KiDS

Universiteit Leiden

Diving deeper into galaxy alignments

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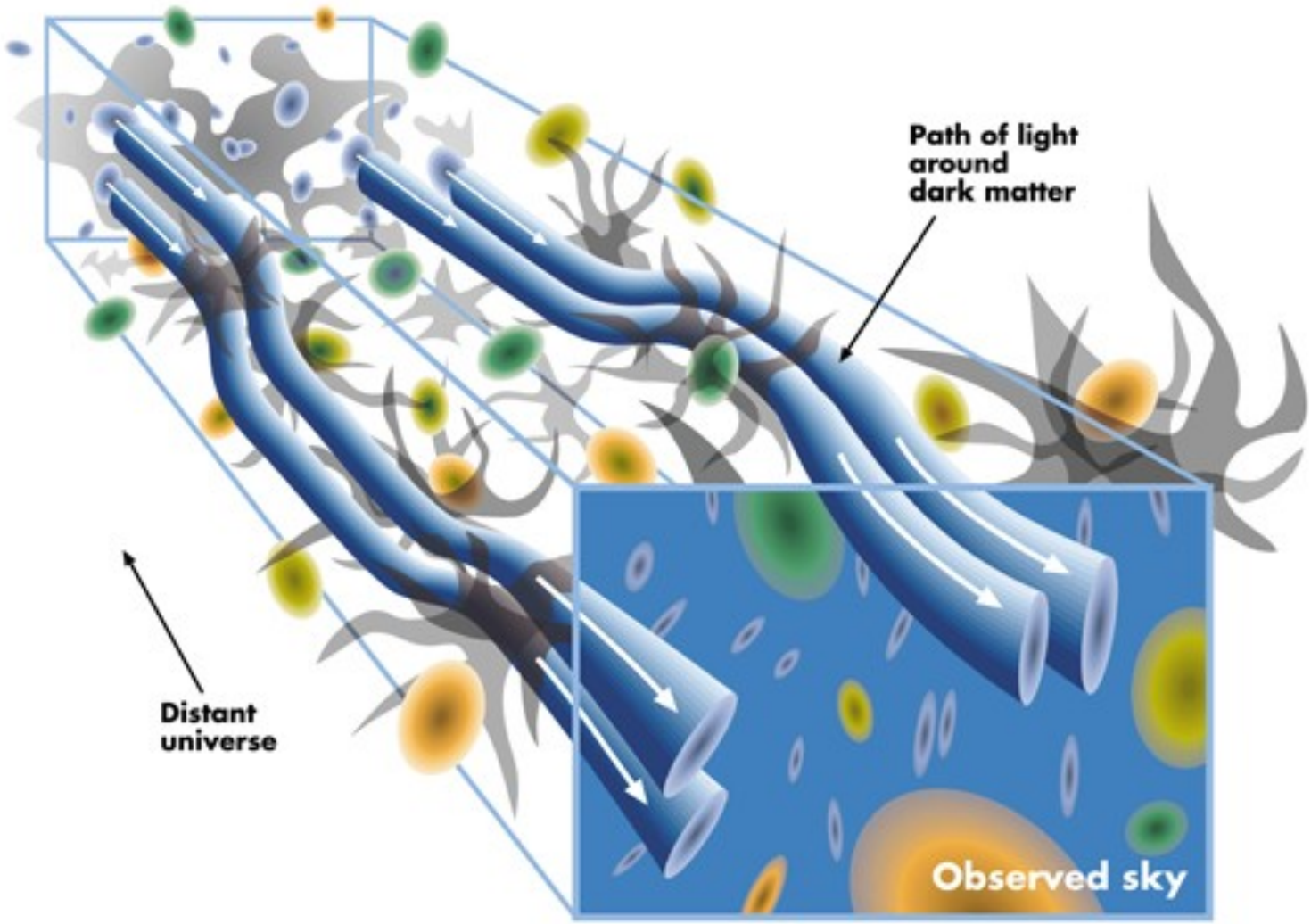
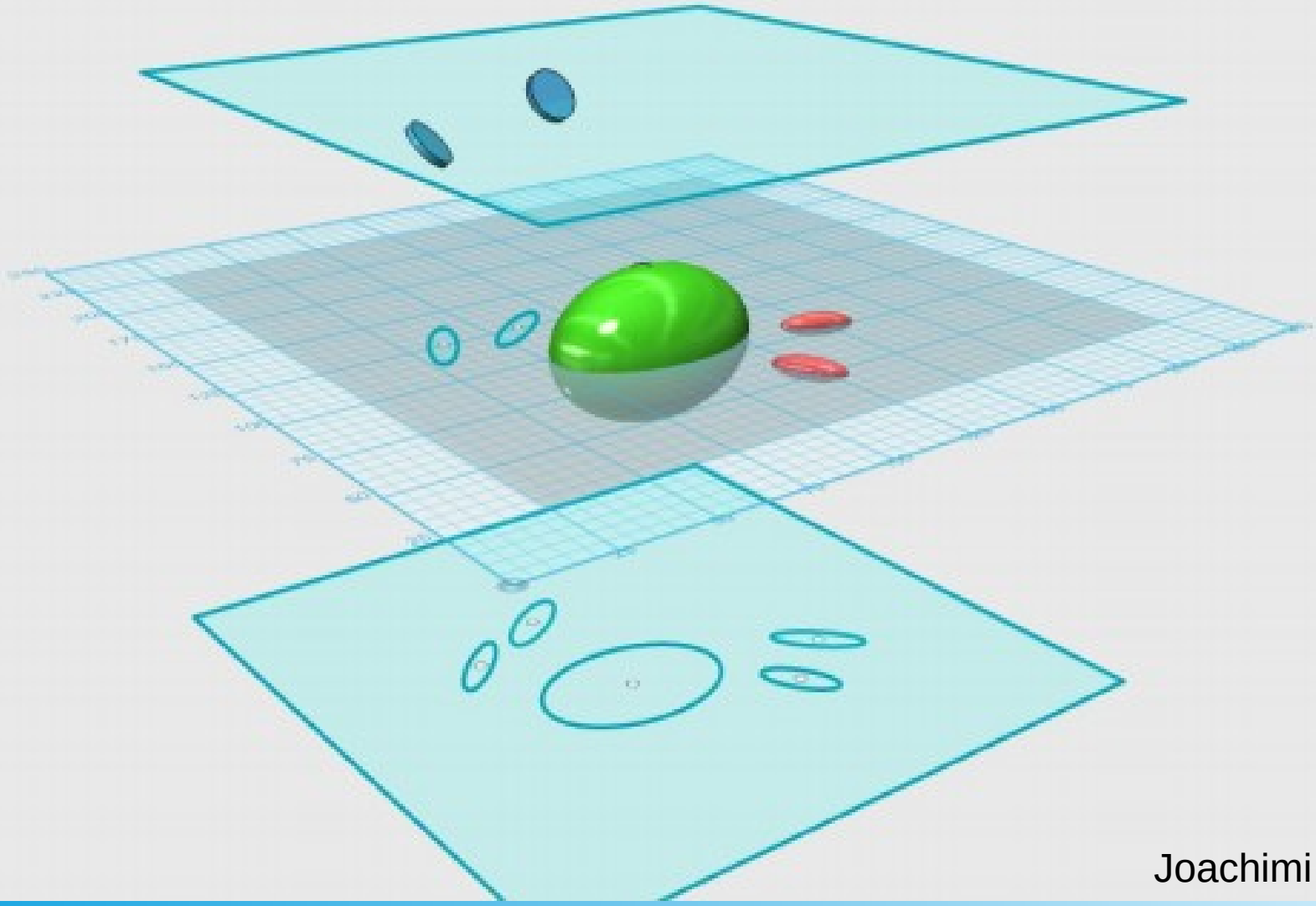
How lensing works



Wittman et al. 2000

Galaxy intrinsic alignments



Joachimi et al. 2015

Why study intrinsic alignments?

- Source of bias on the inferred cosmological parameters of lensing mearuements.
- Understood on large scales, not on small scales.
- Direct measurements will help build descriptive models on small scales.
- Small scales enclose valuable cosmological information for lensing.

