Stellar systematics in photometric galaxy surveys
& applications to WISExSuperCOSMOS catalog

Henrique S. Xavier
IAG – USP
hsxavier@if.usp.br

And collaborators: Marcus V. Duarte, Andrés Balaguera-Antolínez and Maciej Bilicki

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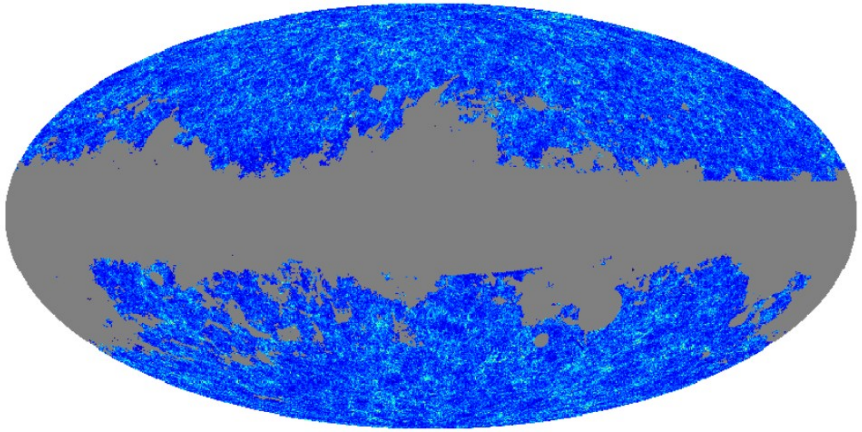
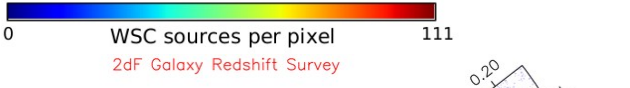
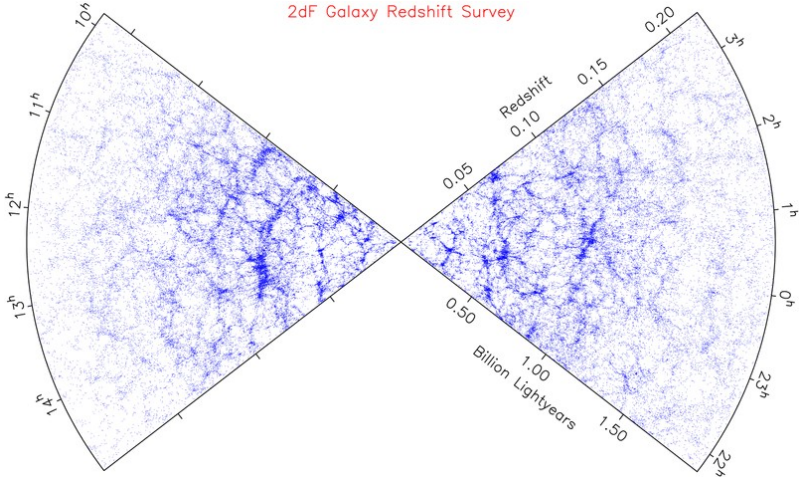
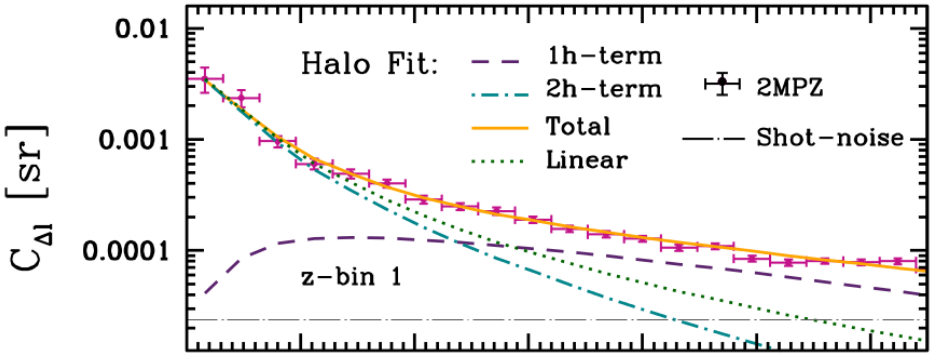
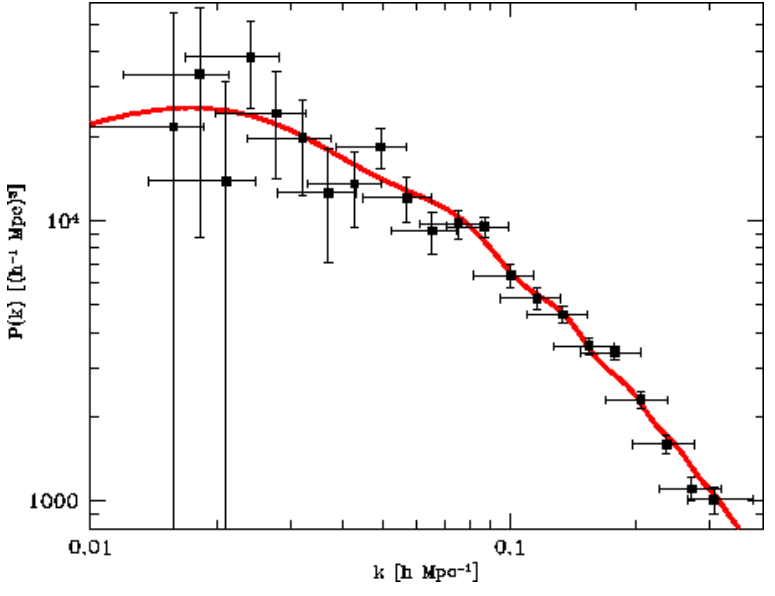
Measuring clustering with galaxy surveys



