Probing the Microscopic with the Macroscopic: from Properties of Star Cluster Systems to Properties of Cluster-Forming Regions

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To understand how systems of star clusters have reached their presently observed properties constitutes a powerful probe into the physics of cluster formation, without needing to resort to high spatial resolution observations of individual cluster-forming regions (CFRg) in distant galaxies. In this contribution I focus on the mass-radius relation of CFRgs, how it can be uncovered by studying the gas expulsion phase of forming star clusters, and what the implications are. I demonstrate that, through the tidal field impact upon exposed star clusters, the CFRg mass-radius relation rules cluster infant weight-loss in dependence of cluster mass. The observational constraint of a time-invariant slope for the power-law young cluster mass function is robustly satisfied by CFRgs with a constant mean volume density. In contrast, a constant mean surface density would be conducive to the preferential destruction of high-mass clusters. A purely dynamical line-of-reasoning leads therefore to a conclusion consistent with star formation a process driven by a volume density threshold. Developing this concept further, properties of molecular clumps and CFRgs naturally get dissociated. This allows to understand: (i) why the star cluster mass function is steeper than the molecular cloud (clump) mass function; (ii) the presence of a massive star formation limit in the mass-size space of molecular structures.

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