The Sensitivity of the Redshift distribution to Galaxy Demographics

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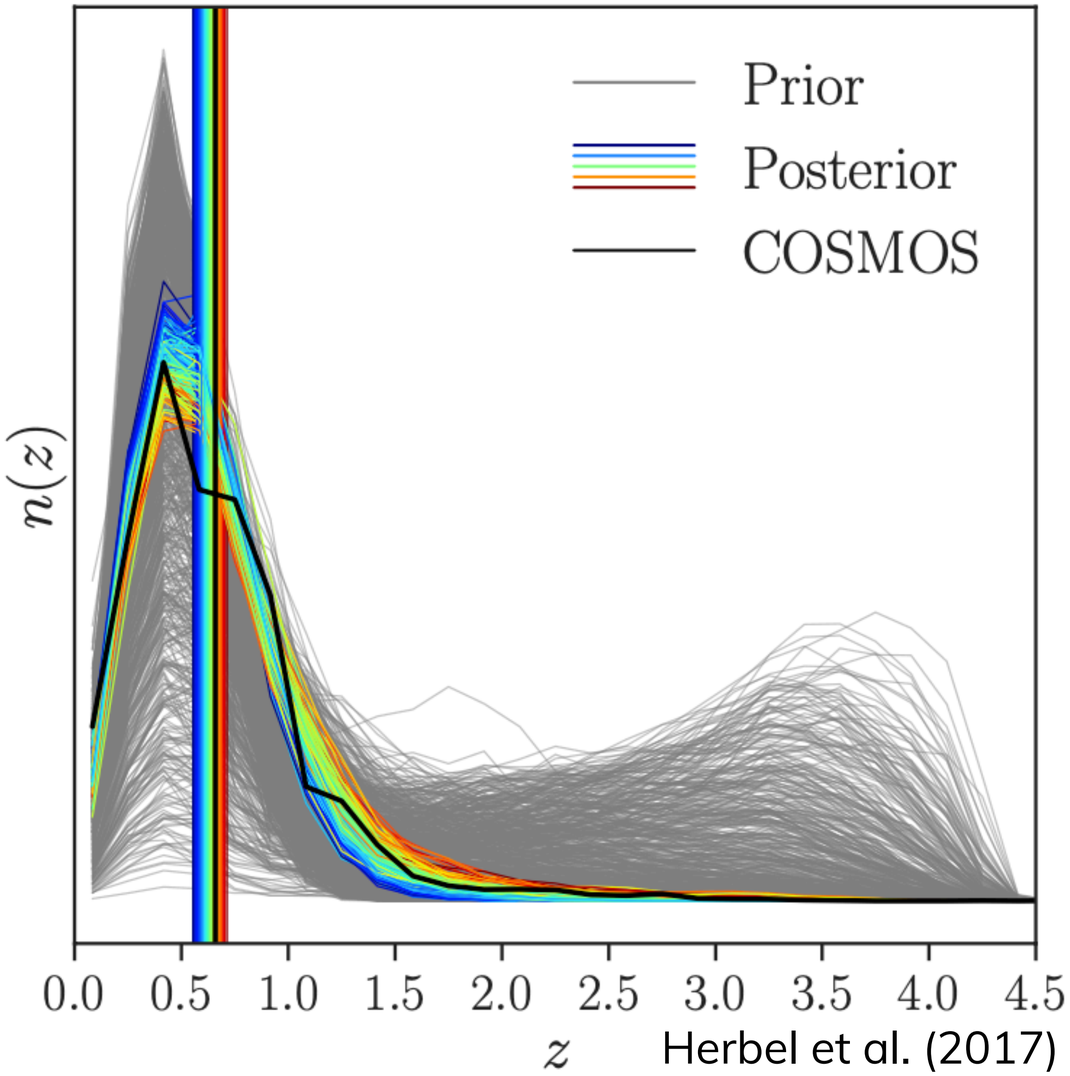
Cosmology from Home 2022

Introduction

- Redshift distribution of galaxies important for different cosmological probes
- **Spectroscopic redshifts** are most precise measurement
  - **BUT**: too time-consuming and cost-intensive for current and upcoming surveys
- **Photometric redshifts** are an alternative for big surveys
  - **BUT**: precision very low

