Abstract

In this thesis we focused on the linear analysis of waves and instabilities propagating along and across the ambient magnetic field in the degenerate and non- degenerate plasmas. In the first part of thesis employing Vlasov-Maxwell set of equations; we have investigated the O-mode and whistler mode instability in a degenerate anisotropic magneto plasma environment and compared the results to those reported for classical plasmas. We propose the excitation of a new banded type of instability for the O-mode case, which grows at some particular values of temperature anisotropy and external magnetic field. For the case of whistler wave, we observe instability saturation mechanism similar to the case of classical plasmas. The existence of both O-mode and whistler mode instability has been observed only for some specific range of unstable wave numbers. The possible excitation of such instabilities in solid state plasma has been discussed, particularly for semiconductor and semimetal plasmas. In the second part general dispersion relation for the right hand circularly polarized waves has been derived using non-relativistic spin quantum kinetic theory. Employing the derived dispersion relation, temporal and spatial damping of the right hand circularly polarized waves is studied for both the degenerate and non-degenerate plasma regimes for two different frequency domains: (i) $k_{||}v >> (\omega + \omega_c), (\omega + \omega_{cg})$ and (ii) $k_{||}v \ll (\omega + \omega_c), (\omega + \omega_{cg})$. Comparison of the cold and hot plasma regimes shows that the right hand circularly polarized wave with spin-effects exists for larger k-values as compared to the spinless case, before it damps completely. It is also found that the spin-effects can significantly influence the phase and group velocities of the whistler waves in both the degenerate and non-degenerate regimes. The results obtained are also analyzed graphically for some laboratory parameters to demonstrate the physical significance of the present work. In third part the dispersion relations for the weakly magnetized perpendicular propagating modes (O-mode, X-mode, and upper hybrid mode) based on the ultra-relativistic Fermi-Dirac distribution function with chemical potential are derived using the Vlasov–Maxwell model. The results are presented in terms of Polylog functions without making any approximation. It is found that as the ratio μ/T is increased, the cutoff points shift downward. A comparison is also performed with the previously derived results for ultra-relativistic Maxwellian distribution.

The forth part contains the discussion on the whistler instability in non-degenerate semi-relativistic bi- Maxwellian plasma. The dispersion relations are analyzed analytically along with the graphical representation and the estimates of the growth rate and instability threshold condition are also presented in the limiting cases i.e.$\xi\pm = (\omega \pm \omega_c)/\left(k_{||} v\right) \ll 1$ (resonant case) and $\xi\pm >> 1$ (non-resonant case). Further for field free case i.e., $B_0=0$, the growth rates for Weibel instability in a semi-relativistic bi-Maxwellian plasma a represented for both the limiting cases.