The Parker Instability in a Thick Galactic Gaseous Disk

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A linear stability analysis of a multi-component and magnetized Galactic disk model is presented. The disk model uses the observed stratifications for the gas density and gravitational acceleration at the solar neighborhood and, in this sense, it can be called a realistic model. The distribution of the total gas pressure is defined by these observed stratifications, and the gaseous disk is assumed isothermal. The initial magnetic field is taken parallel to the disk, with a midplane value of 5 μG, and its stratification along the z-axis is derived from the condition of magnetohydrostatic equilibrium in an isothermal atmosphere. The resulting isothermal sound speed is ~8.4 km s^{-1}, similar to the velocity dispersion of the main gas components within 1.5 kpc from midplane. The thermal-to-magnetic pressure ratio decreases with z and the model is Parker unstable. The dispersion relations show that the fastest growing mode has a wavelength of about 3 kpc, for both symmetric and antisymmetric perturbations, and the corresponding growth time scales are of about 5×10^7 years. The structure of the final equilibrium stage is also derived, and we find that the midplane antisymmetric (MA) mode gathers more gas in the magnetic valleys. The resulting MA gas condensations have larger densities, and the column density enhancements are a factor of about 3 larger than the value of the initial stage. The unstable wavelengths and growth times for the multi-component disk model are substantially larger than those of a thin disk model, and some of the implications of these results are discussed.