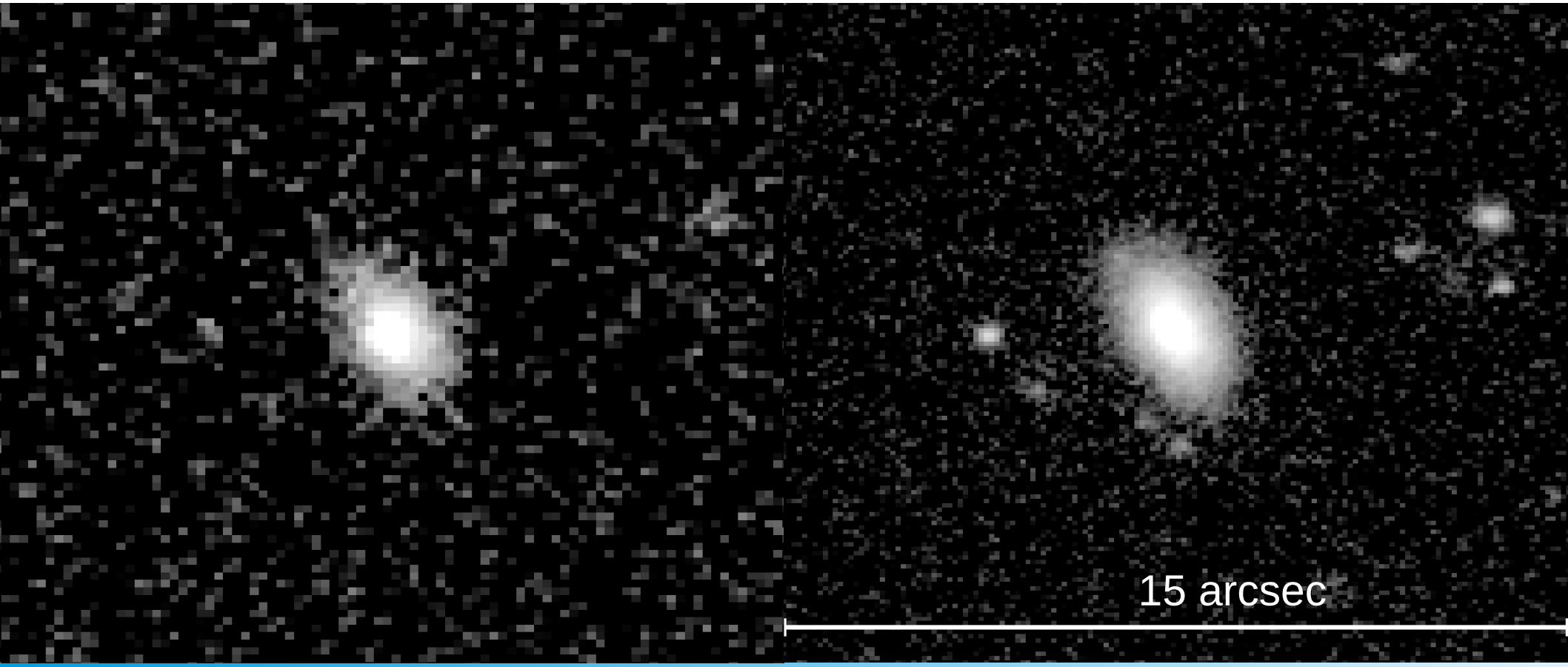
Studying intrinsic alignments

- Physical galaxy pairs – GAMA survey
  - Precise redshifts, 98.5% completeness, galaxy groups.
- Deep imaging data – KiDS survey
  - Smooth PSF. g, *r* and *i*-band imges
- Shape measurement method – DEIMOS
  - Moment-based, analytic PSF correction, weight function correction.

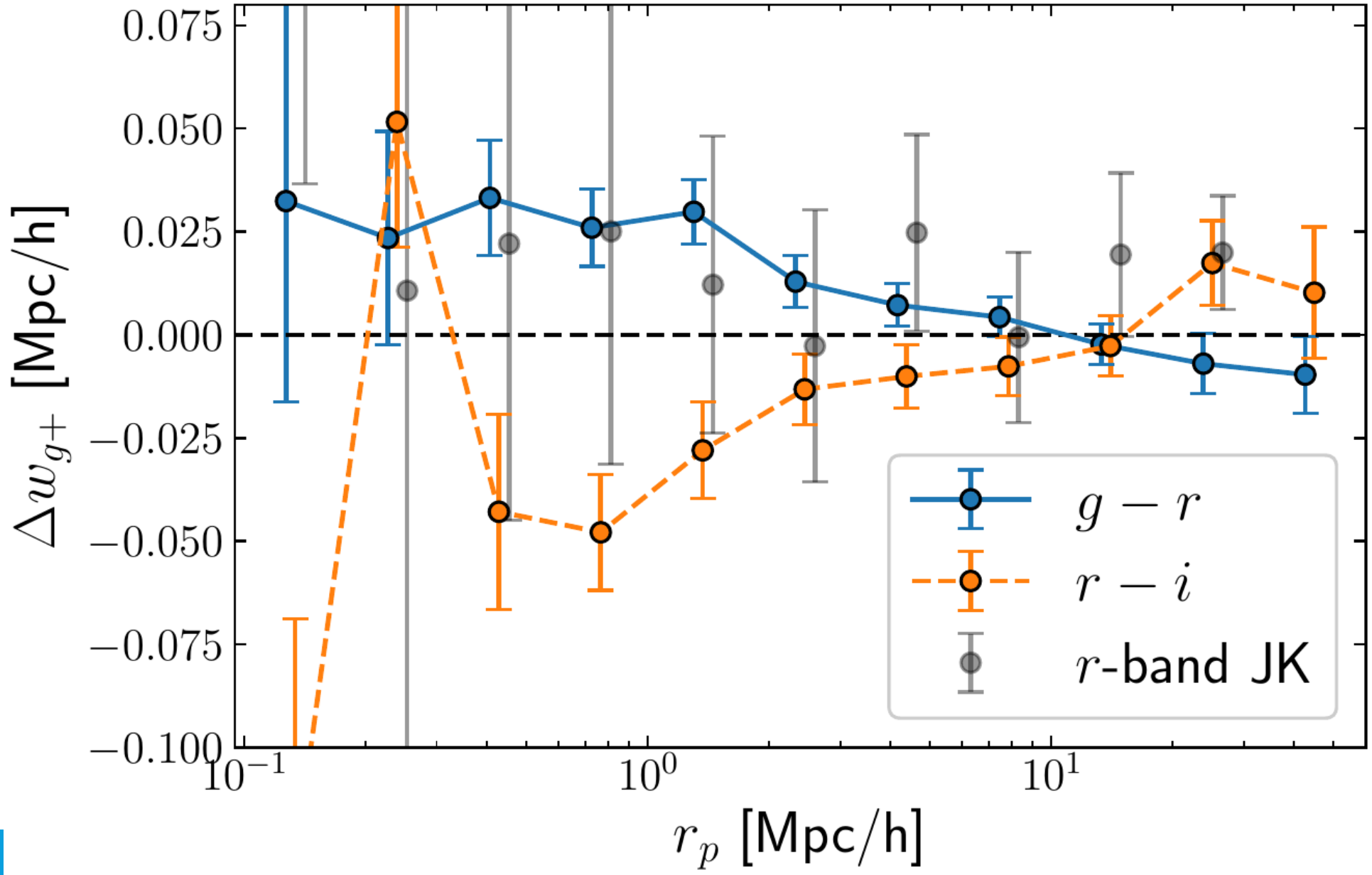
Imaging Data

SDSS **KiDS**

z=0.19



Wavelength dependence



CG et al 2019, arXiv:1809.03602

Wavelength dependence

Δw_{g+} [Mpc/h]

r_p [Mpc/h]

