Measuring BAO with eBOSS data

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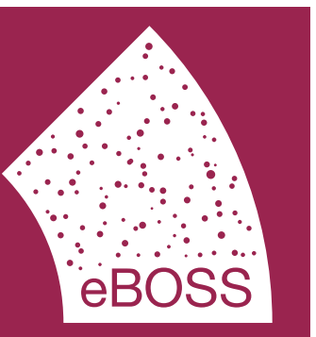
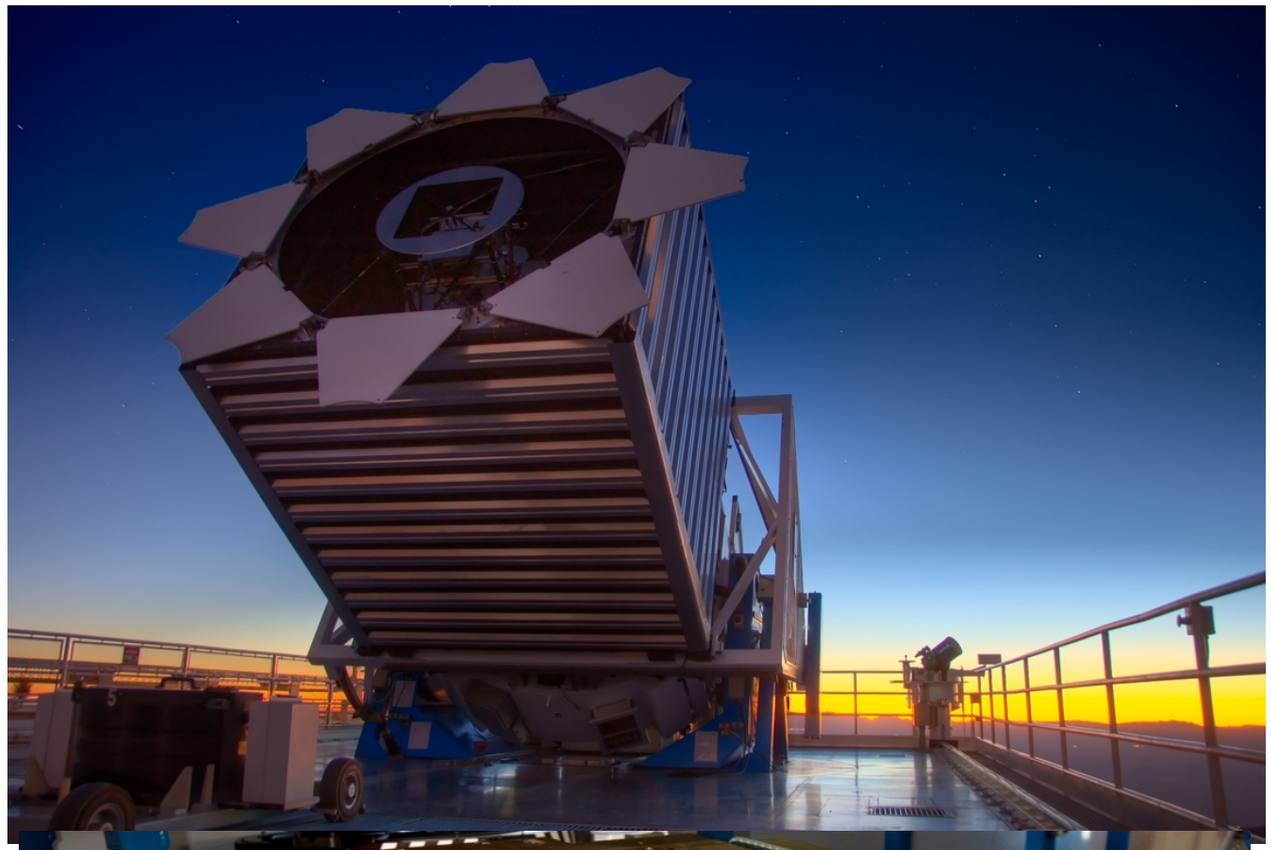


Outline

- (Quickly): Making the catalogs
- Obtaining the catalogs
- Calculating correlation function
- Measuring BAO scale
- All code/scripts for doing everything is here: https://trac.sdss.org/attachment/wiki/eBOSS/QGC/AJR_handson_xibao.zip

Making the catalogs

- "Target": select objects to be observed for spectroscopy
- "Tile": Figure out how most efficiently/completely observed targets
- Observe
- Measure redshifts
- Put everything together into LSS catalogs



Download LSS Catalog

- https://trac.sdss.org/wiki/eBOSS/QGC/LSScats
  - (from eBOSS, go to QGC page, link is near top of that page)
- Help Rita with todo list!

LSS catalogues

Versions 0.x mean preliminary catalogues. Summary of most up-to-date catalogues:

Targets	Catalogue version	Comment
LRGs	#eBOSS-v0.8	eBOSS + SEQUELS. spAll-v5_8_0.fits + spAll-v5_9_0-sequels.fits
LRGs + CMASS	#eBOSS-v0.8	eBOSS + SEQUELS + CMASS. spAll-v5_8_0.fits + spAll-v5_9_0-sequels.fits + DR12v5_CMASSLOWZTOT
QSOs	#eBOSS-v0.7	eBOSS + SEQUELS. spAll-v5_8_0.fits + spAll-v5_9_0-sequels.fits

All catalogues dumped on here:
https://data.sdss.org/sas/ebosswork/eboss/lss/catalogs/

To-do list and schedule

Follow link, go to version specified here

download .dat and .ran files
nbar files give useful info

Correlation Function

- Use Landy-Szalay estimator
  - (DD-2DR+RR)/RR
- Need “pair-counts” (PC)
  - normalized number of pairs binned by co-moving separation (s) and cosine of angle to line of sight (μ)

Prep data for PCs

- *This is my way, not necessarily the "best way"*
- 1) Divide random sample into 1 million object chunks (not necessary with current eBOSS data) with just ra,dec
- 2) put 1st million (or all in eBOSS case right now) into healpix map; use healpix map to define 20 ~equal area regions

Prep data for PCs

- *This is my way, not necessarily the "best way"*
- 3) Make galaxy file, applying redshifts and combining weights into 1 quantity (ra,dec,z,weight)
- 4) Assign redshifts/weights to random ra,dec by randomly selecting from new galaxy file

