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Magnetorotational Instability in differentially rotating degenerate astrophysical electron–positron–ion plasma

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In this current work, we have examined MRI in three components (e–p–i) plasmas using QHD model in a differentially rotating magnetized degenerate plasma. The DR is obtained with the contribution of spin magnetization force from electron and positron. Spin contributions has a significant importance in a high density, low temperature and highly magnetized plasmas that can be found in WDs.

We limited ourselves to the longer wavelength (low frequency) MHD limits, and the reduced dispersion relation is obtained. To analyze the growth rate γ of the instability we numerically solved the reduced dispersion relation and by using various astrophysical plasma (WD) parameters we plotted the dependence of growth rate γ to the wave vector k_z. We obtained four different plots for the growth rate to study the effect of different parameters like magnetic field B, magnetization effect η, electron number density ne and positron number densities n_p. We concluded that the magnetic field strength has stabilizing effects on the growth rate.

As the instability always takes place in the vicinity of a weak magnetic field, amplifies the field strength by the action of magnetic dynamos and pinches the system against the run away from stability. The electron spin magnetization force and the increasing electron number density enhance the growth of the MR mode and the system run towards instability.

At very high number densities corresponding to MR instability results in the core collapse in many stars. On the other hand, the positron number density putting a stabilizing effect on the system. Therefore, the contribution from electron and positron fluids validates our consideration of their quantum mechanical effects in this model. The results of our findings presented here can be of particular importance for multi-species dense astrophysical environments.

References

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