Optimal Weights and Multiple Tracers in Large-Scale Structure

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NH, Uroš Seljak & Vincent Desjacques 2011; 1104.2321 (astro-ph.CO)
NH, Uroš Seljak, Vincent Desjacques, Robert E. Smith & Tobias Baldauf 2010; 1004.5377 (astro-ph.CO) + PRD
Uroš Seljak, NH & Vincent Desjacques 2009; 0904.2963 (astro-ph.CO) + PRL

Cosmological Non-Gaussianity: Observations Confront Theory Workshop
University of Michigan, Ann Arbor, Mai 14th 2011

Consider multiple different-mass tracers of the underlying dark matter density field:

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Each of them is sensitive to primordial non-Gaussianity through their linear bias:

$$b_i\,(k,f_{NL}) = b_i\,(f_{NL}=0) + f_{NL}\,[b_i\,(f_{NL}=0) - 1]\,u(k,z)$$

with

$$u(k,z) \equiv 3\delta_c\Omega_m H_0^2 \Big/ k^2 T(k) D(z) c^2$$

The 2-point clustering statistics is described by the halo covariance matrix in Fourier space:

$$C_{ij} \equiv \langle \delta_i \delta_j \rangle = b_i b_j P + \mathcal{E}_{ij}$$

with $P \equiv \langle \delta^2 \rangle$, $b_i \equiv \langle \delta_i \delta \rangle / \langle \delta^2 \rangle$, $\mathcal{E}_{ij} \equiv \langle \epsilon_i \epsilon_j \rangle$

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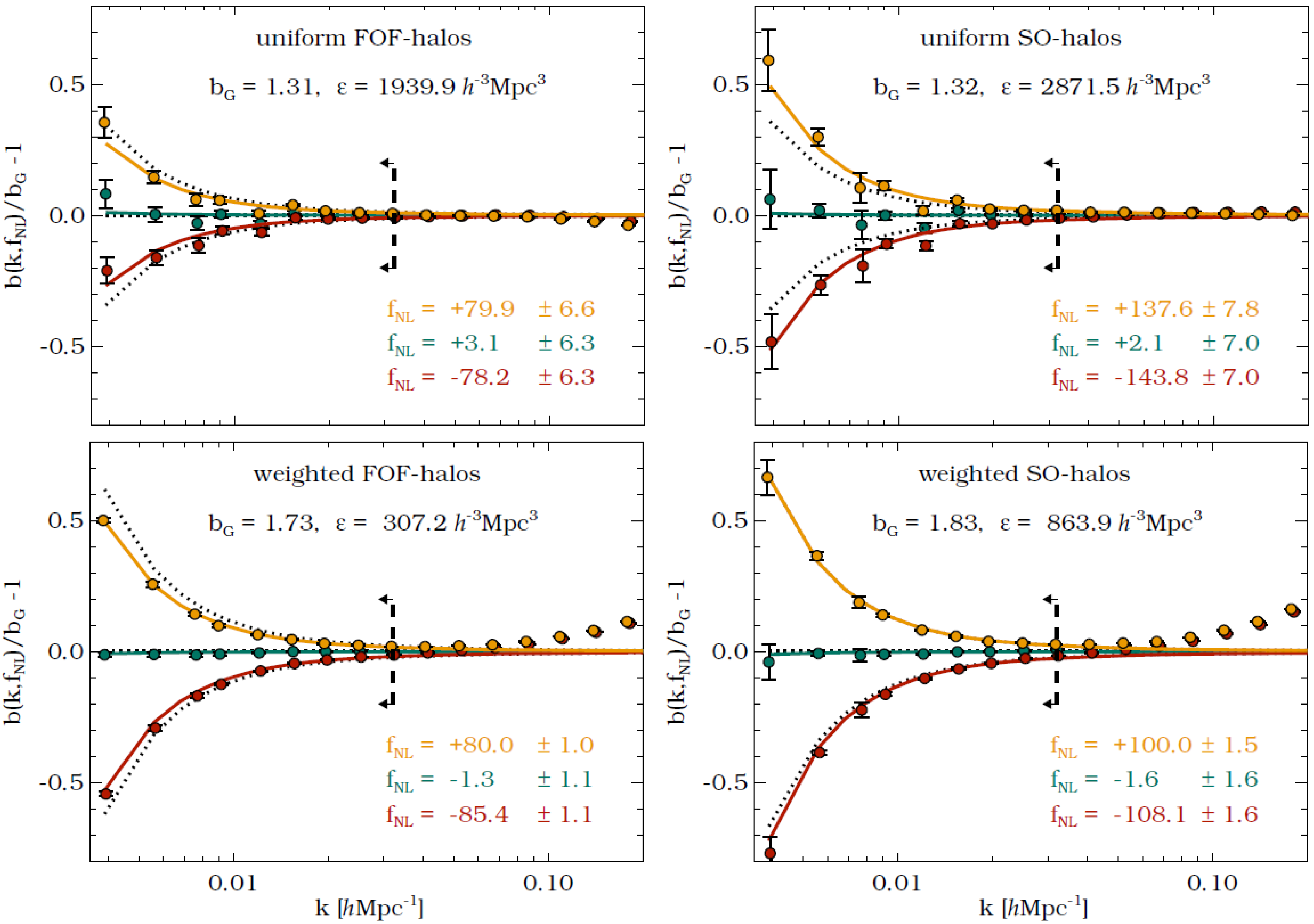
With knowledge of δ (from simulations), we can

