Chapter 6

Conclusions and prologue to the future

The work carried out in the thesis deals with the nonlinear modes of various plasma configurations in relation to laboratory and space plasmas. The work is aimed at drawing attention to the salient features of plasma acoustic modes along with the formation of solitons and double layers in multicomponent as well as in dusty plasmas.

At the commencement of the thesis, a general introduction of the subject matter, on the basis of which the present investigation has been carried out, is given. The chapter is initiated with a short description of plasma and its properties and then the evolution of nonlinear solitary waves is discussed. In addition to that, the mathematical approaches, which have been taken recourse to in the subsequent theoretical investigations, have also been briefly described. As the major areas of interest in the research work are dusty and rotating plasmas, notes on dusty and rotating plasmas have been presented, in which their occurrences and properties have been highlighted.

The fluid theory, on the basis of which the study has been carried out, is sufficiently accurate to explain a large number of plasma phenomena. Again, the dusty plasma is the most common plasma configuration observed in space and laboratory.

Thus, the results of the present investigation are expected to have a close match between theory and experimental observations and hence, could be of interest for laboratory and space plasma investigation.

With a view to investigating the role of slow rotation in plasmas in order to correlate its existence in laboratory and space, simple plasma consisting of isothermal electrons and singly charged positive cold ions has been considered. In order to separately explore the effect of slow rotation, which plays a vital role in plasma as well as in cosmic phenomena, the study has been carried out in the absence of magnetic field.

It is an undeniable fact that dusty plasma has been found to play a very crucial part in astrophysical bodies and space environments such as cometary tails, planetary ring systems, interstellar and circumstellar clouds and asteroid zones as well as in laboratory plasmas. Errors are very likely to creep in any analysis of plasma unless a proper account of the dust particles is taken. In this backdrop, the study has been extended to unmagnetized dusty plasma containing electrons and singly charged positive cold ions.

The study revealed that even the slow rotation in plasma was able to exhibit the radiative soliton in simple as well as in dusty plasma. Moreover it has been shown that the small rotation of plasma produces an equivalent magnetic field effect and changes the nature of soliton; in the process, it exhibits the compressive and rarefactive solitons as well as radiation as similar to those in other plasma configurations.

It is an established fact that any work on plasma might not be flawless unless a due consideration of the presence of negative ions, which have a huge bearing on the features of wave propagation, is given. In this perspective, attention was next paid in studying the behaviour of ion-acoustic waves in magnetized plasma in the presence of negative ions. It was shown that due to the presence of the negative ions, the nonlinear co-efficient of the K-dV equation went to zero at some critical value of the plasma parameters and then turned negative resulting in the formation of rarefactive solitary waves. Furthermore, due to the presence of magnetic field, the dispersive effect goes to zero and consequently, soliton formation fails in plasma acoustic wave.

All the studies mentioned above were conducted with the objective of investigating the formation of solitons in various plasma configurations. It is worth mentioning here that even in the dusty plasma, it was considered that the charge does not vary with time. So finally, the domain of interest shifts to the evolution of double layers in rotating dusty plasma along with the consideration of fluctuation of dust charge.

The new observations emanating from these studies might be helpful in understanding certain basic features of nonlinear plasma dynamics. It may be noted that on account of their stability and robustness, solitons have found enormous applications in almost every branches of physical science. Moreover, the study of rotating plasma is particularly significant for revealing certain properties of space plasma. The formation of double layers and solitons, which had been investigated in particular, is especially important for industrial as well as space plasma.

Lastly, we note that the present study has been confined to an ideal form of dusty plasma. An extension of the study to a more realistic dusty plasma configuration is expected to yield additional new observations. For example, this investigation has ignored the variation in size and mass among the individual dust grains. But it is known that the mass and size of dust particles, in general, behave as dynamic variables and produce novel effects on collective degrees of plasma dynamics. Thus, there is an open road for further research by considering the variation of dust size and mass.