# Bayesian inference of dark matter voids in galaxy surveys

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J. Jasche, F. Leclercq, B. Wandelt, in prep. Bayesian chrono-cosmography with the SDSS DR7 main sample

F. Leclercq, J. Jasche, P. M. Sutter, N. Hamaus, B. Wandelt, in prep. Constrained catalogs of dark matter voids in the SDSS galaxy survey

## Issues with galaxy void catalogs

#### **Sparsity & Bias**

How to disentangle these effects from cosmological signals in presence of the uncertainty inherent to any cosmological observation?

Two approaches:

- Carefully quantify these effects...
  - e.g. Sutter et al. 2013, *Sparse sampling, galaxy bias, and voids*, arXiv:1309.5087 Sutter et al. 2013, *The dark matter of galaxy voids*, arXiv:1311.3301
- Or bypass them! (What if the real Universe looked like dark matter in simulations?)

## Why Bayesian inference?

- Why do we need Bayesian inference?
  Inference of signals = ill-posed problem
  - Incomplete observations: survey geometry, selection effects
  - Noise, biases, systematic effects
  - Cosmic variance



#### No unique recovery is possible!

"Where are dark matter voids in the Universe?"



"What is the probability distribution of possible dark matter voids (signals) compatible with the observations?"

$$p(s|d)p(d) = p(d|s)p(s)$$

#### BORG at work – chronocosmography



Jasche, FL & Wandelt, in prep.

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## Non-linear filtering



#### FL, Jasche, Sutter, Hamaus & Wandelt, in prep. also Jasche, FL, Romano-Díaz & Wandelt, in prep.

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### Dark matter voids: pipeline



#### FL, Jasche, Sutter, Hamaus & Wandelt, in prep.

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#### Dark matter voids in the SDSS



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### Dark matter void properties



#### FL, Jasche, Sutter, Hamaus & Wandelt, in prep.

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#### Dark matter void properties



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## Summary, Conclusions, Questions

- Dark matter voids can be constrained by the *ab initio* analysis of galaxy surveys!
- A general framework for any survey which allows to:
  - Translate voids statistics from galaxies to theory-like, high-resolution dark matter predictions
  - Alleviate the problems due to the sparsity and biasing of tracers
  - Reduce statistical uncertainty in void catalogs (1 OoM more voids at all scales)
- Example of application to the **SDSS DR7**:
  - All catalogs will be made publicly available at <u>www.cosmicvoids.net</u>
- Enhanced data sets for cosmological applications: iSW, lensing, DE, MG, other astrophysical probes of voids...