Solution: Forward model redshift distribution directly

Forward Model Redshift Distributions



Herbel et al. (2017)

- Herbel et al. (2017)'s method provides a **good measure of the redshift distribution** of cosmic shear like galaxy samples

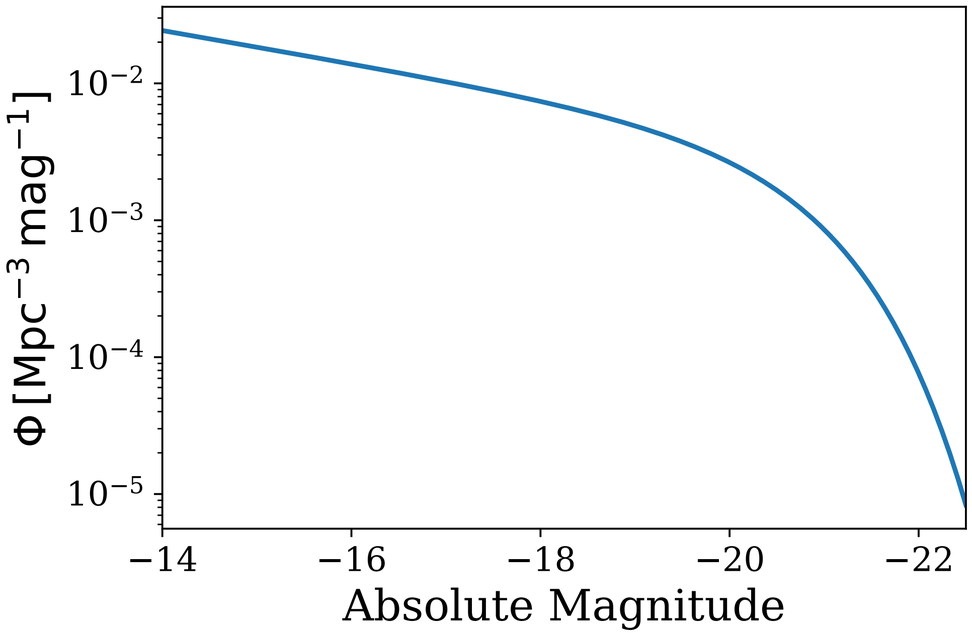
Redshift distribution solely sampled from Schechter luminosity functions

Schechter Function and Model

$$\Phi(z, M) = 0.4 \ln(10) \Phi_*(z) 10^{0.4(M_*(z)-M)(\alpha(z)+1)} \cdot \exp\left(-10^{0.4(M_*(z)-M)}\right)$$