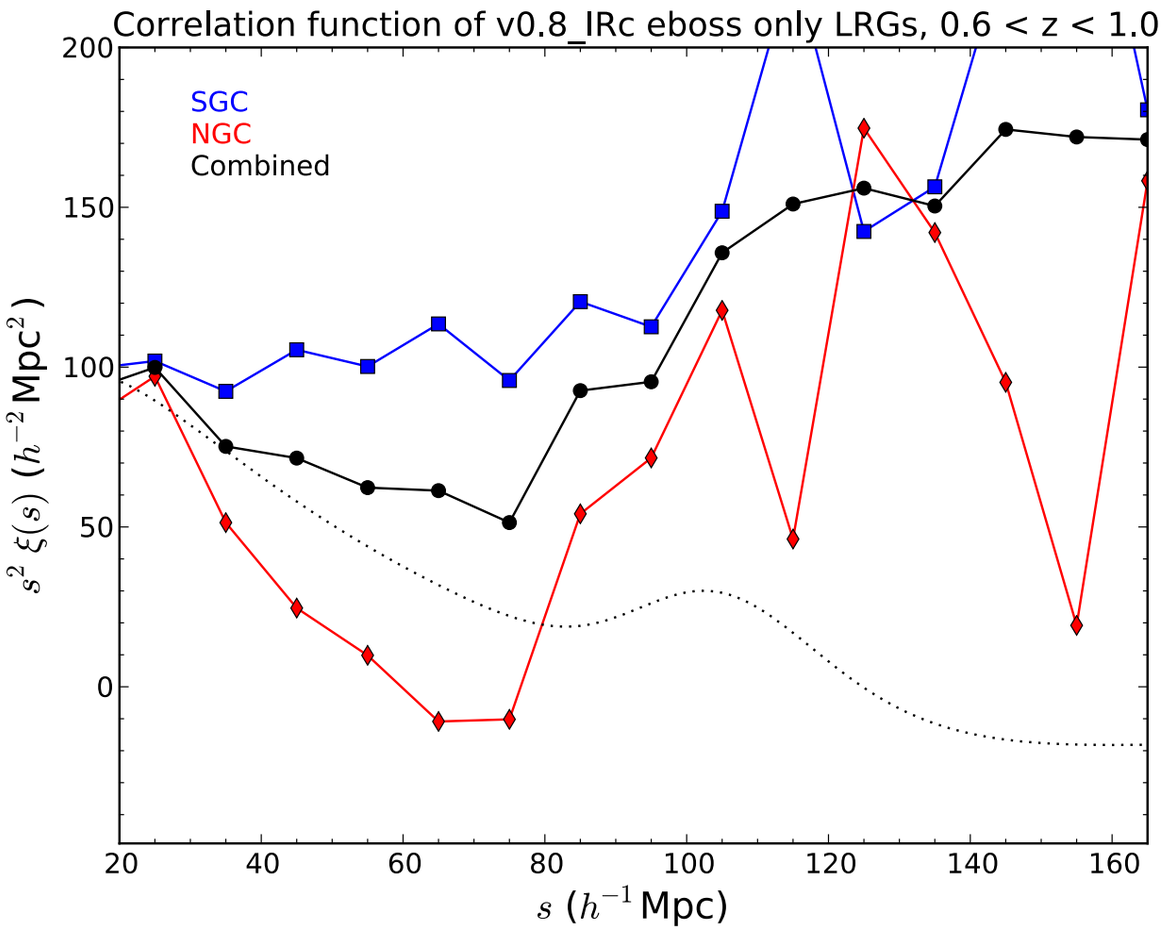
Prep data for PCs

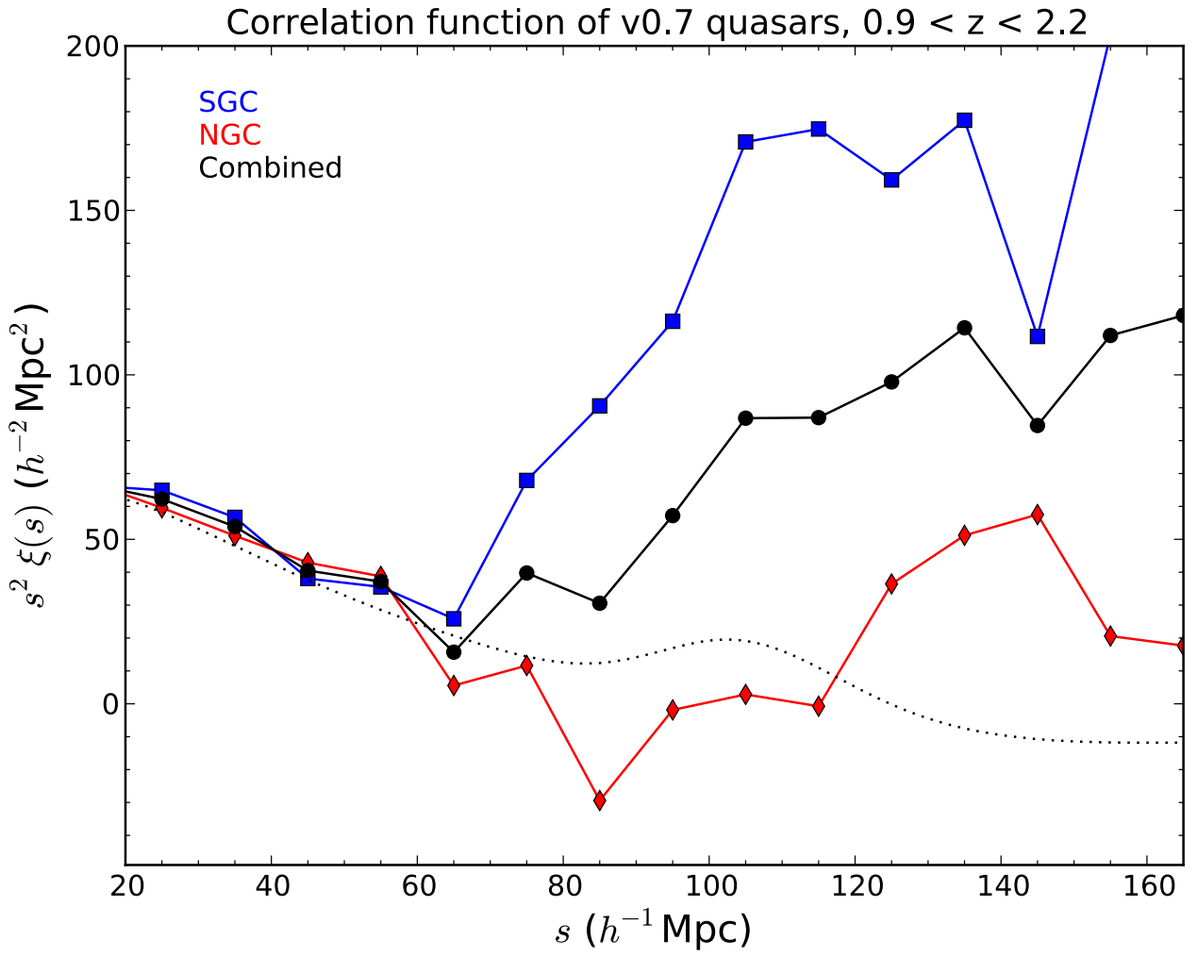
- *This is my way, not necessarily the “best way”*
- 5) Calculate sin(ra),cos(ra),sin(dec),cos(dec),co-moving_distance(z),healpix_pixel(ra,dec) for galaxy and random files
- 6) Divide file into 20 sub-files, based on healpix pixel

