Colour gradient bias in Weak Lensing

Xinzhong Er (SWIFAR,Yunnan)

H.Hoekstra, T.Schrabback, V.Cardone, R.Scaramella, R.Maoli, B.Gillis,

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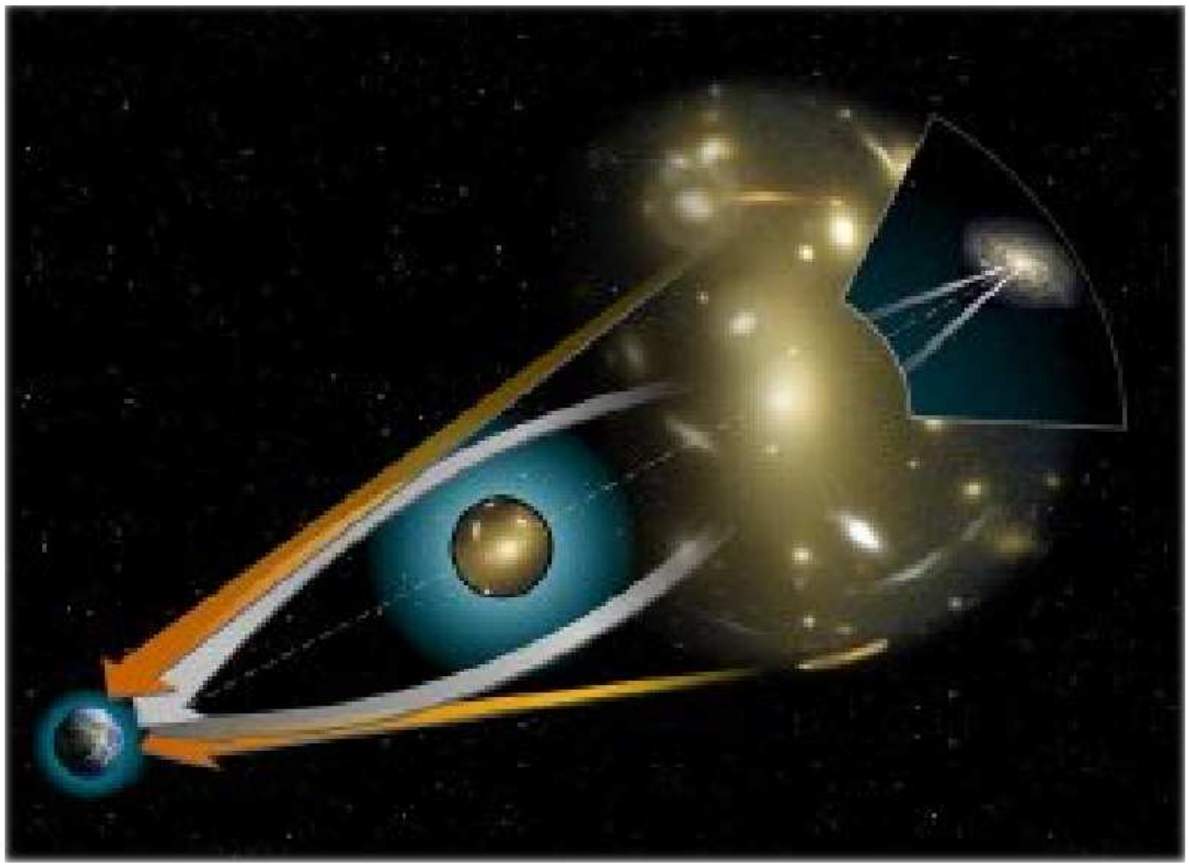
Gravitational lensing

A powerful tool for the whole universe: from LSS to planet



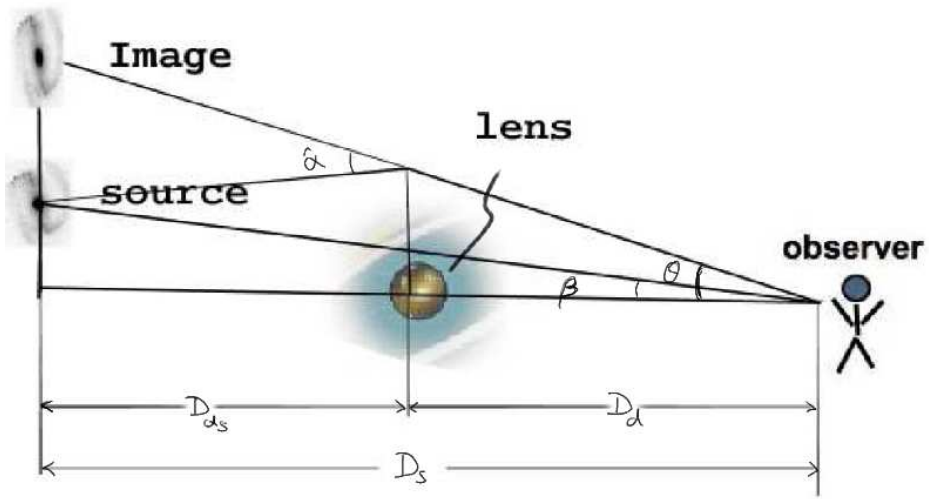
Lens equation

Thin lens approximation:

$$\boldsymbol{\beta} = \boldsymbol{\theta} - \boldsymbol{\alpha}(\boldsymbol{\theta})$$

