Astrophysical distortion
of the
large-scale Lyman-alpha forest

arXiv 1402.0506, 1407.6367

Simeon Bird (CfA), Hiranya Peiris (UCL), Licia Verde (Barcelona)

Andrew Pontzen
variance of 4.2. Weights the flux transmission field and its correlation function (Slosar et flux matches the mean forest flux at the corresponding redshift. in the forest region is then renormalized so that the mean forest

Fig. 4.

is assumed to have noise and LSS contributions:

\[ \hat{\xi}(z) \approx \frac{1}{2} \xi + \lambda \ell^2 \]

where \( \hat{\xi} \) makes the fit slightly sub-optimal. (Later, we will correctl

and poorly determined present in the data for

method, averaged for three ranges of

k < \xi < \mu < \xi < \mu < \xi < \mu

Delubac et al (BOSS collaboration) 2015, AA; 1404.1801
Equation (12) can actually be written as:

\[
F_r = \frac{1}{2} \left( \frac{r^2}{2R_s^2 + R^2} \right),
\]

\[
F_n = \frac{1}{2} \left( \frac{r^2}{2(R_1^2 + R_2^2)} \right),
\]

where \( F_n \) is Kummer's function. In our previous notation,

\[
F_n = \frac{1}{2} \left( \frac{r^2}{4R_s^2} \right),
\]

\[
F_n = \frac{1}{2} \left( \frac{r^2}{2(R_s^2 + R_s^2)} \right).
\]

For the asymptotic behavior, \( F_n \to 1 \) as \( r \to \infty \). Thus, for \( r \gg R_s \), all \( F_n \) are approximately equal, demonstrating that \( \approx 1 + \kappa^2 \xi \) on large scales is satisfied, our modification increases the galaxy correlation functions by the same factor. Some correlation and the density peak occurs at \( r \sim R_s \). Its position is a function of the shape dependence of a Gaussian (assumed Gaussian).

The fluctuation spectrum is shown in both cases, we chose \( \kappa \) values of \( \kappa = 0 \). Transition of the domain of constant transition between

For a demonstration, a plot of the function for a grid with scale factor transitions.

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Uniform UV illumination

Lyman alpha forest

Clumped UV illumination

(b=3)

P_{\text{HI}}(k)/h^3 \text{ Mpc}^3

(aH/k)/(\text{km s}^{-1})

Pontzen 2014, PRD arXiv 1402.0506

see also Gontcho et al 1404.7425
Uniform UV illumination

Clustered UV illumination (b=3)

Lyman alpha forest

Pontzen 2014, PRD arXiv 1402.0506

see also Gontcho a Gontcho et al 1404.7425
UV photon mean-free-path

Pontzen 2014, PRD arXiv 1402.0506
Pontzen 2014, PRD
arXiv 1402.0506
Boltzmann equation

\[ f(x, n, \nu, t) \]

Ionisation equilibrium

\[ n_{HI}(x) \]

Gaussian random field, \( \Lambda CDM \) \( P(k) \)

Shotnoise

\[ \rho(x) \]

\[ j(x) \]

Boltzmann equation

Analytics

Pontzen 2014, PRD
arXiv 1402.0506
Boltzmann equation

\[ f(x, n, \nu, t) \]

Ionisation equilibrium

\[ n_{HI}(x) \]

Gaussian random field, \( \Lambda \text{CDM} \ P(k) \)

Shotnoise

\[ j(x) \]

equilibrium broadband, Boltzmann equation

\[ f(x, n, \nu, t) \]

Ionisation equilibrium

\[ n_{HI}(x) \]

\[ \rho(x) \]

\[ H(x) \] Pontzen 2014, PRD arXiv 1402.0506

Analytics
Effect of source bias

Pontzen 2014, PRD arXiv 1402.0506
Effect of source density

Pontzen 2014, PRD arXiv 1402.0506
Genetically modified halos: Experiments in galaxy formation
Nina Roth [n.roth@ucl.ac.uk]

Introduction

Abstract We propose a method to generate modified initial conditions (ICs) in high-resolution simulations of galaxy formation in a cosmological context. Building on the Hoffmann-Ribak algorithm, we start from a reference simulation with full random initial conditions, then make controlled changes to specific properties of a single halo (such as its mass and merger history). The algorithm makes minimal changes to other properties of the halo and its environment, allowing us to isolate the effect of a given modification.

