COSMOLOGY WITH WEAK LENSSING
CHALLENGES & OPPORTUNITIES

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Cosmology with Lensing Surveys

Dark energy equation of state: \( w = w_0 + w_a(1-a) \)

Joudaki+ (2016)
COSMOLOGY WITH LENSING SURVEYS

Dark energy equation of state: \( w = w_0 + w_a(1-a) \)

Joudaki+ (2016)
CHALLENGES TO PRECISION COSMOLOGY

- Intrinsinc Alignments of Galaxies
- Gastrophysics

H. Hildebrandt’s talk

*Photo-z Calibration

J. Dunkley’s talk

*Robust Pipelines: CCL

**INTRINSIC ALIGNMENTS (IA)**

SDSS LOWZ sample – Singh+ (2015)

Galaxy shapes $\sim$ Tidal field of the large-scale structure

Catelan+ (2001)

SPT extension – Blazek+ (2017)

EFT of galaxy shapes – Vlah, EC, Schmidt (in prep.)
INTRINSIC ALIGNMENTS (IA)

SS = GG + GI + IG + II + Noise

W. Percival’s talk

*SPEC-SURVEY SELECTION*
Bias in cosmology due to galaxy alignments


*not responsible for current tensions
IA IN OBSERVATIONS

KiDS+GAMA - 180 sq. deg., r<19.8

Johnston+, incl EC (2019)
Mind your sample:
A significant satellite-position central-shape contribution to IA
IA IN OBSERVATIONS

KiDS+GAMA – Georgiou, EC+ (2019)

satellite–shape central–position contribution to IA
See also EC+ (2014), Sifón+ (2014), Singh+ (2016)
IA IN SIMULATIONS

Horizon-AGN – EC+ (2016)

Alignment correlation vs. Comoving $r$ (Mpc/$h$)

- $M_r \leq -22$ ellipticals
- $-21 < M_r \leq -20$ discs, $z=3.0$
- $-21 < M_r \leq -20$ discs, $z=1.5$
- $-21 < M_r \leq -20$ discs, $z=0.1$
IA IN SIMULATIONS

• Galaxy-halo alignment connection
  Risa’s talk
  Joachimi+ (2013)
  Tenneti+ (2014)
  Velliscig+ (2015)
  EC, Koukoufilippas+ (2017)

• Alignments with the cosmic web
  Chen+ (2015)
  Codis+, incl EC (2018)

• When do galaxies align?
  Welker+ (2014)
  Bate, EC+ (submitted)
  Bhomwick+ (2019)

• Gastrophysics: the impact on IA
  Tenneti+ (2017)
  Soussana, EC+ (submitted)
GASTROPHYSICS

"Baryons" = Active Galactic Nuclei Feedback in the Context of Weak Lensing

Credit: ESA / V. Beckmann (NASA-GSFC)
An LSST–like survey
Huang+ (2018)
\[ P(k) = \langle |\delta_k|^2 \rangle \]

EC+ (2018/19)
van Daalen+ (2011)
Springel+ (2014)
Hellwing+ (2016)
Huang+ (2018)
Apply existing observational constraints on gas and stellar fractions and distributions to N-body simulations.
CHALLENGES TO PRECISION COSMOLOGY

OPPORTUNITIES FOR

$e \sim 1\%$

INTRINSIC ALIGNMENTS OF GALAXIES
COSMOLOGY WITH INTRINSIC ALIGNMENTS

Galaxy shapes \sim Tidal field of the large-scale structure
Catelan+ (2001)

TESTING THEORIES OF INFLATION
EC+ (2016)
Schmidt, EC & Dvorkin (2015)

PRIMORDIAL GRAVITATIONAL WAVES
EC, Dvorkin & Schmidt (2016)

BARYONS ACOUSTIC OSCILLATIONS
EC & Dvorkin (2013)
COSMOLOGY WITH INTRINSIC ALIGNMENTS

\[ \tilde{b}_{NG} A_2 \]
\[ A_0 \]

*Scale-dependent bias of intrinsic shapes*

*Scale-dependent clustering bias*

LSST expected – single-tracer

Multi-tracer approach

EC+ (2016)

Schmidt, EC & Dvorkin (2015)
COSMOLOGY WITH INTRINSIC ALIGNMENTS

\[ \tilde{b}_{NG}^{I} A_2 \quad Scale-dependent \ bias \ of \ intrinsic \ shapes \]
\[ A_0 \quad Scale-dependent \ clustering \ bias \]

LSST expected – multi-tracer

Multi-tracer approach

EC+ (2016)
Schmidt, EC & Dvorkin (2015)
SUMMARY

Exciting prospects for *weak lensing and combined probes* come at a PRICE.

The need to understand & model astrophysical systematics:
- *the large-scale distribution of matter &*
- *intrinsic alignments.*

An opportunity to learn about the early universe & galaxy evolution.
Thank you.

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