COSMICATLAS
Cosmological Catalogues for Large Scale Structure

Andrés Balaguera-Antolínez
In collaboration with

F.S. Kitaura (IAC), M. Pellejero (DIPC), Martha Lippich (MPE), Ariel Sánchez (MPE), Claudio Dalla Vecchia (IAC)

Instituto de Astrofísica de Canarias

Euclid General Meeting
Helsinki
2019

Cosmological Catalogs for Large Scale Structure

GOAL

- To produce hundreds to thousands of mock catalogs for current and forthcoming LSS surveys (e.g Euclid, DESI).

HOW

- Learning the halo bias from one high resolution N-body simulation

PRODUCTS

- Mock catalogs with
  - 1% precision in the power spectrum, bispectrum and covariance matrices (with respect to the reference)
  - Tracer properties (masses, velocities, to be) provided.

- Extrapolation to larger volumes with same mass resolution of reference

Cosmological Catalogs for Large Scale Structure: BAM

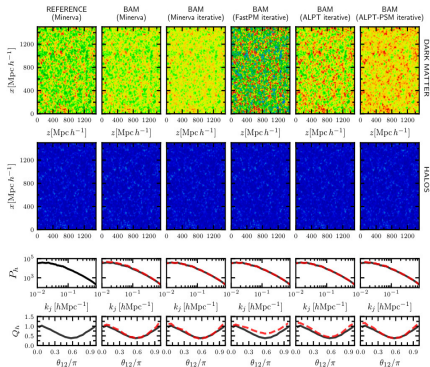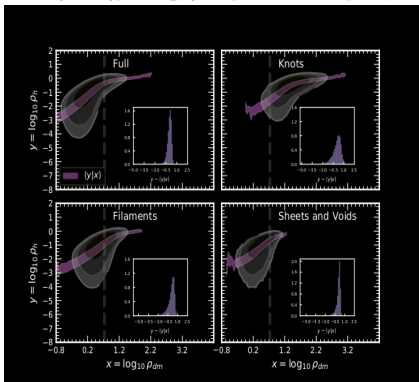**BAM: bias assignment method to generate mock catalogues**

A. Balaguera-Antolínez,[1,2]★ Francisco-Shu Kitaura,[1,2]★ Marcos Pellejero-Ibáñez,[1,2]
Cheng Zhao[3] and Tom Abel[4]

[1] Instituto de Astrofísica de Canarias, s/n, E-38205 La Laguna, Tenerife, Spain
[2] Departamento de Astrofísica, Universidad de La Laguna, E-38206 La Laguna, Tenerife, Spain
[3] National Astronomy Observatories, Chinese Academy of Science, Beijing 100012, P.R. China
[4] Kavli Institute for Particle Astrophysics and Cosmology, Stanford University, SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA

Cosmological Catalogs for Large Scale Structure

<center>

Next step:

</center>

- Assess the capability to reproduce statistical properties of an ensemble of simulations
- Impact on higher statistics (bispectrum and covariance matrix of power spectrum)
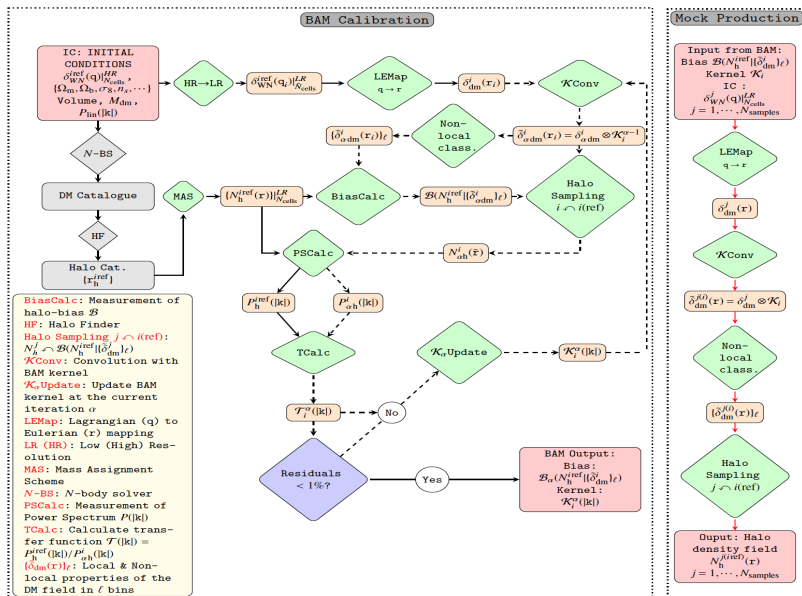- Tracer properties