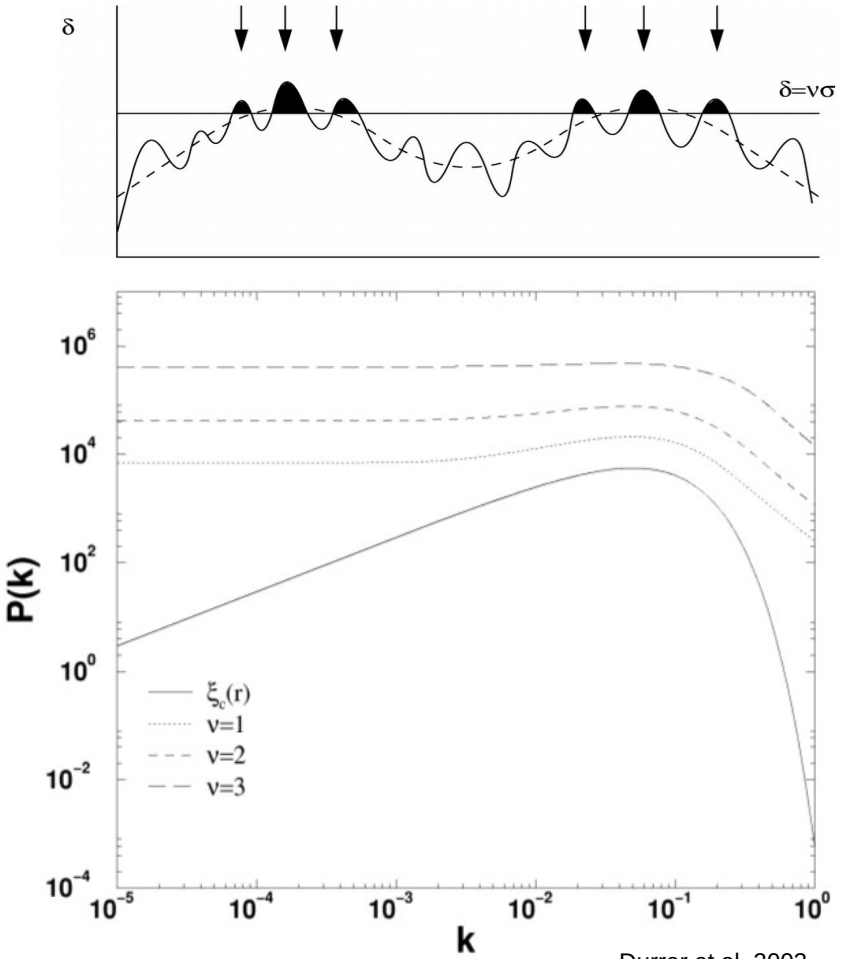




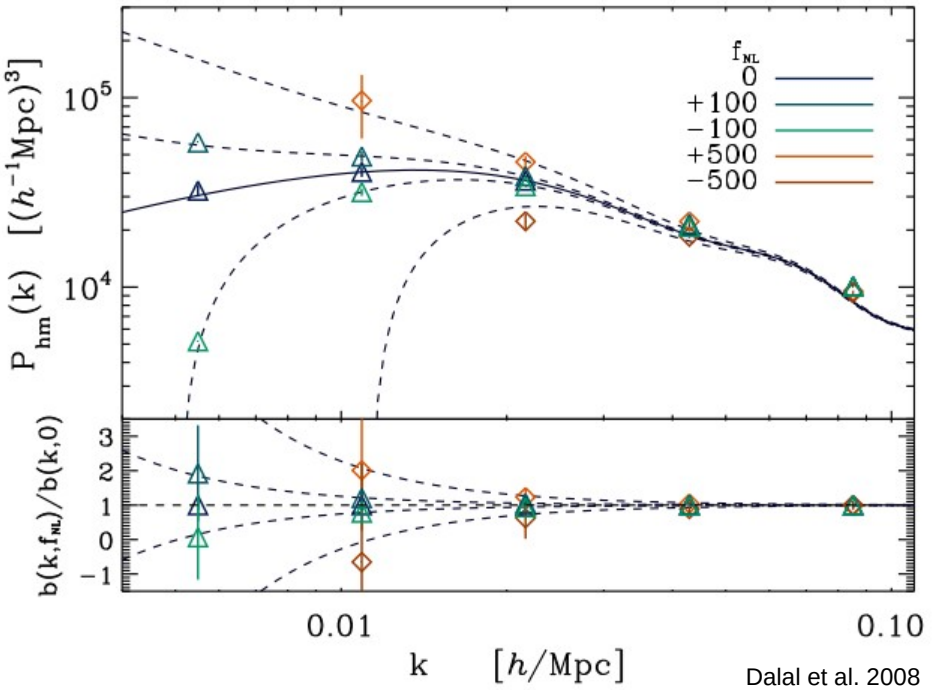




There is information on the largest scales



Durrer et al. 2003



Dalal et al. 2008

Galaxy LSS surveys suffer from systematics:
extinction, seeing & stellar density

Spec surveys suffer from obscuration

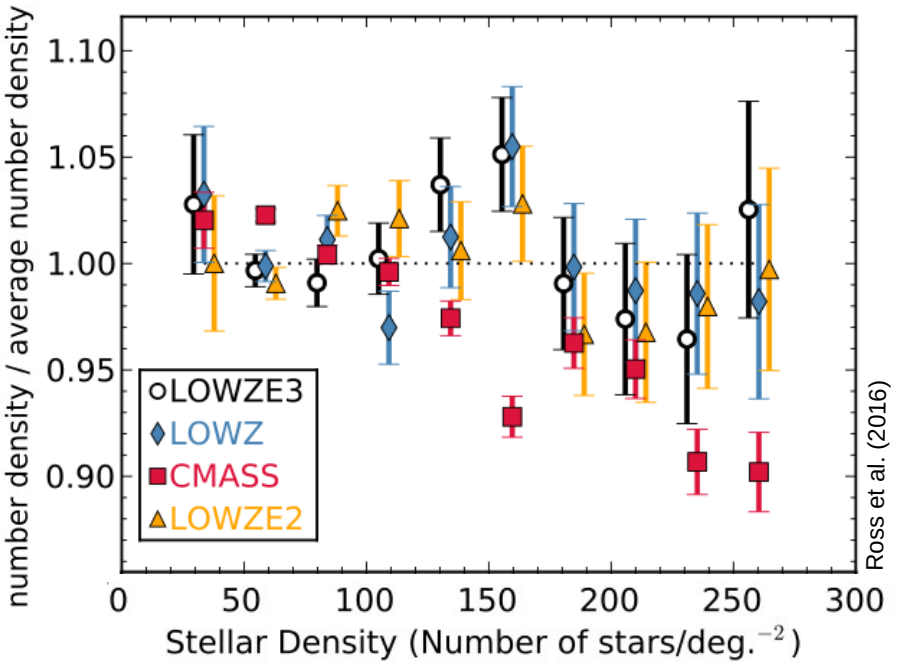
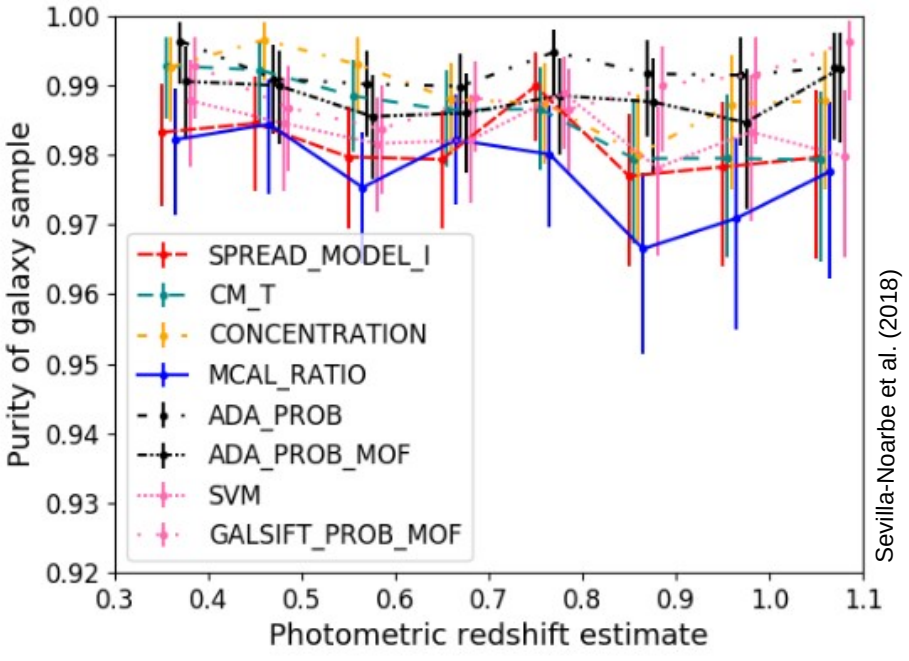
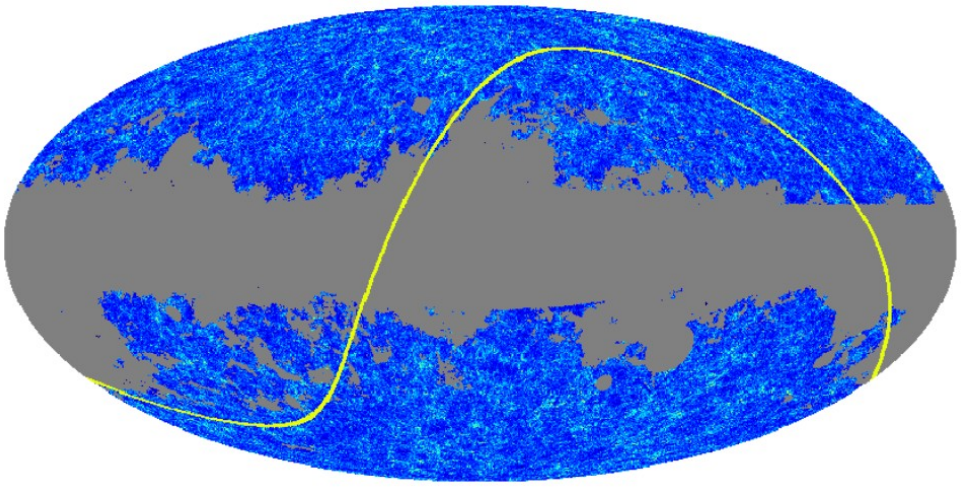
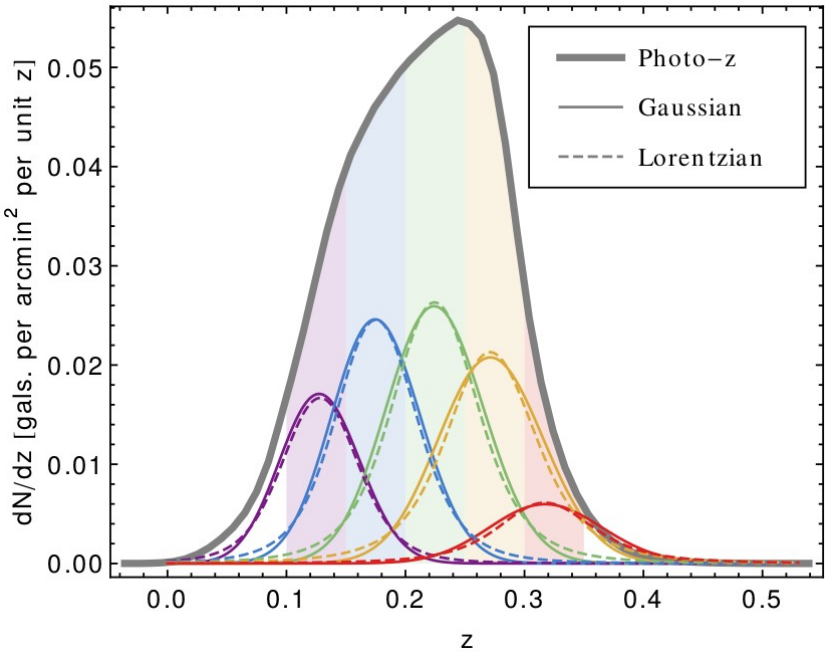


