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Constraining BAO parameter with Bispectrum clustering of DESI Tracers

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ABSTRACT

We use simulations with and without BAO signal to assess the possibility of extracting more information from higher order statistics. We measure the BAO constraints from the power spectrum and the bispectrum of DESI-like LRG tracers. We show that the BAO signal in the bispectrum has a potential of significantly improving the distance constraints by X% compared to the power spectrum alone analysis. The improvement seems to be stable when we marginalize over possible theoretical systematics. We validate our results on simulations with and without BAO for a range of redshifts. We measure isotropic BAO from the AbacusSummit simulations that are designed to replicate the DESI BGS, LRG, ELG, and QSO samples. We find that, in the absence of additional systematic effects we are able to constrain the distance scale with the precision of xxx per cent, xxx per cent, and xxx percent respectively for the BGS, LRG, and ELG samples. Whereas, the forecasted BAO constraints for the power spectrum only are xxx, xxx, and xxx percent respectively.

Key words: Awesome keywords: Perfect

1 INTRODUCTION

With unparalleled amount of spectra, DESI is designed to deepen our understanding of the nature of Dark Energy, masses of neutrinos, and gravity by measuring the clustering of galaxies and quasars. With four distinct tracers, DESI is constructing a 3D map of the Universe covering the redshift range of $? < z <?$. The power spectrum or two-point correlation functions have been the gold standard statistics to condense data and extract information from large-scale structure. Reconstruction techniques can improve the precision by accounting for the smearing effect of BAO, but the amount of information in the two-point statistics is limited by cosmic variance. Recent studies indicated that higher order statistics are capable of extracting more information.

Even for an initial Gaussian field, the Samushia et al. (2021) showed that higher order clustering statistics yield significantly better constraints on cosmological distance measurements relative to reconstruction techniques.

We estimate the reduced covariance matrix from a suite of 15000 simulations (MOLINO) and scale it by the variance of power spectrum or bispectrum for the GLAM or ABACUS realizations.

$$\mathbb{C}_{Y,Y} = (\sigma_Y \otimes \sigma_Y)_{\mathrm{Mock}} \, (\frac{\mathbb{C}_{Y,Y}}{\sigma_Y \otimes \sigma_Y})_{\mathrm{MOLINO}} \tag{1}$$

where $\mathbb{C} = Y, Y$

2 DATA

2.1 GLAM

2.2 ABACUS

Fig. 1 shows the mean bispectrum (left) and the mean power spectrum (right) for the GLAM and ABACUS simulations, relative to the spectra without the BAO signal, which is simulation-based for the GLAM realizations and theory-based for the ABACUS.

3 RESULTS

REFERENCES

Samushia L., Slepian Z., Villaescusa-Navarro F., 2021, Monthly Notices of the Royal Astronomical Society, 505, 628

APPENDIX A: EXTRA

You can put extra stuff here as appendix.

This paper has been typeset from a TeX/LaTeX file prepared by the author.

