

# Studying observational systematics with fast mock galaxy catalogs

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California Institute of Technology



# Challenges with systematics in Euclid



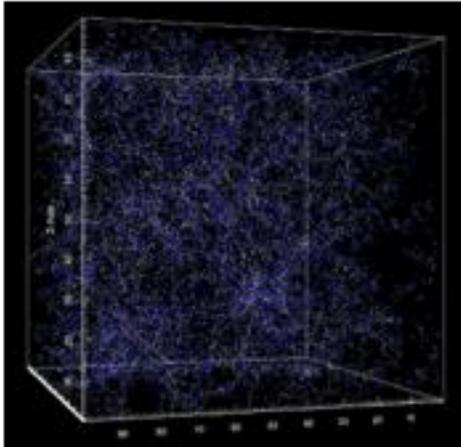
- **MOTIVATION.** **Systematic effects** will dominate the error budget for weak lensing measurements in Euclid
  - Shape measurements
  - Photometric errors
  - Selection function
  - Theoretical predictions
  - ...
- **QUESTION.** What is the contribution of **observational systematic effects** to the overall error budget in Euclid?
  - Which systematics are more relevant?
  - How much can we tolerate the systematics to affect the cosmological observables?
- **METHODOLOGY.** Use **mock galaxy catalogues** and implement realistic errors.
- **GOAL.** Provide **requirements** on the amount of observational systematics that we can tolerate.

# Simulation tool

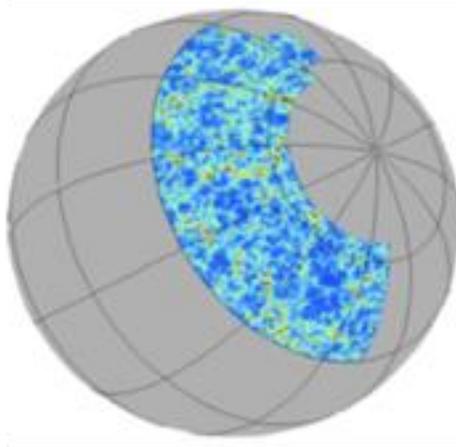
- The COLA method (Tassev et al 2013) provides high **speed-ups** (100-1000x) in numerical cosmological simulations thanks to using a cheaper and faster numerical integration.
- Parallel COLA (Koda et al. 2015).
- ICE-COLA
  - Izard et al. 2016: accuracy of the dark matter field and the halo catalogs.
  - Izard et al 2017: modeling weak lensing and light cones with ICE-COLA.
  - Talk tomorrow in the first morning session.
  - Outputs: halo catalog and weak lensing maps (both in the light cone geometry)
- High speed-up => Many realizations => Covariance matrices

