Close Binary Star Formation and Driving Jet and Outflow

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論　文　内　容　の　要　旨

Observations have been shown that many stars are born as a member of binary. The binary frequency depends on the stellar mass and increases as the stellar mass increases. Especially, it is considered that almost all high-mass stars are members of binary system. Such a high-mass binary system evolves into a binary black hole which can be detected in gravitational wave observation. In addition, high-mass binary systems are closely related to the origin of Type Ia supernova. Thus, it is crucially important to understand how binary systems form in the framework of star formation. Recently, high-velocity twin jets driven by proto-binary system were observed in a nearby star-forming region.

To reproduce the binary jet and investigate the binary formation process, I performed the star formation simulation. Starting from prestellar cloud core, I calculated the gravitational collapse of the star forming cloud. I executed two kinds of simulations. One is the alignment simulation, in which the initial magnetic vectors are aligned with the rotation axis of the prestellar cloud. Another is the misalignment simulation, in which the initial magnetic vectors are misaligned with the rotation axis.

In both cases, fragmentation occurs in the contracting cloud core when the rotational energy exceeds about 5 percent of the gravitational energy in the prestellar clouds. In the alignment case, two protostars appear after fragmentation. They orbit each other and each protostar drives a high-velocity jet. I calculated the evolution of the proto-binary system for about 500 years after its formation. In the misalignment simulations, the merger of fragments frequently occurs. When the merger occurs, only a single star remains. In such a case, a strong jet appears every time the merger occurs. In the misalignment simulations, a proto-binary system can survive when the initial angle between the magnetic vectors and rotation axis is 5 degrees. In such a case, the spin direction of each protostar does not align with the direction of the orbital angular momentum of the binary system. In addition, each protostar drives the high-velocity jet in each direction. Thus, a misaligned jet, which was observed in some past observations, is realized. In this study, I could clarify the early phase of the binary formation and reproduce various characteristics of protobinary systems observed in active star-forming regions.