ESTIMATING THE BAO IN REAL SPACE

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ABSTRACT

The Baryon Acoustic Oscillations (BAO) are an important source of information from the large scale structure of the universe and have significant constraining power on the matter content of the universe. They play the role of standard rulers and can be obtained by probing the galaxy distribution in real or redshift space. Here, we present the steps to obtain the matter power spectrum using an open-source code called `nbodykit`. We used data from the Baryon Oscillation Spectroscopic Survey (BOSS), part of the Sloan Digital Sky Server (SDSS) Data Release 12, containing luminous red galaxies from the LOWZ sample and massive galaxies from the CMASS sample in the redshift range $0.3 < z < 0.65$. Furthermore, we used 500 mocks in order to calculate the covariance matrix of the power spectrum. Here, we obtained the linear power spectrum monopole which is expected to be accurate for large scales. With the power spectrum we were able to obtain the dilation scale D_V. The values found are: $D_V(0.501) = 1791.52 \pm 20.00$ Mpc. The other result is the $r_{BAO}(z = 0.501) \simeq 0.080 \pm 0.001$.

DATA & SOURCE CODE

- DR12 from the SDSS.
- LOWZ and CMASS.
- 993,228 with $0.3 < z < 0.65$ galaxies.
- 500 mocks from [4] and [5], the MultiDark-Patchy mocks.
- We used `nbodykit` from [6].

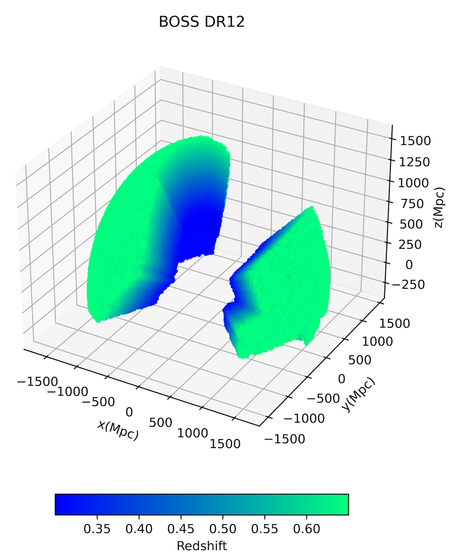

Figure 4: The representation of the data set in 3D. The colorbar represents the redshift and the distances were calcilated with the fiducial model: $\Omega_{CDM} = 0.265, \Omega_b = 0.045, h = 0.7$.