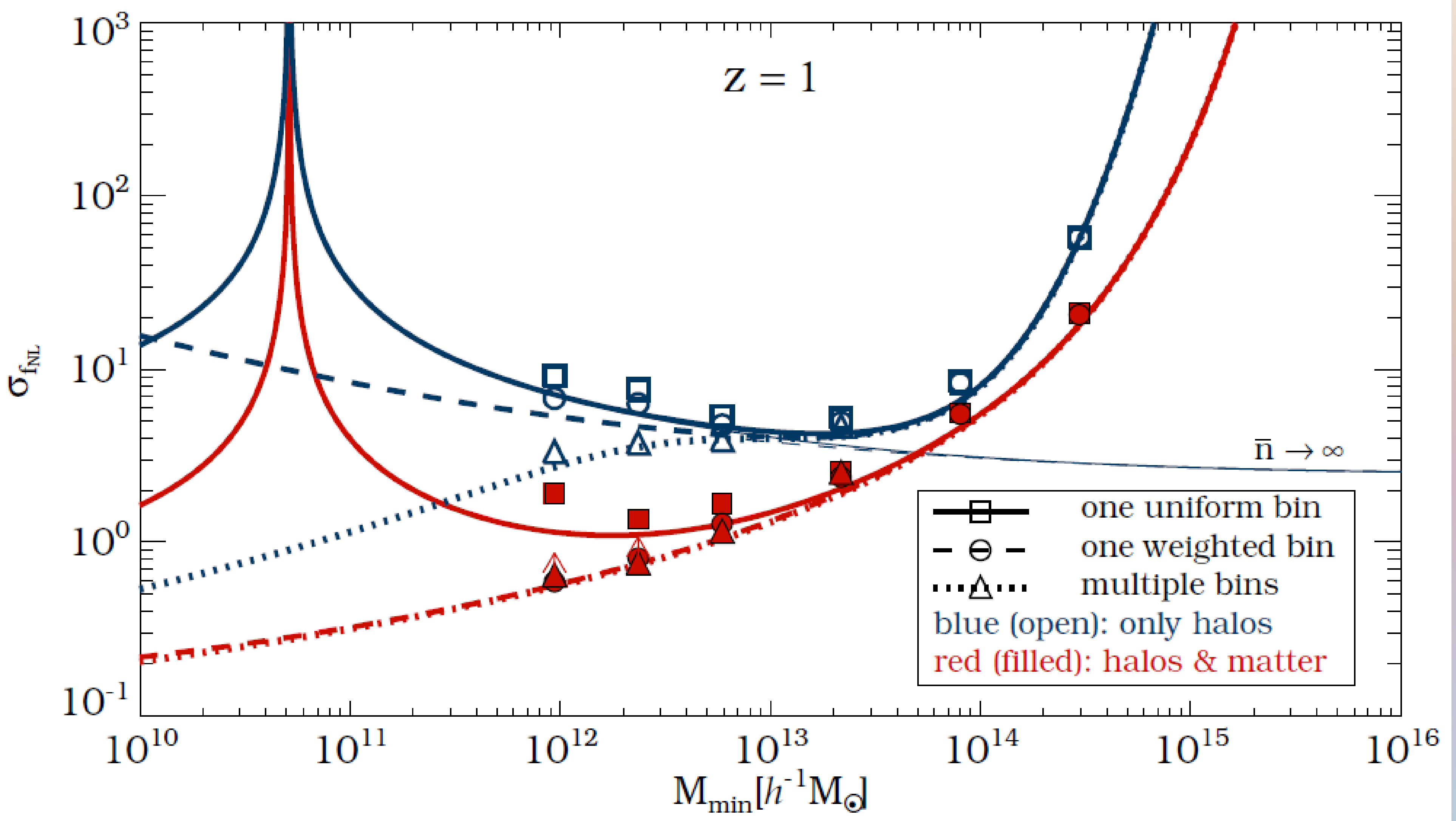
determine $\mathcal{E}_{ij} = <\delta_i \delta_j> - <\delta_i \delta><\delta_j \delta>/<\delta^2>$