Photo surveys suffer from contamination… **also!**



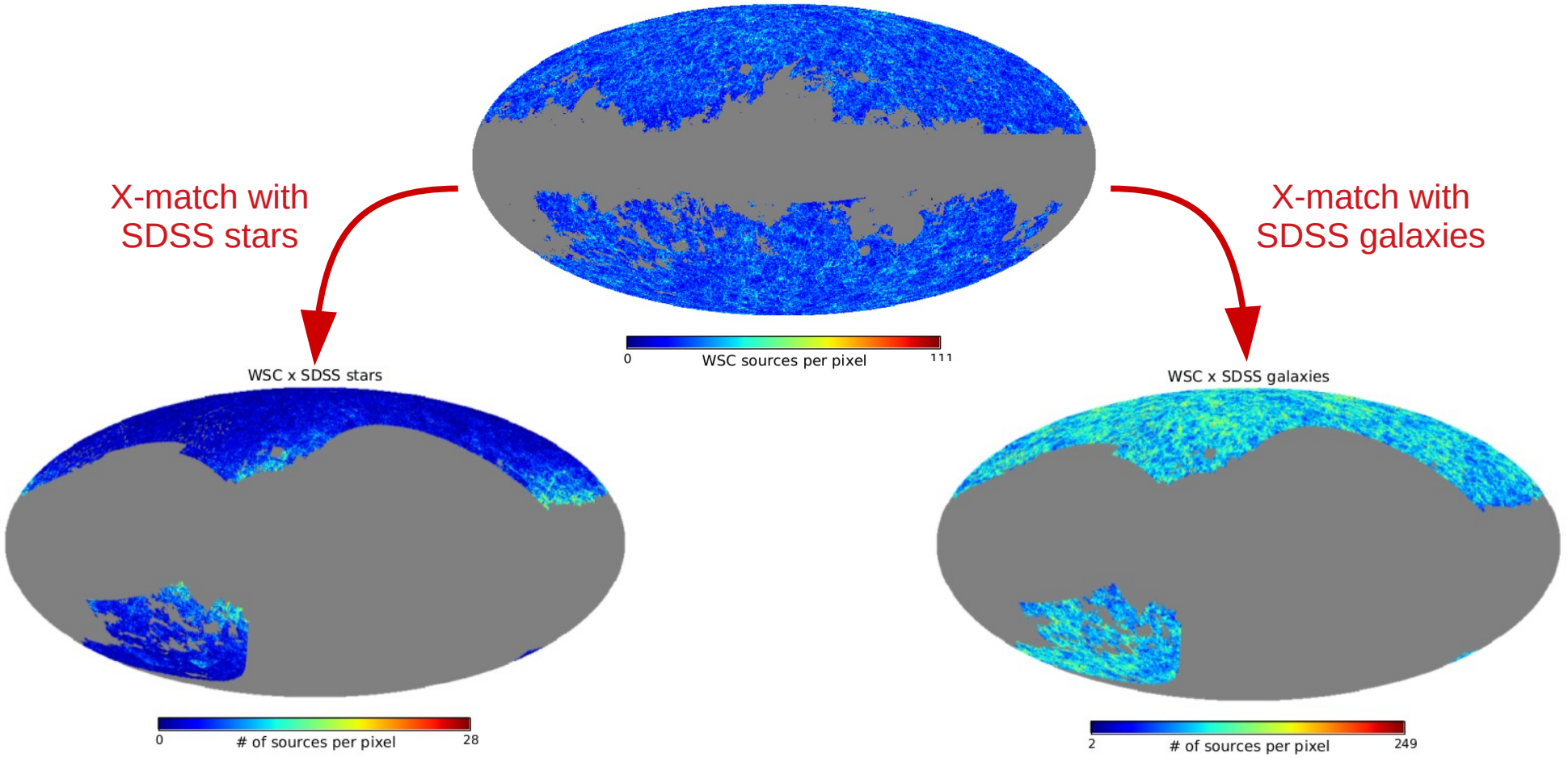
Demonstration with WISExSuperCOSMOS





3−6% contamination

Demonstration with WISExSuperCOSMOS



Modelling stellar obscuration and contamination:

$$n_{\rm obs}(\boldsymbol{\theta}) = [1 - \alpha S(\boldsymbol{\theta})]\bar{n}[1 + \delta(\boldsymbol{\theta})] + \beta S(\boldsymbol{\theta})$$