$$M_*(z) = a_{\mathrm{M}} z + b_{\mathrm{M}}$$

$$\Phi_*(z) = b_\phi \exp(a_\phi z)$$



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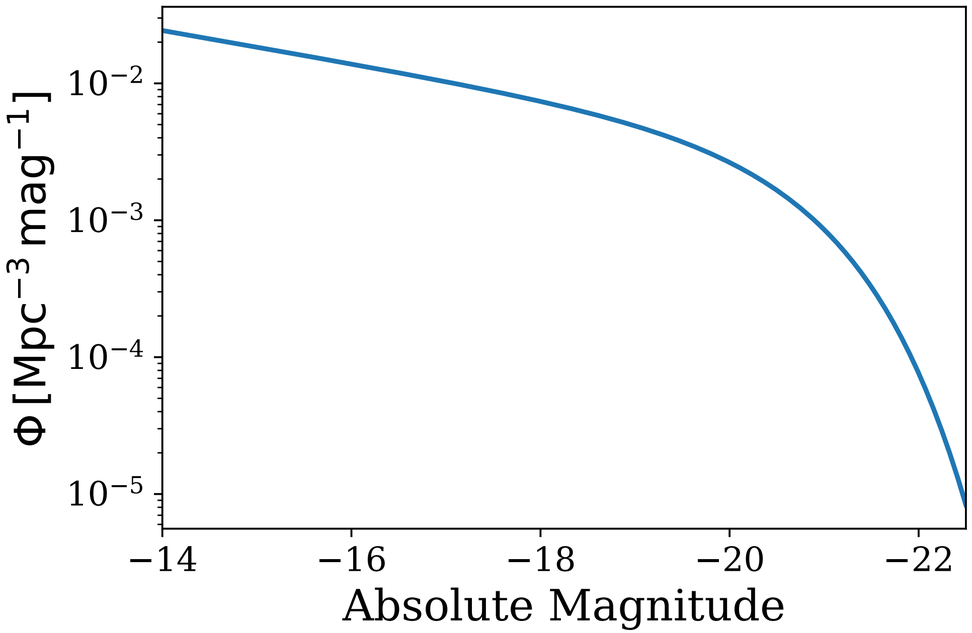
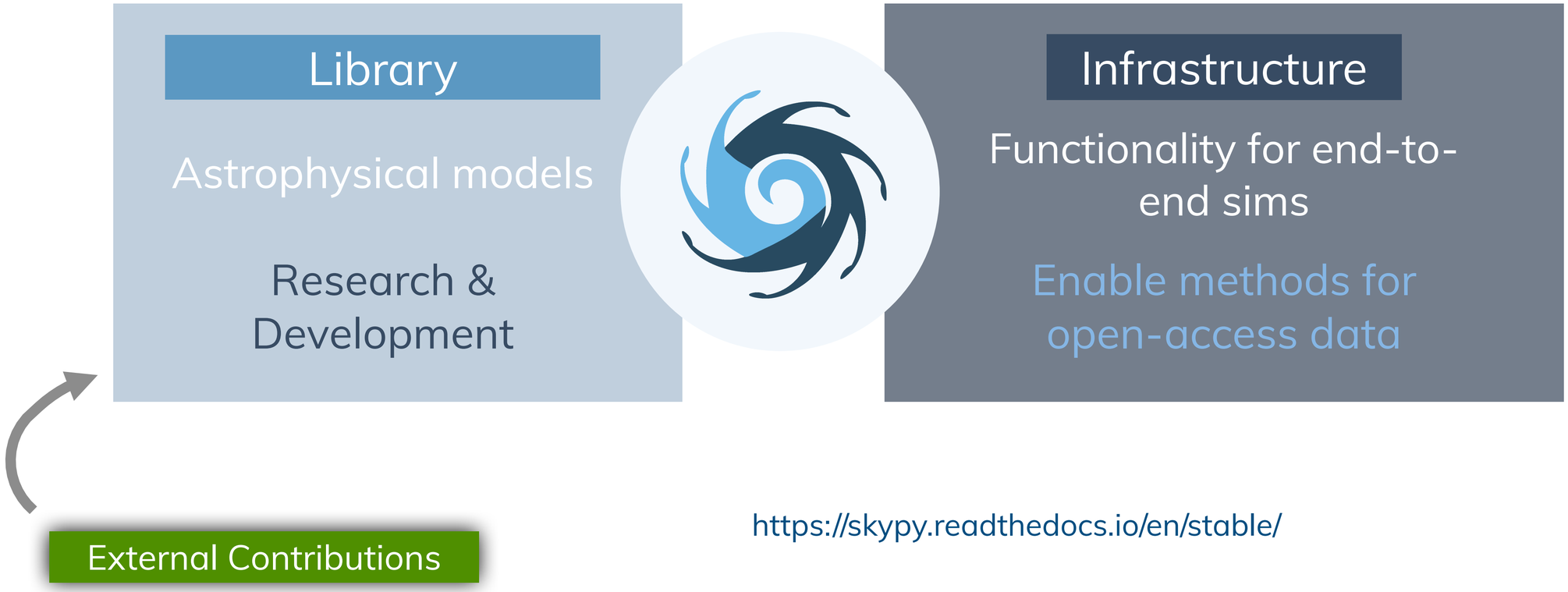


→ 8 free parameters (for 2 populations)