Do pair-counts

- *This is my way, not necessarily the "best way"*
- For 1 random file, 60 jobs sent to queue (20 each for DD, DR, and RR); each job does 20 auto/cross-pair counts (haven't bothered to make this more efficient)
- s,μ calculated as:
- $\theta_p = \cos(dec_1)*\cos(dec_2)*[\cos(ra_1)*\cos(ra_2) + \sin(ra_1)*\sin(ra_2)] + \sin(dec_1)*\sin(dec_2)$
- $s^2 = cd_1^2+cd_2^2-2*cd_1*cd_2*\theta_p$
- $\mu=|(cd_1-cd_2)|/r$

Correlation functions

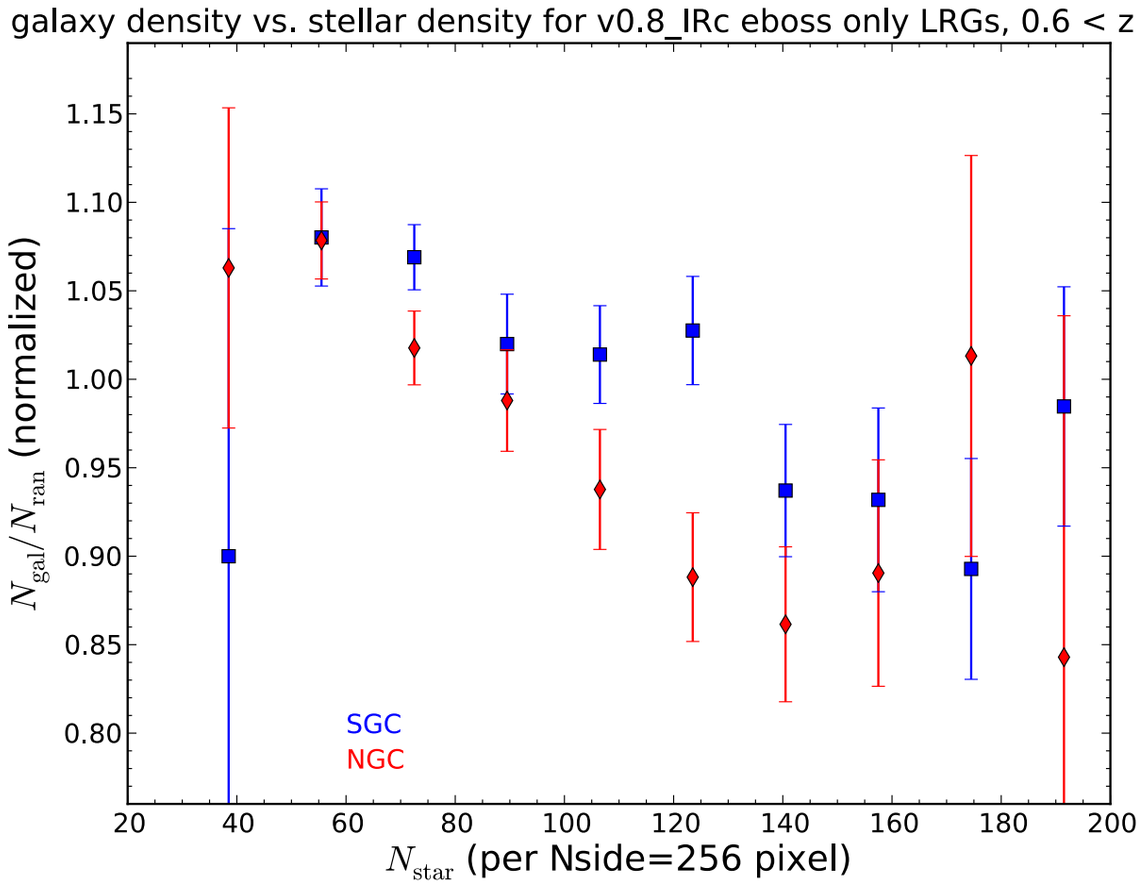


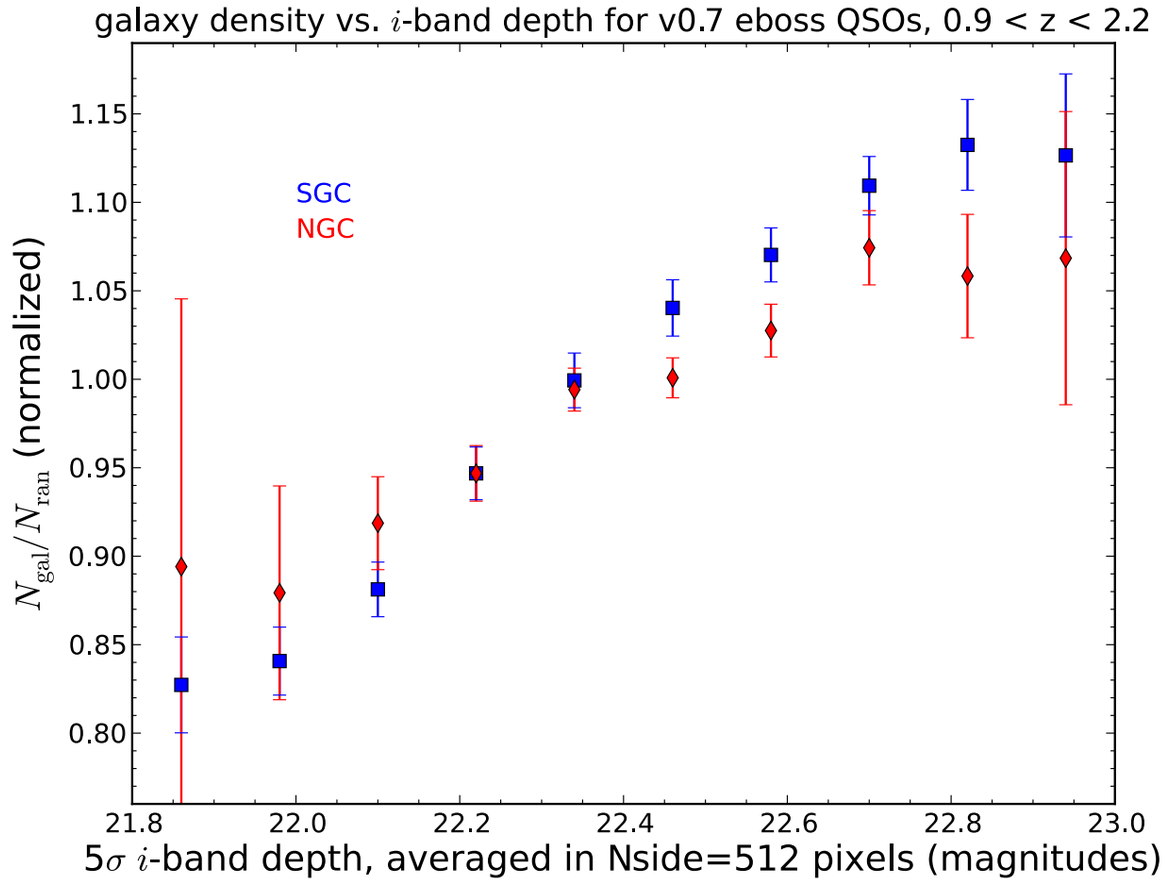


Correct for Systematics

- Compare ngal/nran as function of value of potential systematic (e.g., depth, stellar density, seeing)
- Values of potential systematics currently in healpix maps, but will eventually be in catalogs
- Assign uncertainties based on counts Ngal*w_{FKP}, then treat like Poisson

