Stockholm University

Euclid consortium

Bayesian field-level inference of primordial non-Gaussianity

Adam Andrews

Jens Jasche, Guilhem Lavaux, Fabian Schmidt

arxiv: 2203.08838

Oskar Klein centre

A Cosmic Window to Fundamental Physics:
PNG Workshop
September 22nd 2022

Aquila

How does $f_{\rm nl}$ affect the cosmic matter field?

How does f_{nl} affect the cosmic matter field?

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How does $f_{\rm nl}$ affect the cosmic matter field?

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~~**Summary statistics:**~~

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<u>Goal:</u> ***Fit the full cosmic field***

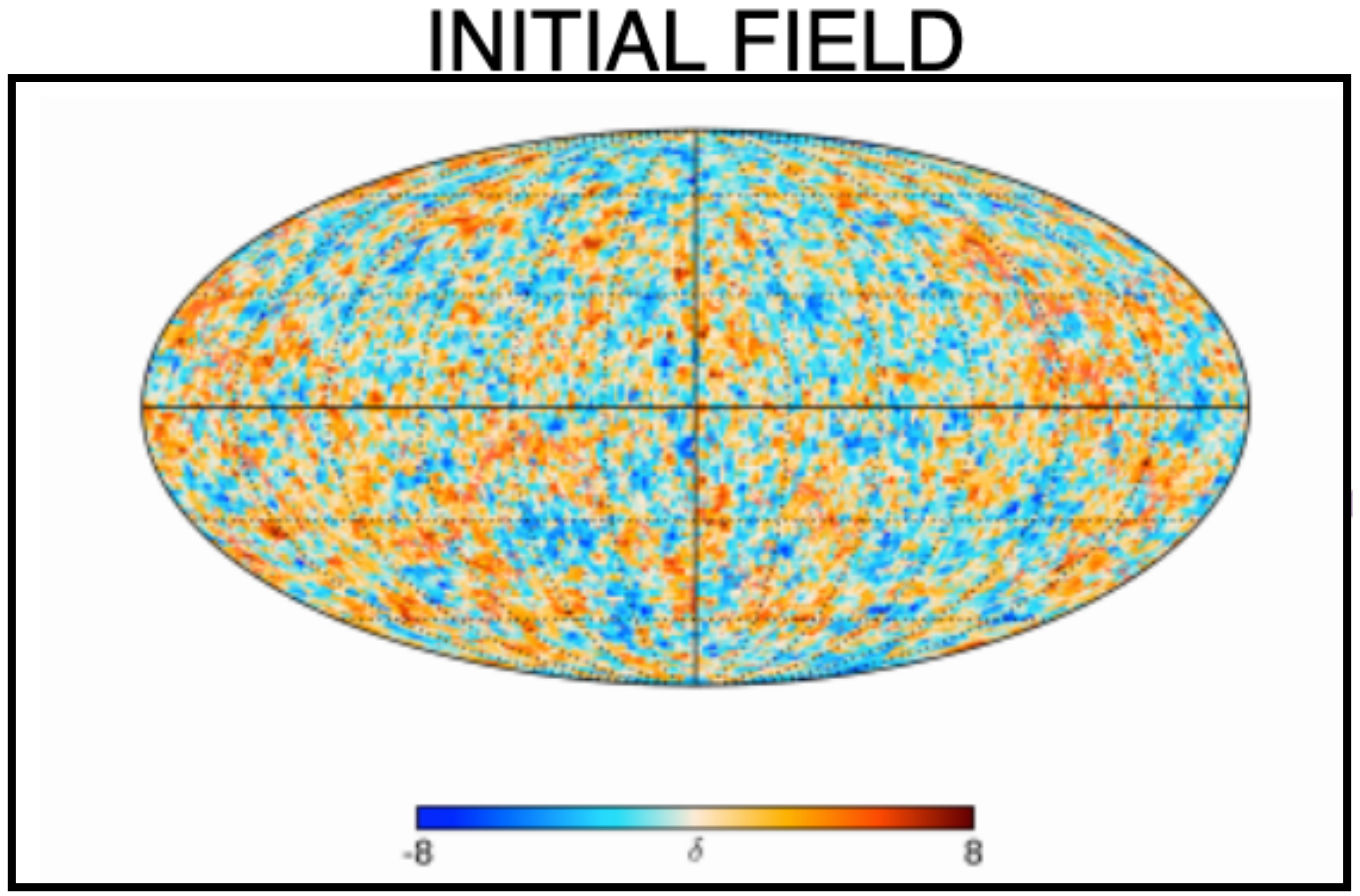
Field-level inference

1) Forward model

2) Statistical inference

Field-level inference

1) Forward model



2) Statistical inference

Field-level inference

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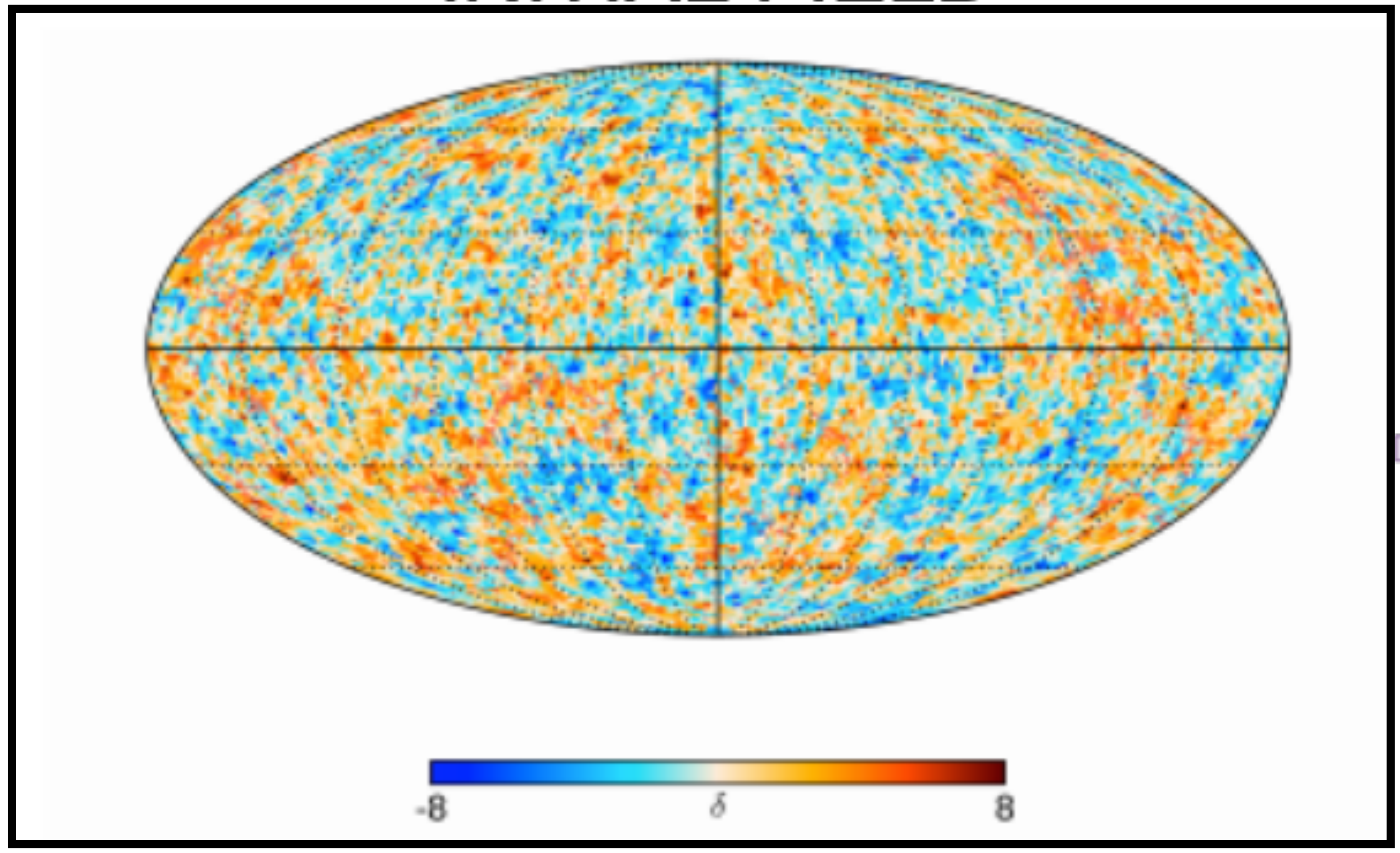
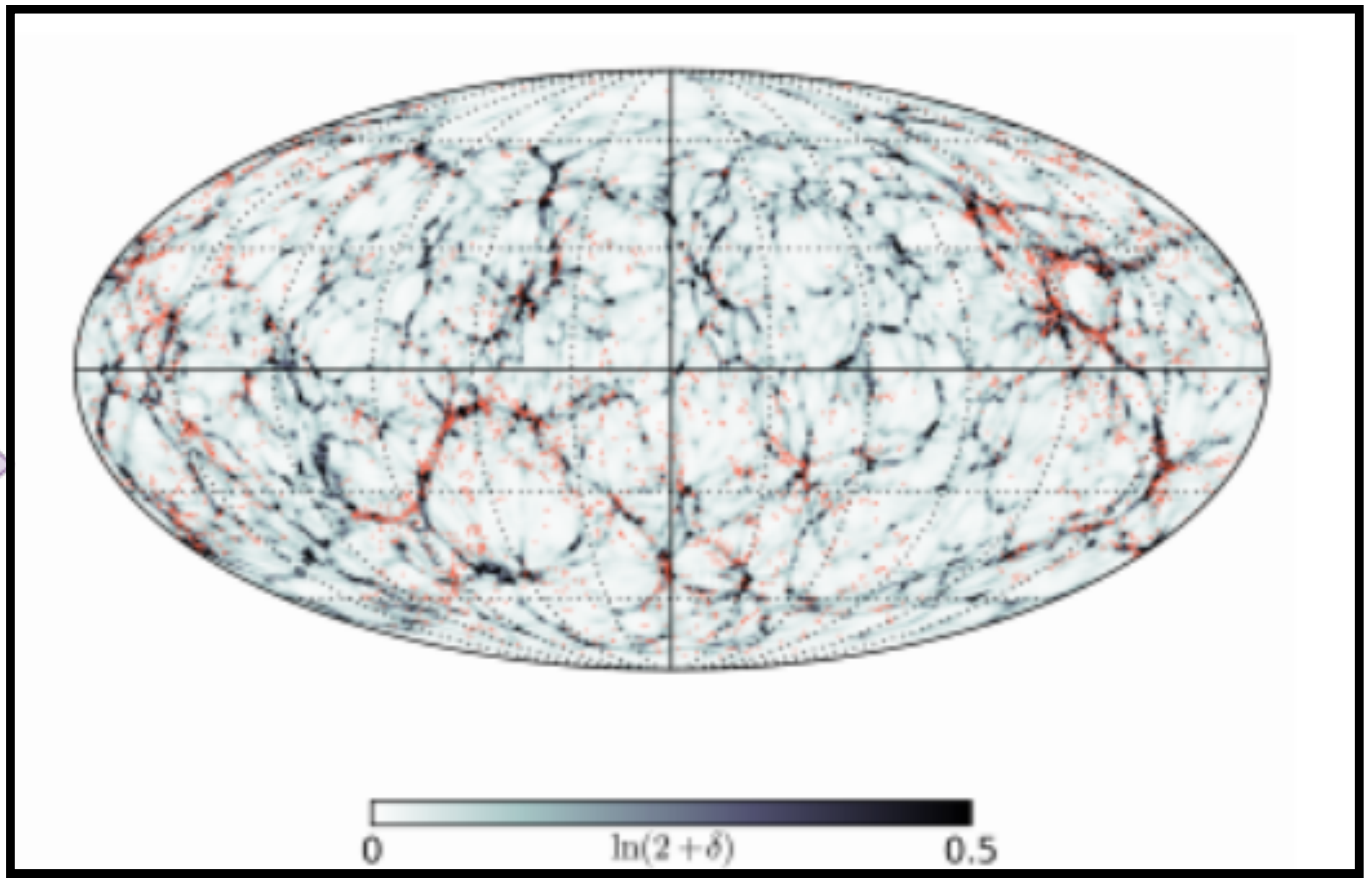


FINAL FIELD



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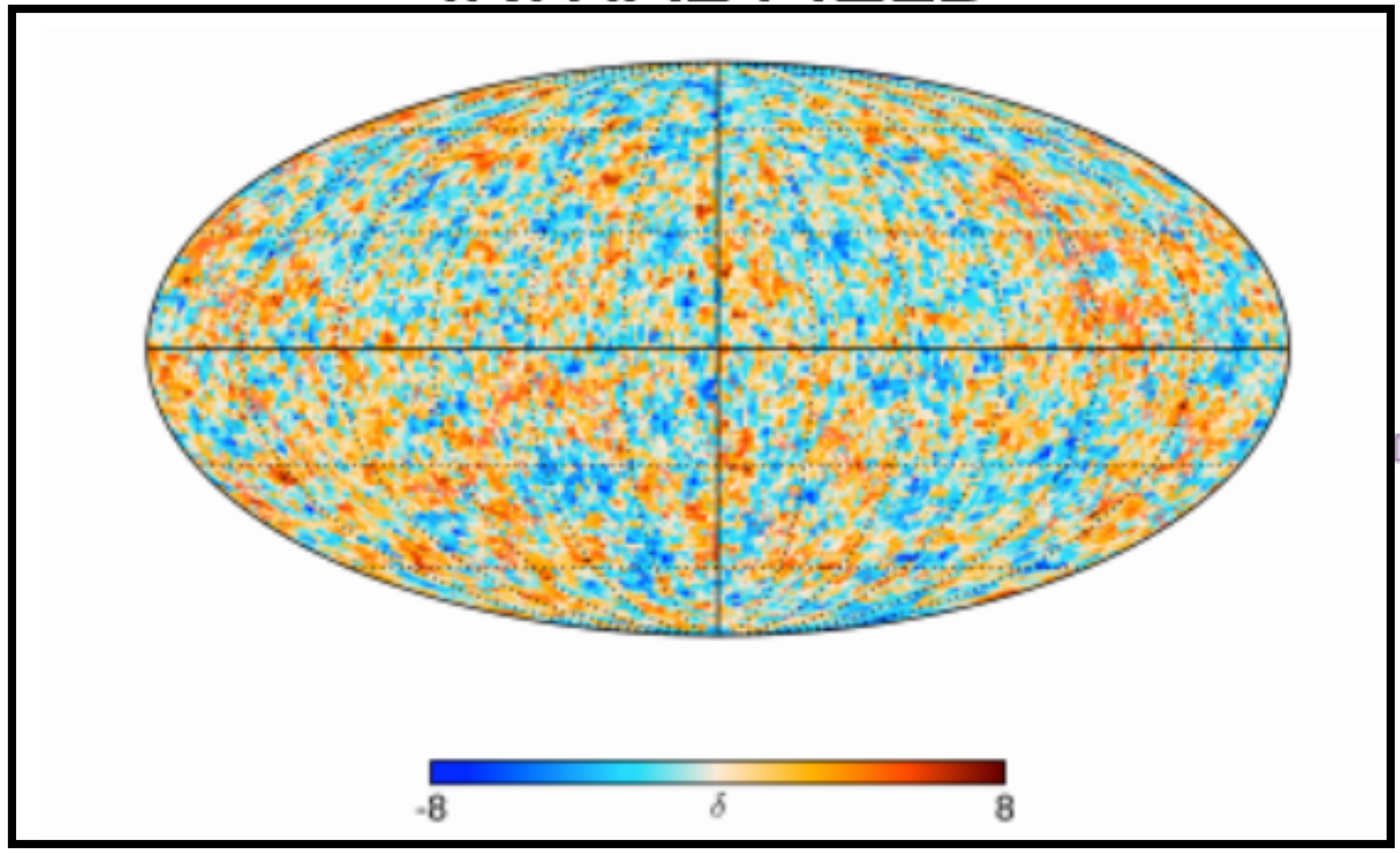

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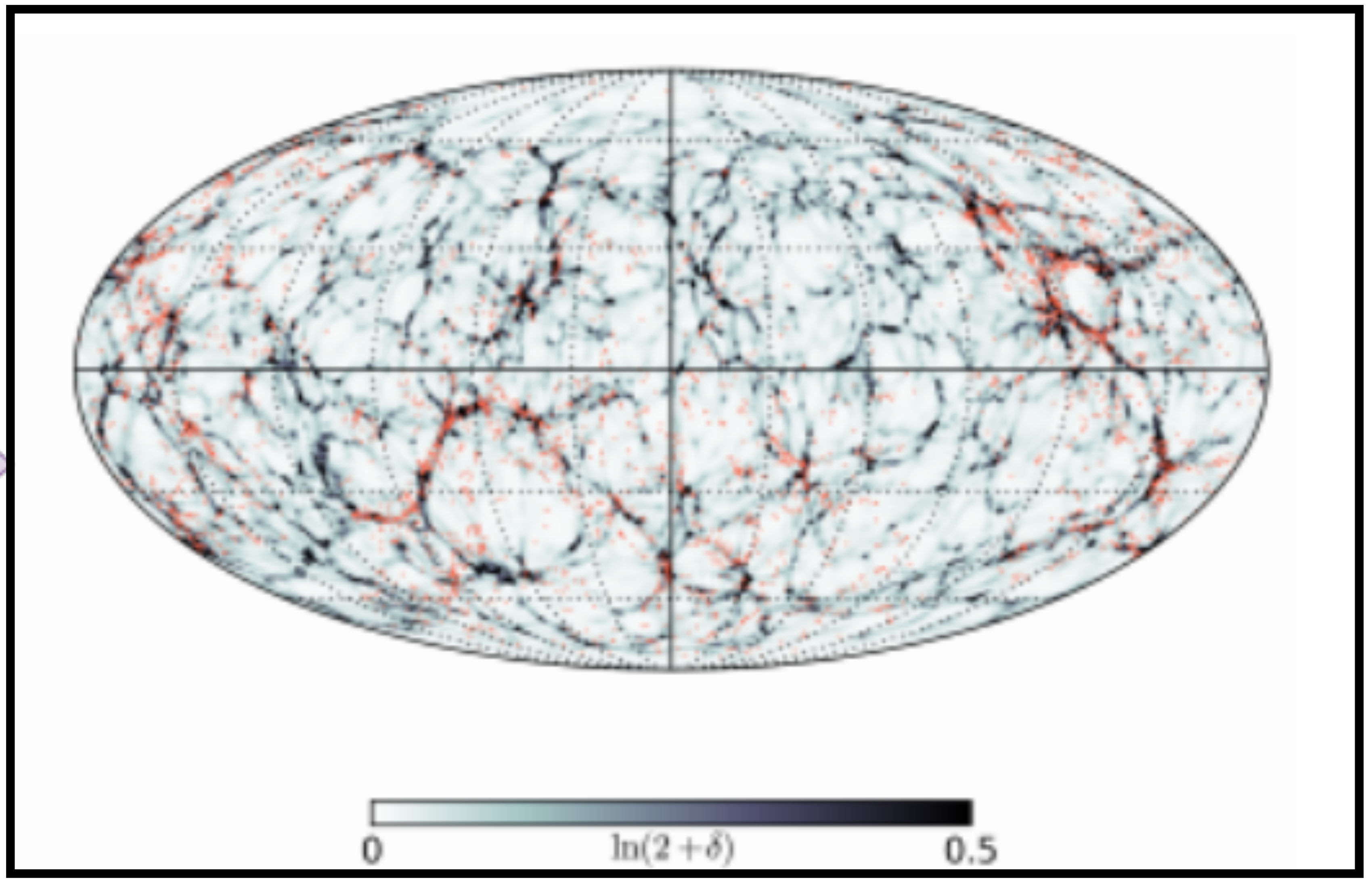

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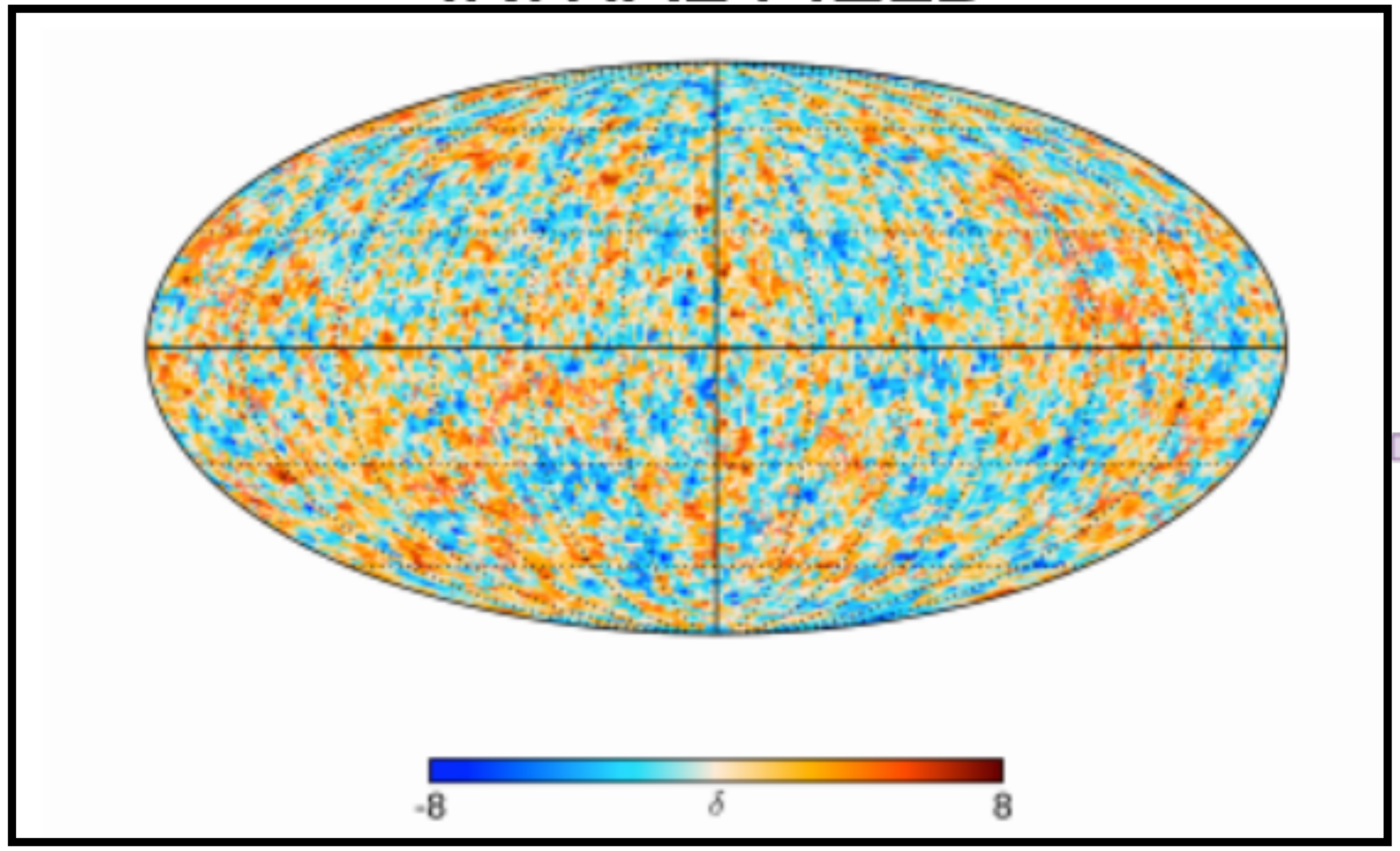

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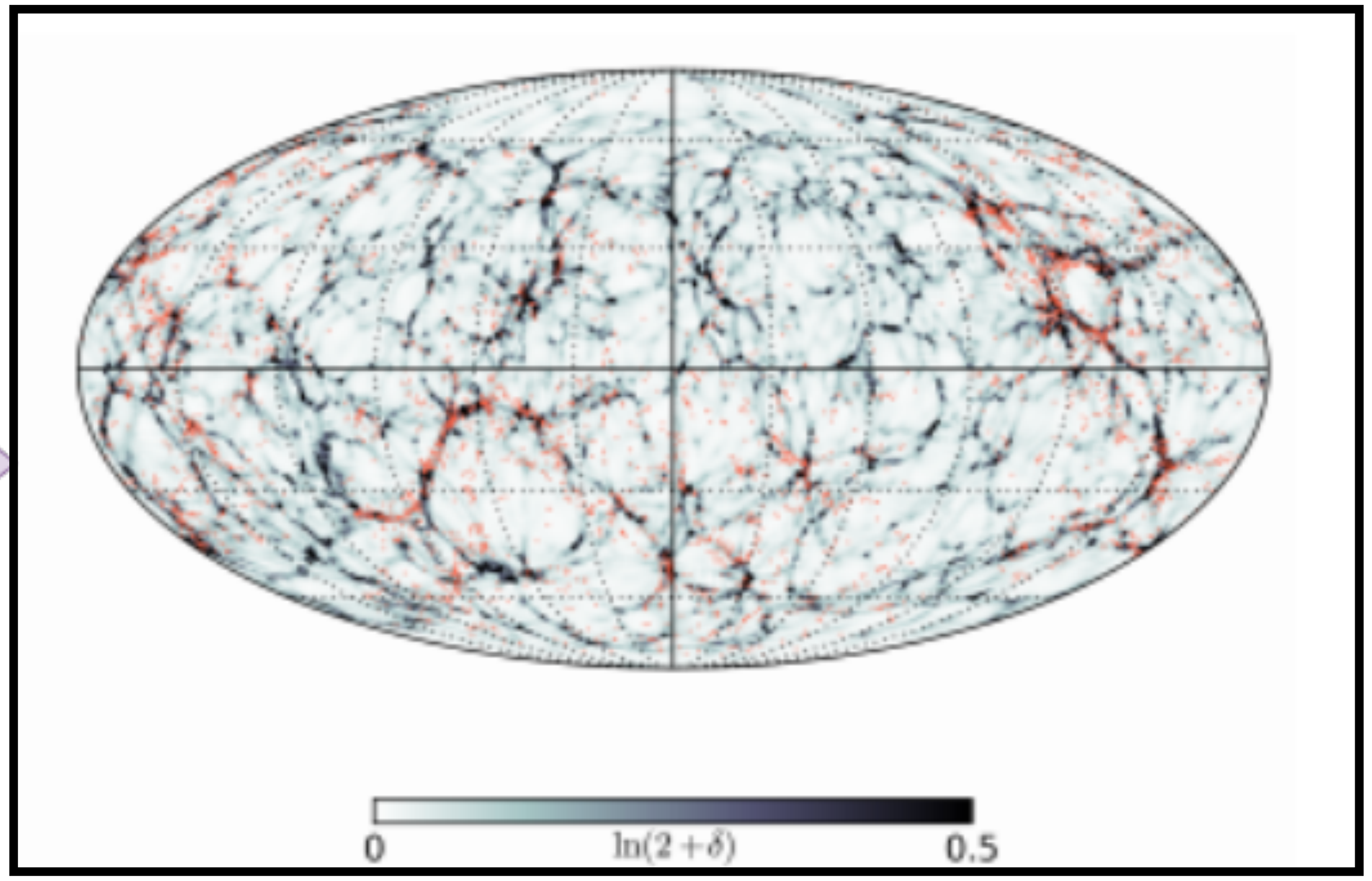

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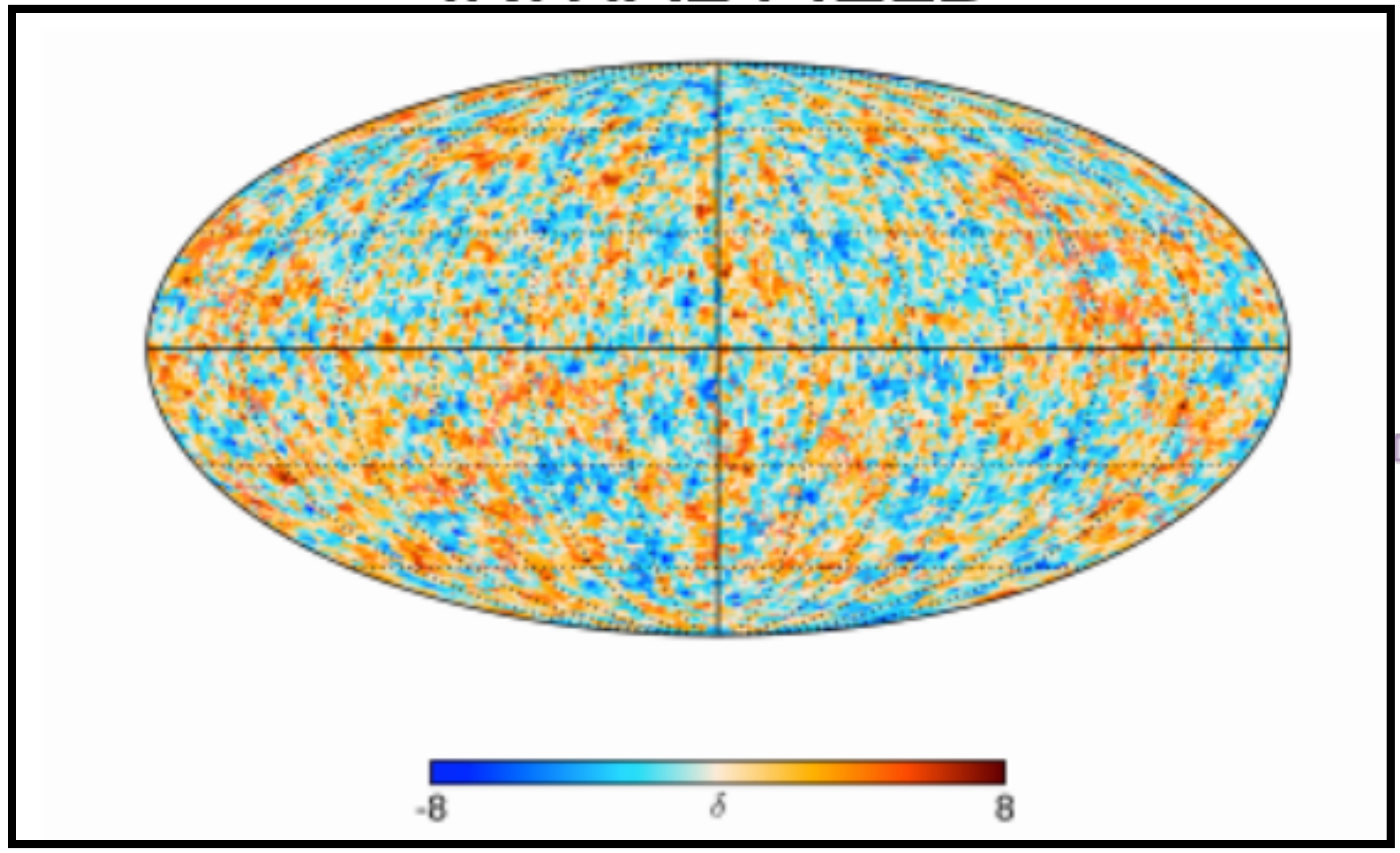

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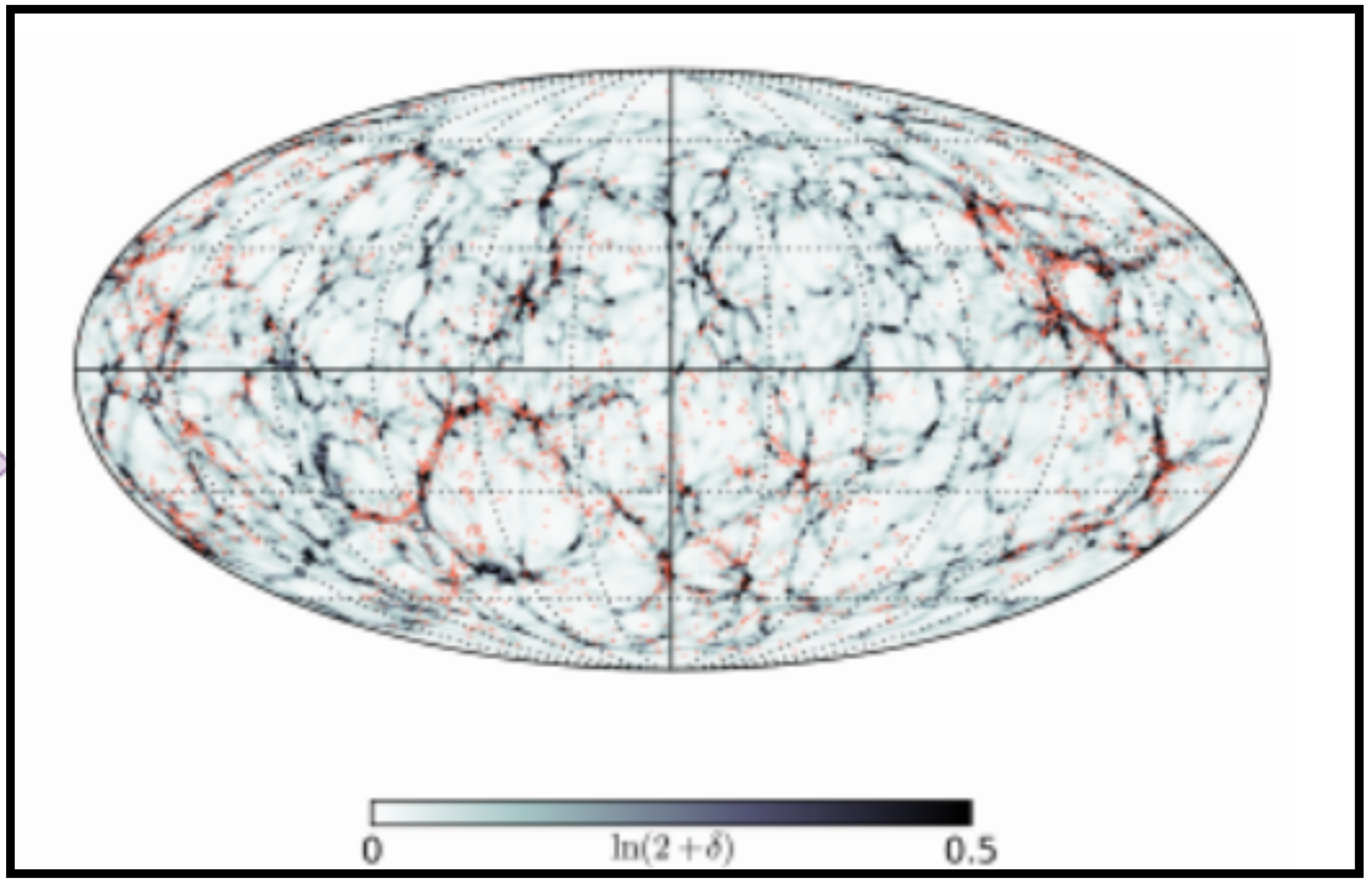