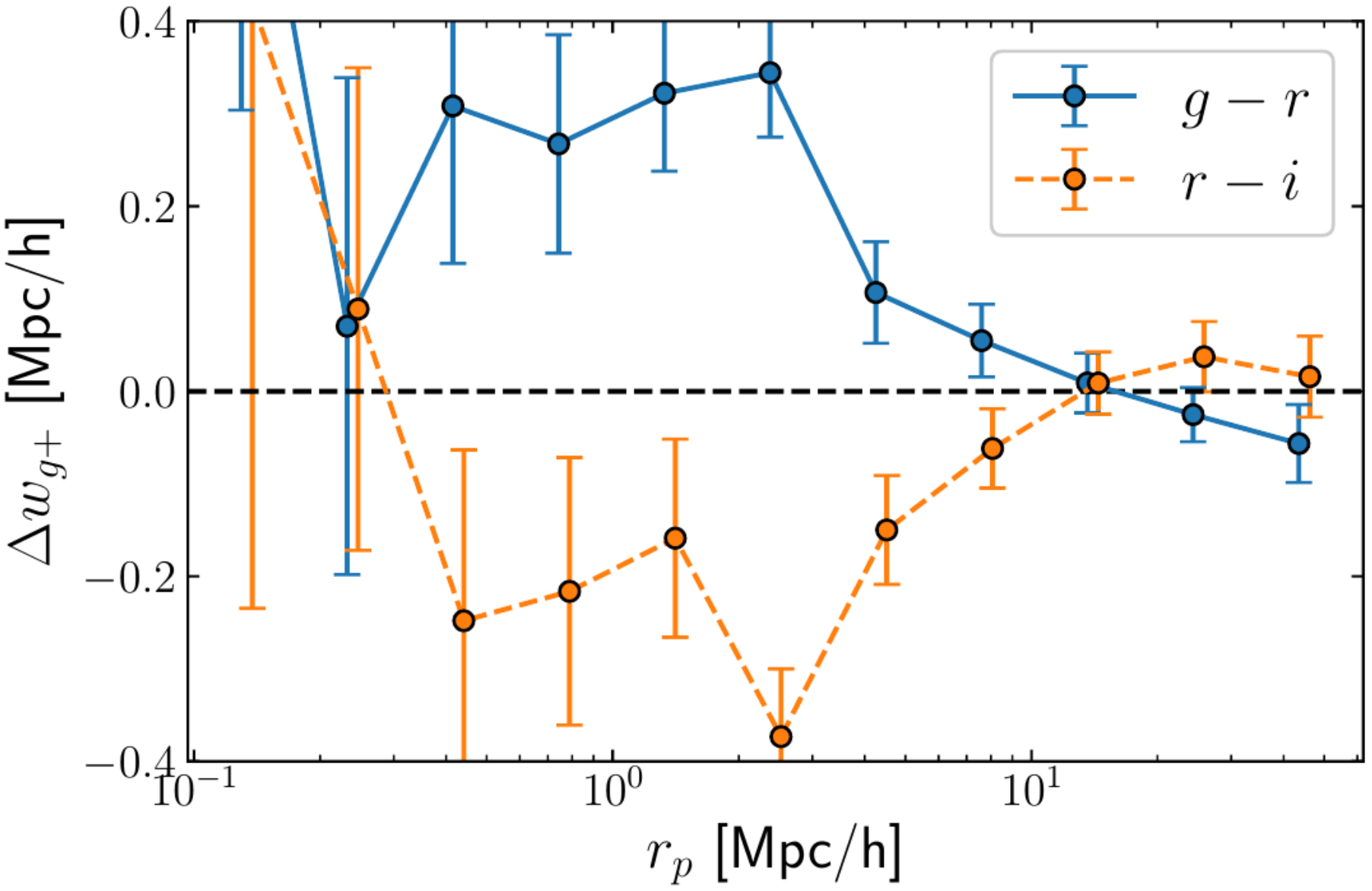
$g - r$

$r - i$

r-band JK

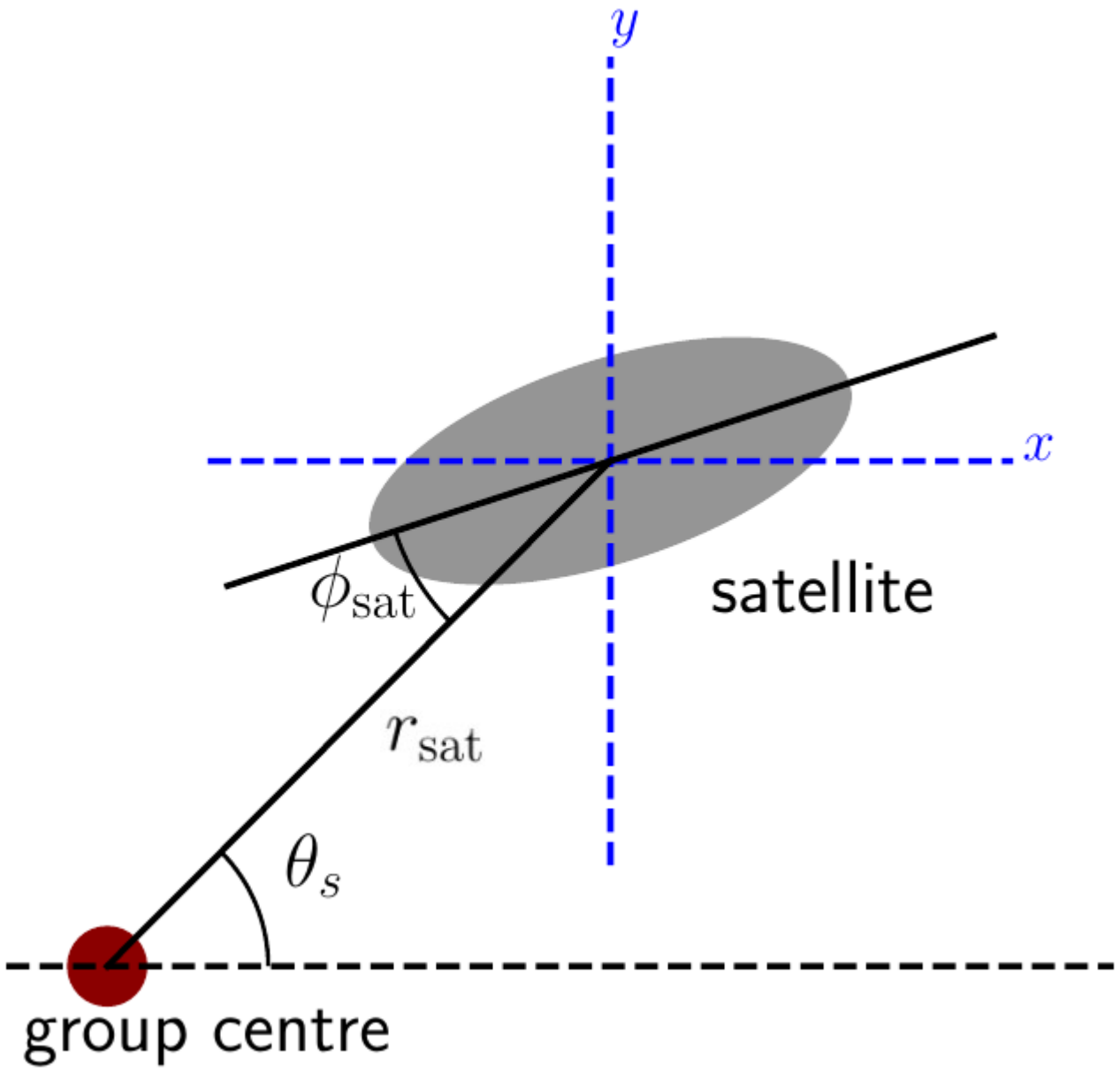
CG et al 2019, arXiv:1809.03602

...sourced by red satellites

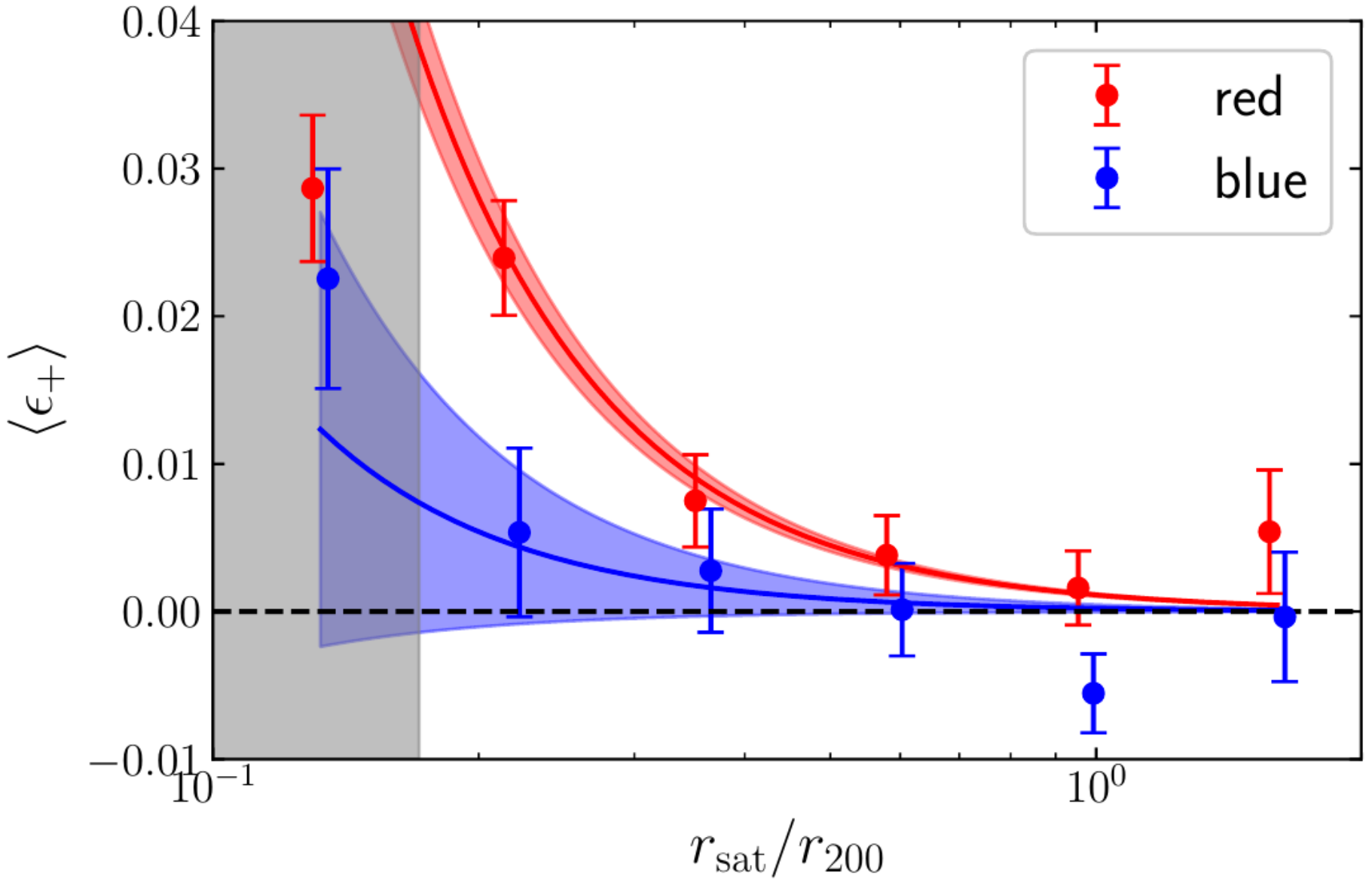


