

Probing AGN through host galaxy morphologies

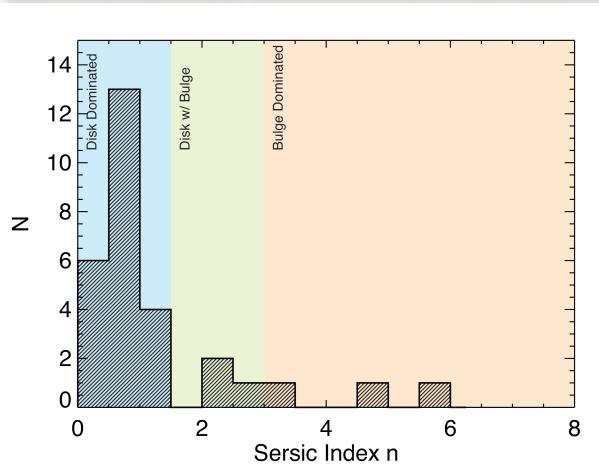
Victoria Bruce

University of Edinburgh

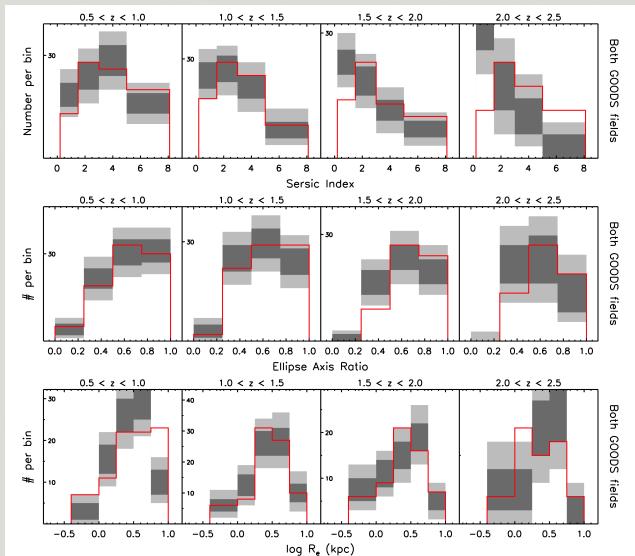
Collaborators: Jim Dunlop & the CANDELS team



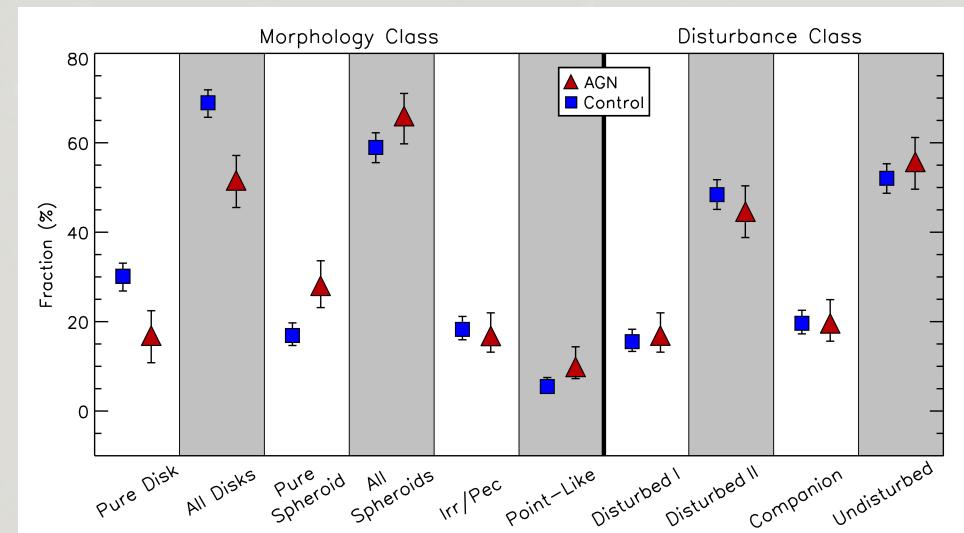
AGN Host Morphology Studies



Schawinski et al. 2012,
Heavily Obscured at $z \sim 2$



Rosario et al. 2015

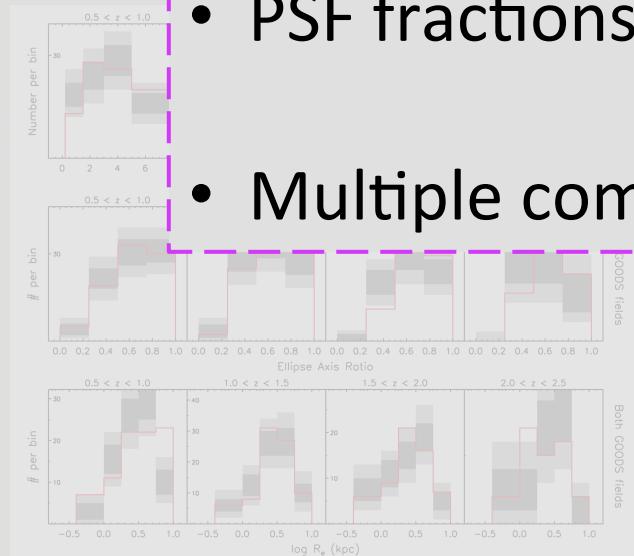


Kocevski et al. 2012,
X-ray selected at $1.5 < z < 2.5$

AGN Host Morphology Studies

Talk Outline:

- Impact of PSF components on single Sérsic fits
- PSF fractions in host and underlying population
- Multiple component host decompositions



X-ray selected at $1.5 < z < 2.5$

Rosario et al. 2015

Astrodeep Sesto Meeting

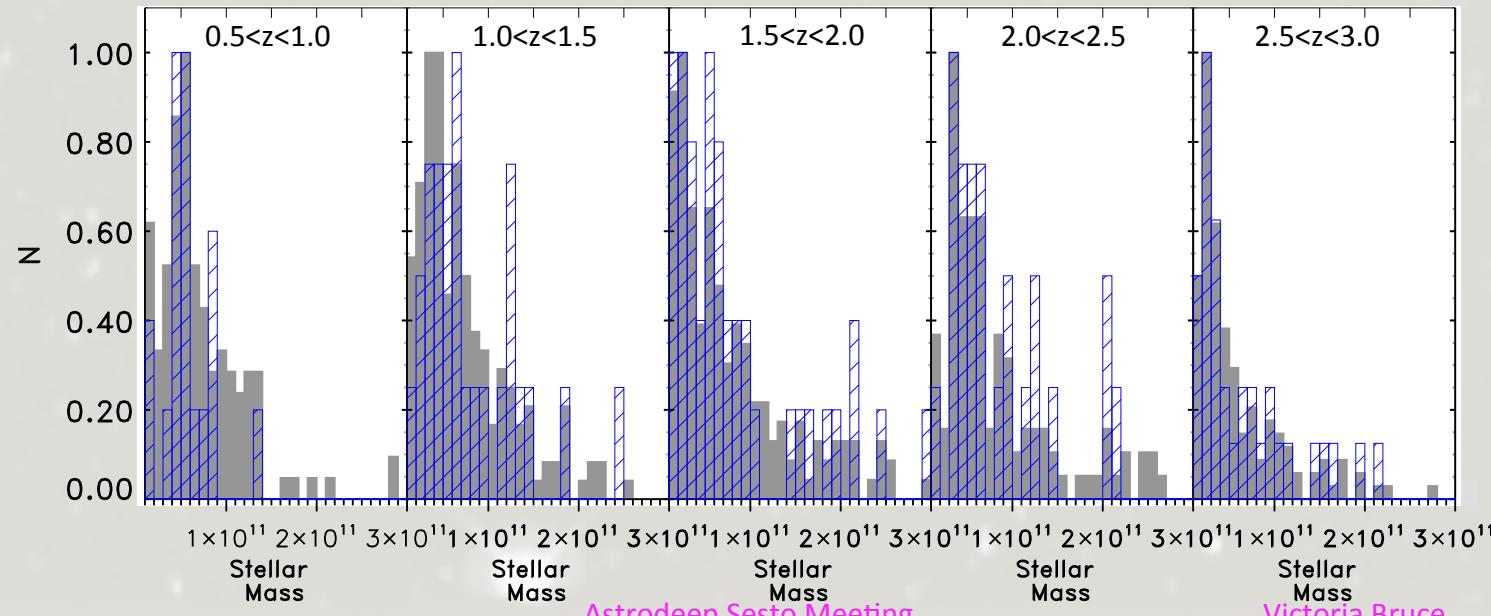
Victoria Bruce

Data Sets

- Near-IR and optical data for morphological decompositions: CANDELS-GOODSS in WFC3:H_{160W}, J_{125W}, Y_{105W} and ACS:Y_{098M}, I_{814W}, i'_{775W}, V_{606W}, g'_{435W} (in addition to U_{CTIO}, U_{VIMOS}, K_s ISAAC and IRAC 3.6 and 4.5μm for photoz fitting).
- AGN catalogue : Kocevski 2012 (internal CANDELS catalogue) = Xue et al. 2011 4Ms Chandra + Donley et al. 2012 IR + Padovani et al. 2011 radio

Mass Matching:

- Binned in 0.5 redshift bins
- Peak bin normalised to 1.0
- 1000 bootstrap samples
- Median of samples within each property bin



Morphological Model Fitting

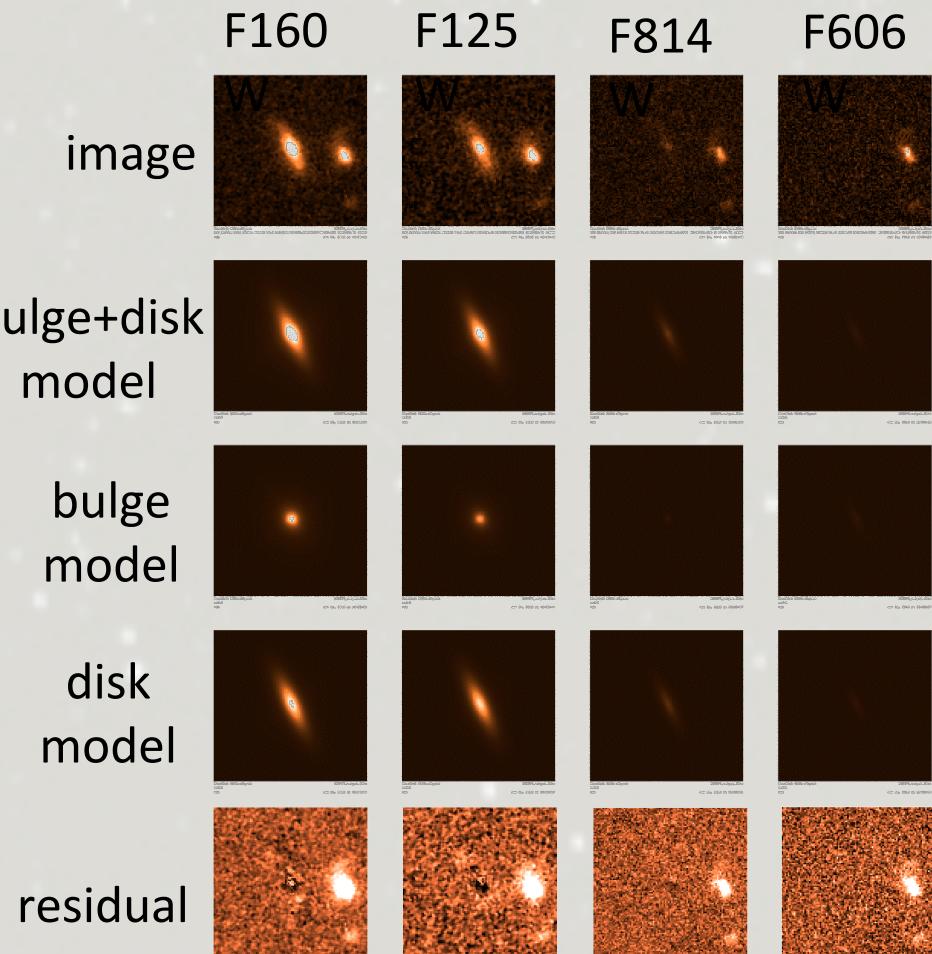
CANDELS sample of ~ 400 galaxies at $M_* > 10^{11} M_\odot$ at $1 < z < 3$ in UDS and COSMOS,
Bruce et al. 2012, 2014a, 2014b.

