The Role of Hierarchy in Galactic Molecular Clouds: Observational Tests of the Global Hierarchical Collapse

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Although the Global Hierarchical Collapse (GHC) scenario is a leading high-mass star formation model[1], its universality across Galactic molecular clouds remains unverified. We investigate the link between cloud hierarchies and star formation. Using the FUGIN[2] data and astrodendro[3], we classified clouds into hierarchical (leaves, branches, trunks) and non-hierarchical (isolated) structures (see Figure 1). We compared these with star-forming activity using SPICY[4] YSOs (low-mass precursors) and Hi-GAL[5] clumps (high-mass precursors).

Trunks are significantly larger and more massive with lower virial parameters than isolated clouds. Despite similar sizes, leaves exhibit higher masses and stronger self-gravity than isolated clouds. Although containing comparable YSO counts, leaves host significantly more Hi-GAL clumps than isolated ones (see Figure 2).

Thus, hierarchical structures are essential for producing a large number of high-mass stars. Isolated clouds form few massive stars, lacking the continuous gas supply for further generation. Conversely, leaves grow massively via continuous gas accretion from parent envelopes (trunks) and internal interactions. This abundant gas reservoir allows hierarchical clouds to consistently genarate numerous high-mass stars.

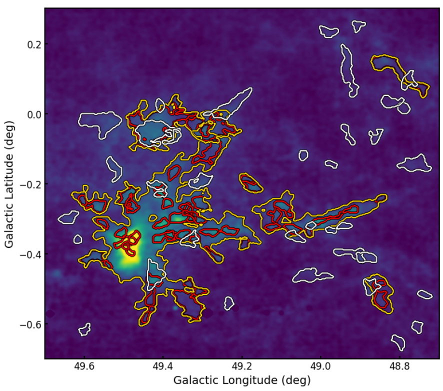

Figure 1: Dendrogram map of the identified cloud structures in W51A region.

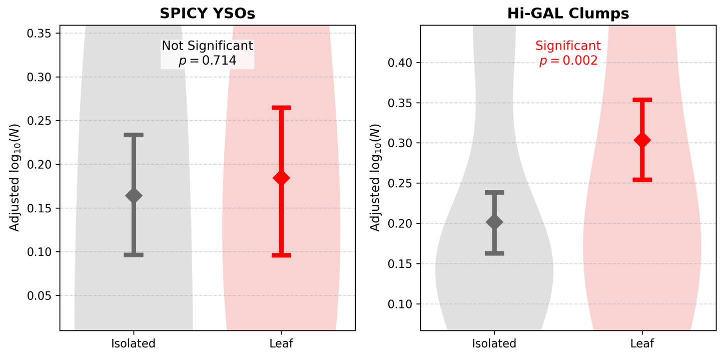

Figure 2: Comparison of the region-adjusted numbers of contained YSOs and Hi-GAL clumps between leaf and isolated structures of similar sizes.

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[3] Rosolowsky E. W., *et al.* 2008, *ApJ*, 679, 1338
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[5] Elia D., *et al.* 2017, *MNRAS*, 471, 100