RESULTS

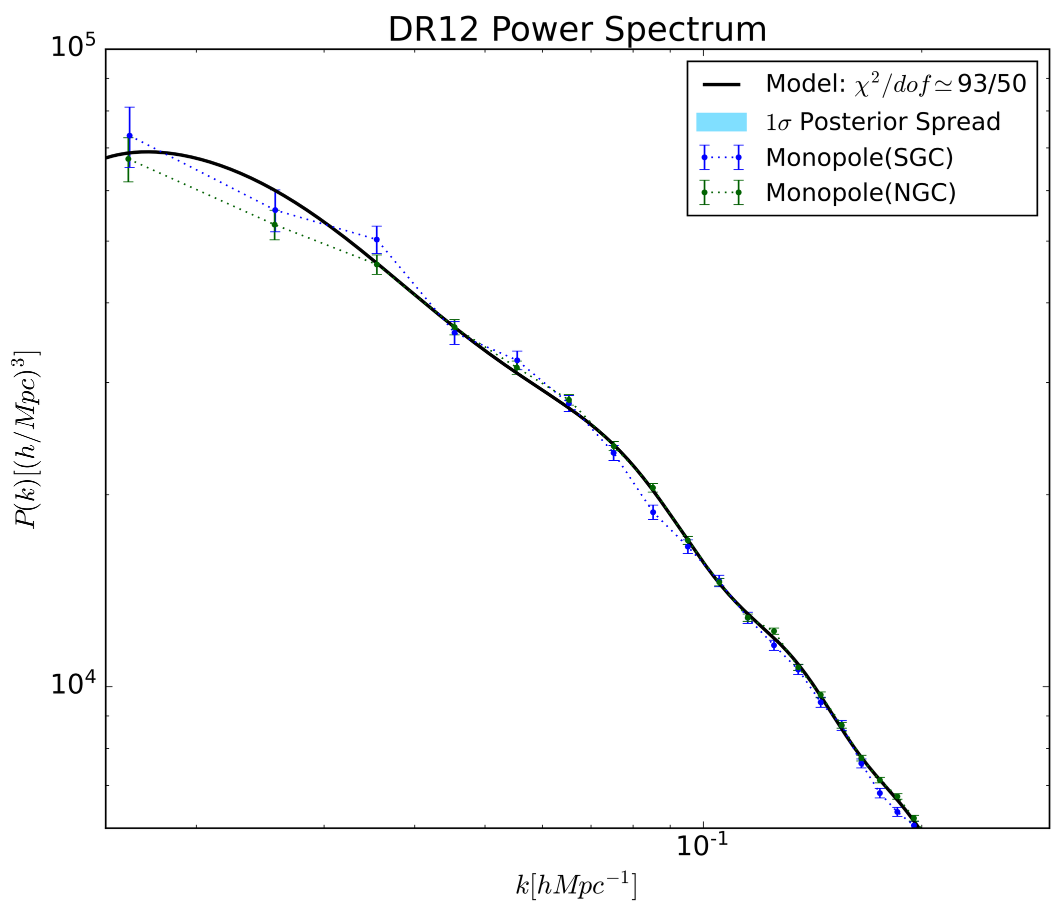

Figure 1: Matter Power Spectrum of DR12 in log_{10}. In green the NGC, and in blue the SGC The best fitted model is the black line. The lighter blue region shows the standard deviation of the posteriors.

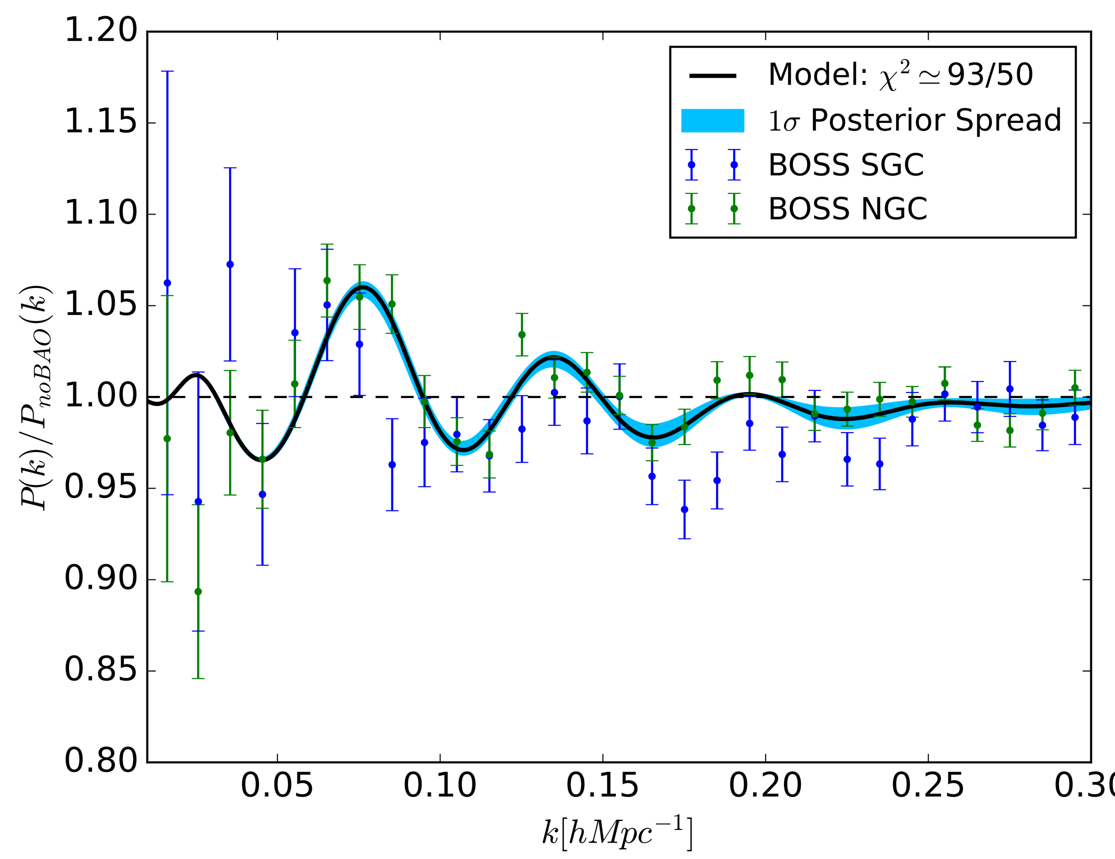

Figure 2: Wiggles plot showing the BAO. In green the NGC, and in blue the SGC The best fitted model is the black line. The lighter blue region shows the standard deviation of the posteriors.