# Mock catalog generator

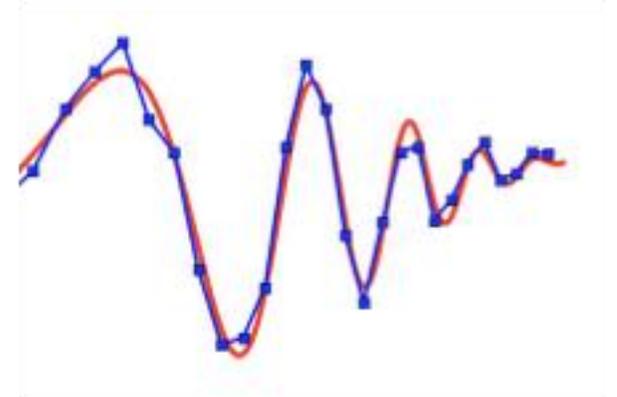
N-body simulation



Realistic catalogues



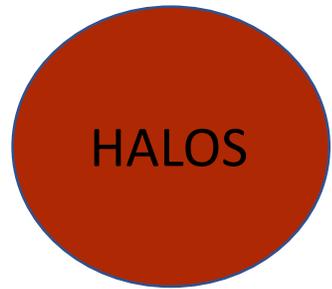
Modelling observables



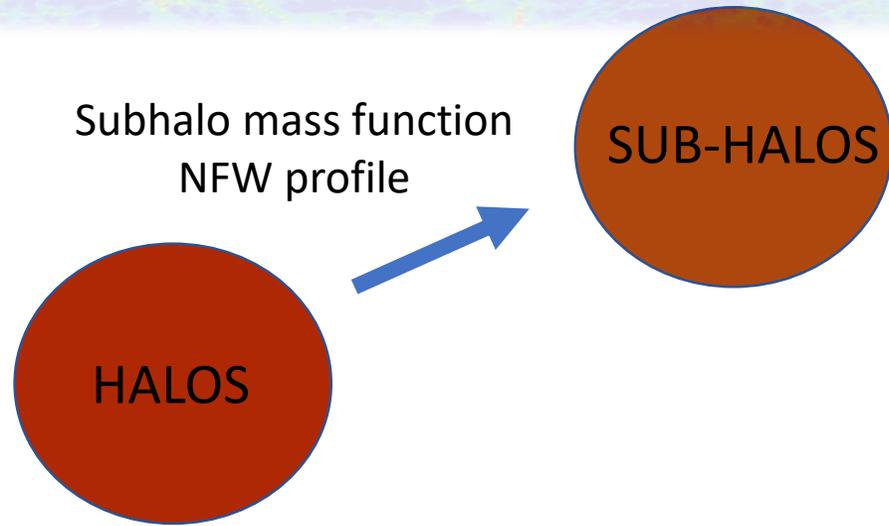