Define 3 components : disk n=1, bulge n=4, PSF

Models:

- bulge only
- bulge + PSF
- disk only
- disk + PSF
- bulge + disk
- bulge + disk + PSF

Adopt simplest model, unless a model with more free parameters has
 $X^2_{\text{complex}} < X^2_{\text{simpler}} - \Delta X^2(\text{d.o.f}_{\text{complex}} - \text{d.o.f}_{\text{simpler}})$
at the 3σ level.



Validity of PSF Component

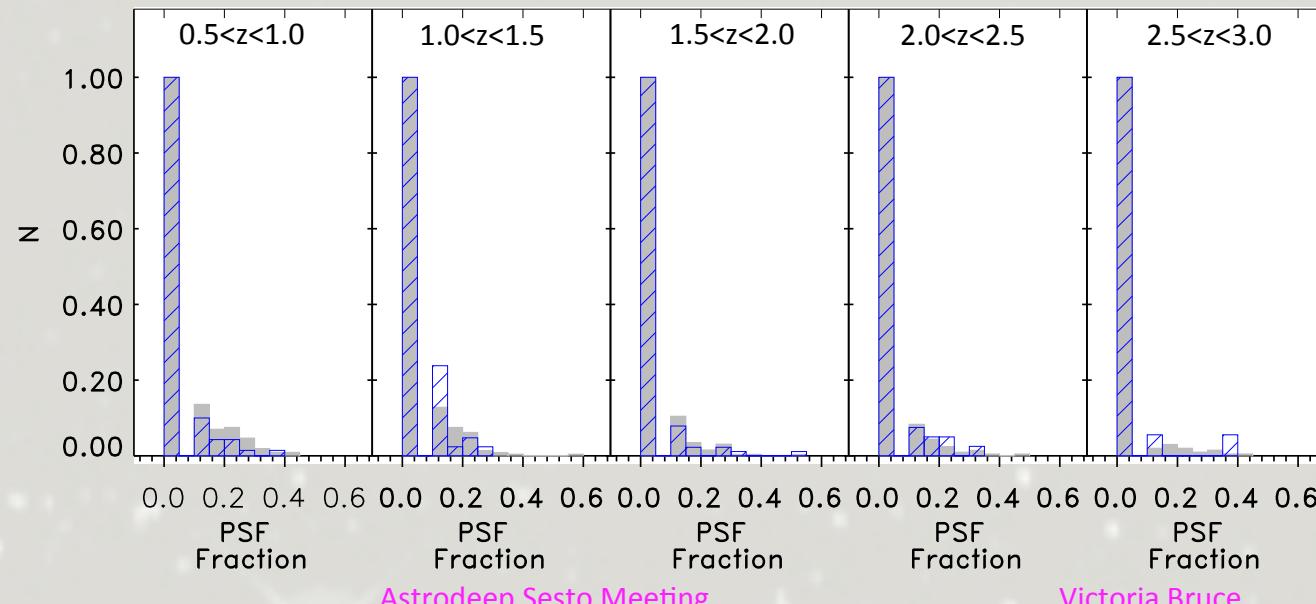
PSF False Positives

- Fitting a PSF to a bulge, disk or bulge+disk model only
- fit=single Sérsic +PSF false positive rate **5%, 0.5%** if all component sizes>1 pixel
 - fit=B+D+PSF false positive rate **3.5%, 0.3%** if all component sizes>1 pixel

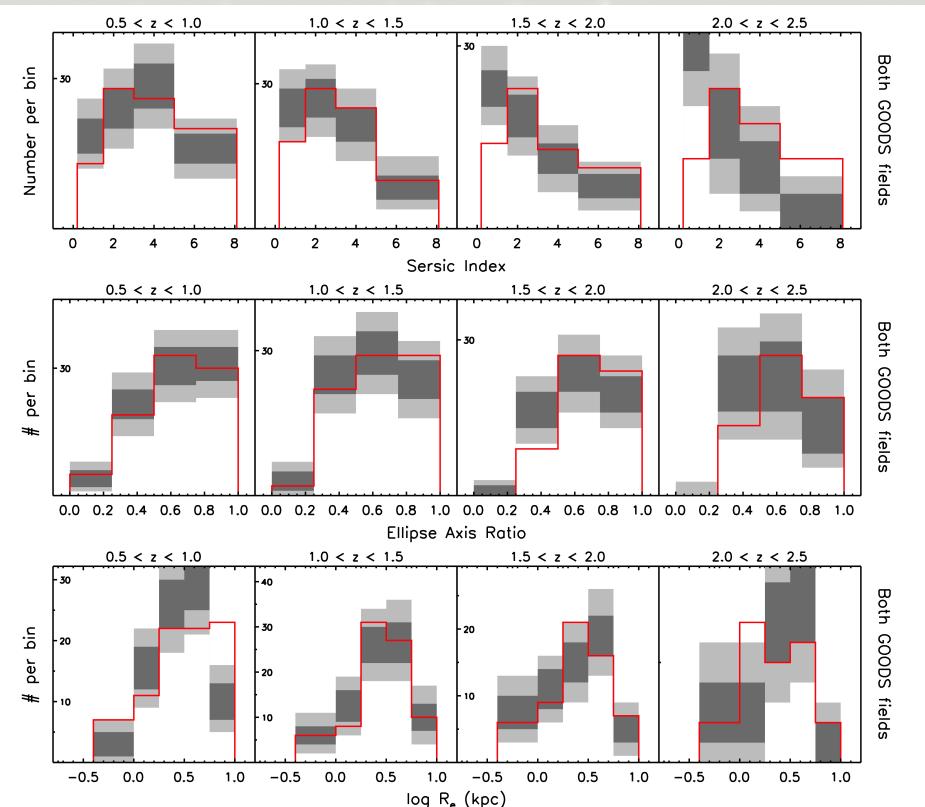
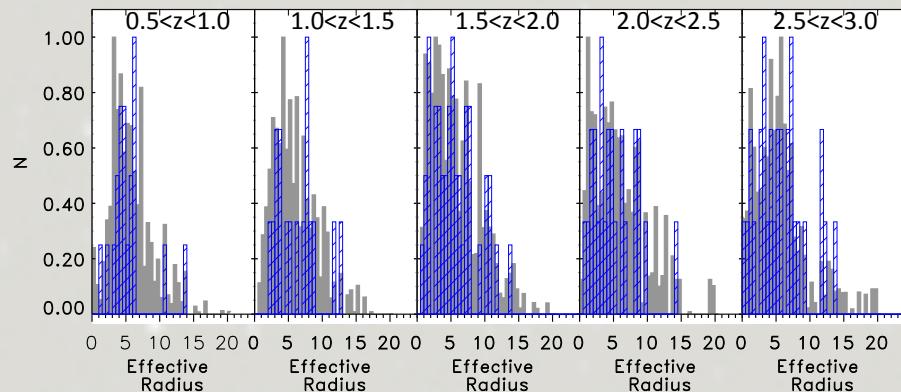
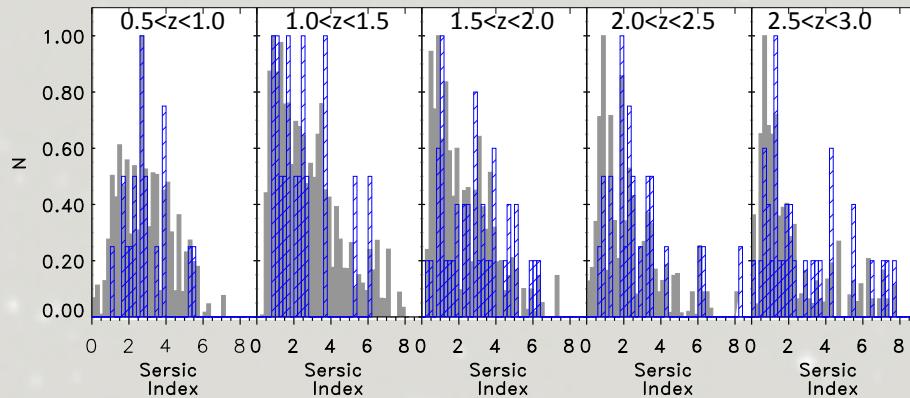
PSF Recovery

- Fitting a PSF to a bulge+PSF, or disk+PSF model
- model=bulge+PSF recovery rate **40%**
 - Model=disk+PSF recovery rate **66%**

