The inhomogeneous distribution of galaxy bias and redshift distribution

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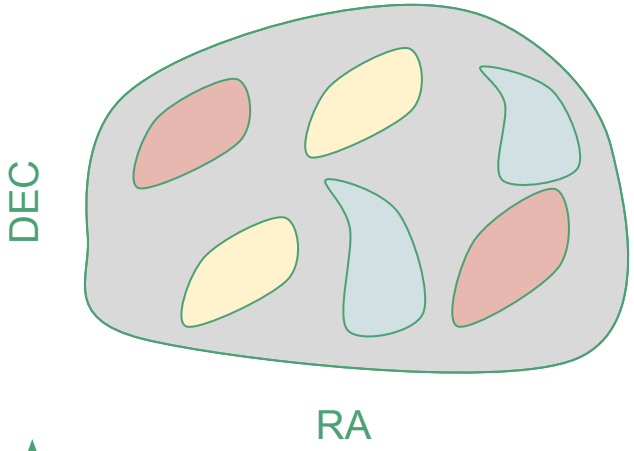
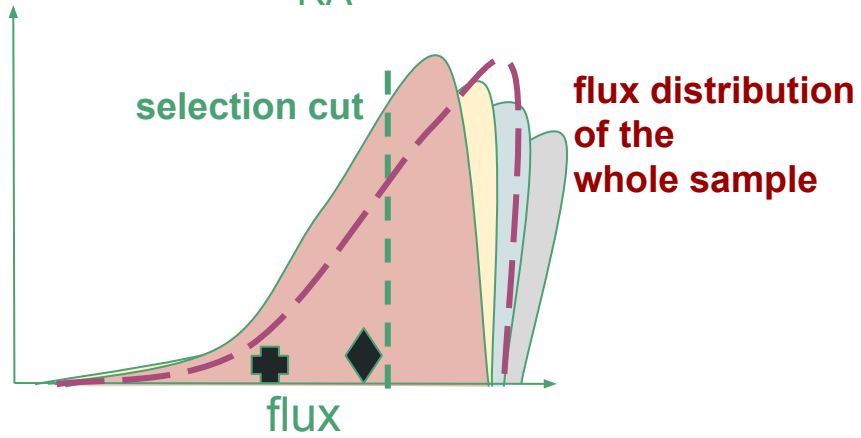
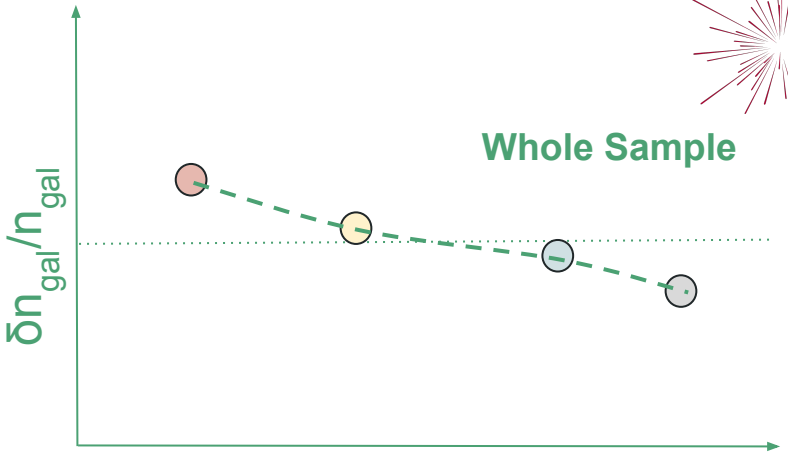
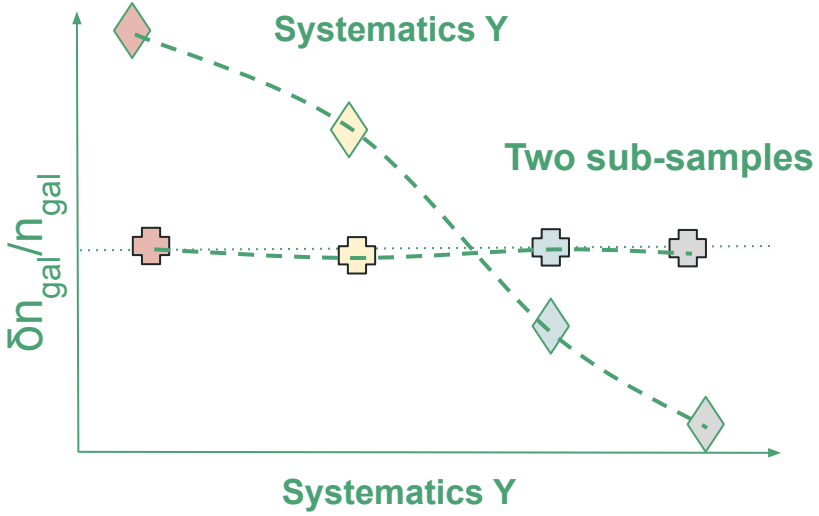
Imaging systematics







