Abstract

The main aim of this thesis is to study the *linear and nonlinear wave propagation in quantum degenerate plasmas* with adiabatic trapping of the lighter particles and Landau quantization in electron ion and electron positron ion dense plasmas.

Trapping and quantum effects have been investigated in the presence of quantizing magnetic field as a microscopic phenomenon in a dense degenerate plasma. The plasmas consist of non-degenerate ions and degenerate electrons. The presence of quantizing magnetic field is discussed here and the Fermi-Dirac distribution function is applied to investigate the trapping effect. Linear and nonlinear properties of the ion acoustic waves have been investigated both for electron-ions and electron-positron- ion for quantum degenerate plasma in the presence of quantizing magnetic field. It is observed that a dispersion relation of ion acoustic longitudinal wave propagating parallel to the ambient magnetic field have strong dependence on the quantizing magnetic field in quantum degenerate plasmas as compared to the classical case, where for parallel propagating waves the effect of external magnetic field is absent. The arbitrary amplitude nonlinear ion acoustic solitary waves have been studied both for partially and fully degenerate dense plasmas in non-relativistic regime having trapping and Landau quantization effects. The Sagdeev pseudo potential approach has been applied to investigate the solitary structures in collisionless, magnetized and dense degenerate electron ions and electron-positron-ion plasmas. The electrons and positrons follow the corresponding non-relativistic Fermi-Dirac distribution functions while the hydrodynamic equations describe the ions dynamics. The existence of the solitary structures is found for both the partially and fully degenerate plasmas. It is observed that both the compressive and rarefactive and supersonic solitons have their existence in such plasmas for different conditions of magnetic field and temperature. The amplitude of solitary structures is found to increase both with increase of temperature and quantizing magnetic field. In *e-p-i* plasma both the linear and nonlinear ion acoustic wave not only depend upon the Landau quantization and electron Fermi temperature but also the positrons concentration. The arbitrary amplitude solitary structures are investigated numerically and only the compressive solitons are observed to form in *e-p-i* plasmas. In contrary to the *e-i* plasma the amplitude of the ion acoustic solitary structures drastically reduce with the positron concentration and the Landau quantization. In the last chapter of the thesis, we investigated the formation of nonlinear ion-acoustic solitary structures for both the

relativistic and ultra-relativistic degenerate magneto-plasma. The effect of trapping of electrons with Landau diamagnetism/quantization is incorporated through Fermi-Dirac distribution function for the first time to the best of our knowledge in a relativistic degenerate plasma. We derived the modified linear dispersion relation for ion acoustic wave for both relativistic and ultra-relativistic regime and it is observed that the electrostatic parallel propagating wave has strong dependence on the Landau quantization and relativistic factor through number density. Linear and nonlinear theoretical results have been investigated numerically for different parameters. We have shown that only compressive solitons are formed for relativistic and ultra-relativistic quantum degenerate plasma for different parameters.

The work presented in this thesis may play an important role in the description of complex phenomena that may be observed in dense astrophysical environments like white dwarfs and neutron stars and in the ultra-strong femtosecond laser-plasma interactions. This work may also be beneficial and applicable to have the understanding of nonlinear solitary structures propagating in dense plasma environments.