nonlinear Lens: Solving the Symmetric McMillan Map

Tim Zolkin, FNAL

Date: Tuesday, November 5
When: 4:00 pm CDT
Where: One West (WH1W) and Zoom

Abstract: In this presentation, we investigate the dynamical properties of the symmetric McMillan map, highlighting its effectiveness in modeling complex nonlinear systems. We demonstrate its utility as a universal model for a typical thin nonlinear lens, effectively approximating horizontal dynamics with sextupole and octupole configurations, as well as longitudinal dynamics in lattices with thin RF stations. While the map is characterized by six parameters, we show that only two are truly irreducible: the linearized rotation number at the fixed point (the bare betatron tune) and a nonlinear parameter representing the ratio of terms in the biquadratic invariant (the sextupole to octupole strength ratio). Through detailed analysis, we classify stable motion regimes, provide exact solutions to the mapping equations, and derive a canonical set of action-angle variables. This establishes crucial analytical approximations for nonlinear betatron tune and nonlinear emittance, alongside exact expressions for twist (nonlinear detuning) and a qualitative understanding of their behavior. In the subsequent talk, we will apply this theory to lattices incorporating sextupole magnets.

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