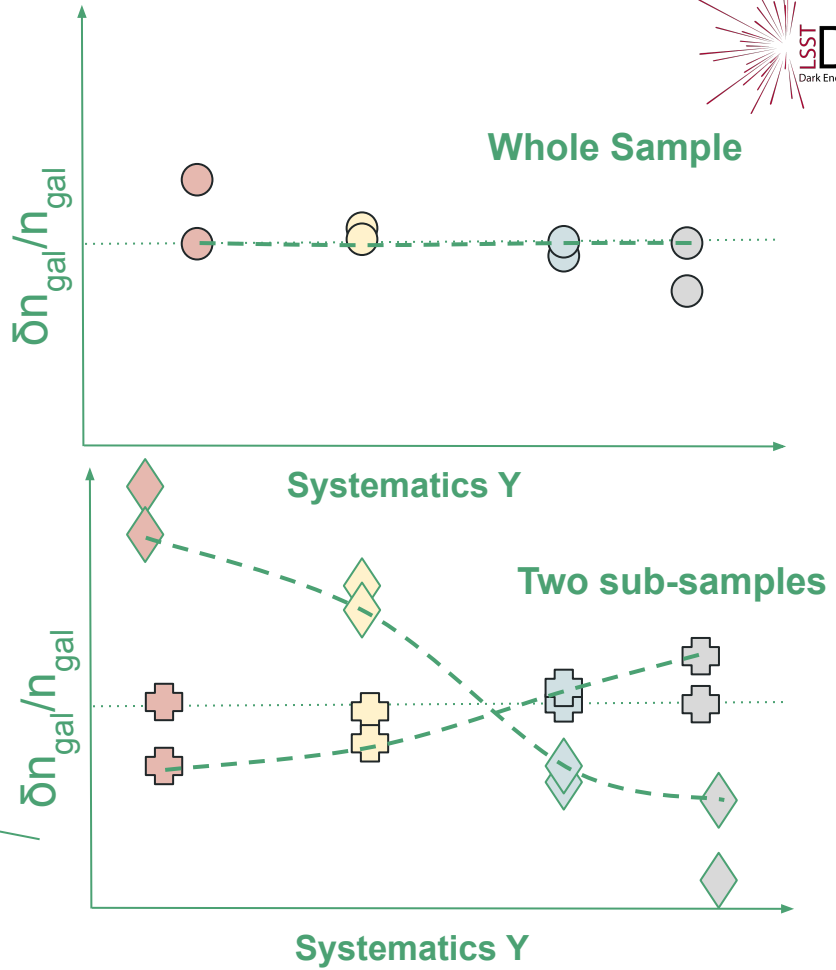


Imaging systematics weight

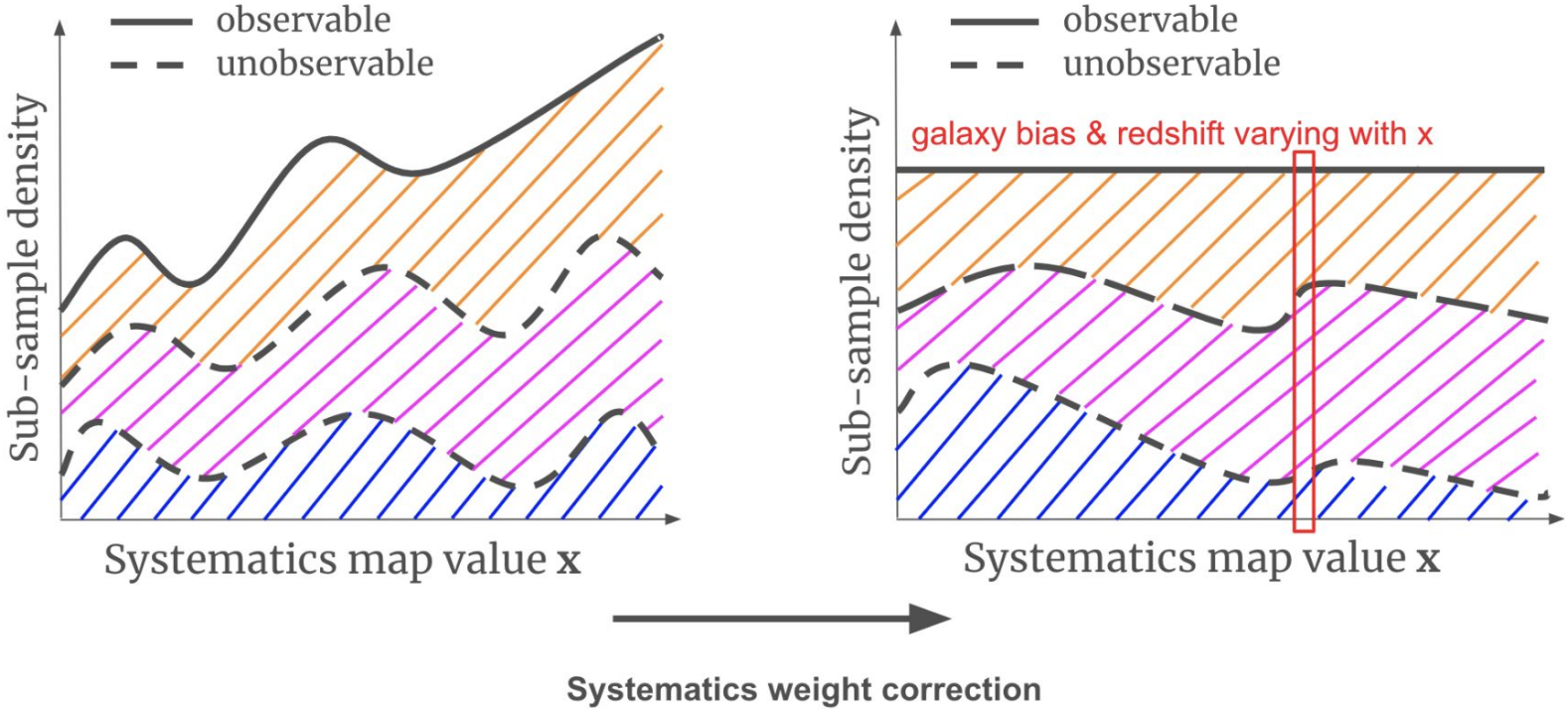
$$w_{sys} = 1/(1 + \delta n_{gal}/n_{gal})$$

Correct the sample as a whole

Trend still exist in sub-samples



The inhomogeneous distribution of galaxy bias and redshift distribution



Correlation function

k: different sub-samples

The observed galaxy density field: $\rho_{obs} = \Sigma_k \rho_{truth,Mk}(1 + f_k)$, $\rho_{obs} = (1+\delta_{obs})$

$$< \delta_{\rm obs}, \delta_{\rm obs} >=< \delta_{\rm truth}, \delta_{\rm truth} >$$

$$+ \sum_{kk\prime} h_k h_{k\prime} < f_k, f_{k\prime} > +$$

$$2 \sum_{k} h_k < f_k \delta_{{\rm truth},\mathcal{M}_k}, \delta_{\rm truth} > +$$

$$+ 2 \sum_{kk\prime} h_k h_{k\prime} < f_k \delta_{{\rm truth},\mathcal{M}_k}, f_{k\prime} >$$

$$+ \sum_{kk\prime} h_k h_{k\prime} < \delta_{{\rm truth},\mathcal{M}_k} f_k, \delta_{{\rm truth},\mathcal{M}_{k\prime}} f_{k\prime} >$$

detectable? YES!

$$f = \sum h_k f_k$$

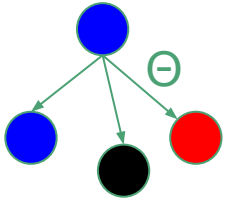
$$< \delta_{\rm obs}, f >= \sum_{kk\prime} h_k h_k < f_k, f_{k\prime} >$$

detectable?

