An Ensemble of Turbulent Cores

preliminary results

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Abstract

We present preliminary results from 50 smoothed particle hydrodynamics (SPH) simulations of weakly turbulent cores of molecular gas with turbulent Mach number 0.2, radius 0.13 pc and mass 5 $M_\odot$. We use the SEREN code[1] which includes self-gravity and sink particles[2] to model protostars. We use a barotropic equation of state and do not include magnetic fields or radiative transfer due to computational limitations.

The cores collapse and fragment, forming protostars; we examine their mass function and binary properties. Each core produces approximately 4 stars with a core mass to star mass efficiency of 25%. The system multiplicity is approximately 40%; cores may produce more than one multiple system.

Rationale

The origin of the initial mass function (IMF) of stars is not yet explained. Stars form in dense cores of molecular gas; observations[3] have shown the core mass function (CMF) is very similar to the IMF. A number of analytic theories of gravoturbulent fragmentation[4,5] have reproduced the form of the CMF. If cores are relatively isolated then the form of the CMF may in turn determine the form of the IMF.

However, the process of forming stars in a dense core, even an isolated one, is non-linear and chaotic. It is also where the binary properties of stars are determined. For this reason it is best studied by numerical simulation; our results may help describe the link from CMF to IMF.

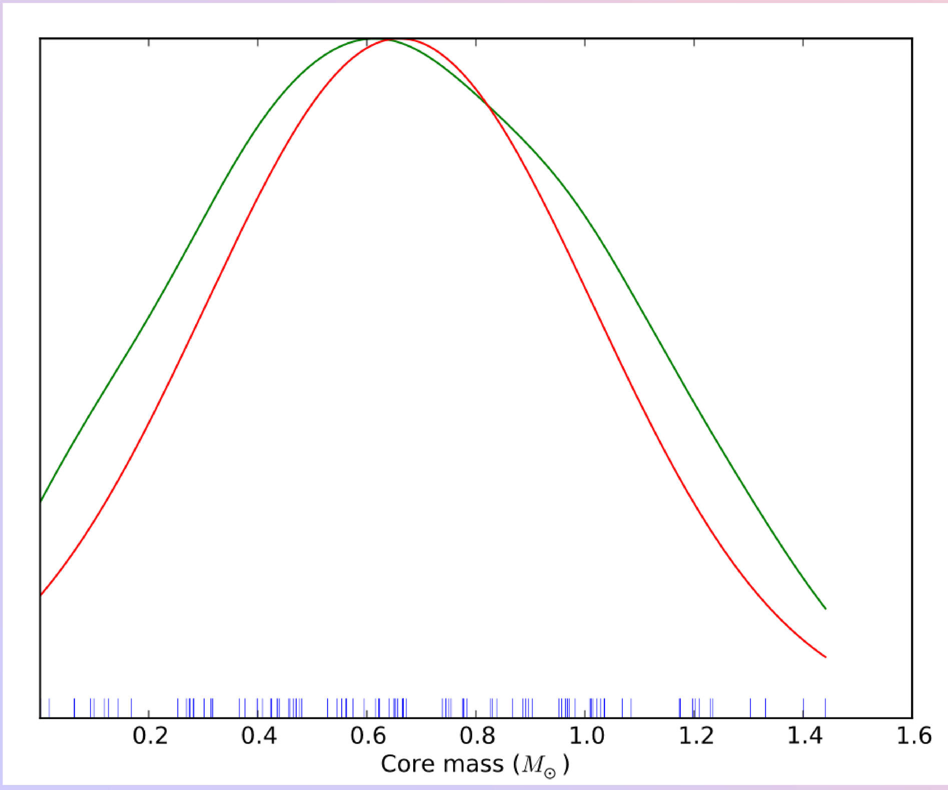
Results: Mass function

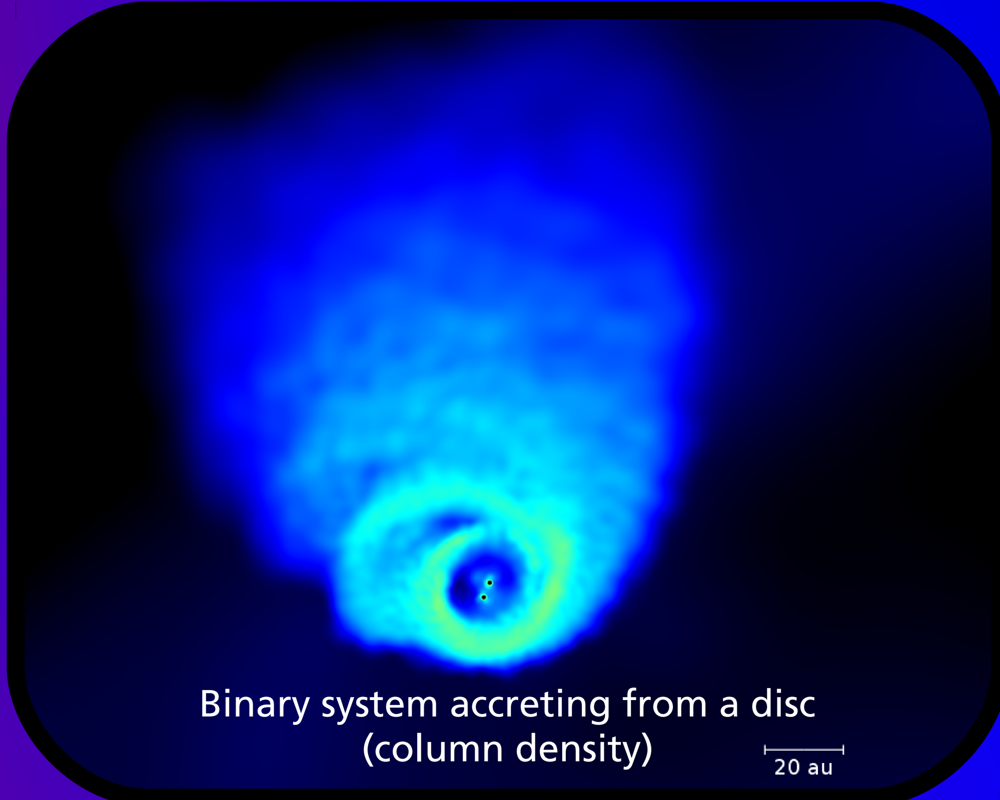
Kernel density estimate: green

Gaussian fit: red

Sink masses: blue markers

This mass function is for a single core mass, and is not an IMF





Binary system accreting from a disc (column density)