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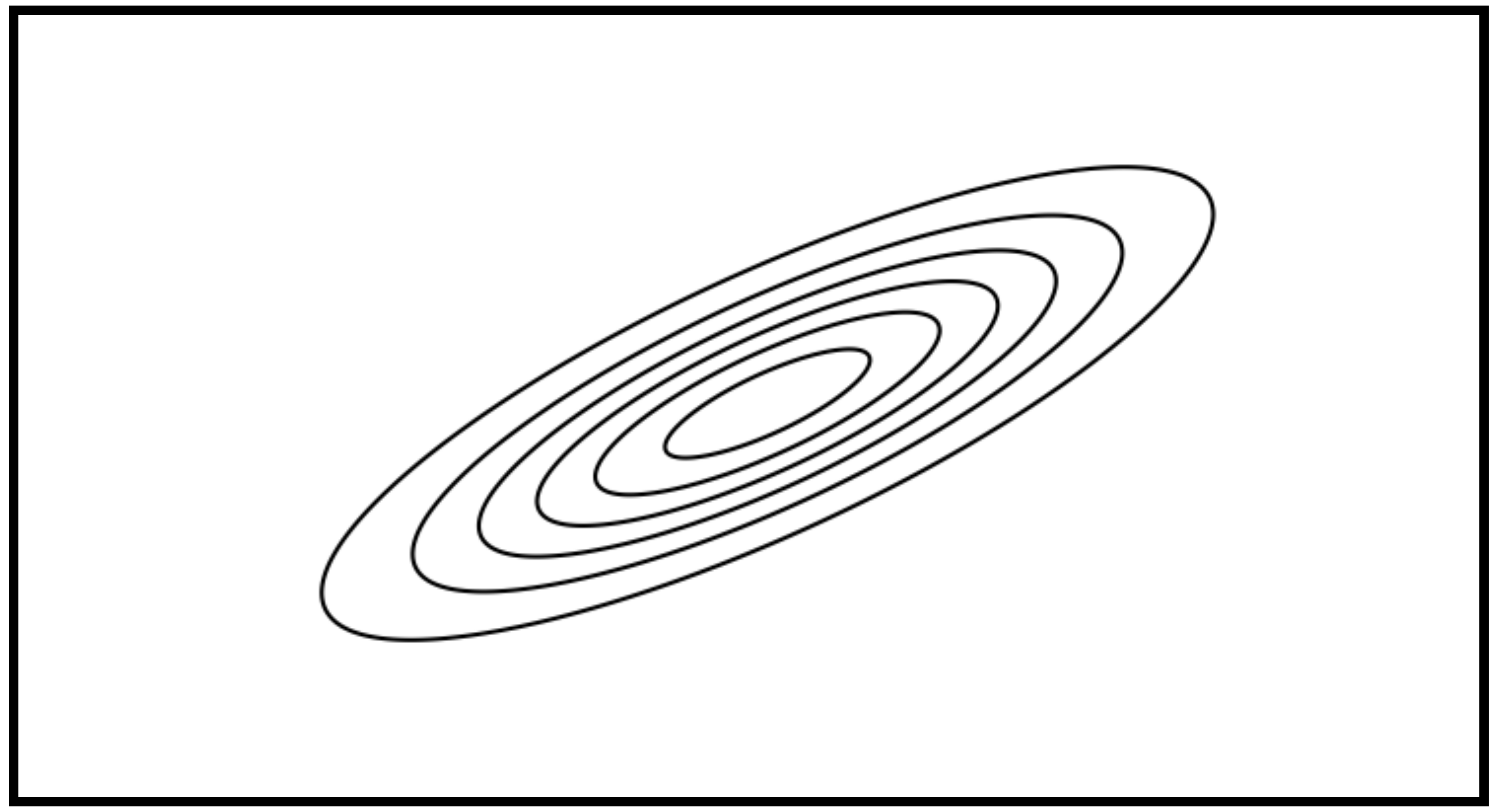

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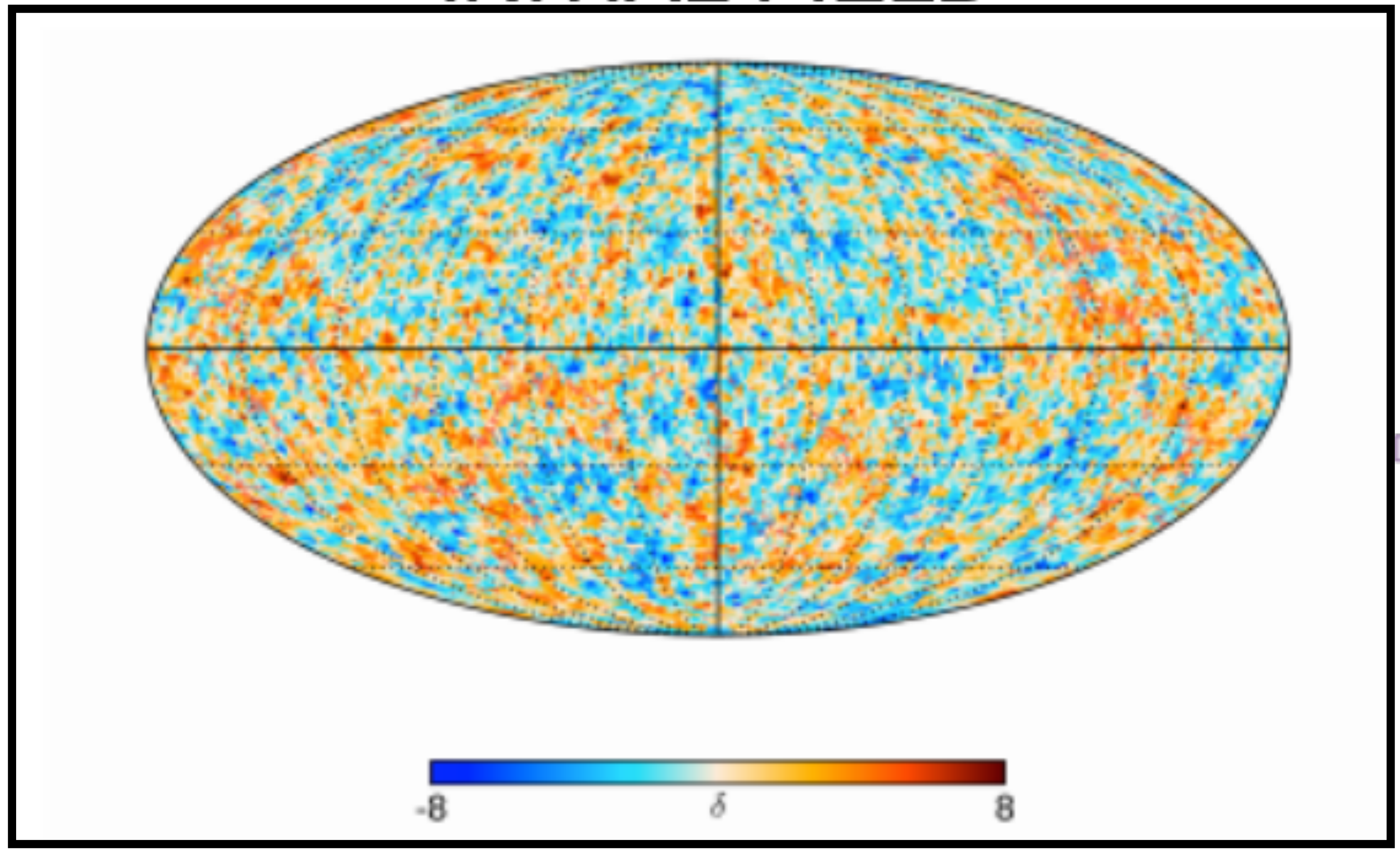

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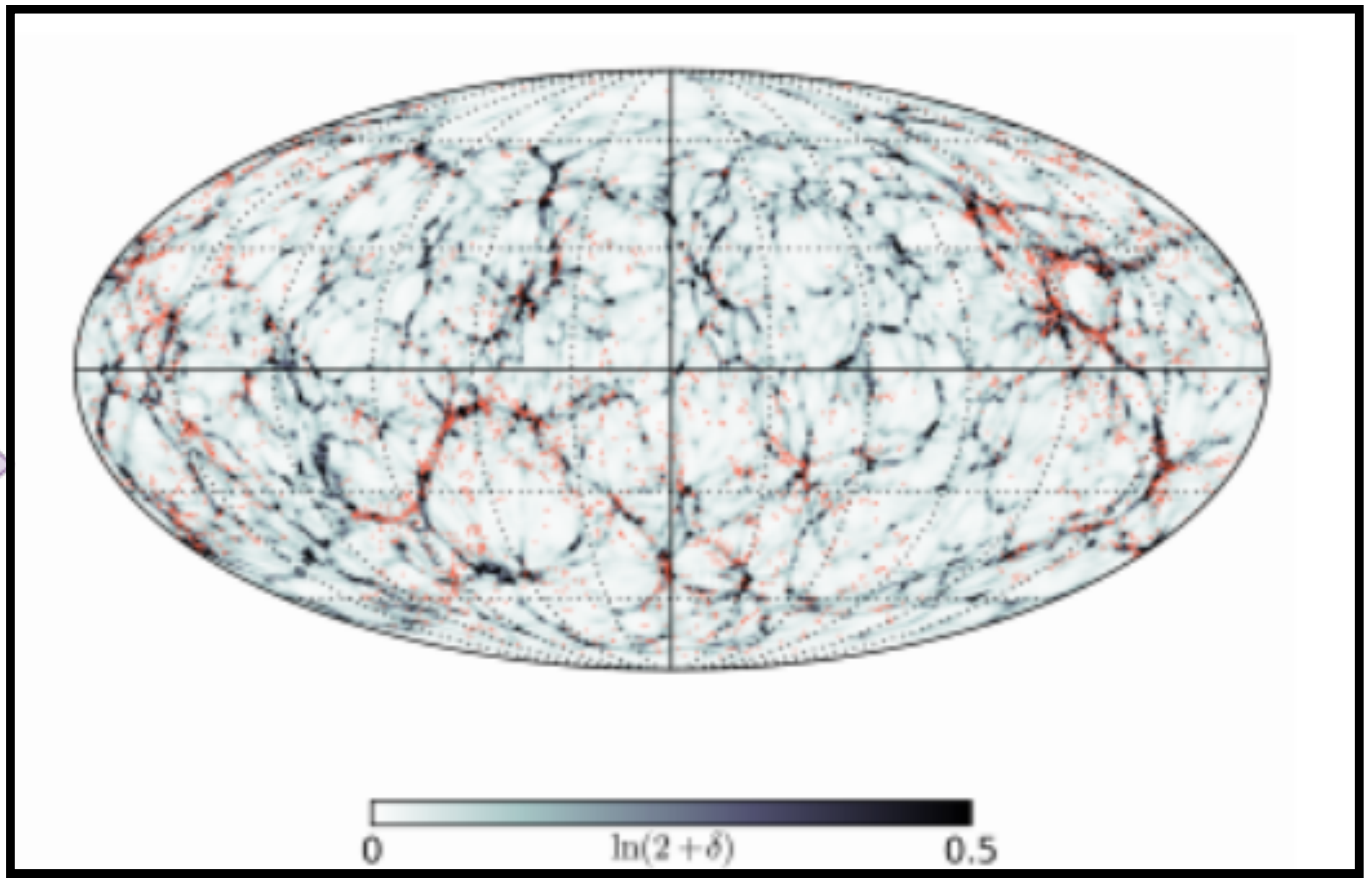

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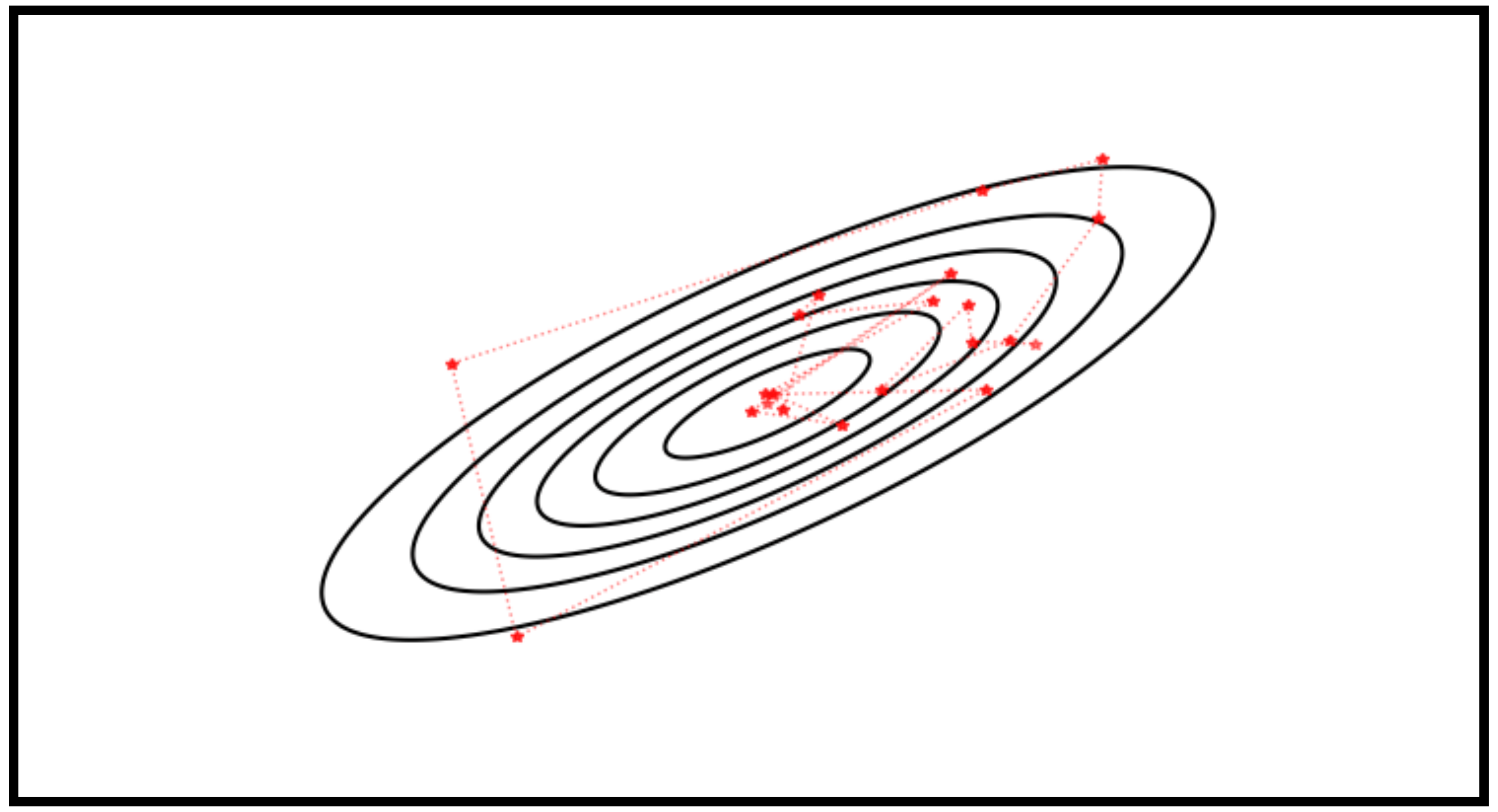

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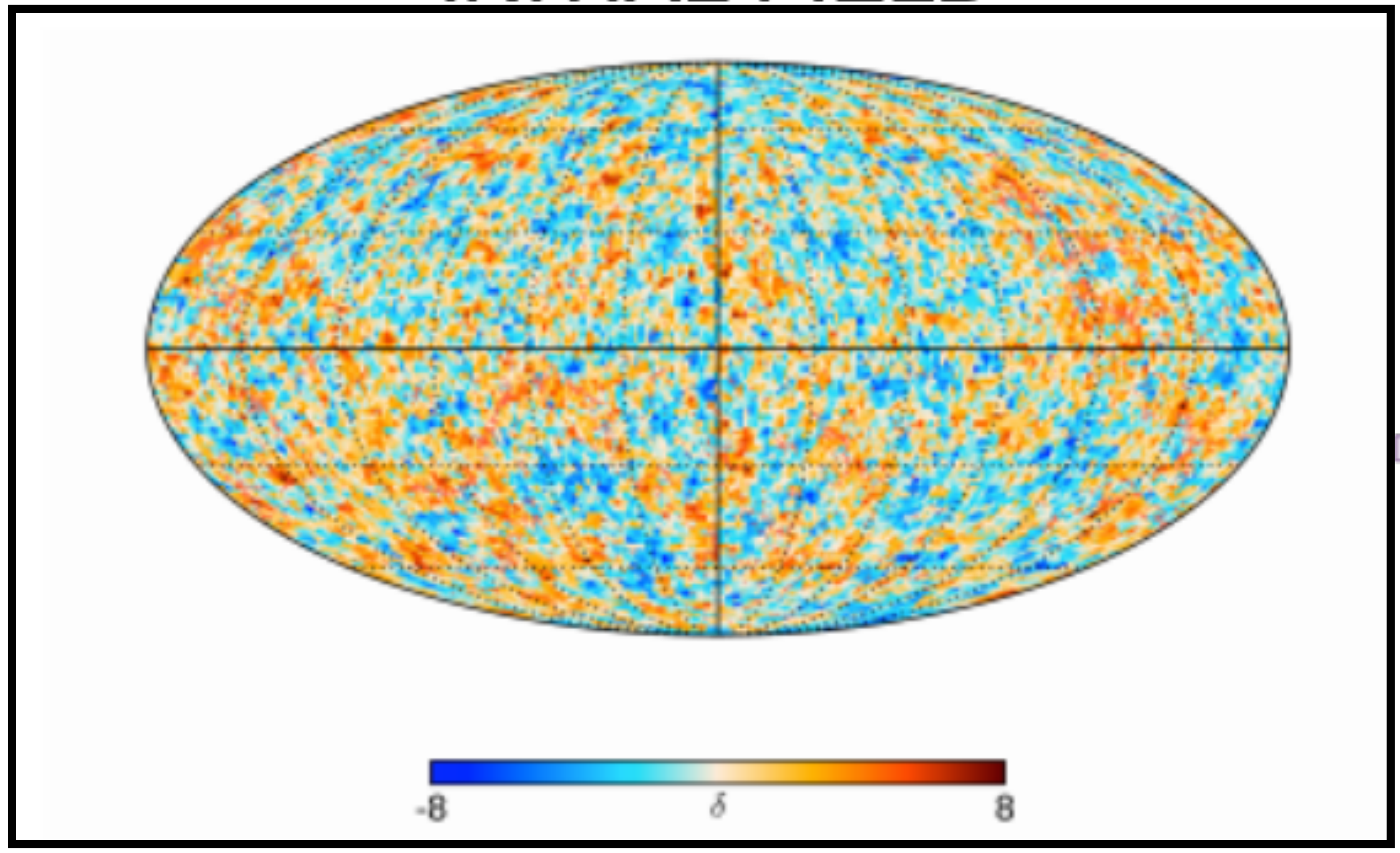

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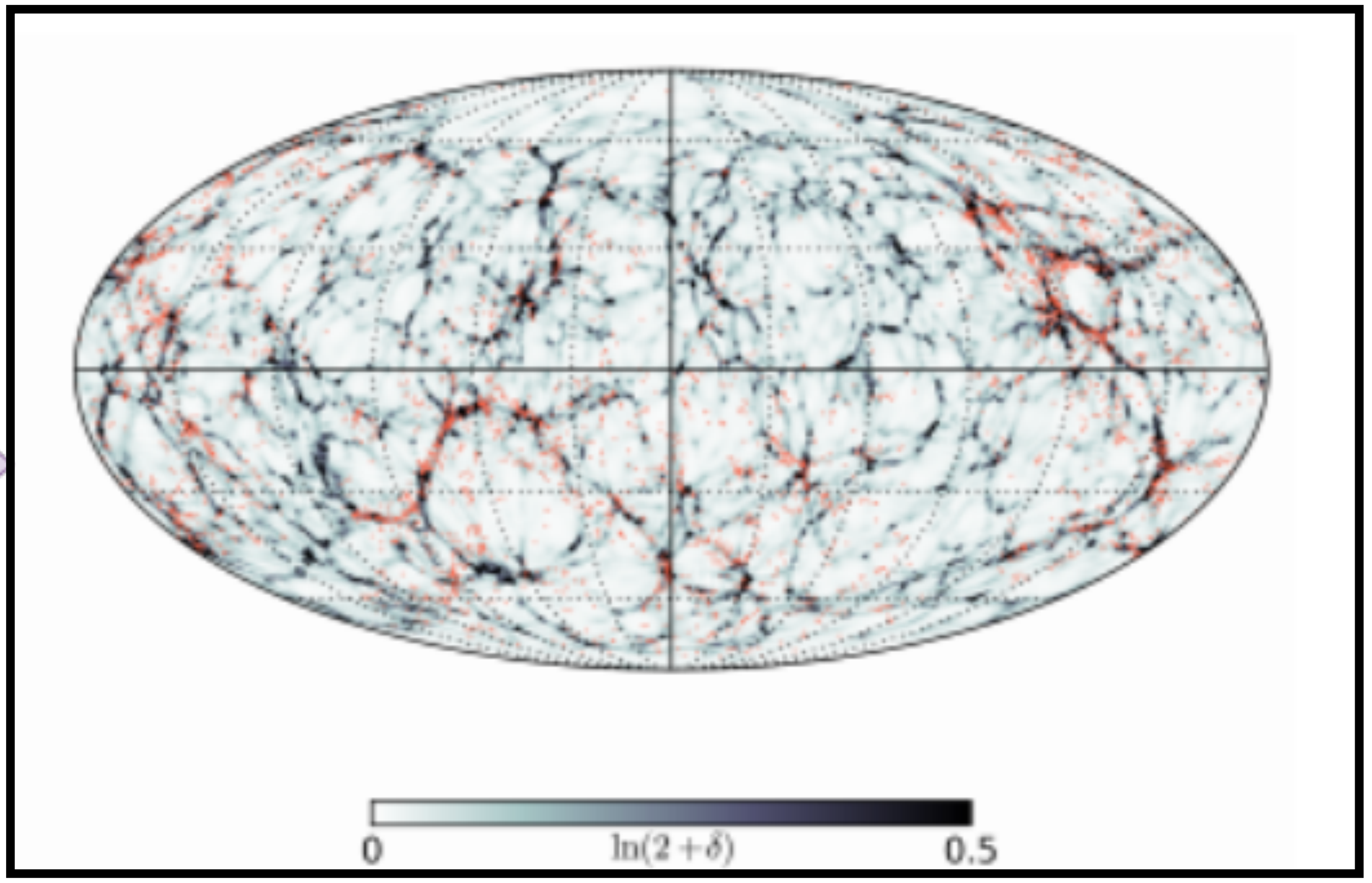

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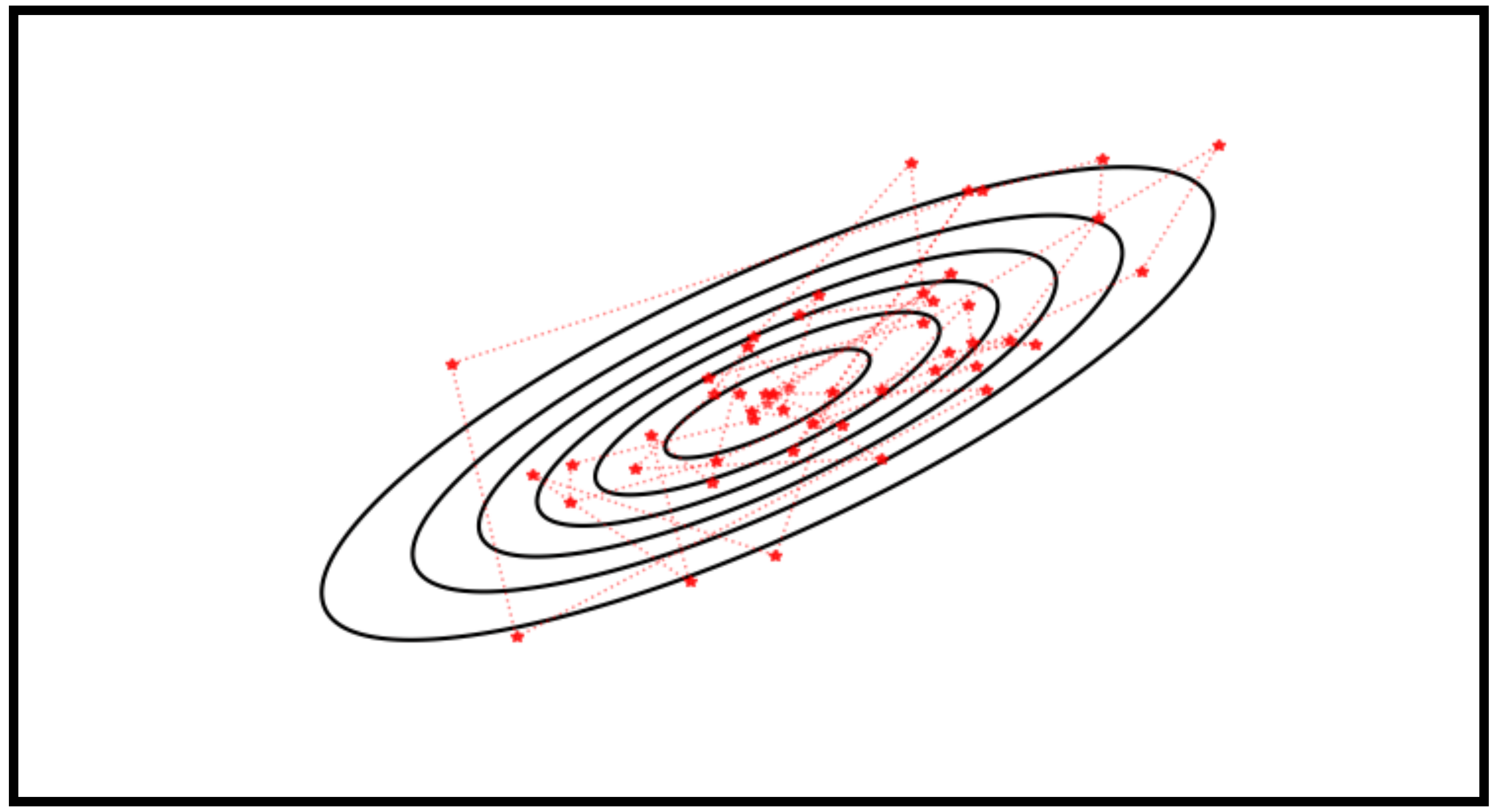

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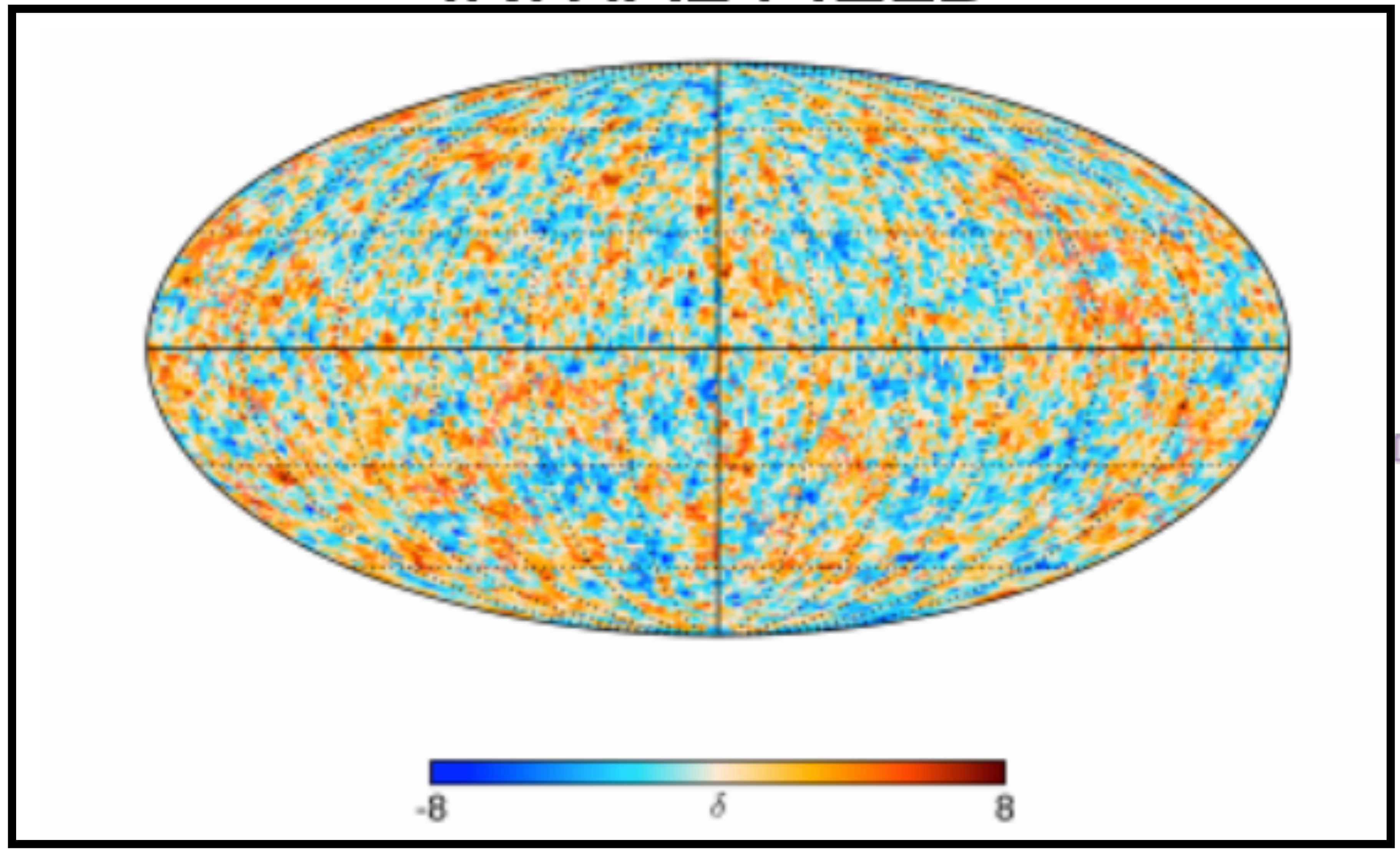

