Abstract

A study has been made on coherent nonlinear wave interactions in homogeneous plasma.

In absence of any dissipation and frequency mismatch or in presence of either frequency mismatch or equal dissipation the equations for the nonlinear wave interactions can be exactly solved analytically.

However, in presence of both dissipation, equal or unequal and frequency mismatch the exact analytical solutions for the wave amplitudes are not possible.

The thesis starts with nonlinear three wave interactions in second order in presence of equal dissipation and frequency mismatch. A nonlinear perturbation technique is used to separate the rapidly fluctuating motion from the slow secular growth of the whole system. The analytical solutions for the temporal evolution of the wave amplitudes are discussed with special emphasis on nonlinear explosive instabilities. The stabilization of the explosive instability in case of three wave interactions due to the presence of third order nonlinear effect is investigated. This study of nonlinear three wave interaction is extended to nonlinear interaction between four positive and negative energy waves in presence of linear dissipation and total equivalent frequency mismatch. Depending on various initial conditions
of the wave amplitudes the analytical solutions of different types are discussed. The condition under which the periodic solutions become explosive, the growth rate, explosion time and threshold value are calculated and the effects of dissipation and frequency mismatch on these parameters have been demonstrated. Next, a study is made on nonlinear coupling of two three wave system with one wave in common in presence of linear dissipation and frequency mismatch including the possibility of negative energy waves. The solutions are analysed for various initial conditions. The condition for infinite growth of the wave amplitudes, explosion time, growth rate and threshold value are calculated. It is also shown that if one triplet be explosively unstable by itself the presence of the second triplet can stabilize the solutions depending on the relative strength of the coupling factor. Moreover, the explosive nature of the beam plasma instability is studied using a formalism based on Lie transform. It is shown that the first order averaged Hamiltonian produces the explosive behaviour, whilst the second order averaged Hamiltonian bounds the unlimited growth of the amplitudes being independent of the initial conditions.