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# Head on collision of ion acoustic shocks in degenerate quantum plasmas

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Dense quantum plasmas have emerged as the active field of research due to their great pertinence in different areas of practical importance, e.g., laser interactions with atomic systems, nanoscale electrochemical systems and in dense astrophysical plasmas such as neutron stars and white dwarfs.[1] In dense quantum plasmas, at extremely high number densities, the de-Broglie wavelength associated with the charge particle becomes comparable to the interparticle distance. The existence of quantum ion acoustic (IA) waves and the role of quantum diffraction effects have been studied by using quantum hydrodynamic (QHD) model. An ideal quantum magnetohydrodynamic (QMHD) model has been devised by Haas with the incorporation of the quantum effects with the relevance to the dense astrophysical objects such as interiors of white dwarfs.[2] Using QMHD and QHD models various nonlinear electrostatic and electromagnetic waves have been studied in different quantum plasma environments. The present work focuses on the interaction of ion-acoustic shock waves in magnetized quantum plasmas with the effects of spin-up and spin-down degenerate electrons. Shocks are generated in the medium due to a delicate balance of different kinds of effects such as nonlinear, dispersive and dissipation effects. Shocks have potential applications for acceleration of charged particles in different kinds of plasma environments. The spin effects are considered as one of the most important properties of quantum plasmas due to great significance of highly magnetized quantum plasmas in the atmospheres of neutron stars.[3] In quantum plasmas, spinning effect urges the continuation of different kinds of waves. By considering separate spin evolution model, new longitudinal waves are obtained and these kinds of waves are propagated along parallel and perpendicular direction of external magnetic field. A theoretical investigation has been carried out to study the interaction of shock waves with the density effects of spin-up and spin-down electrons. We have considered quantum plasma in which a uniform magnetic field is acting along positive z-direction. The separated spin evolution quantum hydrodynamics model (QHD) has been used by considering spin-up and spin-down electrons as different species. By employing extended Poincaré-Lighthill-Kuo method, two Korteweg-de Vries (KdV) equations are derived.[4] The Hirota direct method is used to obtain multi-soliton solutions for each KdV equation and all of them move along the same direction where the fastest moving soliton eventually overtakes the others. The analytical phase shift after a head-on collision of ion acoustic (IA) shock waves are also obtained. The effects of density polarization ratio and other plasma parameters on the characteristics of IA shocks have been analyzed. It is seen that spin density polarization ratio significantly affects the characteristics of IA shock waves as we move from strongly spin polarized case to zero spin polarized case. The results obtained in the present investigation may be useful in comprehending various nonlinear excitations in dense astrophysical regions such as, white dwarfs, neutron stars.[5]

References

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