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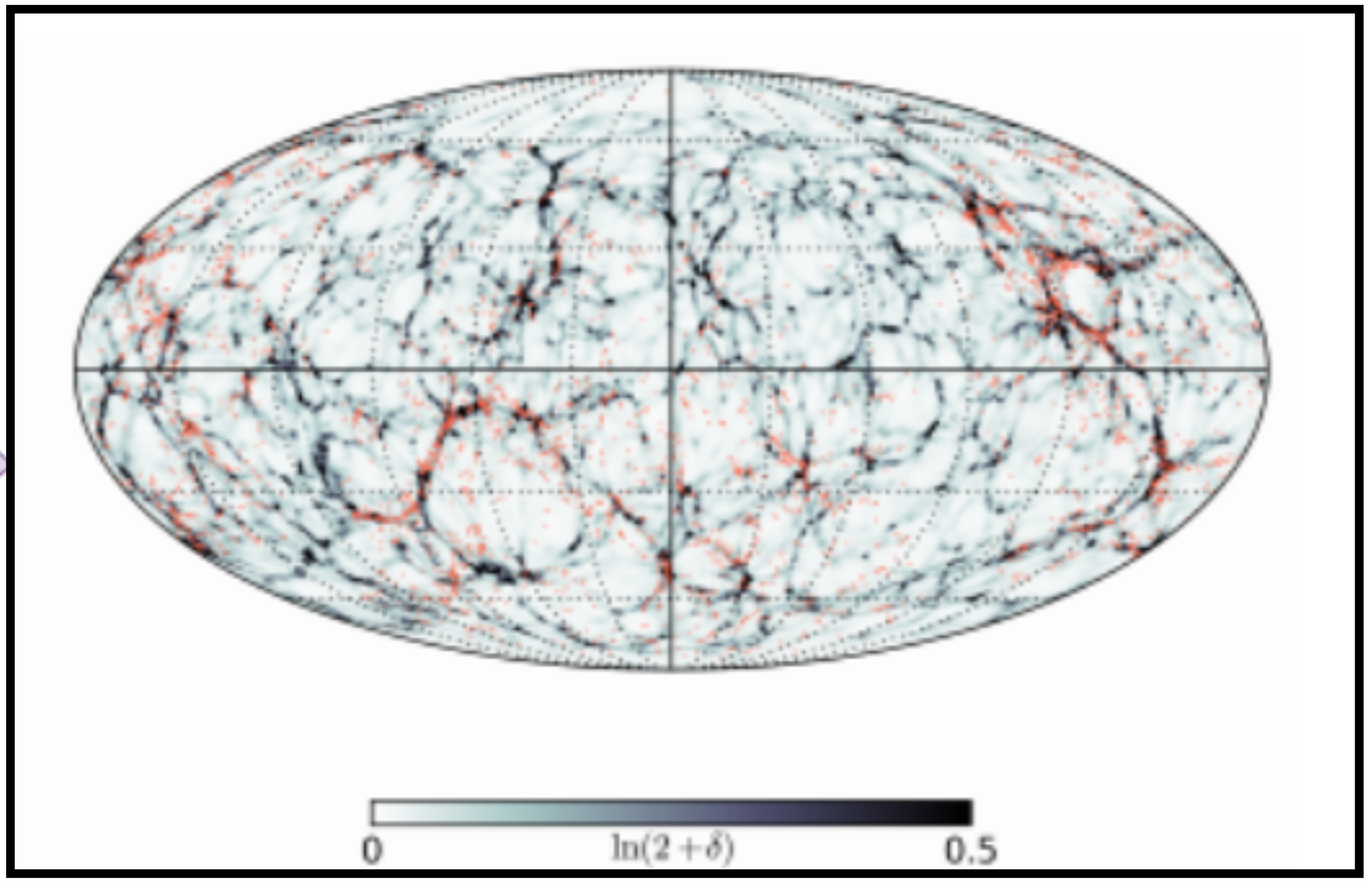

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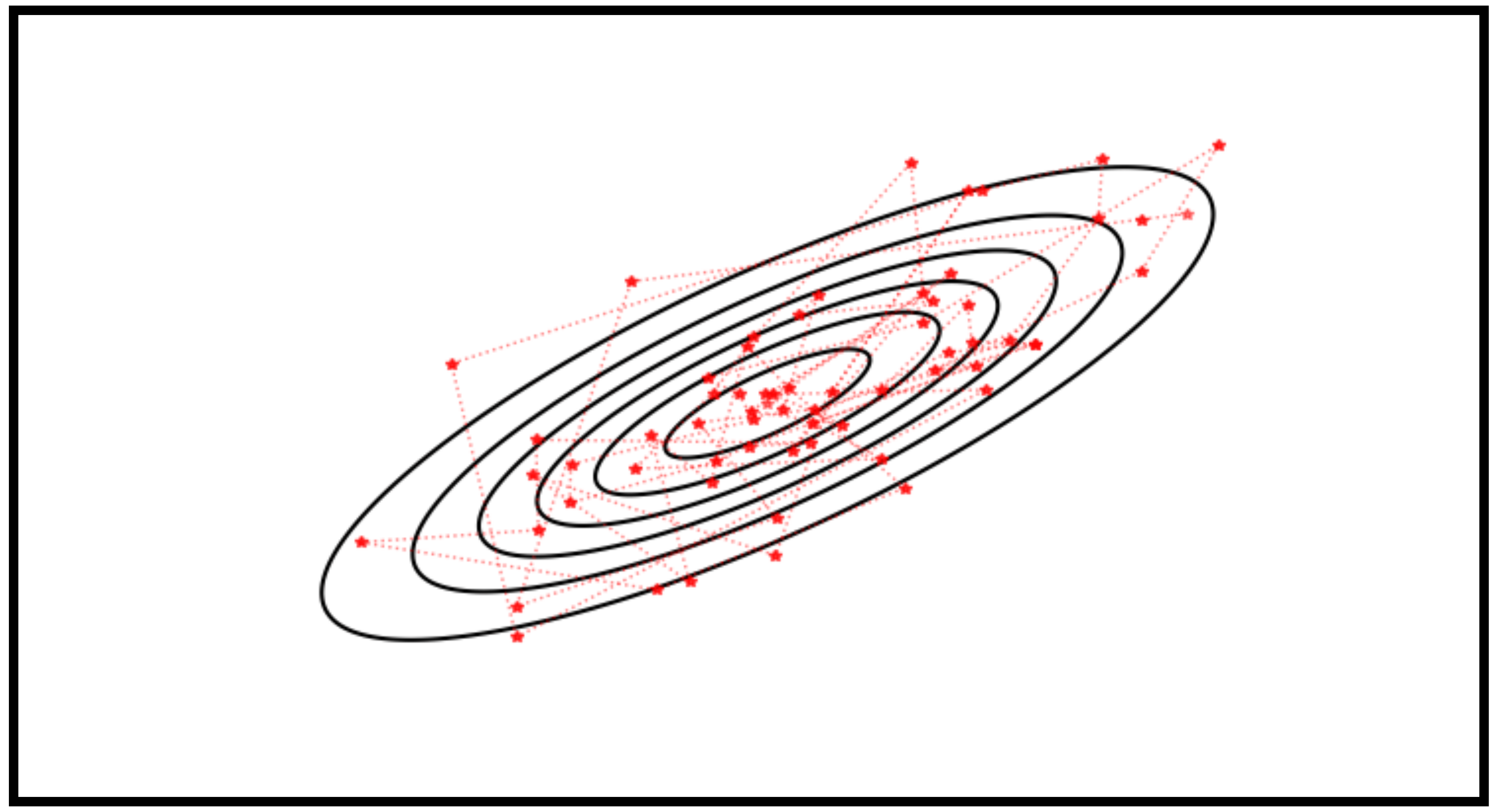

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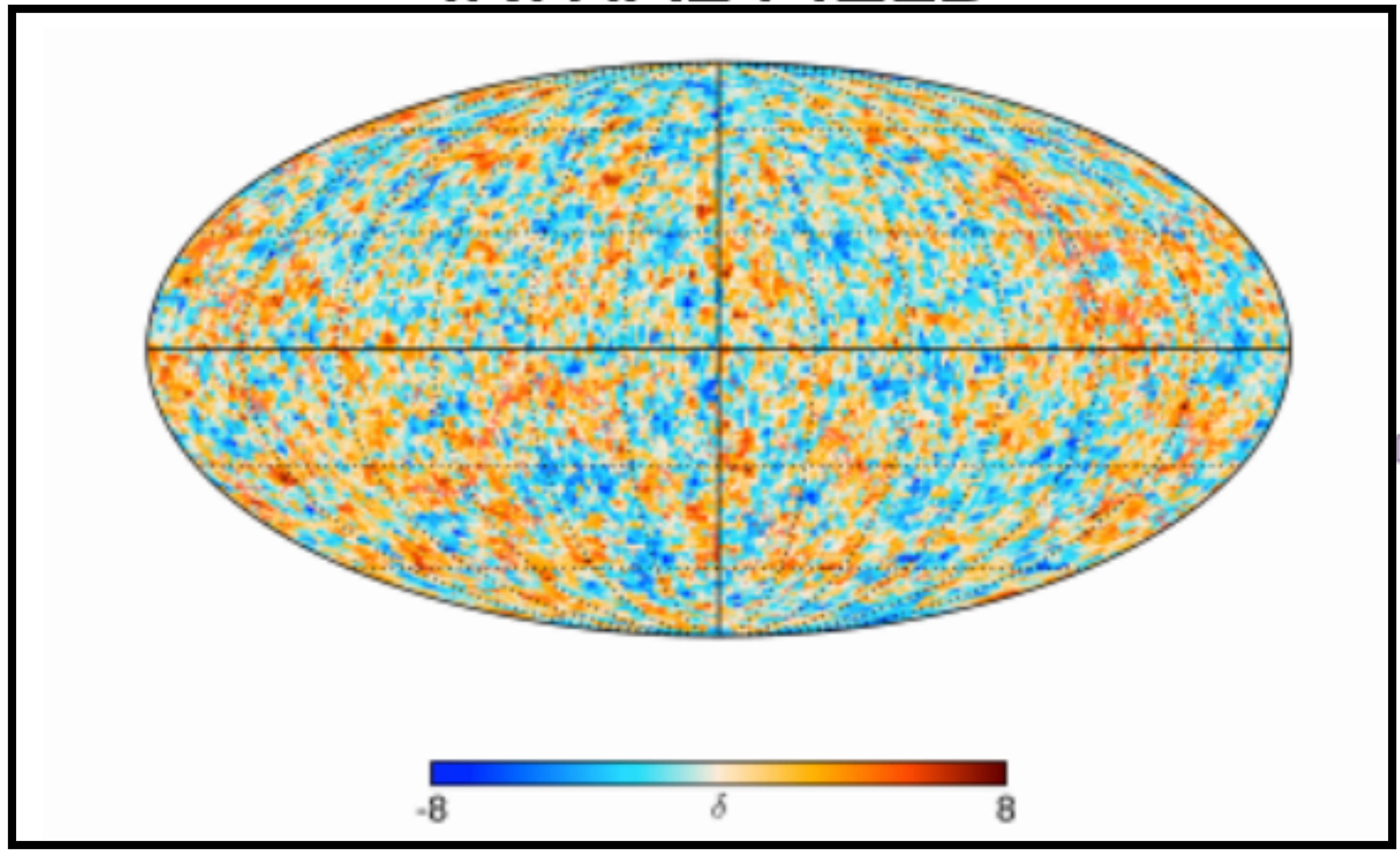

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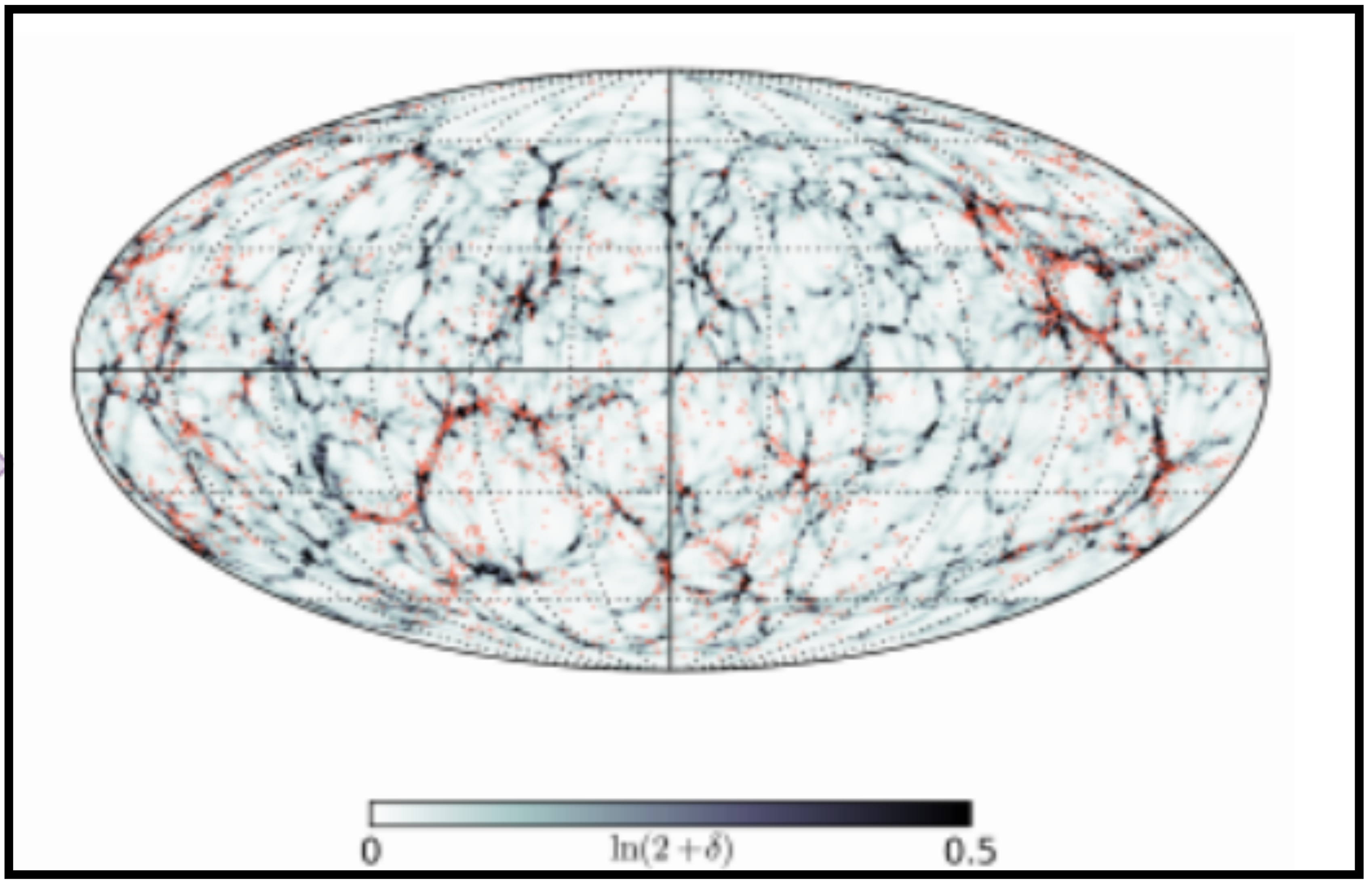

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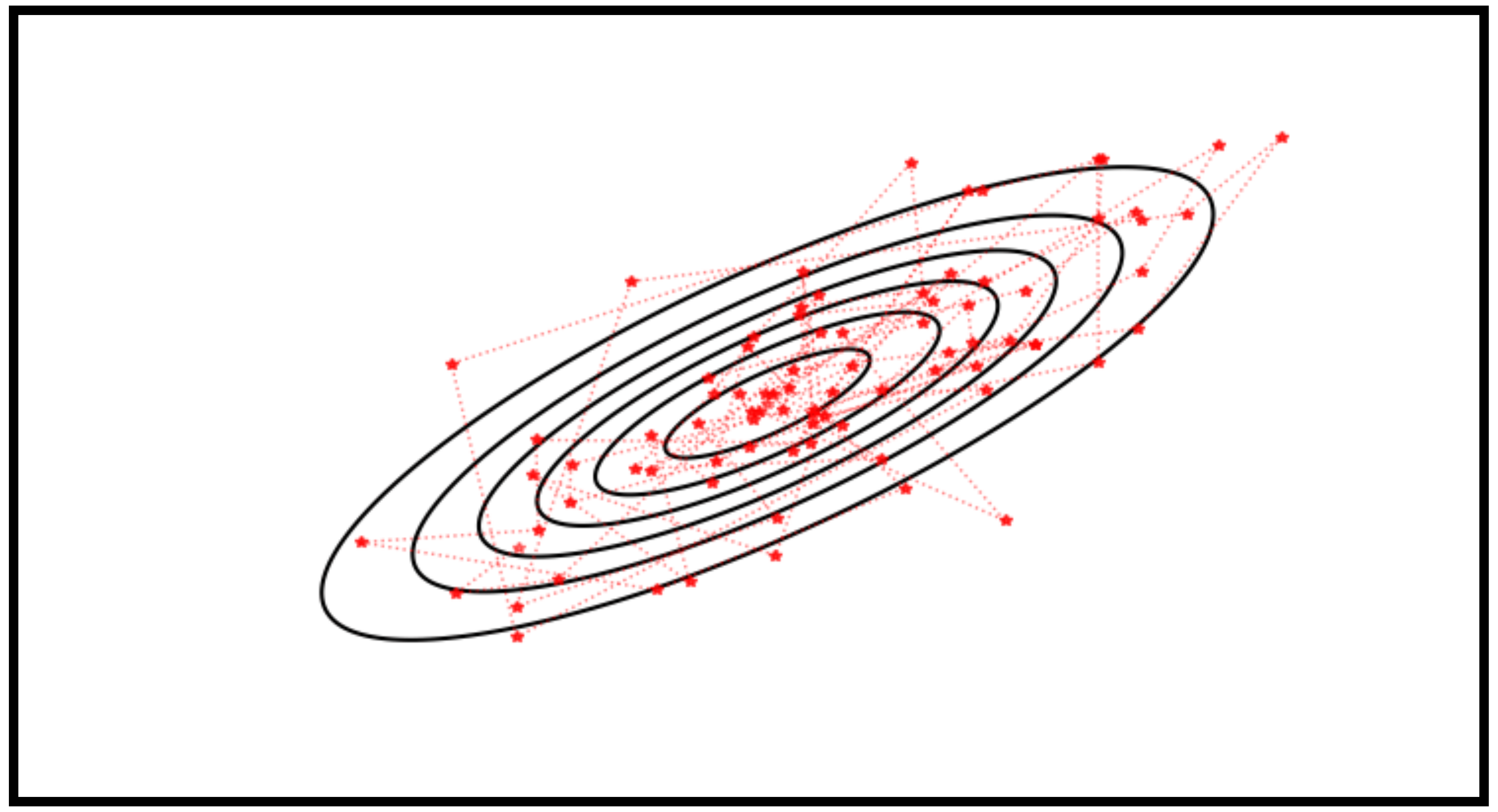

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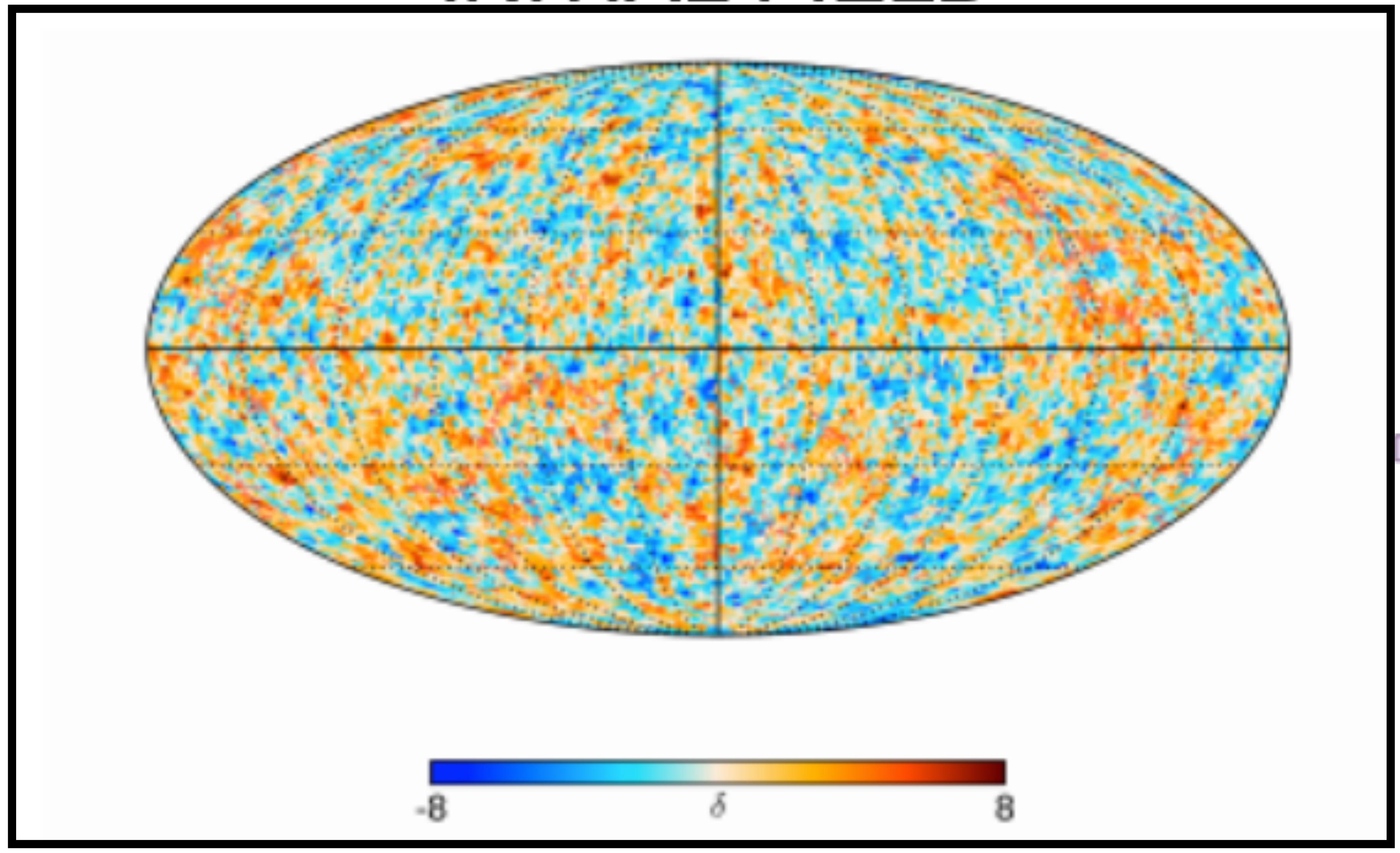

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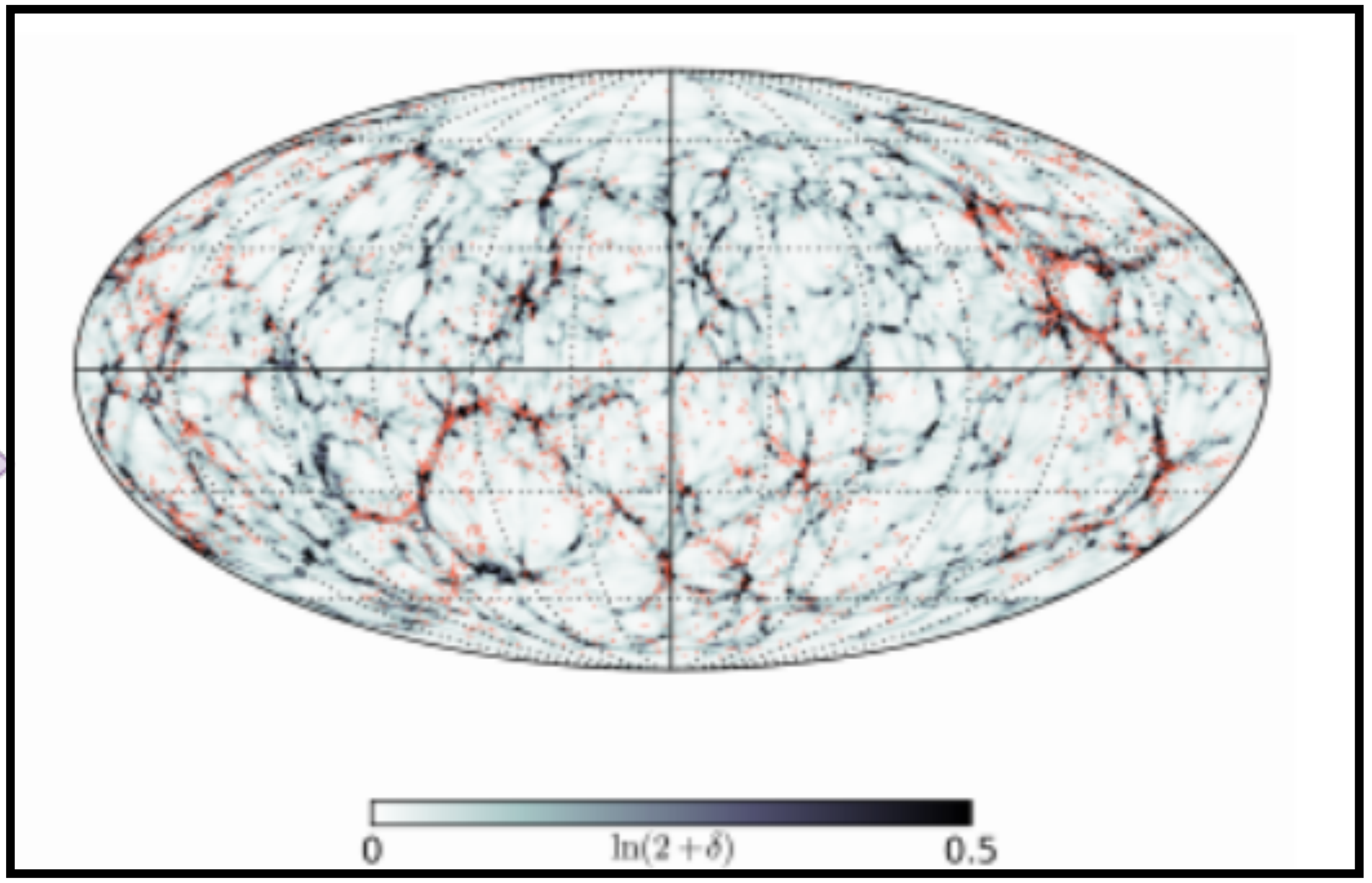

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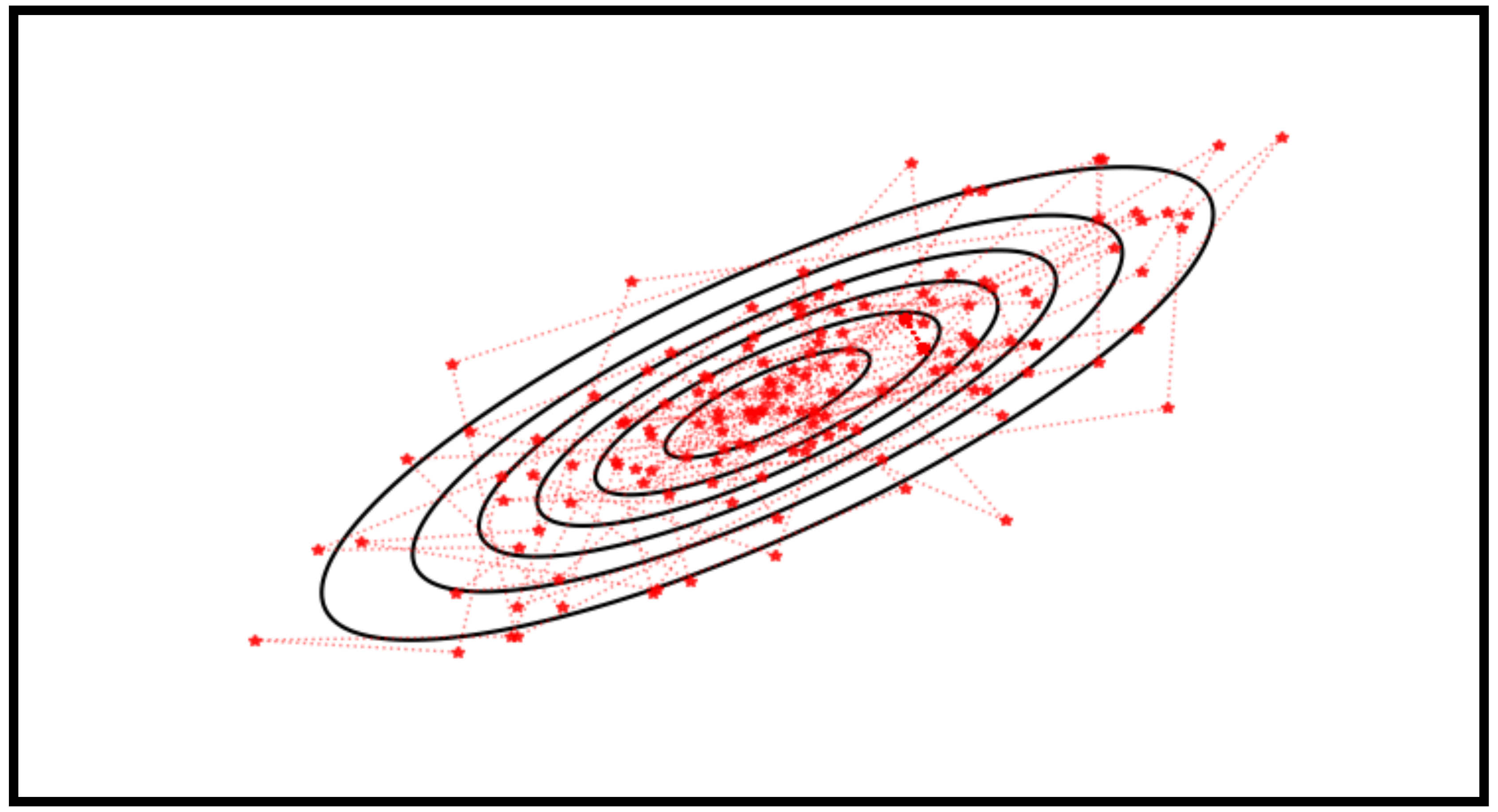

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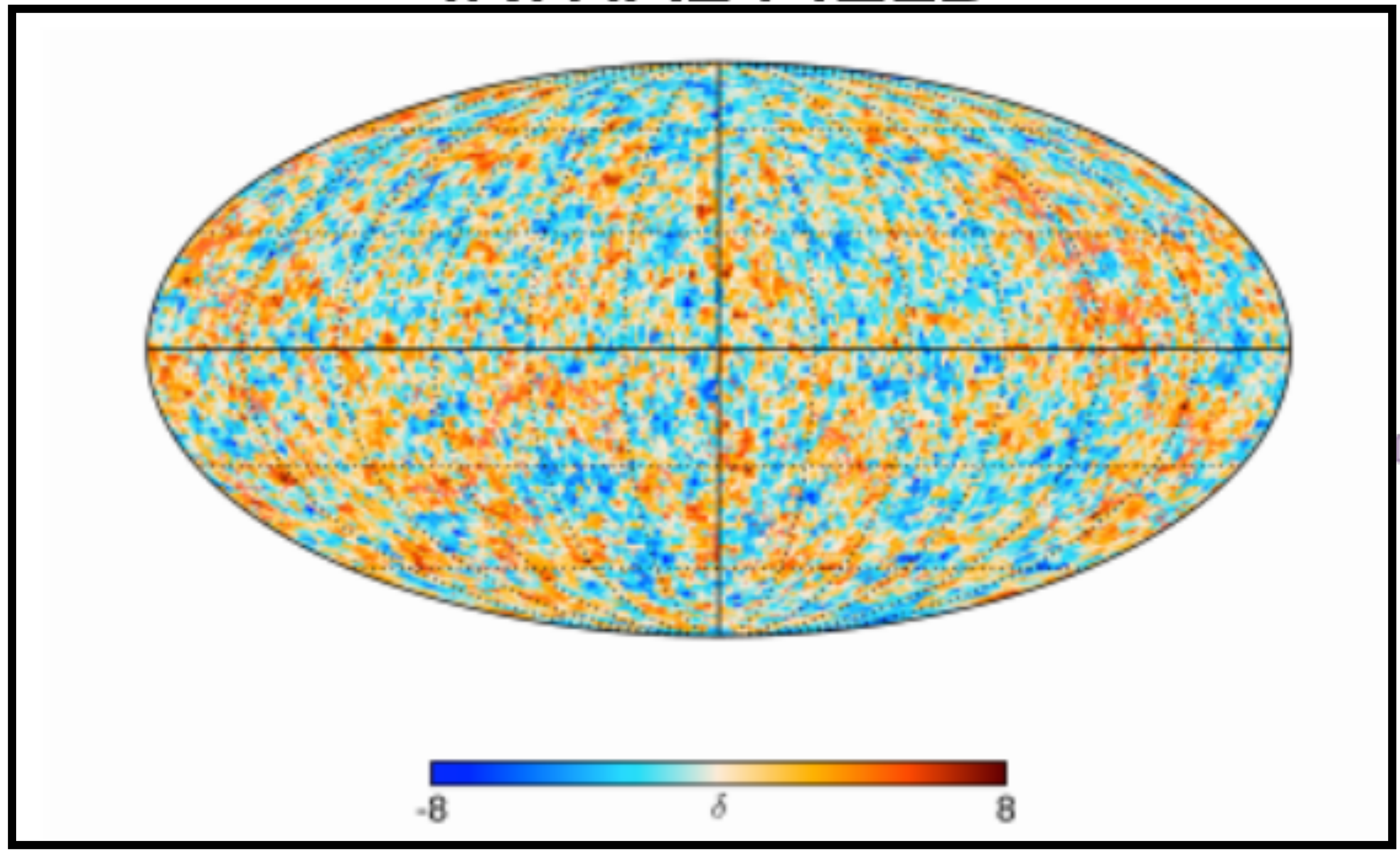

