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Tracing massive star cluster formation: insights from the LISCA project

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Clustered star formation is the dominant mode of star formation across cosmic time. Moreover, it plays a key role in many fundamental areas of astrophysics: from the early interplay between stellar and gas dynamics to the formation of gravitational wave sources and exotica, from the dynamical properties of young star clusters to galaxy assembly and evolution. Yet, the underlying physical processes governing massive star cluster formation are still poorly constrained. In particular, whether clusters form through a monolithic event or as a result of a hierarchical assembly process is still a matter of intense investigation.
Within this context, I will introduce the LISCA project. The project aims to characterize cluster formation and early evolution by performing the first comprehensive spectro-photometric and kinematic analysis of young clusters and associations using both Gaia DR3 and dedicated high-resolution spectroscopy secured through the SPA-TNG large program.
I will focus in particular on recent results obtained in the Perseus complex. We found that the region presents several young (< 30 Myr) star clusters organized in large hierarchical structures (at least three major structures) and embedded in a diffuse "stellar halo"exhibiting cluster-like features and out-of-equilibrium dynamics. These systems show properties in terms of 2D density structure, evidence of tidal interactions, mass segregation, and kinematics compatible with being at the early or at most intermediate stages of a massive cluster assembly process that could lead them to evolve as bound stellar clusters.
The results we obtained show that the formation of small stellar structures and their subsequent growth driven by dynamical interactions might have strongly contributed to shaping the observed properties of these hierarchical structures, thus possibly representing a viable process to form massive and long-lived stellar systems also in relatively low-density environments, like the Milky Way disk.

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