Simulations with SkyPy

Amara et al. (2021)

https://github.com/skypyproject/skypy

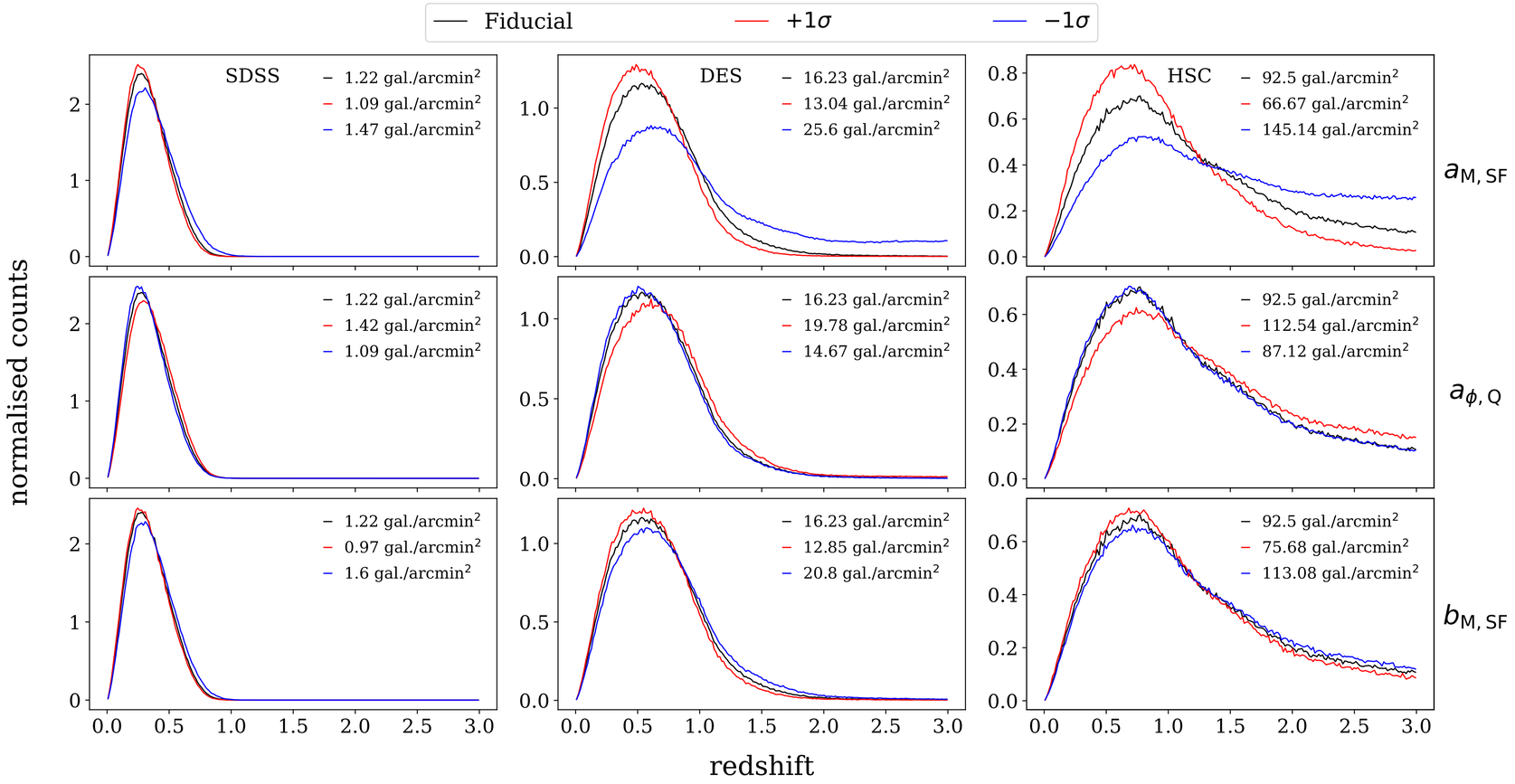


https://skypy.readthedocs.io/en/stable/

Parameter Sensitivity

