Parker Instability under External and Self Gravities: III. A Thick Gas Disk

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The Galactic ISM disk is modeled by a multicomponent, magnetized, isothermal gas layer. This model employs the observed vertical stratifications for the gas density and the gravitational acceleration in the solar neighborhood. In the sense of the stratifications the ISM disk model is a realistic one, but the isothermal assumption makes it still be idealistic. The sum of gas and magnetic pressures at arbitrary height z should balance the weight of the gas-column extending from z to upper boundary z_max. This condition automatically fixes the vertical stratification for magnetic field under given mid-plane value of the field. By solving Poisson equation with the density stratification, we determine the vertical acceleration due to the self gravity as a function of z. By subtracting it from the observed gravitational acceleration, we separate components of the self and external gravities from each other. Onto the resulting equilibrium disk we perform a linear stability analysis and obtain dispersion relations for various conditions of the Galactic ISM disk. The mid-plane value of the magnetic field, the disk thickness z_max, and the isothermal sound speed are important parameters of the disk model. We will discuss how these parameters might affect the fastest growing time and the maximum length scales of the Jeans-Parker instability. Also addressed will be the question whether large scale structures brought by the instability have their cores right in the mid-plane or on the north and south sides of the plane alternatively.