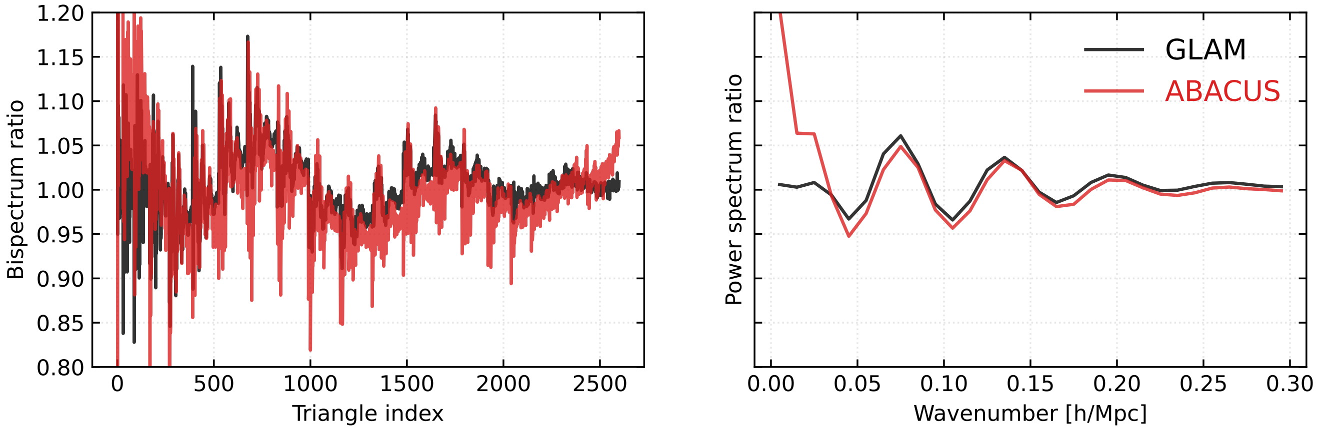

Figure 1. Spectra of ABACUS, GLAM, and MOLINO simulations. Top: Mean bispectrum and power spectrum of simulations relative to smooth spectrum either from the mocks (GLAM) or fitting formula (ABACUS). Bottom: Normalized dispersion of bispectrum and power spectrum.

