Embedded cluster dynamical evolution

From molecular clouds to young open clusters and association

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Studies on star formation show evidence that stars in the galaxy are mainly produced in groups within large collapsing molecular clouds, forming what is called an embedded cluster. This is a gravitationally bound entity, whose long-term evolution is controlled by dynamical events and the complex interplay between the stars and the remaining surrounding gas.

While stars mainly form in dense groups, most of them dissolve to populate the galactic field. It is therefore crucial to understand the long term evolution of stellar clusters to produce a comprehensive picture from star formation to a relaxed state. Stellar dynamics in star clusters has been studied for decades now. And mechanisms leadind to the dilution of clusters in the galactic field are well known. However, these previous studies used outdated models that are not representative of such environment. The early dynamical evolution is much more complex than what we could compute in previous models. To improve this picture, it is necessary to build a hybrid model that manages gas and stars dynamics in parallel within a cluster, from its formation to the complete gas expulsion. It is also necessary to take into account the numerous interactions between the two components, i.e. the gravitational force between gas and stars, as well as feedback processes like HII region expansion around massive stars, jets produced by protostars, and supernovae.

In this poster, I present the numerous implementations I added to the *Phantom* code to produce highly accurate simulations of embedded clusters. First, I describe the star formation prescription, using sink particles, that is capable of generating realistic stars and gas distributions from a molecular cloud collapse. Second, I discuss how I implemented feedback interactions between gas and stars in the form of the HII region expansion around the massive stars. And finally, I introduce all the mandatory algorithms needed to accurately follow the stellar dynamics that I have recently added to *Phantom*. I then show the preliminary results that we can extract from the first simulations.