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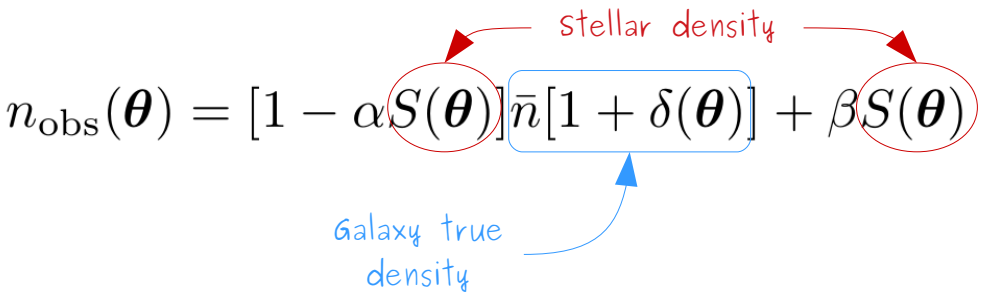

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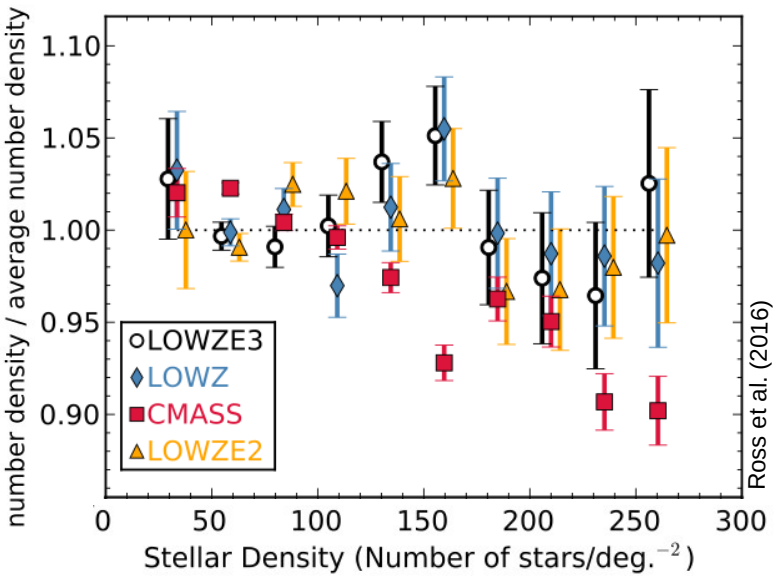
stellar density

Galaxy true density



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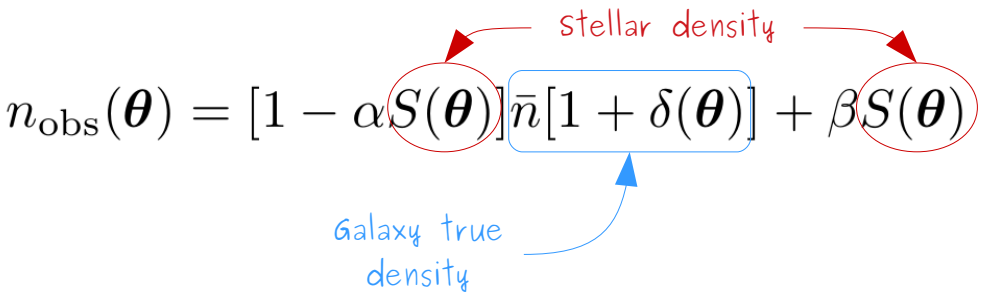

Example:

$$\alpha\bar{n} = \beta$$

$$\delta n_{\rm obs}(\boldsymbol{\theta}) = \bar{n}[1 - \alpha S(\boldsymbol{\theta})]\delta(\boldsymbol{\theta})$$

$$\int \delta n_{\rm obs}(\boldsymbol{\theta})\delta S(\boldsymbol{\theta}) \mathrm{d}^2\boldsymbol{\theta} = \int \bar{n}[1 - \alpha S(\boldsymbol{\theta})]\delta(\boldsymbol{\theta})\delta S(\boldsymbol{\theta}) \mathrm{d}^2\boldsymbol{\theta} = 0$$

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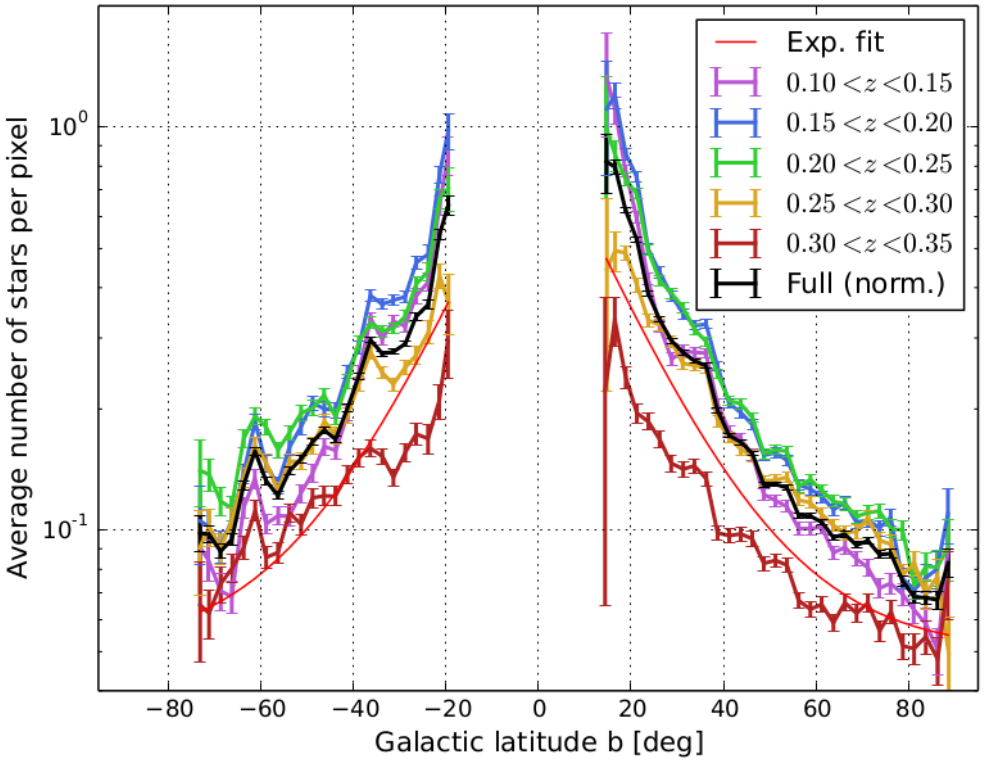
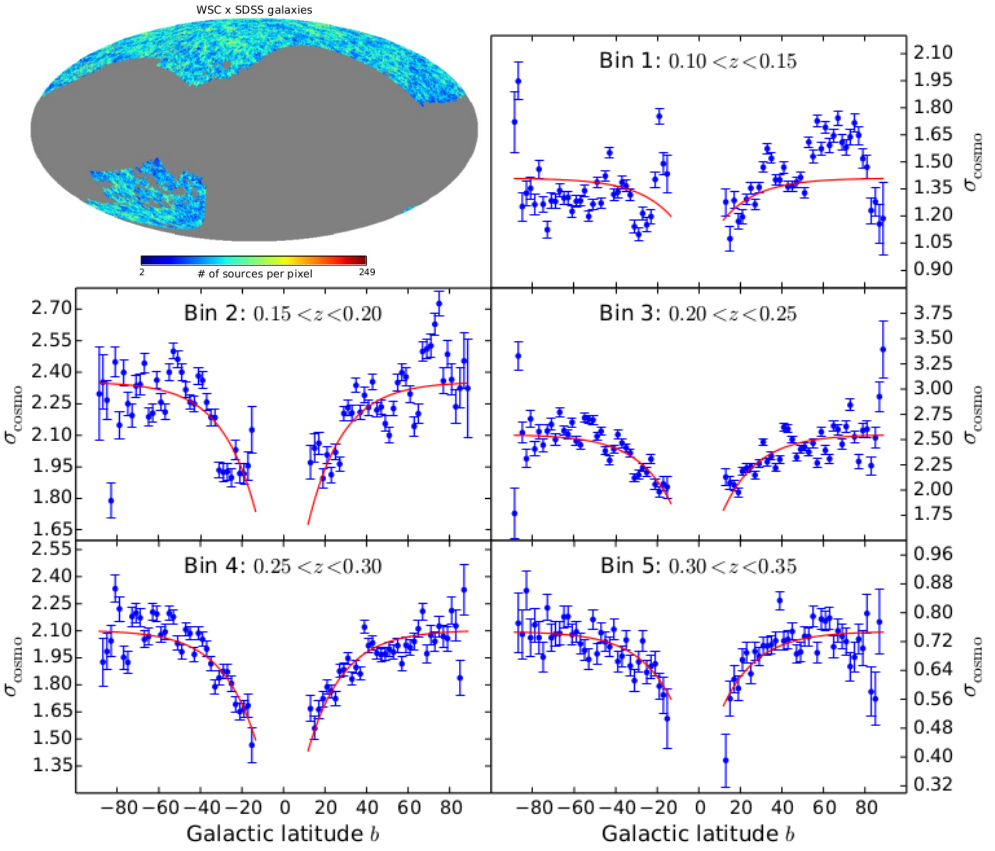
Usurper contamination