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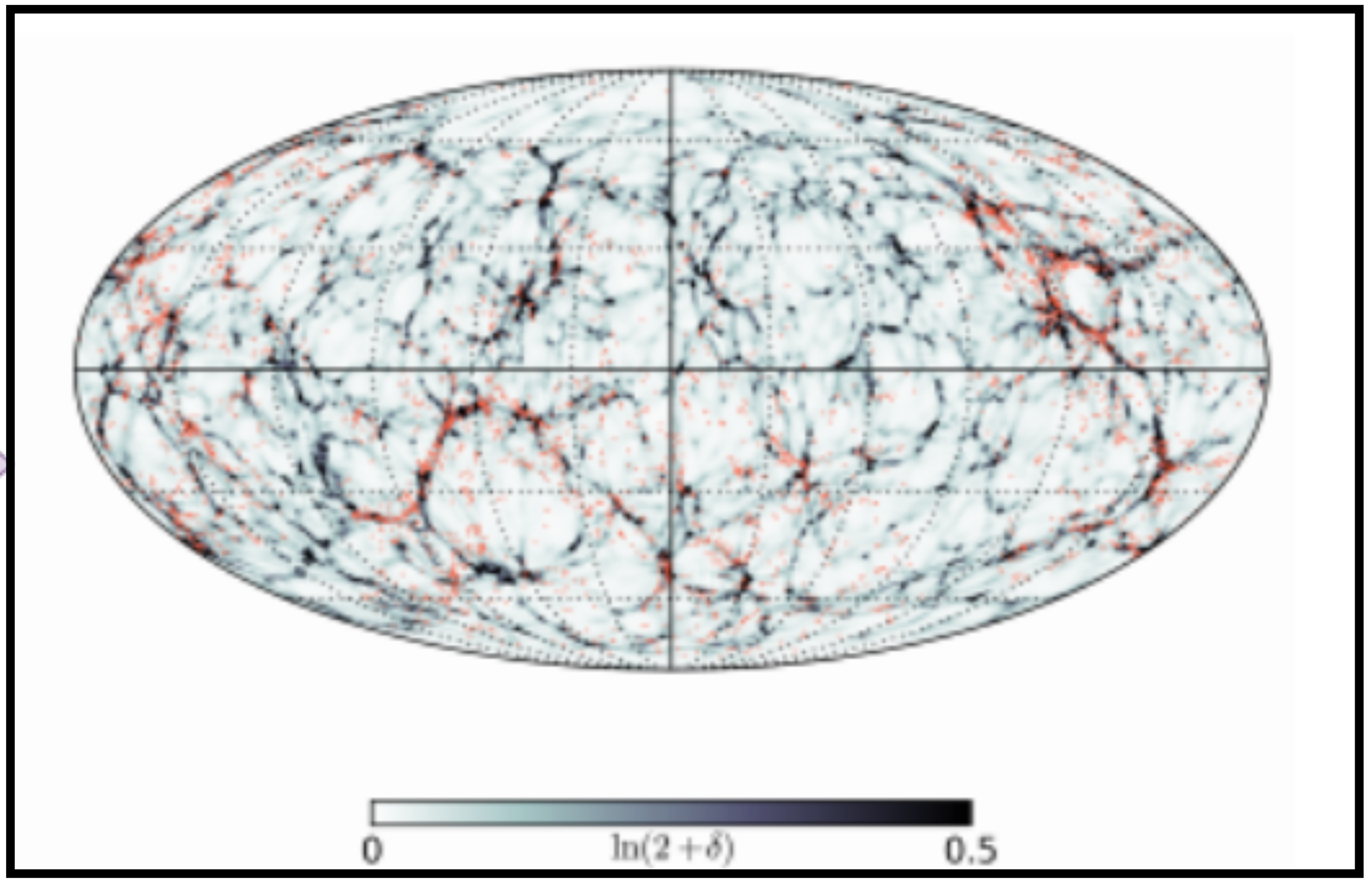

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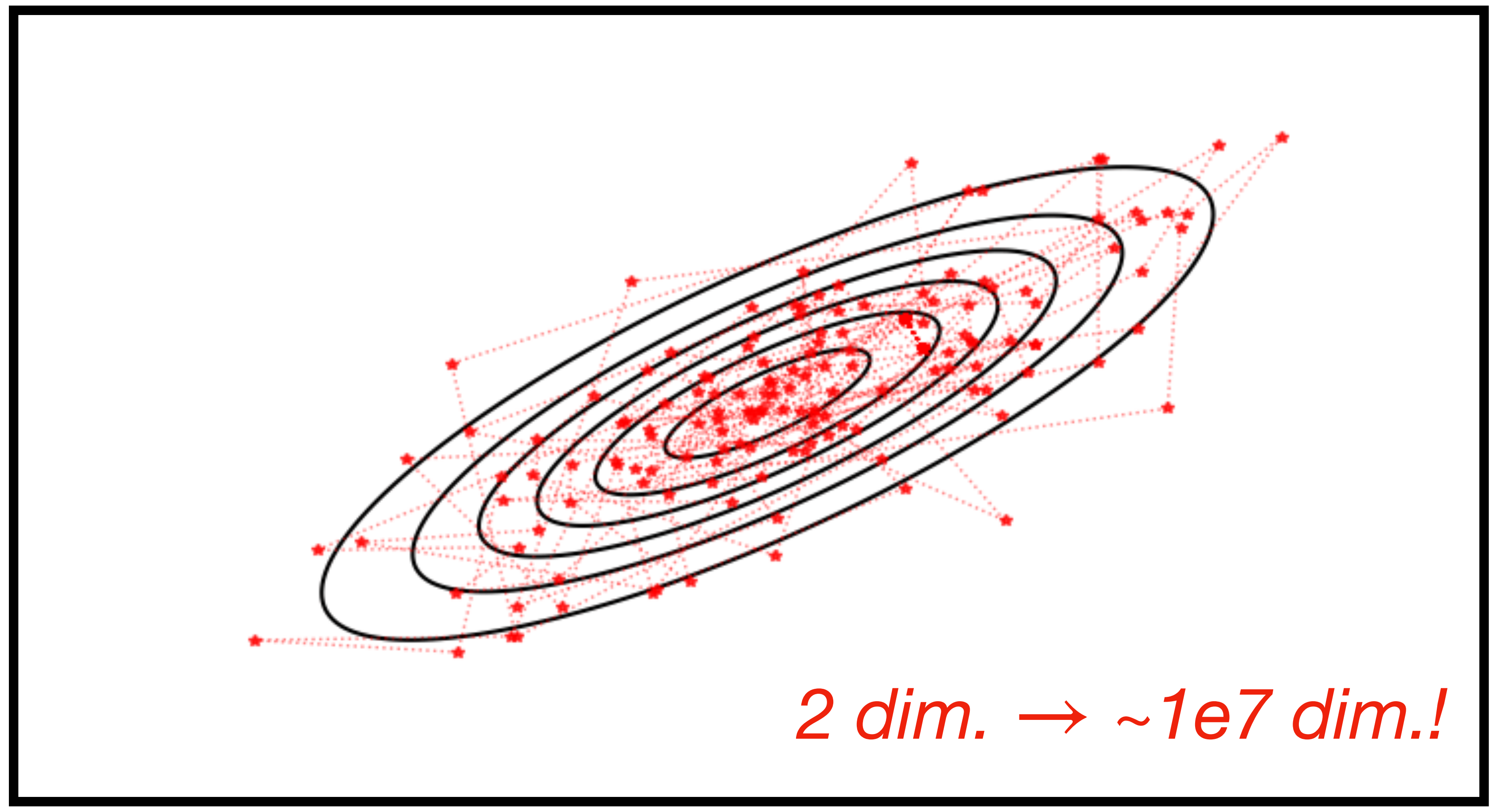

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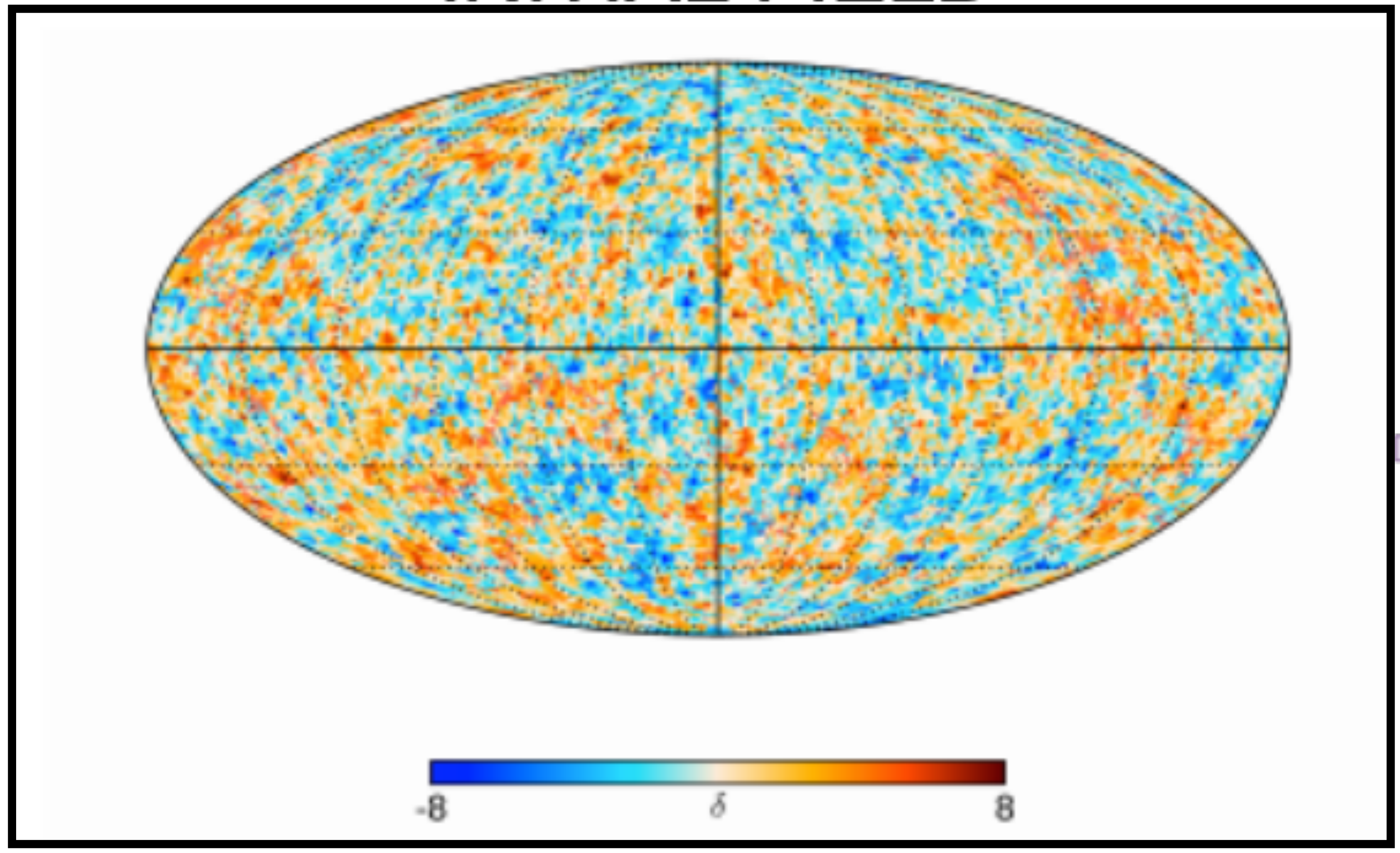

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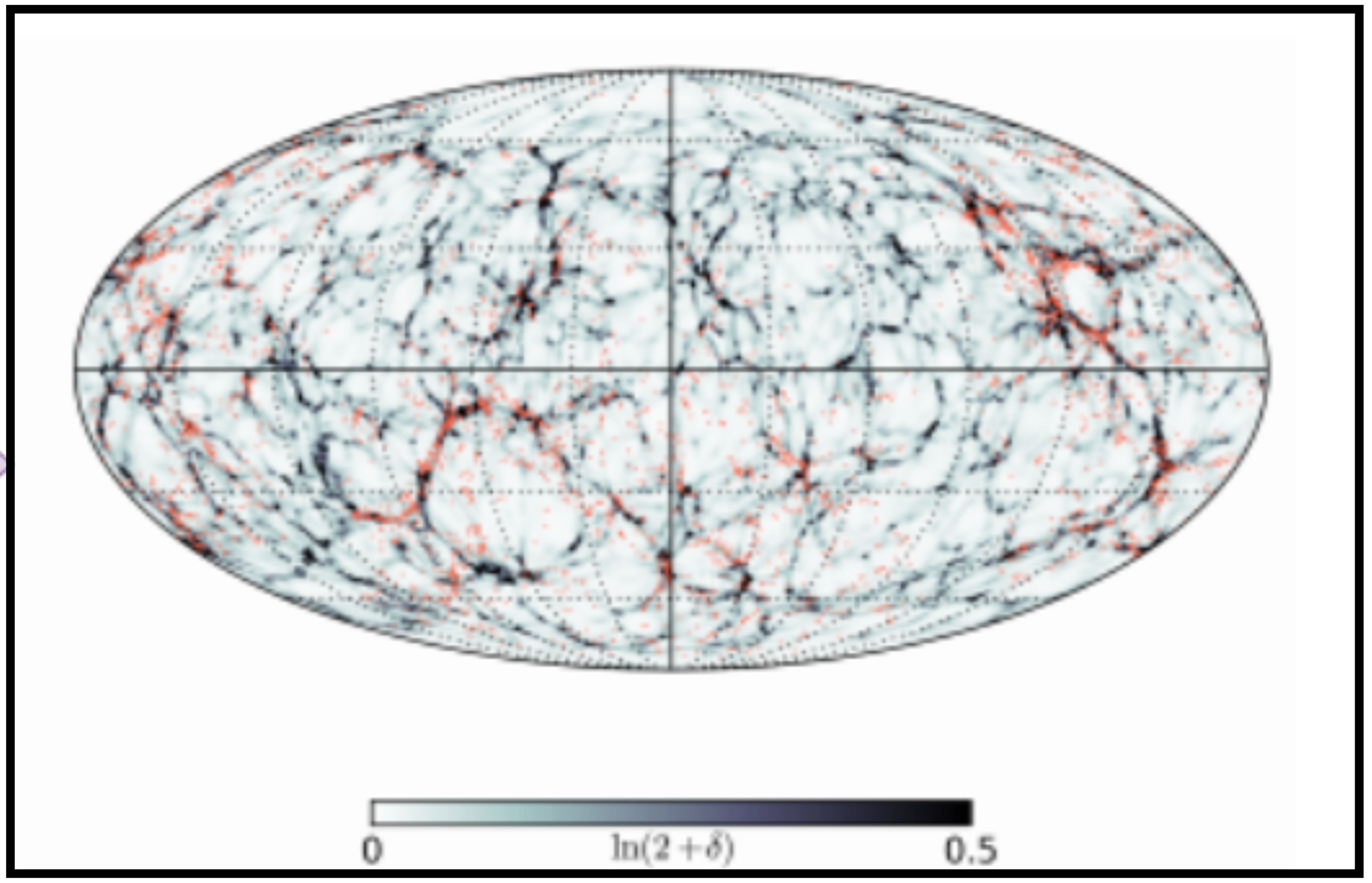

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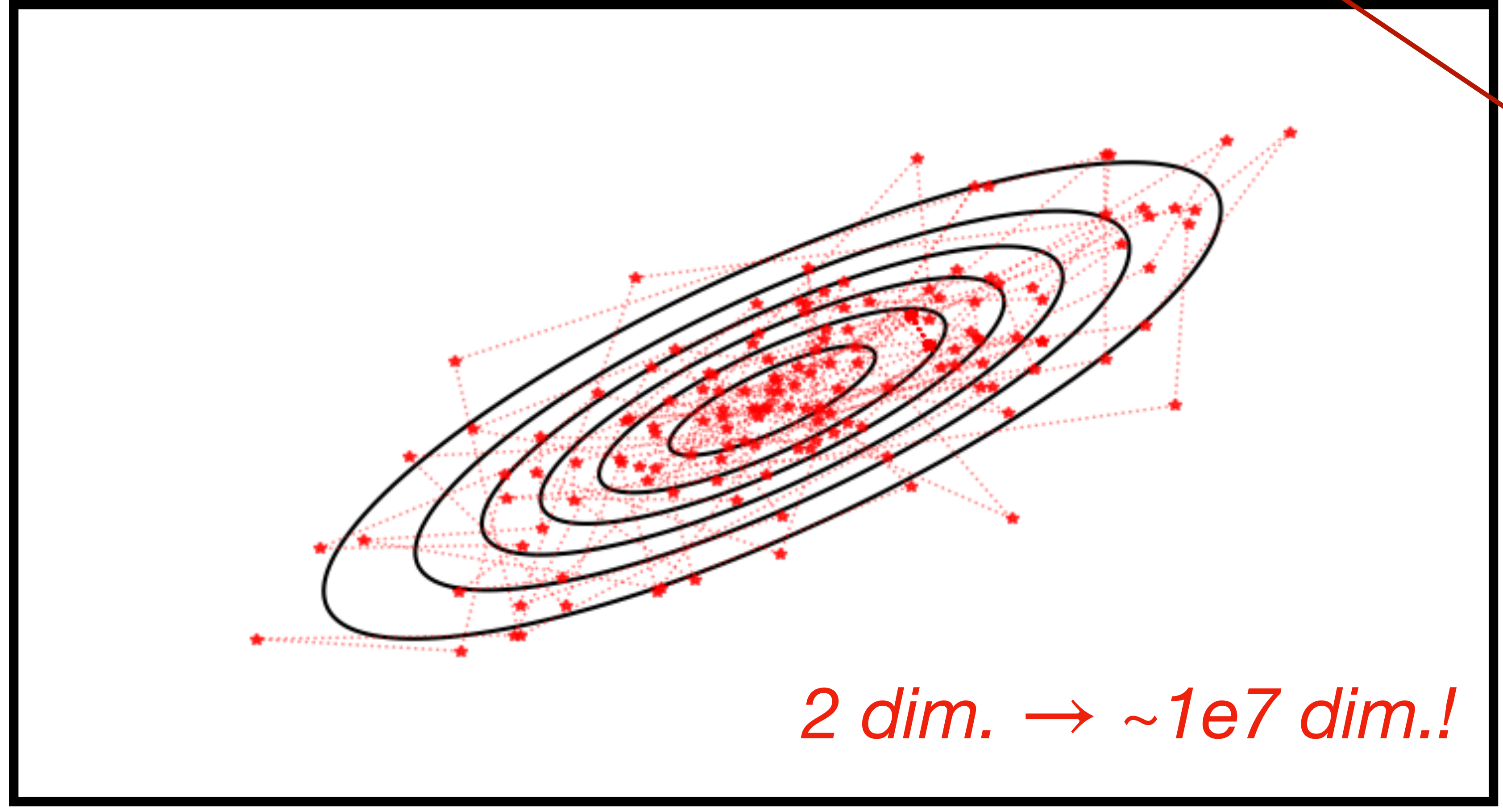

- Go beyond summary statistics
- Handle survey systematics
- Combine multiple probes of PNG
- Cosmic variance cancellation & Super-sample variance

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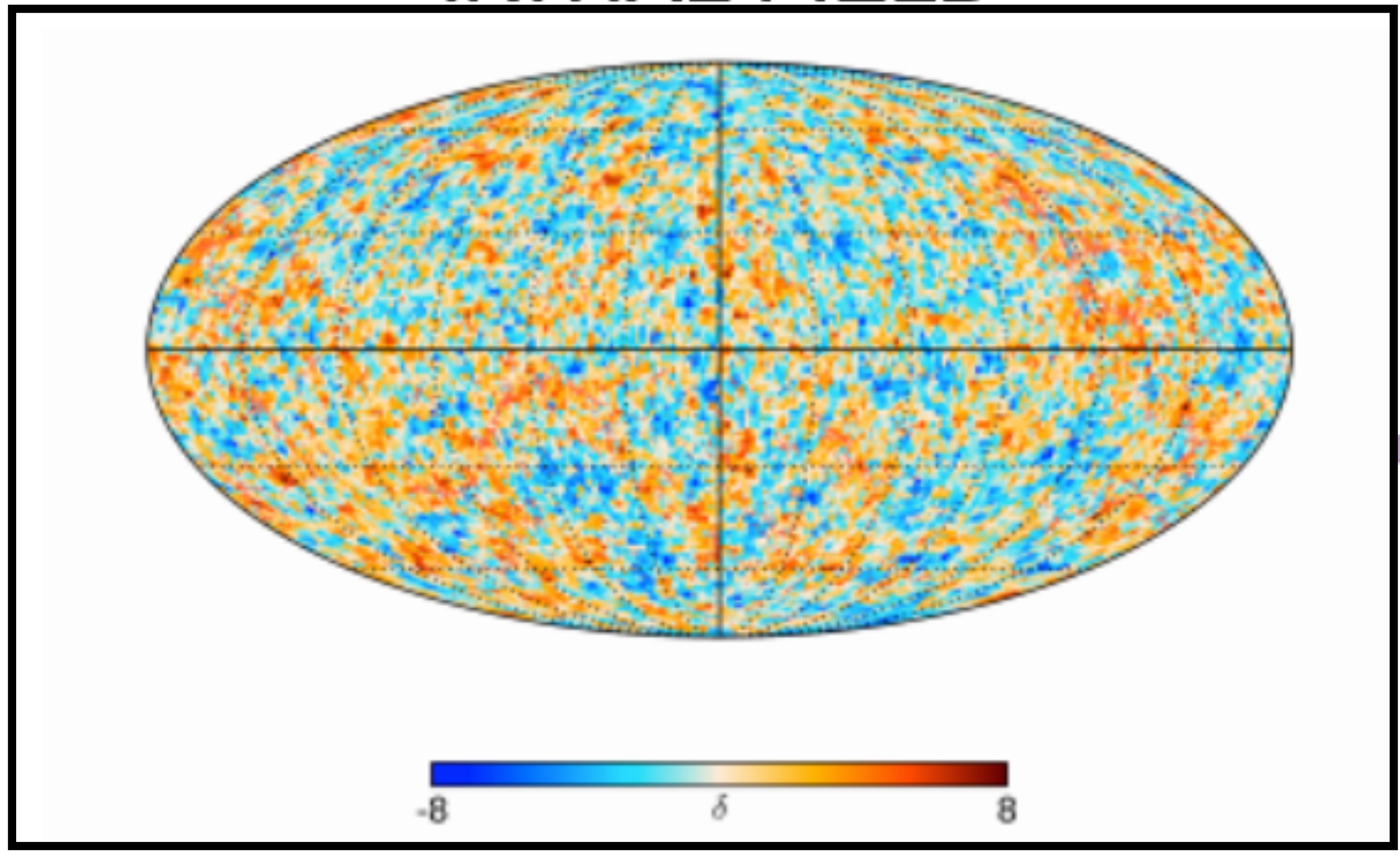

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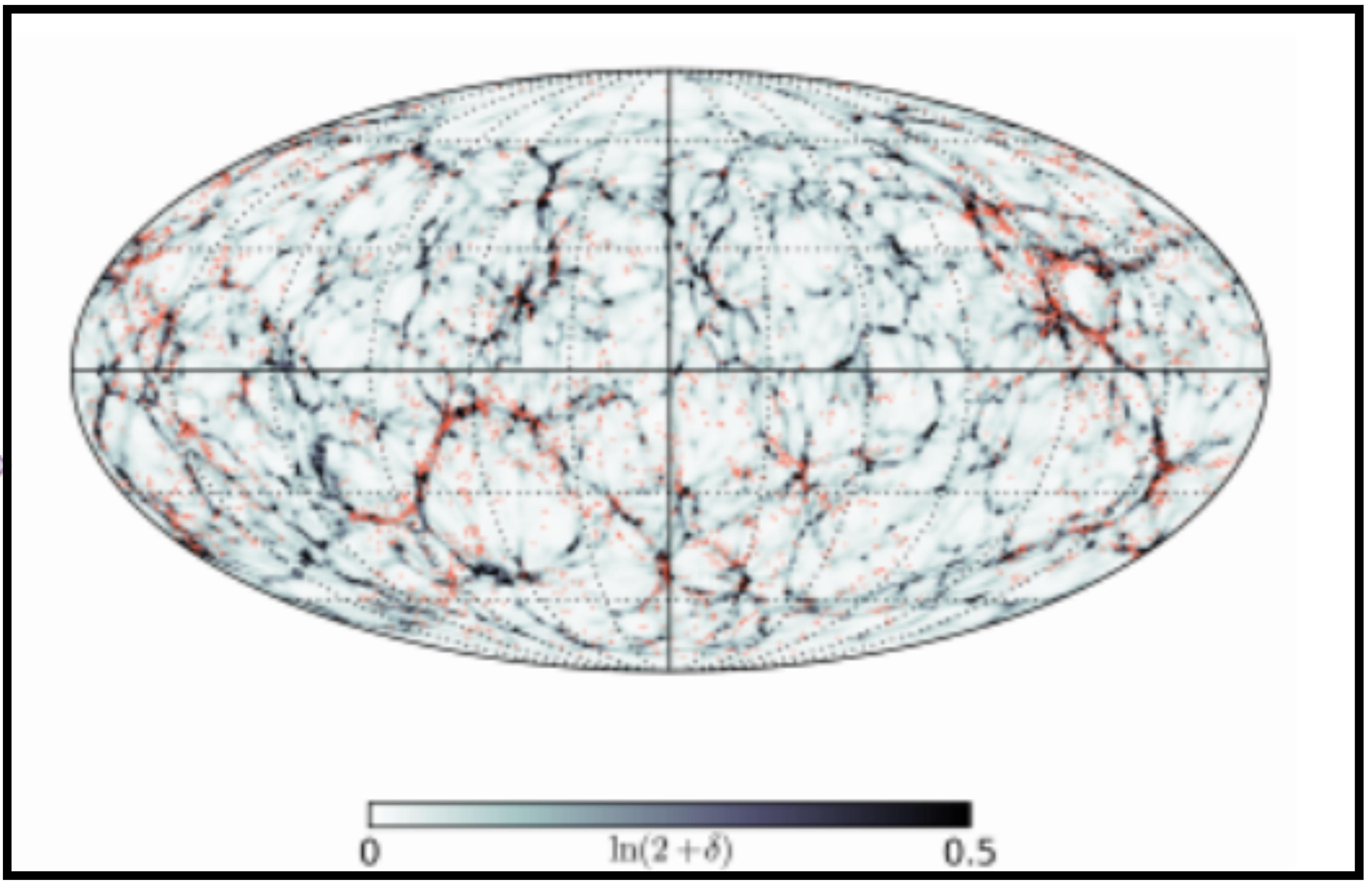

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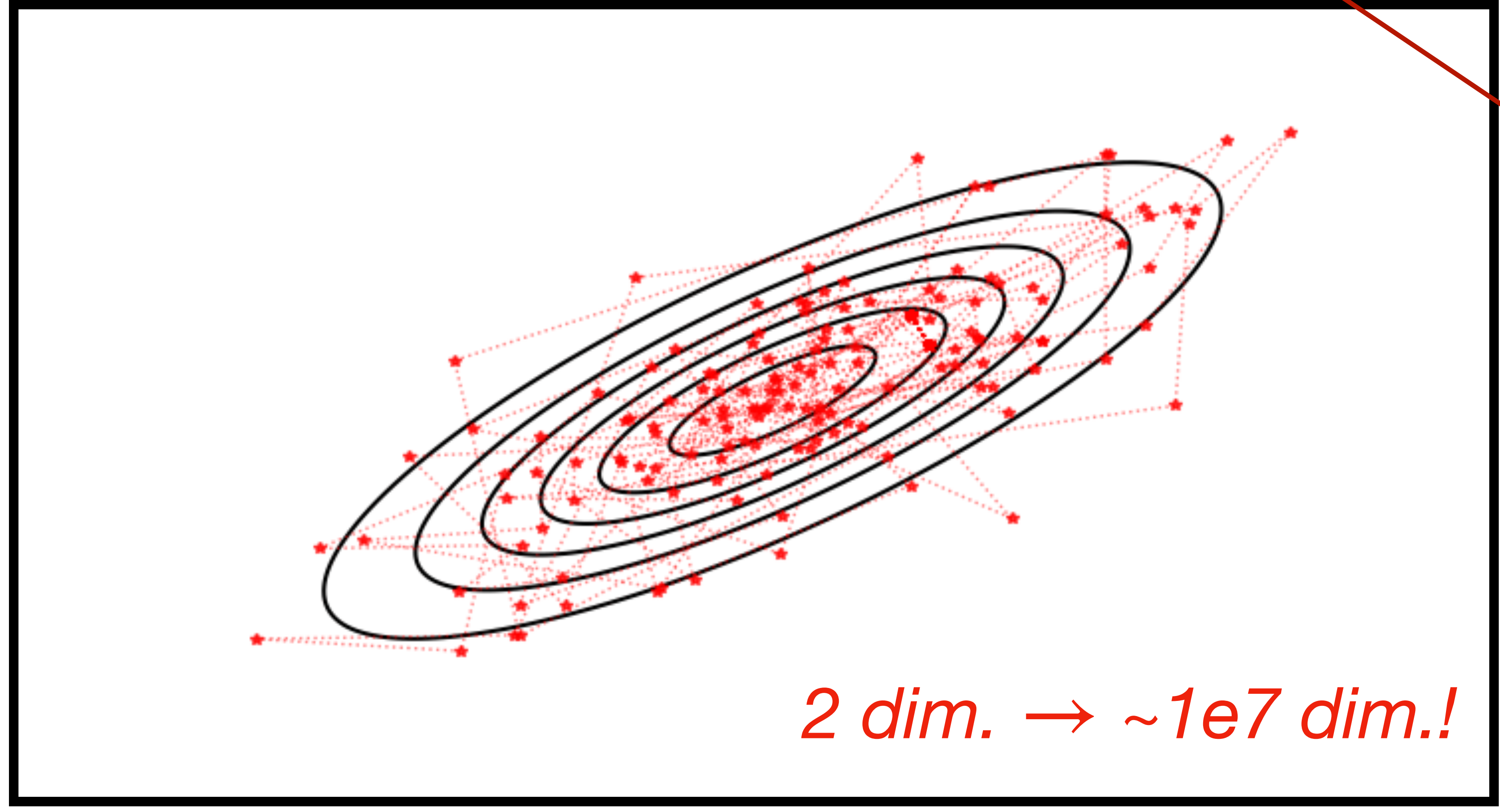

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See Anže's talk

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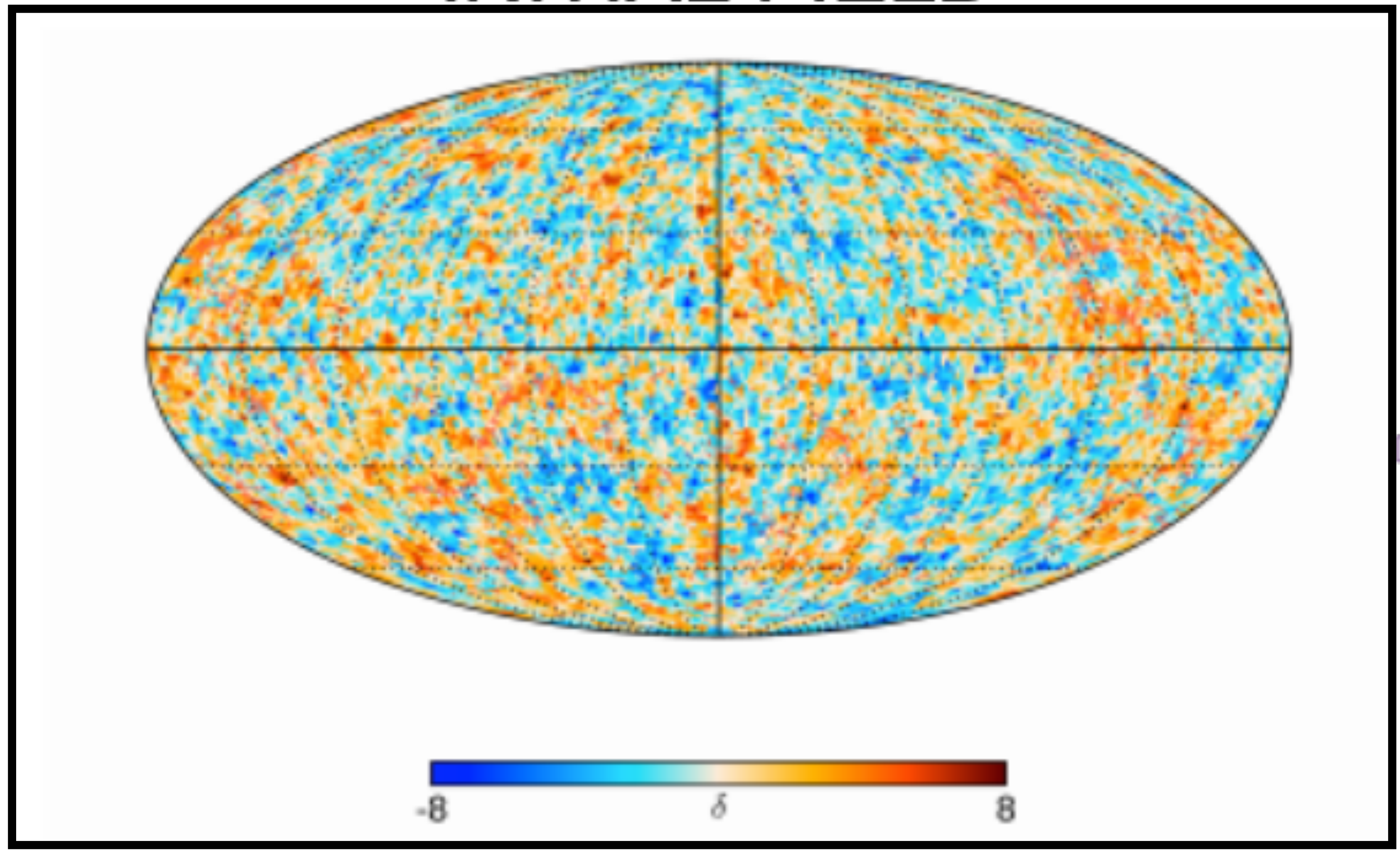

