ABSTRACT

This study focuses on electrostatic waves and instabilities in spin-polarized plasmas. For this, a distinct spin evolution-quantum hydrodynamic model is utilized. Several linear and non-linear modes and instabilities are examined in homogeneous plasmas, with spin polarization, and different quantum phenomena are taken into account.

In the examination of Lower Hybrid (LH) wave instability produced by an electron beam in a spin-polarized degenerate plasma, the general dispersion relation is derived while including Coulomb exchange interaction and Bohm potential. Electron spin polarization and beam streaming speed are found to diminish the growth rate and the k-domain. On the other hand, both the growth rate and the k-domain of LH mode instability are boosted by beam density and propagation angle. Moreover, Bohm potential contributes to the intensity of the growth rate. These variables could have a significant impact on the wave and instability phenomena that happen in laboratory plasmas.

We give a hydrodynamic analysis of counter-streaming instability for spin-polarized electron-positron-ion (e-p-i) plasma. The numerical solution of the dispersion relation produces four solutions: electron and positron spin-dependent waves, Langmuir wave, and positron acoustic mode. The effects of positron concentration, streaming speed, and spin polarization on waves' real frequency and growth rate have also been studied. This study may help researchers better understand how longitudinal waves propagate and how they become unstable in dense magnetized astrophysical environments.

Next, we look at non-linear electrostatic behavior, namely double layers (DLs), which are assumed to be responsible for particle acceleration in non-linear plasmas in both laboratory and astrophysical plasmas. The presence of a structure with spin-dependent double layers is studied. An extended Korteweg-de Vries (eKdV) equation is developed using the reductive perturbation approach to demonstrate the presence of DLs. Spin polarization significantly increases the electrostatic potential associated with DLs and broadens and deepens the Sagdeev potential. It should be highlighted that the role of Bohm potential effect in the development of the spin-dependent DL structure is crucial. Our findings may help to explain particle acceleration in dense astrophysical conditions, such as white dwarfs.

We discovered new linear and non-linear spin-dependent modes in dense magnetized plasma in this dissertation. New waves and instabilities in the electromagnetic wave spectrum may be better understood due to the current research.