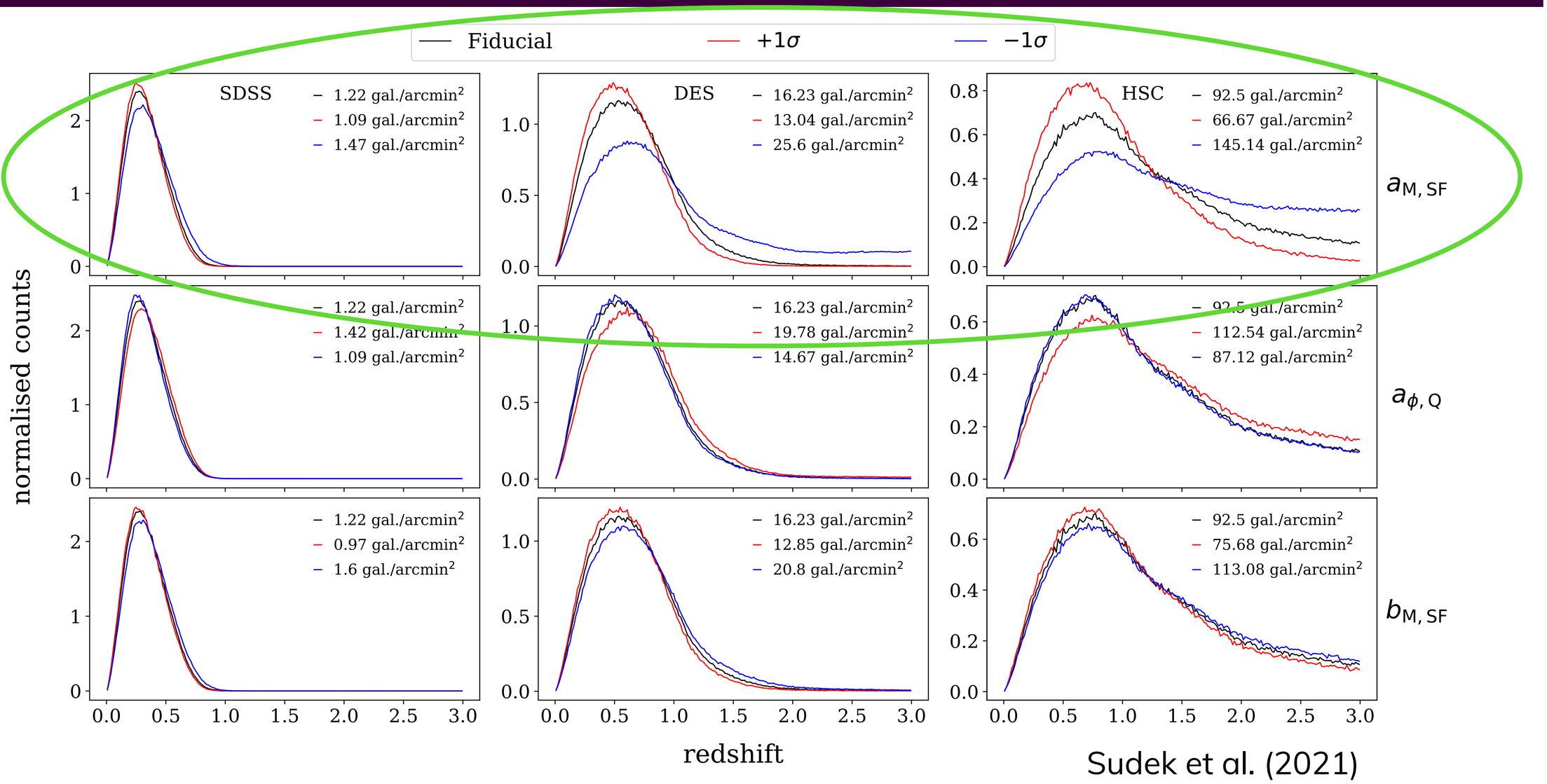
$a_{\mathrm{M,SF}}$
$b_{\mathrm{M,SF}}$
$a_{\phi,\mathrm{SF}}$
$b_{\phi,\mathrm{SF}}$
$a_{\mathrm{M,Q}}$
$b_{\mathrm{M,Q}}$
$a_{\phi,\mathrm{Q}}$
$b_{\phi,\mathrm{Q}}$

