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Galaxies in high-z clusters and proto-clusters in cosmological hydrodynamical simulations

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The study of high-z clusters and proto-clusters is fundamental to understanding the connection between the evolution of galaxies and their environment. Theoretical models of galaxy formation and evolution are still challenged by observations of a highly diverse star formation scenario in (proto-)clusters at z~2, confirming that the physics of galaxy formation is not well understood yet. This cosmic time is characterized by the transition from highly star-forming proto-clusters
to mature clusters, and its study is a fundamental step in constraining our knowledge of galaxy evolution. Cosmological hydrodynamical simulations are currently among the most advanced tools to investigate this. In this talk or poster, I will present the analysis of a set of state-of-the-art high-resolution cosmological hydrodynamical simulations of galaxy (proto-)clusters and compare them with an average cosmological volume, acting as a "control field", to isolate the effects of
environment on galaxy populations. Monte Carlo radiation transfer of stellar light through a modeled dust distribution was included in post-processing in order to enable a proper comparison with the observed properties of (proto-)cluster galaxies. I will show how the simulations succeed in reproducing some observables related to the star formation and dynamics of galaxy populations, while others remain a challenge, leaving questions open on which key ingredients are still lacking in our theoretical framework. Then, I will discuss predictions from cosmological hydrodynamical simulations on the AGN populations in dense environments that can be used as a theoretical benchmark to plan future observations.

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