CG et al 2019, arXiv:1809.03602

Focus on satellites in galaxy groups

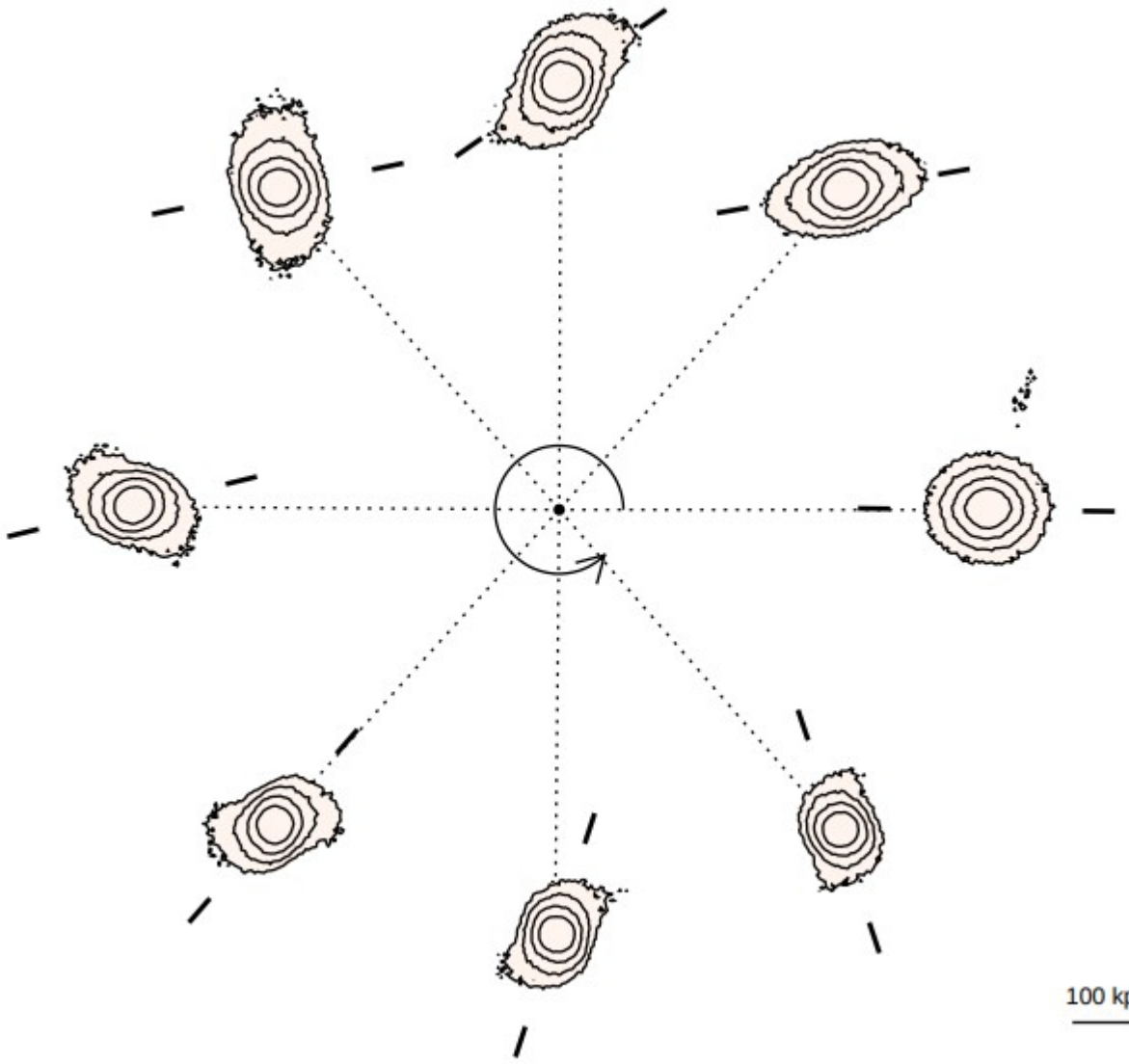


Satellite radial alignment



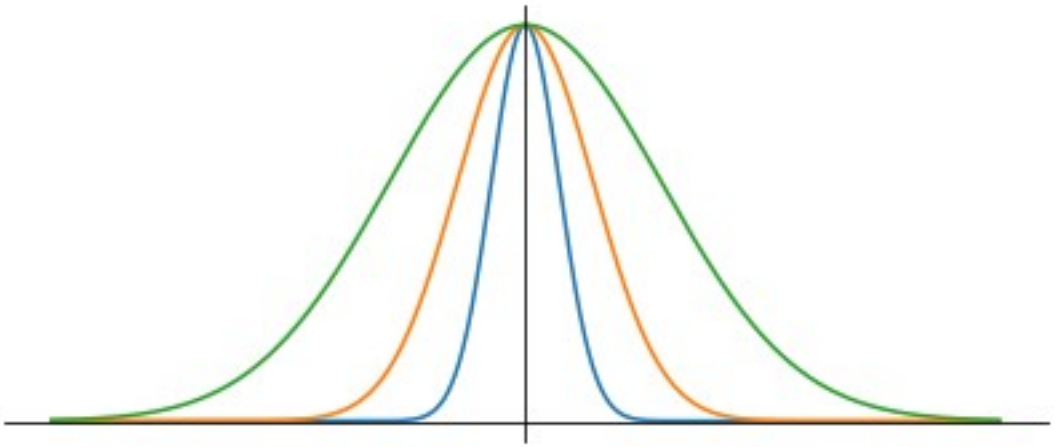
CG et al, in prep.