deflection angle α

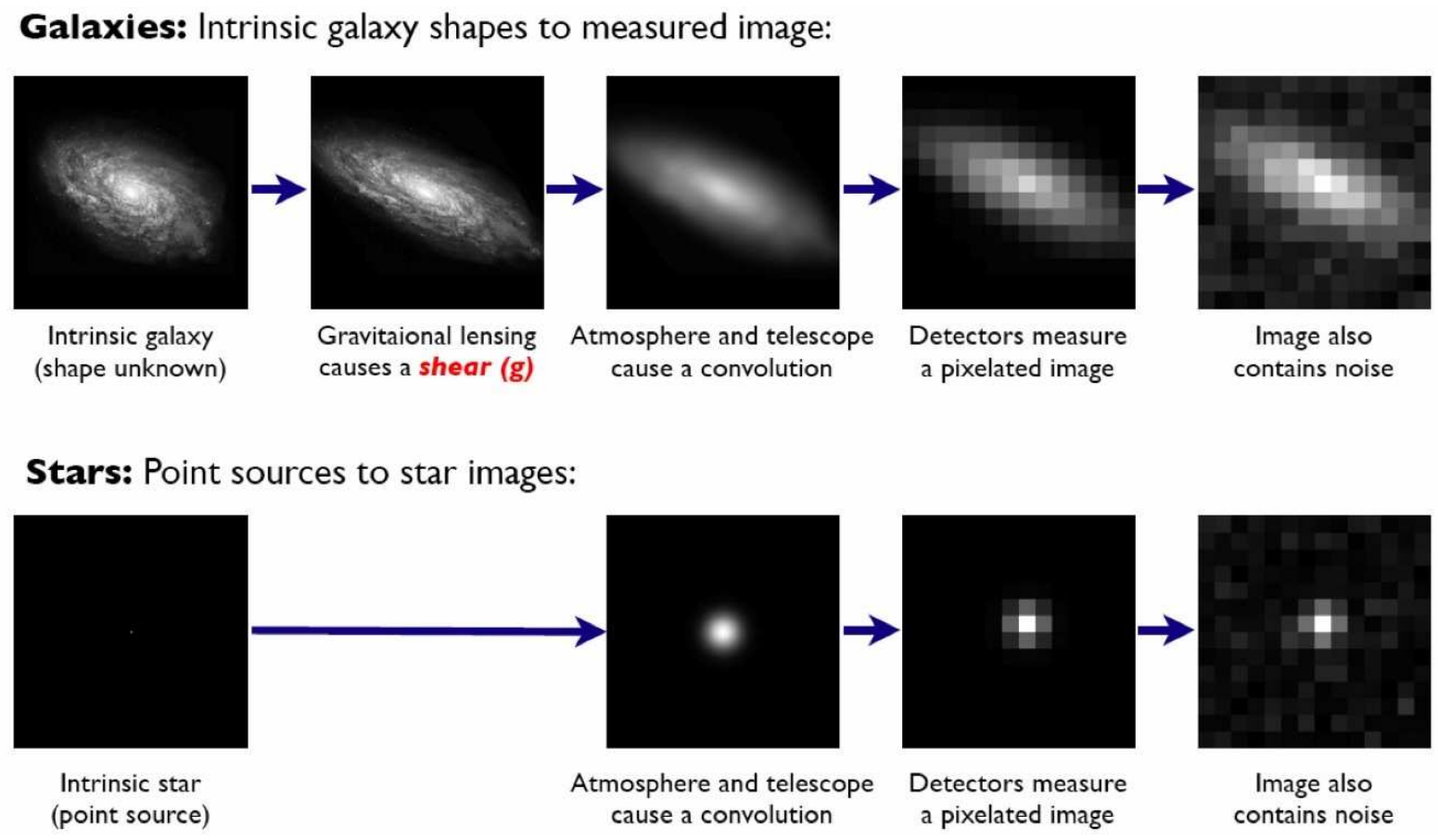
$$\begin{aligned} \boldsymbol{\alpha}(\boldsymbol{\theta}) &= \nabla\psi(\boldsymbol{\theta}), \\ \kappa(\theta) &= \frac{1}{2}\nabla^2\psi(\theta) \end{aligned}$$



- For galaxy, there are shear and flexion

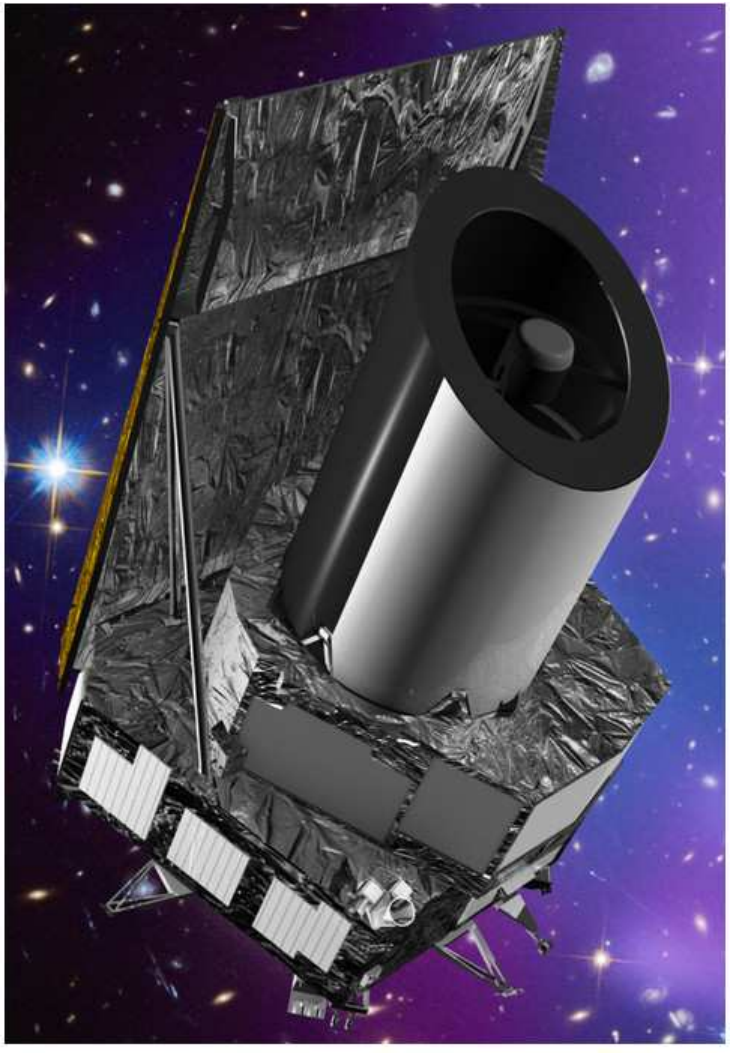
$$\beta = \theta - g\theta^* - F\theta^2 ...$$

