Weak-gravitational analysis of large galaxy surveys

Weak gravitational lensing, the distortion of images of high-redshift galaxies due to foreground matter structures on large scales, is one of the most promising tools of cosmology to probe the dark sector of the Universe. Patterns of lensing distortions derived from galaxy shapes provide us with a wealth of information about the distribution of dark matter on large scales, and the origin of the accelerated expansion of the cosmos.

The student will work on various wide-field instruments which provide imaging surveys of galaxies:

- UNIONS, the Ultraviolet Near-Infrared Optical Northern Sky survey, an ongoing large imaging survey ideally suited for weak lensing [1]. To date UNIONS has covered $4,300$ deg^2 in the Northern hemisphere in multiple optical bands from various telescopes on Hawai'i. The observed data are an integral part of the imaging survey obtained by the European satellite mission Euclid, to be launched in 2023 or 2024.
- WFST, the Wide-Field Survey Telescope [2]. This 2.5m optical telescope under construction in China has a field of view of 6.55 deg^2 and will observe the entire Northern sky ($20,000$ deg^2) in 5 bands.
- CSST, the 2m Chinese Space Station Telescope, to be launched in 2024 into a low Earth orbit, will observe an area of $17,500$ deg^2 in 7 optical and near-UV bands [3].

Starting with ShapePipe, a weak-lensing pipeline created by our group [4], the student will develop new methods to analyse such large datasets. These methods will first be applied to the existing UNIONS data. They will further be developed in preparation of the upcoming surveys from WFST and CSST.

The unprecedented statistical precision of these large datasets will require novel approaches for quantifying observational and instrumental systematic errors. Astrophysical and cosmological observables will be modeled carefully for robust and reliable inference of dark-matter and dark-energy properties from weak-lensing data.

The student joins an existing collaboration between CEA and USTC. Led by Kilbinger, Luo, and Farrens, the cosmology teams at both institutes have worked on various weak-lensing projects over the last two years.

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