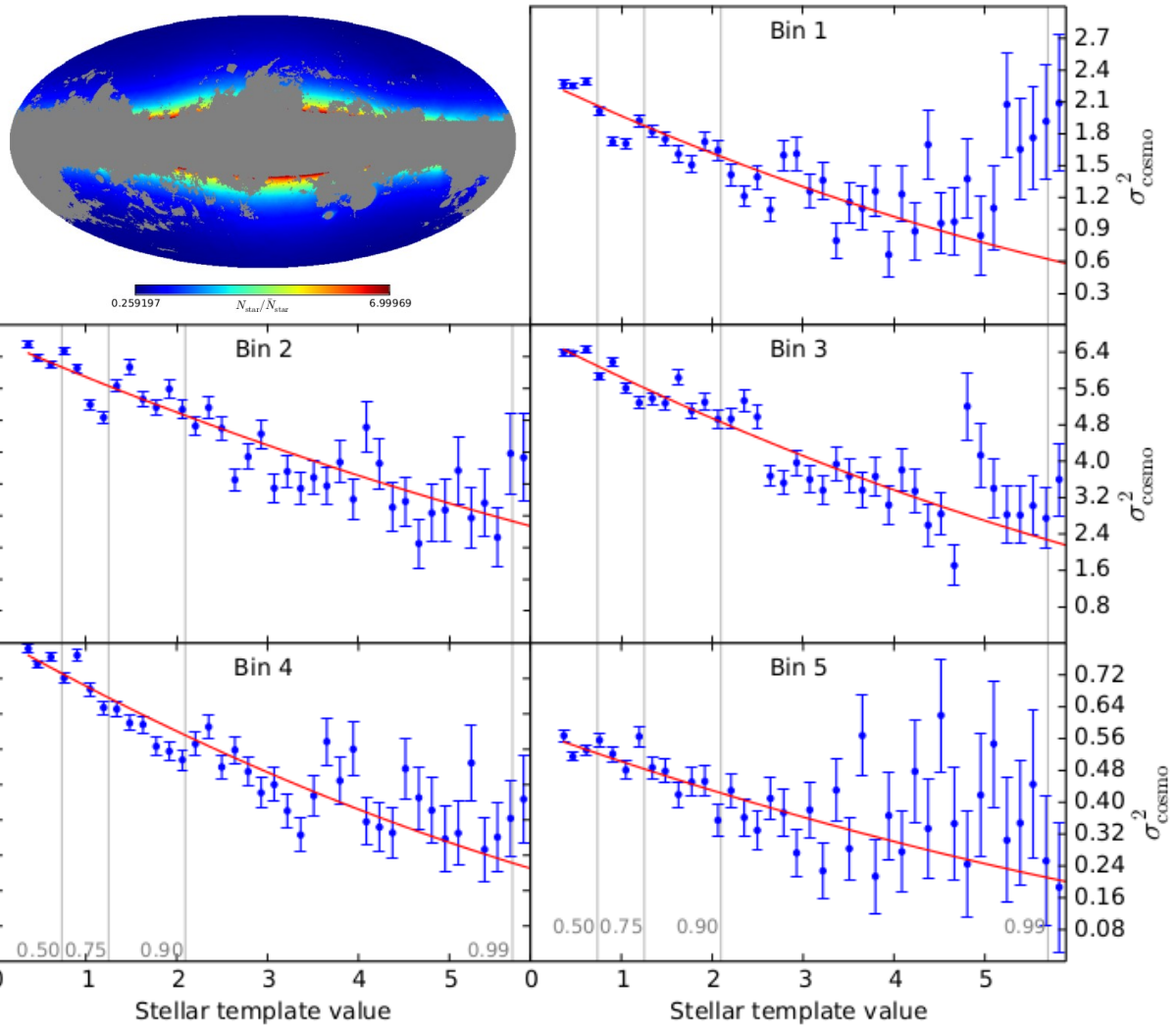
Using exp. model based on SDSS





$$\delta n_{\rm obs}(\boldsymbol{\theta}) = \bar{n}[1-\alpha S(\boldsymbol{\theta})]\delta(\boldsymbol{\theta}) \longrightarrow \sigma^2_{\rm cosmo}(S) \equiv \sigma^2_{\rm obs}(S) - \bar{n}_{\rm obs}(S) = [1-\alpha S]^2\sigma^2_{\rm gal}$$