PSF in weak lensing



(Bridle et al. 2009). better PSF, go to space

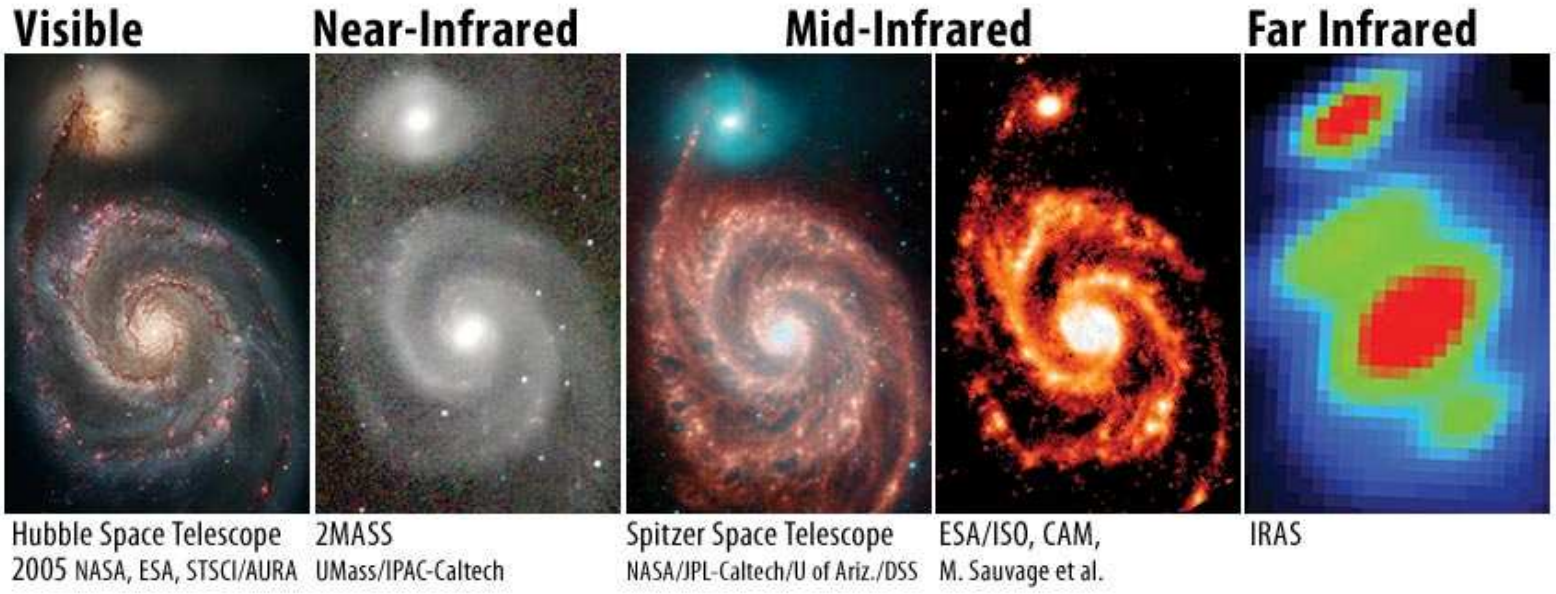
Euclid mission



- Launch in 2021 by ESA,
- Weak Lensing & cluster
- 1.2m, large FOV,
  Full survey 15,000 deg2
- VIS band (550 – 900nm)
  AB mag 24.5
  $\sim$30-35 gal/arcmin^2
- Systematics for WL: CTI,
  CG, IA

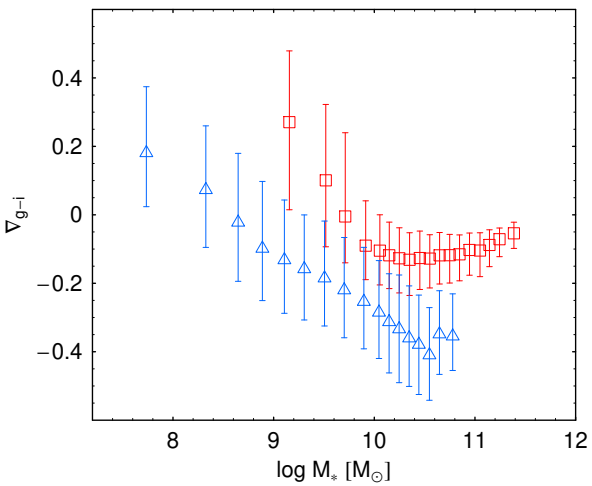
What is Colour gradient in galaxy?

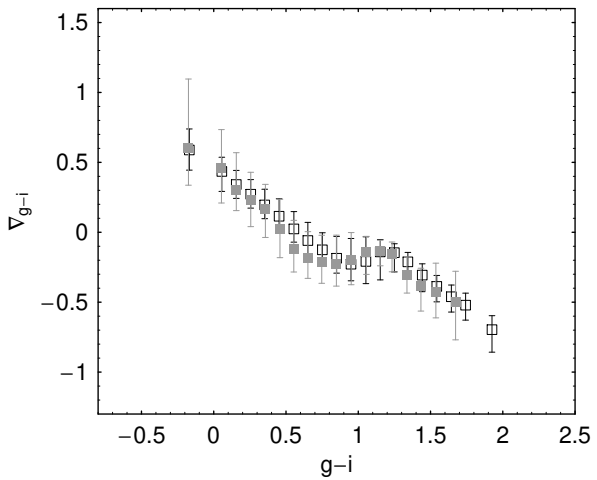
The galaxies have different shape in different band

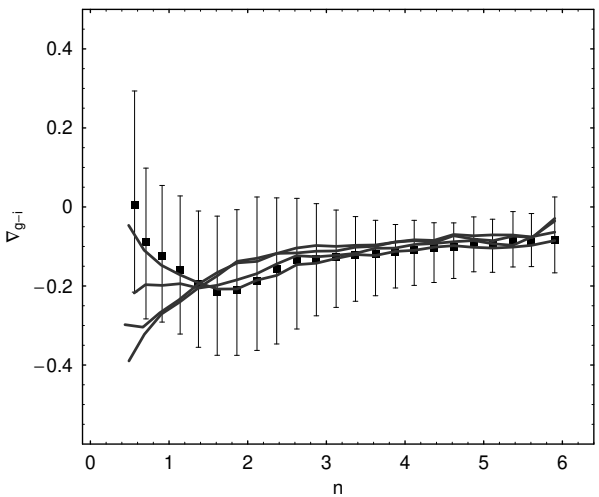


Colour gradients in galaxy

- Not random: Mass, Colour and Morphology



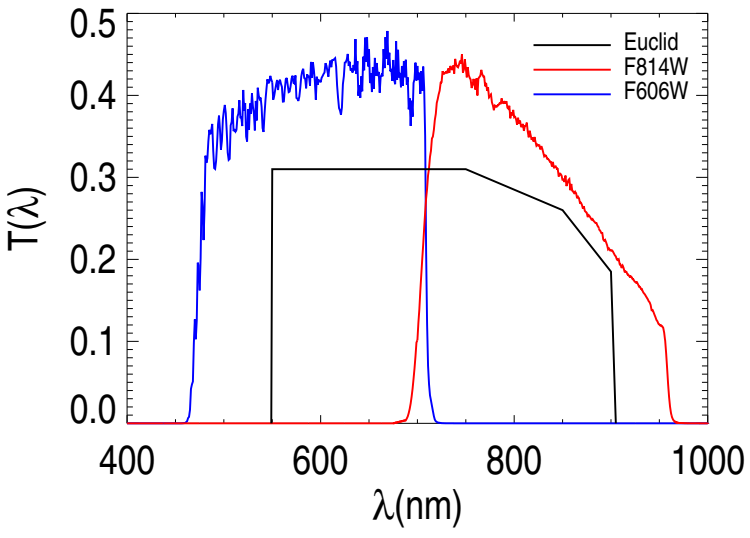


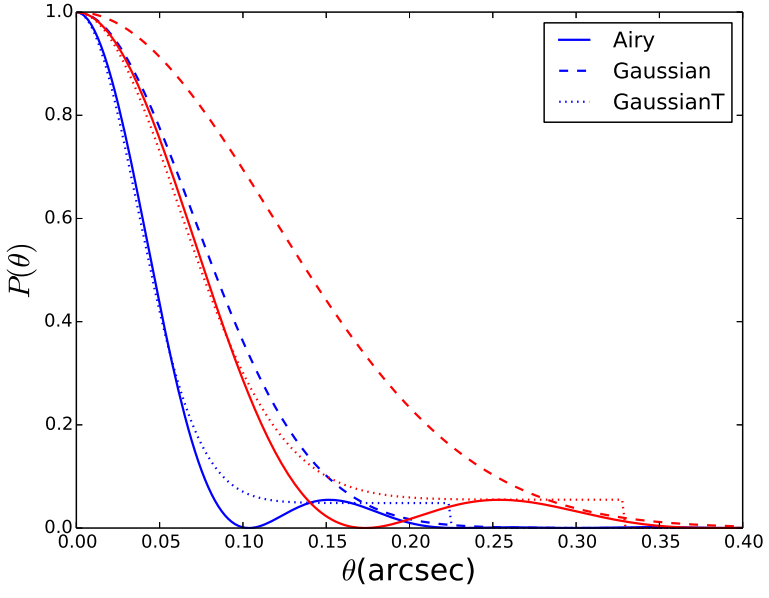


Tortora et al.(2010)