Galaxy scale dependence

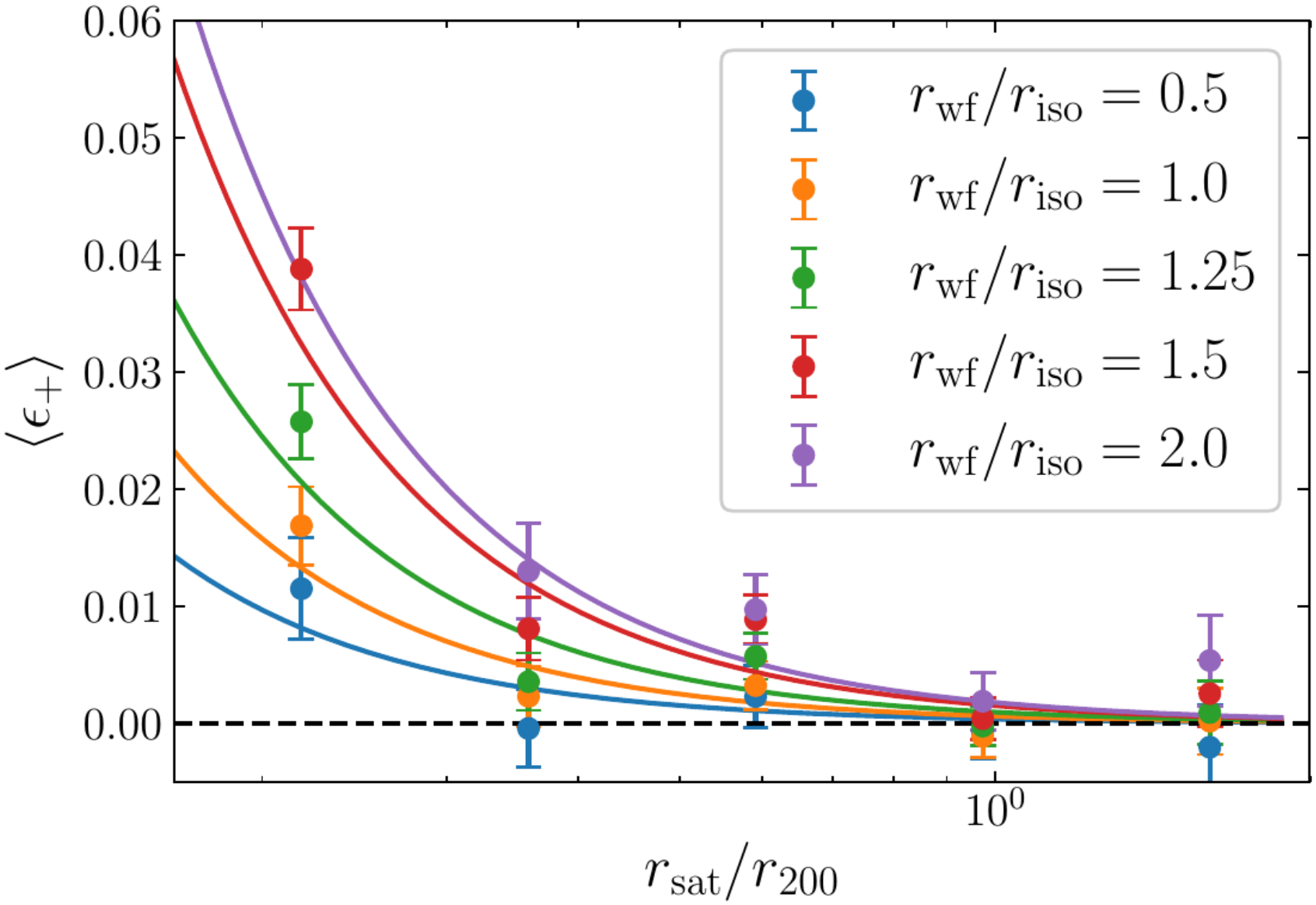


Pereira & Bryan 2010

Weighting and galaxy scale

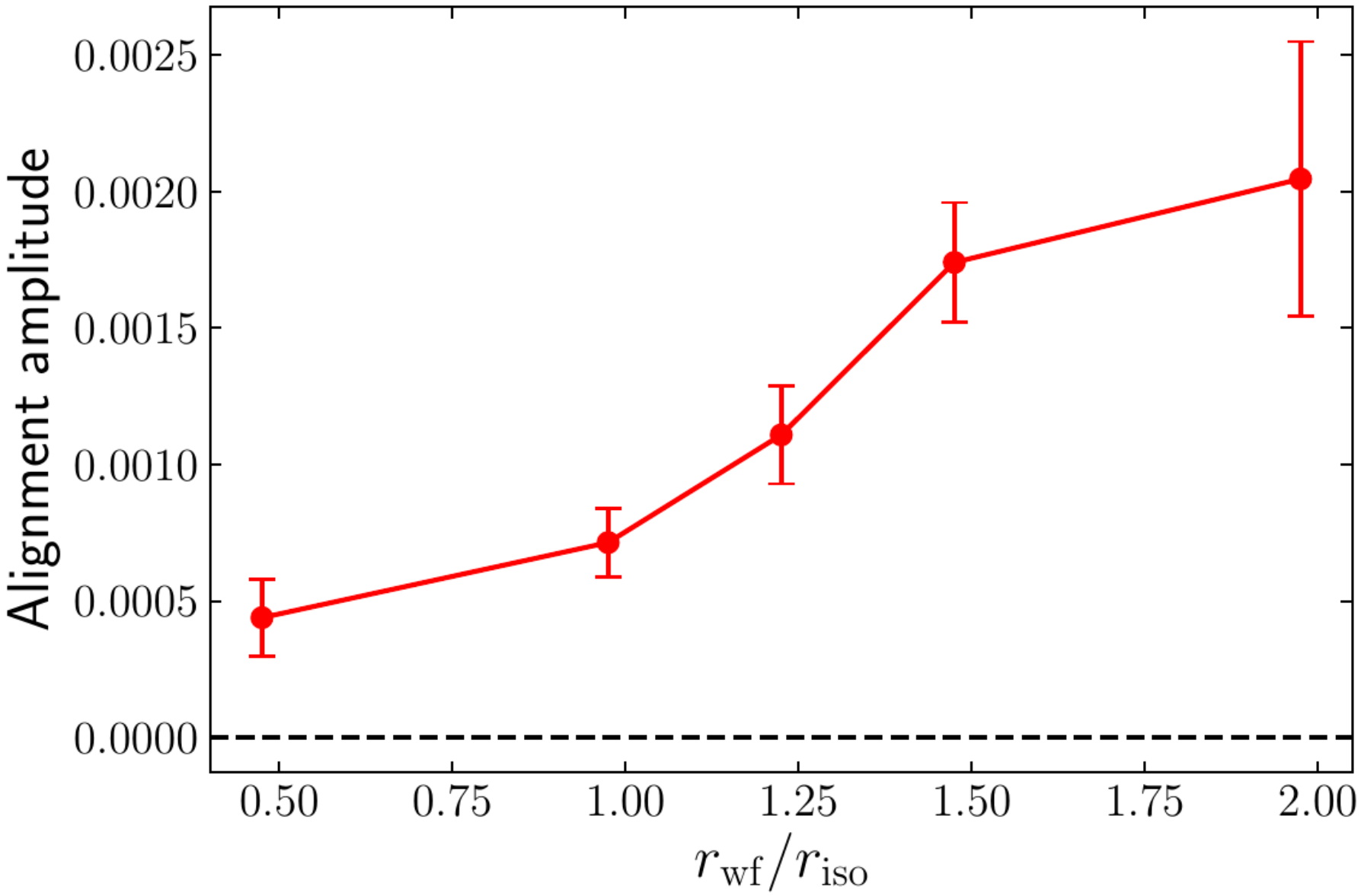


Galaxy scale dependence



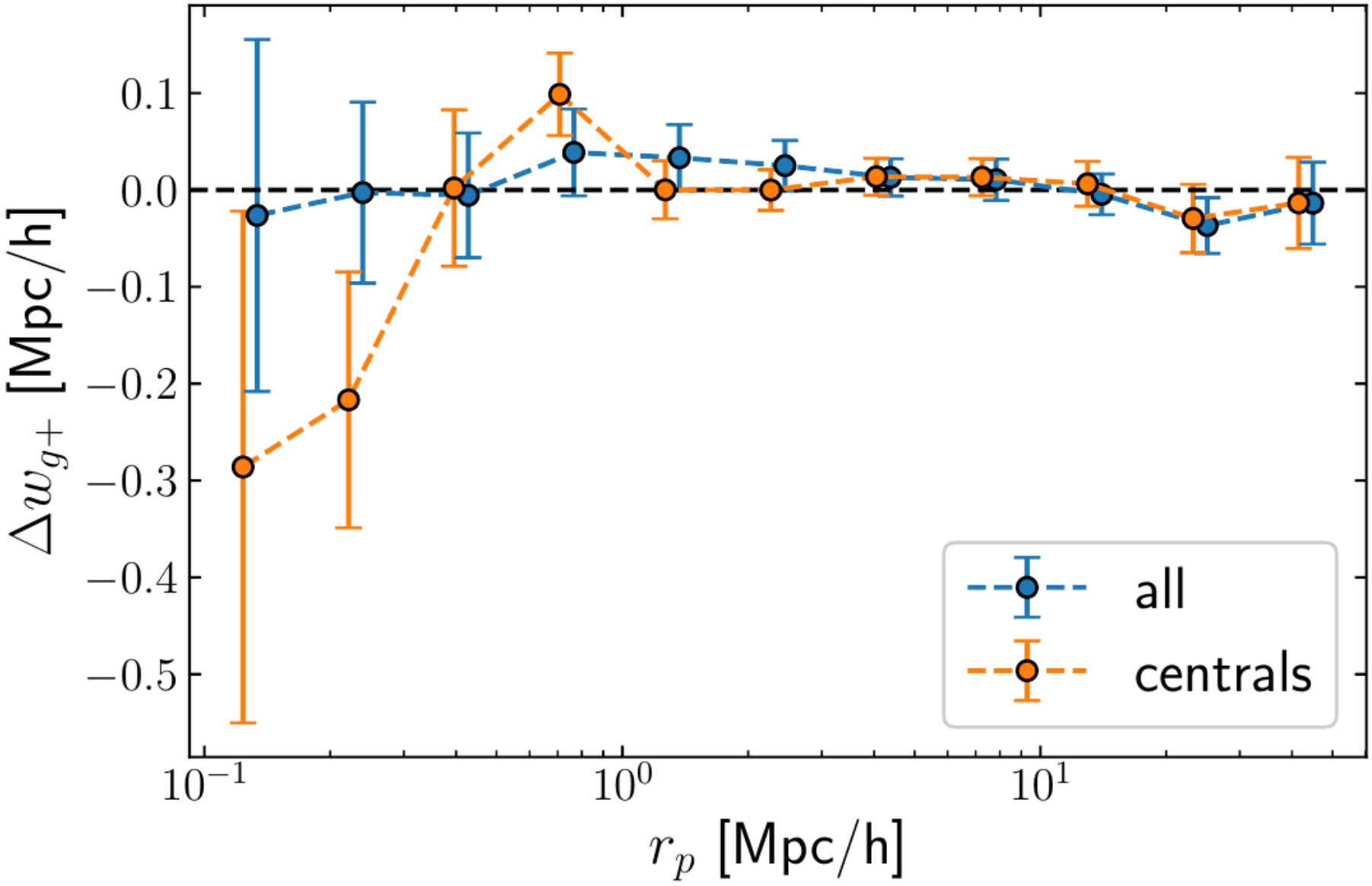
CG et al, in prep.

Galaxy scale dependence



CG et al, in prep.

...not evident in centrals!



CG et al, in prep.

Future outlook

- Repeat measurement with higher precision.

- Calibrate the model for intrinsic alignments on small scales (Halo model).