Add galaxy properties

Observational systematics  
Selection function

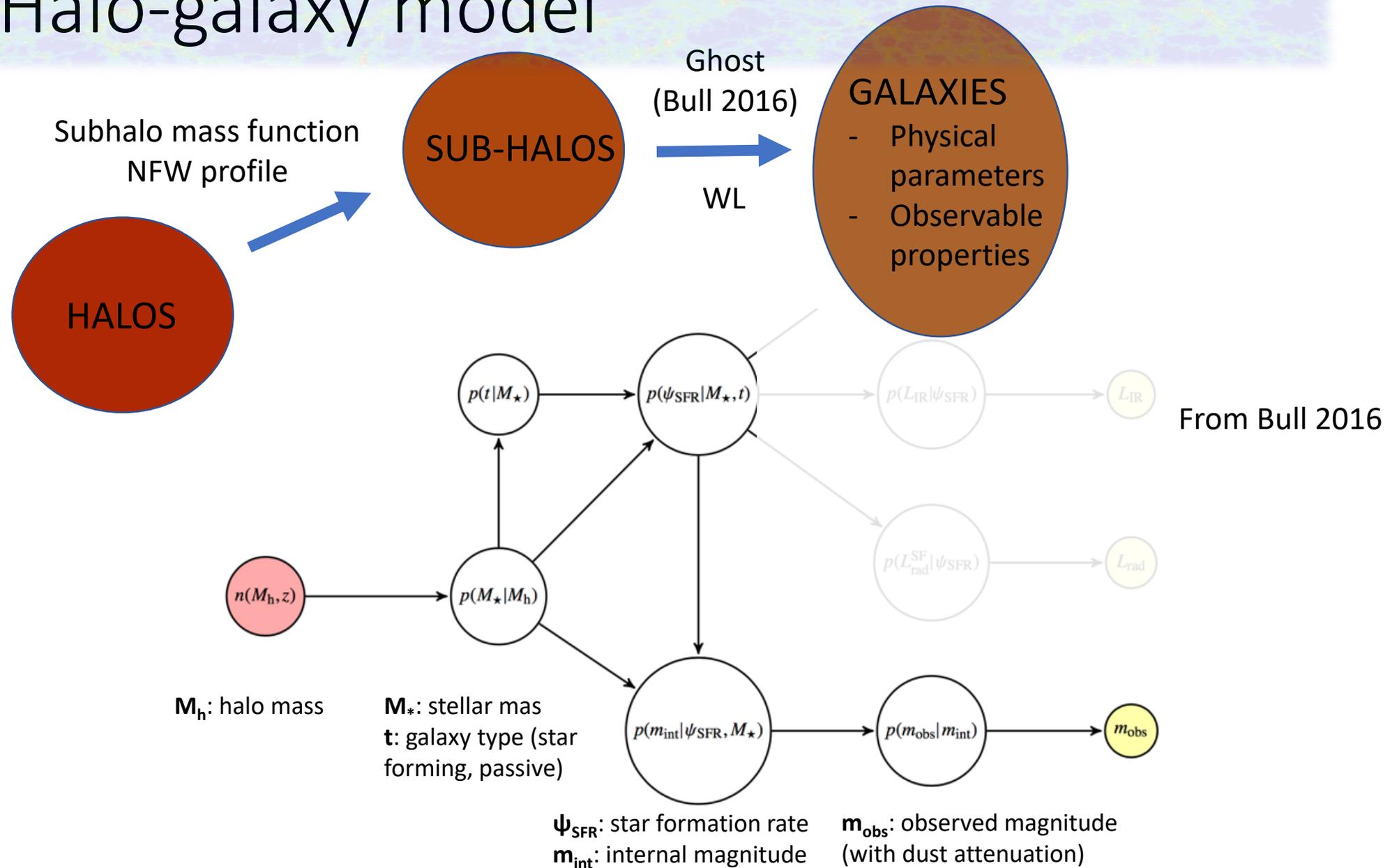
# Halo-galaxy model



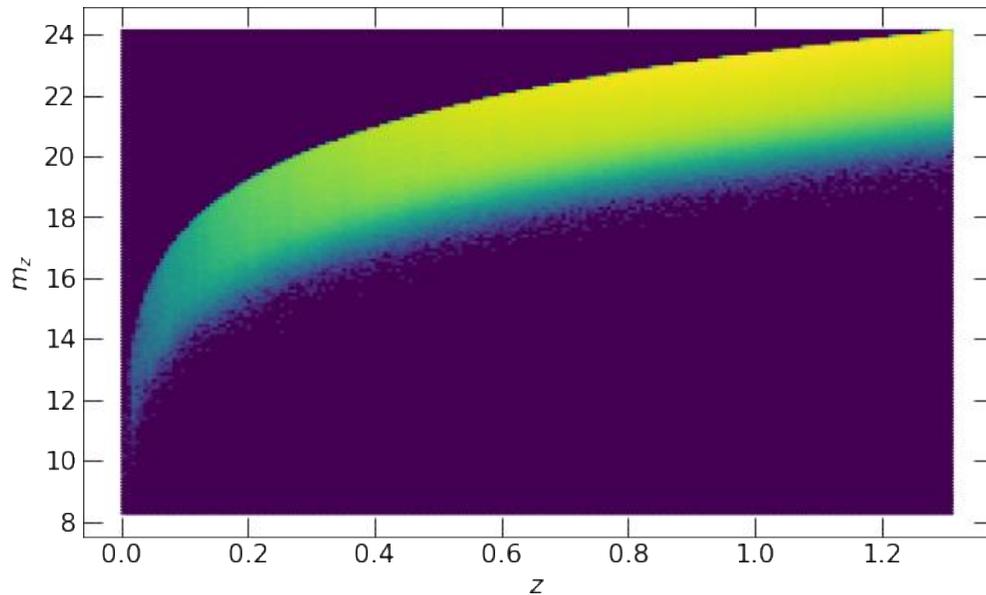
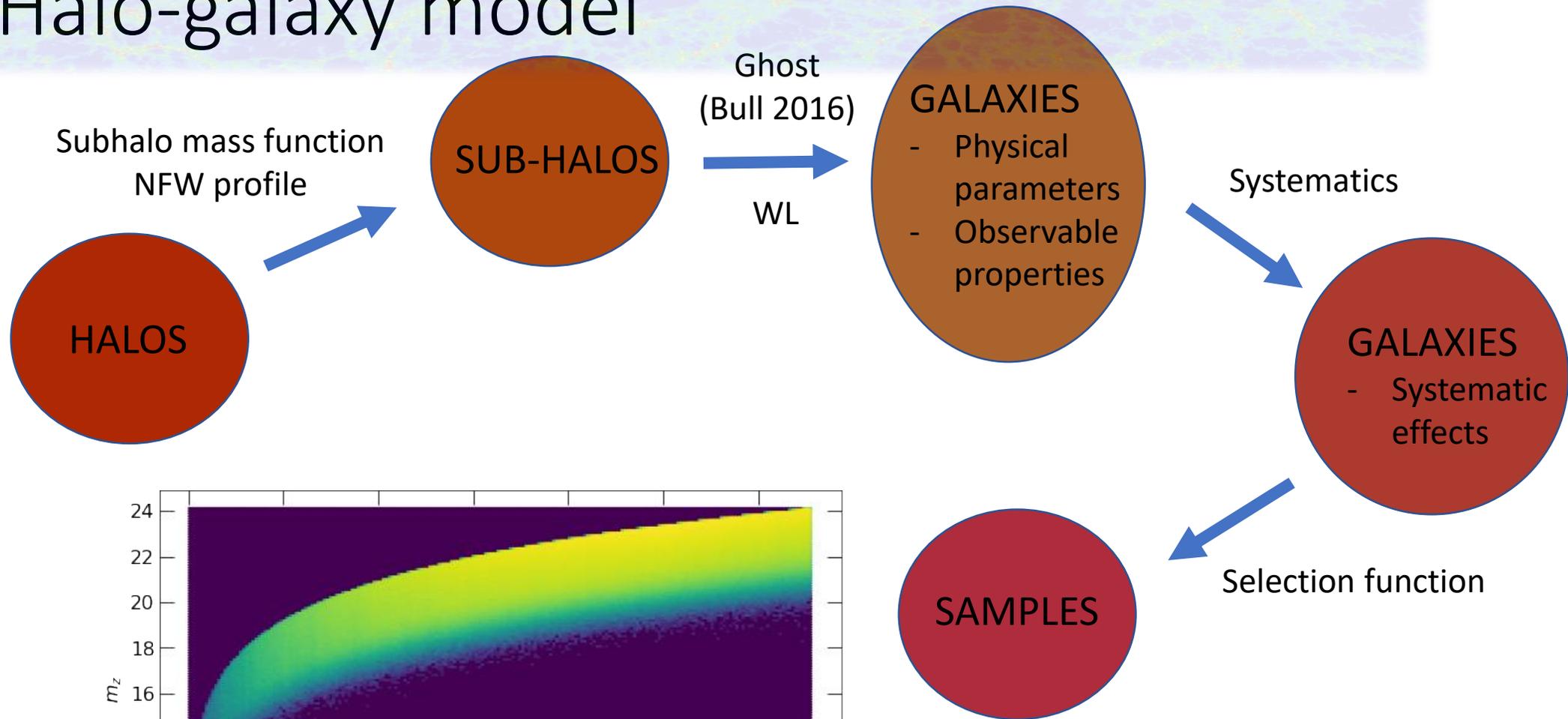
# Halo-galaxy model