24 μ m Connection



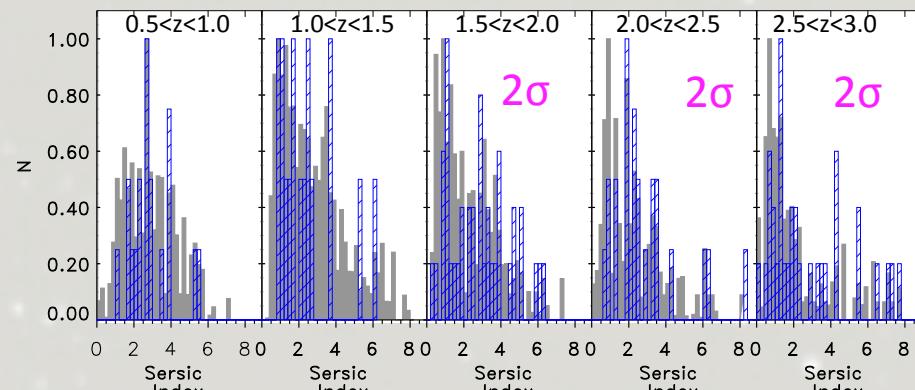
Single Sérsic Fits



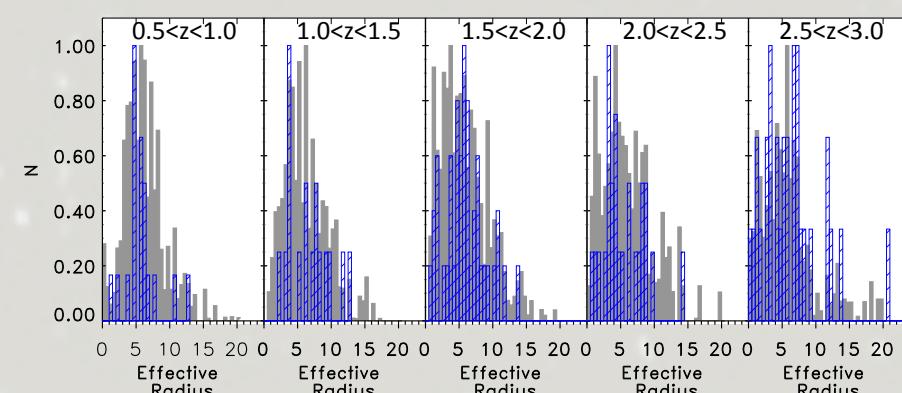
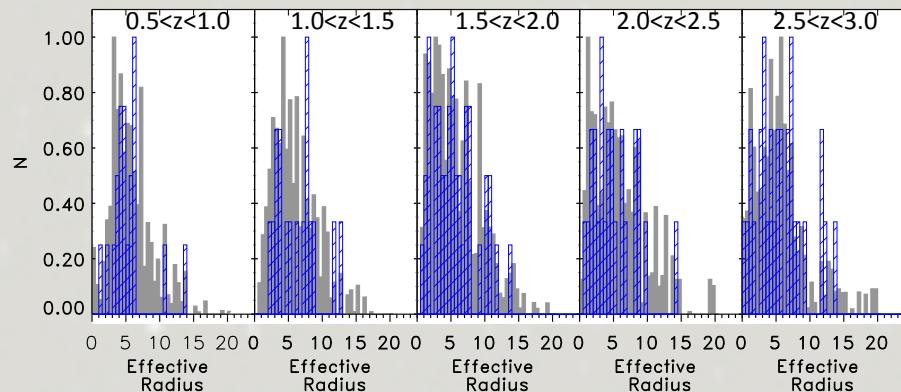
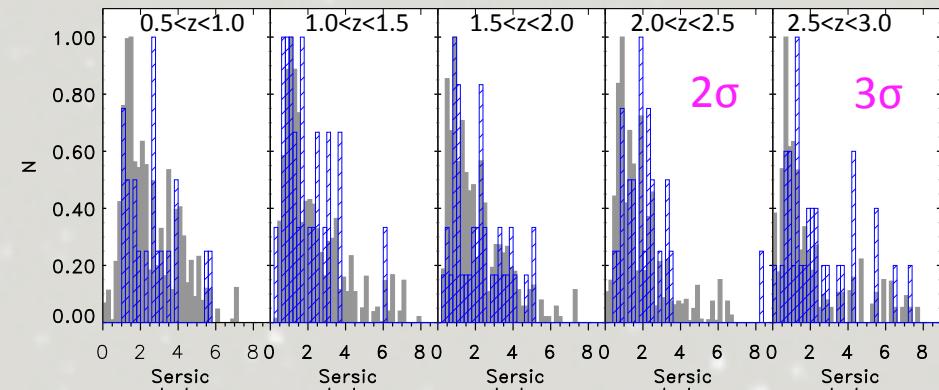
Rosario et al. 2015

Single Sérsic Fits

single Sérsic only

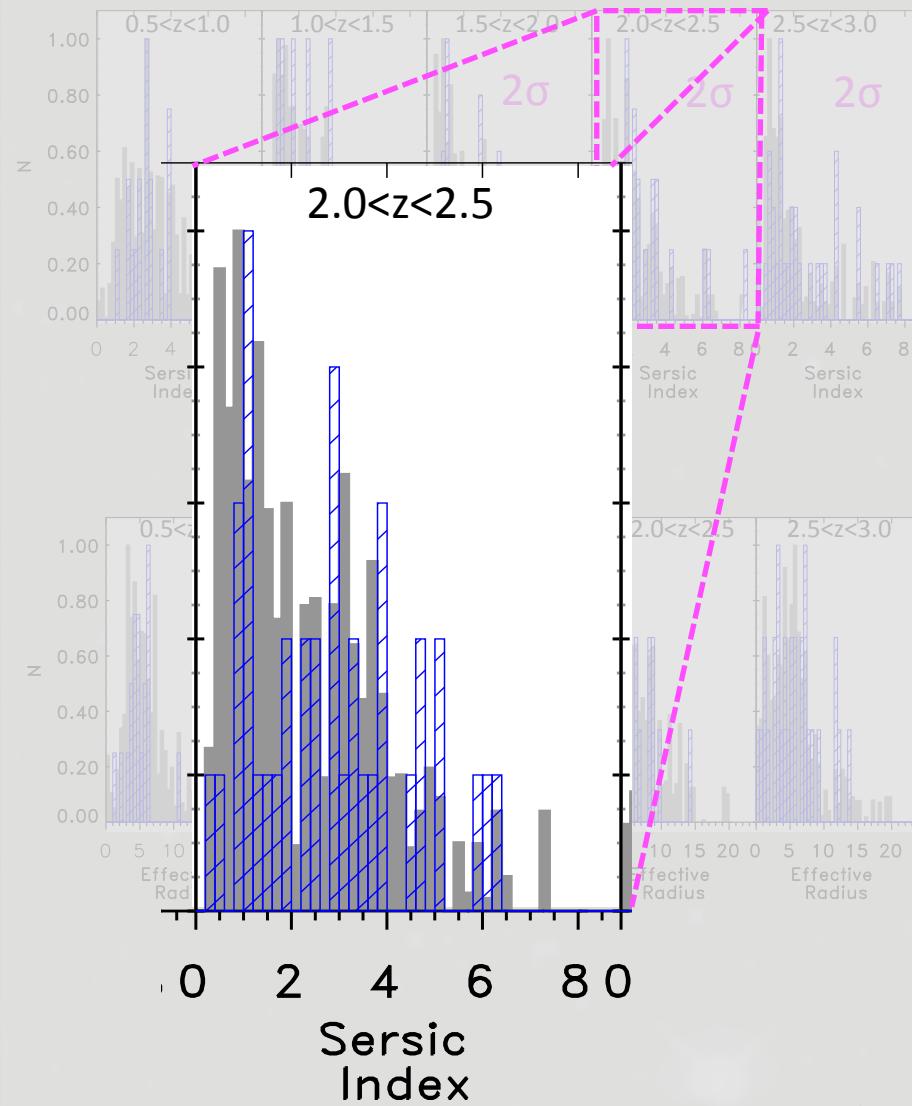


single Sérsic + PSF

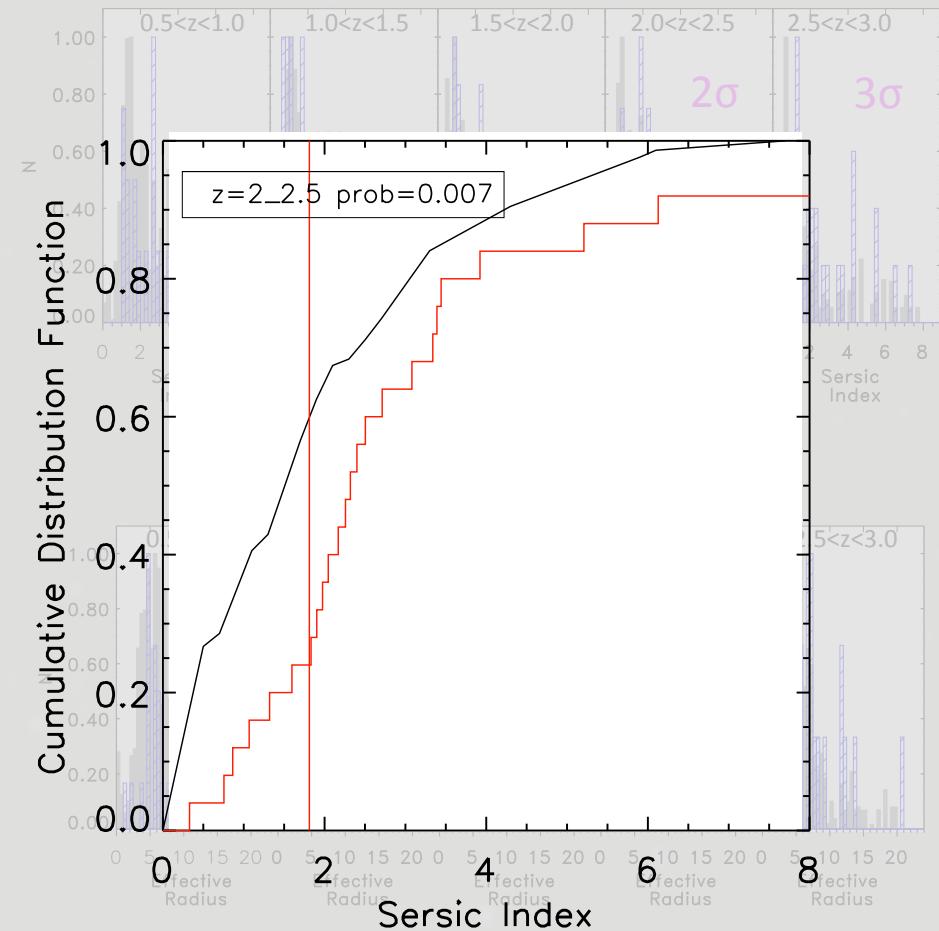


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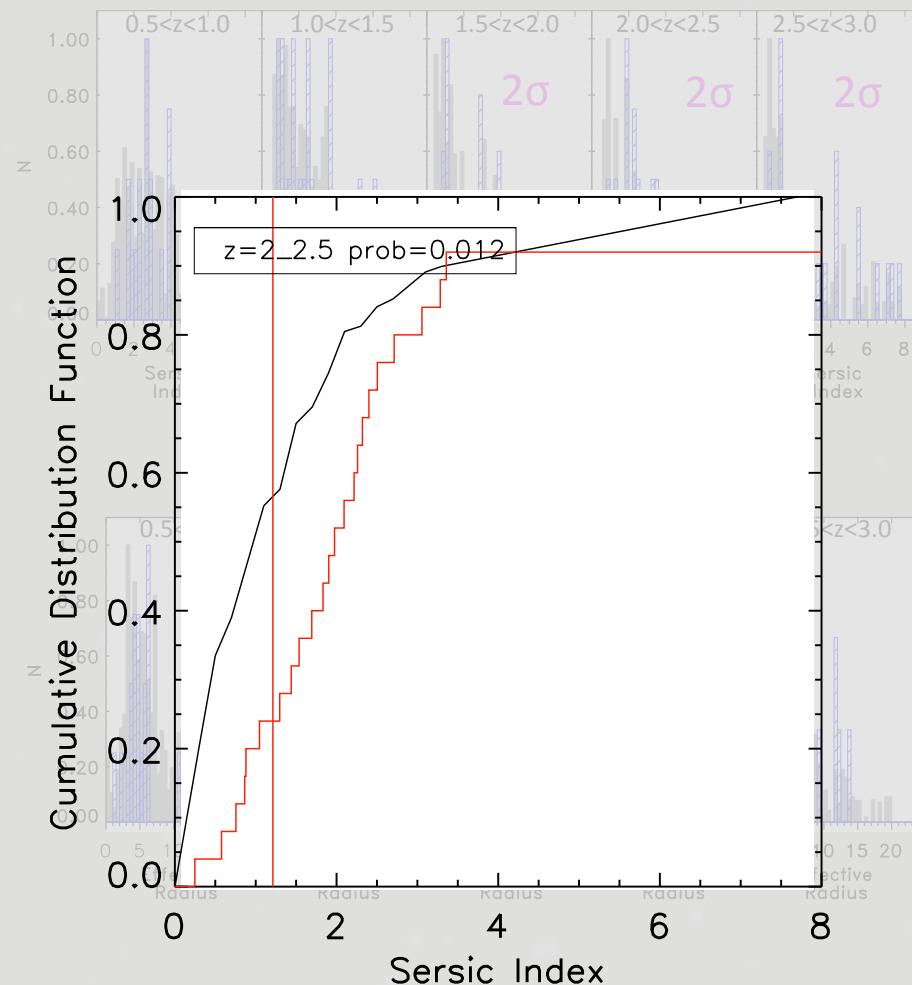


