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Equilibrium and stability of a high-intensity periodically twisted ellipse-shaped charged-particle beam¹ JING ZHOU, RONAK BHATT, CHIP-ING CHEN, Intense Beam Theoretical Research Group, Plasma Science and Fusion Center, MIT, Cambridge, MA 02139 — It is shown that there exists an exact paraxial cold-fluid equilibrium of a high-intensity, space-charge-dominated charged-particle beam with a periodically twisted elliptic cross section in a non-axisymmetric periodic magnetic field. Generalized envelope equations, which determine the beam envelopes, ellipse orientation, density, and internal flow velocity profiles, are derived. Effects of nonlinearities in the magnetic fields and instabilities at high vacuum phase advances are investigated. The parameter space for stable operation is identified. The beam equilibrium and stability properties are verified by two-dimensional selfconsistent particle-in-cell (PIC) simulations using the MIT 2D Periodic Focused Beam (PFB2D) code. The beam equilibrium is further verified by 3D simulations using the commercial code OmniTrak. Applications in high-power microwave sources are discussed.

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