# EZmock

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## 1 Introduction

Zhao et al. (2021)

## 2 Matter Field

Zel'dovich approximation, the linear solution of the LPT.

The displacement field in ZA is given by

$$\vec{\Psi}_{\rm ZA}(\vec{q},a) = D_1(a)\int \frac{{\rm d}^3k}{(2\pi)^3}{\rm e}^{{\rm i}\vec{k}\cdot\vec{q}}\frac{{\rm i}\vec{k}}{k^2}\hat{\delta}(\vec{k}), \tag{1}$$

where $\hat{\delta}(\vec{k})$ is the density contrast in Fourier space at the initial time, and the linear growth factor $D_1(a)$ can be evaluated numerically through the integral representation

$$D_1(a) = a^3H(a)\frac{5\Omega_{\rm m}}{2}\int_0^a \frac{{\rm d}\tilde{a}}{\tilde{a}^3H^3(\tilde{a})}. \tag{2}$$

## 3 Effective Bias Model

Refer to Sec.2.2 of Zhao et al. (2021).

### 3.1 The Bias Function

1. Critical density $\rho_{\rm c}$: To form gravitational bound systems, such as dark matter halos, ***a minimum local denisty*** is required to overcome the background expansion. The first free parameter is ***a density threshold*** $\rho_{\rm c}$, the bias model contains a term of step function $\Theta(\rho_{\rm m}-\rho_{\rm c})$ to set a density threshold, in ohter words, only grid cells with density equal or higher than $\rho_{\rm c}$ are allowed to populate tracers.

2. Density saturation $\rho_{\rm sat}$: [TBD] Due to the strong degeneracies, they fix $\rho_{\rm sat} = 10$.

3. Exponential cut-off of the halo bias relation $\rho_{\rm exp}$: [TBD]

To summarize, the full bias model can be written as

$$\rho_{\rm t} = \theta\left(\rho_{\rm m} - \rho_{\rm c}\right)\rho_{\rm sat}\left[1 - \exp\left(-\rho_{\rm m}/\rho_{\rm exp}\right)\right]B_{\rm s}, \tag{3}$$

where $B_{\rm s}$ is the stochastic bias term to model the scatter in the bias relation.

$$B_{\rm s} = \begin{cases} 1 + G(\lambda), & G(\lambda) \geq 0; \\ \exp(G(\lambda)), & G(\lambda) < 0. \end{cases} \tag{4}$$

Here $G(\lambda)$ is a random number drawn from a Gaussian distribution with mean 0 and variance $\lambda$. The exponentail function is for ensuring the positivity of bias values.

The model of stochastic bias is too simple than people already known. The reason is, in EZmock, only the ***order*** of tracer densities for each cells matters. They fixed $\lambda = 10$ since the effect from it can be achieved by the other parameters, such as $\rho_{\rm c}$ and $\rho_{\rm exp}$.

### 3.2 PDF Mapping Scheme

## References

Zhao C., et al., 2021, Monthly Notices of the Royal Astronomical Society, 503, 1149