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Controlling Charge and Current Neutralization of an Ion Beam Pulse in a Background Plasma by Application of a Small Solenoidal Magnetic Field IGOR D. KAGANOVICH, EDWARD A. STARTSEV, ADAM B. SEFKOW, RONALD C. DAVIDSON, Princeton Plasma Physics Laboratory — Propagation of an intense charged particle beam pulse through a background plasma is a common problem in astrophysics and plasma applications. The plasma can effectively neutralize the charge and current of the beam pulse, and thus provides a convenient medium for beam transport. The application of a small solenoidal magnetic field can drastically change the self-magnetic and self-electric fields of the beam pulse, thus allowing effective control of the beam transport through the background plasma. An analytical model is developed to describe the self-magnetic field of a finite-length ion beam pulse propagating in a cold background plasma in a solenoidal magnetic field. The analytical studies show that the solenoidal magnetic field starts to influence the self-electric and self-magnetic fields when $\omega_{ce} > \omega_{pe}\beta_b$, where $\omega_{ce} = eB/m_e c$ is the electron gyrofrequency, ω_{pe} is the electron plasma frequency, and $\beta_b = V_b/c$ is the ion beam velocity relative to the speed of light. Analytical formulas are derived for the effective radial force acting on the beam ions, which can be used to minimize beam pinching. The results of analytical theory have been verified by comparison with the PIC simulation results, which show good agreement.

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