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Probing the Hierarchy in Stellar Clustering

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The formation of stars is a "social" process. It leads to the assembly of young stars at various length-scales into structures of diverse degrees of self-binding, from gravitationally-bound star clusters to unbound stellar associations, and beyond (e.g., Elmegreen 2000). These different young stellar systems are, however, not independent to each other. In nearby star-forming regions compact clusters appear at few 1-pc scales as the nested centers of star formation within loose stellar aggregations of few 10-pc sizes (e.g., Schmeja et al. 2009). Resolved populations across whole galaxies show that these structures are themselves components of larger stellar complexes with typical sizes of few 100-pc, and this structural behavior seems to extend to kpc scales in galactic super-structures and spiral arms (e.g., Gouliermis *et al.* 2015). From the stellar clustering point-of-view, star formation behaves as a scale-free process, expressed by power-laws in size distributions and correlation functions (e.g., Elmegreen *et al.* 2014). *The origins of the self-similar stellar structural morphology, the scales where it changes behavior, and how these scales are determined, are fundamental questions to our understanding of star formation.*

To address these questions we investigate the spatial distribution of newly-born stars across the star-forming complex N66 in the Small Magellanic Cloud (SMC), imaged with the Hubble Space Telescope. We find that the autocorrelation function of these stars can only be explained as the combination of two distinct stellar clustering designs, a compact centrally concentrated and an extended self-similar distribution of stars (Gouliermis *et al.* 2014). The hierarchical stellar component is found to have a fractal dimension of $D_2 \approx 1.8$, moderately larger than $D_2 \lesssim 1.5$, expected by turbulence (Sreenivasan 1991), implying that mixing may have altered the original hierarchy. This finding suggests that *at ~ 100 pc-scales stellar clustering is determined by both turbulence and the dynamics of the gravity center.* This center was found to host most of the star formation in N66 (Hony *et al.* 2015). On galaxy scales we currently investigate the clustering behavior of young massive stars across the whole extent of the SMC. The autocorrelation function of these stars shows a clear self-similar distribution across all scales with $D_2 \approx 1.6$, closer to that expected by turbulent-driven star formation (Gouliermis *et al.*, in preparation). This implies that *at kpc-scales stellar distribution possibly sustains memory of its initial hierarchy.* The origin of the scale-free stellar clustering and its relation to the hierarchical morphology of the interstellar medium is under investigation.

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