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Neutrino-beam-plasma interactions in gravitating magnetized quantum plasma

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The studies of neutrino-beam-plasma interactions have attracted more attention in recent few years due to their significance in many astrophysical systems viz. core-collapse supernova, interior of white dwarfs, crust of neutron stars and in supernovae explosions [1,2]. The role of neutrino beam is unavoidable in the fragmentation process of dense matter in the presence of self-gravitational force. The pulling of matter due to self-gravitation force beyond a critical mass limit causes collapse through the Jeans or gravitational instability. In recent past years the problems of Jeans instability has been investigated in dusty and quantum plasmas [3-5]. The pulling of matter due to gravitational force in the type-II supernova core-collapse is largely affected by the neutrino bursts. This motivates to investigate the influence of neutrino beam on the magneto- hydrodynamics (MHD) waves and hydrodynamic Jeans instability in astrophysical environments.

In this work, the influence of propagation dynamics of intense neutrino beam on the hydrodynamic Jeans instability in a magnetized quantum plasma is investigated. The dynamics of a self-gravitating and magnetized electron-ion quantum plasma weakly interacting with neutrinos are considered in the neutrino magnetohydrodynamics (NMHD) model [6]. The modified dispersion relations of Jeans instability and fast neutrino-driven short wavelength instability are established using linear perturbation method. In the oblique propagation, the Jeans instability condition is modified due to the presence of neutrino beam effects whereas no effect was observed in the parallel and perpendicular propagations. The neutrino beam density stabilizes while the free energy of neutrino beam destabilizes the growth rate of Jeans instability. The estimated Jeans time scale is comparable to the time scale of type-II core-collapse supernova. The time scale of neutrino beam instability is much shorter that the Jeans time scale which results faster neutrino mixing in the gravitational collapse of the system. The consequences of neutrino beam interactions with a magnetized and self-gravitating quantum plasma have been addressed in astrophysical environments [7].

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