Proposition de stage M2

Location: Laboratoire d'Astrophysique de Marseille (LAM)
Period: 4-6 months; begin March 2020
Supervisors: Carlo Schimd, Eric Jullo, Frédéric Zamkotsian
Title: ***Gravitational lensing of galaxy clusters and filaments: simulations for BATMAN.***

Gravitational lensing provides unbiased map of the mass distribution around specific object. The direct detection of when lenses are filaments and clusters' outskirts is challenging because of the low density of these systems, hence usually investigated by stacking techniques. Some remarkable exception in optical wavebands are the large-scale filament feeding the massive galaxy cluster MACS J0717.5+3745 detected by weak gravitational lensing (Jauzac et al. 2012) or the filament bridging the cluster system A399-A401 detected combining Planck, WISE, and SDSS data (Bonjean et al. 2018).

In statistical studies of galaxy-galaxy lensing (e.g. Leauthaud et al. 2017), lensing by stacked filaments (e.g. Epps & Hudson 2017), or in cosmic shear measurements (e.g. Joudaki et al. 2019), low-accuracy photometric redshifts are sufficient to model the mass distribution of foreground lenses. Instead, aiming at modelling the specific mass map of filaments or galaxy clusters (Jullo et al. 2010) a high-accuracy measurement of redshift is needed to localize these structures along the line-of-sight. The spectroscopic redshift of a subset of (background) sources is also necessary to calibrate the photometric redshifts. This study can be addressed by cross-correlating different data sets, e.g. HSC images and SDSS spectra, namely using different instruments.

An instrument like BATMAN (Zamkotsian et al. 2014, 2018), which is a DMD-based spectro-imager with 2-20 arcmin^2 field-of-view and spectral resolution R = 500-1000 that will be mounted on TNG (~2022) and GEMINI-S (~2024), could allow *simultaneous* measurement of spectroscopic redshift of galaxies located in the foreground filaments or clusters (along caustics and critical lines), using the DMD-programmable slits aligned on specific objects, and the imaging of the background galaxies observed in the same field, eventually augmented by multi-filter photometry.

This M2 project is firstly intended to make the student familiar with both the cosmological problem and the BATMAN instrument, realising a preliminary database of candidate lensing filaments and clusters (using e.g. CFHTLenS and SDSS) that would be potentially observable by BATMAN@TNG and BATMAN@GEMINI (the student will have access to the BATMAN's demonstrator installed at LAM). Working with simple models and state-of-the-art N-body simulations (e.g. Illustris TNG), the student will then define and optimise an observation strategy dedicated to the combined imaging and photometry of background galaxies and spectroscopy (redshift) of foreground galaxies. Based on these results, any observational strategy proposed by the student and designed to optimise the instrument performances is welcome.

This very ambitious program will open to a Ph.D. on related topics.

Prerequisites:
— scientific skills: familiarity with gravitational lensing and astronomical observations (appreciated).
— technical skills: basics of programming in Mathematica/MATLAB/Python/C/C++.

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