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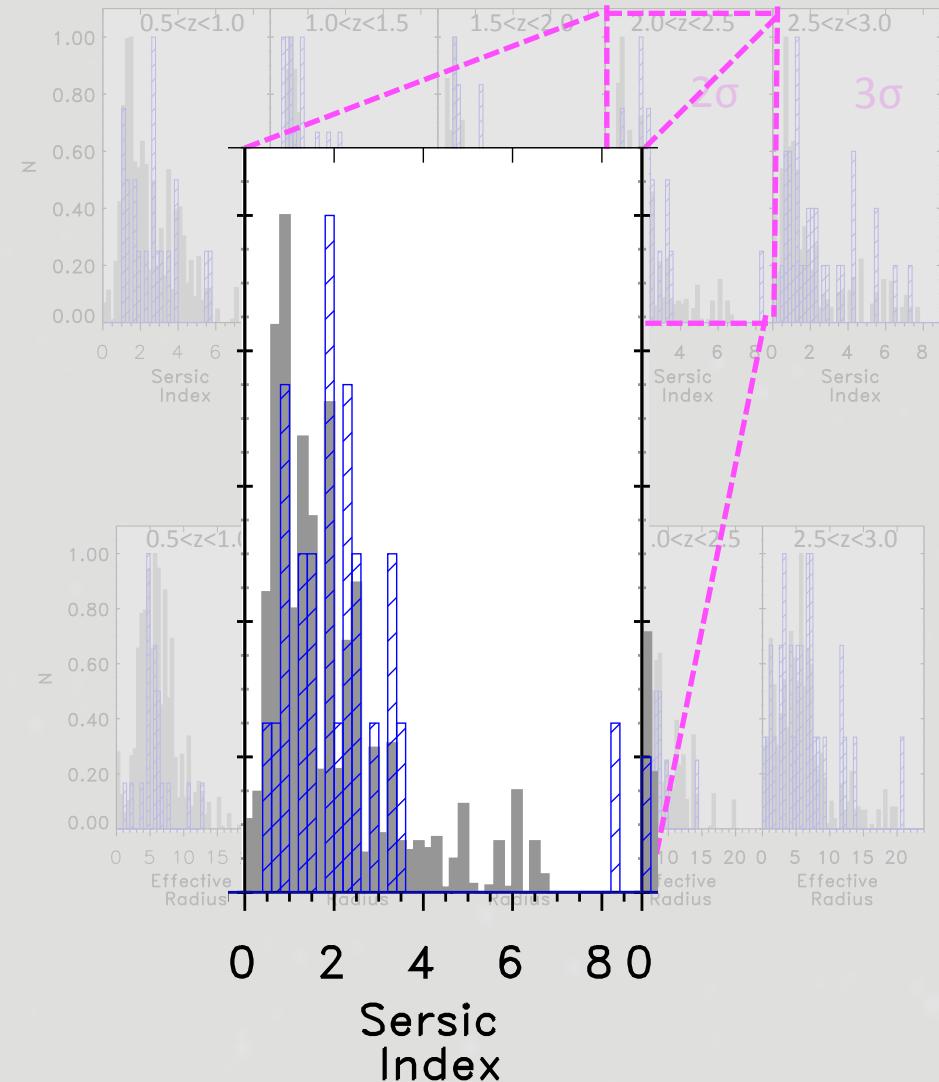


Single Sérsic Fits

single Sérsic only



single Sérsic + PSF



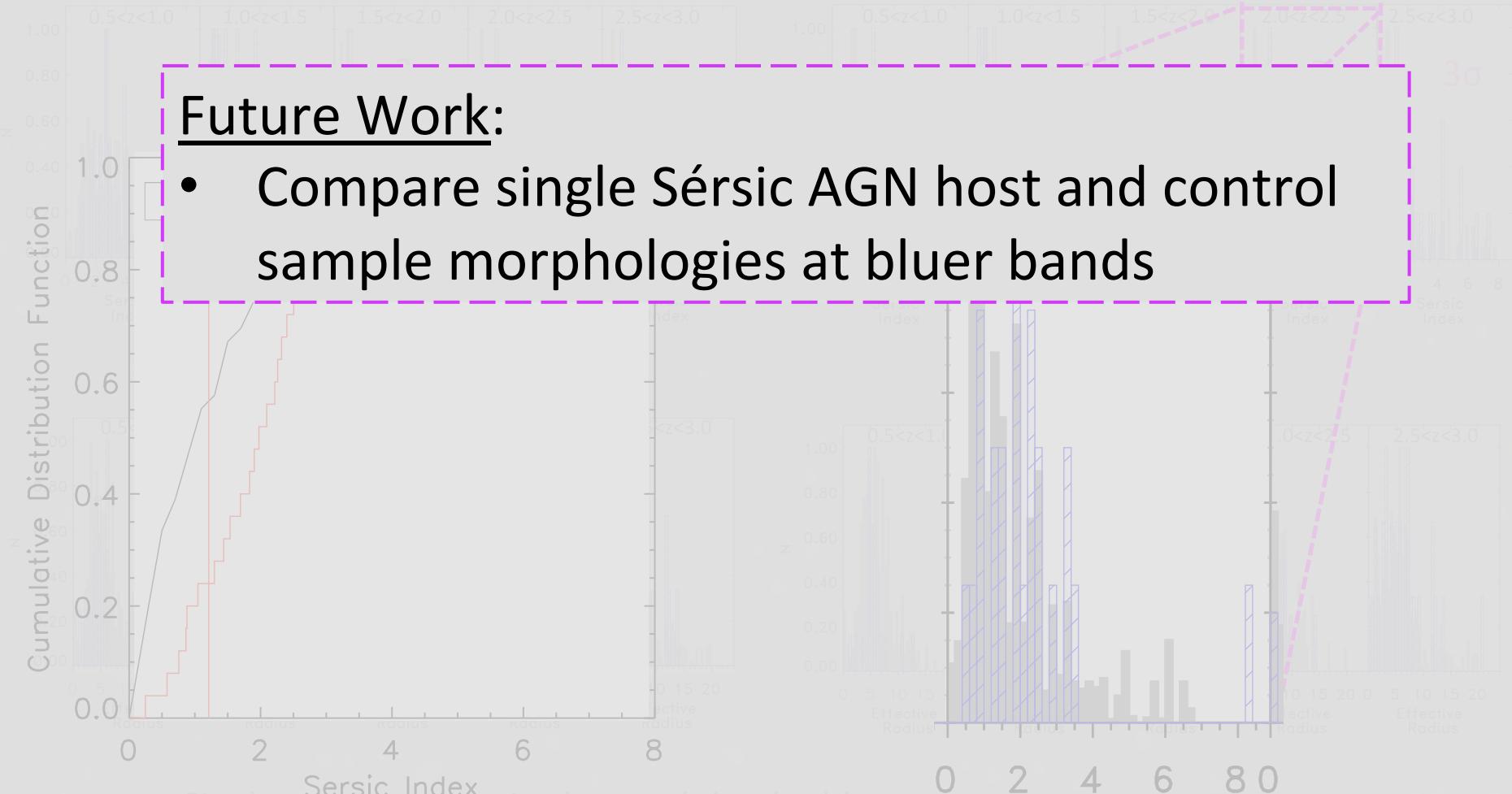
Single Sérsic Fits

single Sérsic only

single Sérsic + PSF

Future Work:

- Compare single Sérsic AGN host and control sample morphologies at bluer bands



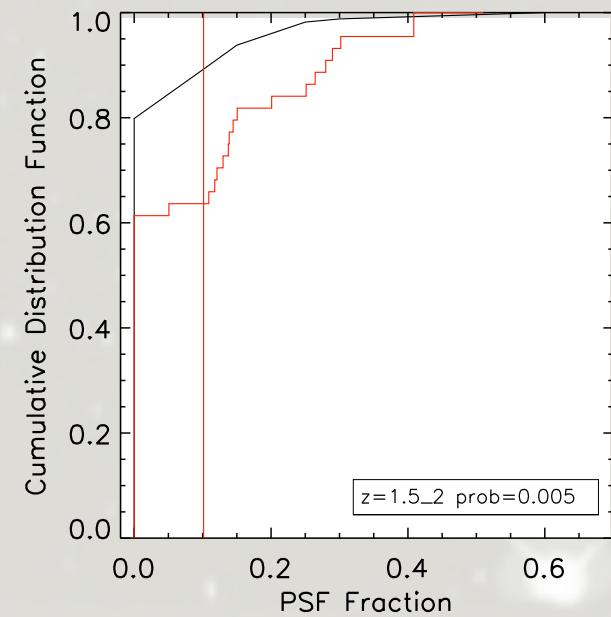
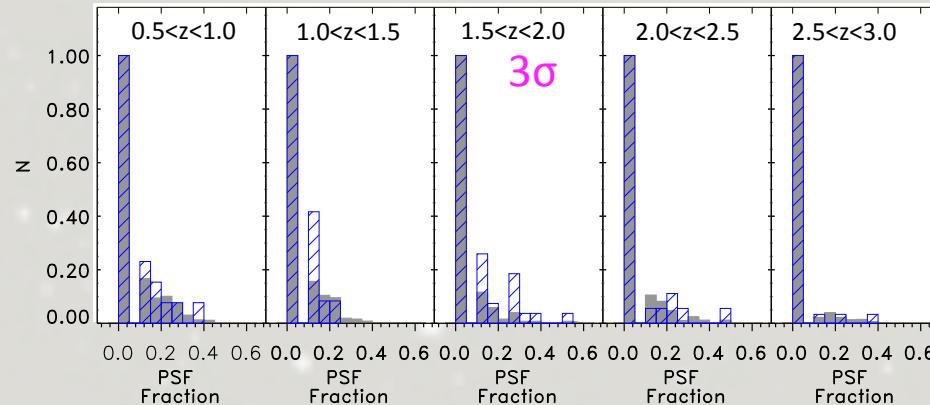
Single sersic n, re, axis plots and the double ones,

