Using AGN to Observe the Growth of the Cosmic Web

Xbootes 9.3 Square Degree Survey

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Outline of Talk

What is the Xbootes Survey

What is AGES

Large Scale Structure

Redshift Distribution

Impact of Environment

Correlation

Future Plans

The XBootes Survey

Xbootes:

    126 ACIS pointings

    5 ksec each field (630 ksec)

    Joint GTO and GO program

    14^h 32^m +34° 06'

    4642 sources detected (>=2 cts)

        625 spurious

    3293 sources detected (>=4 cts)

        22 spurious

    42 extended sources (>=10 cts)
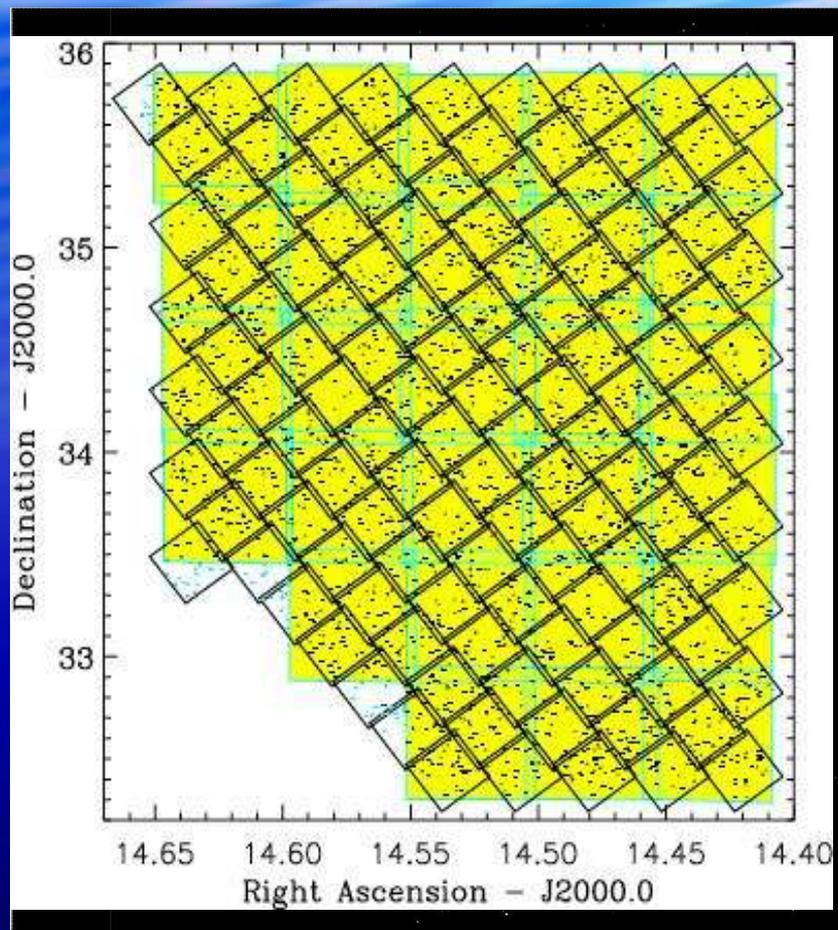
    f_{min}= 4(8)x10^{-15} erg cm^{-2} s^{-1} (0.5-7 keV)

    98% sources >=4 cts matched to NDWFS candidates (R<=26)

    Murray et al. ApJ S 163, 2005

    Kenter et al. ApJ S 163, 2005

    Brand et al. ApJ, 2006

AGN and Galaxy Evolution Survey (AGES)

MMT/Hectospec fiber spectrograph
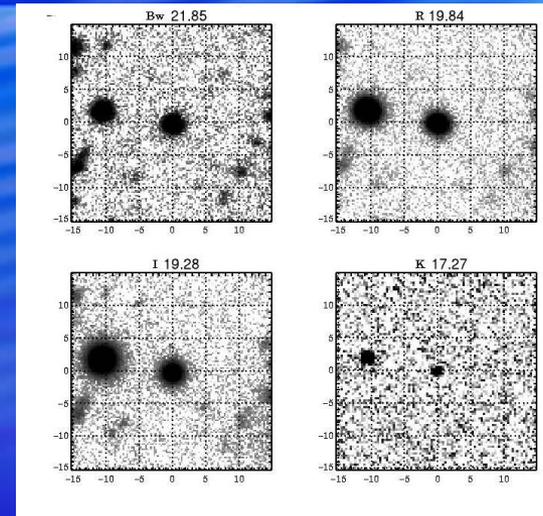
300 fibers/field

Complete galaxies I<19.5
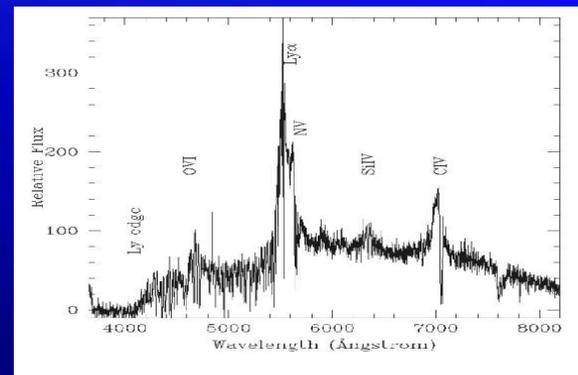
Complete X-ray >4 cts and I<21.5

