Jet Formation and Angular Momentum Problem of YSOs

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Abstract
We performed 2.5 dimensional magnetohydrodynamic numerical simulation of disk accretion onto magnetized YSOs. Our numerical model can explain both jets from YSOs and the angular momentum problem.

1 Introduction
We consider the case in which both the large scale magnetic field penetrating accretion disk and the magnetospheric field of the star originated from the same interstellar magnetic field. In this case there exists magnetically neutral ring at the interface between the accretion disk and the magnetosphere (figure 1(b)), and the magnetic reconnection which occurs at this interface plays an important role as described in the following.

2 Numerical Results
The magnetic braking by the large-scale magnetic field causes the disk accretion, which induces the magnetic reconnection between the magnetospheric field and the disk magnetic field at the inner edge of the disk. Thus the accretion disk gas is allowed to enter the magnetosphere through the magnetic reconnection, and finally falls towards the polar crown along the magnetospheric field.

At the same time, through the magnetic reconnection, a part of the accretion disk gas is accelerated to the bipolar direction by the magnetic tension force. The velocity of the jet is larger than the local escape velocity. Note that the jet gas flows along the opened lines of force rooted to the star, which are the result of the magnetic reconnection between the magnetospheric field and the disk magnetic field.

The disk accretion and the associated jet formation continue as long as the magnetic reconnection continues.

3 Discussion
In our numerical simulation, the stellar rotation is not taken into account because of the numerical problem. The reconnection-driven jet will be accelerated also centrifugally by the stellar rotation and extract the angular momentum from the star. An order-estimating discussion shows that if the jet is finally accelerated to the observed velocity by the stellar rotation, then the magnetic braking by the jet cancels the angular momentum accretion to the star from the disk, which results in the steady rotation of the star. So our model can explain the jet formation and angular momentum problem of YSOs consistently.

Figure 1: (a) Schematic picture of the multiple-structured outflows from a YSO. (b) Situation in the vicinity of a YSO in our model.

In our model, the reconnection-driven jet from the interface between the disk and the magnetosphere corresponds to the optical jet, and the ordinary MHD jet from the inner radii of the disk corresponds to the high-velocity neutral wind (figure 1(a)).

See Hirose et al. (1997) for details.

References
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