Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Mareille

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Subject's title: The role of the environment on galaxy evolution

Subject description: It is now clear that two main parameters have modulated galaxy evolution since their formation: the mass of the galaxy itself and its surrounding environment. Galaxies are distributed within the universe in a non-uniform way, spanning a wide range of densities from the core of rich clusters, to compact and loose groups, filaments and voids. Since the seminal work of Dressler, which indicated a clear morphological segregation in the distribution of galaxies as a function of density, it became evident that the environment plays a major role in shaping galaxy evolution. Cluster of galaxies are mainly composed of quiescent objects (ellipticals and lenticulars), while star forming late-type systems are dominant in the field and in less dense environments. Furthermore, the few spiral galaxies inhabiting high-density regions have, on average, a lower gas content and star formation activity than their field counterparts (Boselli et al. 2022).
Although containing only ~5% of the local galaxies, clusters are ideal laboratories to study the various processes at play. We can thus use these systems to study the undergoing processes and later see whether the results obtained in these particular regions can be extended, and under which conditions, to less extreme environments. Several physical processes have been proposed to explain the observed differences between cluster and field galaxies. These processes can be divided in two main families, those related to the perturbations induced on the galaxy by the gravitational interaction with other cluster members or with the potential of the cluster (tidal stripping, harassment), and those related to the interaction with the hot and dense intergalactic medium trapped within the potential of the cluster and emitting in X-ray (thermal evaporation, ram pressure stripping, starvation). Our team at the LAM is an internationally recognised leader in the study of the role of the environment on galaxy evolution through the multifrequency analysis of nearby clusters. We are leading or participating to several surveys of the Virgo cluster (VESTIGE, GUViCS, HeViCS, HRS, NGVS, MAUVE, ALFALFA, VERTICO, UVIT, LOFAR, MeeerKAT – Boselli et al. 2011, 2018, Ferrarese et al. 2012, Davies et al. 2010, Brown et al. 2021). Being the closest rich clusters to our own Galaxy, still in formation, it is the ideal laboratory to study the different physical processes affecting galaxy evolution. The PhD student will use this unique set of data starting from the narrow band Hα imaging data obtained during the VESTIGE CFHT Large Program (http://mission.lam.fr/vestige/) led by our team in Marseille, but also Herschel, GALEX, ASTROSAT/UVIT, deep optical broad (NGVS), HI (ALFALFA, MeerKAT), CO (VERTICO), and radio continuum (MeerKAT, LOFAR) data, as well as high and low resolution spectroscopic data (MUSE-VLT/MAUVE), and develop multizone models of galaxy evolution especially tailored to consider the effects of the cluster environment, to identify and study the different perturbations affecting galaxies. This work will be done in a tight collaboration with the different teams involved in these ongoing projects, and will thus give a unique opportunity to the candidate to have continuous and constructive exchanges with the international community and several leaders on this topic.

Bibliography: Boselli et al. 2011, A&A, 528, 107 ; 2018, A&A, 614, 56 ; 2022, A&ARv, 30, 3 ; Brown et al. 2021, ApJS, 257, 21 ; Davies et al. 2010, A&A, 518, L48 ; Ferrarese et al. 2012, ApJS, 200, 4 ; A. Boselli is PI of an ongoing Virgo cluster ASTROSAT/UVIT legacy survey, coI of a VLT/MUSE Large Program (MAUVE, PI L. Cortese), and of a blind radio survey of Virgo with MeerKAT and LOFAR (PI. F. deGasperin).