$\pm \sigma$



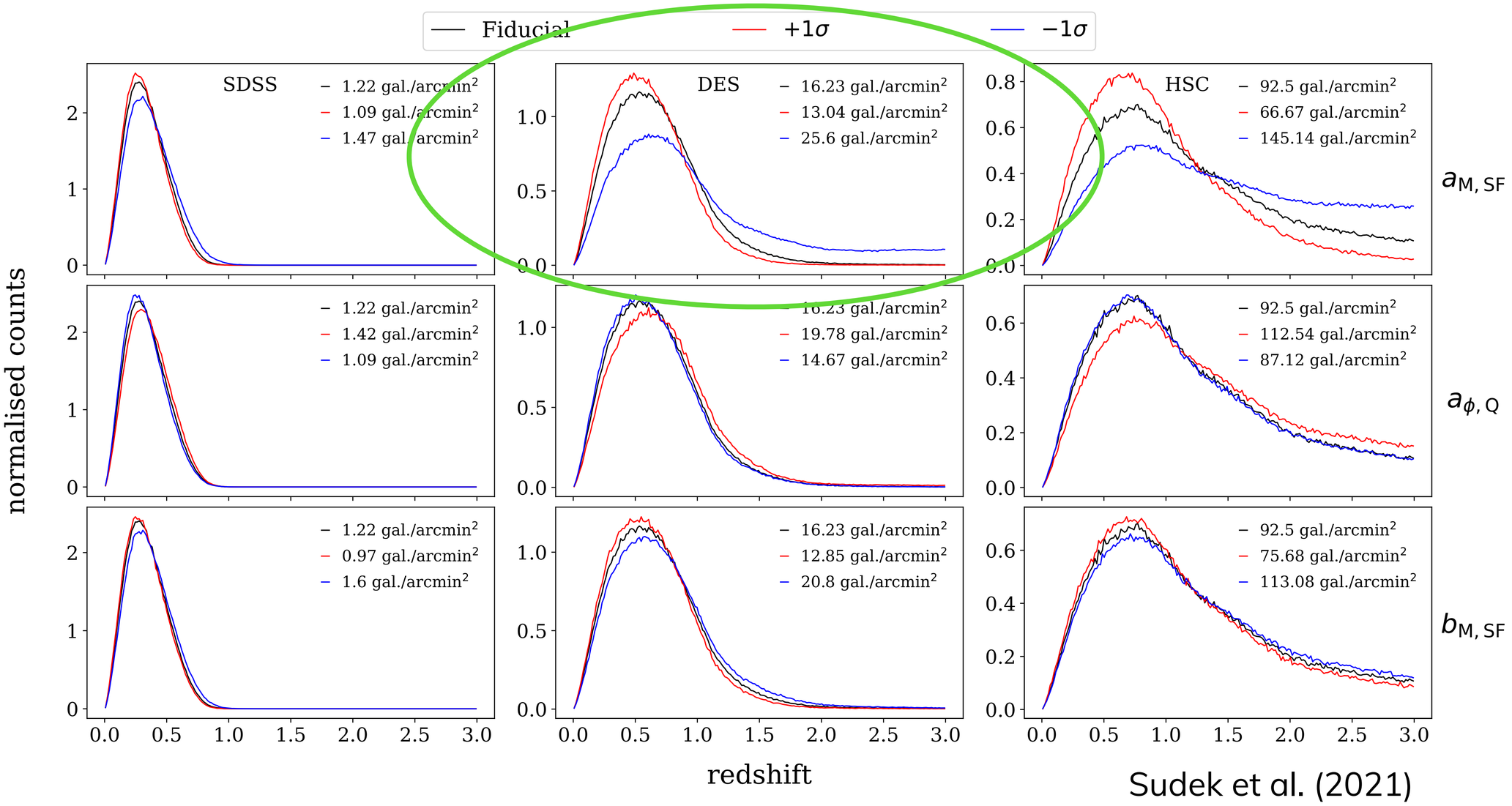
Sudek et al. (2021)

Comparing Surveys



Sudek et al. (2021)

