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Kinetic Description of the Longitudinal Dynamics of Intense Charged Particle Beams with Strong Self-Fields* RONALD C. DAVIDSON, EDWARD A. STARTSEV, HONG QIN, Princeton Plasma Physics Laboratory — A kinetic model is developed that describes self-consistently the longitudinal dynamics of a long, coasting beam propagating in straight (linear) geometry in the z-direction in the smooth-focusing approximation. Making use of the three-dimensional Vlasov-Maxwell equations, and integrating over the phase space $(x_\perp, p_\perp)$ transverse to beam propagation, a closed system of equations is obtained for the nonlinear evolution of the longitudinal distribution function $F_b(z, p_z, t)$ and average axial electric field $\langle E_z^s \rangle (z, t)$. The primary assumptions in the present analysis are that the dependence on axial momentum p_z of the distribution function $f_b(x, p, t)$ is factorable, and that the transverse beam dynamics remains relatively quiescent (absence of transverse instability or beam mismatch). The analysis is carried out assuming that axial spatial variations are weak over a length scale comparable to the conducting wall radius r_w. A closed expression for the average longitudinal electric field expressed in terms of geometric factors, the line density λ_b, and its derivatives $\partial \lambda_b / \partial z$, is presented for the class of bell-shaped density profiles. The general formalism described here is valid for the entire range of beam intensities. The properties of the solitary-wave structures are also investigated. *Research supported by the U. S. Department of Energy.

Igor Kaganovich
PPPL

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