Hydromagnetic Instability Criteria for Stratified Viscoelastic Dusty Finitely Conducting Plasmas

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The instability of a stratified, viscoelastic (Walters B' or Rivlin-Ericksen) magnetoplasma, including the effects of finite resistivity and suspended particles, is investigated using linear analysis. The horizontal applied magnetic field and the viscosity, as well as the viscoelasticity of the medium are assumed to be variable. The dispersion relation, which is obtained for the general case on employing boundary conditions appropriate to the case of two free boundaries, is then specialized for the two models. The hydromagnetic instability conditions are obtained and discussed analytically, and the results are numerically confirmed. The variation of the growth rate of the unstable modes with the different parameters has been evaluated analytically. All the physical parameters are found to have stabilizing as well as destabilizing effects on the considered system. For the Walters B' viscoelastic model it was found that the kinematic viscoelasticity, fluid resistivity, and stratification parameter have a stabilizing effect, while the mass concentration (or relaxation frequency) of the suspended particles, kinematic viscosity, and Alfvén velocity have a destabilizing effect on the considered system. Also, for the case of the Rivlin-Ericksen viscoelastic model we found that the mass concentration of the suspended particles, Alfvén velocity, and kinematic viscosity have a stabilizing effect, while both the finite resistivity and stratification parameter have a destabilizing effect; the relaxation frequency of the suspended particles has no effect on the stability of the system. The case of a dusty plasma with infinite conductivity and presence (or absence) of a magnetic field is also considered. Its stability conditions are obtained, from which it is concluded that the presence of dust always reduces the growth rate of the unstable Rayleigh-Taylor perturbations. The limiting case of a viscid (and inviscid) finitely conducting dusty plasma is considered, and the stability conditions are discussed, from which we found that the magnetic field has a stabilizing effect in the absence of both viscosity and finite resistivity, the stability of the system ocurrs for values of the Alfvén velocity greater than a critical value. — PACS: 47.20.-k; 47.50+d; 47.65.+a.

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