Sensitivity of DES-Like Survey



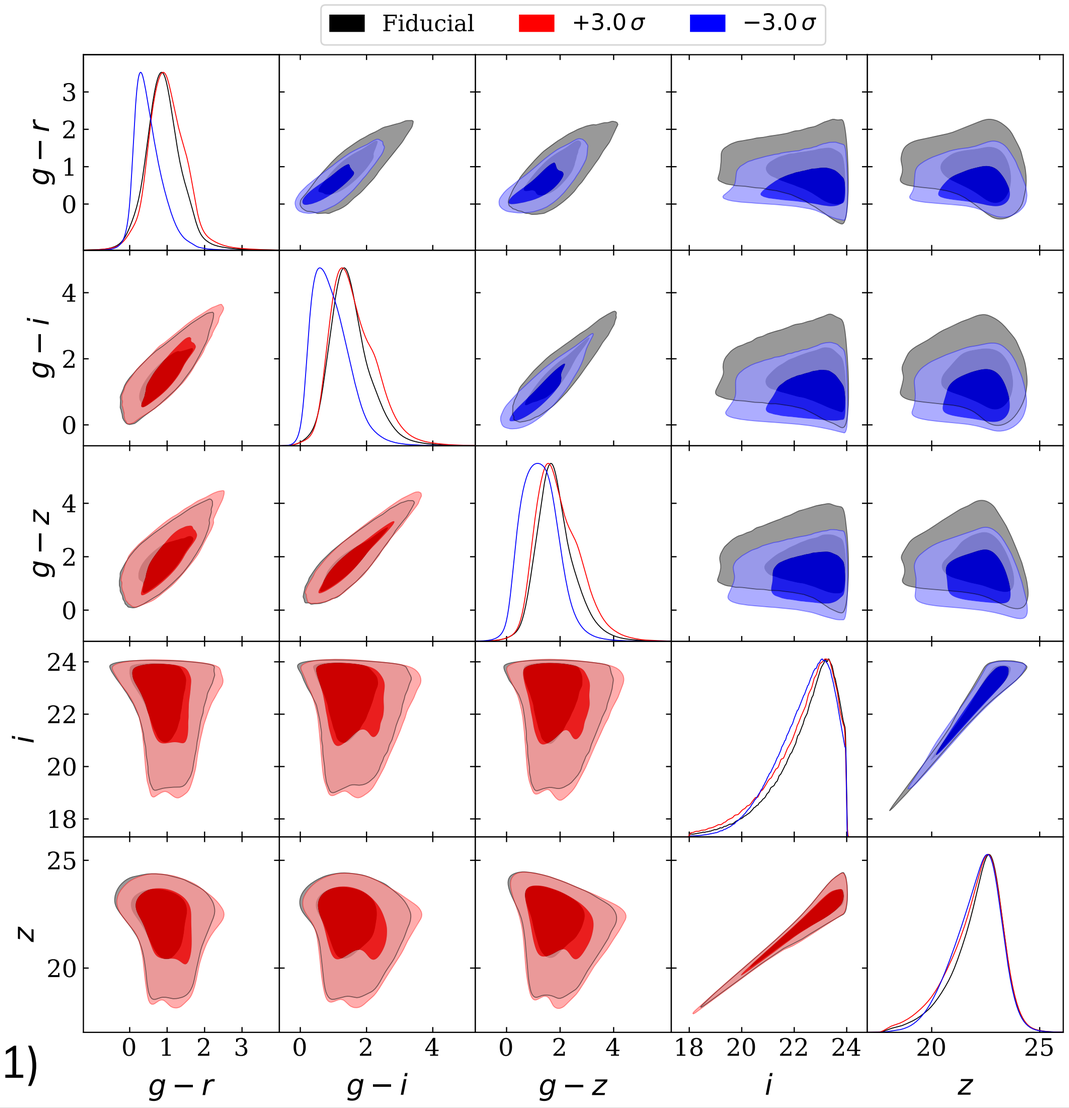
Sudek et al. (2021)

Quantitative Sensitivity

- We compared the change of the mean redshift quantitatively
- Numbers generally agree with the sensitivity that we saw in previous plot
- $a_{\mathrm{M,SF}}$ has the biggest impact
  - Changes DES-like mean redshift by up to ~45% ($\Longleftrightarrow$0.3 units)

$a_{\mathrm{M,SF}}$ is most important to constrain

Sensitivity of Observables



Sudek et al. (2021)

Summary

1. Replace redshift measurements with forward simulations
2. Base simulations on redshift dependent luminosity functions
   - Model parameters still have high uncertainty
3. For upcoming experiments it is most important to constrain slope of characteristic magnitude $a_{\mathrm{M,SF}}$
4. Colour-magnitude measurements could help to constrain parameters in the future