ABSTRACT

One of the growth points of physics, in the present decade is the physics of high temperature gases, i.e., Plasma Physics. To a large extent this is attributed to the efforts for performing controlled thermonuclear reactions in the laboratory, which is expected to be the answer to the pursuit for alternate energy source, in order to satisfy the ever increasing demand for energy of this civilization. The increased activity in experimental investigations and the theoretical developments, has made it clear that one of the main theoretical problems are to find an adequate understanding of physics of high temperature plasmas. So far these attempts have been only partially successful, although theoretical study of nonlinear systems has produced some interesting and possibly far reaching results.

In this thesis we have made an attempt to understand one of the important aspects in the physics of plasma, namely, Parametric Instabilities and nonlinear wave interactions in plasmas. We have studied some aspects of parametric interaction process in a magnetized plasma which have applications in ionospheric modification schemes.

The first chapter gives a discussion of the nature of plasma, oscillations and waves in a plasma, role of nonlinearity in plasma and the parametric phenomena in a plasma.
The second chapter presents a short review of nonlinear optical effects in plasmas. Because of its intimate relation with laser induced fusion nonlinear optics in plasmas has suddenly becoming a blooming field.

In the third chapter we have studied the theory of parametric coupling of waves in a hot inhomogeneous magnetized plasma in which the temperature and density gradient have been taken into account. The general dispersion relation and the polarization of the ordinary and the extraordinary wave modes are discussed. The eigen mode solutions of the coupled differential equations for the wave amplitudes are obtained in terms of the so called three wave interaction matrix elements. The theory of nonlinear wave-wave interactions, which has been extended to the case of an inhomogeneous magnetized plasma, is used to determine the threshold value of the electric field and frequency shift. The general features of density gradient in the nonlinear interactions of plasma oscillations play an important role in connection with its use as an optical density probe.

In the fourth chapter we have studied the nonlinear parametric wave interaction in a plasma with random fluctuation. One effective growth rate and threshold for the mean amplitude and intensity are calculated from Bourret's integral equation. It is found that in a randomly inhomogeneous plasma, the effect of fluctuation is to enhance the threshold values but to make
the growth weaker. Plasma produced by irradiating pellets with a laser or some other agency promotes some fluctuations and is likely to be turbulent in general. The background turbulence will create random density fluctuation and may influence the propagation characteristics of the interacting waves of the parametric coupling process. The investigation of parametric instability in presence of background turbulence in a plasma is of great relevance to laser fusion problem.