Measuring Intrinsic Alignment in the UNIONS and BOSS/eBOSS surveys

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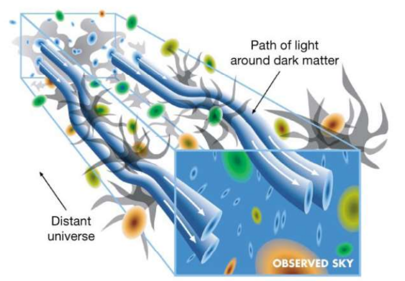
Introduction

We use accurate shape measurements from 3500 deg^2 of the *Ultraviolet Near- Infrared Optical Northern Survey* (**UNIONS**) [1] with redshift information from BOSS/eBOSS to measure intrinsic alignement

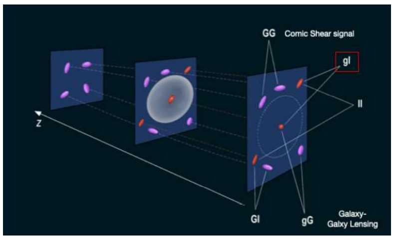
Our goals are:

1. Measure the strength of intrinsic alignment with specific samples combining precise shape and redshift measurements
2. Identify galaxy properties allowing for a finer model of intrinsic alignment, either analytic or in simulations
3. Distinguish amongst the developed models the one which most accurately captures the intrinsic alignment signal

Weak-lensing, Intrinsic Alignment



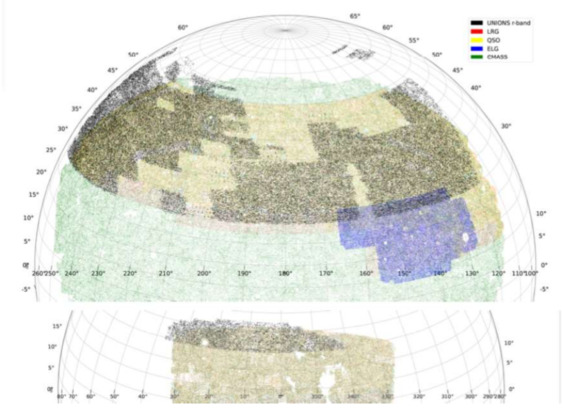
Weak lensing is the study of coherent distortions of galaxies to infer the foreground distribution of dark matter and to constrain cosmological scenarios from the amplitude of the lensing.



Intrinsic Alignment is a systematic for this effect as it produces a similarly coherent deformations in galaxies. During their formation galaxies get stretched by the tidal field which makes them align with the surrounding large scale structure.

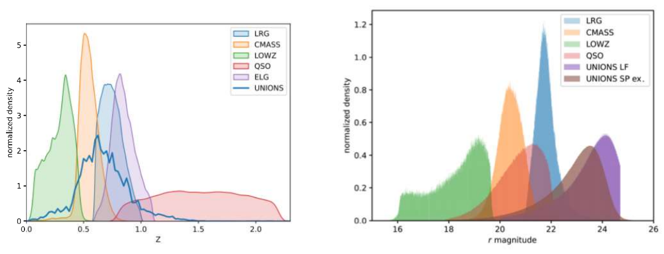
Image credit: Fortuna and Chisari 2022

Survey sky-coverage



Sky coverage of the different surveys (NGC,SGC)

Catalogue Information



$n(z)$ distribution and r-magnitude distribution of the different samples

NLA or TATT?

The two most commonly used models to quantify the contribution of intinsic alignment are the non-linear alignment (NLA) [2] and Tidal Alignment and Tidal Torque (TATT) [3] model. TATT is a higher-order expansion of NLA.

The tidal tensor is defined as:

$$s_{ij}(k) = (\hat{k}_i\hat{k}_j - \frac{1}{3}\delta_{ij})\delta(k)$$

The intrinsic part of the shear of a galaxy is:

$$\gamma^I_{ij}(x) = C_1 s_{ij} + C_2(s_{ik}s_{kj} - \frac{1}{3}\delta_{ij}s^2) + C_{1\delta}(\delta s_{ij})...$$

Measuring the integrated correlation function

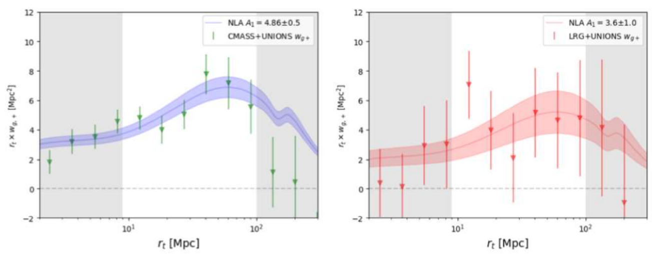
Estimator: $$\xi_{g+}(r_p,\Pi) = \frac{\text{Shape}_+(\text{Density} - \text{Rand}_D)}{\text{Rand}_D\text{Rand}_S}$$

L.O.S. Integration: $$w_{g+}(r_p) = \int_{-\Pi_{max}}^{\Pi_{max}} \xi_{g+}(r_p,\Pi)\mathrm{d}\Pi \; ; \; \Pi_{max} = 150 \text{ Mpc}$$

Signal – w_{g+} of different samples

CMASS ≈ 200 000 galaxies
NLA: $A_1 = 4.86 \pm 0.51$

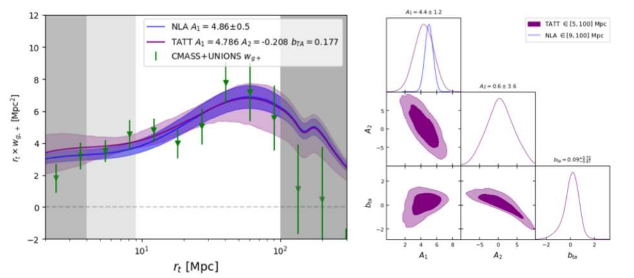
LRG ≈ 80 000 galaxies
NLA: $A_1 = 3.6 \pm 1.0$



Results – NLA or TATT?

Best NLA fit:
χ^2/d.o.f. =3.40/(6-1)=0.68

Best TATT fit:
χ^2/d.o.f. = 3.58/(8-3)=0.72



Conclusions

Our work is in broad agreement with previous measurements showing:

- Strong intrinsic alignment in Luminous Red Galaxies (LRG and CMASS)
- No preference for TATT on large linear scales
- Systematics in the UNIONS ShapePipe catalog are under control

We want to use these precise measurements to identify properties correlating with intrinsic alignment (luminosity, density...)

References

[1] A. Guinot, M. Kilbinger, S. Farrens, *et al.*, "ShapePipe: A new shape measurement pipeline and weak-lensing application to UNIONS/CFIS data", en, *Astronomy & Astrophysics*, vol. 666, A162, Oct. 2022, ISSN: 0004-6361, 1432-0746.

[2] C. M. Hirata and U. Seljak, "Intrinsic alignment-lensing interference as a contaminant of cosmic shear", en, *Physical Review D*, vol. 70, no. 6, p. 063 526, Sep. 2004, ISSN: 1550-7998, 1550-2368.

[3] J. A. Blazek, N. MacCrann, M. A. Troxel, and X. Fang, "Beyond linear galaxy alignments", en, *Physical Review D*, vol. 100, no. 10, p. 103 506, Nov. 2019, ISSN: 2470-0010, 2470-0029.

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