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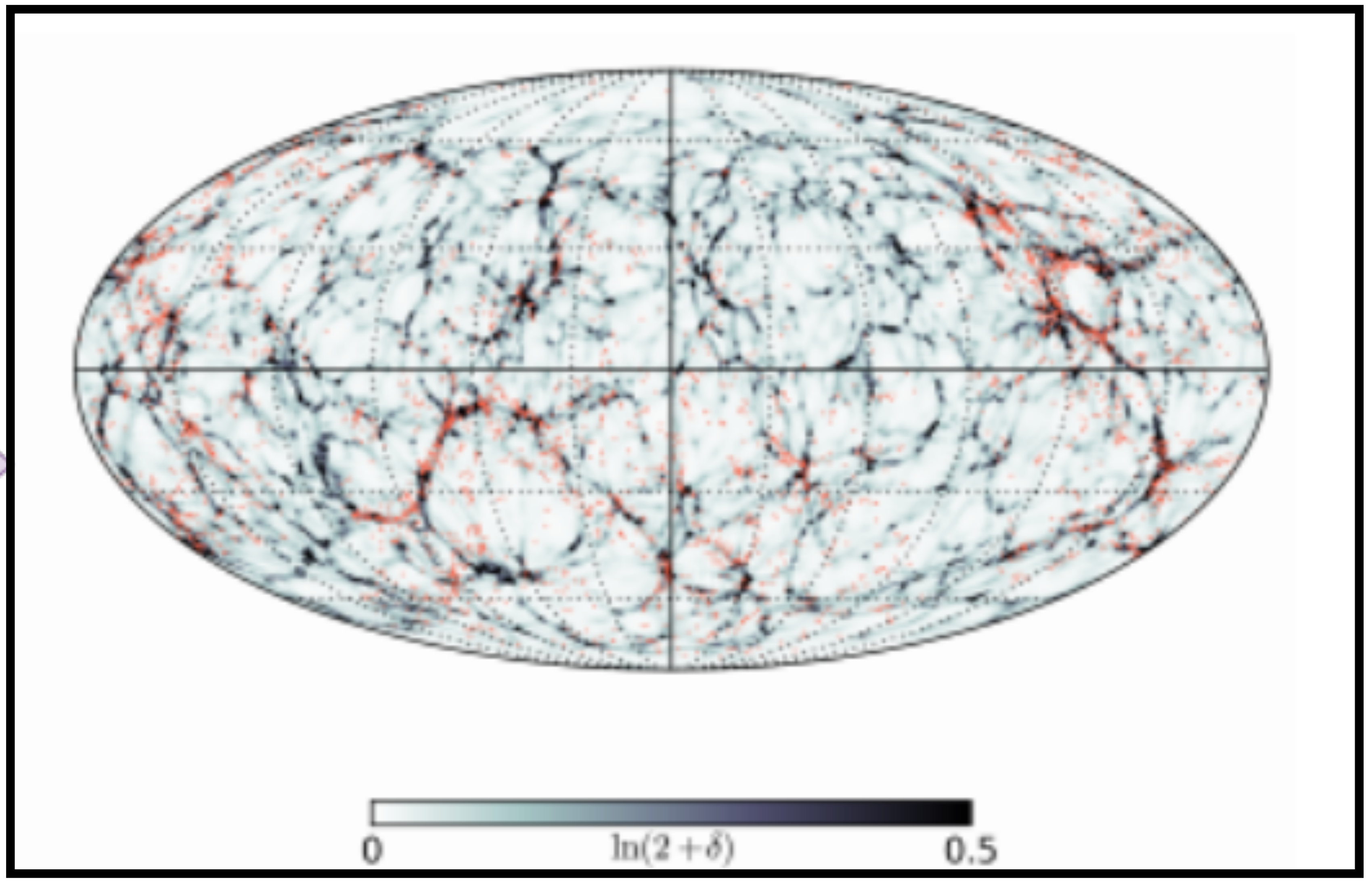

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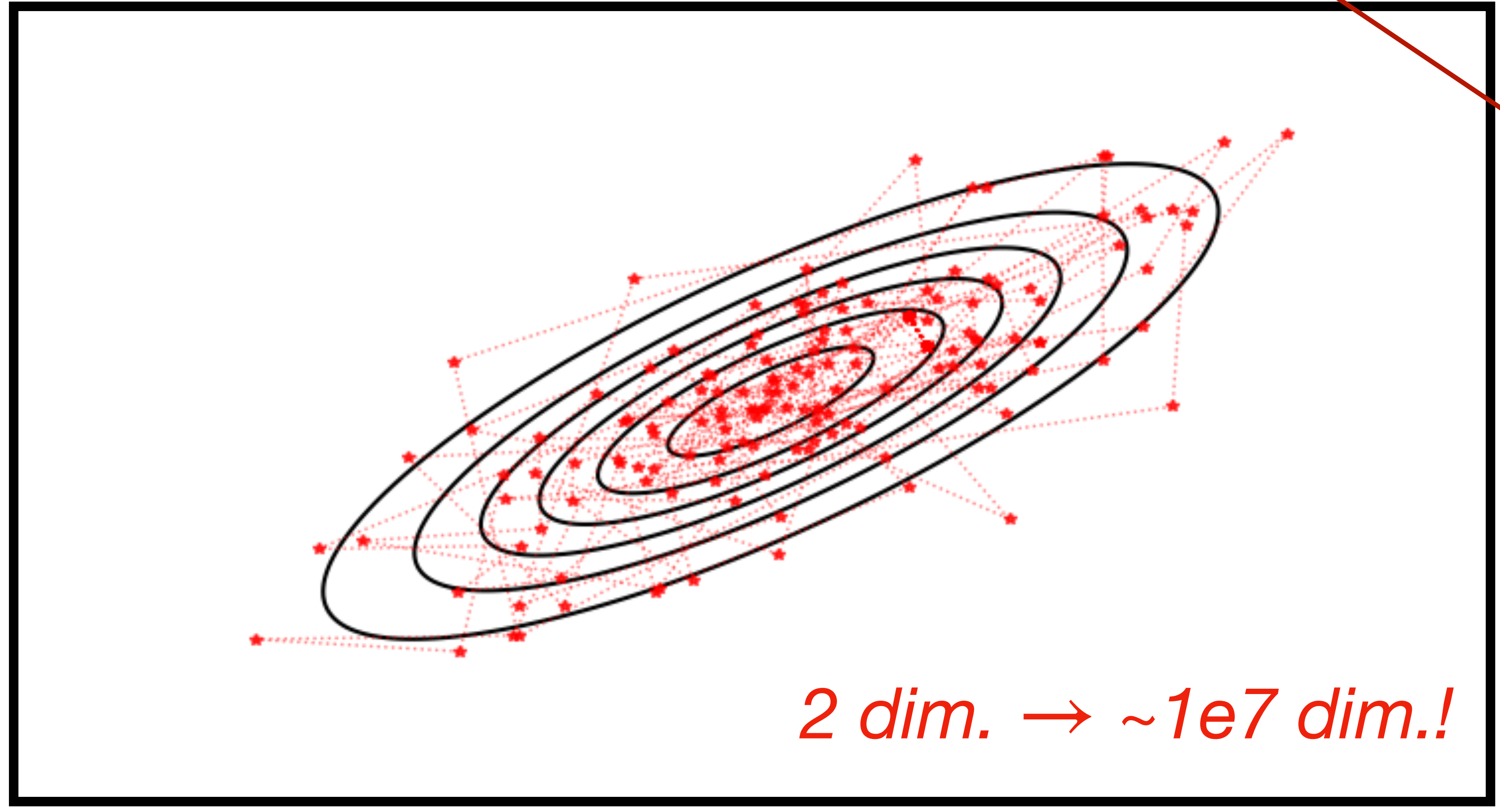

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Bayesian **O**rigin **R**econstruction **f**rom **G**alaxies

https://www.aquila-consortium.org/

Mock data test

Mock data test

SDSS3

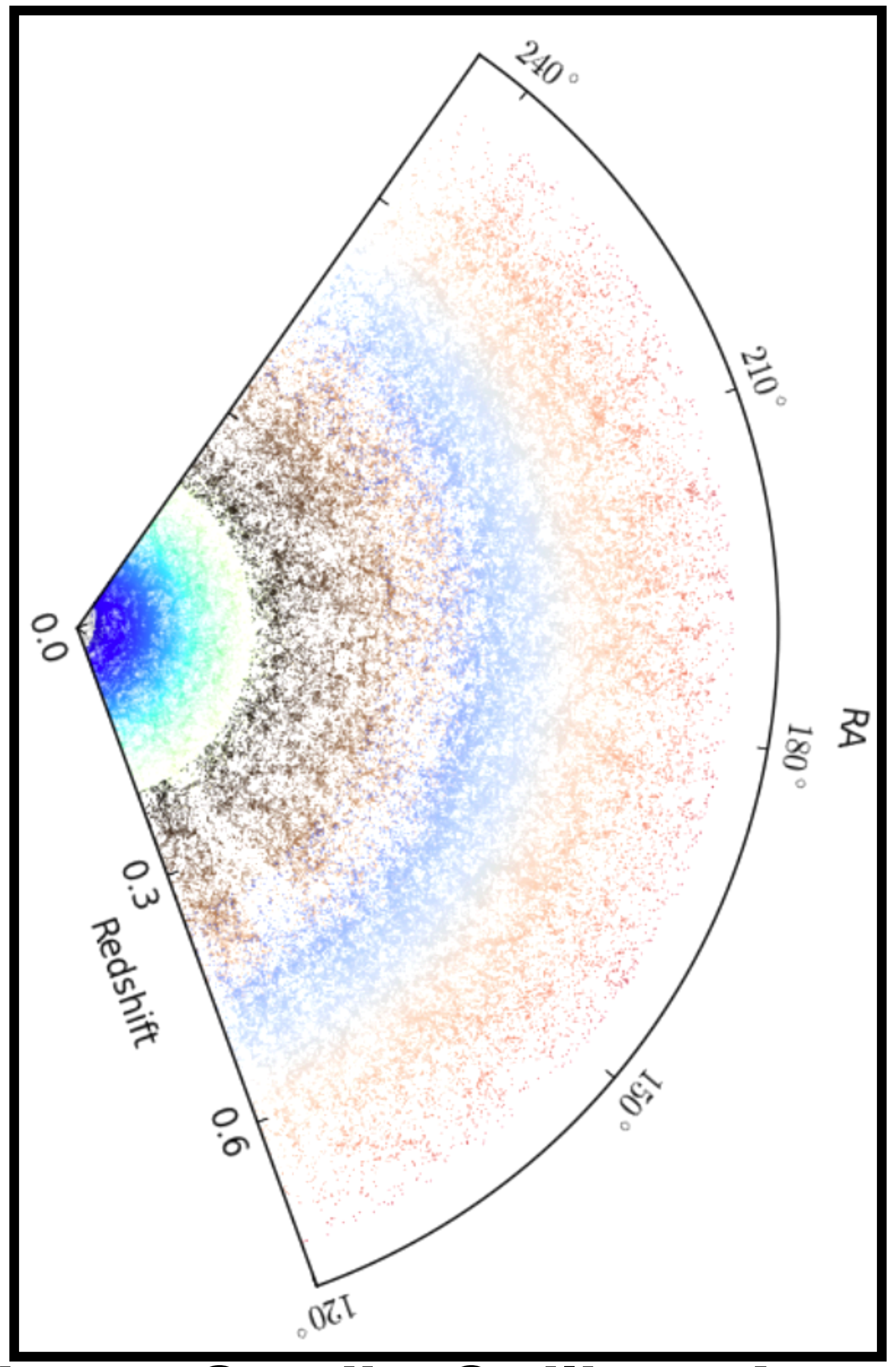

Figure Credit: Guilhem Lavaux

Mock data test

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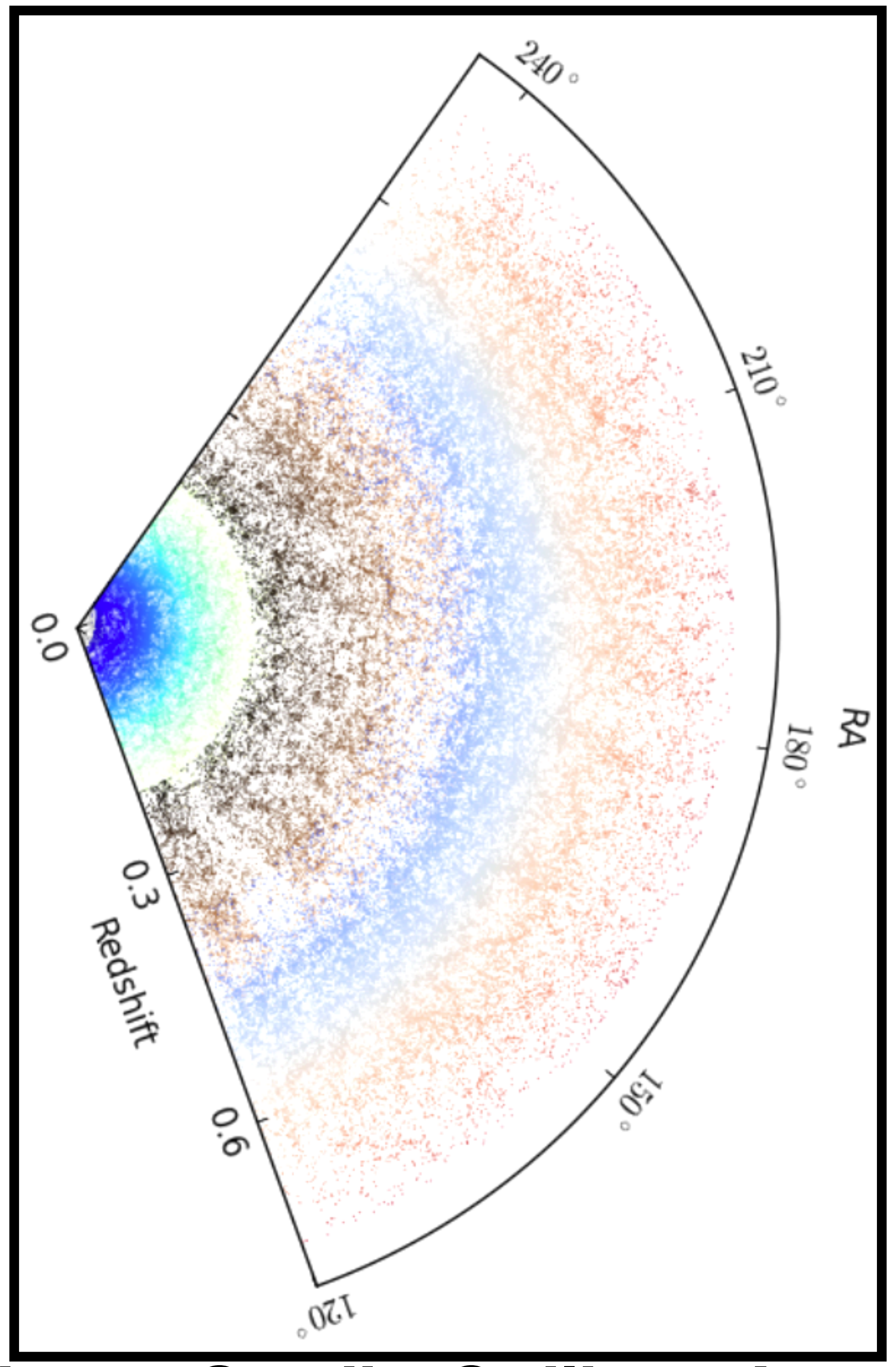

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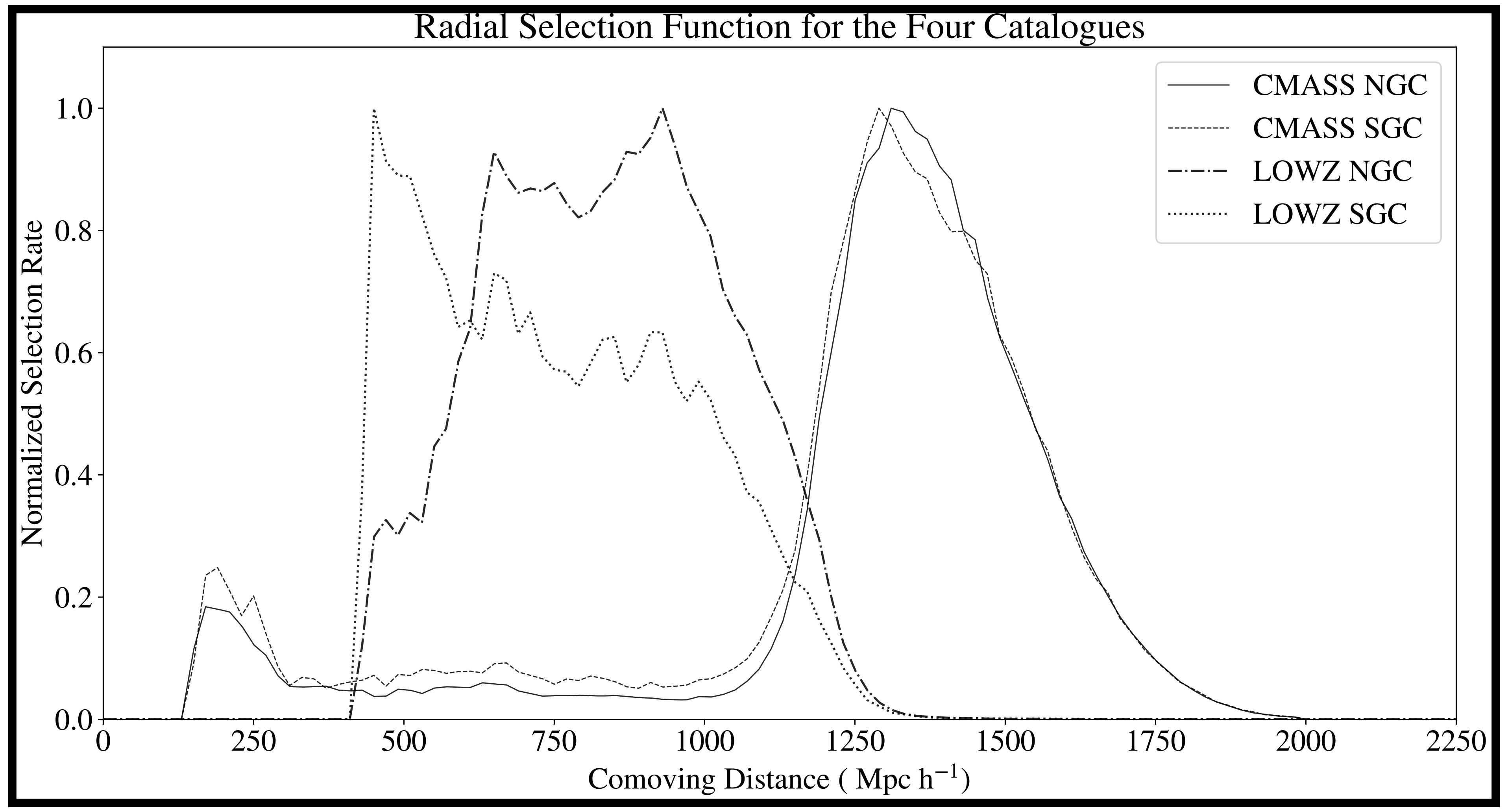
Radial Selection



Andrews et al. 2022

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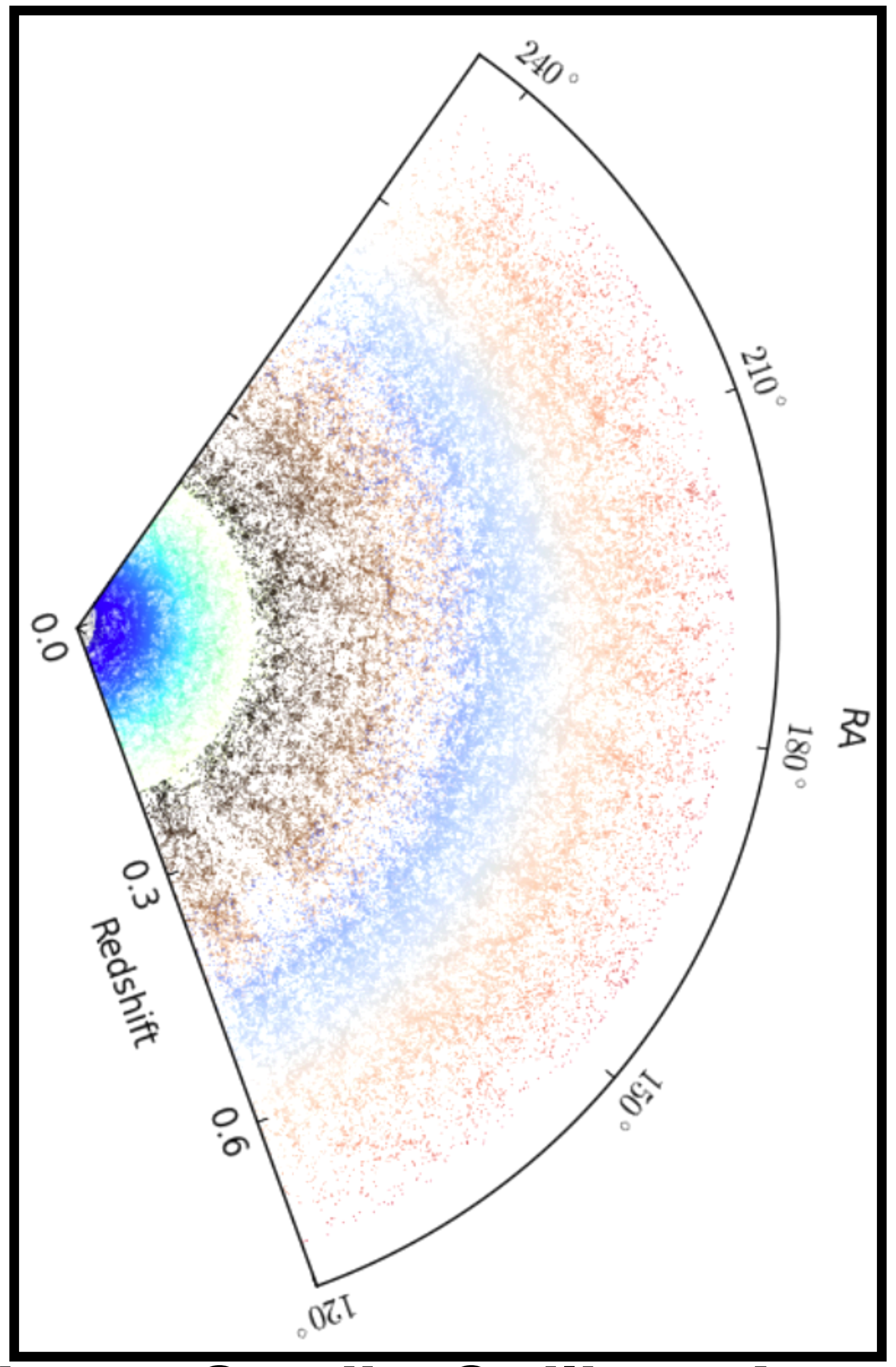

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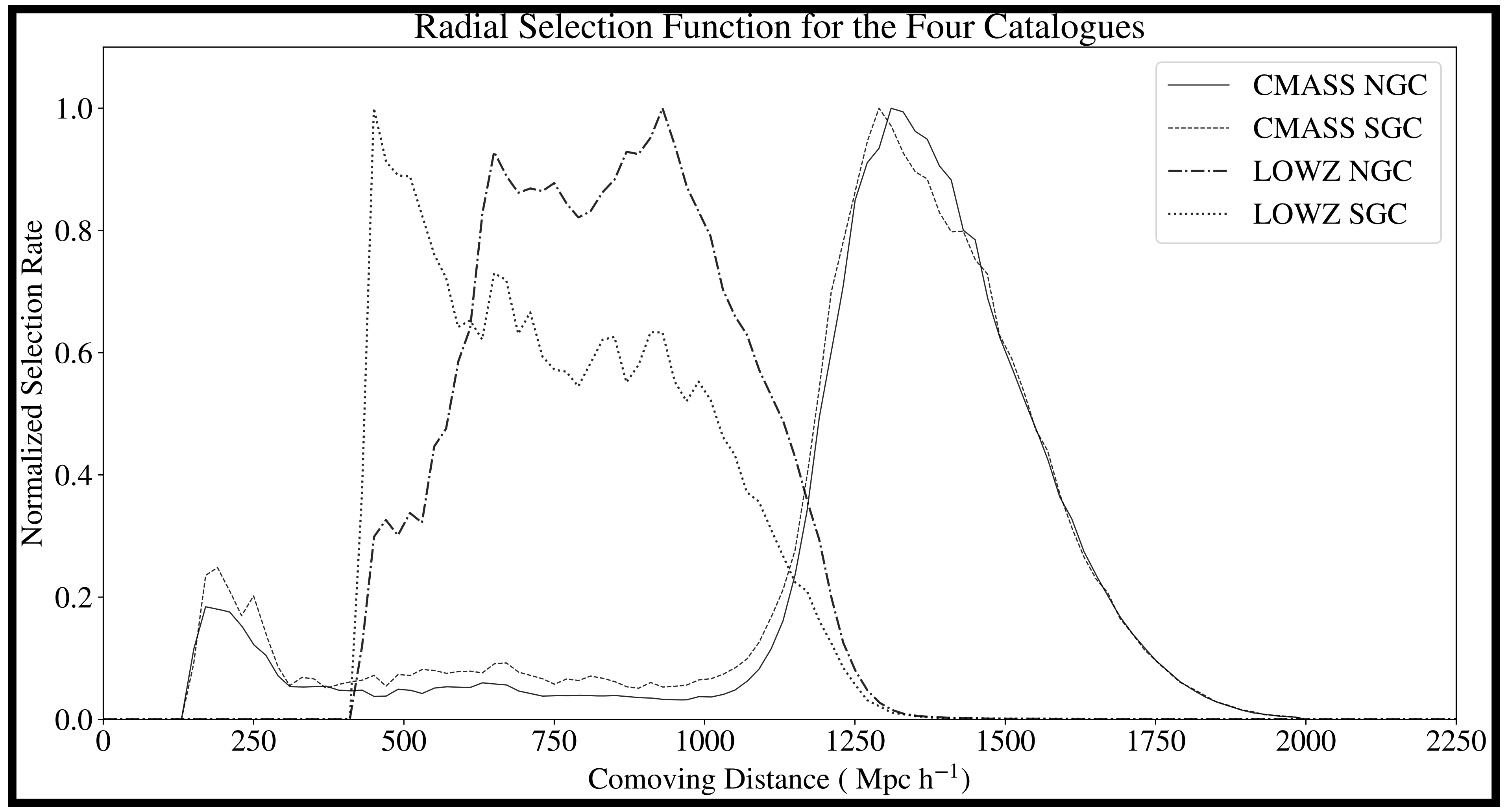
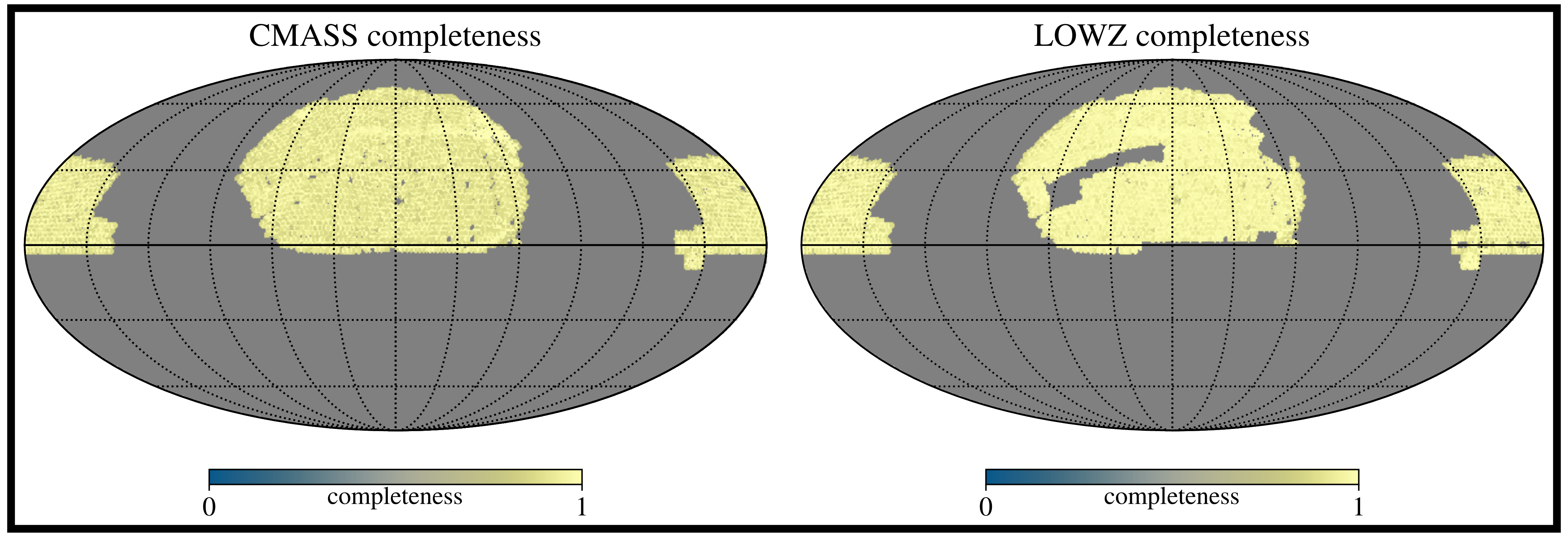


