Abstract

Classical theories for the stellar initial mass function (IMF) predict a peak mass that scales with the properties of the molecular cloud. In this work, we explore a new theory proposed by Lee and Hennebelle. The idea is that the tidal field around first Larson cores prevents the formation of other collapsing clumps within a certain radius. The protostar can then freely accrete the gas within this radius. This leads to a peak mass of roughly $10\,M_{\rm 1LC}$, independent of the parent cloud properties. Using simple analytical arguments, we derive a collapse condition for clumps located close to a protostar. We then study the tidal field and the corresponding collapse condition using a series of hydrodynamic simulations with self-gravity. We find that the tidal field around protostars is indeed strong enough to prevent clumps from collapsing unless they have high enough densities. For each newly formed protostar, we determine the region in which tidal screening is dominant. We call this the tidal bubble. The mass within this bubble is our estimate for the final mass of the star. Using this formalism, we are able to construct a very good prediction for the final IMF in our simulations. Not only do we correctly predict the peak, but we are also able to reproduce the high- and low-mass end. We conclude that tidal forces are important in determining the final mass of a star and might be the dominant effect in setting the peak mass of the IMF.