

Unveiling the 3-D structure of a remarkable distant super-cluster and the roles of environment, mass and galaxy properties at $z \sim 0.8$

Supervisors: David Sobral (sobral@strw.leidenuniv.nl), José Afonso, Philip Best (Edinburgh)

Abstract: Why were galaxies in the distant Universe so efficient at producing new stars? What were the roles of "nature" (stellar mass) and "nurture" (environment) in the past, how did they change with cosmic time and is there a connection between those and the declining star formation activity? Is our current view of how galaxies form and evolve correct? By probing a very wide range of environments (from fields to clusters of galaxies) and masses, we are now obtaining a much better picture of the roles and inter-dependences of mass and environment in the distant Universe. However, there are significant limitations in current studies, due to the small sample sizes, lack of multi-wavelength data in cluster fields, projection effects, and the dilution/confusion of environments (e.g. filaments vs small groups). In order to obtain the sharp view that we need, overcoming current limitations (from the use of photometric redshifts), the student will use the VLT (with VIMOS, 40 hours of observations already conducted at the VLT, all in excellent conditions) to accurately map in 3-D a unique super-structure at $z = 0.84$ in the COSMOS field (10×13 Mpc). This massive, large structure contains 3 confirmed massive X-ray clusters/groups and shows a striking filamentary structure of star-forming galaxies. By targeting > 1000 galaxies residing in such structure, the student will measure accurate redshifts (from both emission and absorption lines) and make a detailed/accurate 3-D map of the complex structure, identifying filaments, fields, outskirts, small groups and the cluster cores. The student will obtain independent mass estimates from the absorption lines, and map SFRs down to even the least active galaxies, but also detect post-starburst galaxies (K+A) and map their fraction in the cluster, group, filament and field environments over the entire structure. The results of this project will reveal exactly where star formation activity is being enhanced/quenched, clearly disentangling the roles of mass and environment in the distant Universe in a robust way for the first time.

Moreover, due to the fact that this super-structure is in the COSMOS field, the student will be able to fully explore the rich multi-wavelength data-set to detail and expand the conclusions of the study, particularly by investigating the morphologies (with Hubble Space Telescope imaging), but also to look at radio, near- (Spitzer) and far-infrared (Herschel) properties of galaxies residing in the various environments within the super-structure.

Facilities: VLT/VIMOS, HST, Subaru/Suprime-cam, Herschel