Andrews et al. 2022

Sky Coverage



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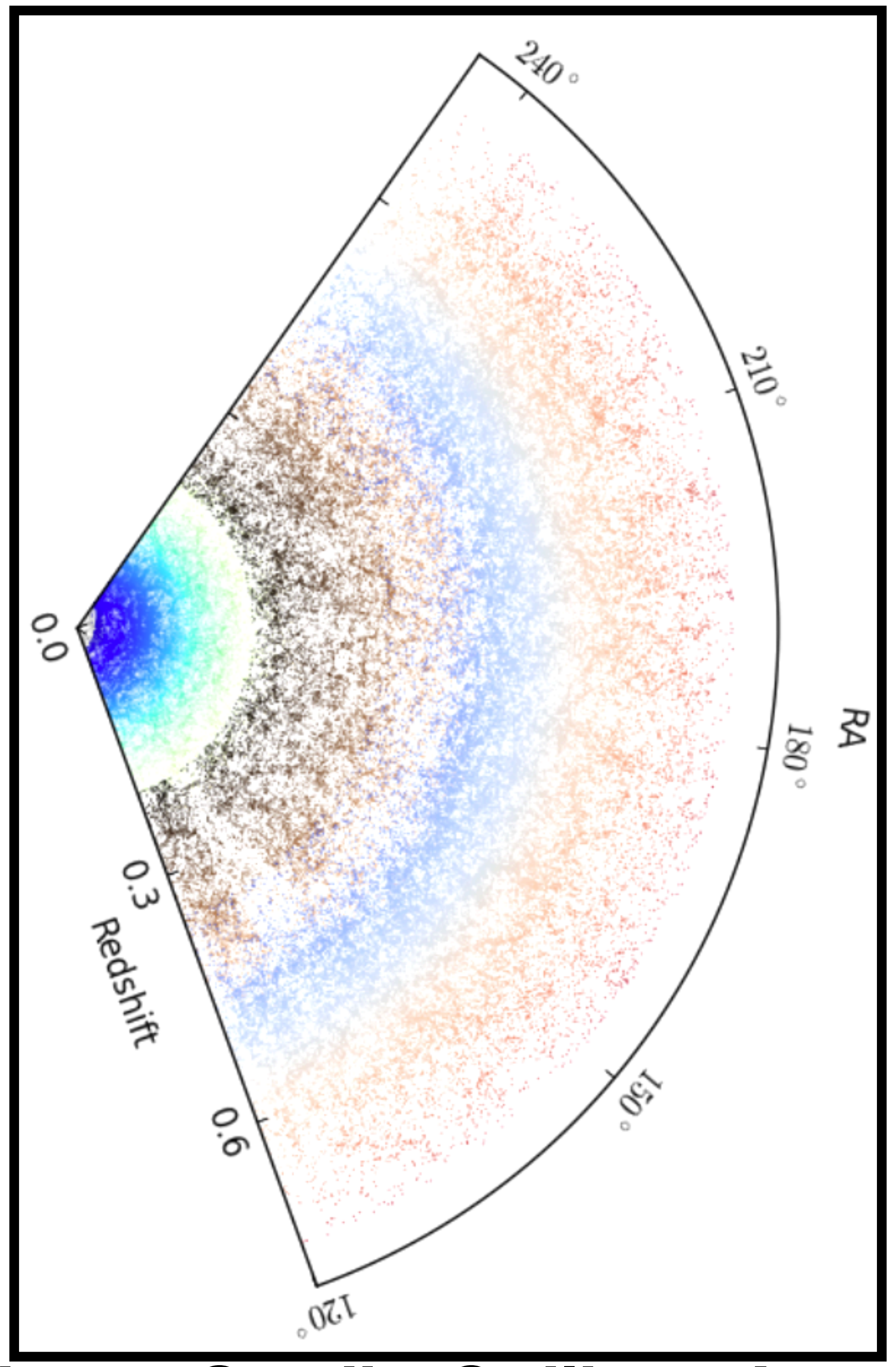

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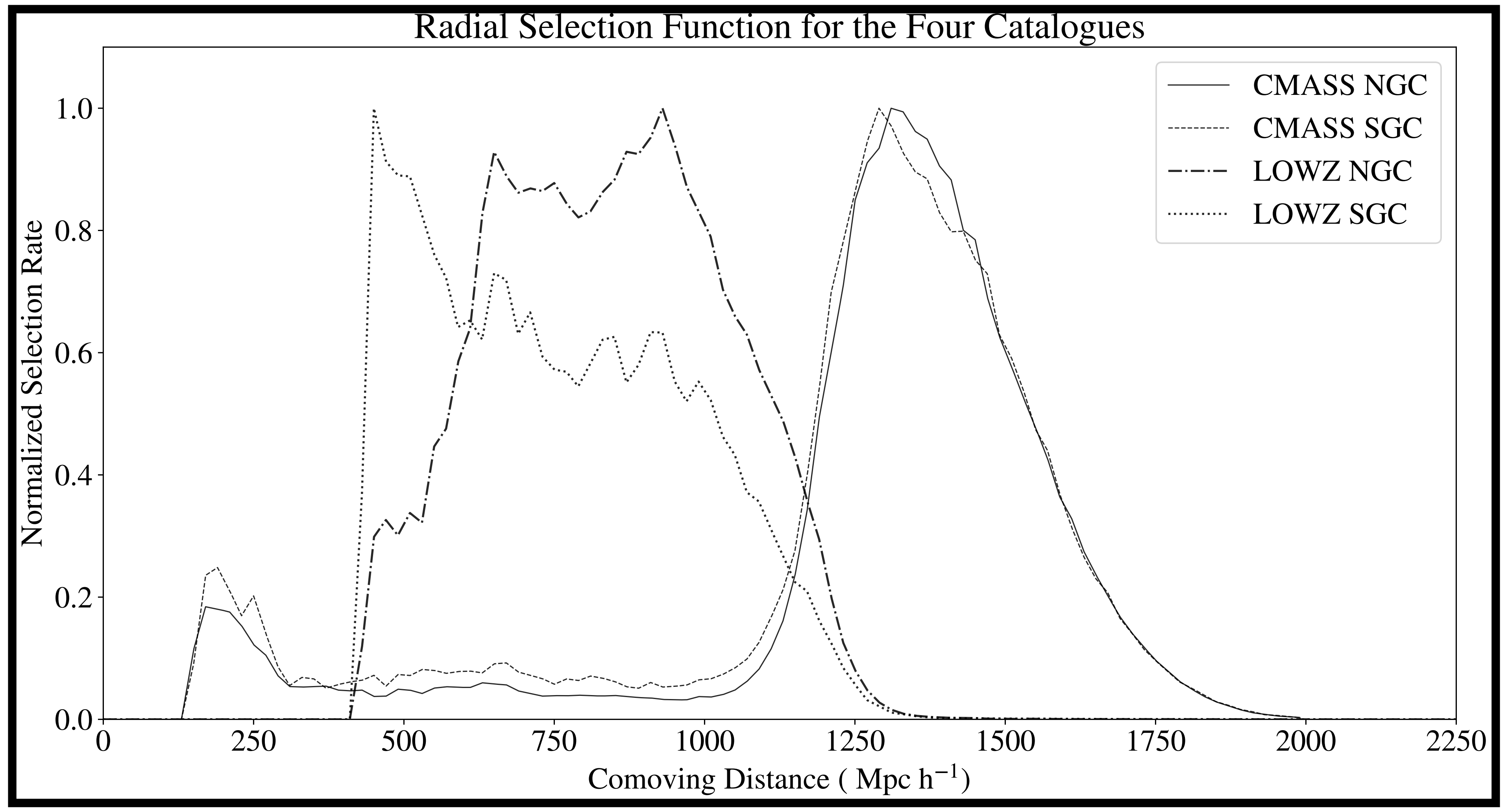

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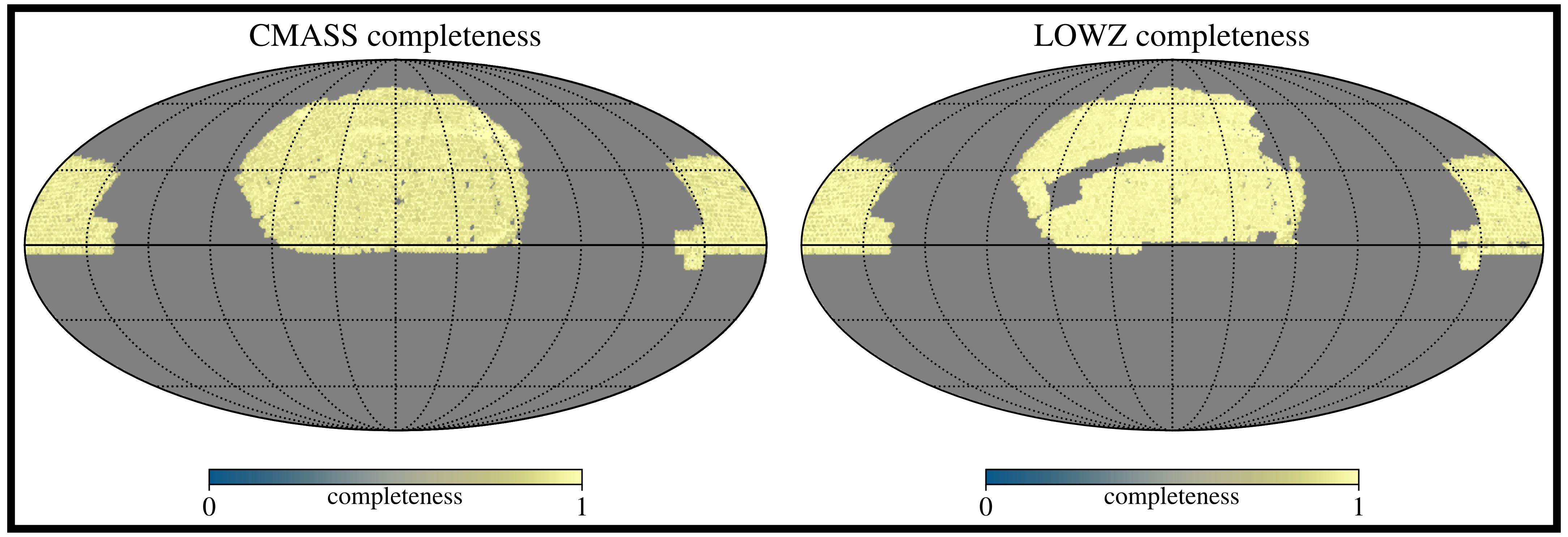

Andrews et al. 2022

$f_{\rm nl} = 5$

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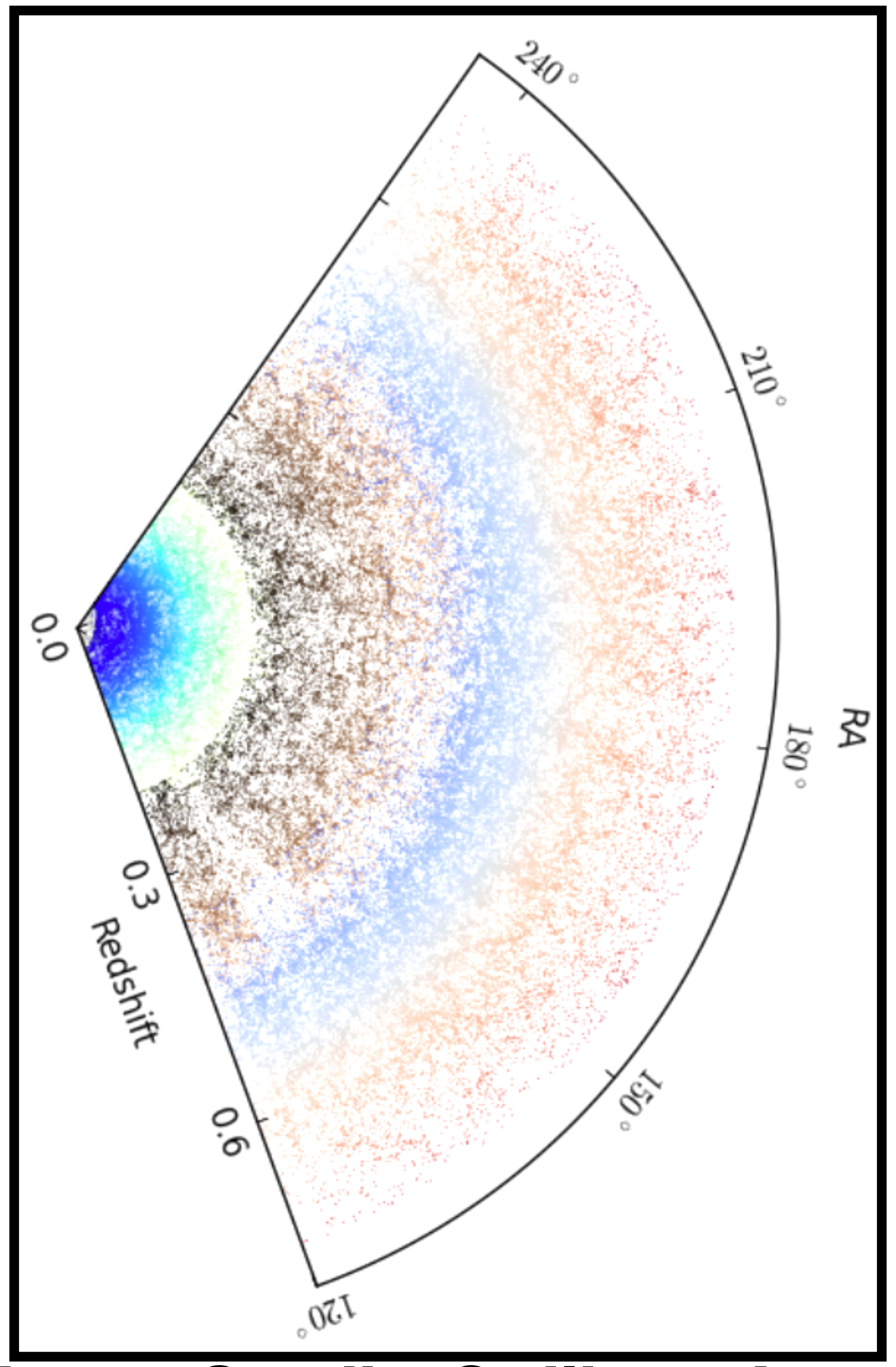

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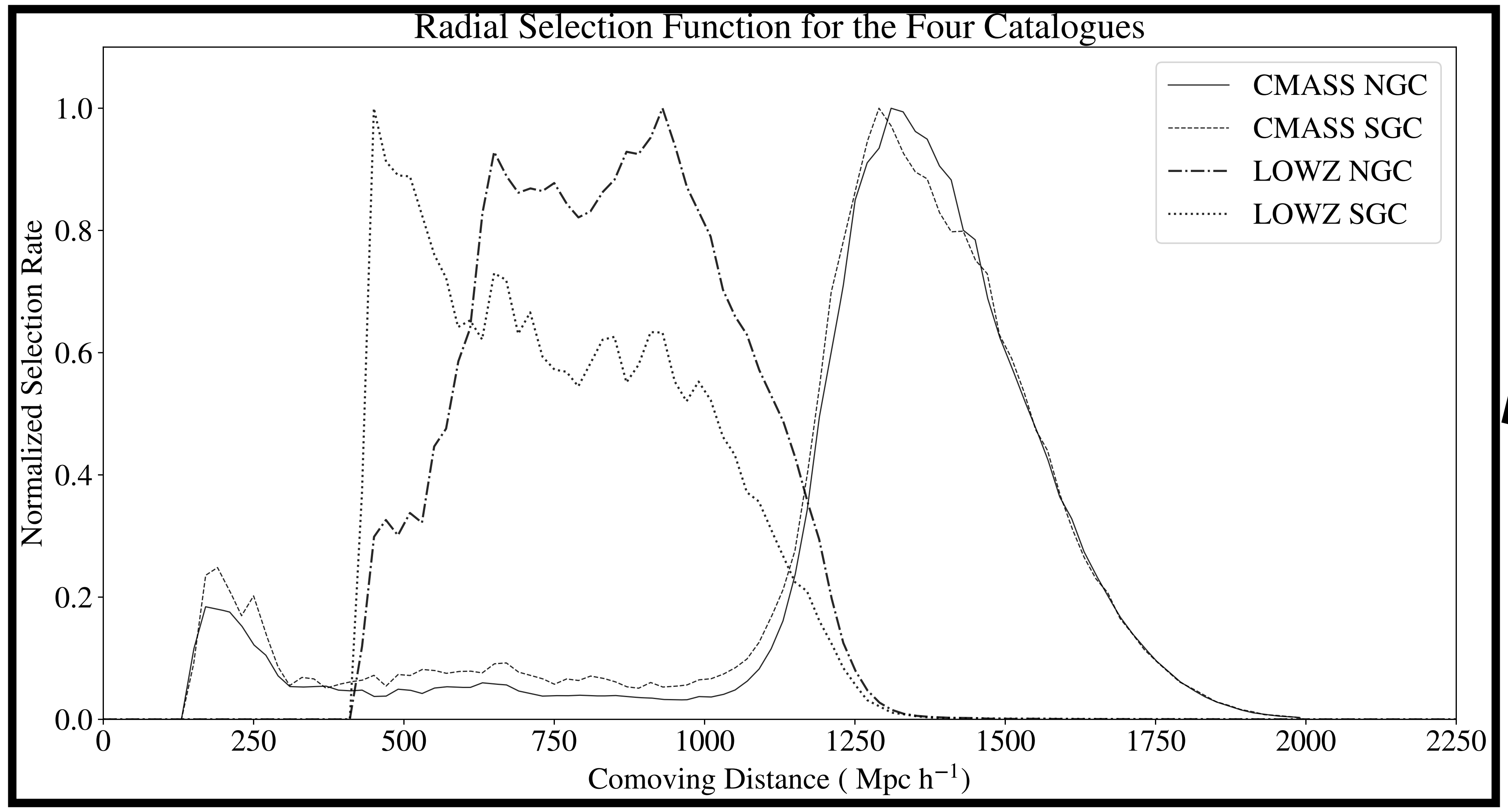

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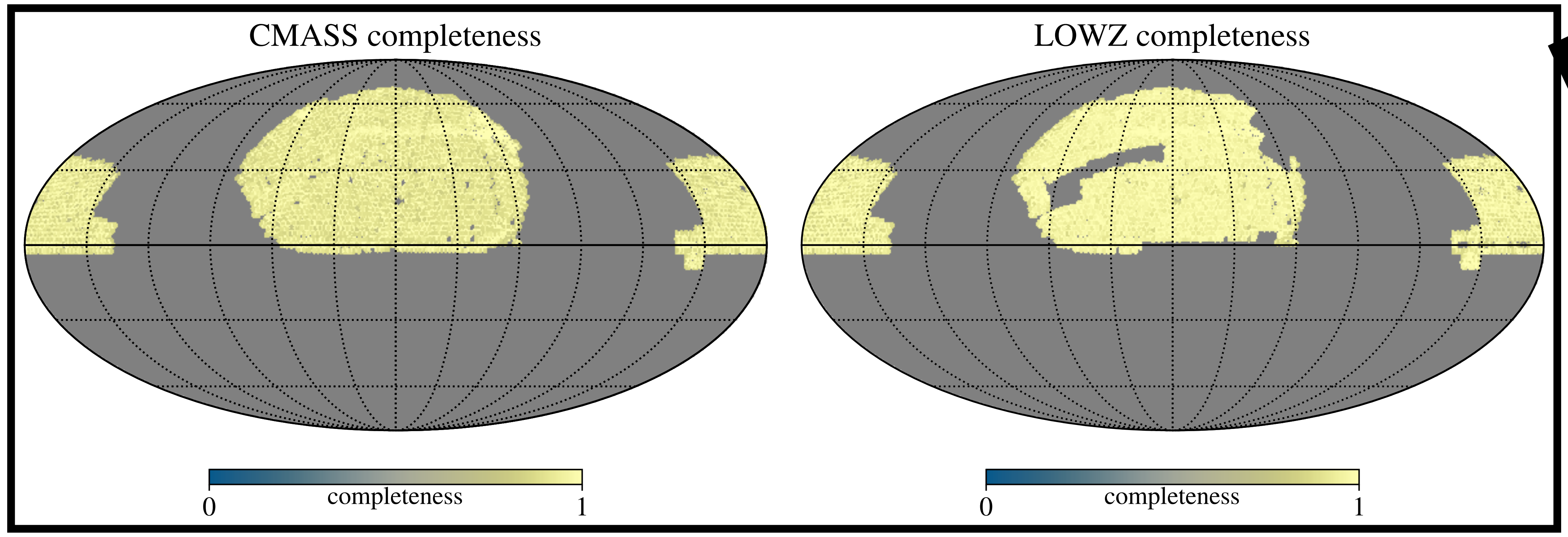
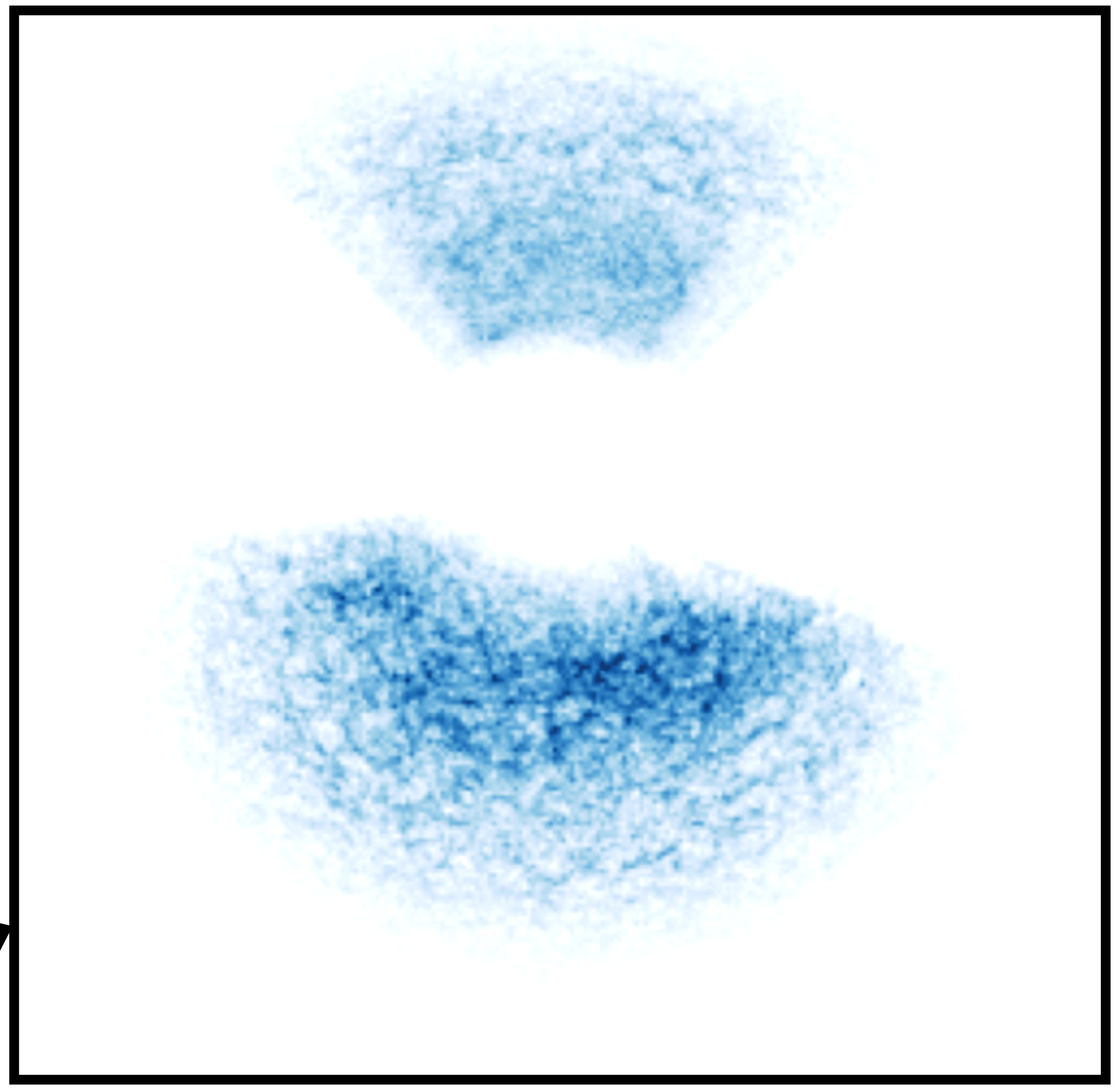


Andrews et al. 2022

Mock Data



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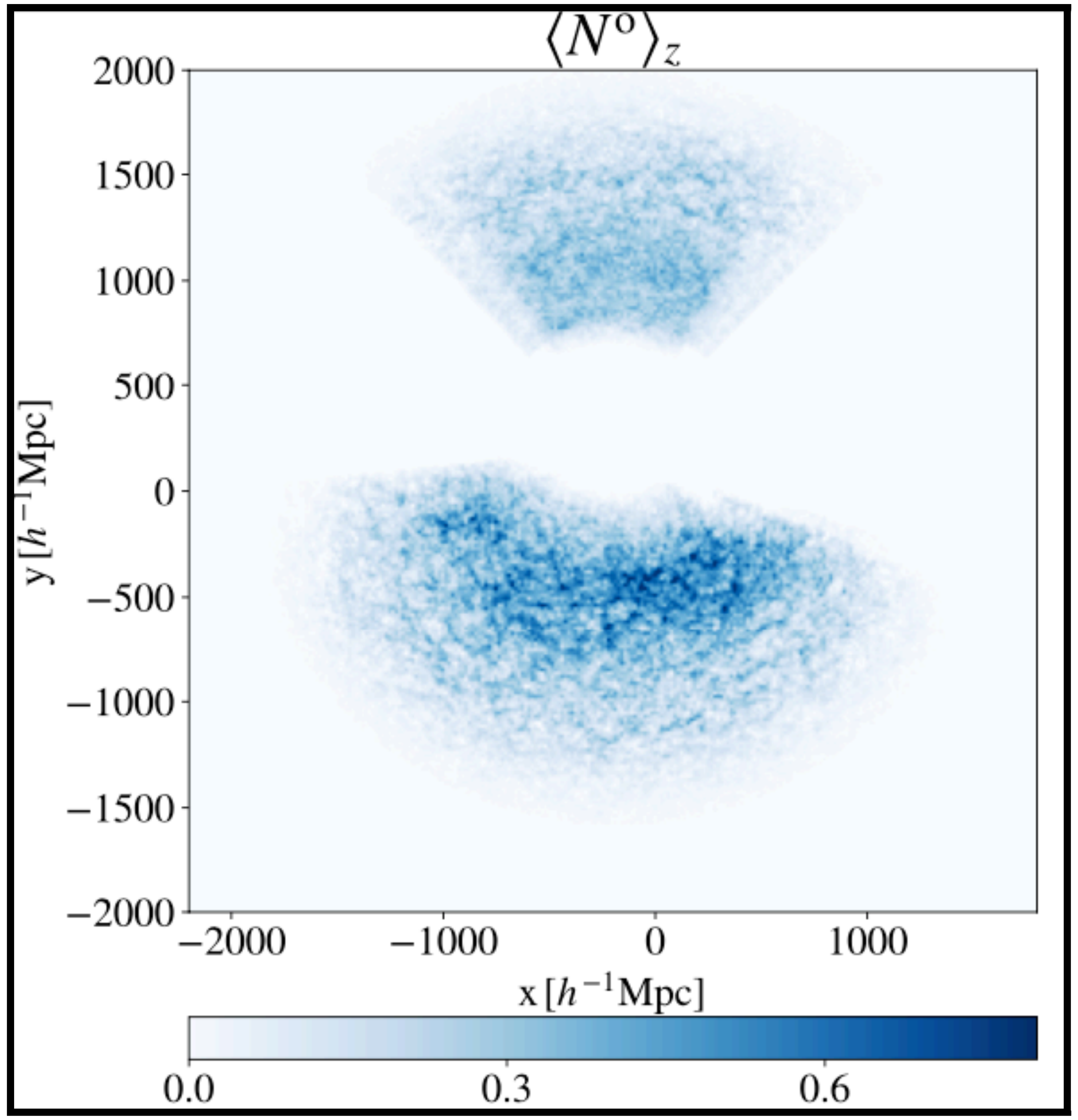
Inferring the density field

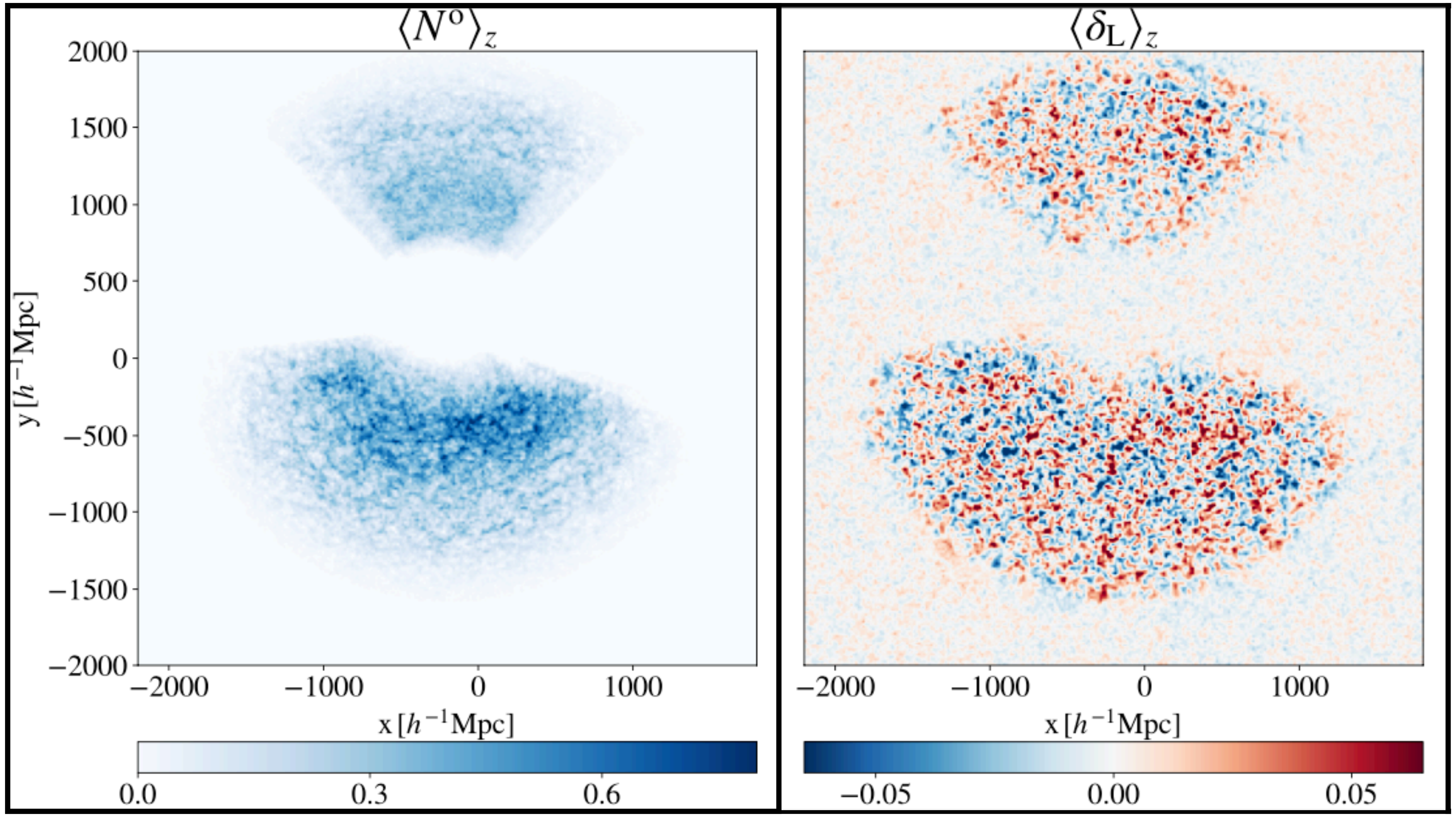
Andrews et al. 2022

Inferring the density field



Andrews et al. 2022

Inferring the density field



Andrews et al. 2022

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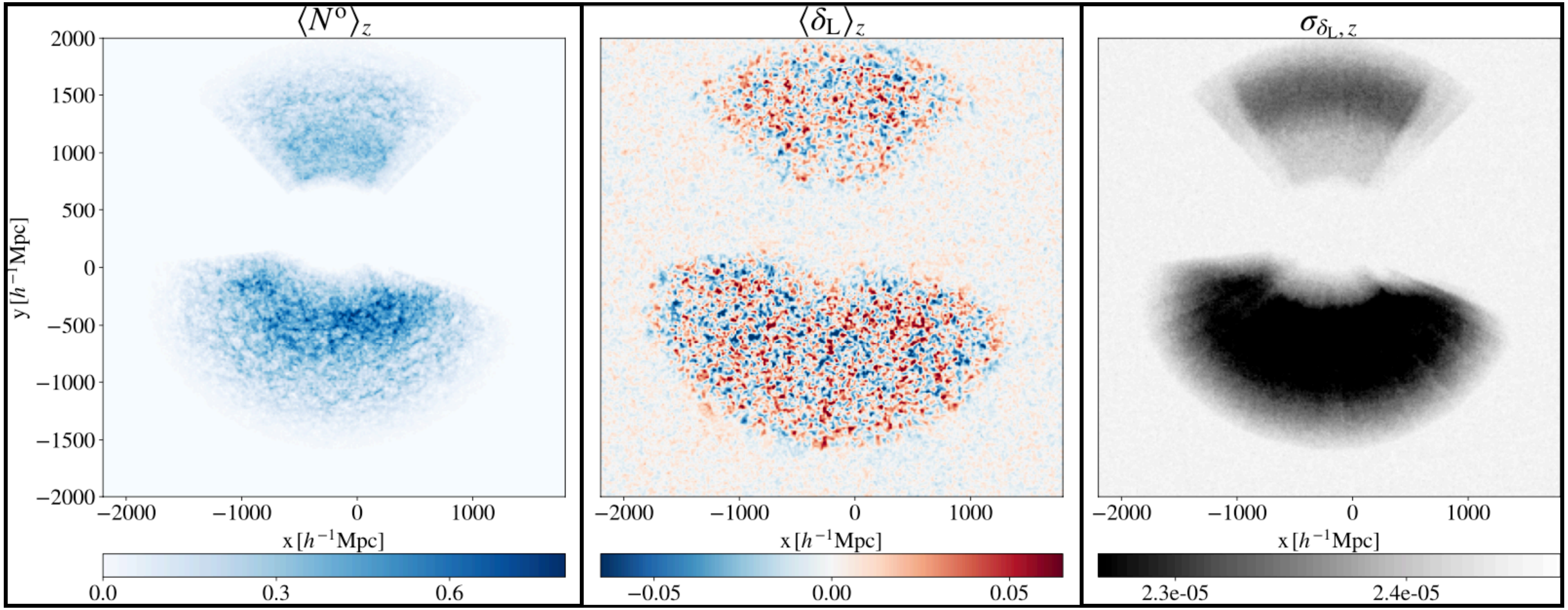

