Fundamental processes in the generation mechanism of bipolar molecular outflow in a proto-solar nebula

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Bipolar molecular outflows are squeesed bidirectional molecular gas flow from protostars and are unique phenomena during the earliest (Class I) protostellar evolution phase. Since the first discovery (Snell et al.,1980) of this phenomena, more than 200 bipolar phenomena have been identified. It has been believed that our solar system had experienced such a stage during the protostellar phase. The purpose of this study is to understand the basic physical process concerning the origin of this outflow phenomena considering transport of angular momentum through the plasma processes in the weakly ionized proto-solar nebula.

The basic mechanism of the bipolarflows has been proposed to be centrifugally driven wind from the disk surface due to the angular momentum transport in the disk(Blandford and Payne 1982). The proposed processes for the launching mechanism of the bipolar flow can be further devided into two models:i.e.,Disk-wind model (Wardle and Konigl 1993) which is based on the poloidal magnetic field of an open geometry (interstellar magnetic field),and X-wind model (Shu et al.,1994) which comes from a strong coupling between the central star and the accretion disk through the magnetic field.

In the present study, we examine a hypothesis that the origin of the outflows is closely related to the angular momentum transport from the protostar to the accretion disk. For this purpose, we have studied the basic physical processes of wind-launching mechanism by theoretical and computer simulation works. In the present theoretical work, the disk density and temperature profiles are assumed to be similar to the alpha-parameter accretion model (Shakura and Sunyaev,1973)with alpha = 0.003 . Furthermore the inhomogeneity effect in the ionization ratio in the disk has been considerd, based on the MHD equations for weakly ionized gas.

As a result of numerical simulations, it has been found that a bipolar flow is difficult to be launched only by the open magnetic field effect as proposed by Wardle and Konigl (1993). It is concluded that an intense magnetic field more than 1G near the disk region is necessary to drive the bipolar outflow.