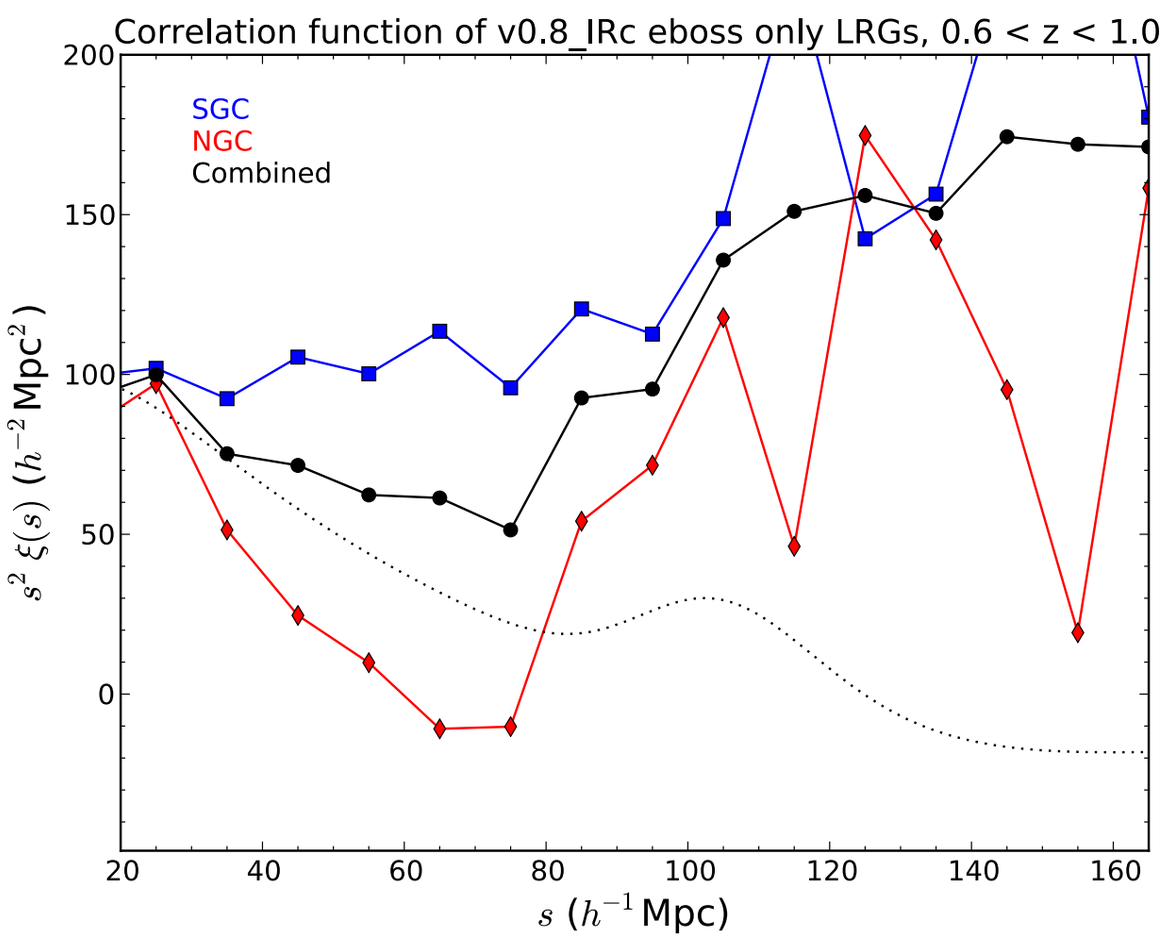
Correct for Systematics

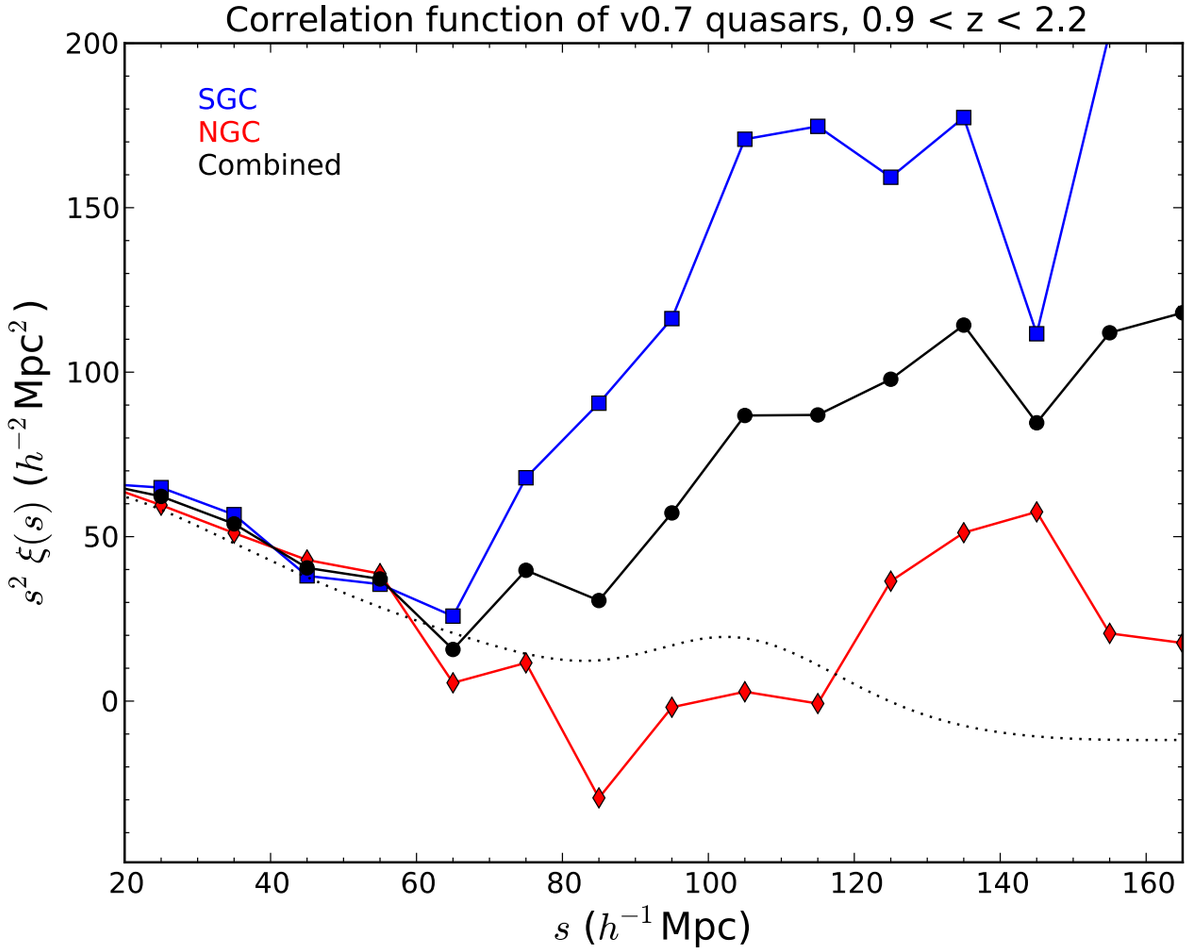




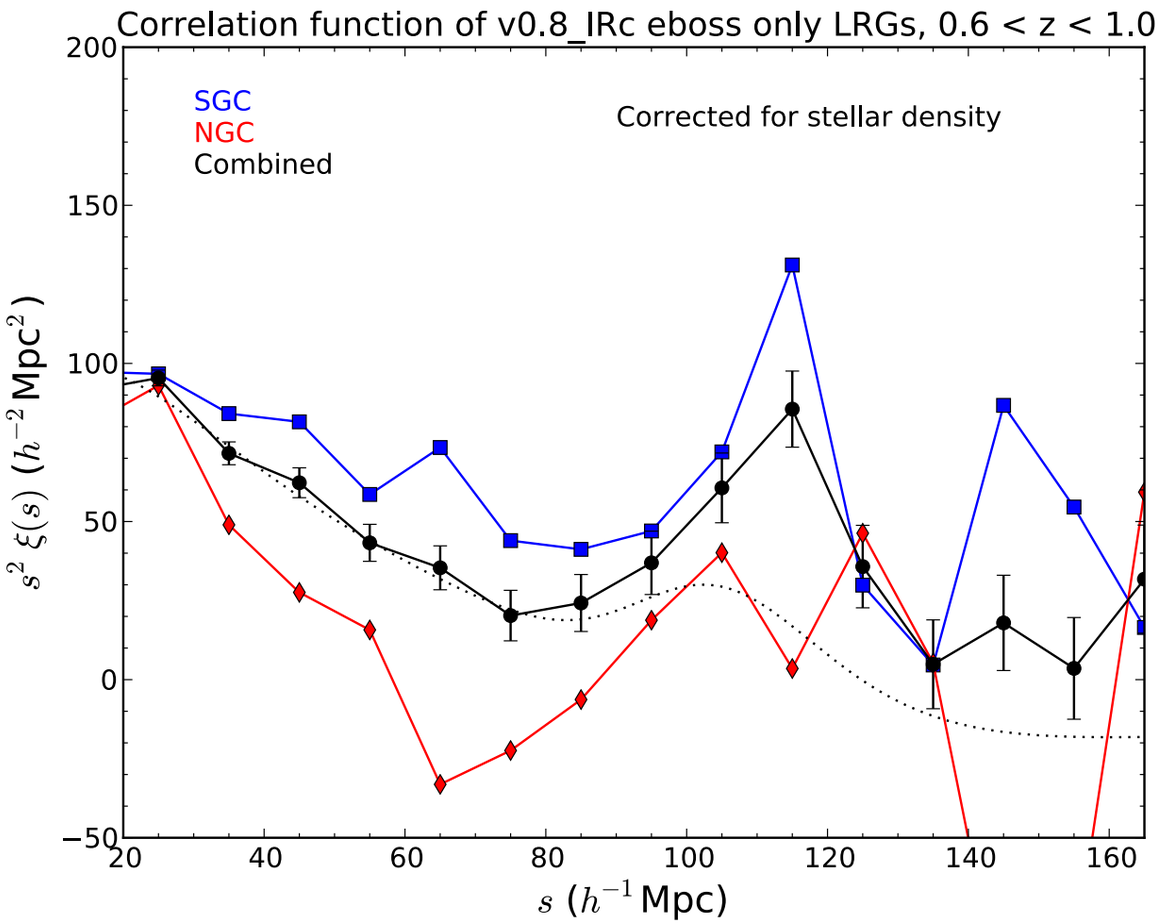
- Define systematic weights that are inverse of linear fits
- apply to galaxy catalogs
- redo randoms (n(z) changes slightly)