NO!

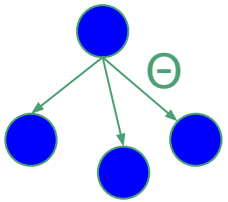
Galaxy Pair Count Re-ordering

homogeneous:



$$\sum_{kk\prime} D_k D_{k\prime}(\theta)\big|_{kk\prime \text{ pair in } (\theta,\theta+\Delta\theta)}$$

inhomogeneous:



$$w_{obs} = \sum_{ij}^{N} \frac{R_i R_j}{R_{tot} R_{tot}} \frac{D_i D_j - D_i R_j - R_i D_j + R_i R_j}{R_i R_j}$$

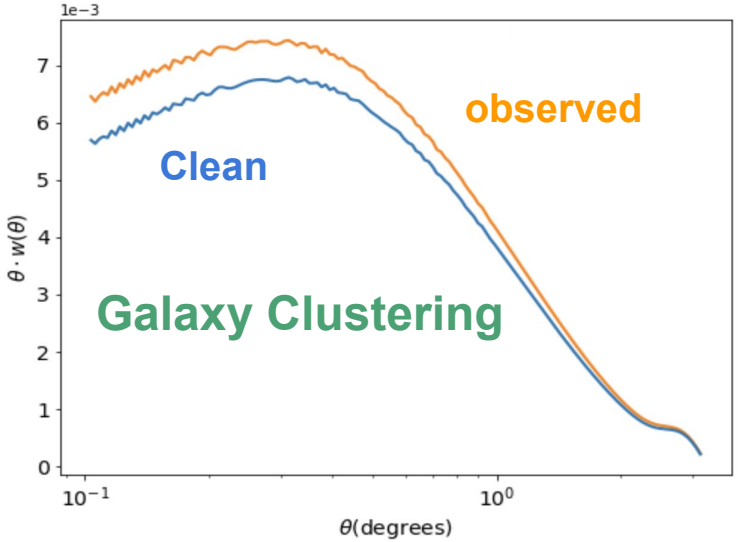
$$\mathrm{Win}_{ij} = \frac{R_i R_j}{R_{tot} R_{tot}}$$

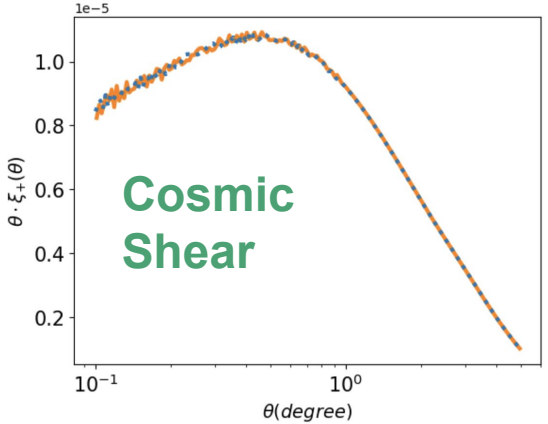
Angular correlation function w(Θ) with b(z, **sys**), n(z, **sys**)

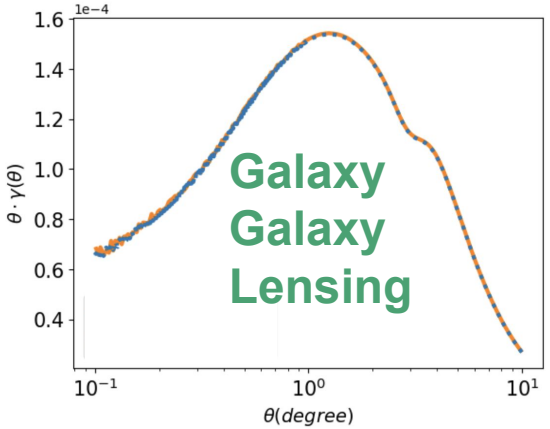
Impact on Galaxy Clustering, Galaxy-Galaxy Lensing, Cosmic Shear