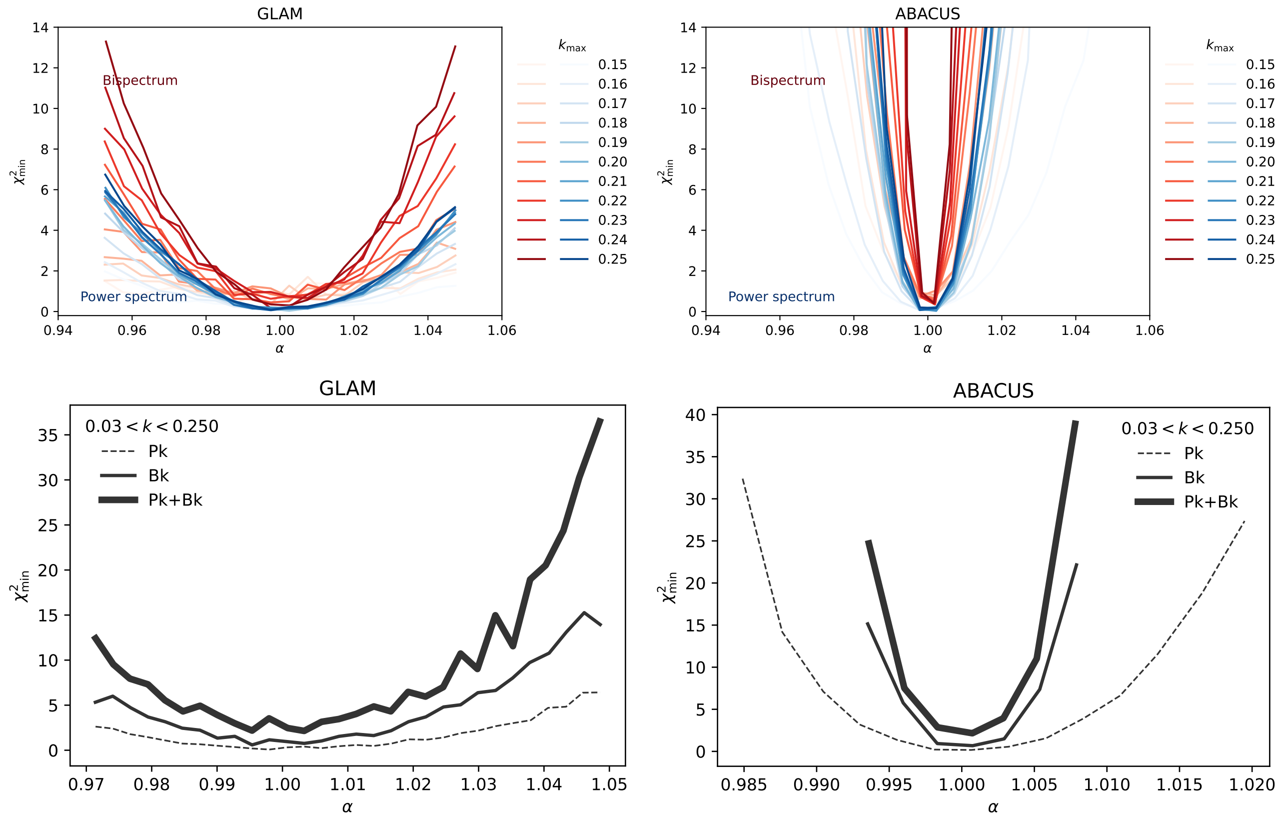

Figure 2. Marginalized minimum χ^2 as a function of the BAO peak α

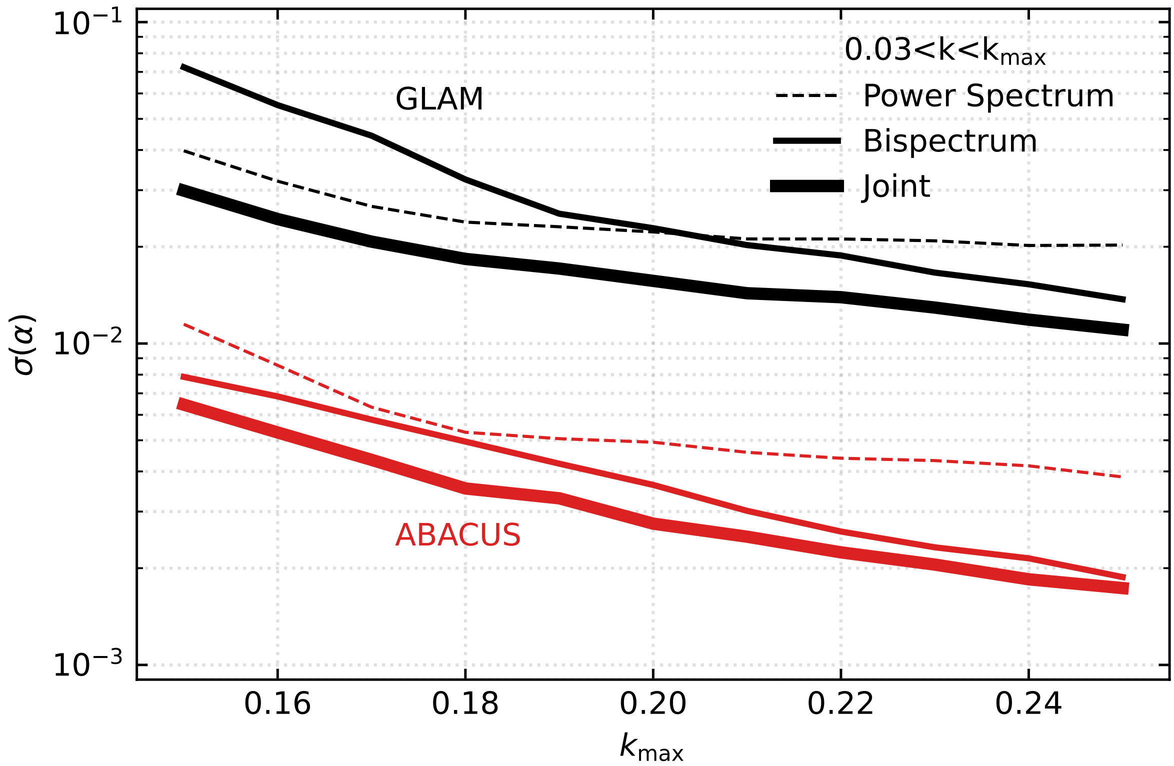

Figure 3. Dispersion in the BAO peak α as a function of the maximum wavenumber $k_{\rm max}$