JEANS-PARKER INSTABILITY AS A GMC FORMATION MECHANISM

S. M. Lee[1], S. S. Hong[1], J. Kim[2] T. W. Jones[4], and D. Ryu[5]

[1]*Astronomy Program, SEES, Seoul National University, Seoul, KOREA*

[2]*Korea Astronomy Observatory, Daejeon, KOREA*

[3]*National Center for Supercomputing Applications, University of Illinois, Urbana, U.S.A.*

[4]*Department of Astronomy, University of Minnesota, Minneapolis, U.S.A.*

[5]*Department of Astronomy & Space Science, Chungnam Nat'l University, Daejeon, KOREA*

Using a TVD MHD code we have performed a three-dimensional simulation of the Parker-type instability under an influence of the self-gravity. The disk is consisted of a self-gravitating, magnetized, isothermal gas. In the x and y directions it extends infinitely, and in the z over a finite thickness. The disk is subject to the Jeans, Parker and convective instabilities simultaneously. Our objective is to investigate whether the Parker-type instability under the self-gravity can be a formation mechanism for such large scale structures as the giant molecular cloud (GMC) complexes in the Galaxy. On the basis of a thorough linear stability analysis we have chosen the perturbation wave numbers in such a way that the gravitational instability may override the disruptive tendency of the convection. The initial magnetic fields are taken along the y axis, and 256^3 grids are employed with 64 processors. The computational box is fixed by the chosen perturbation wavelengths along the x and y axes and 10 times the disk scale height over the z axis. The boundary condition is periodic in the x and y, and reflective in the z axes, respectively. The ratio of the magnetic to the gas pressure is initially fixed at 1.0, and random velocity perturbations are added to the disk in an equilibrium state. In early stage of the evolution, the gravity wave propagates from the mid-plane toward the upper boundary. As the wave disappears, the convective features emerged predominantly from the upper region of the disk evolve into chaotic ones. Finally, the chaotic features change into filaments all over the region. On the other hand, a dense prolate bar develops in the central plane with its longer axis being perpendicular to the direction of the initial magnetic fields. The filaments are connected all the way down to the surface of the prolate bar along the magnetic field lines, which become highly curved by then. A combined action of the Jeans gravitational instability with the Parker-type one is capable to suppress the disruptive role of the convection and generates a dense prolate cloud in the central plane. The resulting mass of the dense cloud amounts to $\sim 10^6 M_\odot$, which is a typical value for the giant molecular cloud complexes in the Sagittarius arm (Dame et al. 1986). The filamentary structures seen near the dense core may find their counterparts in the recent observations reported by Haffner et al. (1998). We conclude that theJeans-Parker instability can be a formation mechanism for the GMC-scale structures in the Galaxy.