Andrews et al. 2022

SDSS Mock Test: Main result

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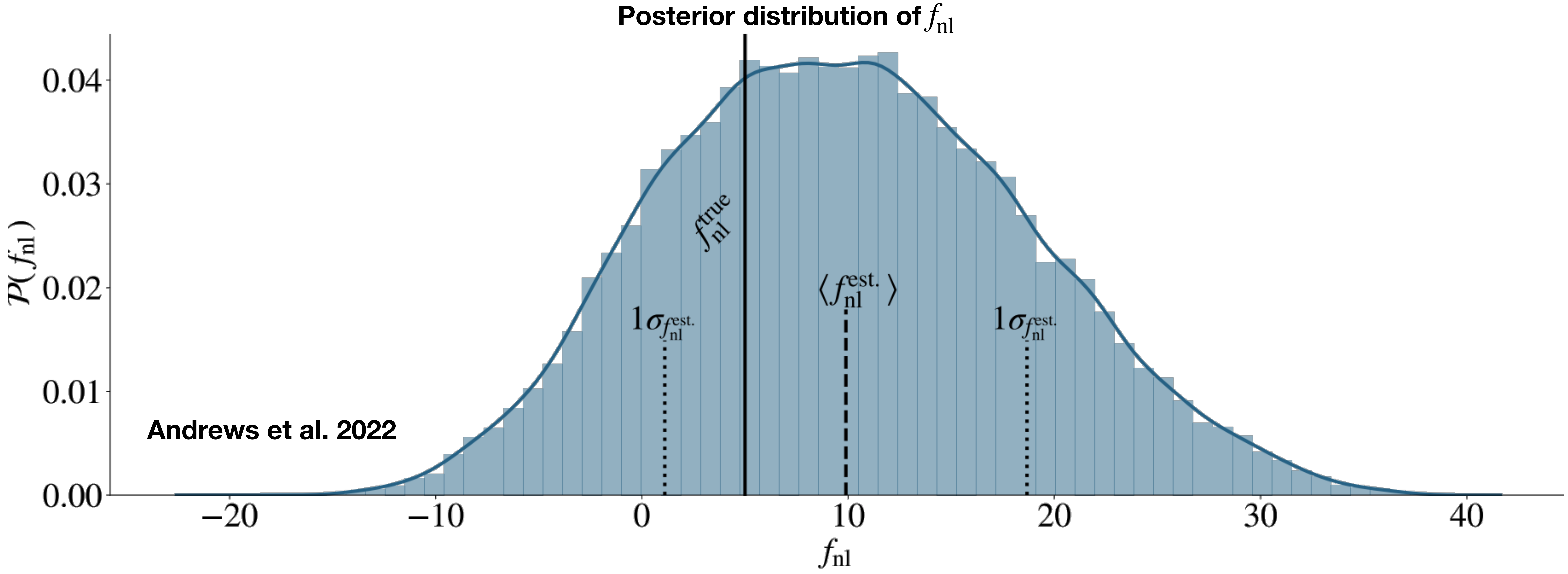

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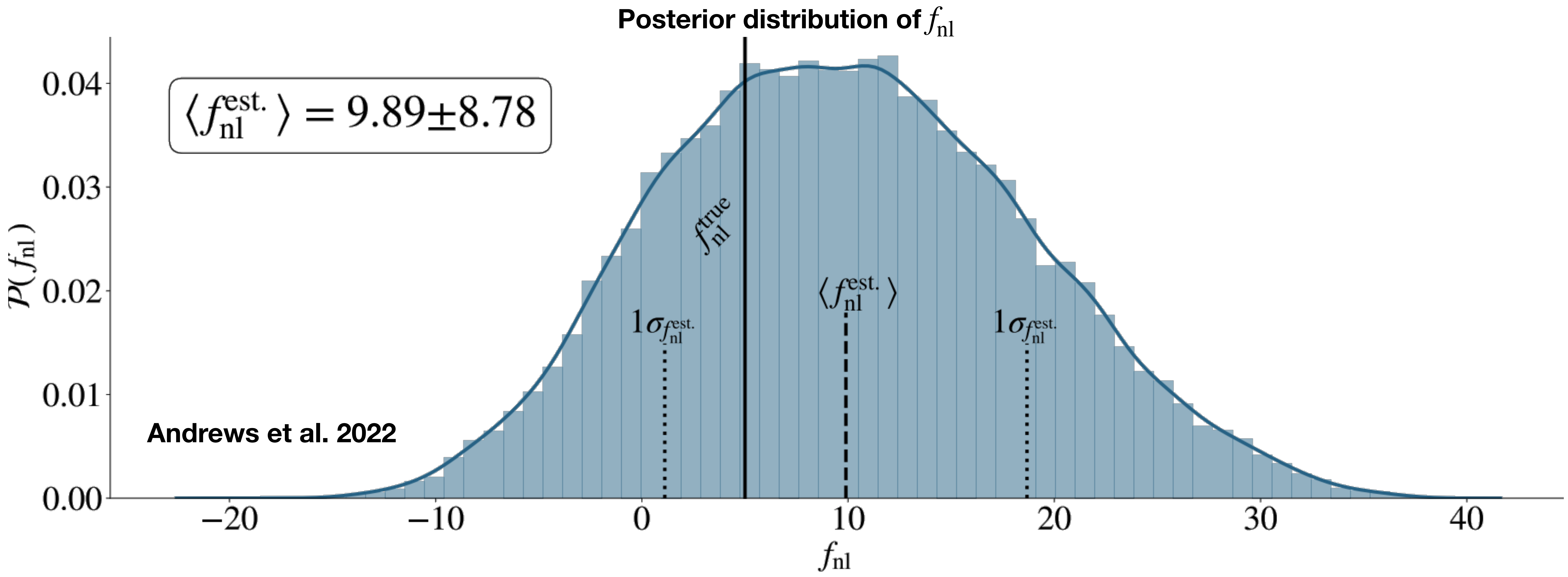
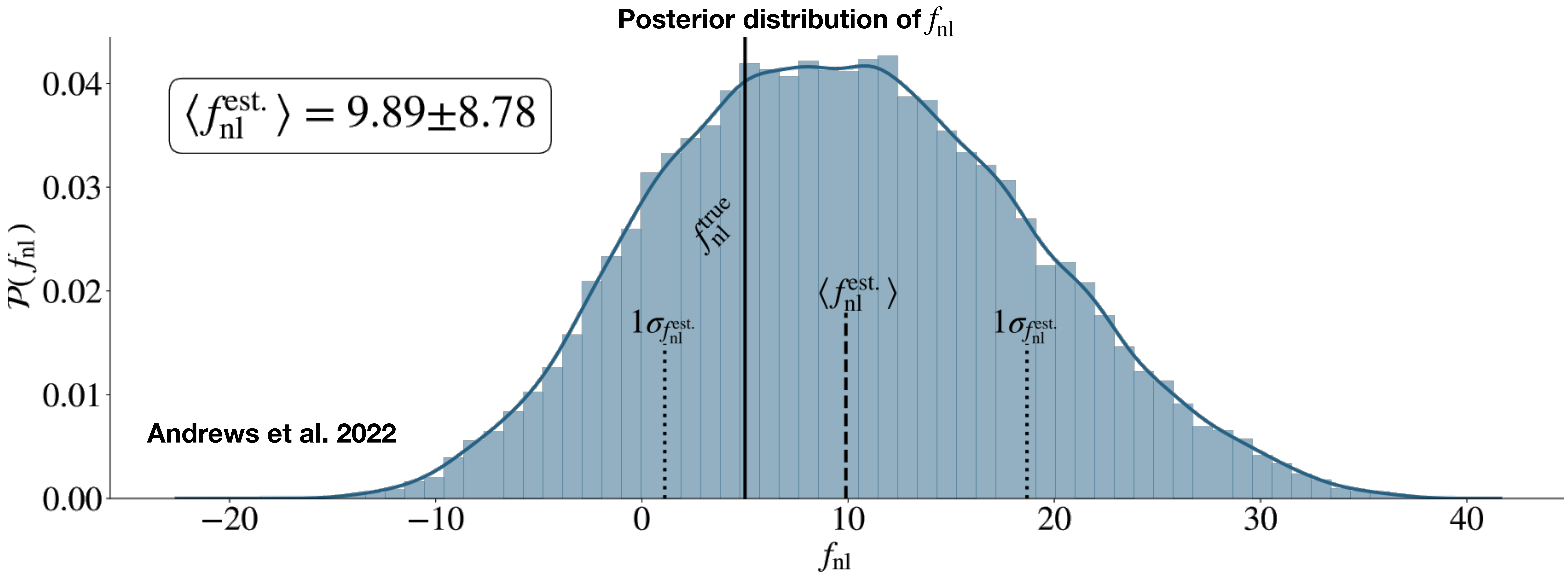


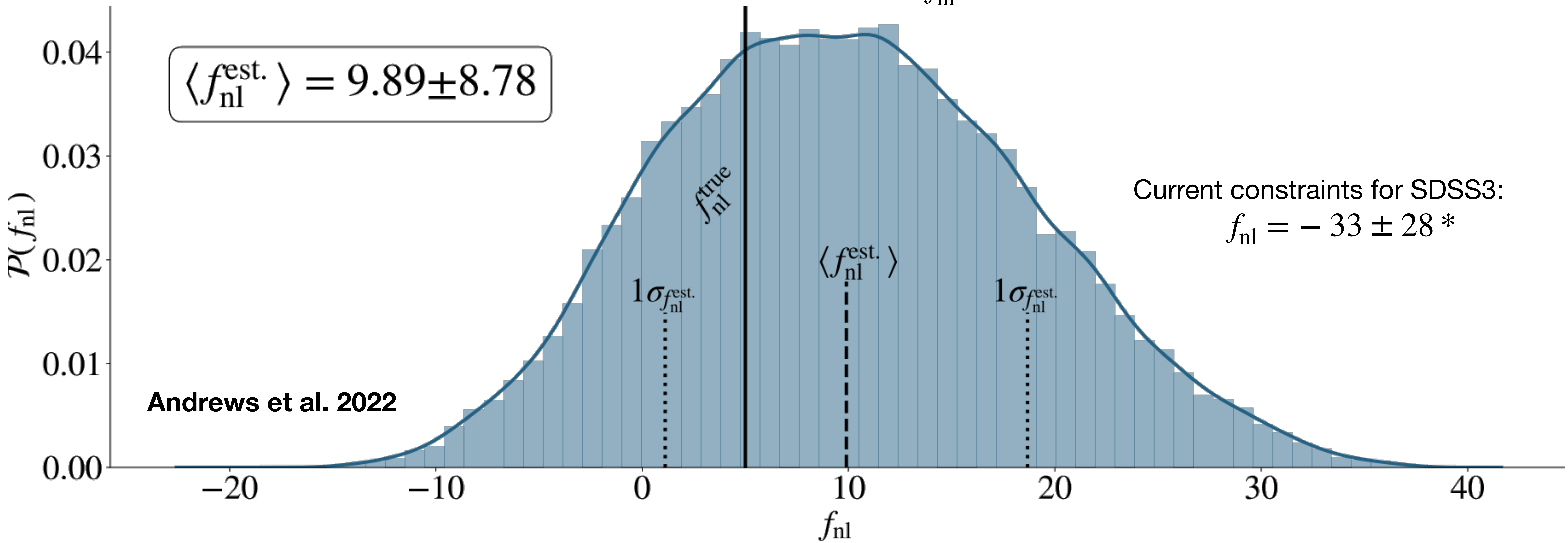
SDSS Mock Test: Main result



Full statement on the information content available in the data!

SDSS Mock Test: Main result

Posterior distribution of $f_{\rm nl}$



Current constraints for SDSS3:

$f_{\rm nl} = -33 \pm 28$ *

Full statement on the information content available in the data!

See Oliver's talk

***Cabass et al. 2022**

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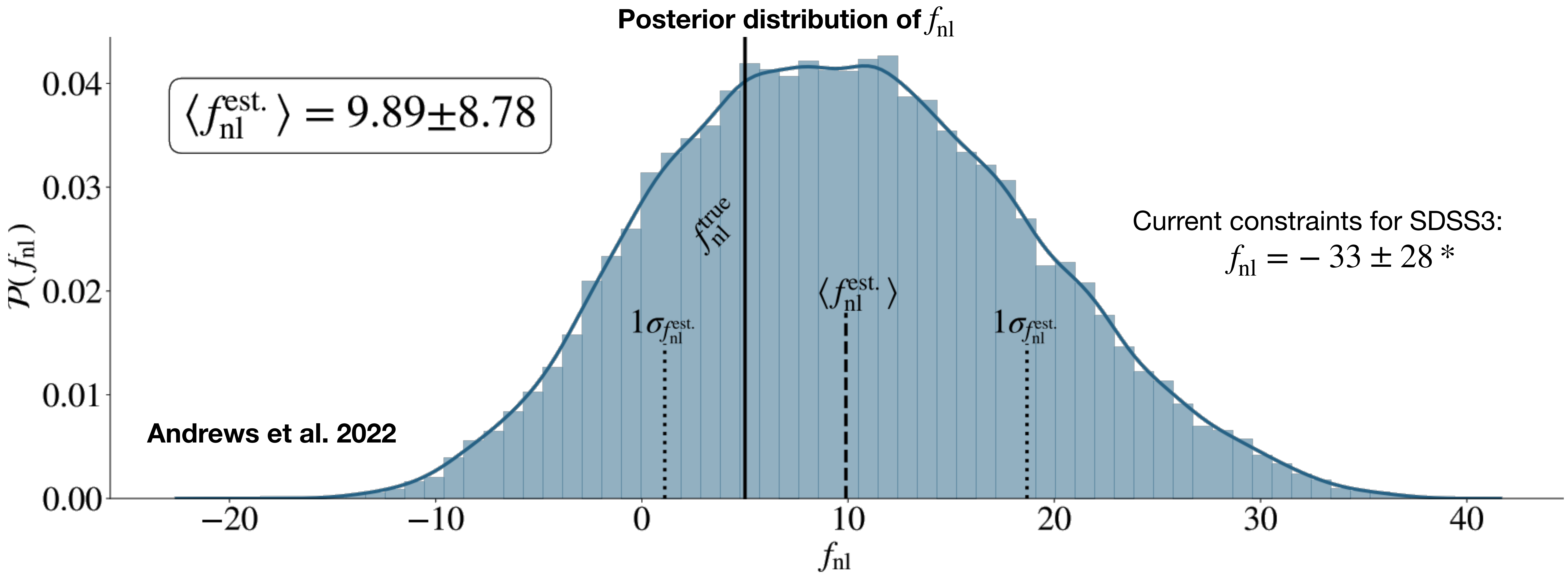

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***Cabass et al. 2022**

SDSS Mock Test: Main result

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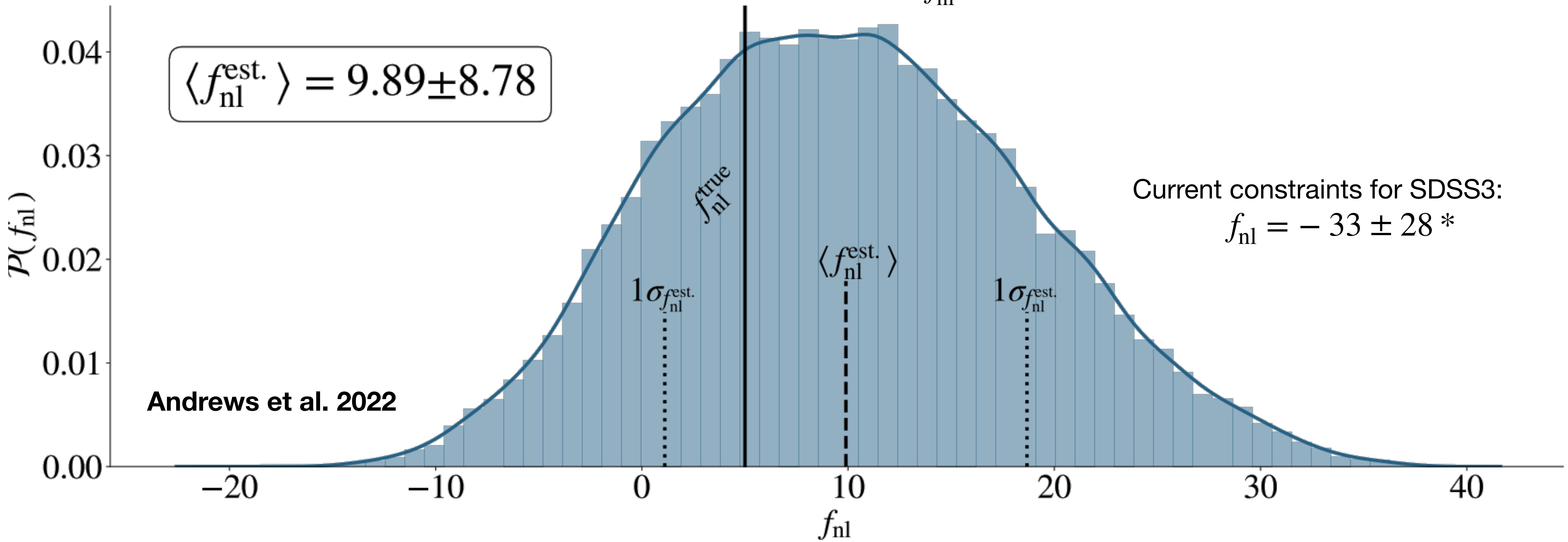

Current constraints for SDSS3:

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Full statement on the information content available in the data!

However…

missing realistic survey systematics (Ashley's and Eva's talks)

fixed p=1 (Alex's talk and yesterday's discussion)

See Oliver's talk

***Cabass et al. 2022**

Opportunities for field-level inference

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Handle survey systematics?

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-Physics informed model

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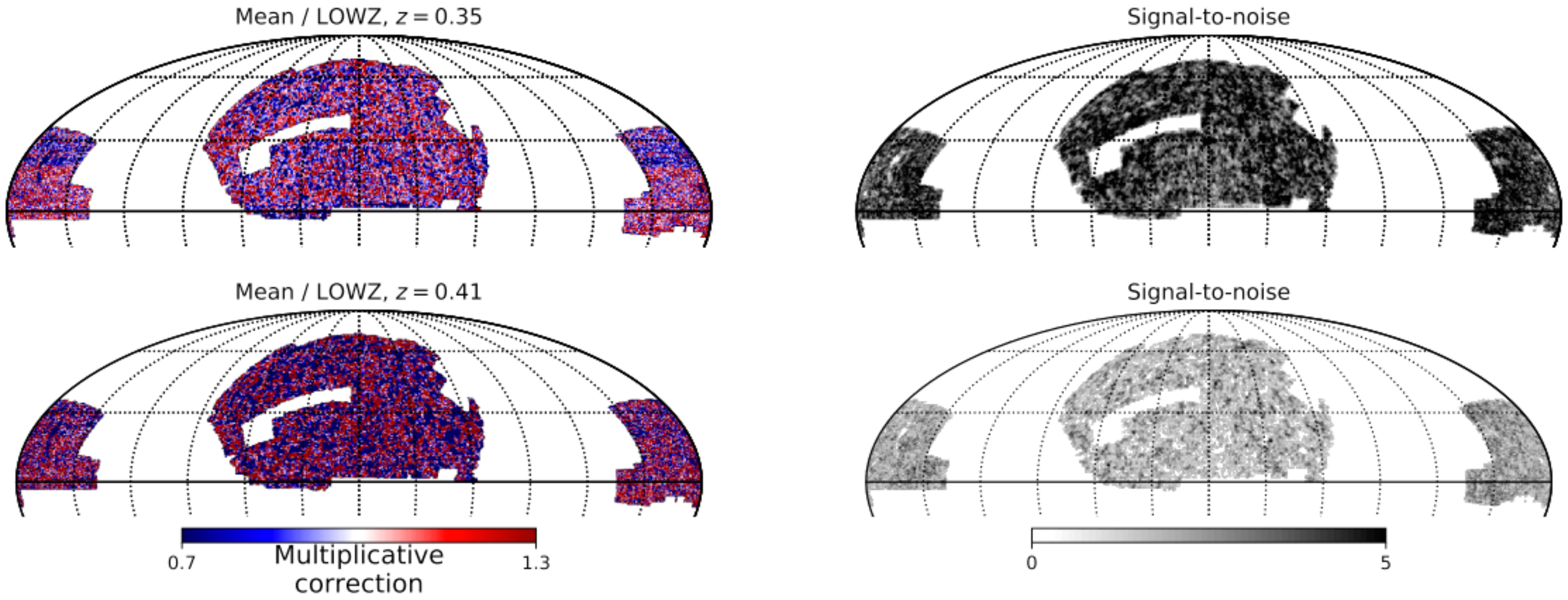

Lavaux et al. 2019

Opportunities for field-level inference

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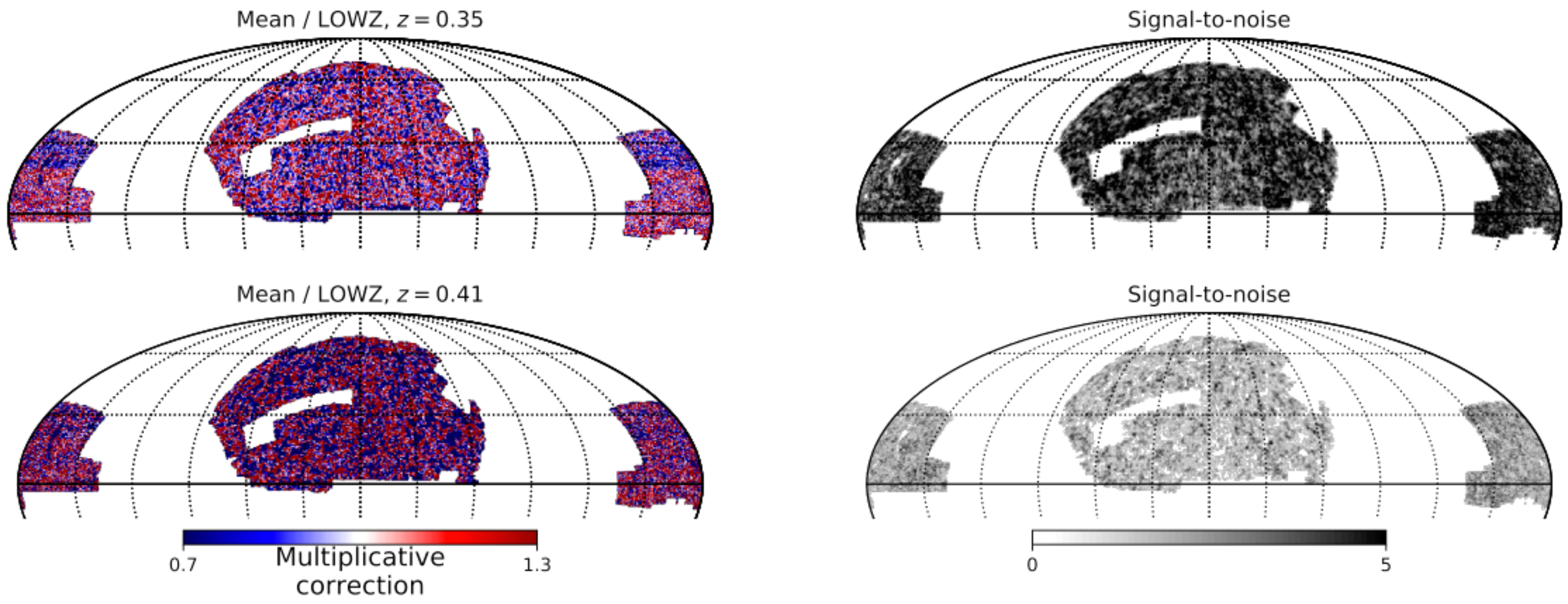

Where to point of new discoveries?

Lavaux et al. 2019

Opportunities for field-level inference

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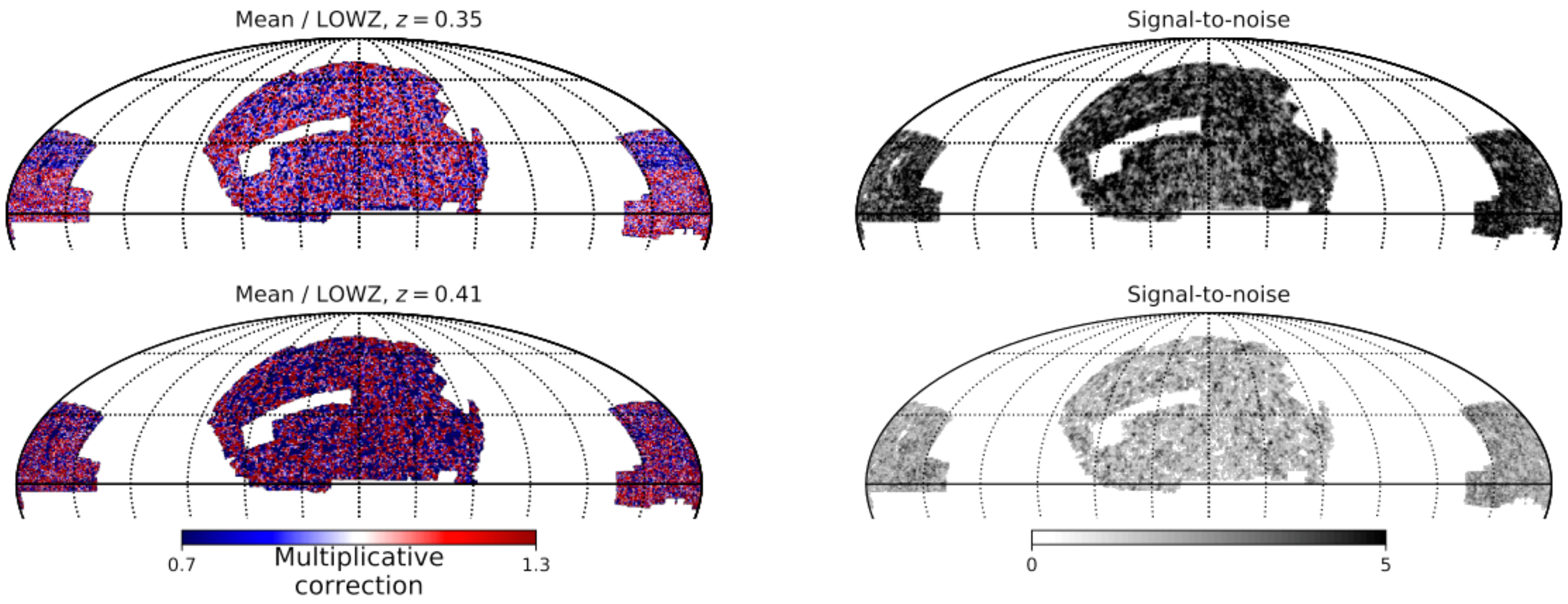
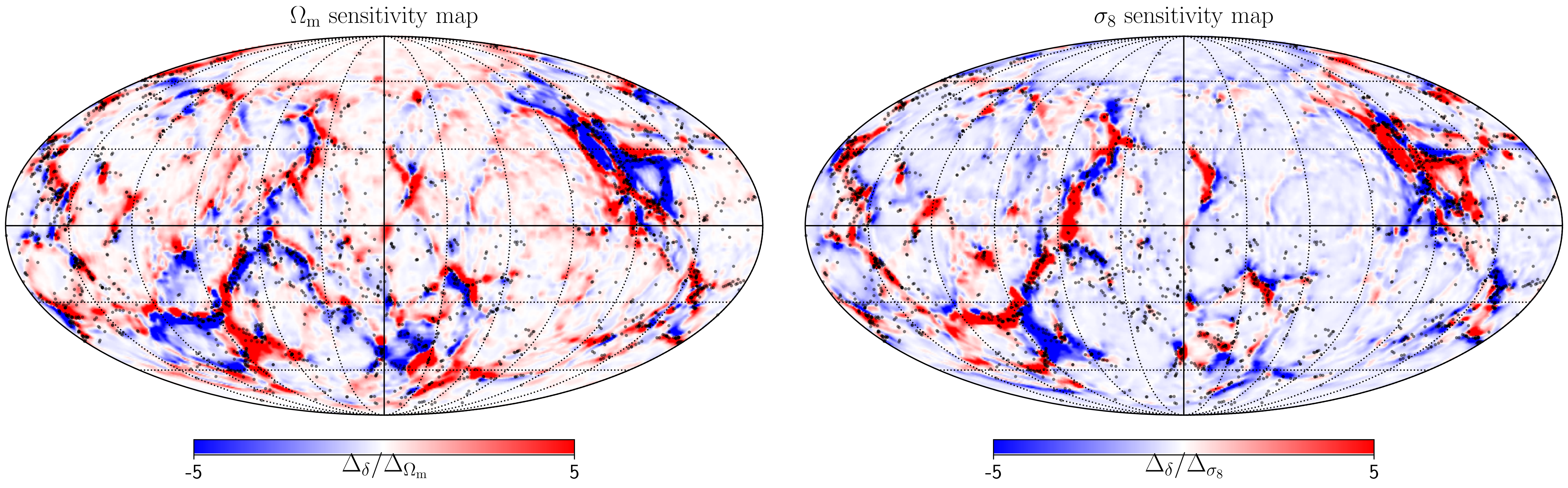


Where to point of new discoveries?