Precise covariance matrices from mocks with the Bias Assignment Method

A. Balaguera-Antolínez[*1,2], Francisco-Shu Kitaura[†1,2], Marcos Pellejero-Ibáñez[3], Martha Lippich[4], Cheng Zhao[5], Tom Abel[6], Ariel G. Sánchez[4], Raúl E. Angulo[3,7], Claudio Dalla Vecchia[1,2] and Martín Crocce[8]
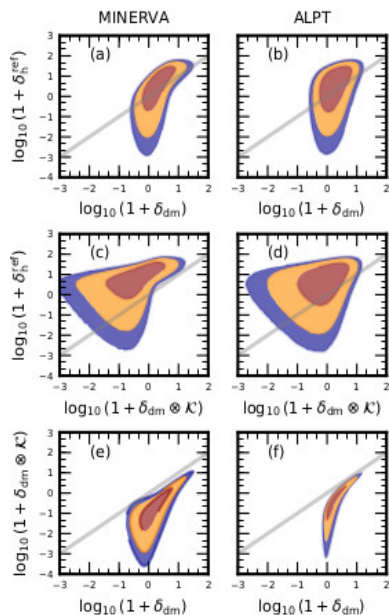
(Next week on the arXive)

Cosmological Catalogs for Large Scale Structure

Cosmological Catalogs for Large Scale Structure

What BAM does is:

- Iteratively *modifies* the underlying DM field with a *kernel* in order to statistically sample the DM field with a *halo-DM bias*.
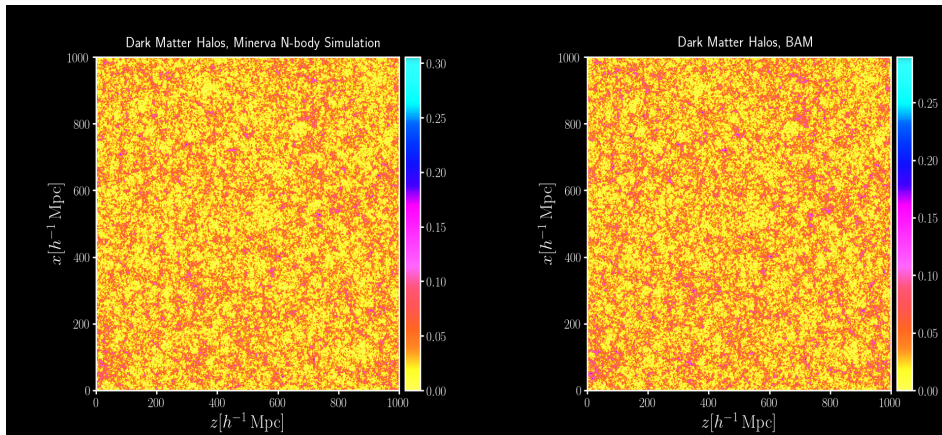
Outputs

- Halo bias: probabilistic picture

$$\mathcal{B}\left(N_{\mathrm{h}}^{i\,\mathrm{ref}} \mid \{\tilde{\delta}_{\mathrm{dm}}^{i}\}_{\ell} \right)$$

- Kernel (acting on the DM density field)

Cosmological Catalogs for Large Scale Structure

BAM vs Reference (Minerva Simulations, Grieb et al 2016)

Cosmological Catalogs for Large Scale Structure

BAM in action: using the UnitSim (Zhang et. al 2019)

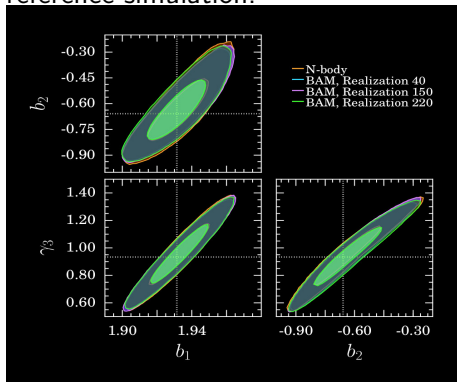# Cosmological Catalogs for Large Scale Structure: $P(k)$

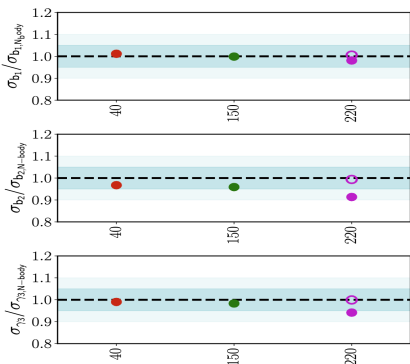# Cosmological Catalogs for Large Scale Structure: bi-spectrum

Cosmological Catalogs for Large Scale Structure: Covariance matrix of power spectrum

BAM covariance matrix reproduce to $< 5\%$ the errors obtained from the reference simulation.

(Credits: M. Lippich and A. Sánchez)

Cosmological Catalogs for Large Scale Structure

Summary:

- COSMICATLAS: long term project to generate mock catalogs using BAM
- One simulation to learn the bias. But not any simulation: high resolution and moderate volumes ($1 - 3Gpc^3$)
- Percent precision in power spectrum and covariance matrices
- BAM is in position to generate accurate mocks.

Next step:

- Extrapolate to larger volumes (Kernel properties) $\rightarrow$ Pair simulations
- Improve the signal of the bispectrum
- Assign halo properties