Constrained realizations The initial density contrast field of a cosmological simulation, \( \delta \), is a realization of a Gaussian random field with covariance \( C_{\delta} = \langle (\delta - \delta_0)(\delta - \delta_0) \rangle \) and mean \( \langle \delta \rangle = \delta_0 \). Imposing a constraint – expressed by a constraint vector \( \vec{\delta} - \vec{a} + \vec{d} \) with \( \vec{d} \in \mathbb{C} \) – is equivalent to multiplying the original probability distribution by a penalty function, leading to a new probability density with different mean and covariance. Several such constraints can be applied in succession, and the constrained property can be anything linearly related to the density contrast, including angular momentum. Refer to Roth, Pontzen & Peiris (2015) for full details and derivations.

Modifying halos Our approach differs from previous studies because we directly modify the halo. For this we select the halo particles identified by a Friends-of-friends (FoF) algorithm at \( z = 0 \), and trace them back into the initial conditions. We then modify this proto-halo by constraining the overdensity of its particles, and run the simulation again until \( z = 0 \). This new simulation can then be directly compared to the result of the reference run.

Results: Halo concentration

The change in density profile from the collapse constraint can be expressed by the concentration parameter \( c = \frac{r_{200}}{r_s} \) where \( r_{200} \) is the virial radius and \( r_s \) is the scale radius in the NFW density profile. The collapse time is defined by fitting an exponential to the mass accretion history. These two quantities have been shown to correlate, albeit with significant scatter (e.g., Wechsler et al. 2002). We show the results of imposing these different halos (identified by their halo finder ID), and where they fall on this correlation.

Results: Density constraints

We demonstrate our technique by constraining a halo’s collapse time (given by the slope of its mass accretion history, see Wechsler et al. 2002). For this, we keep the density averaged over all halo particles the same, but enhance or decrease the density of the 10% of particles in the innermost region in the proto-halo (top figure). While the total mass at \( z = 0 \) remains unchanged, the halo assembly and its density profile differ significantly (bottom figure).

Results: Constraint probability

A naive choice of constraints can easily result in extreme configurations which are very unlikely to occur within the Hubble volume of the real universe. We can compare the unconstrained and constrained fields with respect to the unmodified CDM covariance matrix \( C_0 \) by evaluating the change in \( \chi^2 \), defined as

\[
\Delta \chi^2 = C_0^{-1} \delta C_0 \delta \quad (1)
\]

where \( \delta \) is a field with \( n \) constraints. This constrained field has a relative abundance in the universe of \( e^{-\Delta \chi^2/2} \) compared to the original, unconstrained field \( \delta_0 \).

Results: Halo concentration

Above: Concentration-collapse time relation of three constrained halo families (halos 24, 37 and 40). The solid coloured lines show the fit to each halo family individually and the black dashed line shows a fit to all halos together. The grey band show the average scatter of this relation obtained from a large sample of halos from the reference run, consistent with other studies (e.g., Wechsler et al. 2002). Understanding the origin of the different slopes for each halo family can provide physical insight into this empirical scaling relation.

References


Genetically modified halos: Experiments in galaxy formation
Nina Roth

Roth, Pontzen & Peiris (2015)
Ionisation fluctuations dominate the Lyman-alpha forest power spectrum on the largest scales. Thermal fluctuations will also be important.

Effects on BAO small and correctable; but “non-BAO” cosmology needs astrophysical effects to be understood and marginalised.