AAPPS-DPP2024, Nov 3-8 2024, Grand Swiss-Bel Hotel, Malacca, Malaysia

Radiative-Gravitational charged surface waves in an incompressible plasma

Ch. Rozina[1], N. Maryam[1], B. Arooj[1], A. Asma[1], I. Kourakis[2]
[1] LCW University, Pakistan, [2] Khalifa University, Abu Dhabi
e-mail (speaker): plasmaphysics07@gmail.com

The impact of temperature inhomogeneity, surface charge and surface mass densities on the stability analysis of charged surface waves at the interface between dense, incompressible, radiative, self-gravitating magnetized electron–ion plasma and vacuum is investigated. Self-gravitational forces may play a significant role in stellar collapse, and in the evolution and formation of dense astrophysical objects [1].

For such an incompressible plasma system, the temperature inhomogeneity is governed by an energy balance equation. Adopting the one-fluid magnetohydrodynamic (MHD) approximation, a general dispersion relation is obtained for capillary surface waves, which takes into account gravitational, radiative and magnetic field effects.

The dispersion relation is analyzed to obtain the conditions under which the plasma–vacuum interface may become unstable. In the absence of electromagnetic (EM) pressure, astrophysical objects undergo gravitational collapse through Jeans surface oscillations in contrast to the usual central contraction of massive objects due to enhanced gravity [2,3]. EM radiation does not affect the dispersion relation much, but actually tends to stabilize the Jeans surface instability.

In certain particular cases, pure gravitational radiation may propagate on the plasma vacuum interface. The growth rate of radiative dissipative instability is obtained in terms of the wavevector. It is shown that a negative pressure gradient is generated due to thermal motion in the plane perpendicular to the interface, i.e., $e\delta\Phi \sim K_B\delta T_e$.

Furthermore, we have investigated the dispersion relation, as well as the growth rate of unstable modes, in their respective regions of validity, both numerically and graphically.

We draw the conclusion that the Jeans surface instability may be associated with (and contribute to) fragmentation of astrophysical objects through surface oscillations of these objects. It is shown that the combination of gravitational and radiative effects for non-uniform plasma stabilizes the Jeans-type instability of surface waves. Furthermore, pure gravity waves may propagate at the plasma–vacuum interface if some particular condition is satisfied. Finally, we have shown that for a particular wavevector, the interface may undergo radiative dissipative instability.

Our theoretical model of the Jeans surface instability is applicable in astrophysical environments and also in laboratory plasmas.

[1] Prajapati, R. P. 2011 Effect of polarization force on the Jeans instability of self-gravitating dusty plasma. *Phys. Lett. A* **375**, 2624–2628.

[2] Rozina, C., Tsintsadze, L. N., Tsintsadze, N. L. & Ruby, R. 2019 Jeans surface instability of an electron-ion plasma. *Phys. Scr.* **94**, 105601.

[3] Ruby, R., Rozina, C., Tsintsadze, N. L. & Iqbal, Z. 2020 Gravitating–radiative magnetohydrodynamic surface waves. *J. Plasma Phys.* **86**, 905860406