Finding the Baryon Acoustic Oscillation Signal with Cosmic Voids

Ishani Kulkarni, Christina Kreisch, Princeton University Department of Astrophysical Sciences, isk@princeton.edu

Background

- The Baryon Acoustic Oscillation (BAO) signal results in a higher probability of finding a galaxy at the "BAO distance" from another given galaxy
- It can be seen in the halo correlation function.
- Cosmic voids are large, underdense regions bound by regions densely populated with galaxies
- The voids correlation function has a characteristic peak at the void exclusion scale, corresponding to the location at which voids are most closely packed together

Research Questions

- Can we isolate the BAO signal from the clustering pattern of voids with high significance?
- Is there a resonant void size that emphasizes the BAO signal?

Methods and Materials

- Artificially remove the BAO signal from the n-body simulation[1]
- From halo data, use a void finder[2] to produce a void catalog
- Produce void correlation function and plot difference between BAO and BAO- removed function to observe the effect of the BAO
- Subsample halos and voids to enhance signal

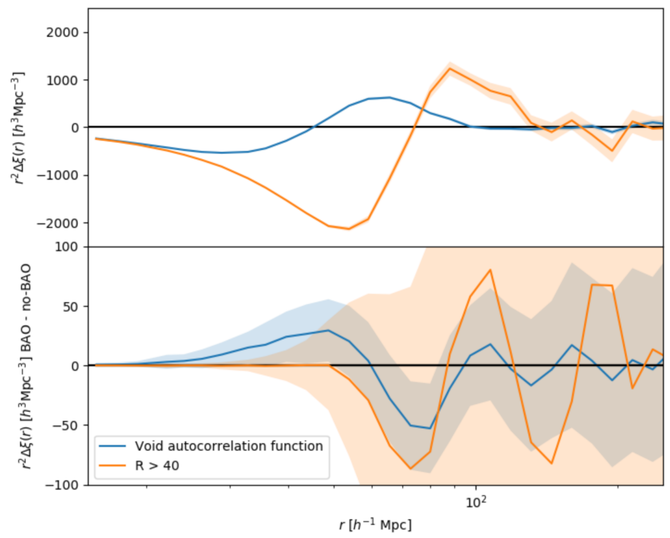

Figure 1: Void- Void Correlation Function
Top panel: the void correlation function for the original and subsampled data.
Bottom panel: the result of subtracting the BAO correlation function by the removed-BAO correlation function. This was done for both the original and subsampled data.
The radius cut was done by taking only the voids with a radius greater than 40.

Results

- We were able to find the BAO signal using cosmic voids
- Subsampling in various ways shifted the peak of the correlation function
- Mass cuts of large halos shifted it to the right
- Fraction of voids used for void cut: 5529/24081 (~23%)

Conclusions

- The BAO can be extracted from the void-void correlation function
- Did not isolate the signal with high significance
- Resonant void size is near 40 because that is the void cut that most enhanced the signal (weak statistics)

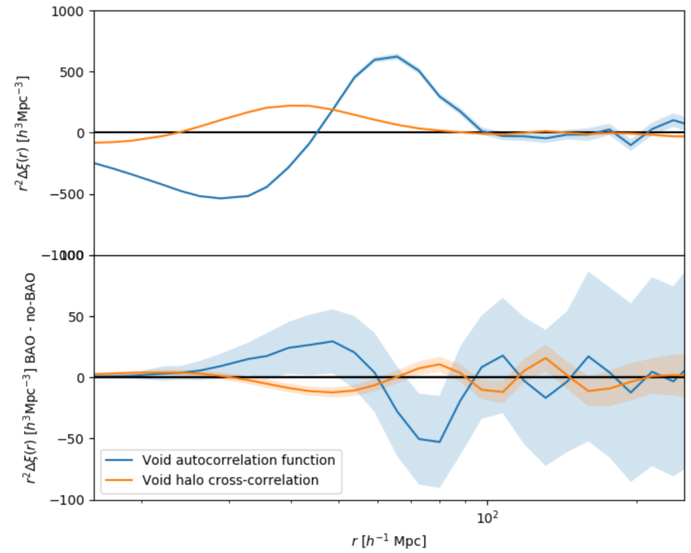

Figure 2: Void- Halo Correlation Function
Top panel: the void-halo correlation function for the original and the subsampled data.
Bottom panel: the result of subtracting the BAO correlation function by the removed-BAO correlation function. This was done for both the original and subsampled data.
The radius cut was done by taking only the voids with a radius greater than 40.

Implications

- Impacts future large scale surveys because cosmic voids can be studied with good statistics
- Affects survey design by providing information about a luminosity cut to enhance the BAO signal
- Combining BAO measurements with Cosmic Microwave Background (CMB) measurements helps constrain the Hubble constant

Acknowledgments

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(1): https://github.com/franciscovillaescusa/Quijote-simulations
(2) VIDE: arXiv:1406.1191 [astro-ph.CO]
(3) arXiv:1511.04391v1 [astro-ph.CO] 13 Nov 2015