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## Thesis subject

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Subject's title: Searching high-z sources with EUCLID

### Subject description:

**Context.** High-z galaxies and quasars ( $z > 7$ ) are probes of the primordial universe that encode key information on the early formation of stars, black holes and galaxies and on the re-ionization of the Universe. The observation of the high-z Universe is at the core of most of the large scale projects and programmes in astronomy and astrophysics of the coming decades. In the immediate future, and before WFIRST, SKA, ATHENA and LISA, the missions most likely to uncover high-z objects are EUCLID and JWST. The later will discover faint galaxies in the faint end of the luminosity function while EUCLID will find bright galaxies in the DEEP survey and high-z quasars in the WIDE survey. EUCLID will therefore provide unique samples of sources that will be followed-up in spectroscopy with JWST and ELTs (and 8-10 m telescopes in the meantime). These samples of bright objects will enable great progress in our understanding of the re-ionization era and on the formation of primordial objects: nature and topology of the sources responsible for the re-ionization of the Universe, stellar populations and dynamics of galaxies at high redshifts, super-massive black hole masses, etc.

**Work program.** EUCLID will identify hundreds (resp. tens) of galaxies and quasars at redshifts  $> 7$  (resp. 8). However, obscured early type galaxies and late type stars (T-type brown dwarfs) have colors very similar to the colors of objects in the [7-8] redshift range and will make the selection of these high-z sources a difficult endeavor. Color-color selection is inappropriate to effectively separate high-z objects from nearby low mass stars. The work will consist in developing a Bayesian-type model that handles photometric errors and a priori knowledge of the various populations of high-z objects and contaminants. This model will enable a reliable selection on a statistical basis of high-z candidates from the EUCLID source catalogs. Simulations will be performed in the environment of the EUCLID ground segment using EUCLID simulated data, extraction tools and catalogs. Detailed analyses will be performed of the completeness level, reliability and efficiency of the selection model. Specific extraction methods will also be developed and tested in spectroscopy either for the identification and selection of high-z quasars in the WIDE survey or for high-z galaxies in the DEEP survey.

**Method.** The selection model will implement: i) the luminosity functions of high-z objects and of ii) obscured early type galaxies at intermediate redshifts, iii) the distribution of low mass stars, including binaries, in the local Milky Way environment, iv) all relevant datasets (EUCLID and ancillary data) with v) the corresponding photometric errors. The relevant ancillary data will consist of EUCLID and DESI

preparatory surveys (CFIS, MzLS, etc.), as well as DES, VISTA and WISE data. Using the most recent results available in the literature, populations of high- $z$  galaxies and quasars and of low mass stars and red galaxies will be generated and injected in EUCLID simulation data both in imaging and in spectroscopy (such exotic populations are marginally included in the EUCLID cosmological simulations). The selection model will be applied on these simulated data, enabling detailed analyses of the completeness rate as a function of magnitude, data type, photometric errors, galactic latitude, etc.

Overall, the subject of this PhD is to develop a toolbox enabling reliable and efficient selection of high- $z$  sources from the EUCLID imaging and spectroscopic data and adequately interfaced to the ground segment infrastructure of the mission. Real EUCLID data will be available towards the end of the PhD. This project provides an excellent opportunity for the successful PhD candidate to continue on a EUCLID fellowship or postdoctoral position.

## Bibliography:

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- Probabilistic selection of high-redshift quasars, Mortlock et al., *Monthly Notices of the Royal Astronomical Society*, Volume 419, Issue 1, pp. 390-410 (2012)
- A Remarkably Luminous Galaxy at  $z=11.1$  Measured with Hubble Space Telescope Grism Spectroscopy, Oesch et al., *The Astrophysical Journal*, Volume 819, Issue 2, article id. 129, 11 pp. (2016)
- On the nature of the luminous Ly $\alpha$  emitter CR7 and its UV components: physical conditions and JWST predictions, Sobral et al., arXiv:1710.08422