K-s plots for just one or two, and K_S numbers for inconsistent

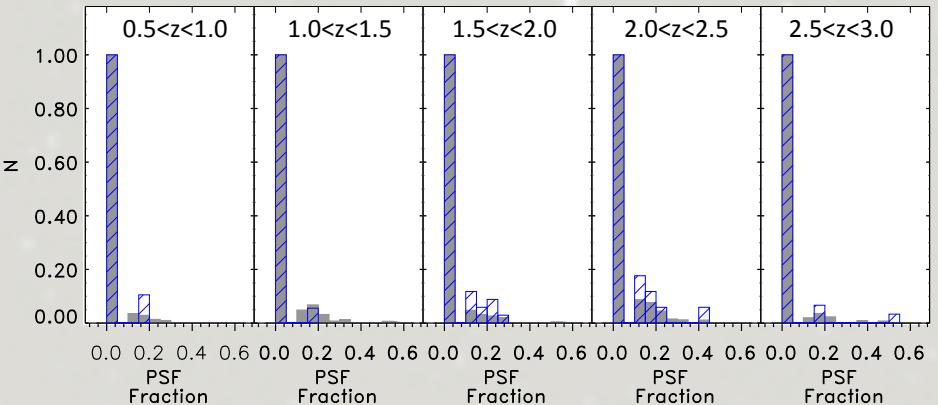
Compare with Rosario for single s

PSF Fractions

single Sérsic + PSF



bulge+disk+ PSF

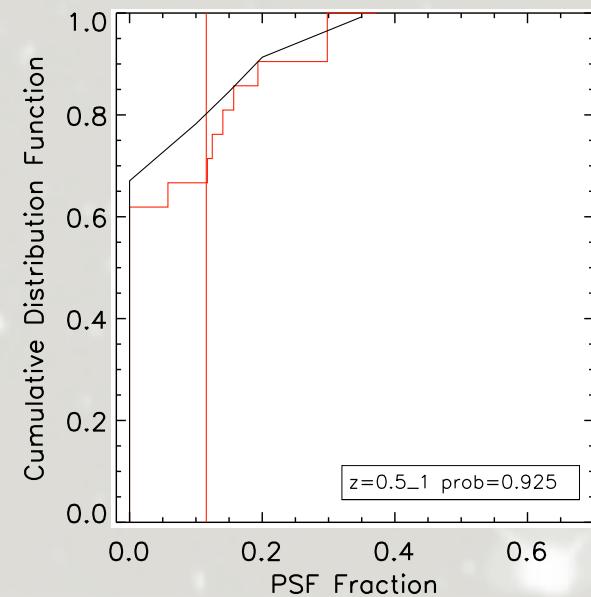
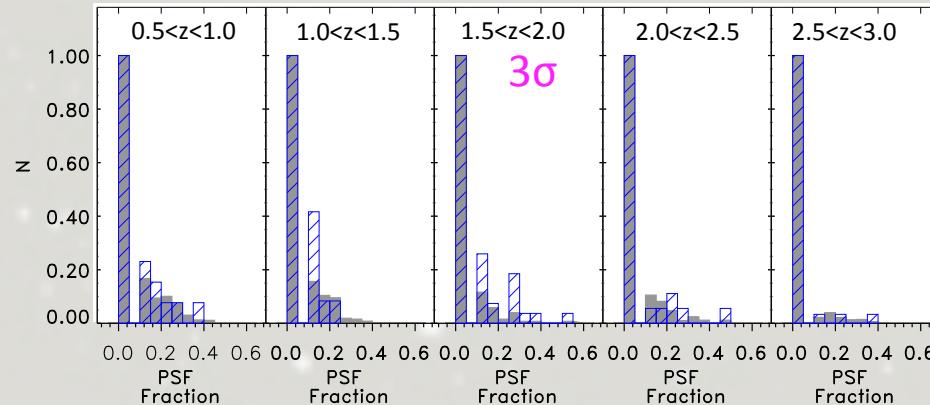


Failed to reject the null hypothesis that the PSF light fractions from the AGN hosts vs the control sample are drawn from the same distribution.

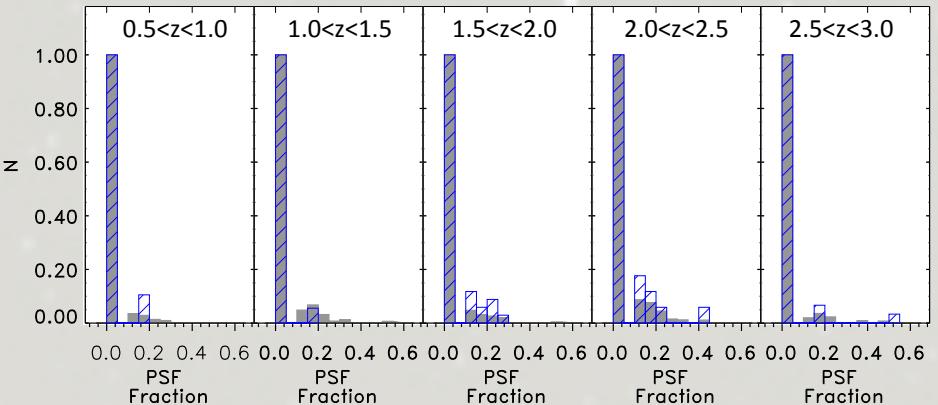
No evidence that a PSF component correlates with the presence of an AGN.

PSF Fractions

single Sérsic + PSF



bulge+disk+ PSF

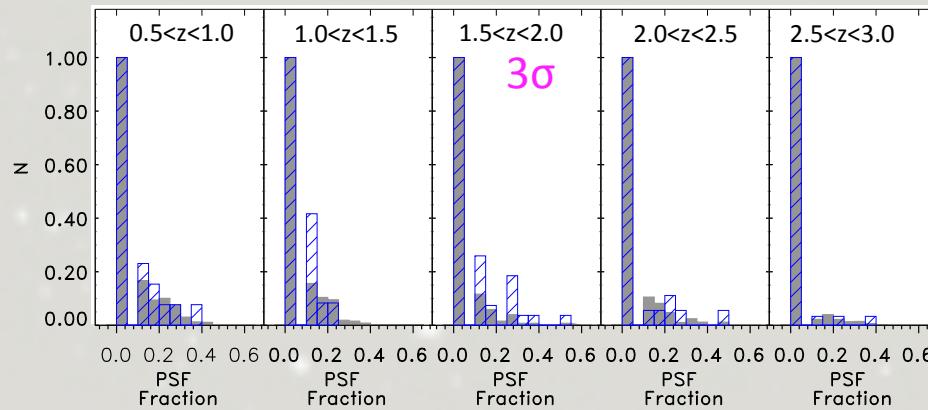


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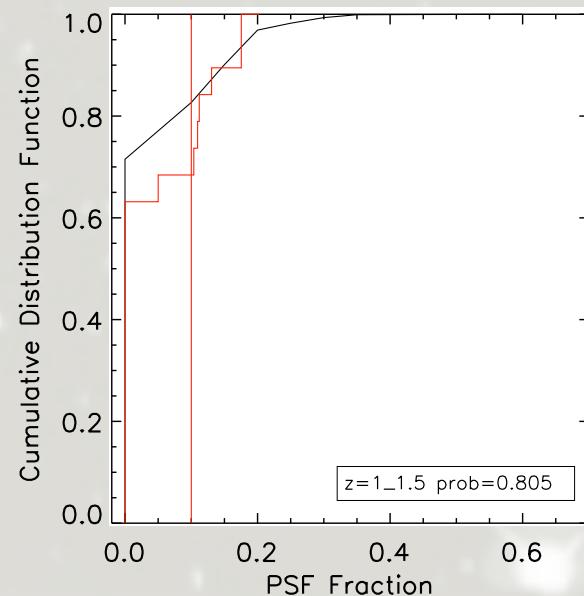
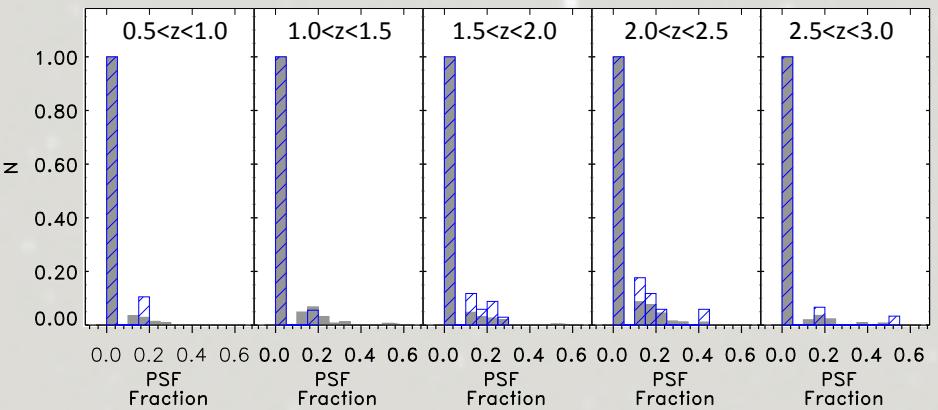
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PSF Fractions

