Observations of Nonlinear Phenomena of Linearly Unstable Modes in an Electron-Beam Plasma

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Experimental studies were performed on one dimensional evolution and formation of the nonlinear structure of unstable waves in an electron-beam plasma.

The plasma system is linearly unstable in a frequency range lower than the critical value (plasma frequency), but is stabilized in its nonlinear stage by generating wave packets irregularly. The system is also unstable for an external perturbation, rf-burst. The burst wave initially grows linearly along the electron-beam path and the amplitude gradually saturates in its nonlinear stage. Finally the plasma system becomes stable by the emission of a series of burst waves. The number of emitted bursts increases with the beam density.

A phase-space distribution of a weak electron-beam injected into a cold plasma has been investigated in electron time scales (1). It is shown that electron-beam holes in phase-space evolve dynamically, as synchronized with a wave packet dominated by a beam mode. The dependence of the hole velocity radii on the packet crest amplitudes indicates that the holes are induced by self trapping of the beam. It is found that the beam is well trapped while the packet grows linearly, but easy to be detrapped after that.

(1) T. Takeda and K. Yamagiwa, Phys. Lett. A, 339, 118 (2005)