Seminar

Institute for Plasma Research

Title : Effects of ion motion on the breaking of relativistically intense electron plasma waves

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Date : 22nd February 2019 (Friday)

Time : 11:00 AM

Venue : Committee Room 3, (New Building), IPR

Abstract :

The study of relativistically intense longitudinal waves in a plasma is a fascinating field of research in nonlinear plasma physics. The amplitude of these waves are limited by a phenomenon called wave breaking. In this talk, we mainly present our current research work which reveals the effects of ion motion on the breaking of relativistically intense electron plasma waves in a cold plasma in various circumstances.

Firstly, the propagation of large amplitude electrostatic waves in a fully relativistic plasma consisting of relativistic electrons and ions has been studied analytically and numerically using Particle-in-Cell (PIC) simulation method. The dispersion relation of the wave has been found in the weakly relativistic limit and verified via simulations. The effect of ion mass on the wave electric field and frequency has been demonstrated. It is found that relativistic traveling waves supported by the motion of both electrons and ions, break gradually far below their conventional wave-breaking limit, when perturbed longitudinally. An analytical expression for this wave breaking time has been derived and it is found that wave breaking time explicitly depends on the amplitude of the wave, applied perturbation and electron to ion mass ratio. This theoretical prediction has been verified further via simulations, for an entire range of input parameters.

Another manifestation of breaking of nonlinear plasma oscillation via phase mixing against an ion-pulse/cavity has been studied in both non-relativistic and relativistic limit using PIC simulation code. It is found that for both the cases oscillations gradually start to deform and eventually break at arbitrarily small initial amplitude due to crossing of neighboring electron trajectories (phase mixing). The variation of phase mixing time (wave breaking time) for different input parameters has been studied and compared with the existing theoretical results.