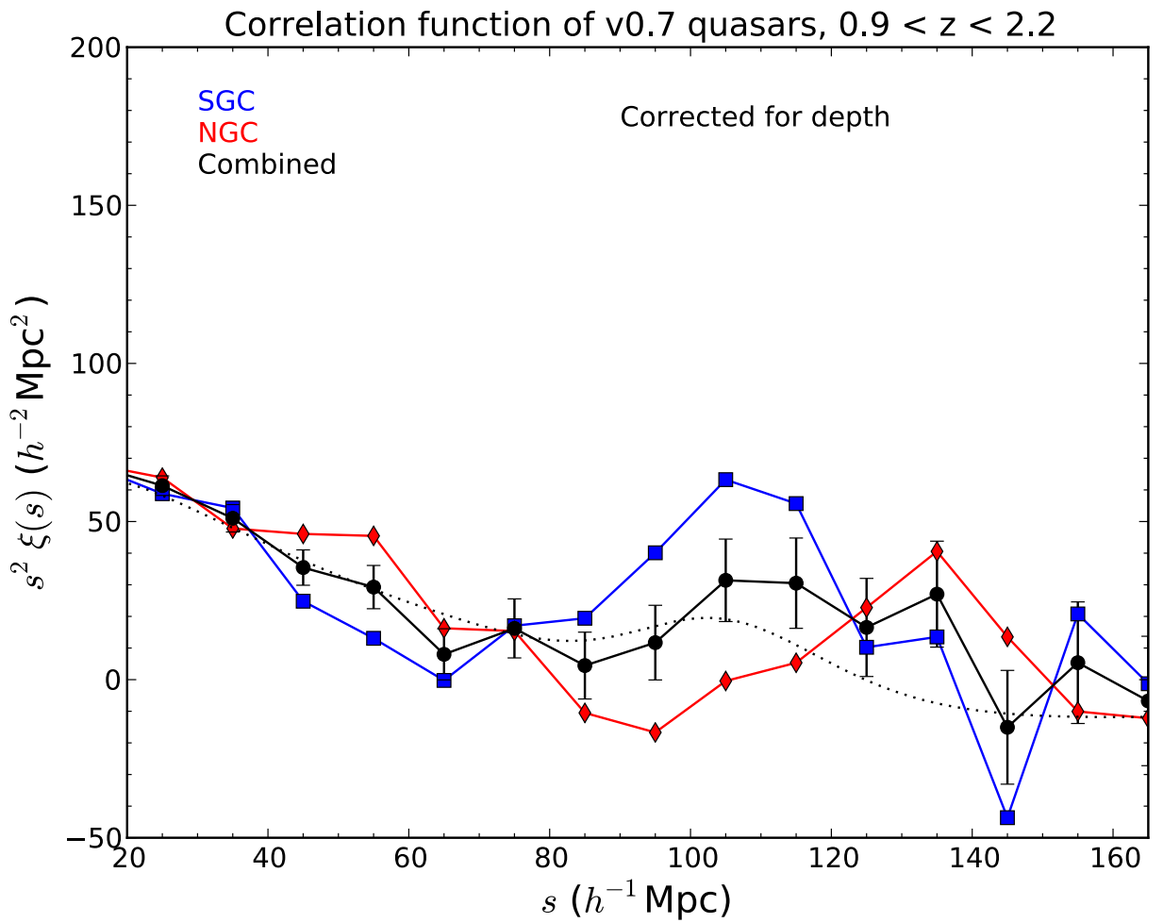
Correlation functions





Correlation functions





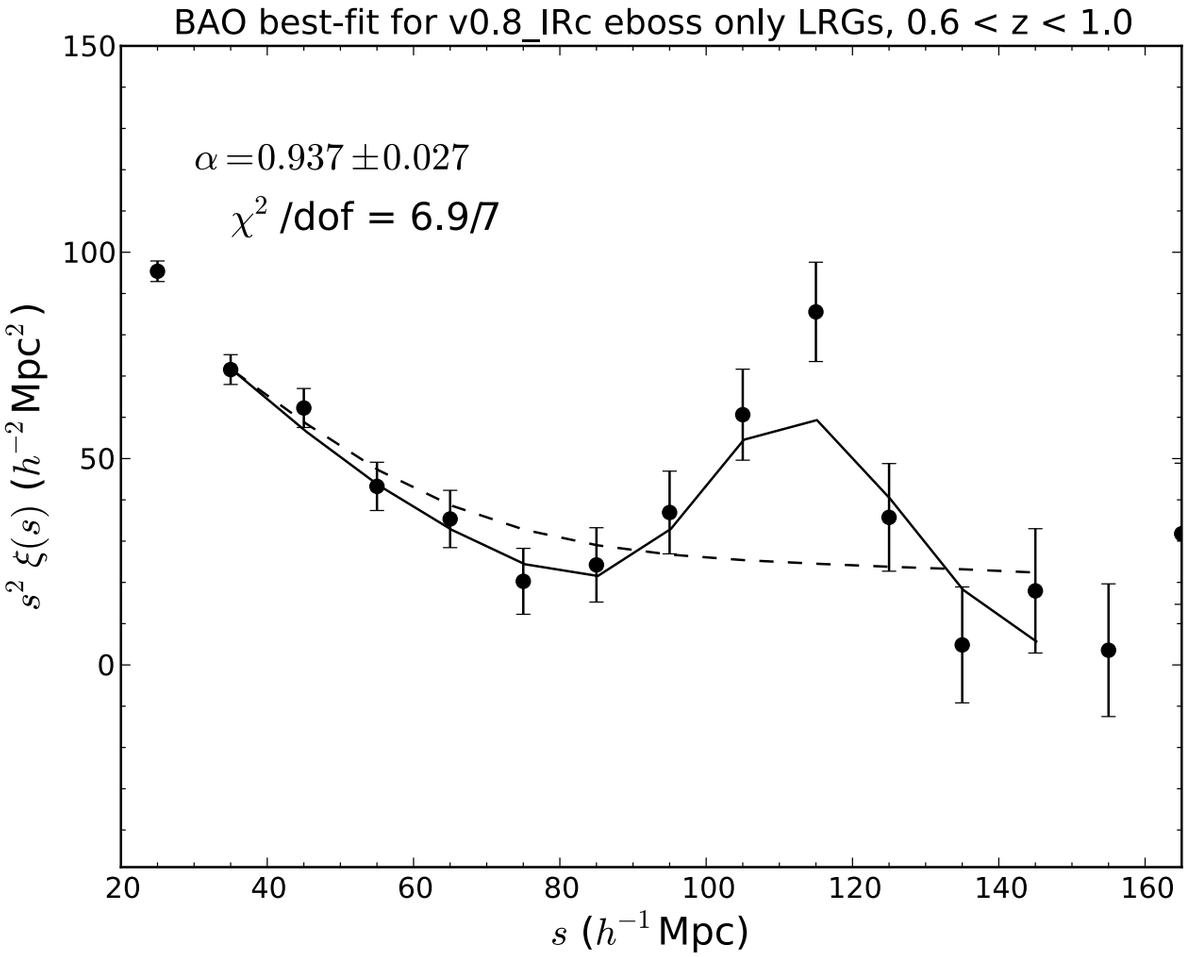
BAO fits

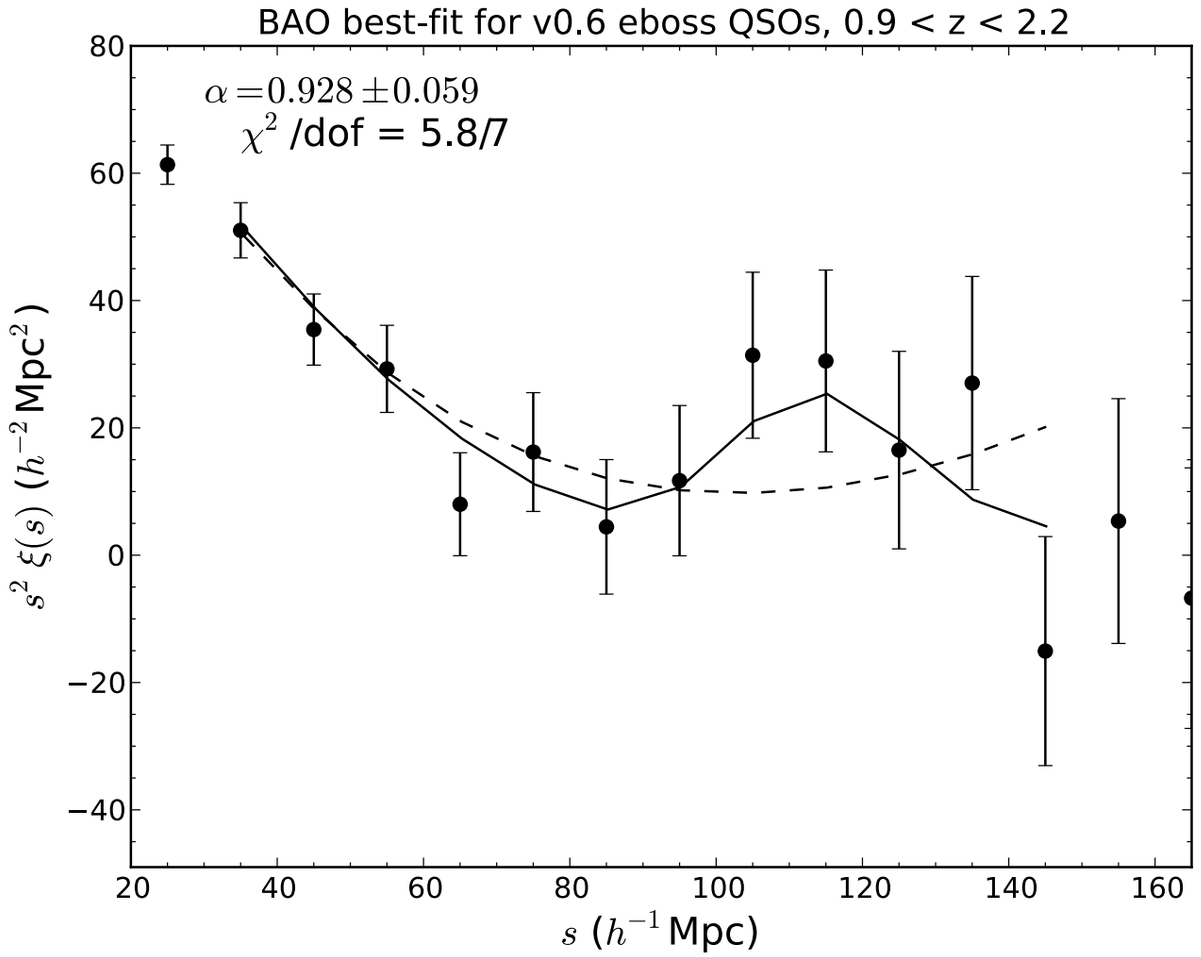
- Analytic Gaussian covariance matrix (no accounting for mask, *NOT* science standard)