single Sérsic + PSF



bulge+disk+ PSF

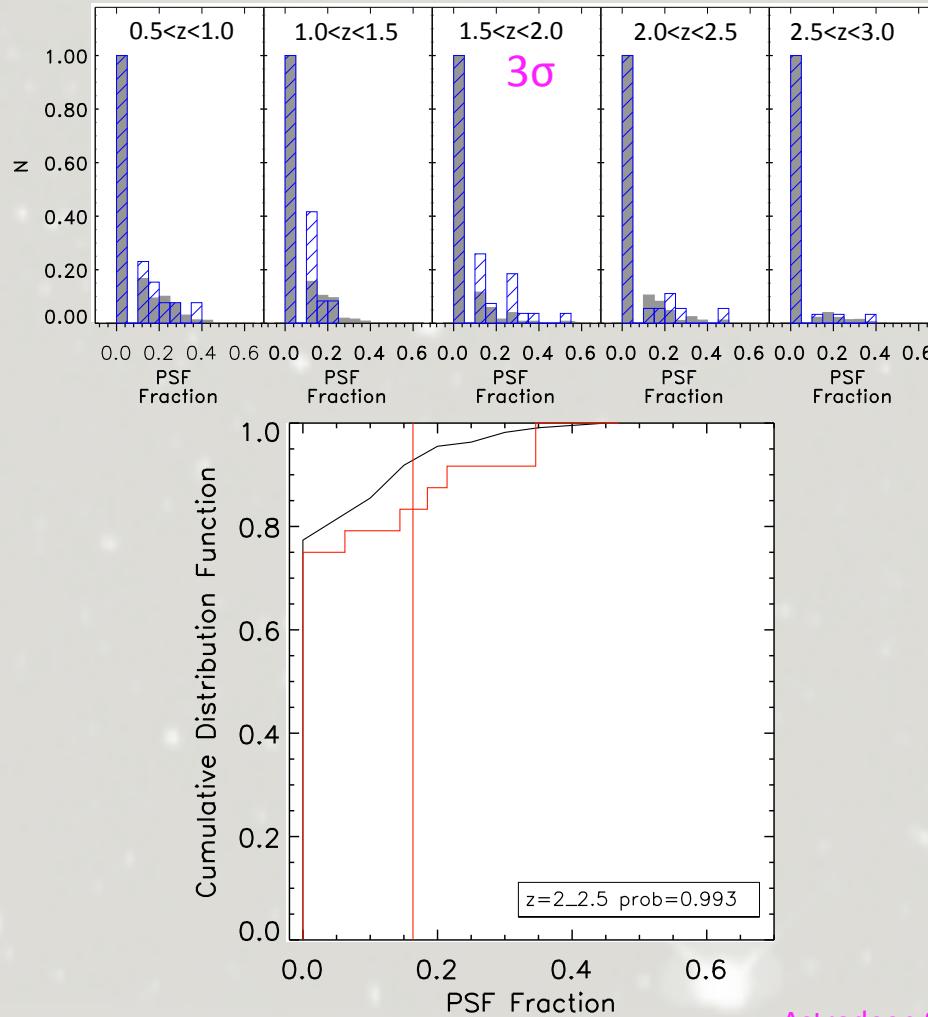


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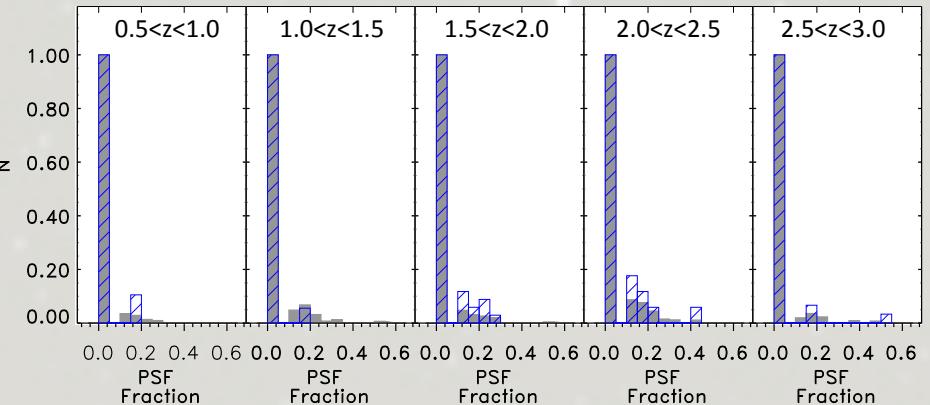
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PSF Fractions

single Sérsic + PSF



bulge+disk+ PSF

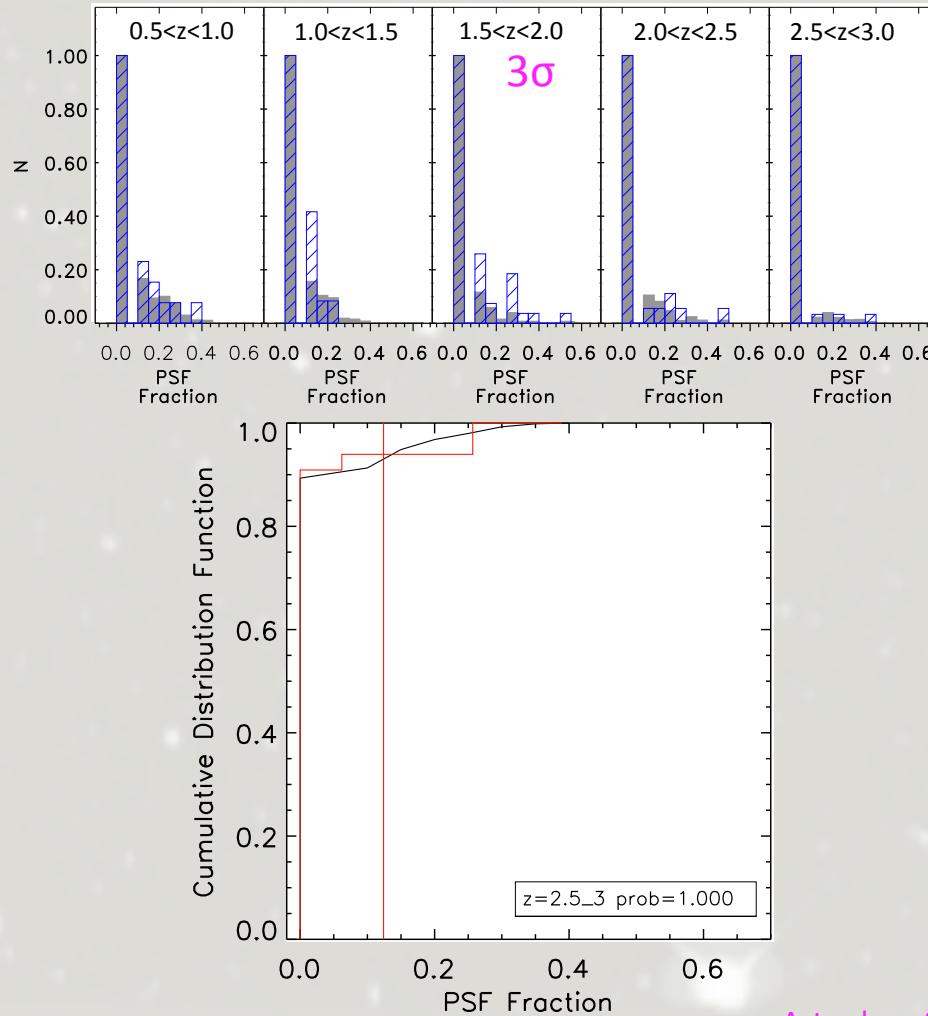


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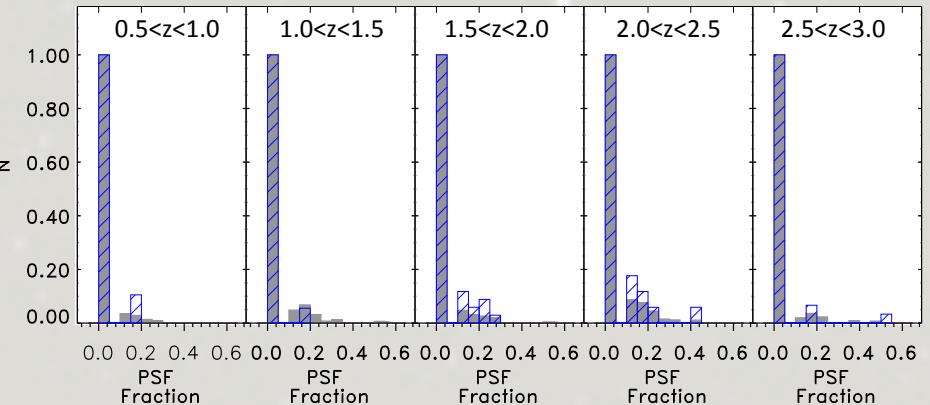
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PSF Fractions