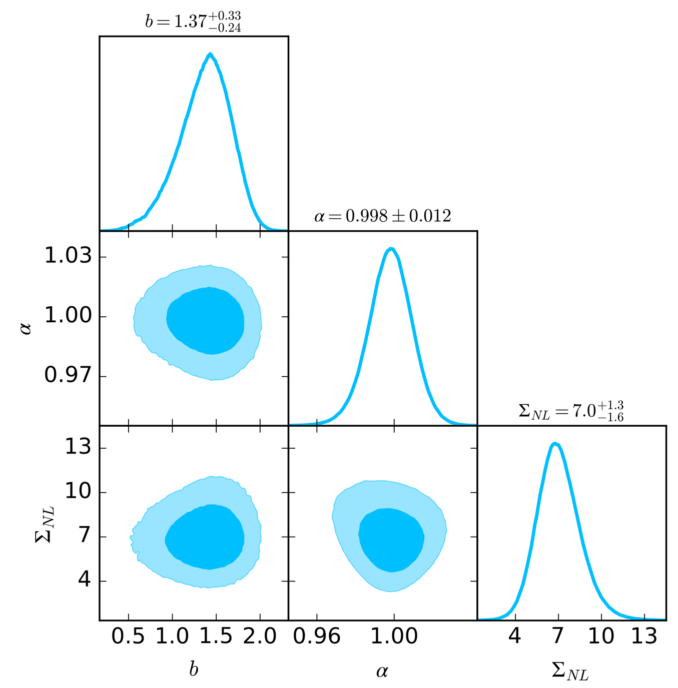

Figure 3: Triangular plot in terms of the likelihood distribution of the physical parameters.

- $D_V(0.501) = 1792 \pm 20$ Mpc.
- The last result is the relative BAO distance, $r_{BAO} = \frac{r_s(z_{drag})}{D_V(z_{eff}=0.501)}$,
- $r_s(z_{drag}) = 147.78$ Mpc was calculated in [3]
- $r_{BAO}(z = 0.501) \simeq 0.080 \pm 0.001$

POWER SPECTRUM

$$D_V(z) = \left[(1+z)^2 D_A(z)^2 \frac{cz}{H(z)}\right]^{1/3} \quad (1)$$

We fit a polynomial which represent the wiggles of the power spectrum. This method is the same used in [1].
The smooth model is defined as

$$P_s(k) = b^2 P_{nB}(k) + A_1 k + A_2 + \frac{A_3}{k} + \frac{A_4}{k^2} + \frac{A_5}{k^3} \quad (2)$$

The model that contains the oscillations is described as

$$P_{fit}(k) = P_s(k)\left[1 + \left(\Theta\left(\frac{k}{\alpha}\right) - 1\right) e^{-0.5k^2\Sigma_{nl}^2}\right] \quad (3)$$

Θ is the power spectrum with the oscillations calculated using [2] fitting formulas in `nbodykit`. α is the scale dilation parameter given by

$$\alpha = \frac{D_V(z)}{D_{V,fid}(z)} \quad (4)$$

where D_V and $D_{V,fid}$ are the dilation scales, both from the data set and the fiducial model.
The wiggles are computed dividing $P_{fit}(k)$ by $P_{nB}(k)$ as

$$P_{wiggles}(k) = P_{fit}(k)/P_{nB}(k). \quad (5)$$

CONCLUSION

- We obtained the BAO in real space using an open source code `nbodykit`.
- The BAO starts around wave-number $k \simeq 0.04$ h Mpc^{-1}.
- We noticed model errors are more pronounced on larger scales, in accordance with the cosmic variance.
- $D_V(0.501) = 1792 \pm 20$ Mpc.
- $r_{BAO}(z = 0.501) \simeq 0.080 \pm 0.001$.
- Future work: compare results with other publications, usually the redshift range is smaller than ours, we expect that our results will have D_V, smaller error bars.

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