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A mass invariant at the origin of the universality of the Core Mass Function?

Explaining the universality of the peak of the Core Mass Function is a major unsolved problem in astrophysics. Recently, Jaupart & Chabrier (2021) suggested that this universality can be related to a mass invariant M_inv first derived by Chandrasekhar (1951) based on several assumptions, namely the statistical homogeneity of the turbulent density field.
This invariant depends on the variance and correlation length of the density field. In this work, we performed numerical simulations of homogeneous and isotropic compressible turbulence to test the validity of this invariant in a medium subject to decaying turbulence or to self-gravity. We study several input configurations, namely different Mach numbers, injection lengths of turbulence, equations of state and average gas densities to cover the variety of star formation conditions. We confirm that M_inv remains constant during the decaying phase of turbulence and also for self-gravitating flows. Furthermore, we develop a theoretical model of the density field statistics which predicts without any free parameter the evolution of the correlation length with the variance of the logdensity field beyond the assumption of the gaussian field for the logdensity. Noting that M_inv is independent of the Mach number, we show that this invariant can be used to relate the non-gaussian evolution of the logdensity probability distribution function to its variance with no free parameters. Finally, we will discuss what we can learn from this invariant in terms of the statistics of the structures formed in star-forming regions and its link to the peak of the core mass function.

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