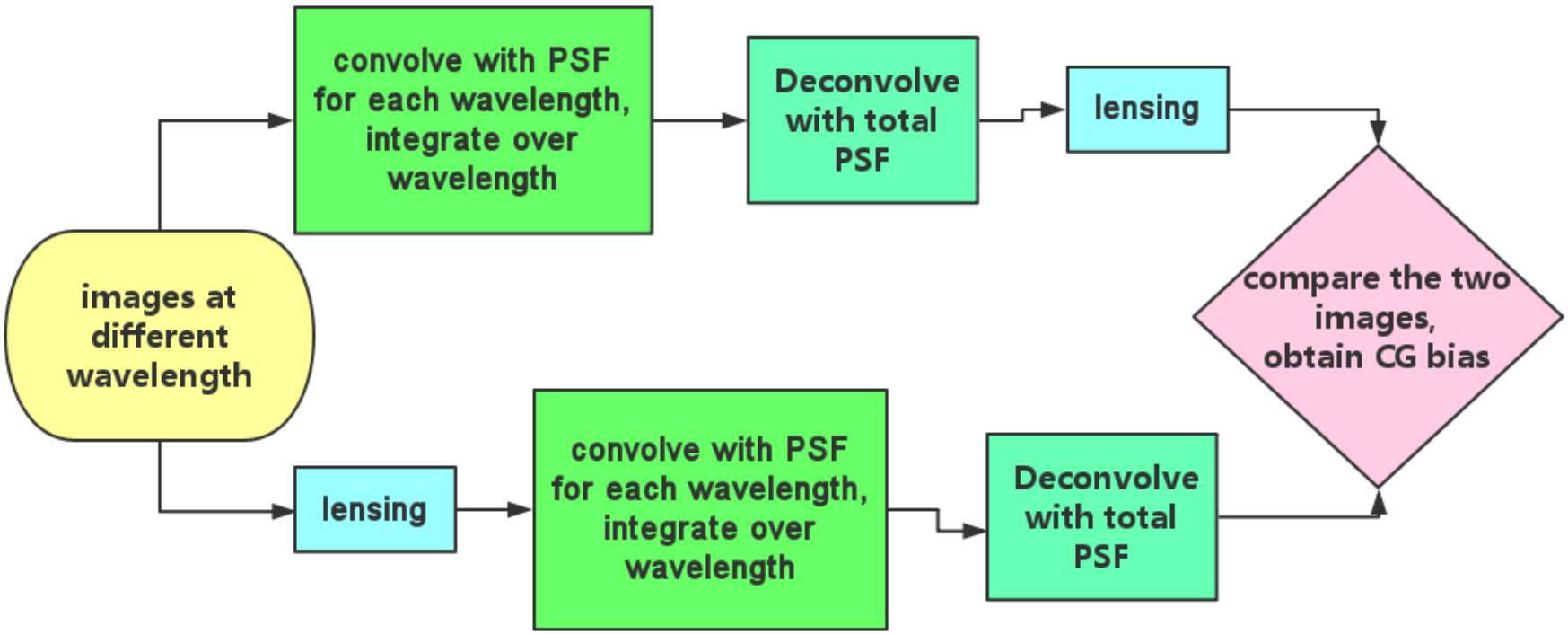
PSF variations in wide band

Non uniform galaxy convolve with chromatic PSF



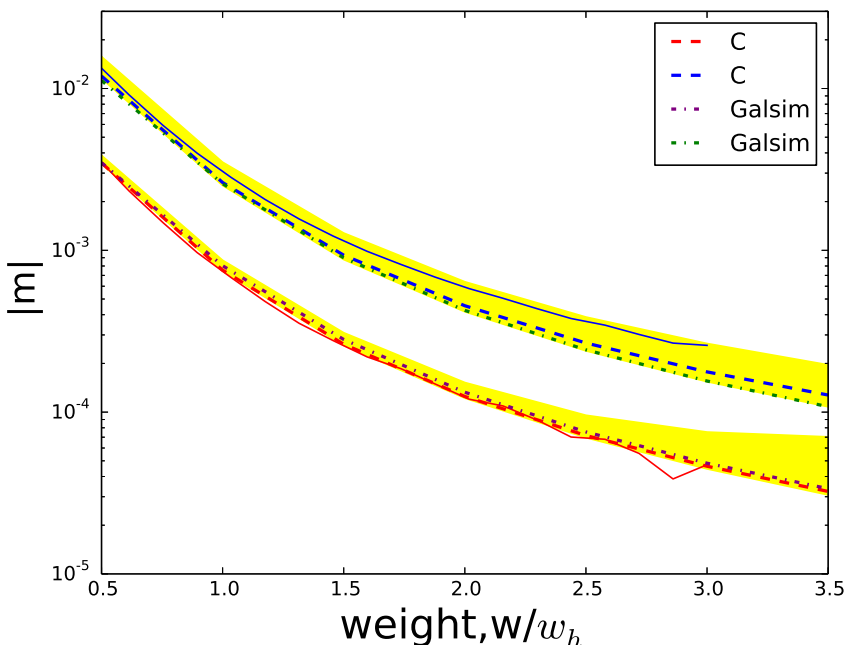


How do we estimate CG bias

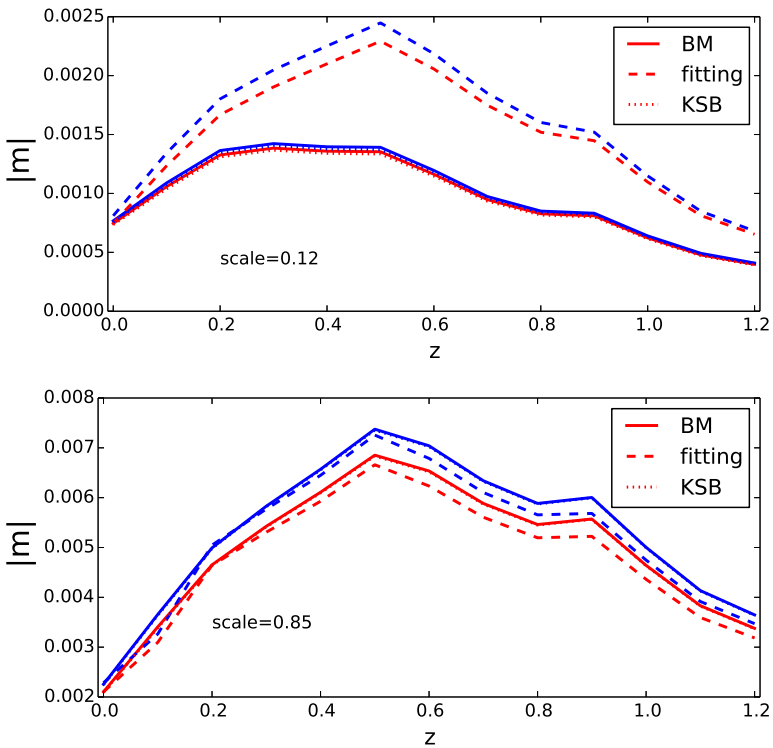


Simulated galaxy images

Weighting



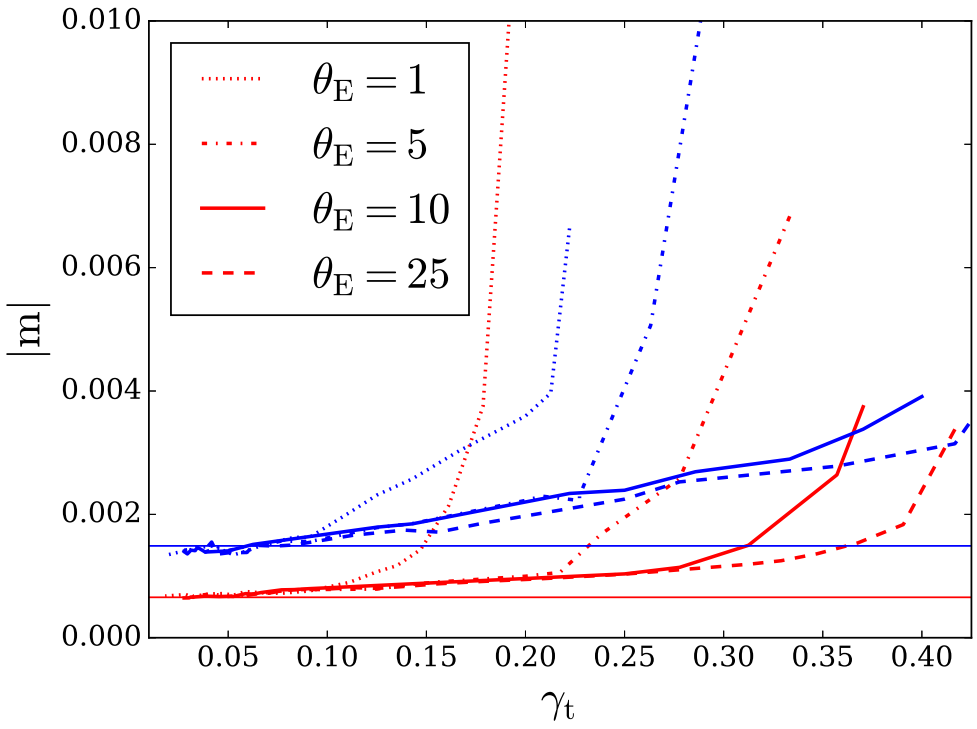
Method dependent



– >numerical noise

Weak lensing goes higher order

In the galaxy-galaxy lensing



No SED, only two bands

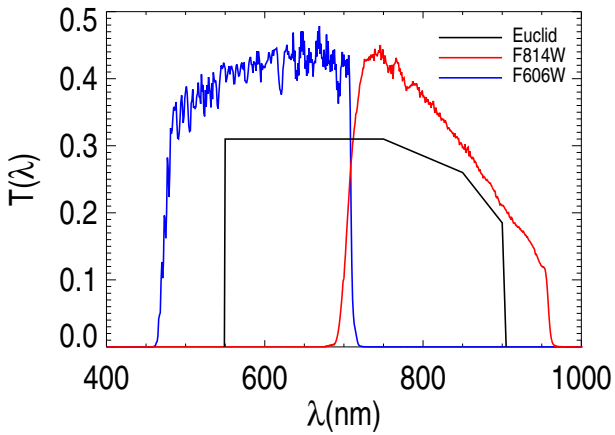
