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Title
Combining weak-lensing and galaxy-clustering to constraint cosmological parameters

Scientific context
The primary science probes of EUCLID are weak-lensing cosmic shear, and BAO to measure expansion of the Universe in the redshift range $1 < z < 2$. Redshift space distortion of the galaxy-clustering in this same redshift range will also allow measure the growth of structure, and test deviation to general relativity.

Existing surveys, such as KiDS and DES are already paving the way to EUCLID. However, it becomes every time more obvious that the cross-correlation of weak-lensing and galaxy-clustering can boost the constraining power of each individual probes, raising the EUCLID figure of merit (FoM) from 400 to possibly 1400, pushing measurements to small scales (ℓ ~5000) (see talk by Isaac Tutusaus at the Milan WL+GC meeting, Dec 2018).

In de la Torre et al. 2017, and in Jullo et al. 2019, we combined weak-lensing CFHTLens and CFHT-Stripe 82 weak-lensing catalogues with the VIPERS and SDSS/CMASS galaxy samples. Building on the non-linear small-scale modeling of RSD and galaxy-galaxy lensing, we demonstrated that we could break the degeneracy between the amplitude of the matter power-spectrum $\sigma 8$, and the growth rate of structure f, thus allowing to more efficiently probe deviations to general relativity. Thanks to our model, we take advantage of the signal at small scales, reaching a precision on the cosmological parameters similar to KiDS and DES, although with a field of view 5 times smaller.

Scientific objectives
The objective of this thesis is repeat this analysis with the forthcoming spectroscopic data from eBOSS and DESI. Thanks to the significant financial support of Aix-Marseille University and INSU, we are now full members of these two collaborations, and we would like to adapt our techniques to these 2 surveys. Simultaneously for EUCLID, it is very timely to go beyond the Fisher matrix analytical forecasts that have claimed the FoM of 1400 and prepare the full analysis with realistic mock catalogues.

Both eBOSS and DESI observe emission line galaxies (ELG) in the redshift range $0.7 < z < 1.2$. EUCLID observes Halpha emitters in the redshift range $1 < z < 2$. For eBOSS and DESI, we will use the weak-lensing catalogue from DECaLS (4200 deg^2), and the CFIS data (~3000 deg^2) to perform this analysis. We also have signed a MoU with Dark Energy Survey to use their Year 3 catalogue, and thus increase the depth of the imaging coverage. Therefore, we have all in hands to perform this analysis. Also being a member of these collaboration for already a few years, Eric Jullo is already identified in the eBOSS and DESI are a lead for these analysis.

With respect to EUCLID, Eric JULLO is the lead of the galaxy-galaxy lensing work-package in the Weak-Lensing SWG, and as such has to prepare the analysis, and provide requirements (in terms on photometric redshift precision, number density of Halpha emitters, completeness, etc).

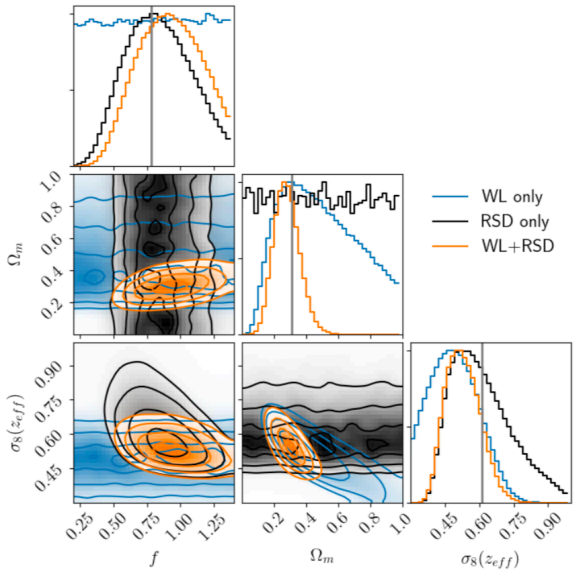

Figure 1: Improvement on estimating Ωm and σ8 when com- bining RSD and WL measurements. Blue and black curves are respectively obtained with WL and RSD constraints only. Orange curves are obtained with the combination of WL and RSD. Vertical lines indicate Planck TT,TE,EE+lowE 2018 results

Schedule. 2019-2020

By September 2019, the eBOSS large-scale structure catalogue will be fully analyzed by the BAO and RSD teams. The student will therefore measure the galaxy-galaxy lensing signal around these galaxies, and will fit the cosmological parameters. He/She will use the mock catalogues provided by the collaboration to derive covariance matrices, in the same manner as what has been done in de la Torre et al. 2017 and Jullo et al. 2019. This will result in a publication, with a lot of impact, as being one of the first GGL analysis in eBOSS.

2020-2021

In the second part of the thesis, he/she will continue the work already started in the GGL EUCLID SWG, and will investigate how much GGL improves the FoM. He/She will use mock catalogues from Flagship. This will result in a second publication.

2021-2022

Finally, the DESI data will start to arrive, and the student will get involved in their analysis. He/She will repeat the analysis done in eBOSS. This will lead to a third publication.

Bibliography

Niemiec, Jullo et al. 2018, "Dark matter stripping in galaxy clusters: a look at the Stellar to Halo Mass relation in the Illustris simulation", arXiv:1811.04996, submitted to MNRAS

Jullo, de la Torre et al. 2019, " Testing gravity with galaxy-galaxy lensing and redshift-space distortions using CFHT-Stripe 82, CFHTLenS and BOSS CMASS datasets", submitted to A&A

de la Torre et al., Jullo et al. 2017, "The VIMOS Public Extragalactic Redshift Survey (VIPERS) Gravity test from the combination of redshift-space distortions and galaxy-galaxy lensing at $0.5 < z < 1.2$", A&A, 608, A44

Dawson et al., 2016, "THE SDSS-IV EXTENDED BARYON OSCILLATION SPECTROSCOPIC SURVEY: OVERVIEW AND EARLY DATA", AJ, 151, 44

Levi et al., 2013, " The DESI Experiment, a whitepaper for Snowmass 2013", rXiv:1308.0847