- Generate template for ξ for fiducial cosmology (using BOSS DR12 one)
- Model to fit:

$$\xi_{\rm mod}(s) = B\xi_{\rm temp}(s\alpha) + A_0 + A_1/s + A_2/s^2$$

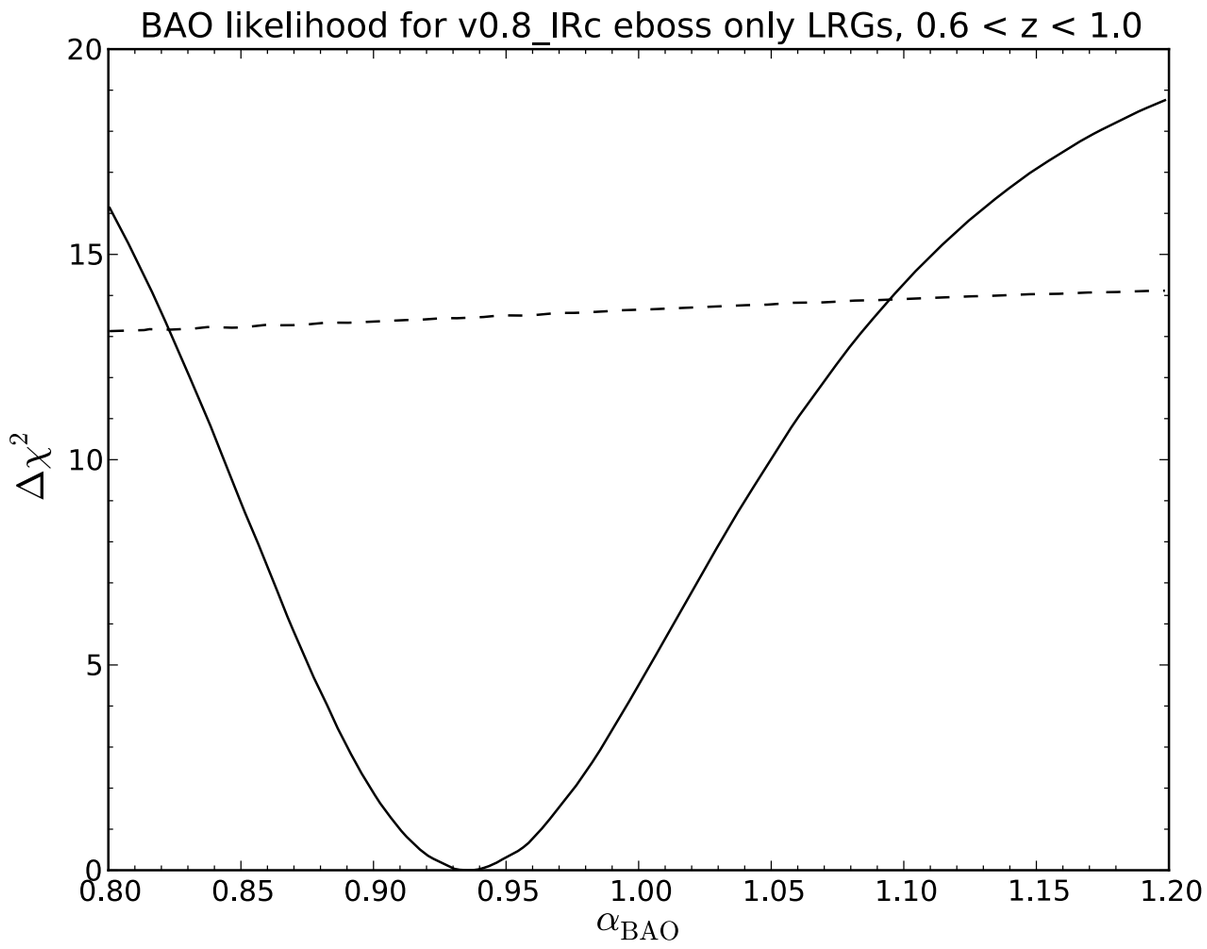
- Find minimum χ^2 on grid of α (Δ0.001 between 0.8 and 1.2)