Using an **unrealistic** toy model, we found:

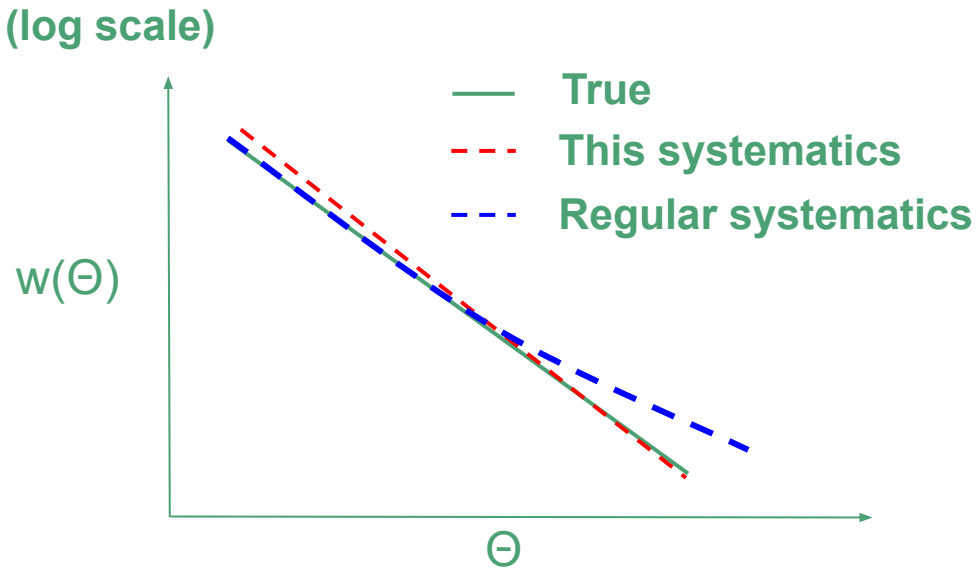
- Large impact on Galaxy Clustering
- Negligible impact on GGL and CS



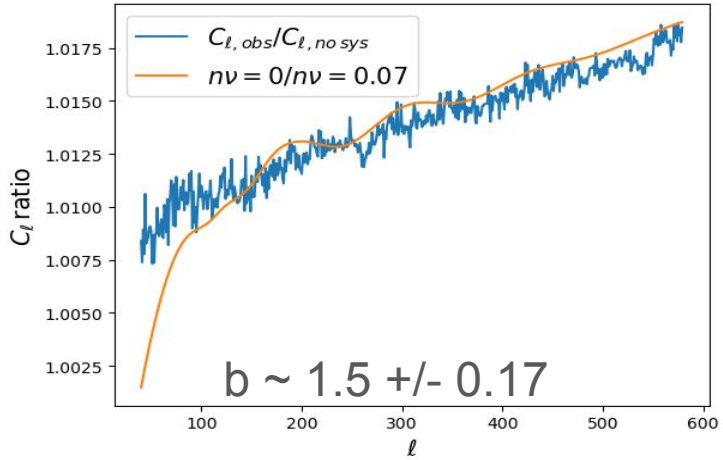




Impact on Cosmological Analysis



- Impacting correlation functions in an unnoticed way
- Impacting neutrino measurement
- More!



$< \delta_{\mathrm{truth},\mathcal{M}_k} f_k, \delta_{\mathrm{truth},\mathcal{M}_{k'}} f_{k'} >$ **vs**

Multiplicative

Additive $< f_k, f_{k'} >$

Mitigation of b&z inhomogeneity

- Measure correlation function for **real** galaxies:
  - ξ_R: Correlation function without sub-sample correction
  - ξ'_R: Correlation function with sub-sample correction

- Produce **synthetic** galaxies through forward modeling, estimate the redshift and galaxy bias variation
  - ξ_s: Similar to ξ_R
  - ξ'_s: Similar to ξ'_R
  - ξ''_s: The clean correlation function
- Validate that: $\xi_R - \xi'_R \sim \xi_s - \xi'_s$
- Impact of b&z inhomogeneity is:
  - $\xi_s - \xi''_s$; Or $\xi'_s - \xi''_s$ if we apply sub-sample weight to real galaxies
  - Make sure that the difference is small enough!