single Sérsic + PSF



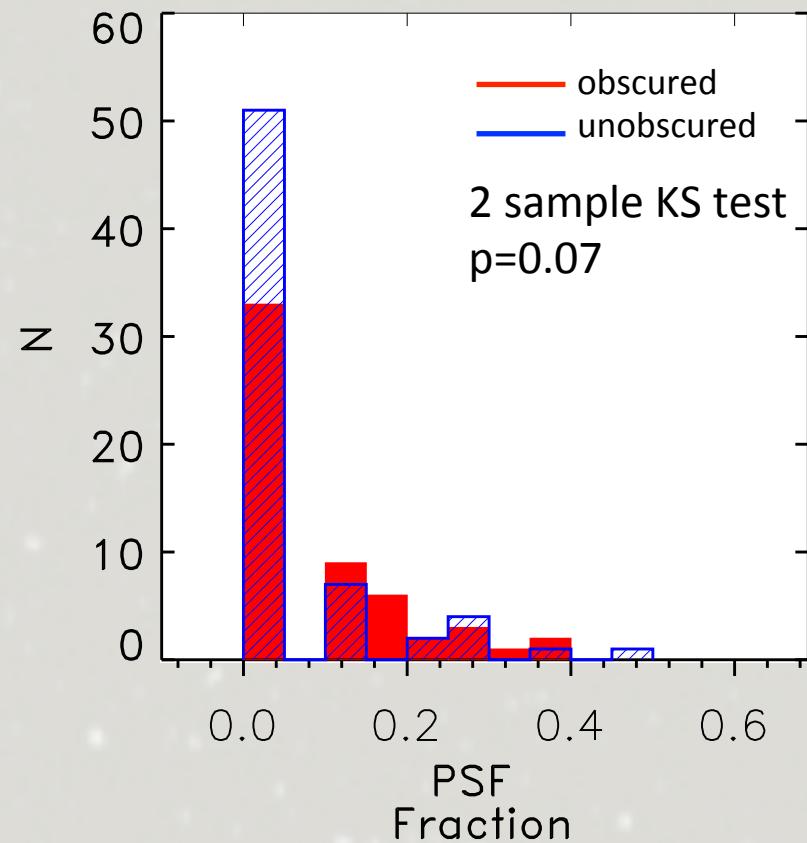
bulge+disk+ PSF



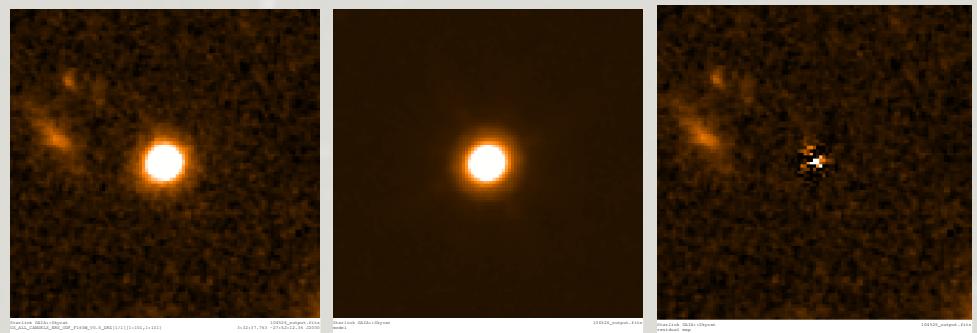
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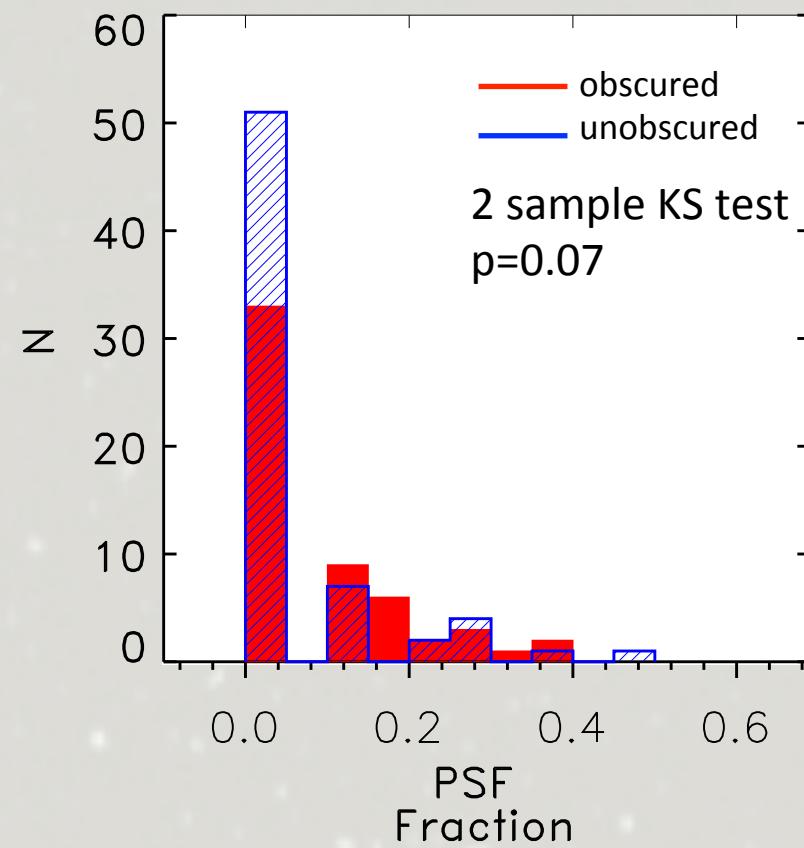


Szokoly et al. 2004 FORS/FORS2 follow-up of X-ray detections in the 942 ks CDFS catalogue

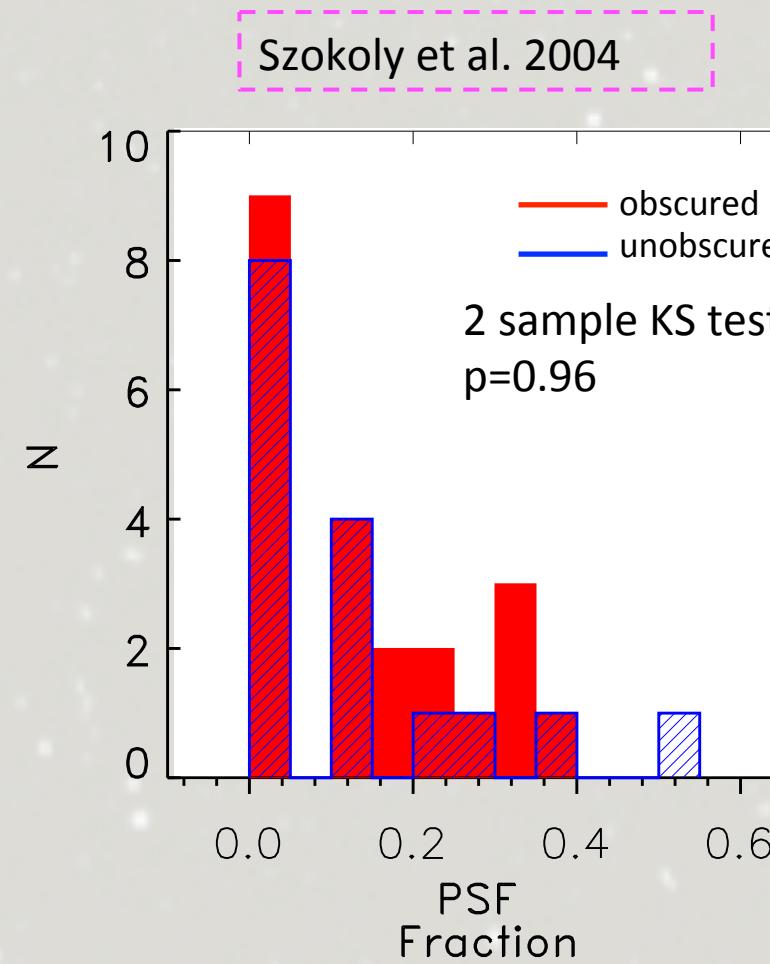


PSF fraction =0.51, QSO, type 1, strong emission lines in optical indicating AGN

PSF Fractions



X-ray spectrum classification

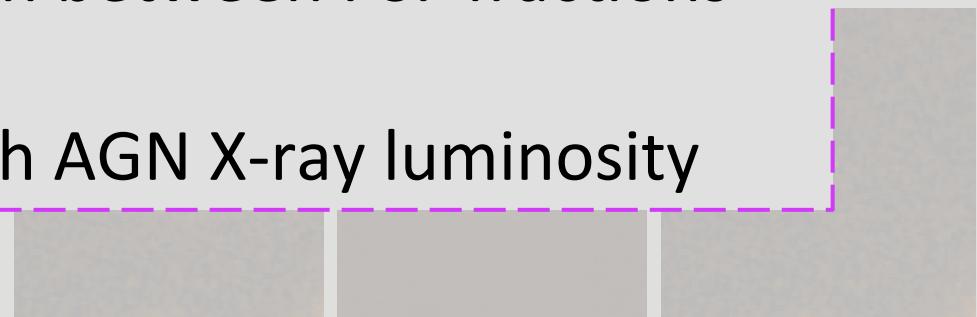
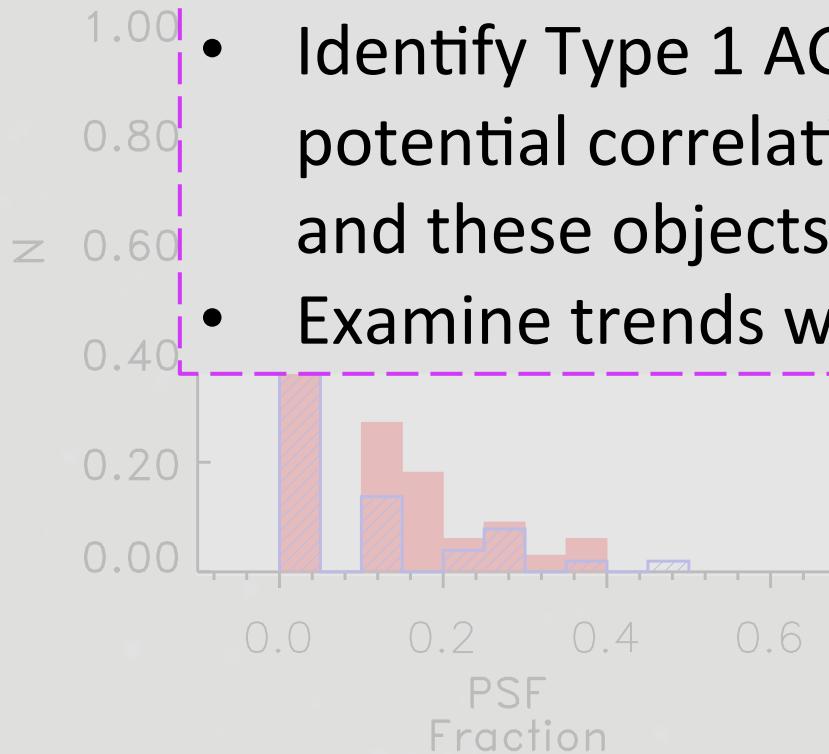


Optical spectrum classification

PSF Fractions

Future Work:

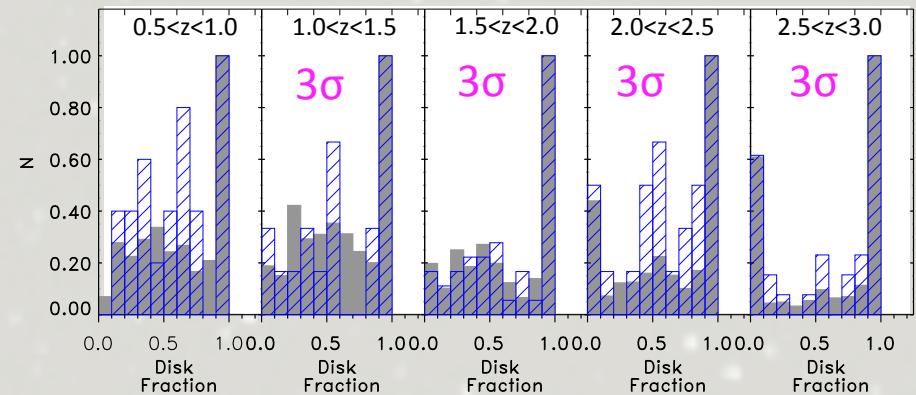
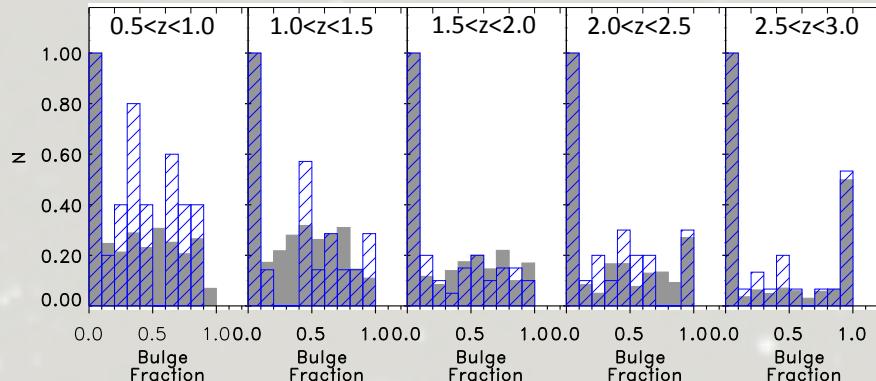
- Identify Type 1 AGN from spectra and explore potential correlation between PSF fractions and these objects
- Examine trends with AGN X-ray luminosity



