DPP08-2008-000145

Abstract for an Invited Paper
for the DPP08 Meeting of
the American Physical Society

James Clerk Maxwell Prize Talk: Collective Interaction Processes and Nonlinear Dynamics of Nonneutral Plasmas and Intense Charged Particle Beam[1]

RONALD DAVIDSON, Princeton Plasma Physics Laboratory

A nonneutral plasma is a many-body collection of charged particles in which there is not overall charge neutrality. Such systems are characterized by intense self-electric fields and, in high-current configurations, by intense self-magnetic fields. Nonneutral plasmas, like electrically neutral plasmas, exhibit a broad range of collective properties. This presentation summarizes several recent advances in understanding the collective processes and nonlinear dynamics of intense charged particle beams and nonneutral plasmas. Particular emphasis is placed on: basic experimental investigations of nonneutral plasmas confined in the Paul Trap Simulator Experiment (PTSX), a compact laboratory device with oscillatory wall voltages, used to simulate intense beam propagation through a periodic quadrupole field over equivalent distances of tens of kilometers; and analytical and numerical studies of the nonlinear dynamics and collective processes in intense one-component beams propagating in periodic-focusing accelerators and transport systems, such as next-generation accelerators for ion-beam-driven high energy density physics and heavy ion fusion, and high energy physics applications. The topics covered include: nonlinear stability theorem for quiescent beam propagation; electrostatic Harris and electromagnetic Weibel instabilities in highly anisotropic, intense one-component beams; and the electron-ion two-stream (electron cloud) instability for an intense ion beam propagating through a partially neutralizing electron background. In the longitudinal drift compression and transverse compression regions, collective processes associated with the interaction of an intense ion beam with a charge-neutralizing background plasma are discussed.

[1]Research supported by the Department of Energy.