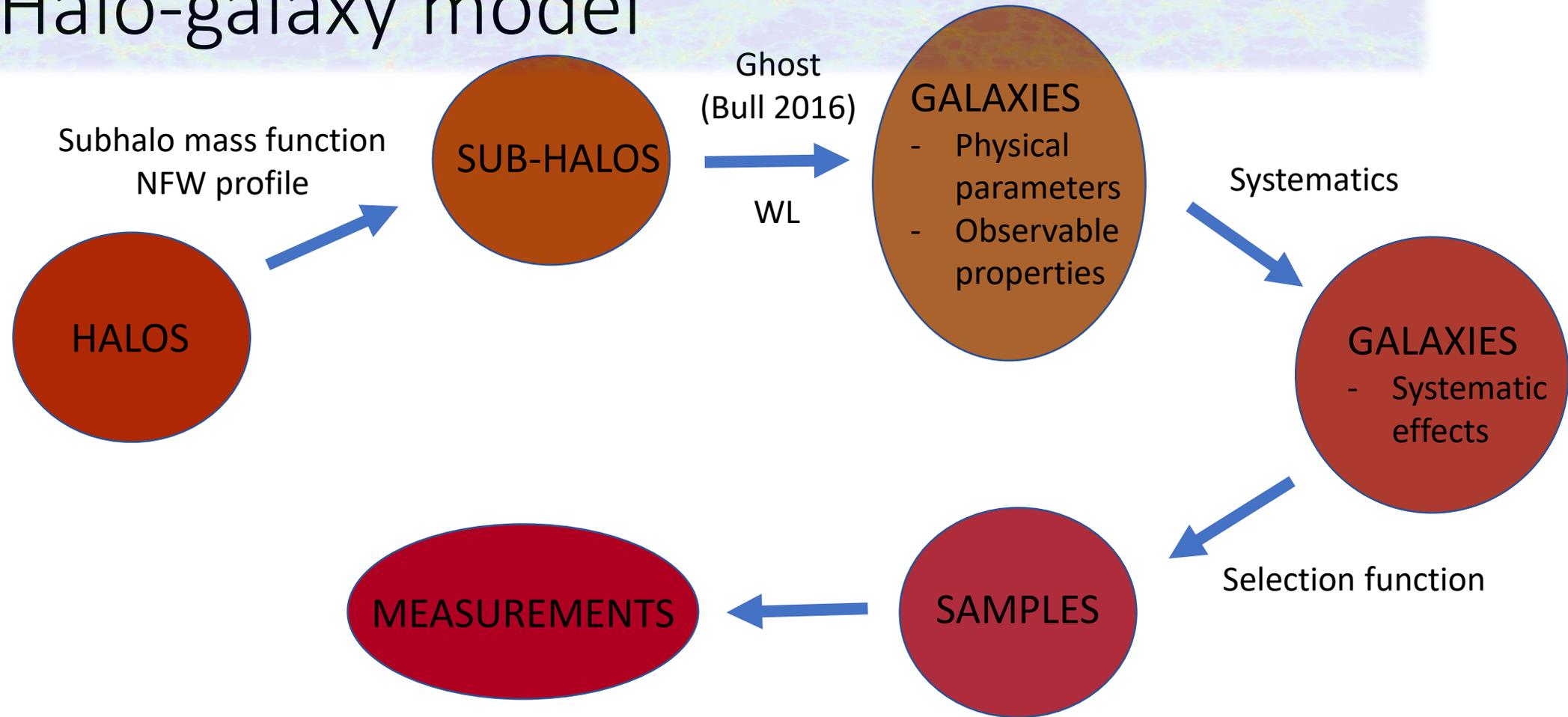
# Halo-galaxy model



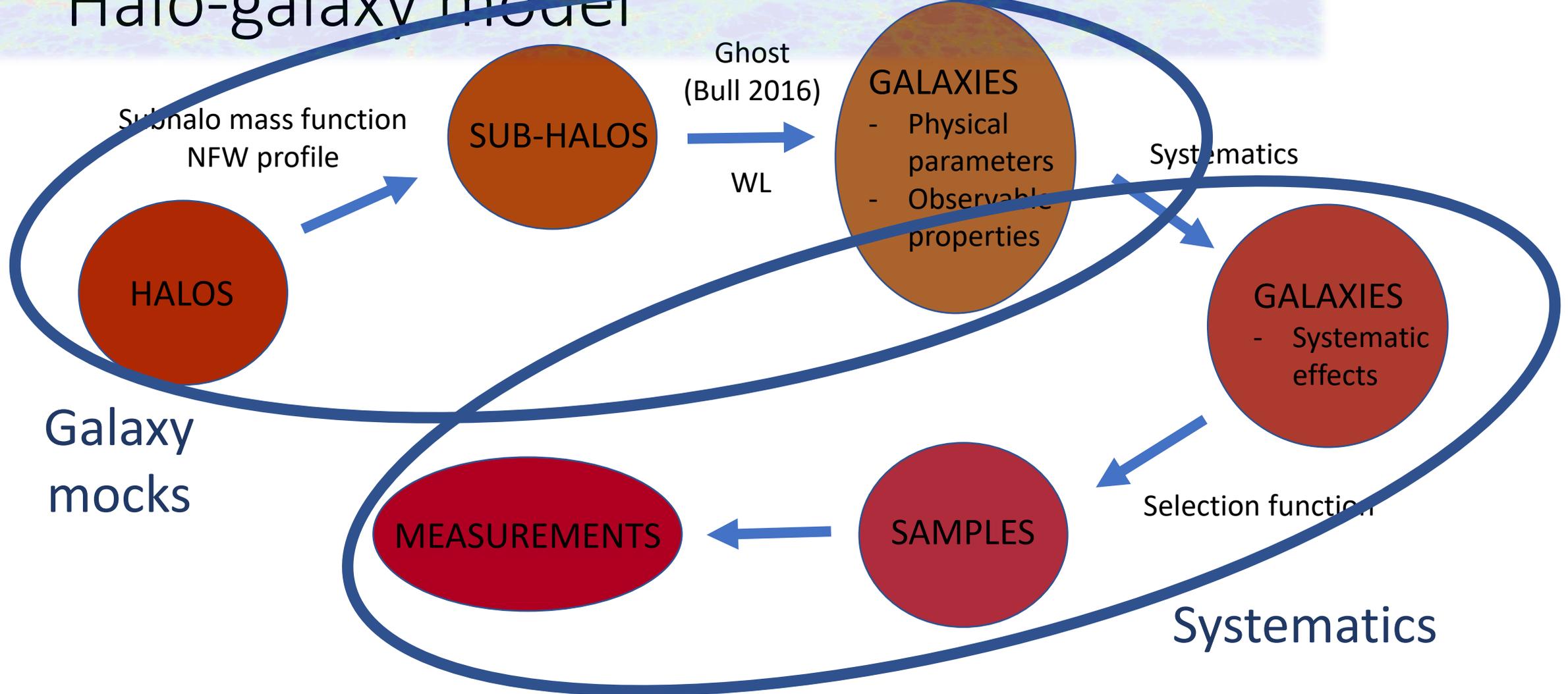
# Halo-galaxy model



# Halo-galaxy model



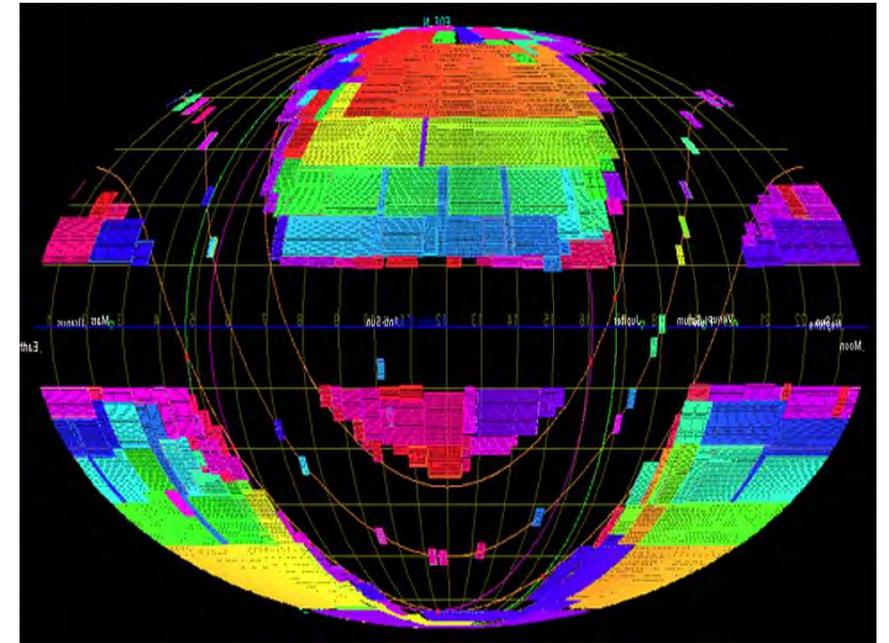
# Halo-galaxy model



# Modeling systematic effects

- Observational errors on the galaxy properties
  - Shape uncertainties
  - Photometric redshift errors
