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TRANSPORT LIMITS IN PERIODIC FOCUSING CHANNELS

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Abstract

It has been empirically observed in both experiments and particle-in-cell simulations that space-charge-dominated beams suffer strong growth in emittance and particle losses in alternating gradient quadrupole transport channels when the undepressed phase advance increases beyond about 85 degrees per lattice period. Although this criterion has been used extensively in practical designs of strong focusing intense beam transport lattices, the origin of the limit has not been understood. We propose a mechanism for the transport limit resulting from strongly chaotic classes of halo particle resonances near the core of the beam that allow near-edge particles to rapidly increase in oscillation amplitude when the space-charge intensity and the flutter of the matched beam envelope are both sufficiently large. A core particle model is applied to parametrically analyze this process and the results are compared with extensive particle simulations.