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The life cycle of star clusters in low-metallicity dwarf galaxies

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The earliest known proto-globular clusters (GCs) detected with the James Webb Space Telescope were compact (effective radii ~parsecs) and extremely dense, ideal to harbour energetic massive stars and possibly intermediate mass black holes. The detailed conditions and time-scales of star formation and stellar feedback during the earliest stages of galaxy assembly are however still unclear. This is both due to the limiting resolution (parsecs) and sensitivity in even the most optimal gravitationally lensed detections; and the lack of complementary high-fidelity simulations able to capture the key astrophysical processes of clustered star formation on small, sub-parsec scales.

In the GRIFFIN project (Galaxy Realizations Including Feedback From INdividual massive stars) we examine the formation and evolution of resolved star clusters up to the GC-mass range using high-resolution (sub-parsec, star-by-star) hydrodynamical simulations. Our low-metallicity dwarf galaxy simulations account for the radiation, stellar winds and supernovae of individual stars. I will briefly discuss how massive star clusters form hierarchically and rapidly over time-scales of less than 10 Myr, yet they are able to self-enrich through stellar winds. Recently, we supplemented the methodology with a regularised integrator to accurately solve the stellar gravitational dynamics on small spatial scales. This was shown to be critically important for the modelling of more realistic star cluster life cycles from formation until disruption in the tidal field of the host galaxy. I will conclude with future avenues toward unravelling the cosmic origin of GCs.

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