  - Survey selection function
- These may vary across the sky and in a coherent way, affecting both the signal and the covariance matrix
- We model the conditional probability

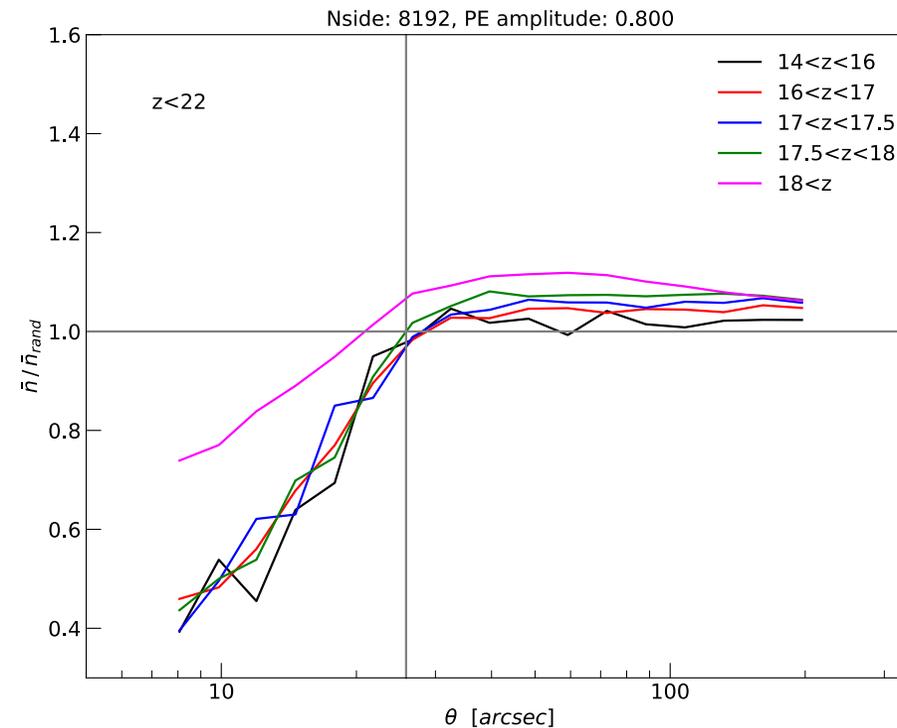
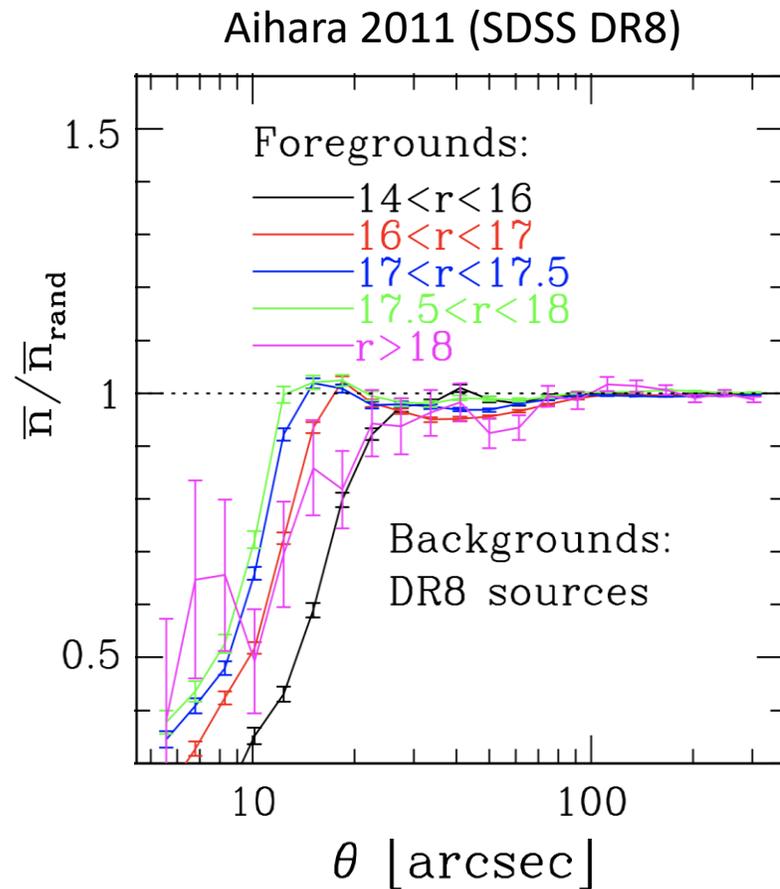
$$P(\gamma_{obs}, z_{obs}, detection | \gamma_{true}, z_{true}, \theta)$$