Using Gaia stellar template



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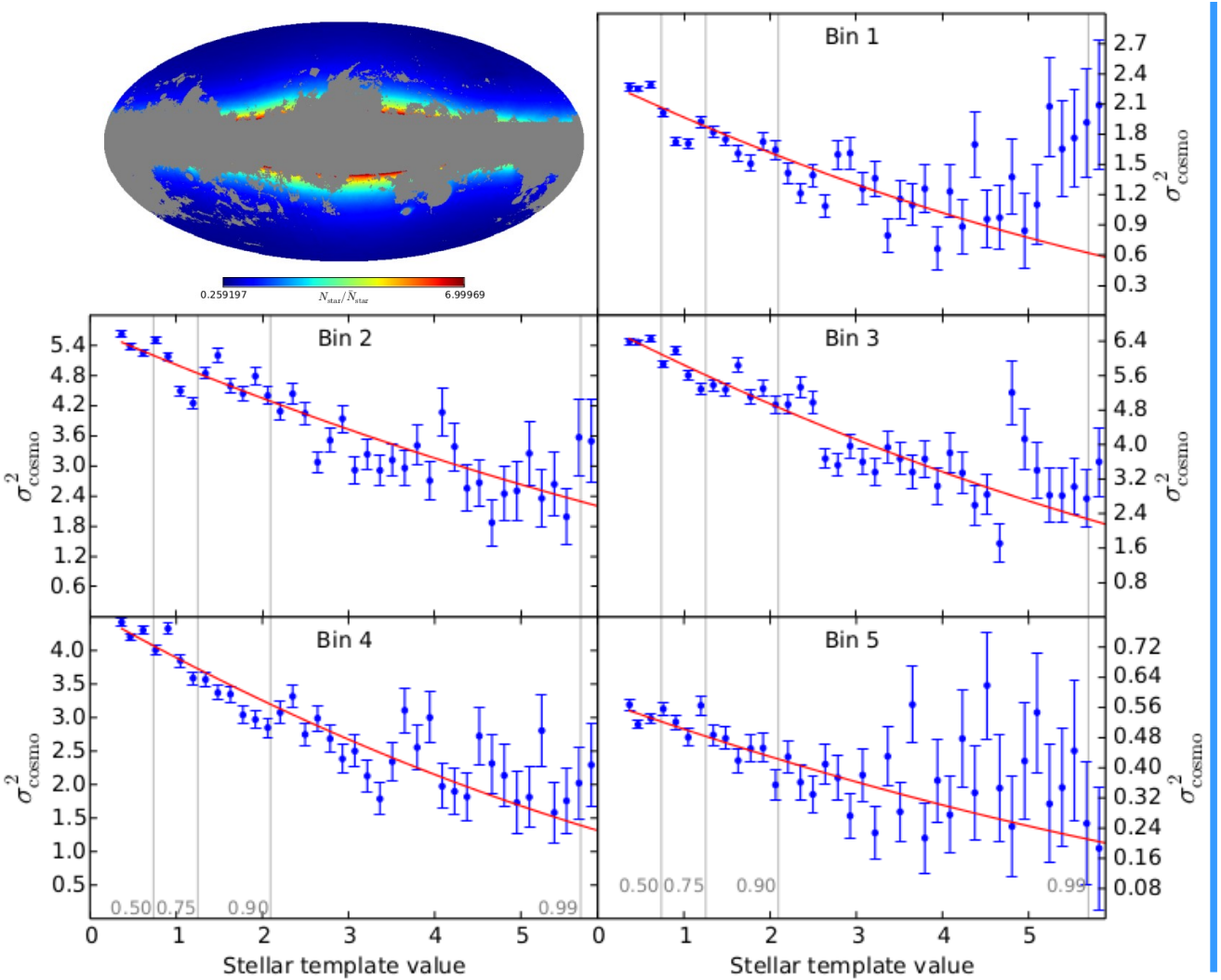


Removing usurper contamination

$$n_{\rm obs}(\boldsymbol{\theta}) = [1 - \alpha S(\boldsymbol{\theta})]\bar{n}[1 + \delta(\boldsymbol{\theta})] + \beta S(\boldsymbol{\theta})$$

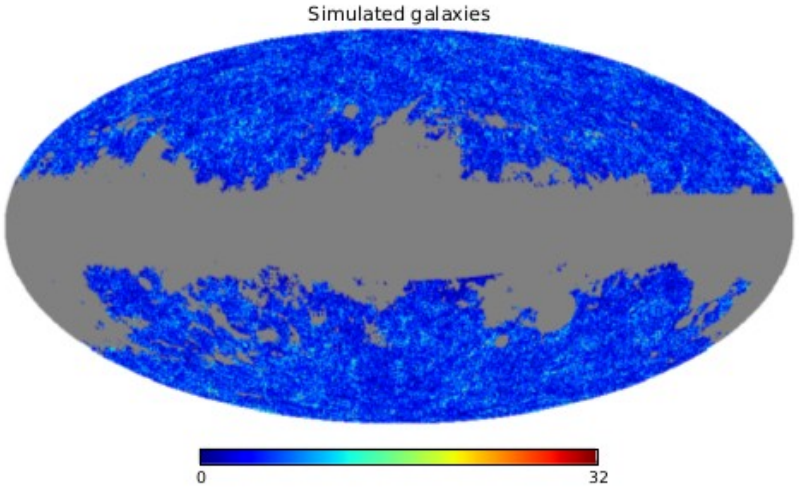
Fit variance for α ⇓ Weight by obscuration

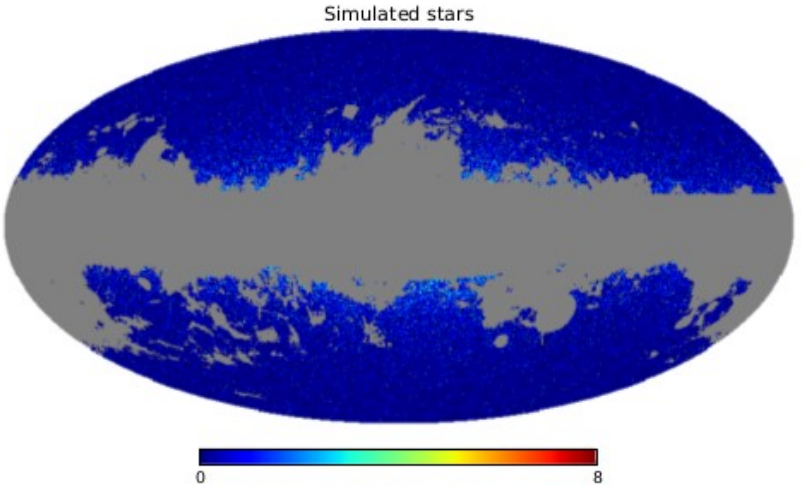
$$\frac{n_{\rm obs}(\boldsymbol{\theta})}{1 - \alpha S(\boldsymbol{\theta})} = n(\boldsymbol{\theta}) + \beta \frac{S(\boldsymbol{\theta})}{1 - \alpha S(\boldsymbol{\theta})}$$

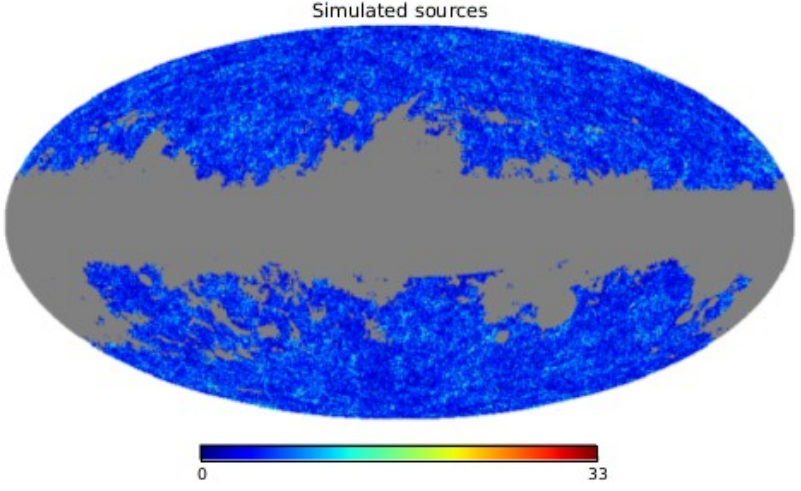
X-corr ⇒ β ⇓ Subtract weighted template

$$n(\boldsymbol{\theta}) = \frac{n_{\rm obs}(\boldsymbol{\theta}) - \beta S(\boldsymbol{\theta})}{1 - \alpha S(\boldsymbol{\theta})}$$

Testing on simulations:







FLASK (Xavier et al. 2016)

Testing on simulations:

Bin	α_0	$\bar{\alpha}$	σ_α	% bias	β_0	$\bar{\beta}$	σ_β	% bias	$n_{\rm g0}$	$\bar{n}_{\rm g}$	$\sigma_{n_{\rm g}}$	% bias
1	0.0902	0.0934	0.0157	3.4	0.421	0.435	0.039	3.2	3.223	3.22	0.049	-0.1
2	0.0681	0.0705	0.0077	3.5	0.259	0.273	0.029	5.3	5.499	5.498	0.042	-0.0
3	0.0735	0.0755	0.0056	2.6	0.136	0.15	0.028	9.0	6.601	6.601	0.033	-0.0
4	0.0818	0.0836	0.005	2.2	0.095	0.106	0.024	10.5	5.826	5.826	0.023	0.0
5	0.0674	0.0703	0.0081	4.0	0.051	0.056	0.013	8.8	1.748	1.748	0.008	0.0

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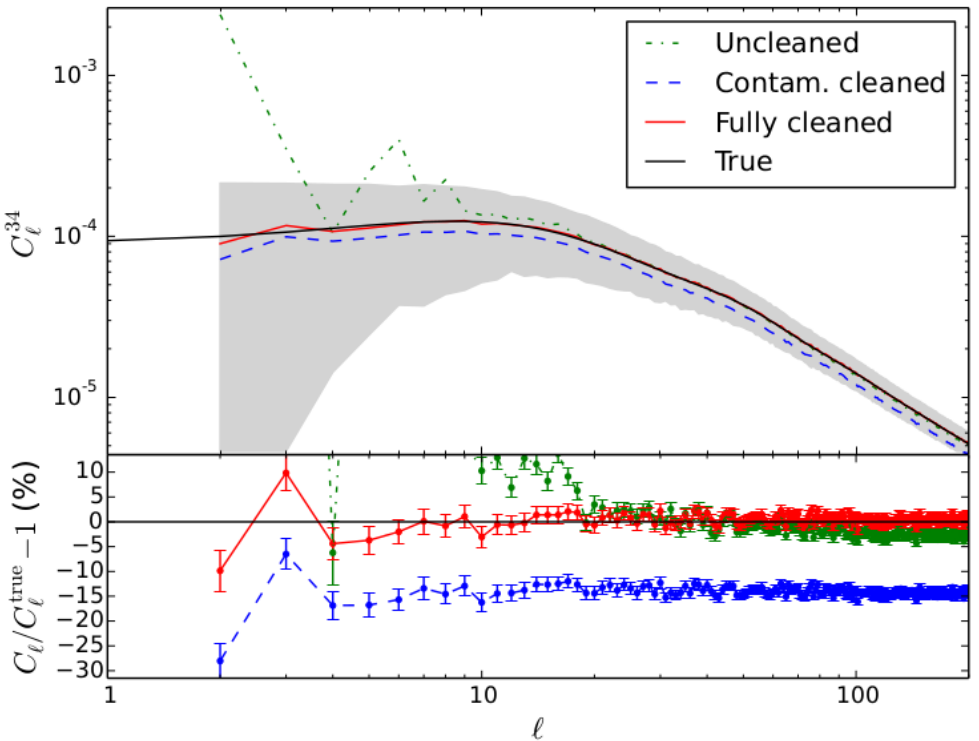

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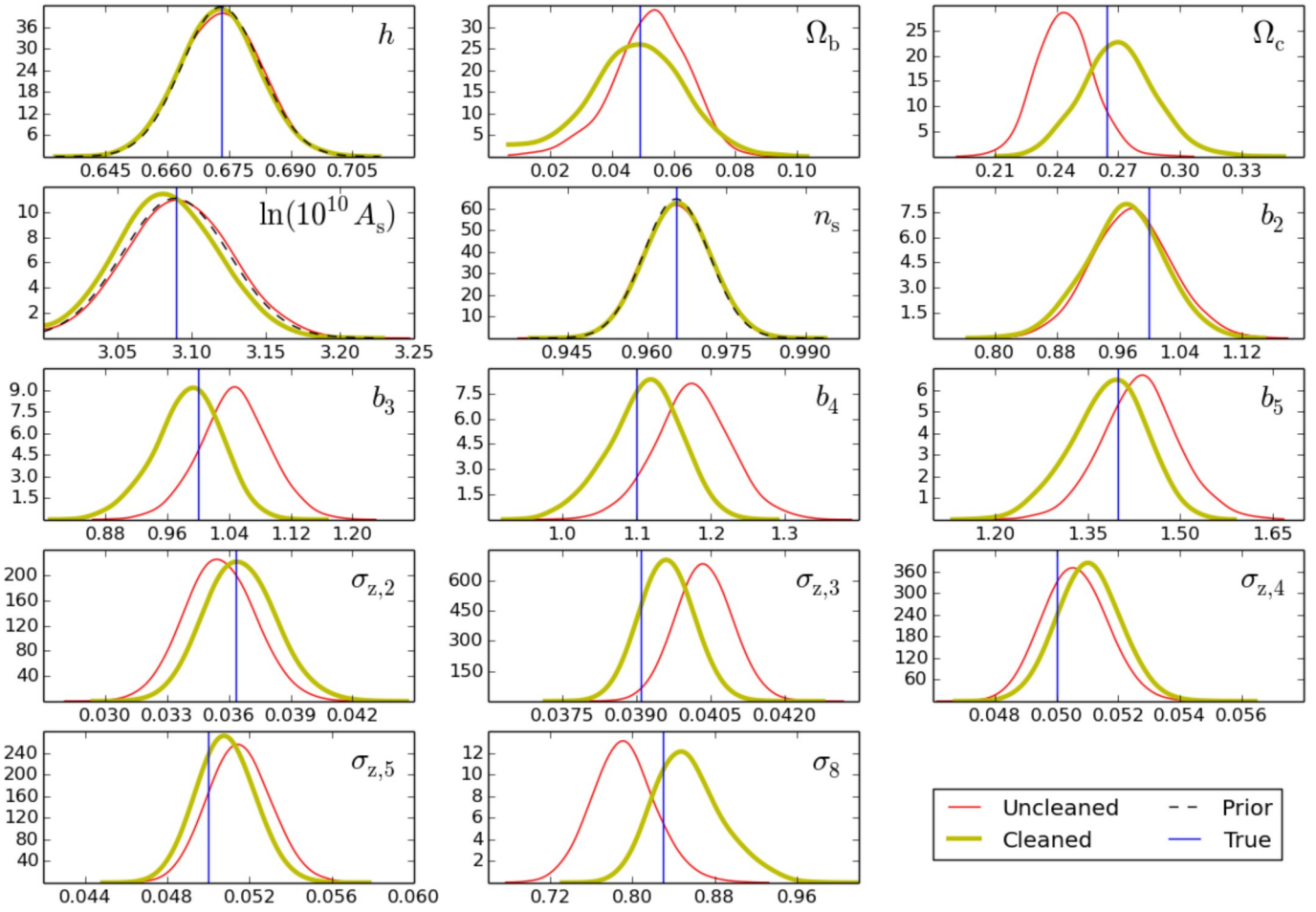
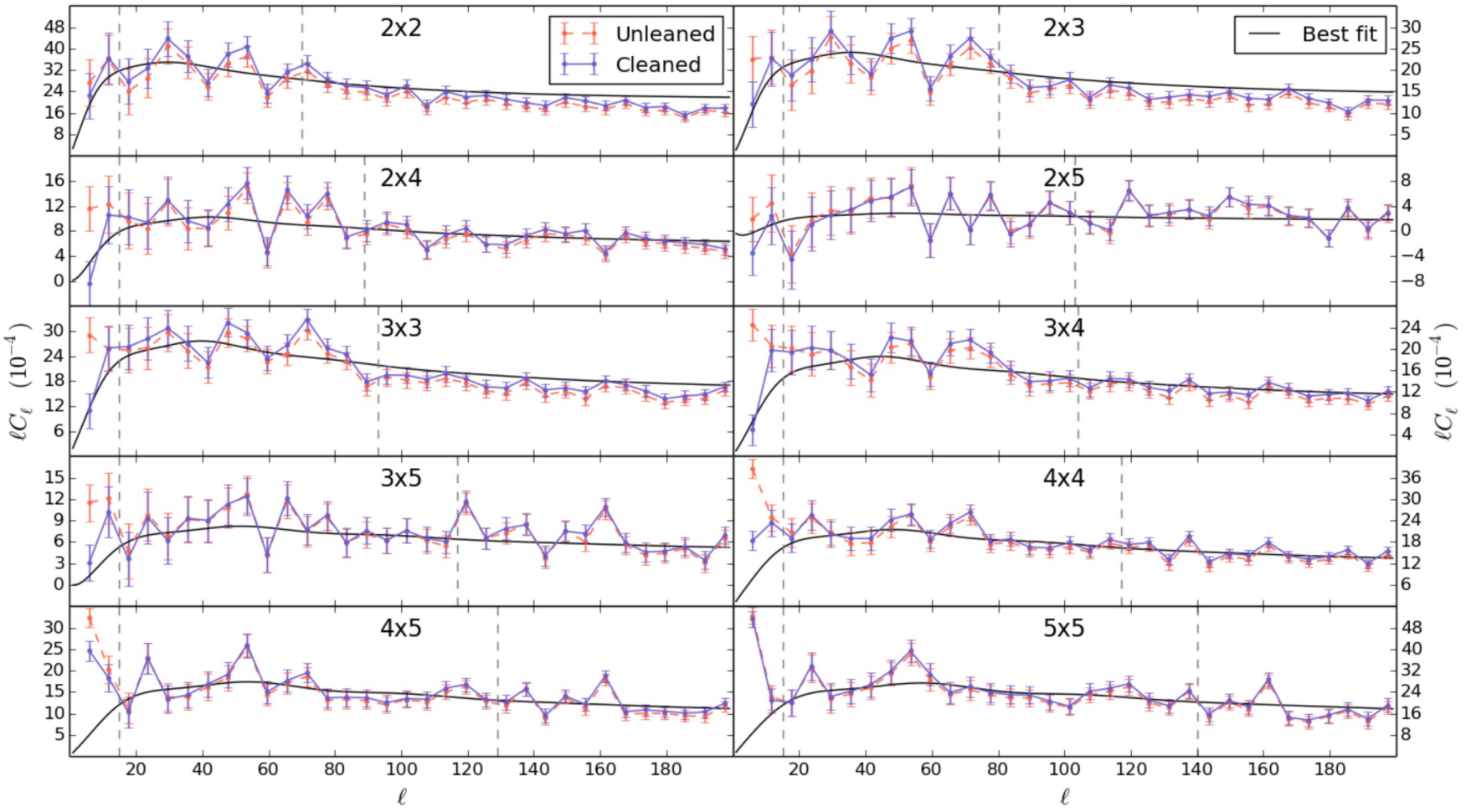