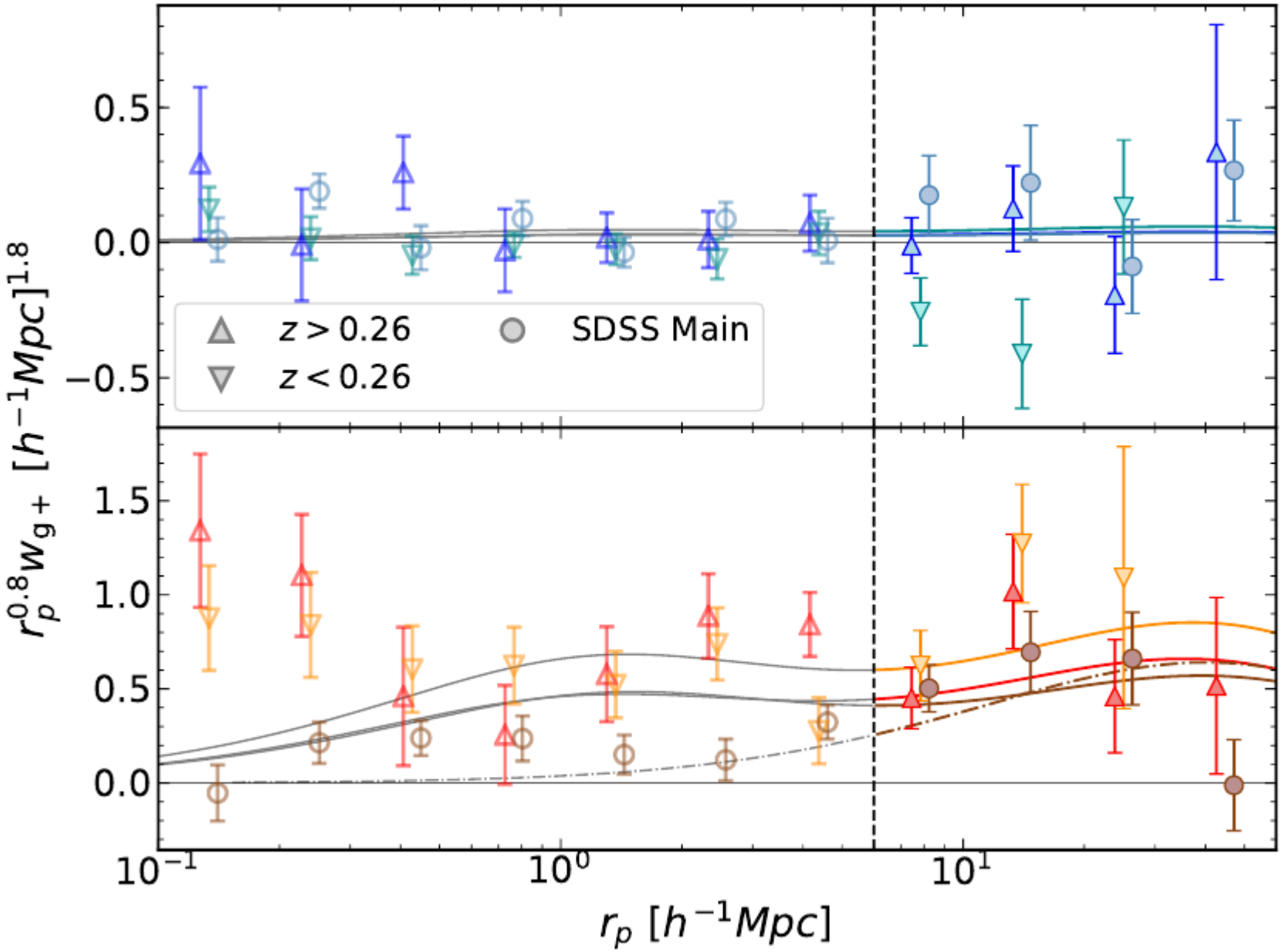
Maria Cristina Fortuna

Conclusion

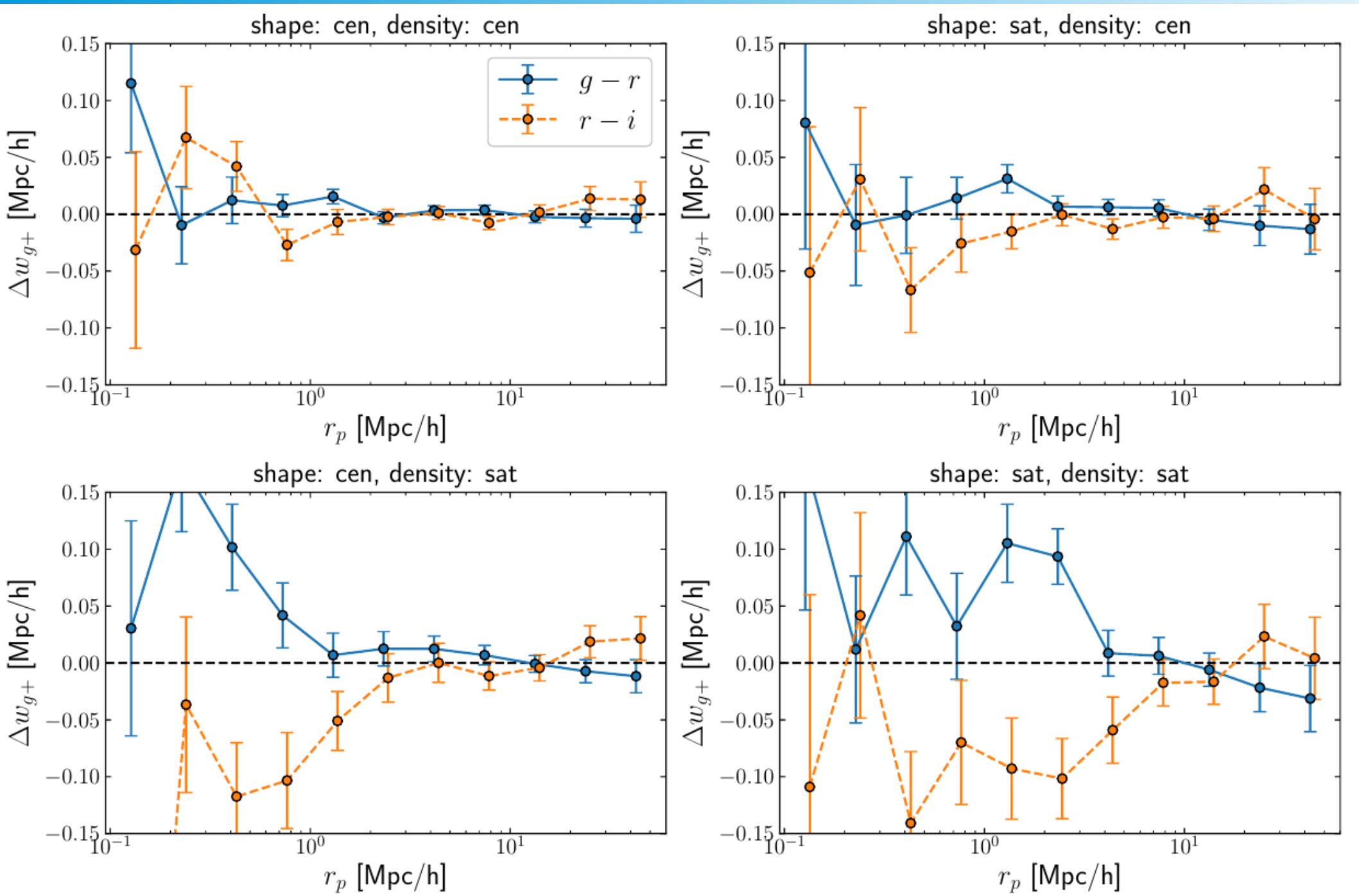
- Intrinsic alignment measurements on small scales are important for utilizing weak lensing cosmological information.
- Alignments depend on wavelength on scales ~1Mpc/*h*. This is dominated by red satellites.