Euclid footprint (Euclid Consortium)

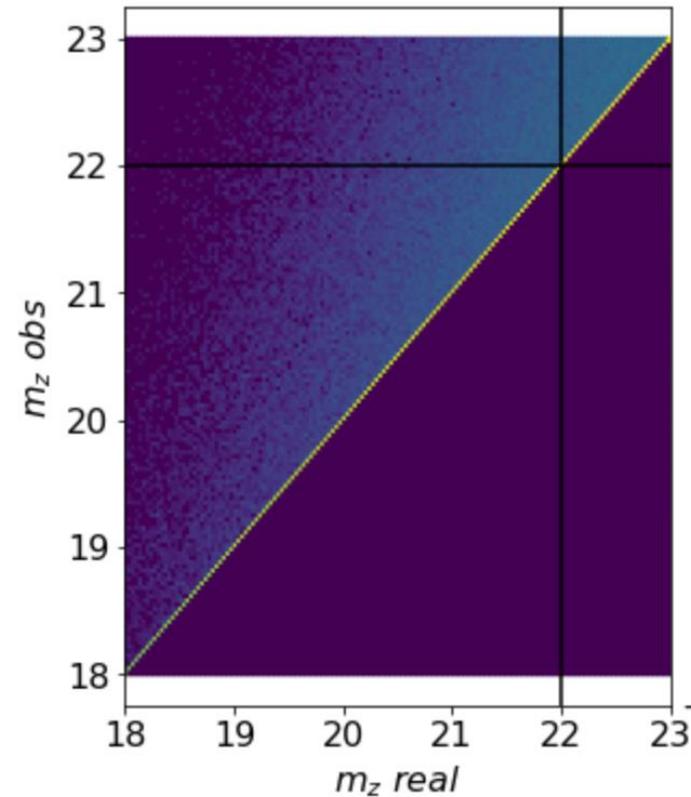
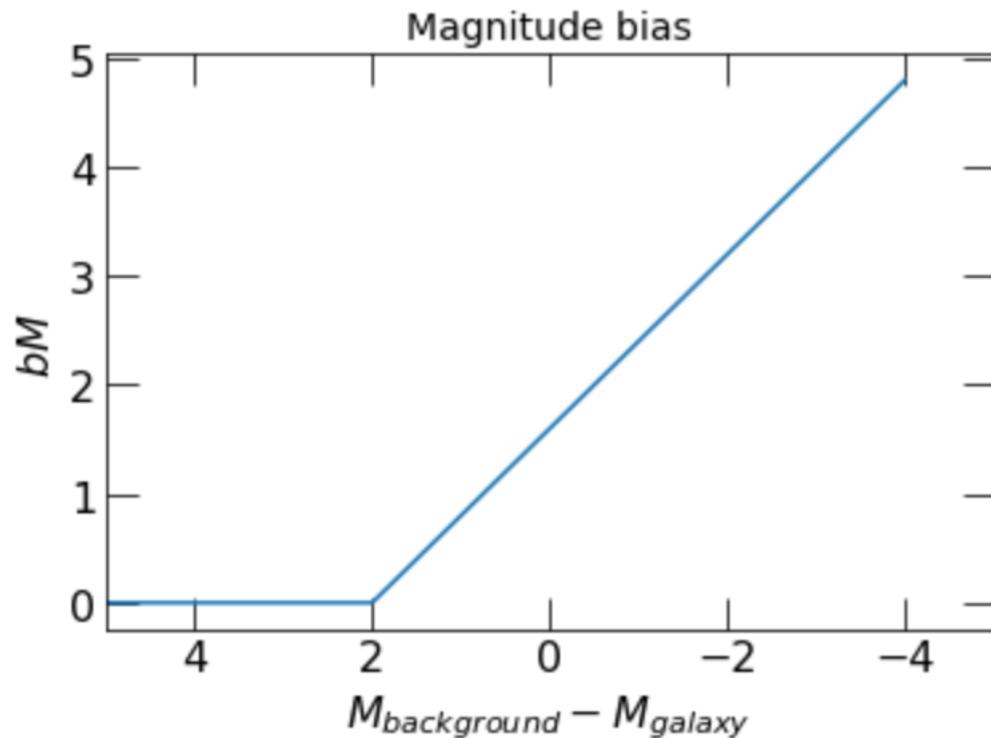
# Proximity effect