- $\mathcal{E}_{ij} \neq \delta_{ij}^K/n_i$ (Poisson sampling)
- $\mathcal{E}_{ij}$ exhibits one low eigenvalue $\lambda_- < 1/n_i$
- Eigenvector V_- provides optimal weighting

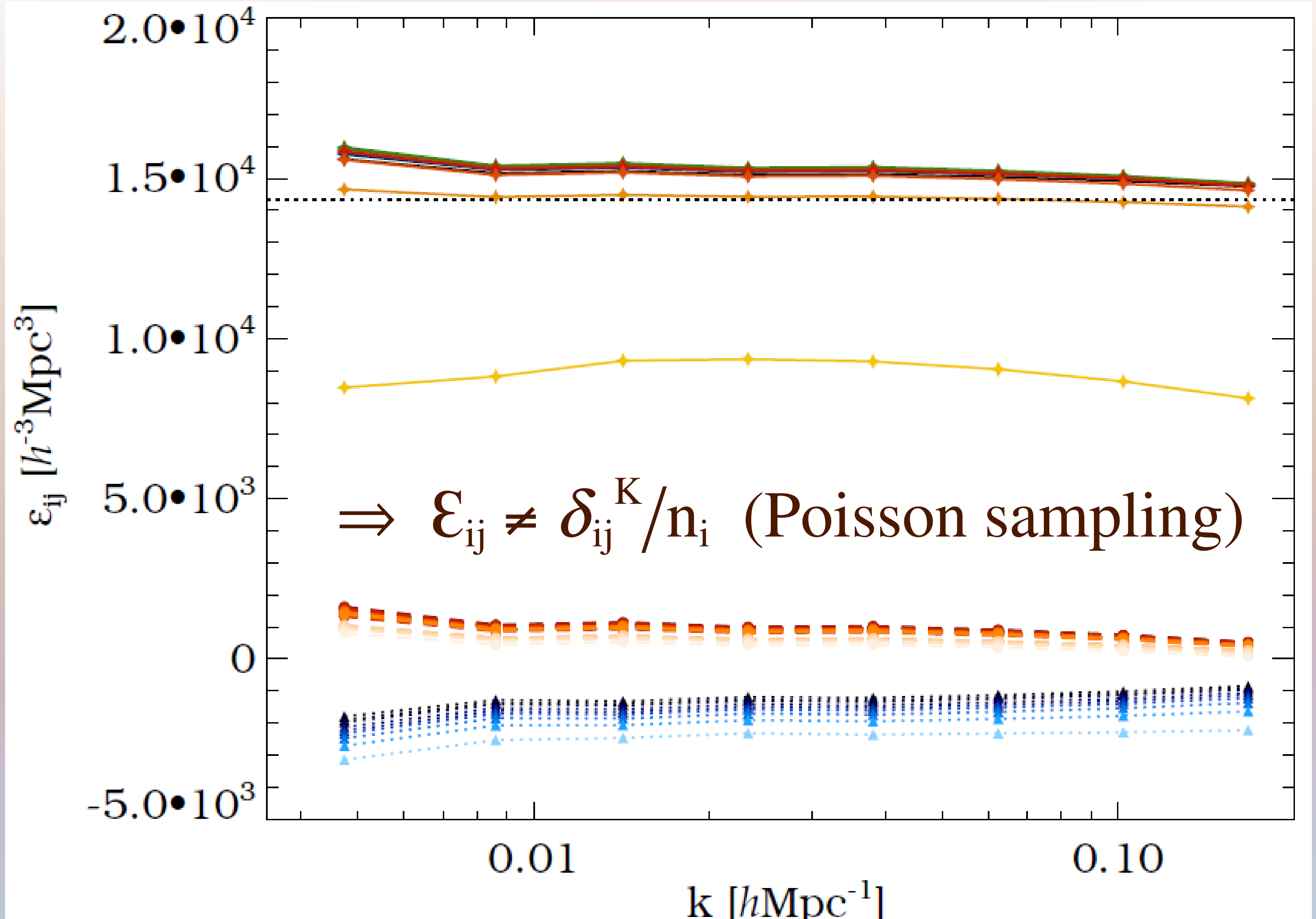

uniform FOF-halos
b_G = 1.31, ε = 1939.9 h^{-3}Mpc^3
f_{NL} = +79.9 ± 6.6
f_{NL} = +3.1 ± 6.3
f_{NL} = -78.2 ± 6.3
uniform SO-halos
b_G = 1.32, ε = 2871.5 h^{-3}Mpc^3
f_{NL} = +137.6 ± 7.8
f_{NL} = +2.1 ± 7.0
f_{NL} = -143.8 ± 7.0
weighted FOF-halos
