

Electron Polarization in Ultrarelativistic Plasma Current Filamentation Instabilities

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By utilizing particle-in-cell simulations, we investigate the plasma current filamentation of an ultrarelativistic electron beam impinging on an overdense plasma. The effect of the radiation-induced electron polarization is self-consistently studied. Here, three different regimes of the current filaments, namely, the normal filament, abnormal filament, and quenching regimes, are identified. We show that electron radiative polarization emerges during the instability along the azimuthal direction in the momentum space, which significantly varies across the regimes. We put forward a Hamiltonian model to trace the origin of the electron polarization dynamics. In particular, we discern the role of nonlinear transverse motion of plasma filaments, which induces asymmetry in radiative spin flips, yielding an accumulation of electron polarization.