Two x(V,I) images are used to interpolate for local SED:

$$\begin{aligned} T_V(\lambda)[a(x)\lambda + b(x)] &= I_V^{obs}(x) \\ T_I(\lambda)[a(x)\lambda + b(x)] &= I_I^{obs}(x) \end{aligned}$$

After solving the equations for $a(x)$ and $b(x)$, we can generate the galaxy image for different wavelength

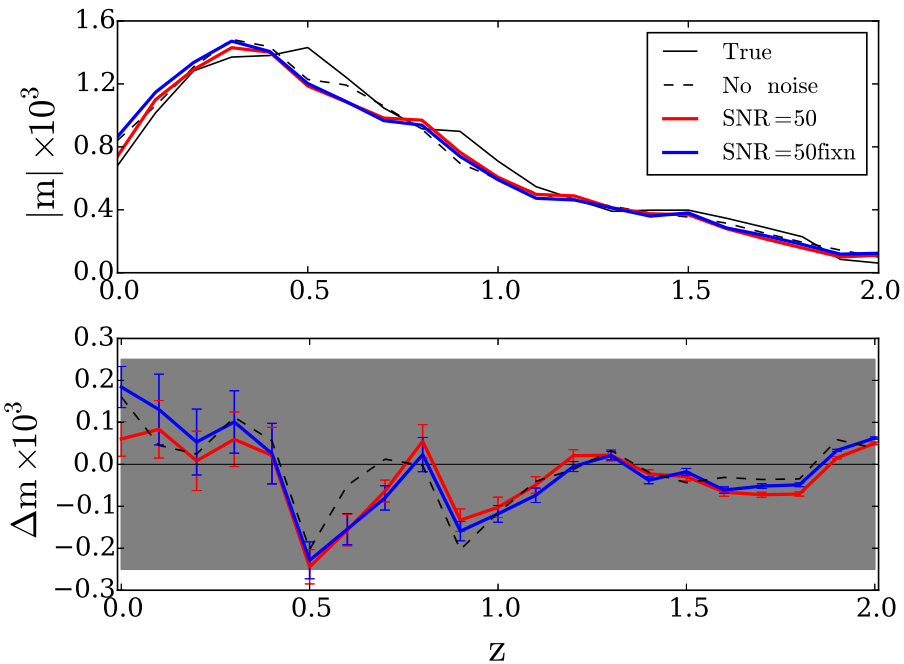
$$I(x, \lambda) = a(x)\lambda + b(x)$$

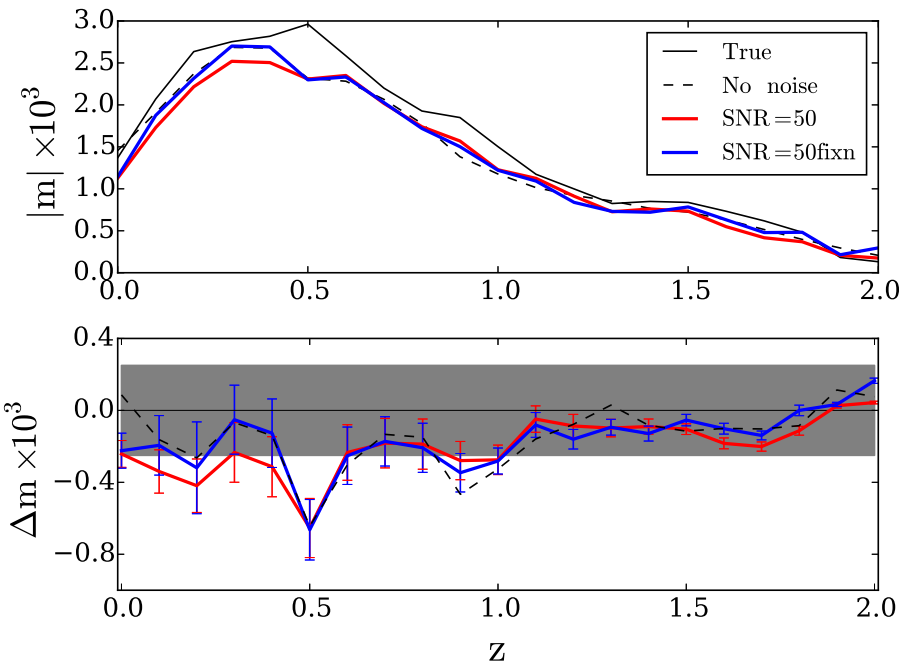
(Semboloni et al. 2013)



