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Nonlinear Delta-f Particle Simulations of Collective Effects in High Intensity Bunched Beams[1] HONG QIN, RONALD C. DAVIDSON, EDWARD A. STARTSEV, Plasma Physics Laboratory, Princeton University — The nonlinear delta-f method, a particle simulation method for solving the nonlinear Vlasov-Maxwell equations, is being used to study the collective effects in high-intensity bunched beams. For high intensity bunched beams, the equilibrium and collective excitation properties are qualitatively different from those for long 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, particle trajectories on constant-energy surfaces are non-integrable, which implies that it is impossible to perform an integration along unperturbed orbits to analytically calculate the linear eigenmodes. For the case of a thermal equilibrium beam with isotropic temperature, the self-consistent kinetic equilibrium for a bunched beam is first established numerically. Then, the collective excitations of the equilibrium are systematically investigated using the nonlinear delta-f method implemented in the Beam Equilibrium Stability and Transport (BEST) code. For the case of a beam with anisotropic temperature, an approximate equilibrium is adopted when the nonlinear coupling due to the space-charge field is weak. The validity and collective excitations about this approximate equilibrium are studied numerically.

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