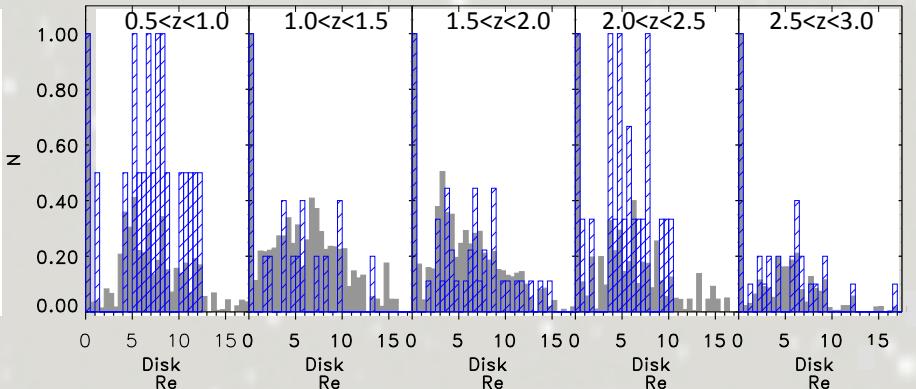
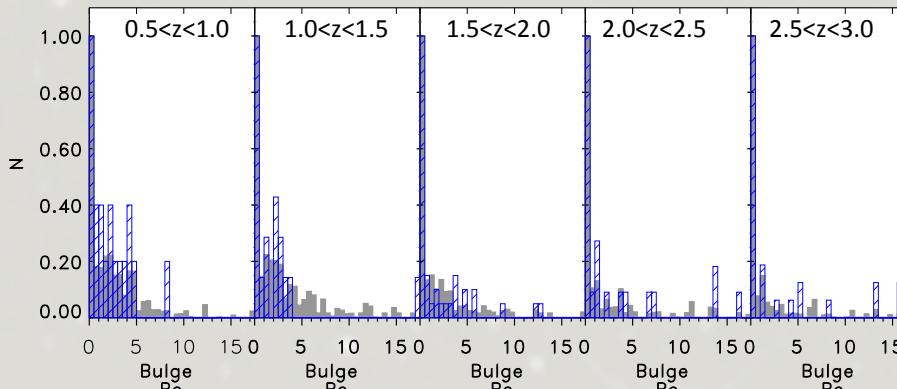
PSF fraction =0.51, QSO, type 1, strong emission lines in optical indicating AGN

Multiple Sérsic Fits

light fractions

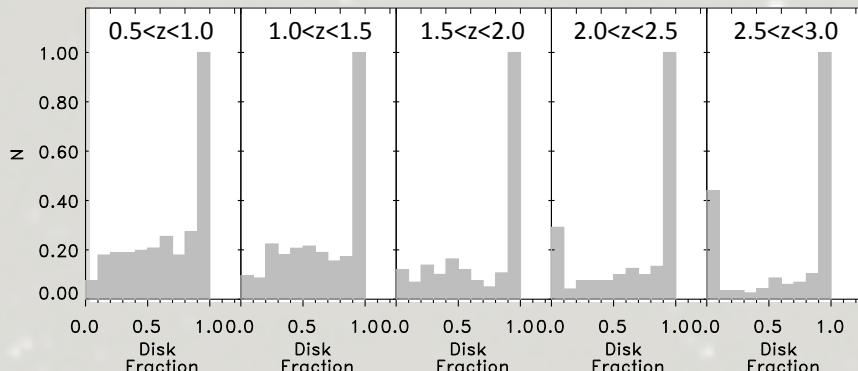


component sizes

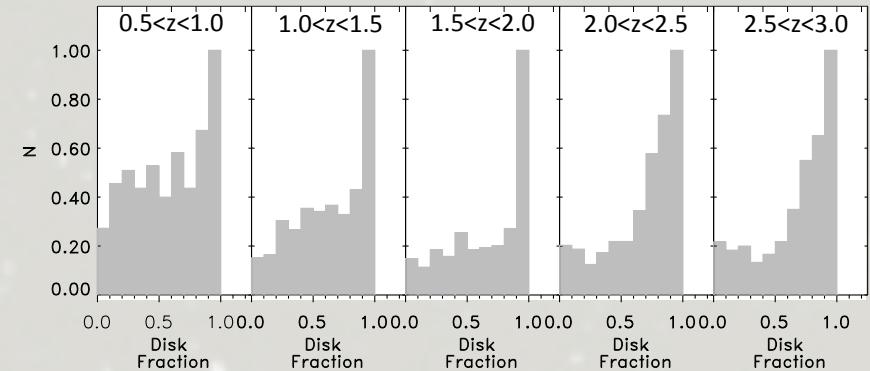


Multiple Sérsic Fits

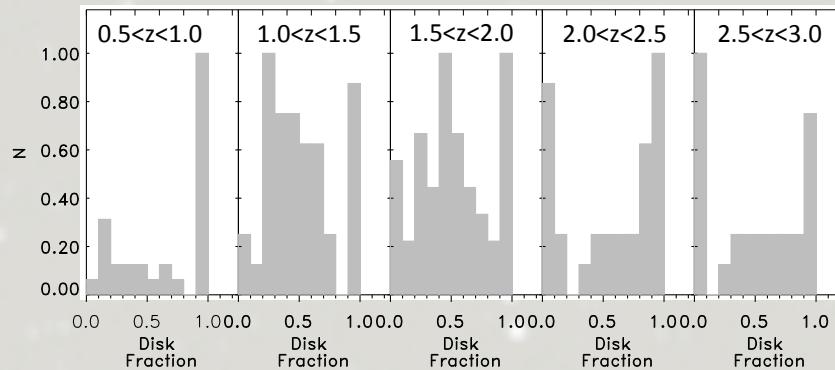
likelihood ratio fits



all bulge+disk(+PSF) >10% fits



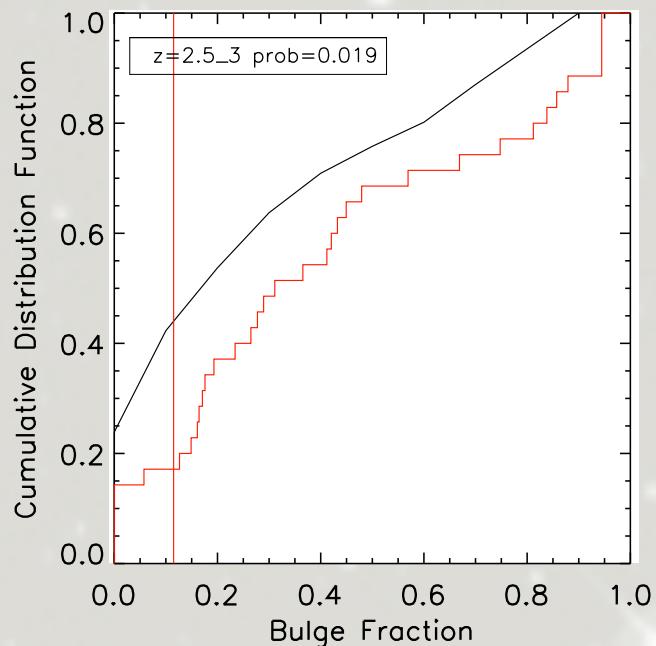
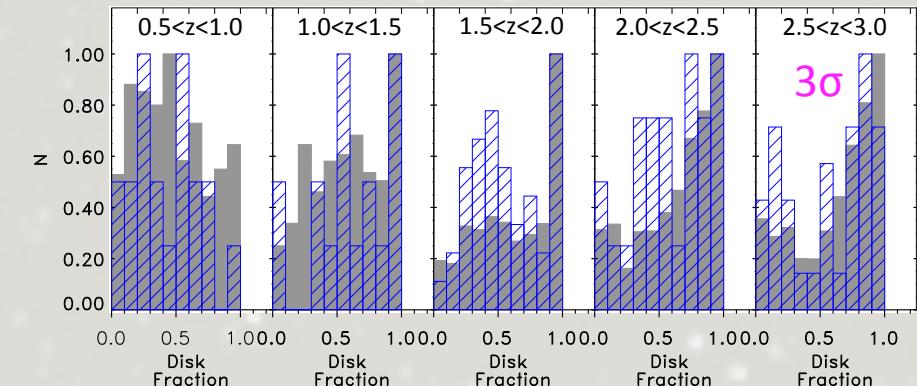
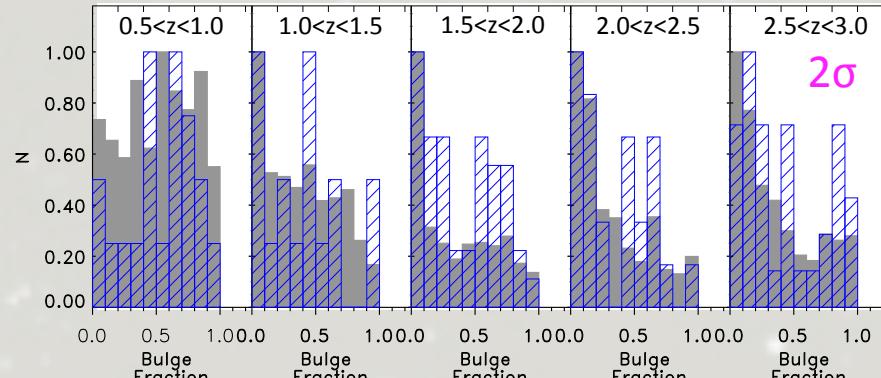
likelihood ratio fits $M > 10^{11} M_{\text{solar}}$



suggests that for comparing populations
we should be using the all bulge+disk
+PSF fits (as long as not biased - tbd)

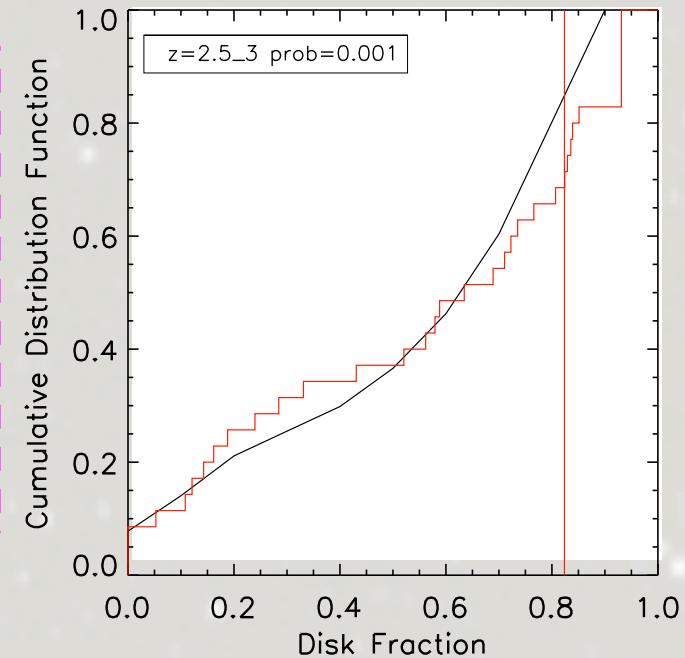
Multiple Sérsic Fits

re-evaluated light fractions



- AGN have:
- less low bulge fractions
 - more low disk fractions
 - more pure bulges

still bulgier



Conclusions

- AGN hosts are bulgier (or less disky) than control sample galaxies at $z>1.5$ using both single component of single+PSF fits.
- Using decomposed fits AGN at $z>2.5$ are also bulgier.
- However fitted sizes show no difference.
- No strong evidence yet for a correlation between PSF components and AGN detections.

Future Work

- Look for variations in trends at different wavelengths – e.g. PSF and Sérsic indices in the bluer ACS bands.
- Explore trends with $L_{\text{x-ray}}$; are more luminous AGN bulgier ?
- Do fitted PSF fractions vary with AGN type – obscured, unobscured, Compton thick ?
- Conduct fully decomposed SED fitting to determine individual bulge and disk stellar masses and star-formation rates for comparison between control sample and AGN hosts.
- Also experiment with fitting PSF components with QSO templates in SED fitting.