Simulated HST images (F606W,F814W)

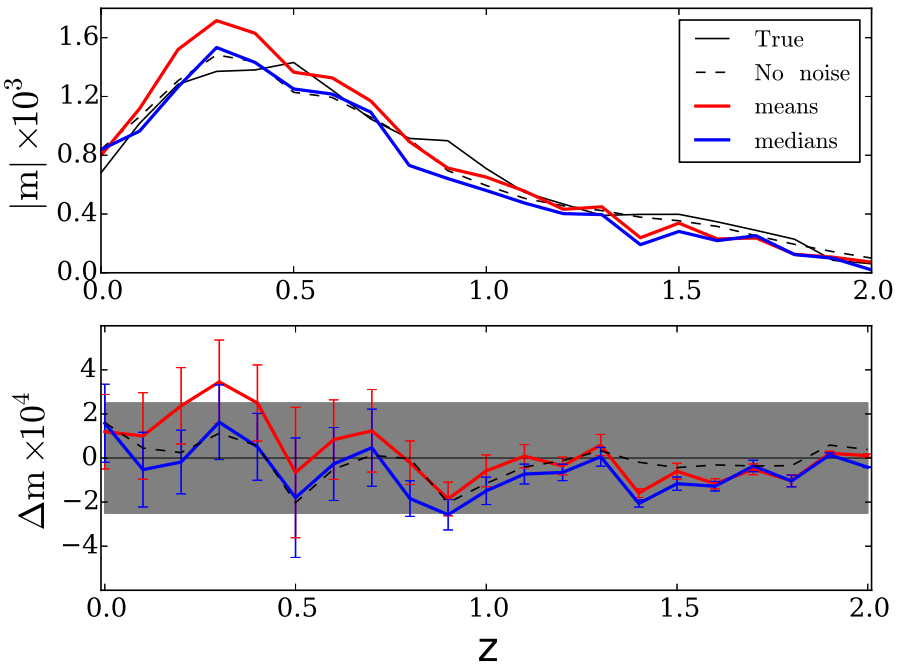
Method validation for Euclid, $SNR = 50$





Simulated HST images (F606W,F814W) II

$SNR = 15$



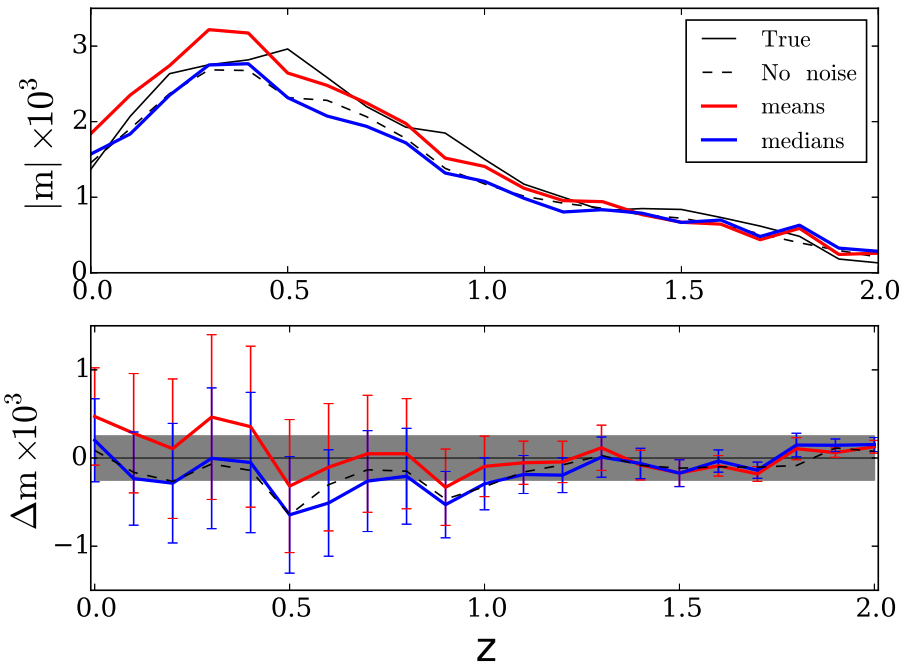
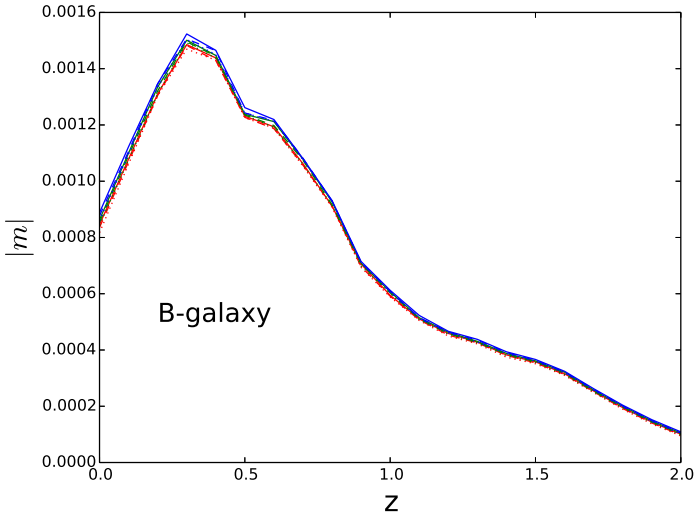
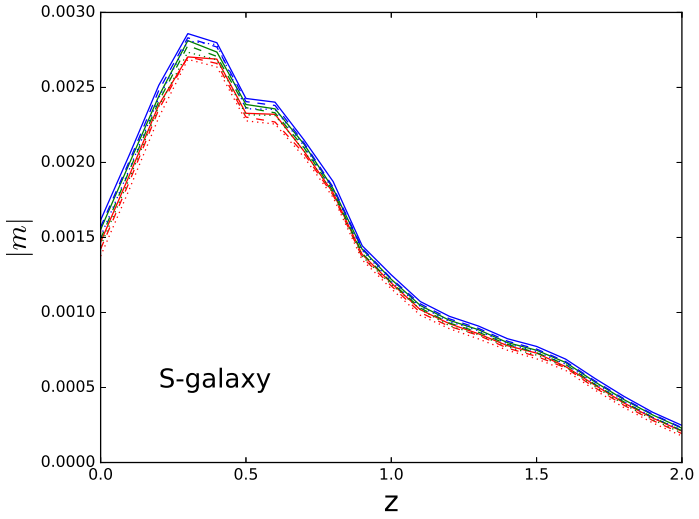


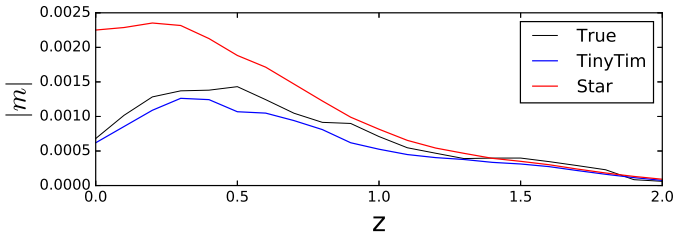
Image fitting biased! need large sample

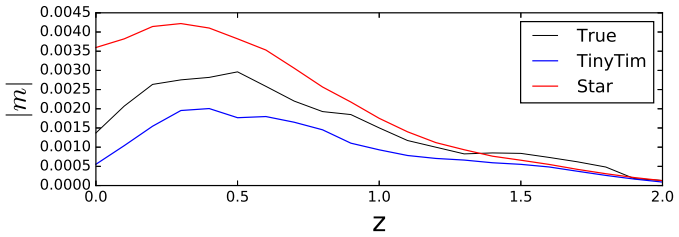
PSF variation





Binary PSF!