Lavaux et al. 2019

Kostić et al. 2021

Stockholm University

Oskar Klein centre

Aquila

Euclid consortium

Summary

arxiv: 2203.08838
adam.andrews@fysik.su.se

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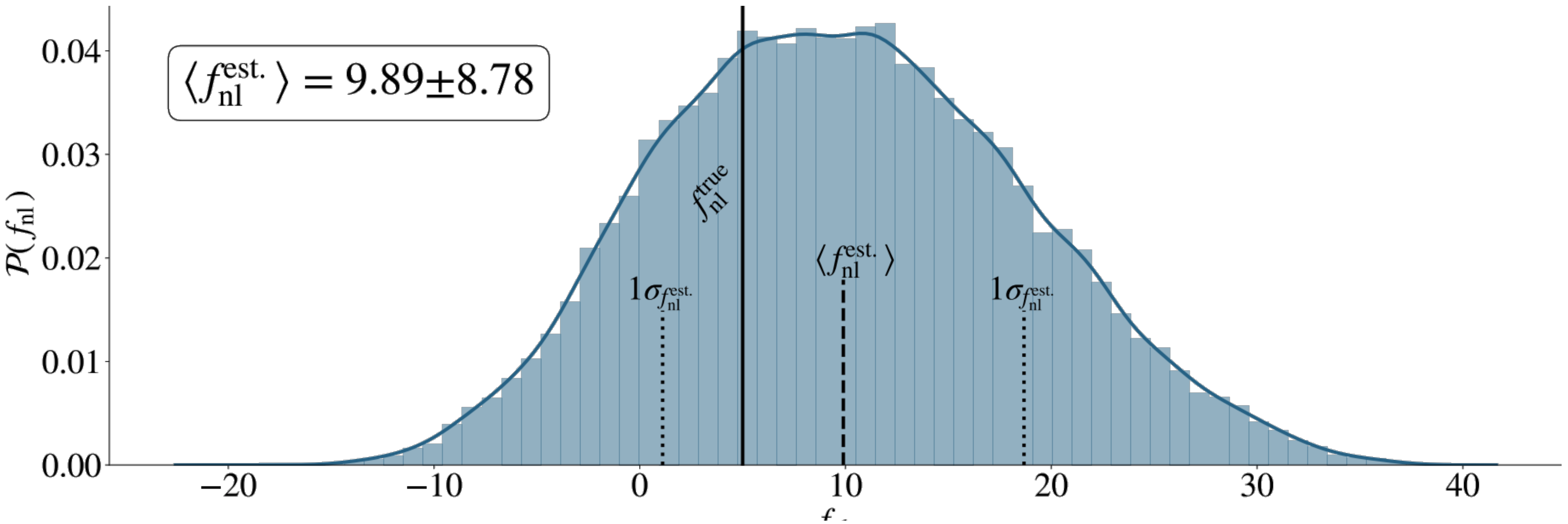
1. Developed a field-level inference which constrains $\sigma_{f_{\mathrm{nl}}} \approx 9\ (68\%)$ on SDSS3-like data

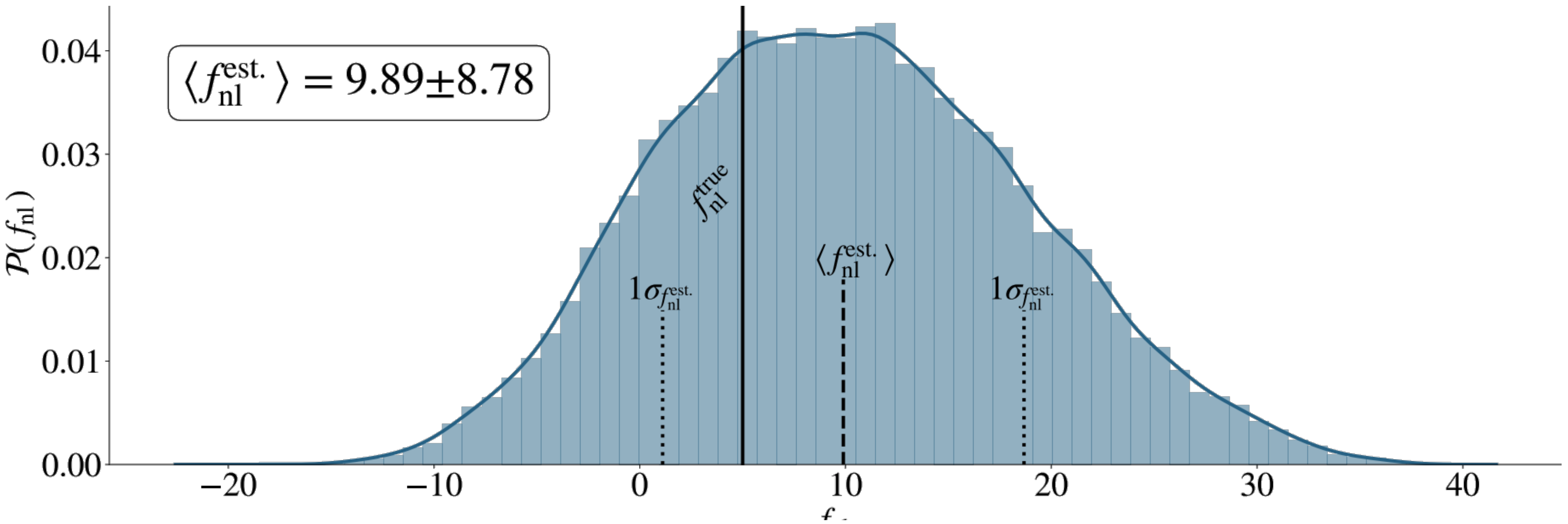
Posterior distribution of f_{nl}



Summary

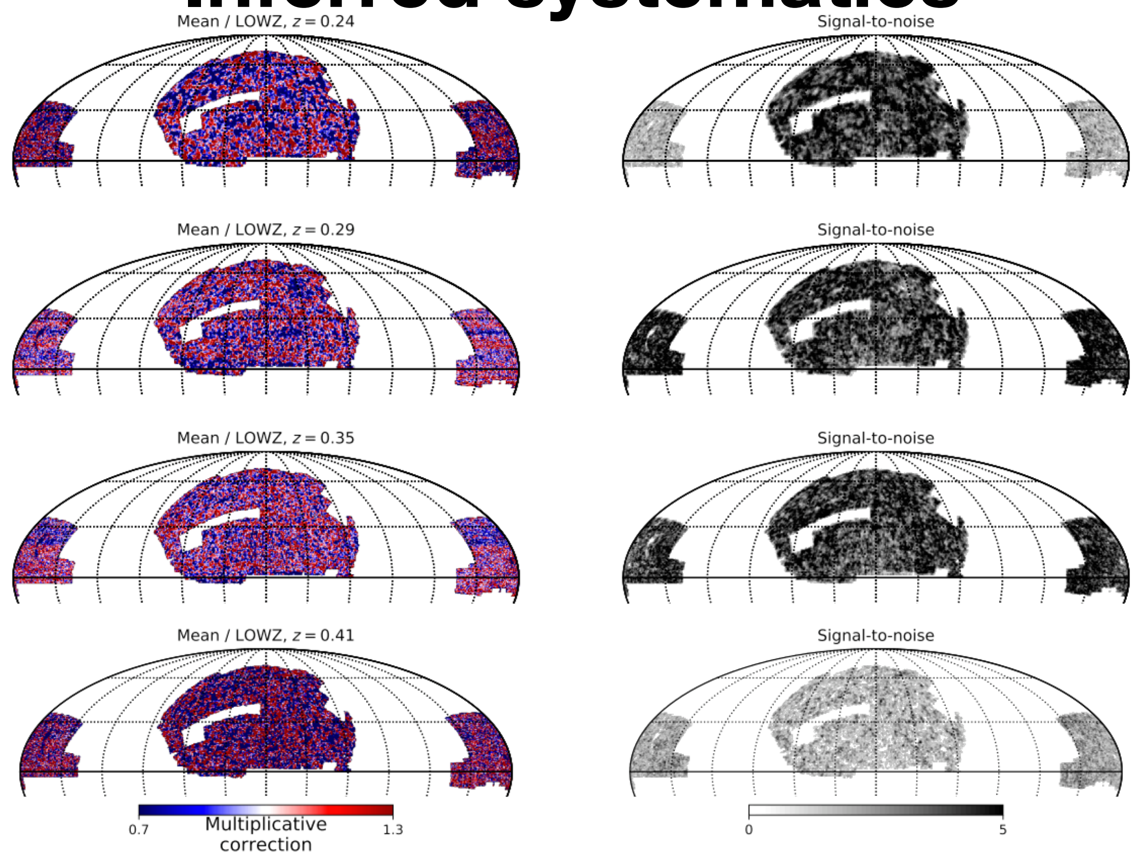
arxiv: 2203.08838
adam.andrews@fysik.su.se

Posterior distribution of $f_{\rm nl}$



1. Developed a field-level inference which constrains $\sigma_{f_{\rm nl}} \approx 9\ (68\%)$ on SDSS3-like data
2. Opportunity to include systematic effects into analysis

Inferred systematics



Summary

arxiv: 2203.08838
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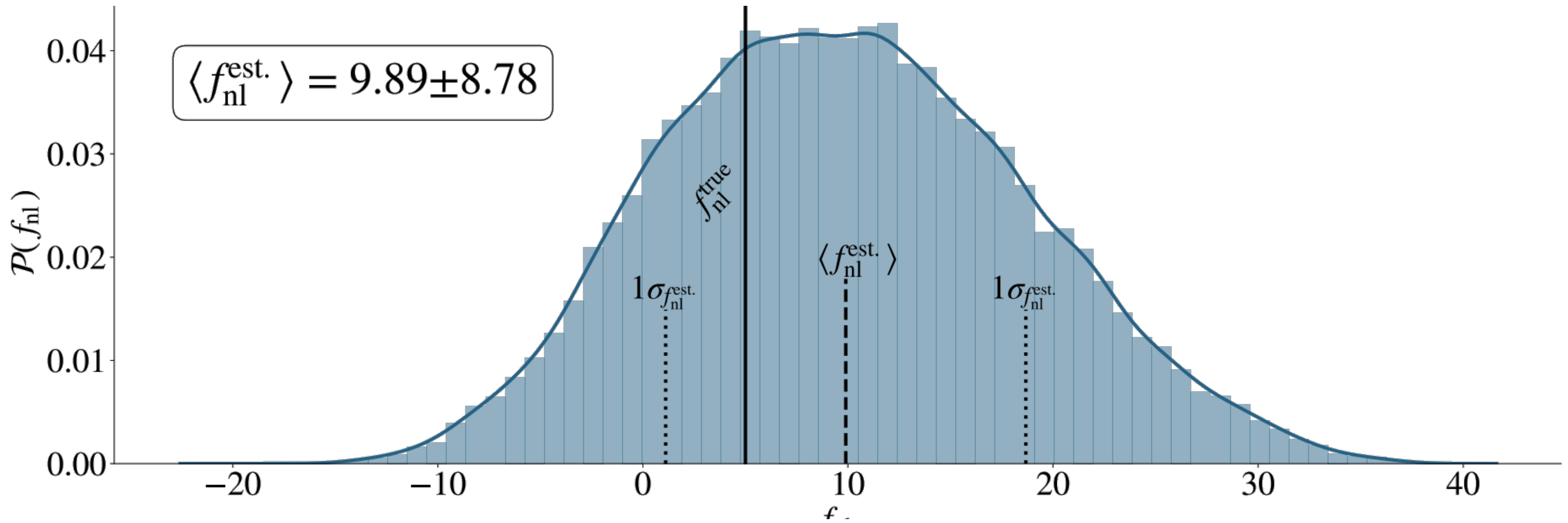
1. Developed a field-level inference which constrains $\sigma_{f_{\rm nl}} \approx 9\ (68\%)$ on SDSS3-like data
2. Opportunity to include systematic effects into analysis
3. Additional data products

Posterior distribution of $f_{\rm nl}$



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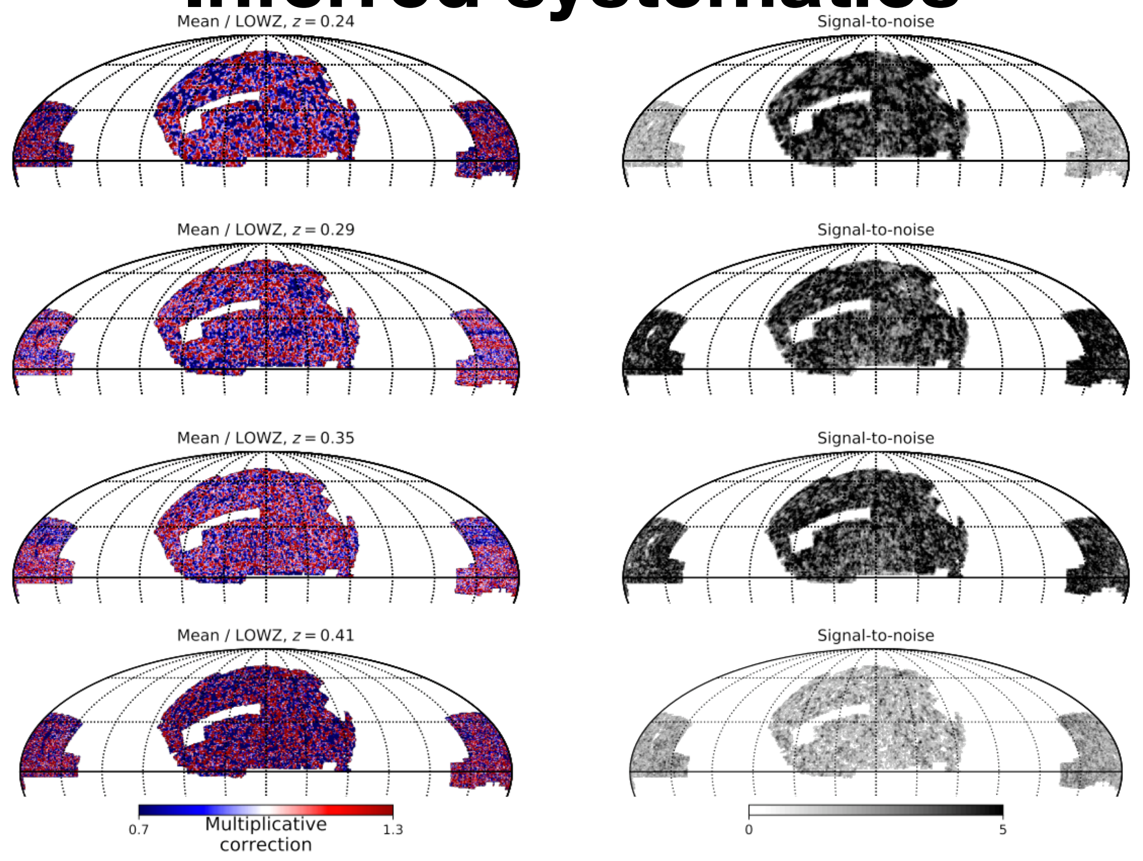
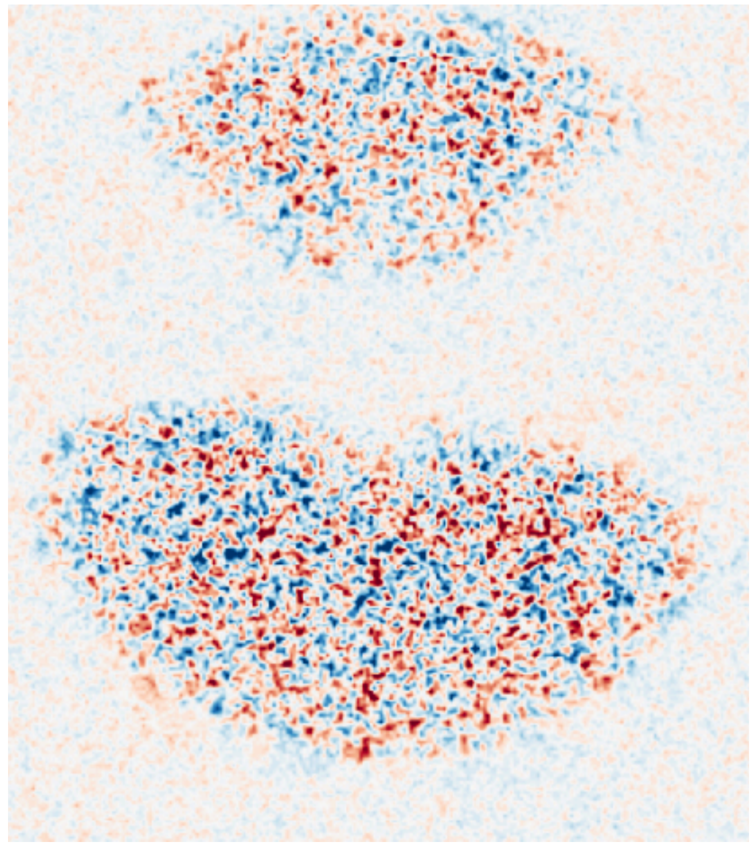
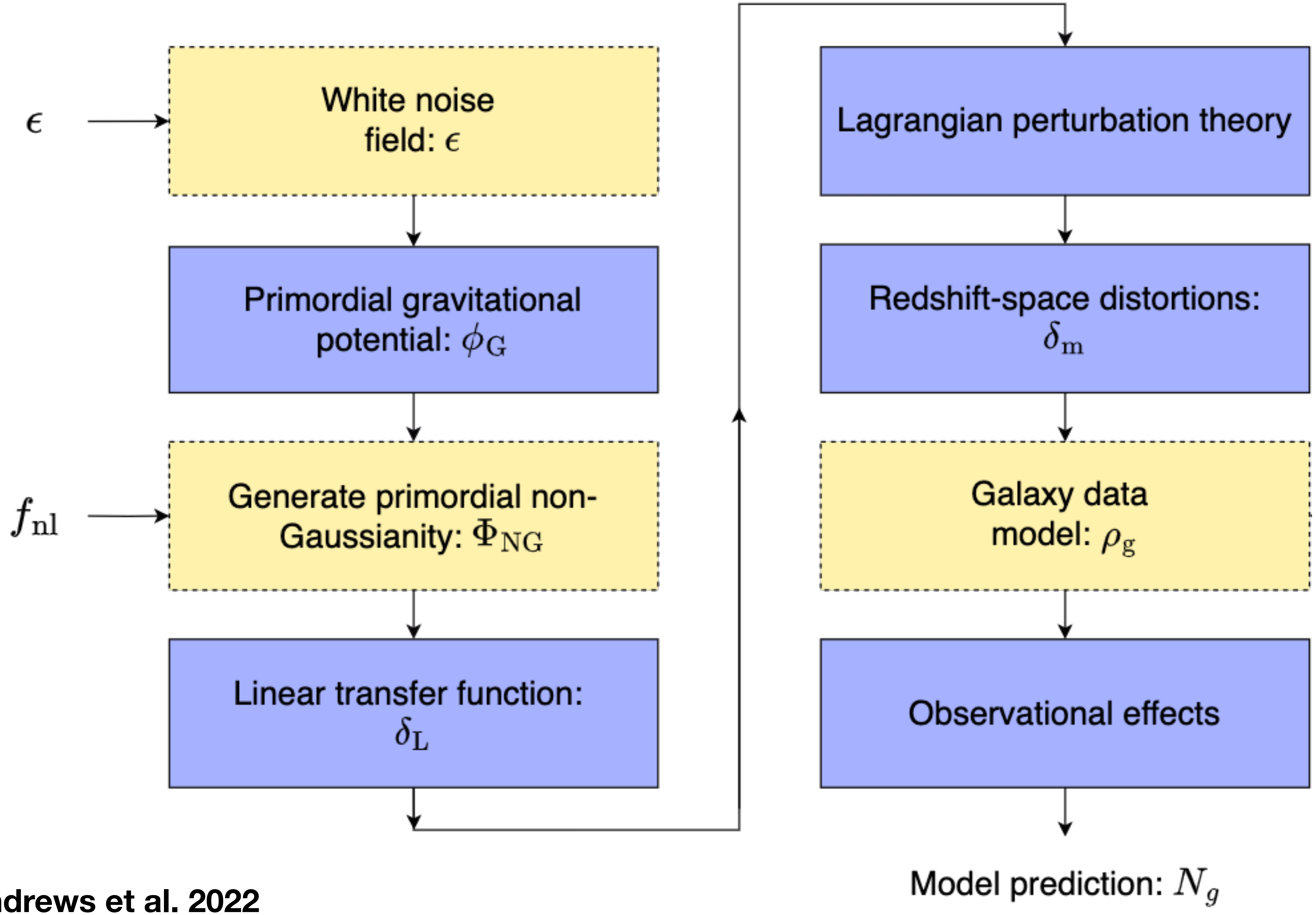


Inferred Density Field



Appendix

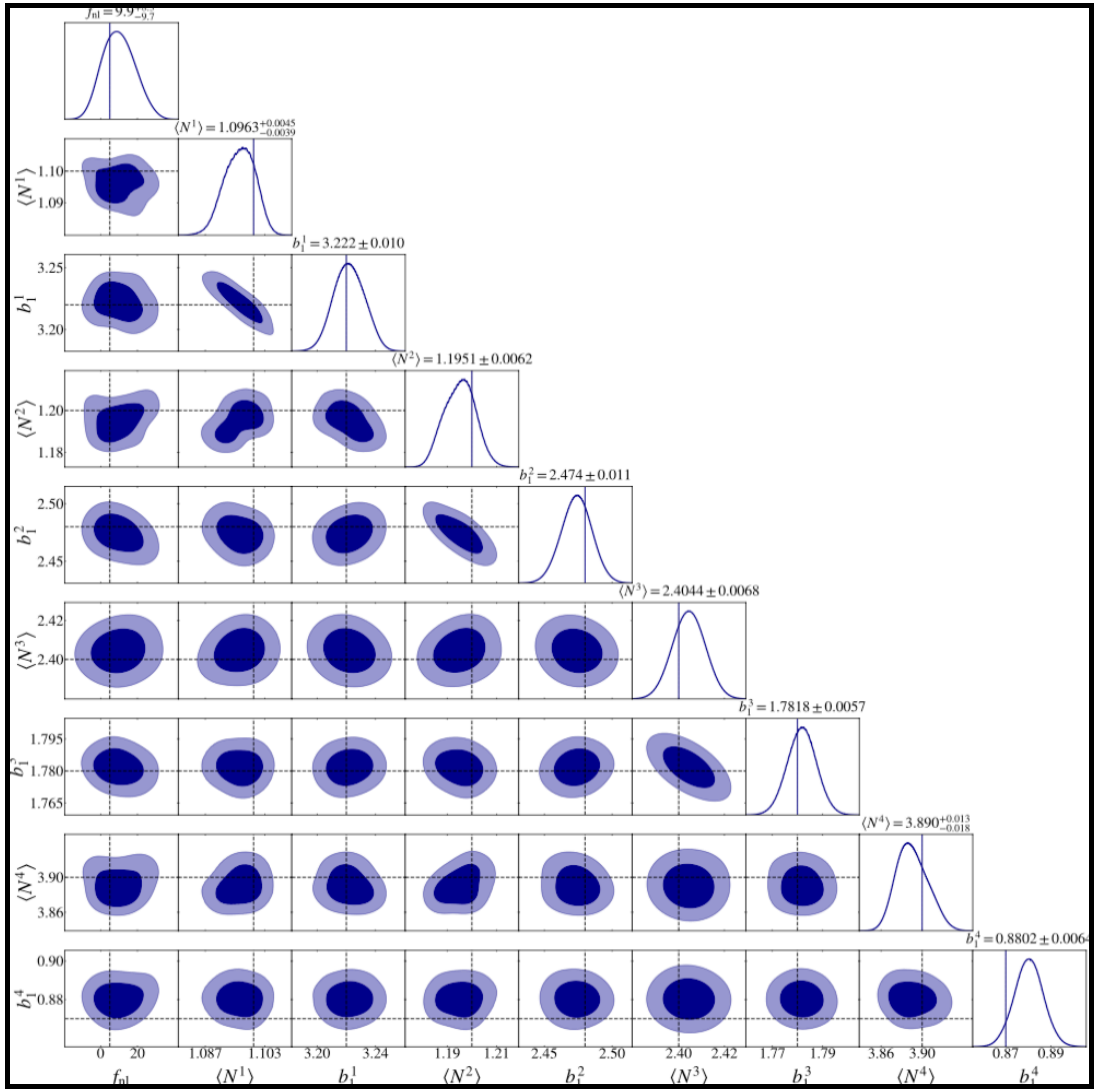
The Physics model



$$\rho_g = \langle N_g \rangle \left(1 + \left[b_1^g + b_\phi f_{\mathrm{nl}} \alpha^{-1}(k) \right] \delta_{\mathrm{m}} \right)$$

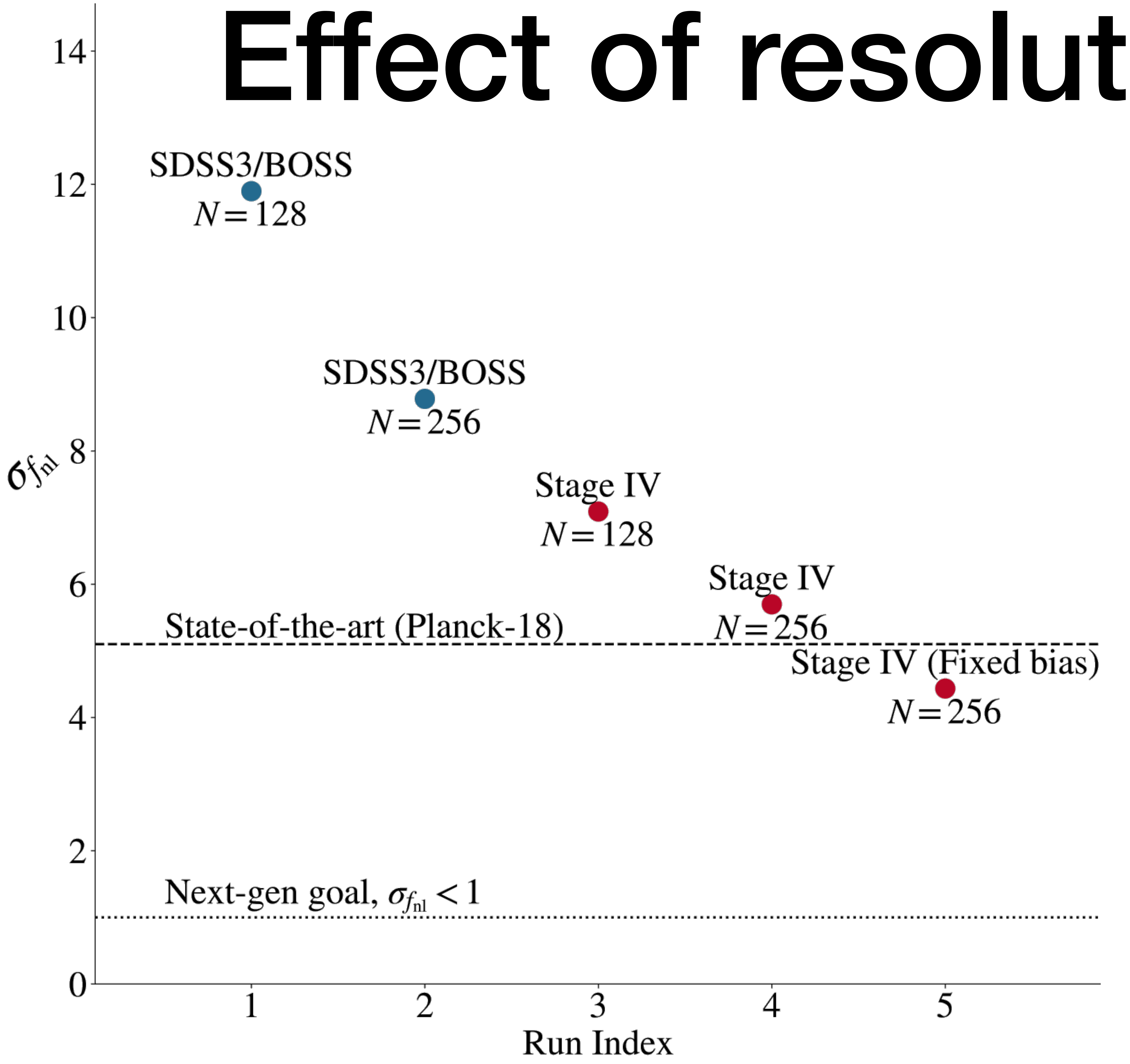
Andrews et al. 2022

Marginalising out bias parameters



Andrews et al. 2022

Effect of resolution increase



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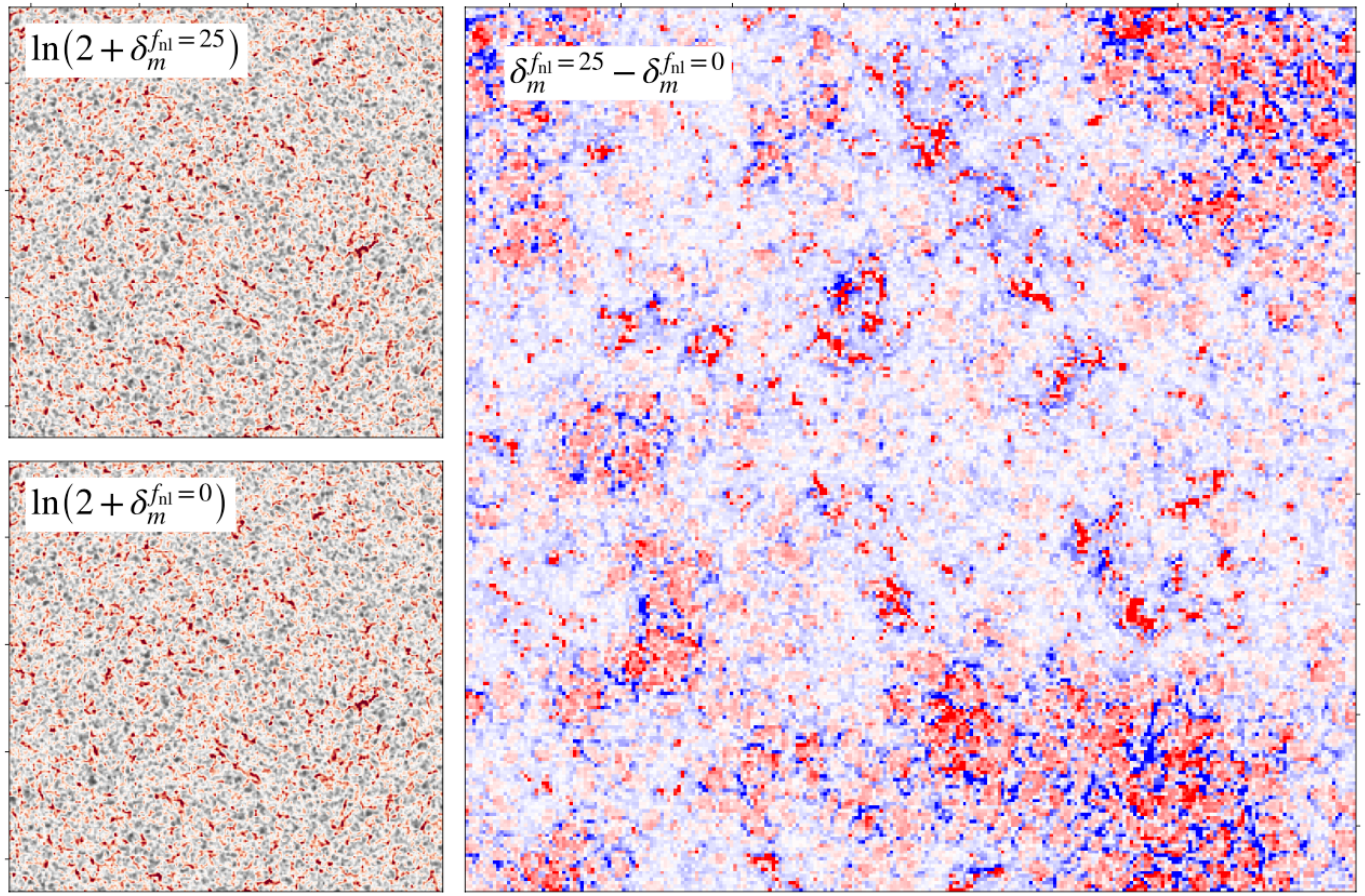
Effect of Primordial Non-Gaussianity



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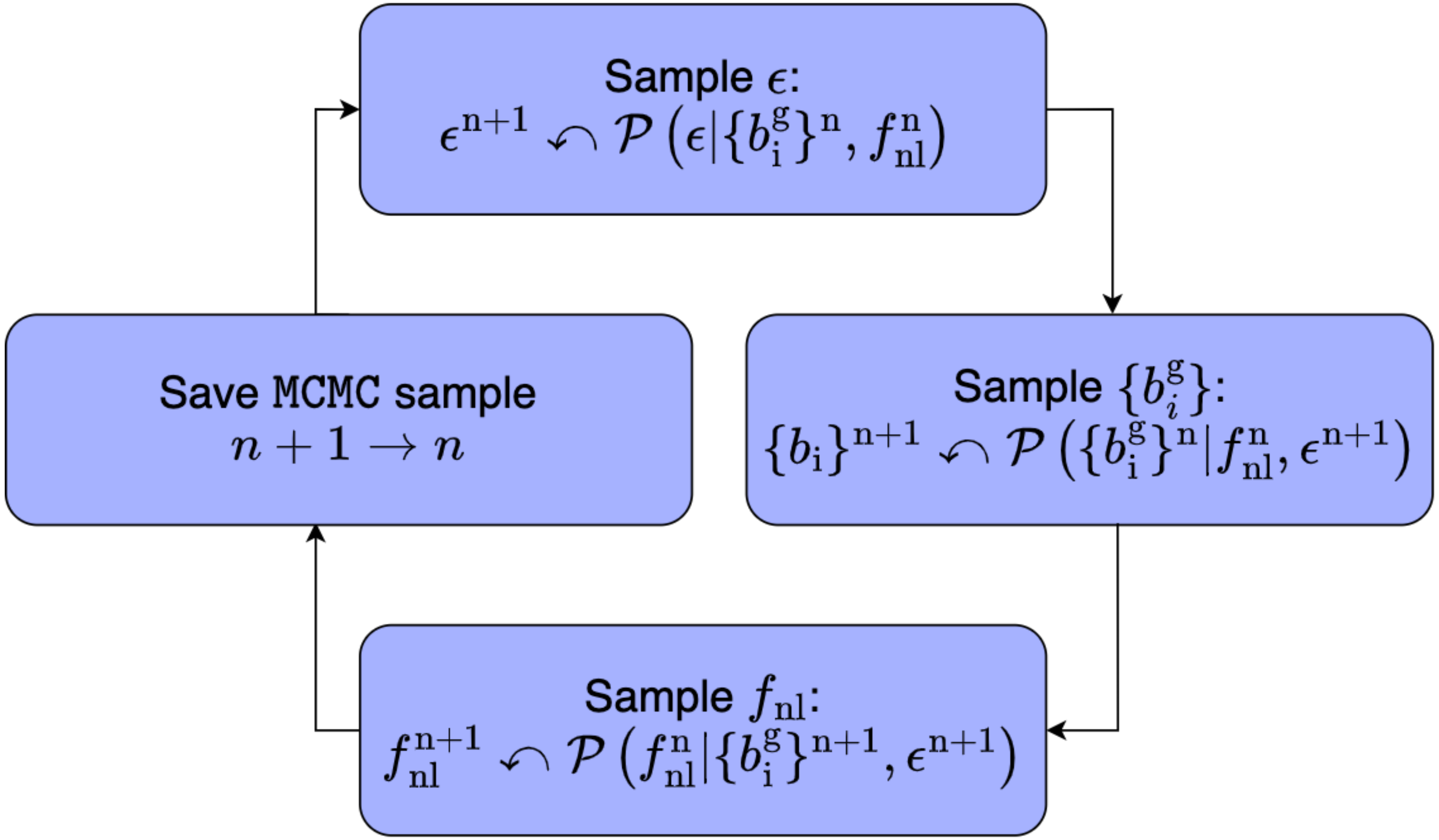
Statistical sampling (BORG)



Andrews et al. 2022