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Enhanced slowing of electron beams in finite resistivity plasmas[1]

CARL SIEMON, VLADIMIR KHUDIK, GENNADY SHVETS, University of Texas at Austin — The physics of underdense relativistic electron beam propagation through a collisional background plasma in the presence of transverse Weibel Instability (WI) is described. Collisional simulation results are presented, which sharply contrast collisionless dynamics in that longitudinal beam slowing is dramatically enhanced. Collisional beam slowing can be thought of as a two step process for high beam energies: 1) At first, the beam filaments' merger during the nonlinear stage of the WI induces transverse thermalization of the beam (Weibel slowing); 2) Once filaments stop merging, the electric force induced by collisions acts on the warm beam, causing its velocity to decay. Weibel slowing is more efficient with collisions than without because collisions enable magnetic field diffusion, which expedites the filaments' merger. When filaments merge, beam density and thus magnetic field strength increase, enhancing transverse thermalization, which decreases longitudinal beam velocity. Models are presented that quantify Weibel slowing and the slowing of a warm beam in the presence of collisions. These models, along with numerical results, show that the WI facilitates beam slowing at first, but actually impairs it once filaments stop merging.

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