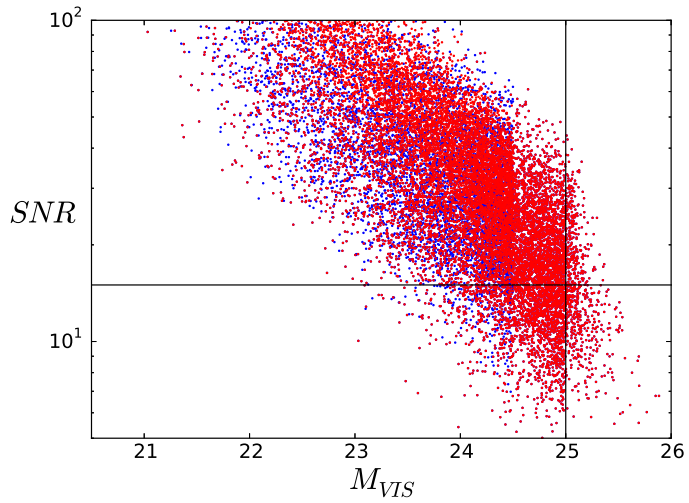




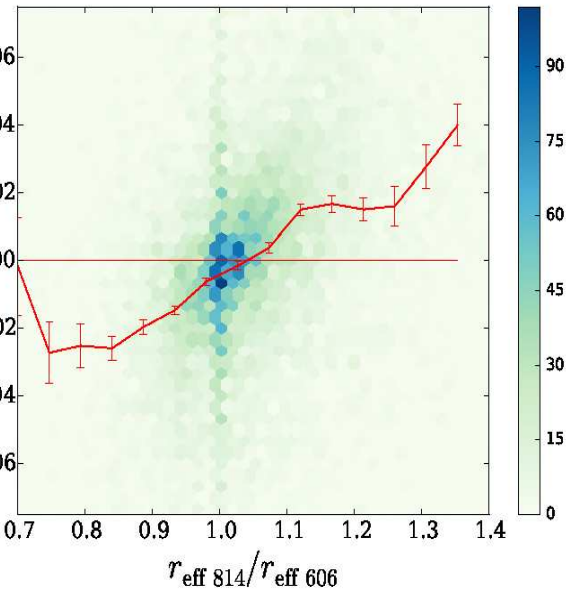
HST, CANDELS data

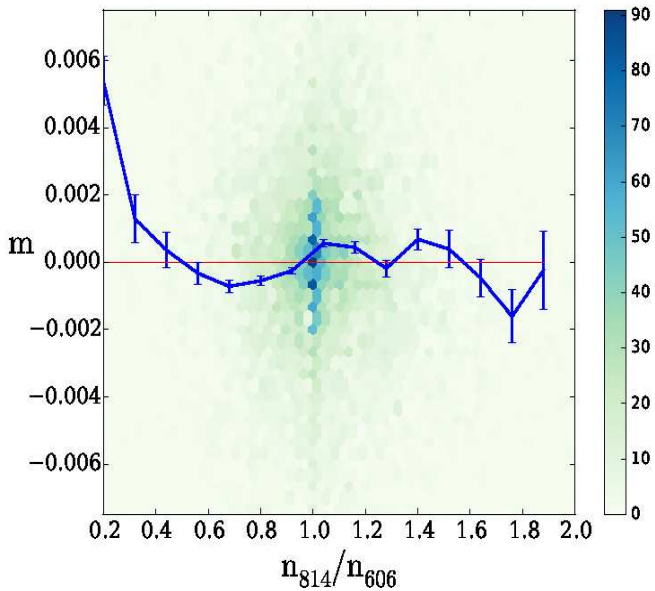
Field	Area	N
AEGIS	180	5518
COSMOS	139	4794
UDS	146	4311
Total	465	14623

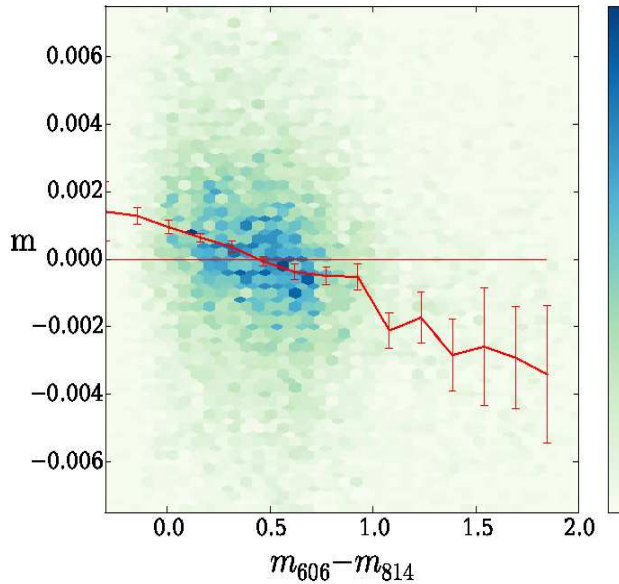
$m_{VIS} < 25$
31.5 gals/arcmin^2,
close to Euclid require 35



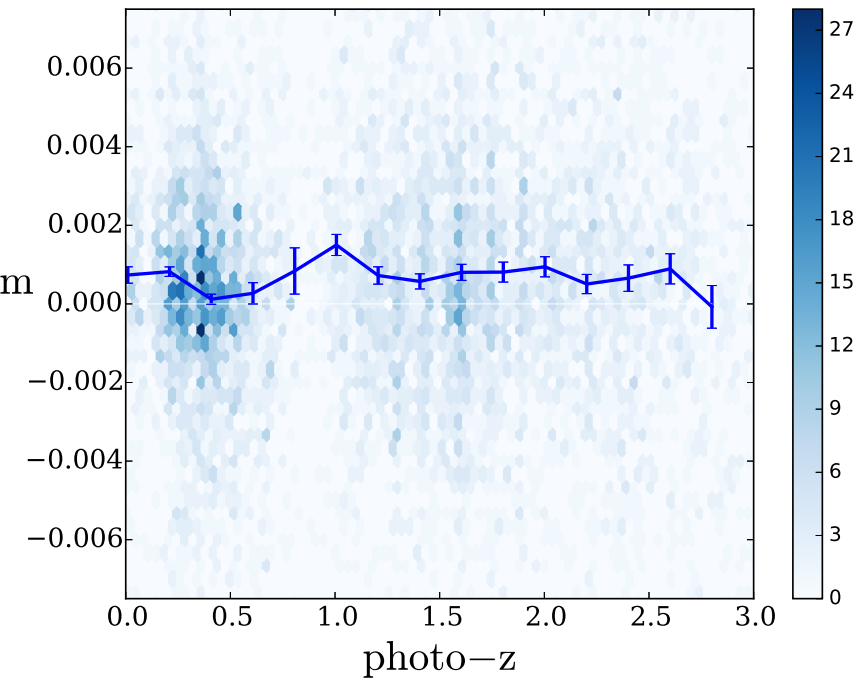
CG bias with galaxy properties and colour