Results: parameters

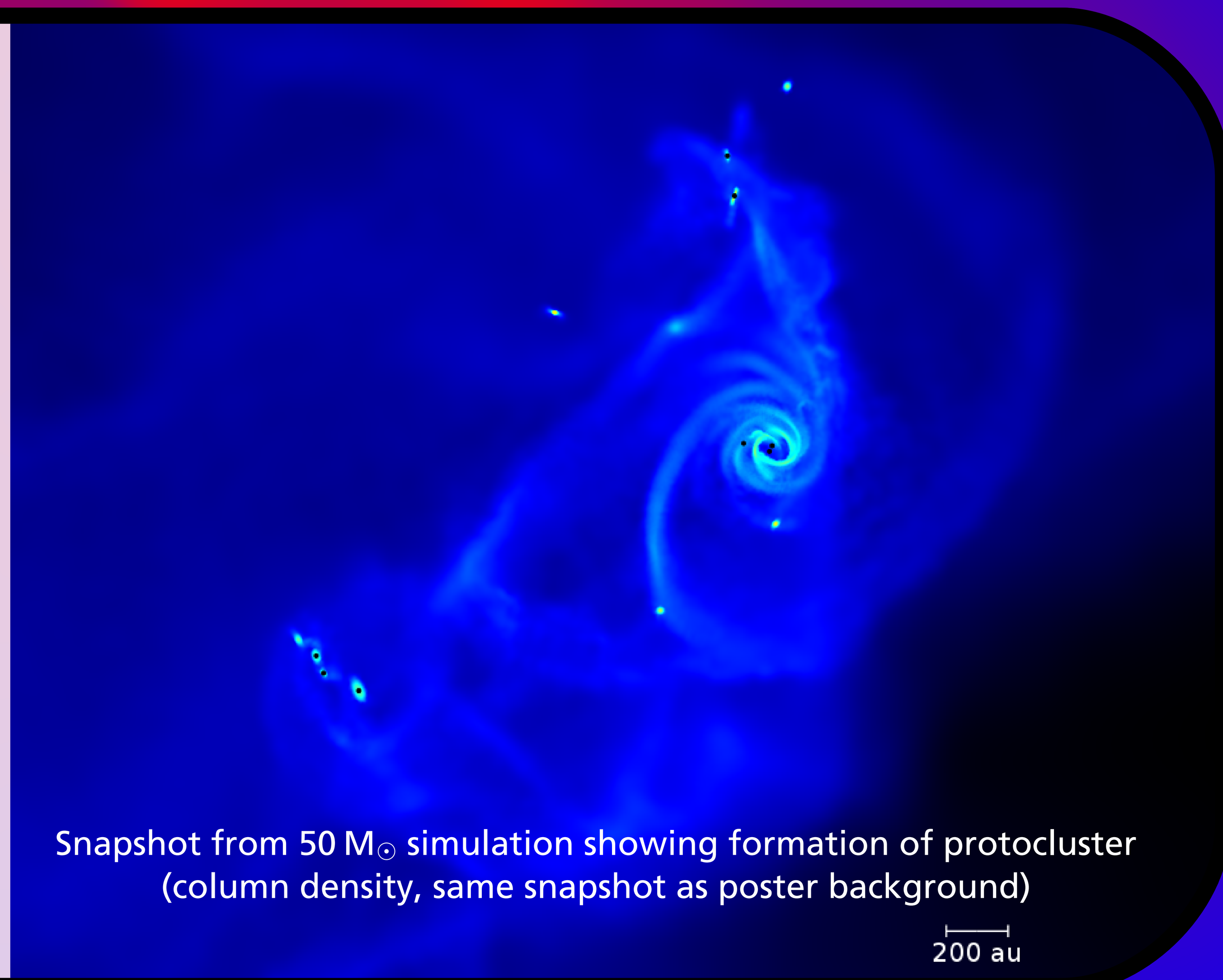
Number of stars per core:	1.94 ± 0.95
Efficiency parameter: (conversion of core mass to stellar mass)	25% ± 10%
Multiplicity fraction: (fraction of systems that are multiple)	39%
Gaussian fit to mass function	
Mean:	0.66 $M_\odot$
Standard deviation:	0.36 $M_\odot$

Conclusions and further work

Using SPH simulations of a large ensemble of 5 $M_\odot$ cores with different turbulent velocity fields, we calculate statistical properties of the resulting protostars. We find a core mass to star mass efficiency of approximately 25%, similar to previous theoretical and numerical estimates[6,7]. Stellar masses formed in these cores appear to be normally distributed, with a mean mass of 0.66 $M_\odot$.

We find an average system multiplicity of approximately 40% which is similar to the value for field stars[8]. In future work we will estimate the effects of dynamical processing, which destroys weakly-bound binary systems..

These simulations are part of a larger suite of simulations of 5, 10, 20, 30, 40 and 50 $M_\odot$ cores. Using these additional simulations, the basic properties of star formation can be determined as a function of core mass. These can then be convolved with the core mass function to predict the properties of stars.



Snapshot from 50 $M_\odot$ simulation showing formation of protocluster (column density, same snapshot as poster background)

References

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