

HMHD INSTABILITY OF ROTATING DISKS IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD

E. Liverts, M. Mond, and Y.M. Shtemler

Department of Mechanical Engineering, Ben-Gurion University, Beer-Sheva, Israel

The linear stability of an electrically conducting rotating fluid disk threaded by an external magnetic field is examined within the Hall-magnetohydrodynamics (HMHD) model. In particular such a model is relevant to weakly ionized gaseous disks (ionization degree about 10-12) where the temperature and density in the disk are below a few thousand K and between 10^{13} and 10^{14} cm⁻³, respectively. Stable and unstable axisymmetric modes are studied by eigenmode analysis. The dispersion relation that describes waves propagating in such disks is obtained by using the WKB approach, limiting cases of short and long waves are discussed, and physical interpretation of the results is presented. Our results are compared with those obtained from a local stability analysis. Non axisymmetric modes are found to be unstable in the presence radial density or magnetic field inhomogeneities, if the inhomogeneity length is small enough. The values of the inhomogeneity scale length which destabilizes the flow as well as growth rate of the instability are calculated, and physical interpretation of the results is presented. It is shown that unstable non axisymmetric modes grow on a disk's rotation period time scale, and hence are relevant for the processes which lead to the development of planetesimals in protoplanetary clouds. In addition, the influence of azimuthal magnetic is discussed.