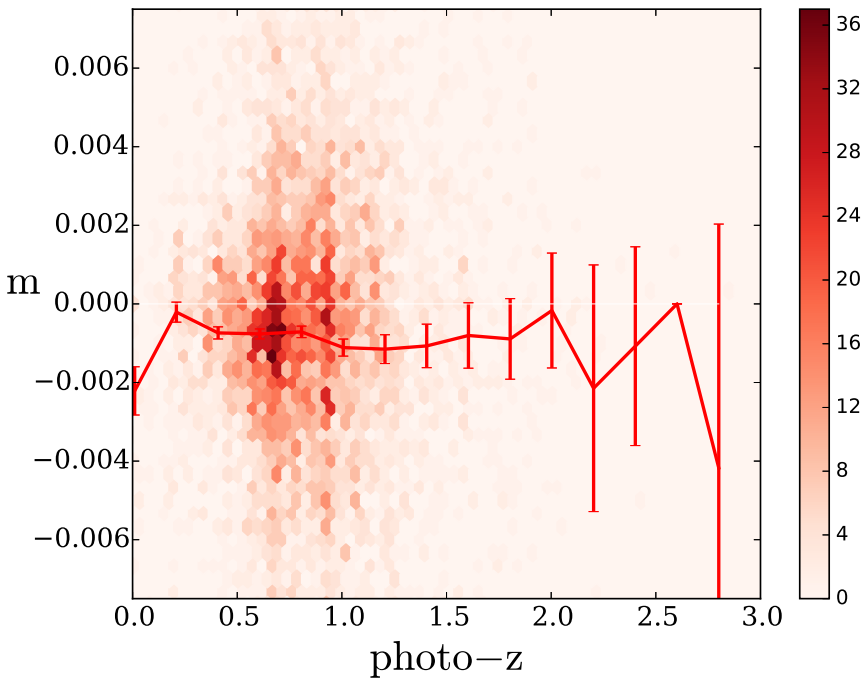






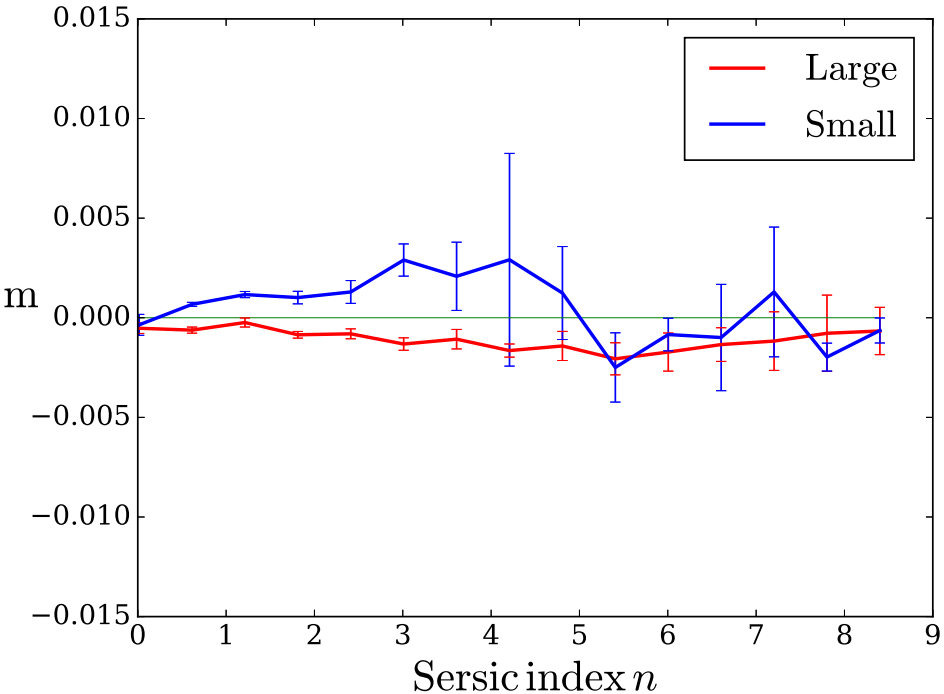
CG bias with redshift

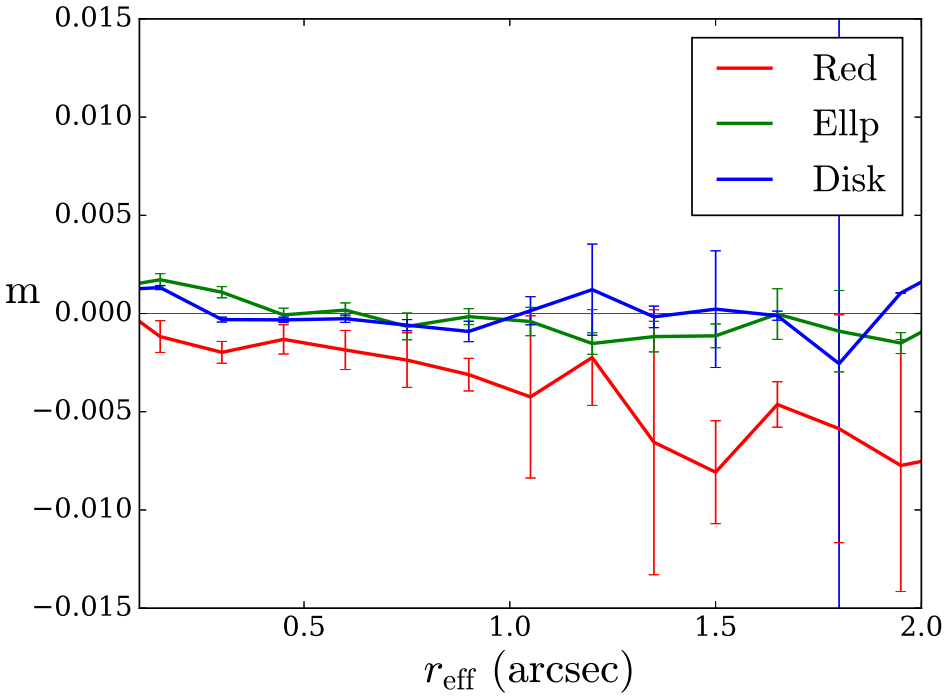




In Euclid only *VIS* image

What can we have? r_e, n_s





It would be great if we have colour!

Summary of CG bias

- Gravitational lensing: wonderful!
- PSF: trouble maker
  - Wide band image: CG bias
  - CG bias: small, but...
  - method-, colour-, size-, morphology- dependence
  - General for Euclid, what about others?
  - Correlation with z, and IA; problem for SL

SED assumed to be smooth, otherwise