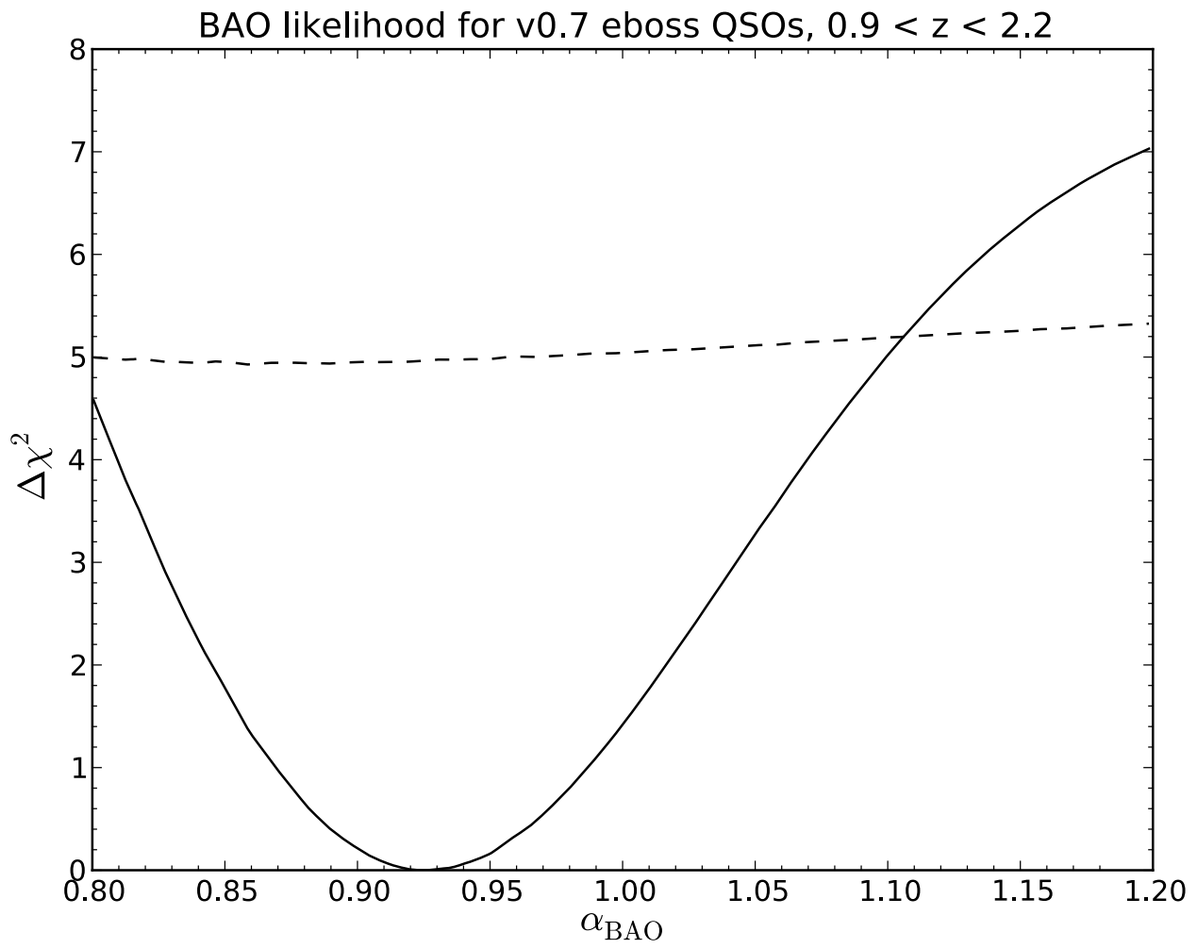
BAO fits


BAO best-fit for v0.8_IRc eboss only LRGs, 0.6 < z < 1.0
$\alpha = 0.937 \pm 0.027$
χ^2 /dof = 6.9/7
$s^2\,\xi(s)$ $(h^{-2}\,\mathrm{Mpc}^2)$
s $(h^{-1}\,\mathrm{Mpc})$


BAO best-fit for v0.6 eboss QSOs, 0.9 < z < 2.2
$\alpha = 0.928 \pm 0.059$
χ^2 /dof = 5.8/7
$s^2\,\xi(s)$ $(h^{-2}\,\mathrm{Mpc}^2)$
s $(h^{-1}\,\mathrm{Mpc})$

BAO likelihoods





Conclusions

- That was obviously pretty approximate
- (Need proper covariance matrices N/S difference in LRGs looks like potential issue)
- All code/scripts available here: https://trac.sdss.org/attachment/wiki/eBOSS/QGC/AJR_handson_xibao.zip