- Satellite galaxies in groups align radially. Red satellites align much more strongly than blue.
- Satellite alignments exhibit a galaxy scale dependence. This dependence is not evident in central galaxy alignments.

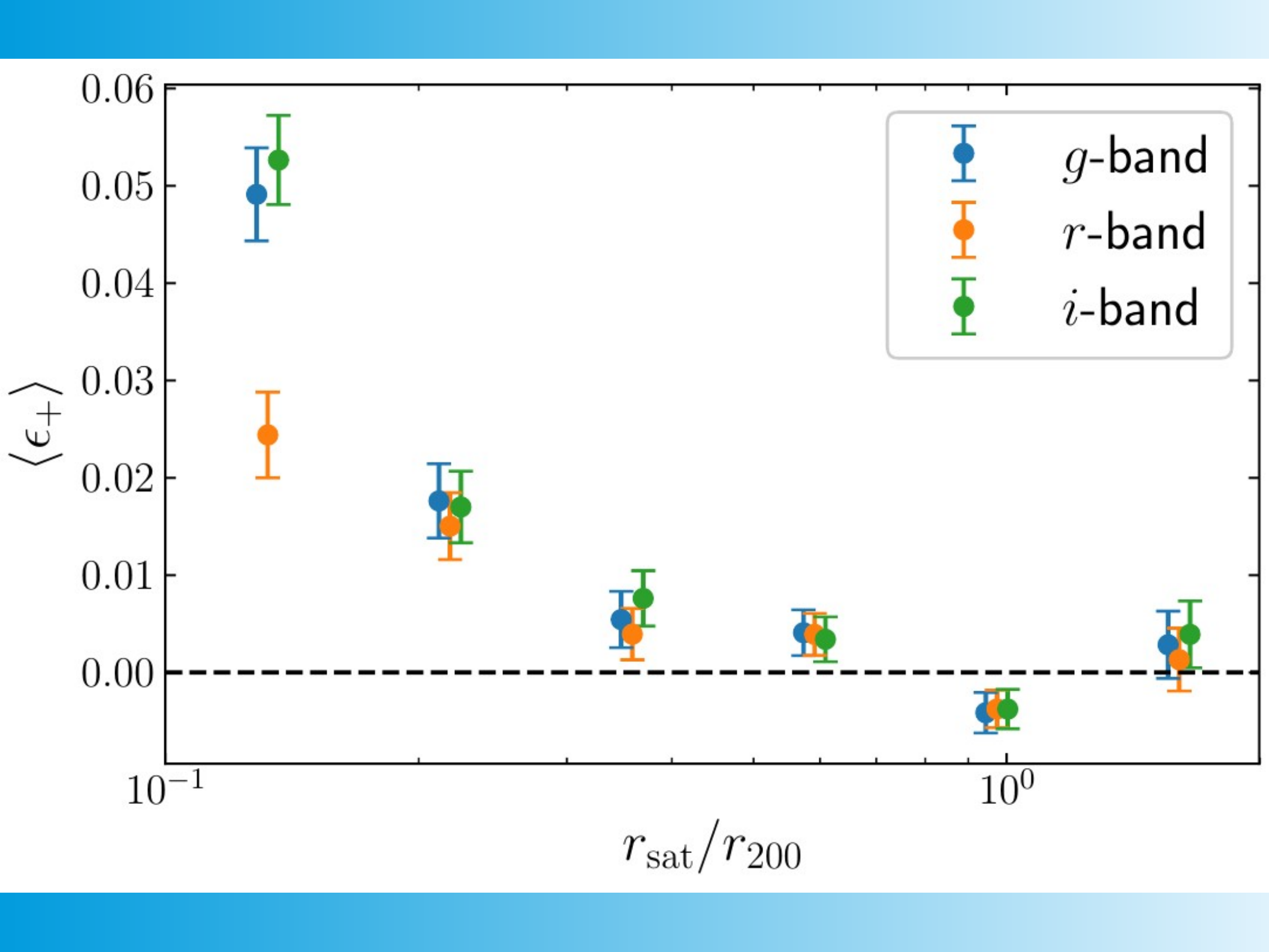
Thank you for your attention!