b_G = 1.73, ε = 307.2 h^{-3}Mpc^3
f_{NL} = +80.0 ± 1.0
f_{NL} = -1.3 ± 1.1
f_{NL} = -85.4 ± 1.1
weighted SO-halos
b_G = 1.83, ε = 863.9 h^{-3}Mpc^3
f_{NL} = +100.0 ± 1.5
f_{NL} = -1.6 ± 1.6
f_{NL} = -108.1 ± 1.6
b(k,f_{NL})/b_G -1
k [hMpc^{-1}]
0.5
0.0
-0.5
0.01
0.10

Fisher information on primordial non-Gaussianity:

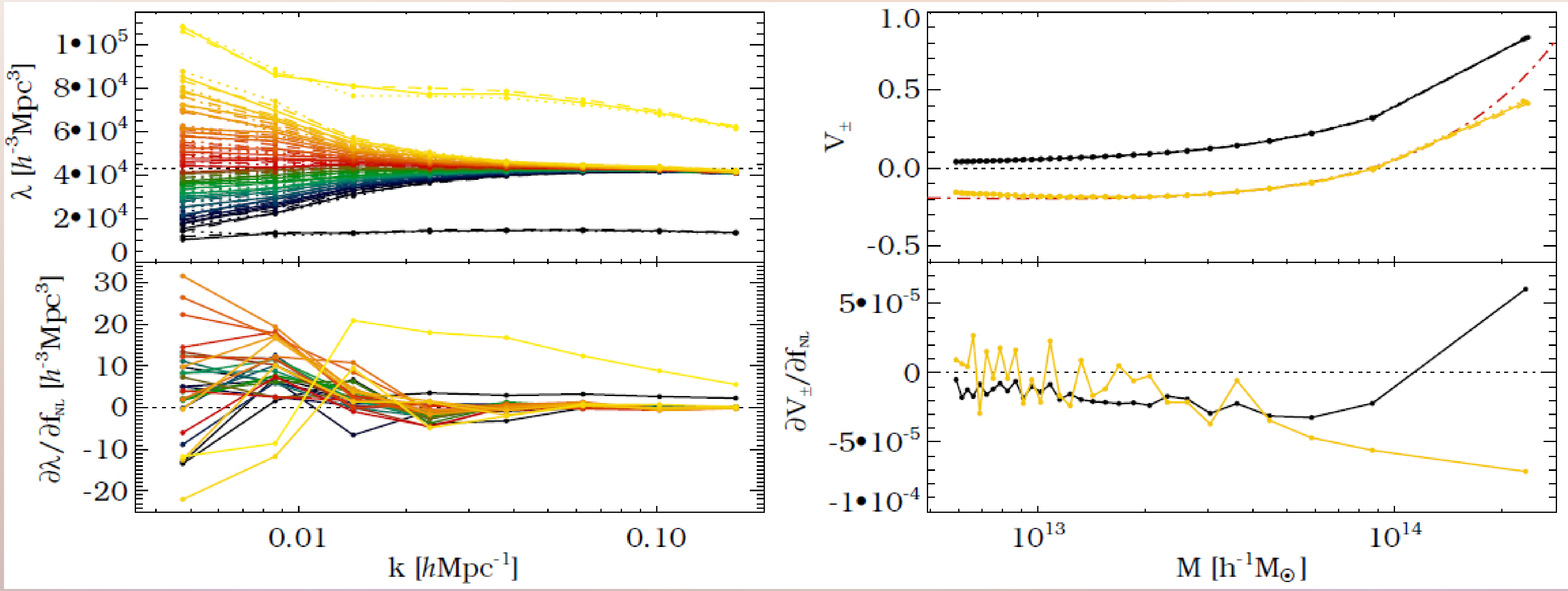
$$F_{f_{NL}f_{NL}} = \tfrac{1}{2}\,\mathrm{Tr}[C^{-1}\,\partial C/\partial f_{NL}\;C^{-1}\,\partial C/\partial f_{NL}]$$



