Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

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Subject's title: The first galaxies with ELT-MOSAIC

Subject description: To bring new light on the first epoch of galaxy formation is among the most ambitious challenges for astronomers in the next decades and the goal of this PhD thesis.
The ESO Extremely Large Telescopes (ELT) will allow us to see the high redshift universe using new eyes of unprecedented power having the potential to transform our understanding of the formation and early evolution of galaxies and black holes, first light and cosmic reionisation.
In this context, the proposed PhD thesis aims to revisit the technical performances of ELT-MOSAIC in exploring the properties of galaxies in the early universe and to prepare the scientific cases and observational specifications of the spectroscopic surveys which will be undertaken by the MOSAIC Consortium.

In the recent past, a lot of progress have been done in searching for galaxies during the epoch of reionisation, $6 < z < 10$, (e.g. Bouwens et al., 2015; Bowler et al. 2015). Still, the number of spectroscopically confirmed galaxies at $z > 6$ is small, their physical properties are not well characterised and the end of the reionisation epoch is not well constrained (Robertson et al. 2015). ELT-MOSAIC will be the first multi-object spectrograph on an ELT and will be the most powerful instrument for catching the faintest sources up to one or two magnitude deeper than JWST. Indeed, its main scientific objective will be the detection and study of the formation of the very first structures in the early universe, 10-13 billion years ago, thanks to its high resolution and its unmatched sensitivity due to the great collecting power of a 39m telescope (Evans et al. 2015).

The morphological diversity of galaxies in the local universe is the visible outcome of the various physical processes at play when galaxies are assembling along cosmic time. Recently, we observed two unexpected trends which are challenging our knowledge of high redshift galaxies: 1) galaxies' sizes, at $2 < z < 4.5$, remain roughly constant on average with a median value ~2.2 kpc (Ribeiro et al., 2016); 2) the fraction of clumpy galaxies increase with redshift (Ribeiro et al., 2017). In a first phase, after a bibliographic work, the successful candidate will use the VUDS (Tasca et al., 2016) and VANDELS spectroscopy combined with the HST/WFC3 and ACS photometry to look into these trends at even higher redshifts. A comparison of galaxies properties at different redshifts will then be performed to identify evolutionary trends.

In a second phase, the PhD student will familiarise with the ELT-MOSAIC scientific specifications and technical level requirements. He/She will use them to produce simulations of high redshift galaxy observations, deep into the reionisation epoch, as seen by ELT-MOSAIC. He/She will review the current knowledge of high redshift galaxy properties and will use on-going photometric and spectroscopic surveys to provide realistic luminosity functions and number counts. This will provide the observational predictions needed to prepare next generations surveys.

The MOSAIC Consortium agreed to use the GTO to perform one or more surveys. The survey strategy should be optimised to maximise the scientific return and the discovery expectations of the scientific community. ELT-MOSAIC will give a tremendous leap forward in our understanding of how present-day galaxies formed and evolved. This includes detecting nearby primordial stars, the very first galaxies at the epoch of re-ionization and the most exhaustive dynamical survey of distant galaxies ever undertaken. Therefore, in a third phase, the PhD student will develop a specific ELT-MOSAIC survey outline in order to optimise the number of sources which will be simultaneously observed during the MOSAIC GTO.

The successful candidate will join the GECO team at LAM and will be a member of the MOSAIC Consortium. He/She will have access to information and data of different international collaborations like ELT-HARMONI, PFS, Euclid, COSMOS, UltraVISTA, VANDELS, VUDS, VIPERS (among others), opening a large range of career opportunities after the PhD thesis.

Bibliography:
- Bouwens et al., 2015, ApJ, 803
- Bowler et al., 2015, 452, 1817
- Evans et al., 2015, arXiv:1501.04726
- Ribeiro, Le Fèvre, **Tasca L.A.M.** et al., 2016, A&A, 593, 22
- Ribeiro et al., 2017, A&A, 608, 16
- Robertson et al., 2015, ApJ, 802, 19
- **Tasca L. A. M.** et al., 2017, A&A, 600, 110