STABILITY OF COLLAPSING DENSE CORES

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Understanding the formation of binary and multiple stellar systems largely comes down to analyzing the circumstances under which a collapsing core undergoes fragmentation (or not) during the early stages of the collapse.

On the other hand, it has been shown from numerical experiments that both the probability for fragmentation and the number of fragments largely depend on the initial physical state of the core. However, these simulations are usually highly non-linear and complex, so it is hard to isolate the different processes and disentangle their individual effects on the fragmentation. This is exactly what we aim to do in this work.

We perform linear perturbations of two well-known collapse solutions, the simple homologous isothermal sphere collapse and the Larson-Penston flow. The perturbation is made out of not only a radial component and a spherical harmonic, but also a shock, which is meant to naturally bridge the subsonic to the supersonic regimes of the flow. This new element allows for the integration of the equations for any growth rate. We thus confirm the relevant stability of the Larson-Penston flow to perturbations and the unstable nature of the homologous collapse.

The insight offered by the analytical treatment of the problem, valid for very cold cores, is carried onto numerical simulations, which also deal with the effects of thermal pressure. We simulate a number of collapsing isothermal cores, varying their initial Virial parameter (thermal over gravitational energy) and the shape of the initial perturbation (linear perturbations in the form of spherical harmonics). Overall the simulations seem to be in consistent with the predicted analytical behavior for the most unstable cores, while they pose a limit of a Virial parameter for fragmentation equal to 0.1.