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Transverse Linear Beam Dynamics III

Wednesday 25 September 2024 08:30 (1 hour)

The subject of this introductory course is transverse dynamics of charged par-ticle beams in linear approximation. Starting with a discussion of the most im-portant types of magnets and defining their multipole strengths, the linearizedequations of motion of charged particles in static magnetic fields are derivedusing an orthogonal reference frame following the design orbit. Analyticalsolutions are determined for linear elements of a typical beam transfer line(drift, dipole and quadrupole magnets), and stepwise combined by introducingthe matrix formalism in which each element's contribution is represented bya single transfer matrix. Application of this formalism allows to calculate sin-gle particle's trajectories in linear approximation. After introducing the beamemittance as the area occupied by a particle beam in phase space, a lineartreatment of transverse beam dynamics based on appropriately defined opticalfunctions is introduced. The formalism is applied to the concepts of both weakand strong focusing, in particular discussing the properties of the widely-usedFODO cell. Specific characteristics of transverse beam dynamics in periodicsystems like circular accelerators are studied in detail, emphazising the effectsof linear field errors on orbit stability and introducing the phenomena of opti-cal resonances. Finally, the dynamics of off-momentum particles is presented,introducing dispersion functions and explaining effects like chromaticity.

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