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Nonlinear Perturbative Simulation Studies of Collective Processes in 3D Finite-Length Charge Bunches at High Space-Charge Intensities[1] HONG QIN, RONALD C. DAVIDSON, EDWARD A. STARTSEV, Princeton Plasma Physics Laboratory, Princeton University — The collective processes in 3D finite-length charge bunches at high space-charge intensities are described self-consistently by the nonlinear Vlasov-Maxwell equations. The nonlinear delta- f method, a particle simulation method for solving the nonlinear Vlasov-Maxwell equations, is being used to study collective effects in high-intensity bunched beams. For bunched beams, the equilibrium and collective excitation properties are qualitatively different from those for coasting beams. Due to the coupling between the transverse and longitudinal dynamics induced by the 2D nonlinear space-charge field, there exists no exact kinetic equilibrium which has anisotropic temperature in the transverse and longitudinal directions. Even in a thermal equilibrium with isotropic temperature, the particles' trajectories on constant energy surfaces are non-integrable, which implies that it is not possible to perform an integration along unperturbed orbits to analytically calculate the linear eigenmodes. An approximate self-consistent kinetic equilibrium is first established for bunched beams with anisotropic temperature. Then, the collective excitations about the equilibrium are systematically investigated using the delta-f method implemented in the Beam Equilibrium Stability and Transport (BEST) code.

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