Evolution of binary fragments in collapsing prestellar cores

〇Nikita Lileiko[1] 富田 賢吾[1] 岩崎 一成[2] (1.東北大学 2.国立天文台)

Binary stars are ubiquitous. They exhibit a range of physical effects unique to multiple systems and are the primary focus of many modern observational surveys. In particular, recent Gaia observations provide increasing evidence of peculiar features in binary parameter distributions across different mass ranges: the existence of close binaries with separation much smaller than 1 au as well as overabundance of twin systems with mass ratio of near unity. However, existing numerical studies that consider evolution of isolated binary stars can not address the observed parameter statistics consistently.

Since stars are formed in large-scale collapsing gaseous envelopes and naturally interact with the surrounding environment, it is necessary to study the early evolution of binary seeds submerged in realistic large-scale prestellar cores. In addition, observations suggest that star forming regions are highly magnetized. As a result, to uncover what physical processes govern evolution of newly formed binaries, we derive appropriate initial conditions based on a large-scale collapse model and systematically study the growth of binary systems by performing 3-dimensional numerical simulations. Here, we use a grid-based magnetohydrodynamics framework Athena++ and incorporate gas self-gravity as well as magnetic phenomena.

The results reveal a complex interaction between the binary fragments and the surrounding gas. We find that the orbital evolution of young binaries is driven not only by gas accretion but is also significantly affected by the interactions with the massive, collapsing gaseous core, leading to orbital decay even in non-magnetized cases. In this presentation, we focus on reporting the specific physical mechanisms that drive binary migration and discuss what dictates parameter evolution during the early protostellar epoch.