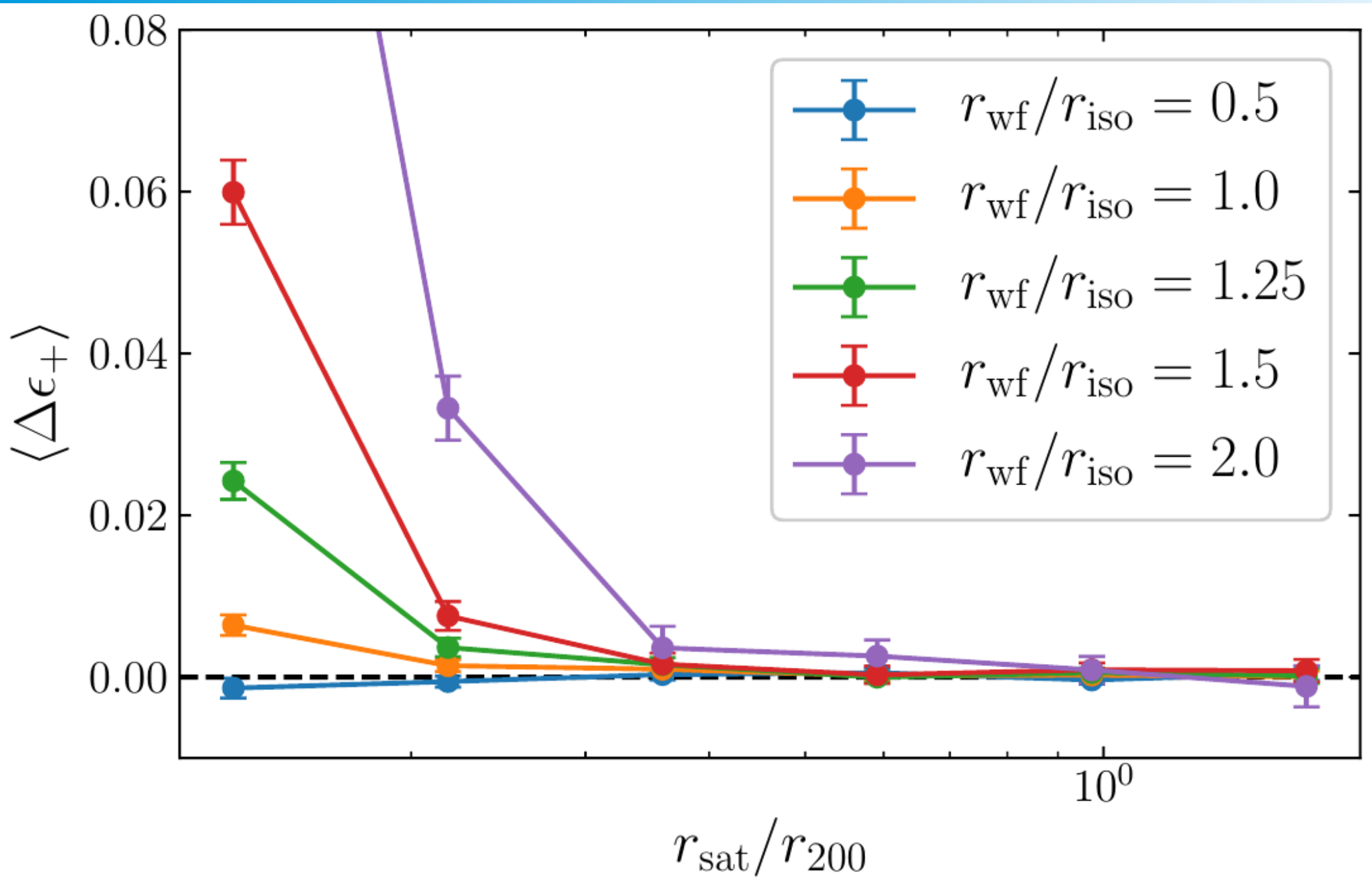
Intrinsic alignment measurement

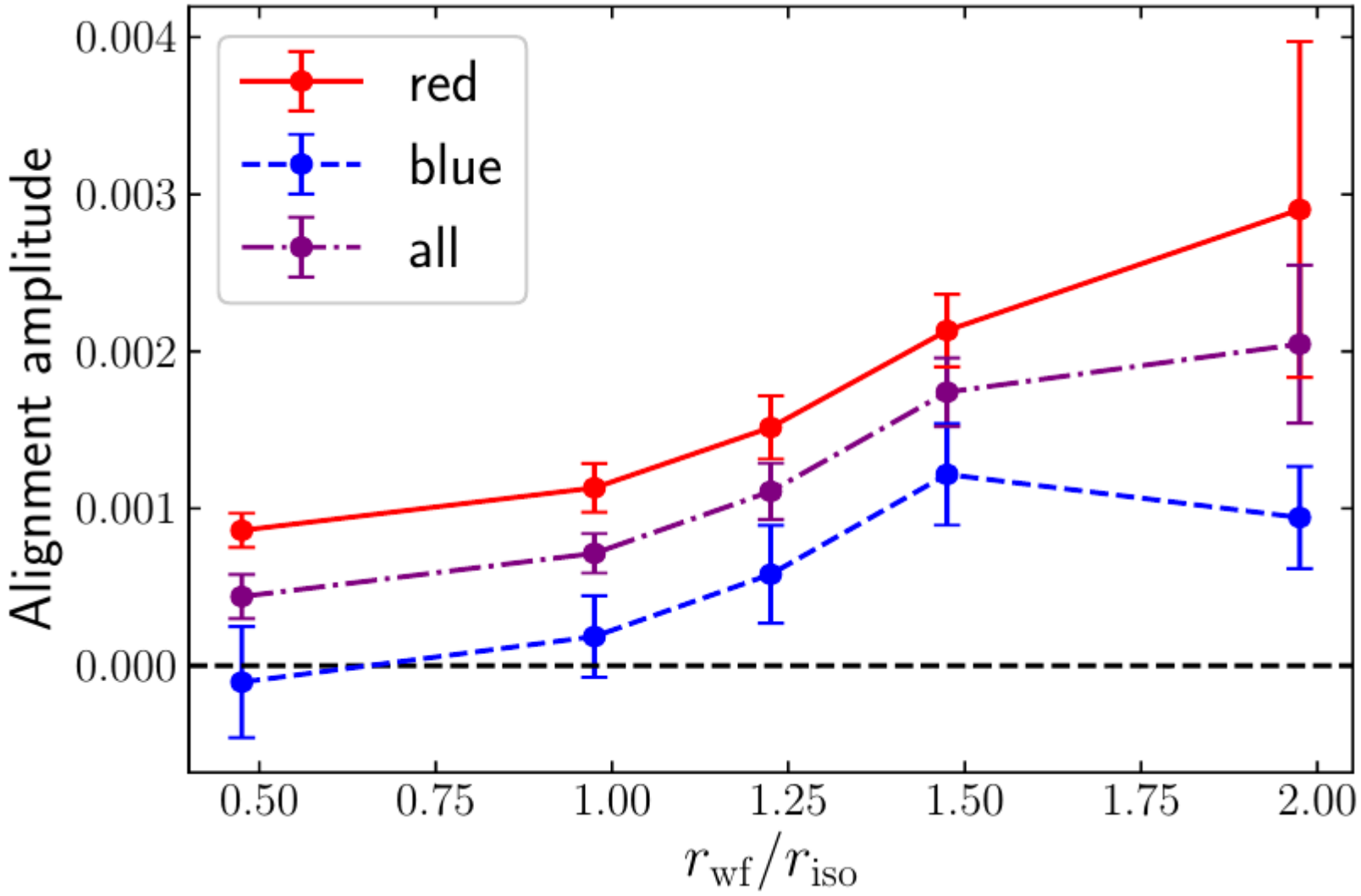


Johnston, CG, et al 2018, arXiv:1811.09598


shape: cen, density: cen
shape: sat, density: cen
shape: cen, density: sat
shape: sat, density: sat
$g-r$
$r-i$
Δw_{g+} [Mpc/h]
r_p [Mpc/h]
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
10^{-1}
10^{0}
10^{1}


0.06
0.05
0.04
0.03
0.02
0.01
0.00
$\langle \epsilon_+ \rangle$
10^{-1}
10^{0}
$r_{\rm sat}/r_{200}$
g-band
r-band
i-band


0.08
0.06
0.04
0.02
0.00
$\langle \Delta\epsilon_+ \rangle$
10^0
$r_{\rm sat}/r_{200}$
$r_{\rm wf}/r_{\rm iso} = 0.5$
$r_{\rm wf}/r_{\rm iso} = 1.0$
$r_{\rm wf}/r_{\rm iso} = 1.25$
$r_{\rm wf}/r_{\rm iso} = 1.5$
$r_{\rm wf}/r_{\rm iso} = 2.0$


red
blue
all
Alignment amplitude
0.004
0.003
0.002
0.001
0.000
0.50
0.75
1.00
1.25
1.50
1.75
2.00
$r_{\mathrm{wf}}/r_{\mathrm{iso}}$

Challenges

Shapes

- m-bias
- detector effects

Distances

- photo-z bias

Combination (correlation functions)

- Baryonic power spectrum
- Intrinsic alignments