Thesis subject

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Subject's title: Star Formation Histories of galaxies from deep multi-color images

Subject description:

One major challenge in observational cosmology is to understand how the galaxies formed their stars along cosmic time. How a primordial cloud of gas could become a huge rotating system including billions of stars ? What are the physical processes which govern the star formation rate ? Is star formation history linked to the galaxy morphological transformation ? The thesis will participate in elucidating these questions by interpreting a massive dataset.

In the last decade, huge galaxy samples have been established with millions of galaxies observed from the ultra-violet to the far-infrared. We propose to work with one of the best sample available today to study galaxy evolution, i.e. the COSMOS survey (http://cosmos.astro.caltech.edu/). We are currently creating a catalogue with >1 million of galaxies observed in 30 bands (an update of Laigle et al. 2016), with the best telescopes and methods available today, including galaxies as distant as z~8-9 (the light from these galaxies has been emitted when the Universe was only 700 million years old). This catalogue will be ready at the beginning of the thesis.

One of the main difficulty to understand galaxy evolution is that we don't follow the same galaxies over cosmic time : we see different galaxies at different epochs, and we try to connect these pictures of the Universe taken at different times. We could solve this problem by being able to reconstruct the star formation history of an observed galaxy. Unfortunately,

we don't have such robust method yet. In this thesis, we propose to overcome this problem : we plan to develop a new approach based on unsupervised machine learning to accomplish this challenging task. At the beginning, we will use Self organizing Maps methods, but other methods can be investigated. We will first calibrate this method on cosmological simulations (Horizon-AGN simulation, Laigle et al. 2019, https://www.horizon-simulation.org/). Preliminary results look promising. We will study the reliability of our approach, and then apply it to the COSMOS data. We will be particularly interested in extreme events in the histories, like burst of star formation forming hundreds of stars per year, or a sudden suppression of any star formation activity in massive galaxies.

Once we will have reconstructed the Star Formation Histories of our real COSMOS galaxies, we will have a unique sample in hand to study galaxy evolution. We will be able to understand how star formation histories depend on the galaxy morphology with Hubble Space Telescope images, on the environment, on the energy radiated away by Active Galaxy Nuclei, etc. Such sample could open new avenues in our understanding of galaxy evolution.

Finally, we will also investigate if such approach could be applied to future surveys like the future space mission Euclid (https://www.euclid-ec.org/), or the imaging data from the LSST (https://www.lsst.org).

The student will often interact with our close collaborators in IAP (Paris), DAWN (Denmark), Caltech (US) and people in the Euclid consortium.

Bibliography:

Davidzon et al. (2019), "HORIZON-AGN virtual observatory - 2. Template-free estimates of galaxy properties from colours", https://ui.adsabs.harvard.edu/abs/2019MNRAS.489.4817D%2F/abstract

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