- The light coming from nearby objects affects the determination of the flux of a galaxy

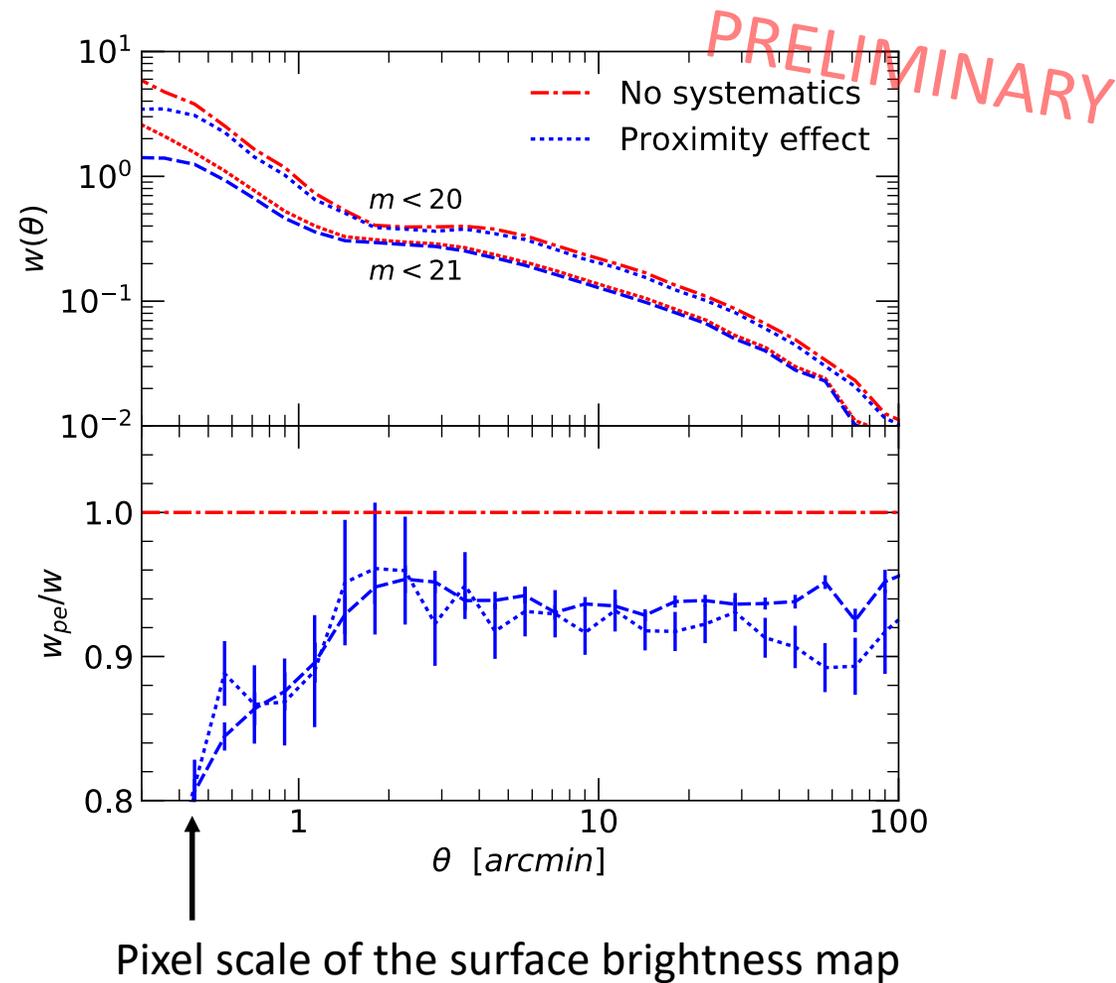


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# Proximity effect



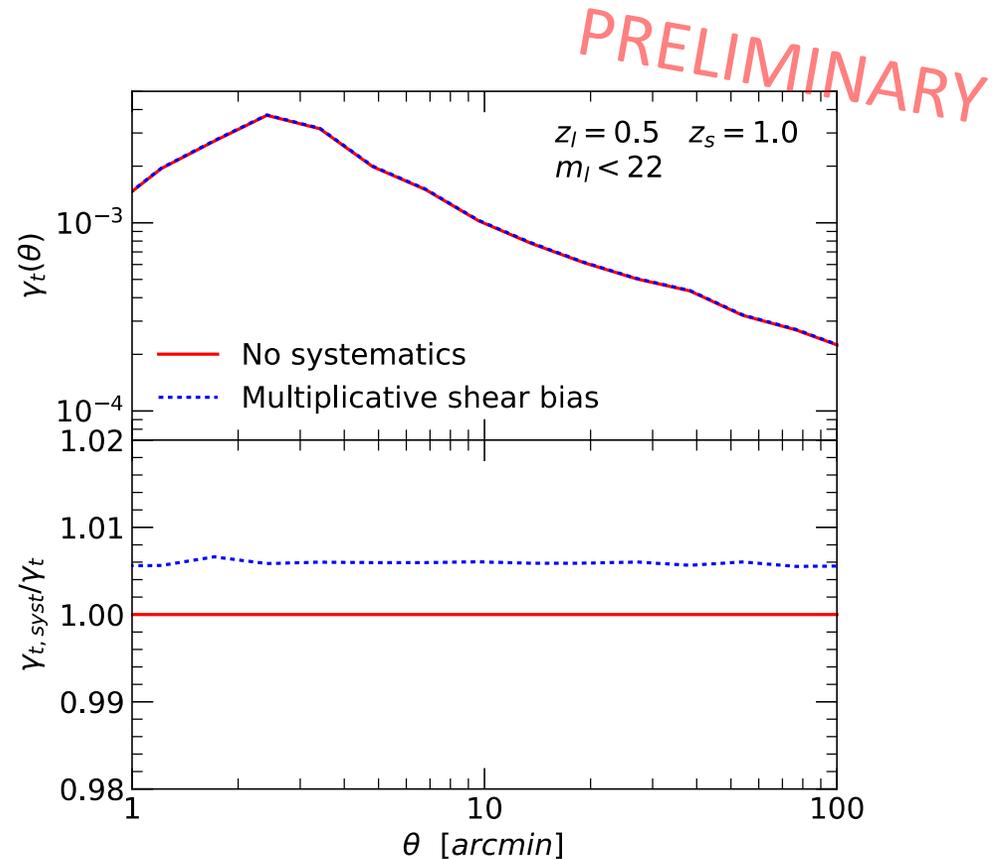
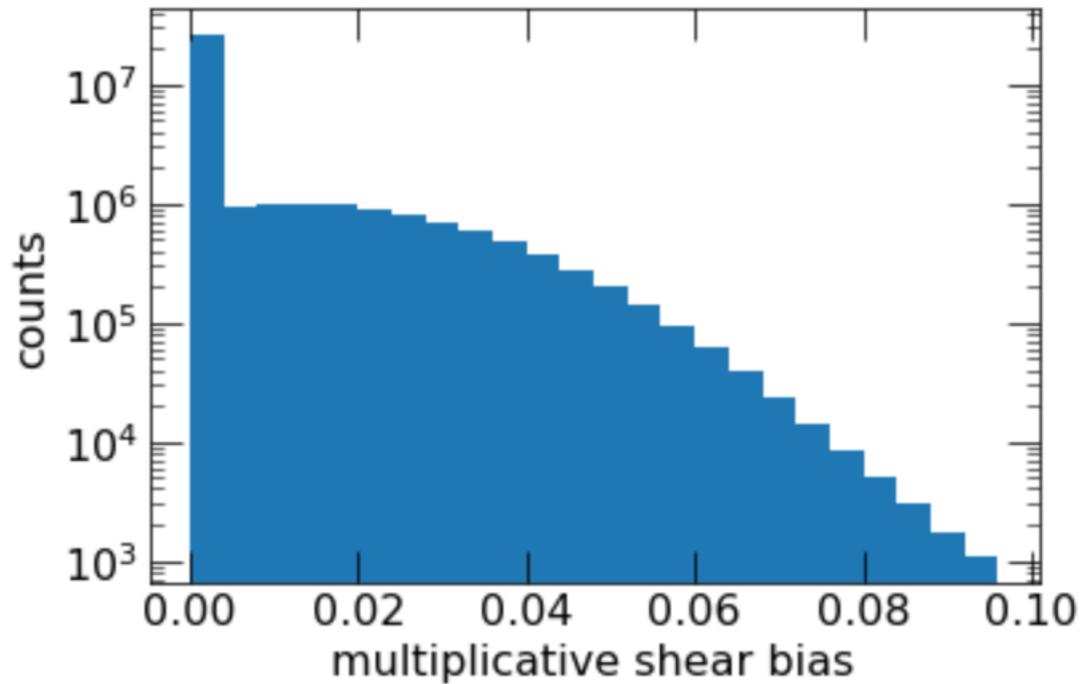
# Summary

- We developed a **fast and efficient pipeline** to generate mock galaxy catalogues with systematics.
- We model **observational systematics** that are coupled with the **density field**.
- With this tool it is straightforward to **propagate the systematics to observables**.

Some more slides...

# Tangential shear

- We model the multiplicative shear bias that depends on the amount of background light



# What is next

- Stellar Population Synthesis codes to connect physical and observed properties of galaxies
- Implement other systematics (blending, photo-z, shear biases...)
- Model galaxy sizes, shapes
- Determine the impact of systematics on covariance matrices