PhD project in ASTROPHYSICS

Title:
Quenching in Fornax Cluster Galaxies Traced by Atomic Hydrogen

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Star formation quenching and the processes that regulate it are crucial to understanding galaxy evolution. One key indicator of quenching is the decline in the availability of cold gas (both atomic and molecular), the raw material for star formation. In dense environments such as galaxy clusters, understanding the gas-star formation cycle requires considering a wide range of environmental processes that influence how star formation proceeds in cluster galaxies (e.g., starvation, tidal stripping, thermal evaporation, and gravitational interactions). These mechanisms primarily affect galaxy evolution by perturbing the total gas. Atomic hydrogen gas (HI) is usually the most massive and extended component of the interstellar medium (ISM), extending well beyond the galaxy stellar radius, making it an excellent tracer of the environmental influence on galaxies.

This PhD project aims to investigate quenching in Fornax cluster galaxies using HI observations from the MeerKAT Fornax Survey (MFS; Serra et al. 2023, A&A, 673, A146). With high angular resolution (~1 kpc), fine spectral resolution (1.4 km s^{-1}), and deep HI mass sensitivity (~6×10^5 $M_\odot$, 3σ over 50 km s^{-1}), MFS makes the Fornax cluster at 20 Mpc, the nearest low-mass galaxy cluster, an exceptional laboratory to study how environment shapes galaxy evolution. The project will exploit scaling relations between atomic gas content and other galaxy properties to trace galaxy quenching and quantify how environmental processes regulate star formation. The morphology and kinematics of the HI will be used as diagnostic tools to identify the nature of environmental interactions, providing additional constraints on the physical processes driving gas removal and redistribution. The analysis also benefits from multi-wavelength ancillary data covering galaxy properties such as stellar mass (VST), molecular gas (ALMA), and dust (Herschel), as well as star formation rate tracers (e.g., Hα imaging from VST, optical spectroscopy including MUSE, WISE IR data, UV observations). These datasets will be combined with HI to investigate how environmental processes affect the multi-phase ISM and the star formation efficiency within galaxy disks. The analysis will be performed as a function of galaxy stellar mass and cluster environment, comparing galaxies in the central regions with those in the infalling Fornax A group. This panchromatic study will provide a complete view of the baryonic cycle in a dense environment. Finally, the project will train the candidate for future SKA-era HI surveys at high resolution and sensitivity.

This project is carried out within a team of experts in galaxy evolution and the physics of the cold ISM, spanning observational and theoretical/numerical approaches. The team includes the PI of MFS, ensuring direct access to the data and strong scientific leadership.

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