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Tracking Star-Forming Cores as Mass Reservoirs in Clustered and Isolated Regions Using Numerical Passive Tracer Particles

Understanding the physical properties of star-forming cores as mass reservoirs for protostars and the role of turbulence is essential in star formation studies. We implemented passive tracer particles in clump-scale numerical simulations with turbulence strengths of $M_{\rm rms} = 2,\ 10$. Unlike core identification methods based on density thresholds, we identified 260 star-forming cores by tracking tracer particles falling onto protostars. Our results show that star-forming cores do not always coincide with high-density regions. In clustered star-forming environments, they tend to exhibit a fragmented, clumpy structure as gas selectively accretes onto protostars. We constructed convex hull cores from the identified star-forming cores and evaluated their filling factors. Regardless of turbulence strength, cores with lower filling factors tend to be more massive, larger, and contain more protostars, suggesting that clustered regions host systematically larger and more massive cores. The filling factor thus serves as a useful indicator for distinguishing between isolated and clustered star-forming regions. Most convex hull cores are gravitationally bound, but in the $M_{\rm rms} = 10$ model, the fraction of low-mass, unbound cores is higher than in the $M_{\rm rms} = 2$ model. In particular, $16\,\%$ of the convex hull cores in the $M_{\rm rms} = 10$ model are unbound, which may be explained by the inertial-inflow model. These results highlight the impact of turbulence on core mass and gravitational stability.

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