Applying to real WISExSuperCOSMOS (North):



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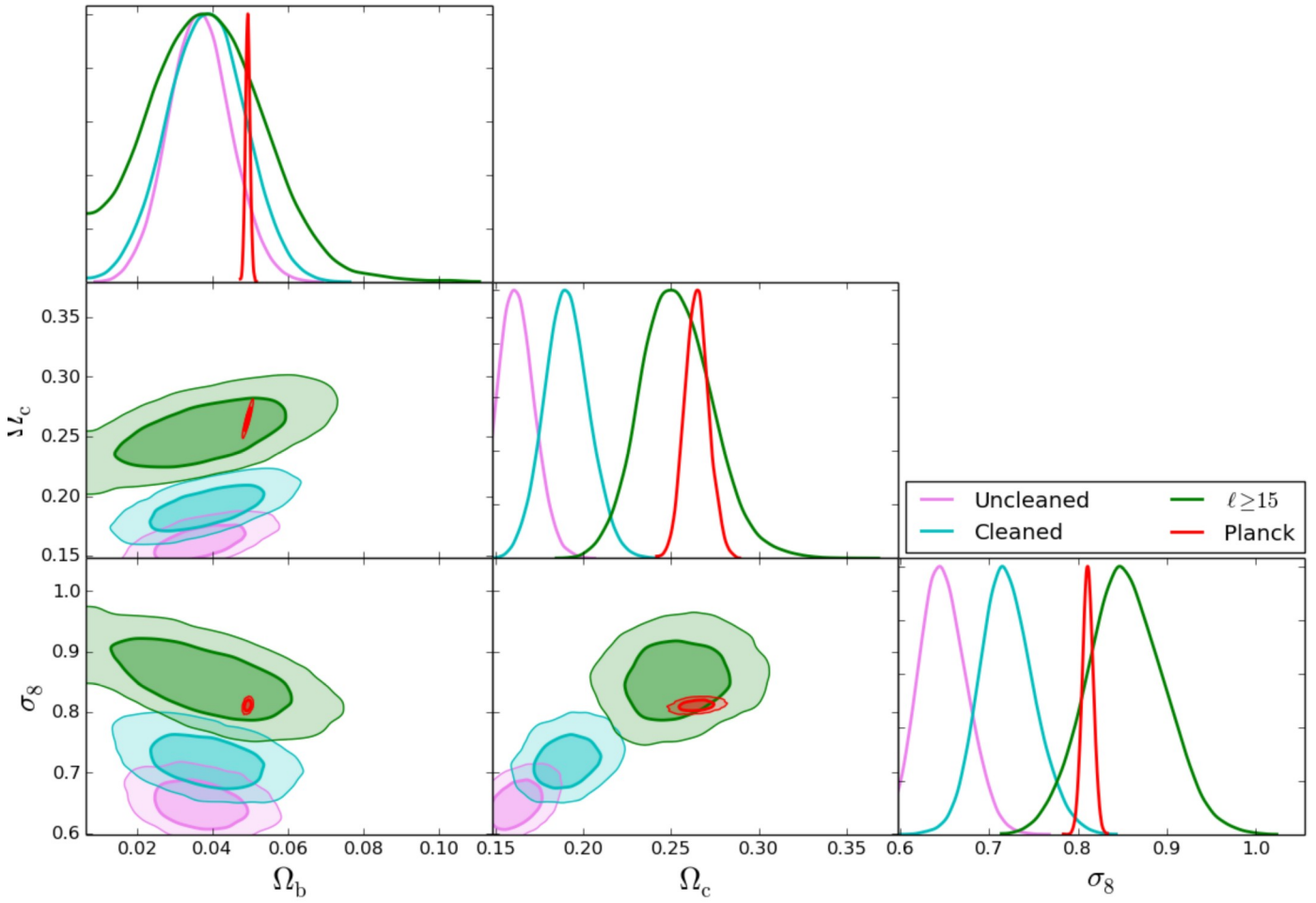

Conclusions

- Photometric surveys suffer from usurper contamination.
- Measure stellar contamination properly (first correct for obscuration).
- Specially if measuring galaxy bias.
- Make the largest scales usable.
- WISExSuperCOSMOS present other systematics besides stellar related ones.

More at: arXiv:1812.08182

North x South tension: southern systematics?