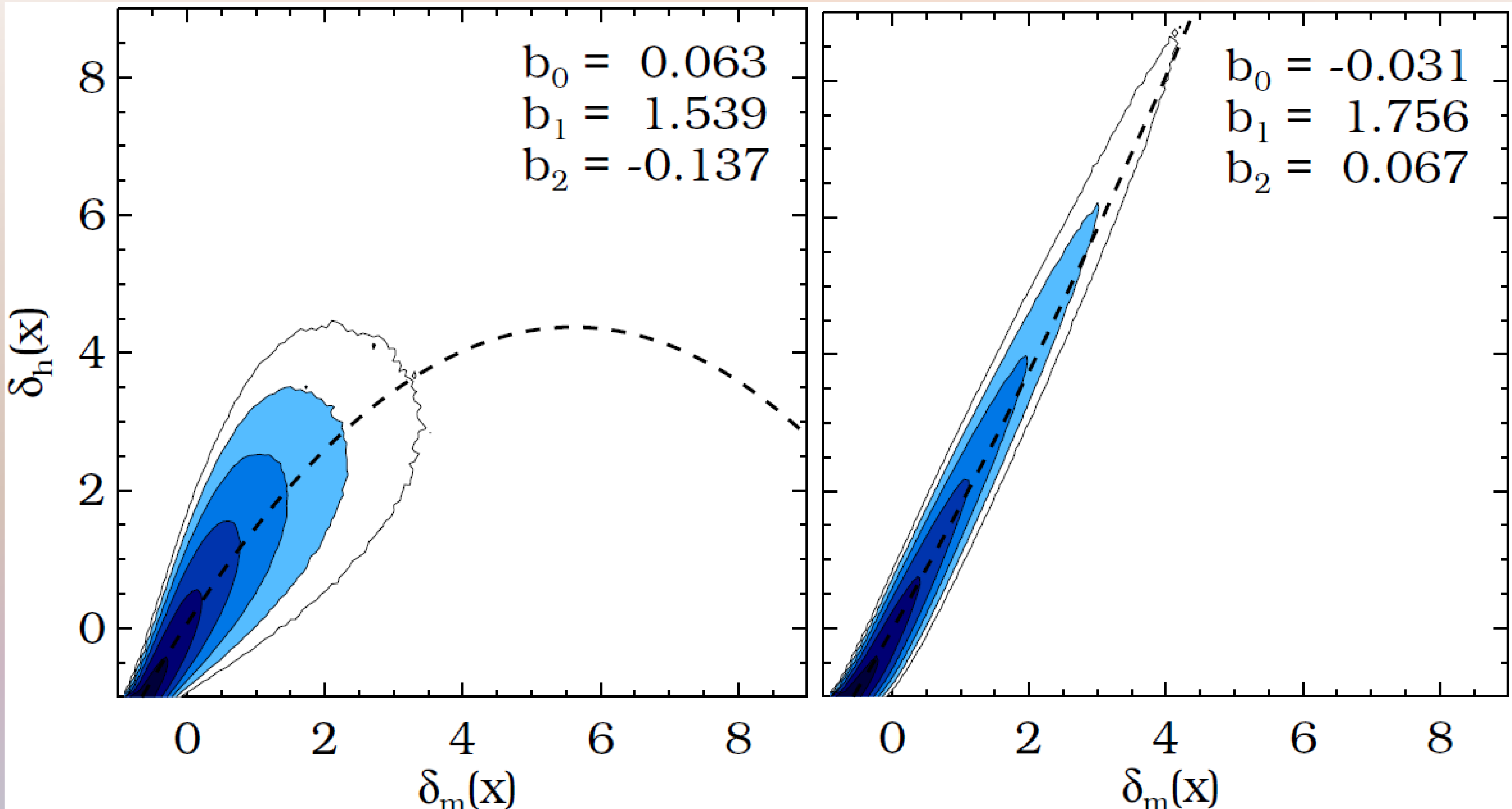
Thank you!


2.0•10^4
1.5•10^4
1.0•10^4
5.0•10^3
0
-5.0•10^3
ε_ij [h^-3Mpc^3]
0.01
0.10
k [hMpc^-1]
⇒ $\varepsilon_{ij} \neq \delta_{ij}^{K}/n_i$ (Poisson sampling)

Eigendecomposition of $\mathcal{E}_{ij}$:



- Enhanced and suppressed eigenvalue w.r.t. $1/n_i$
- Eigenvectors provide weights for each mass bin



b_0 = 0.063
b_1 = 1.539
b_2 = -0.137
$\delta_h(x)$
$\delta_m(x)$
0
2
4
6
8
b_0 = -0.031
b_1 = 1.756
b_2 = 0.067
$\delta_m(x)$