~19,000 galaxies

~1,500 X-ray selected

   E.g., z=3.53 AGN with 12 cts
L_x=3x10^{45} erg s^{-1} (0.5- 7keV)

Kochanek et al. ApJ, 2006

CXOXB J142547.4+352719

Large Scale Structure

Other Surveys

DEEP2
0.7 < z < 1.4
4 x 1 sq. deg
40,000 redshifts
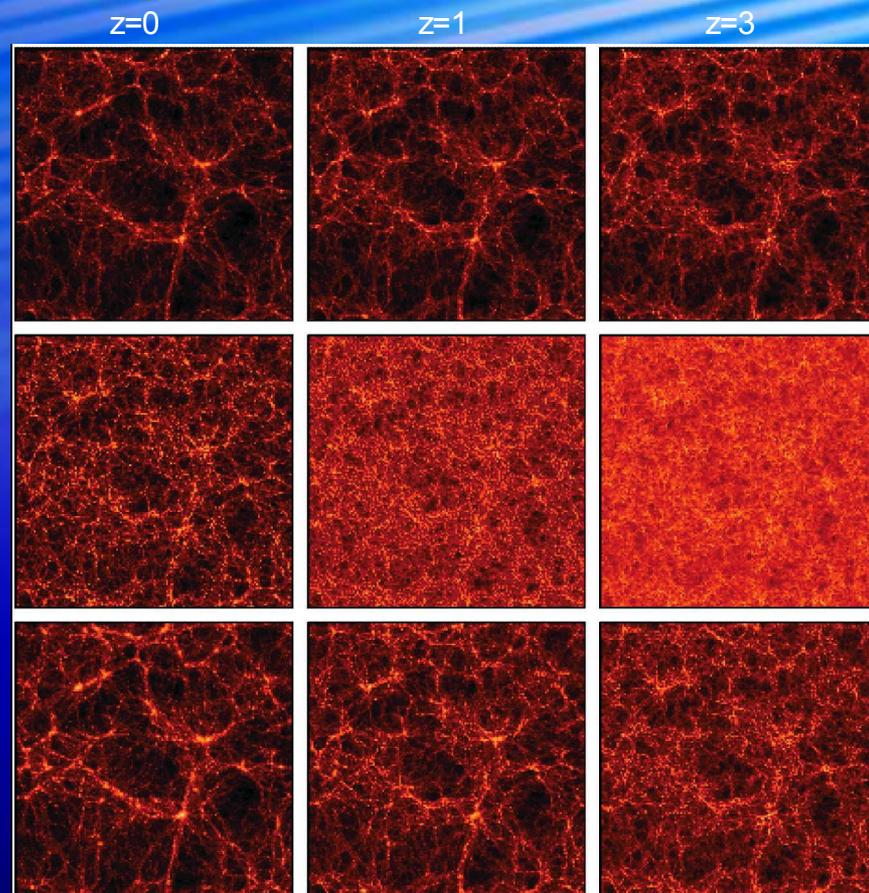
2dF
z<0.2
1500 sq. deg
200,000 redshifts

SDSS
z<2.3
6600 sq. deg
850,000 redshifts

z=0   z=1   z=3

OCDM
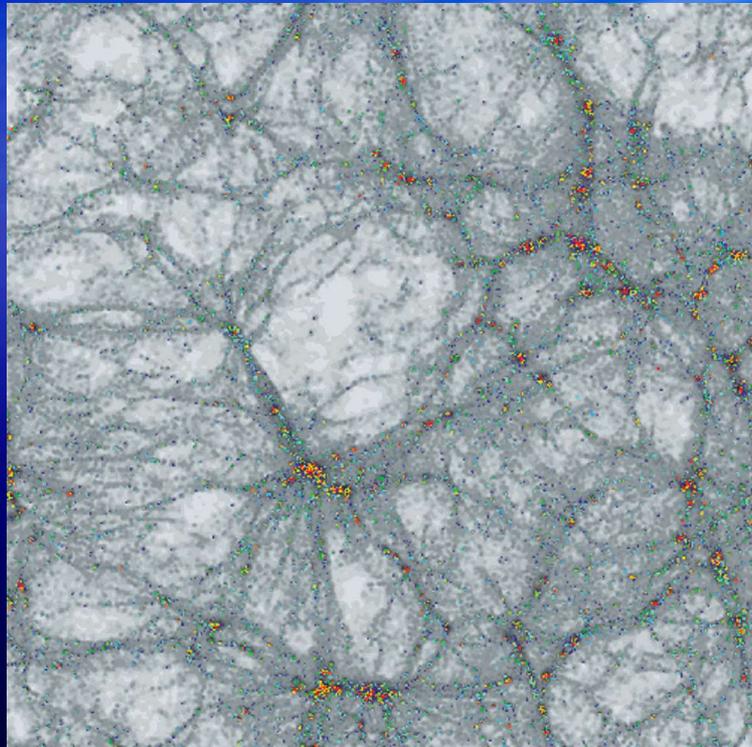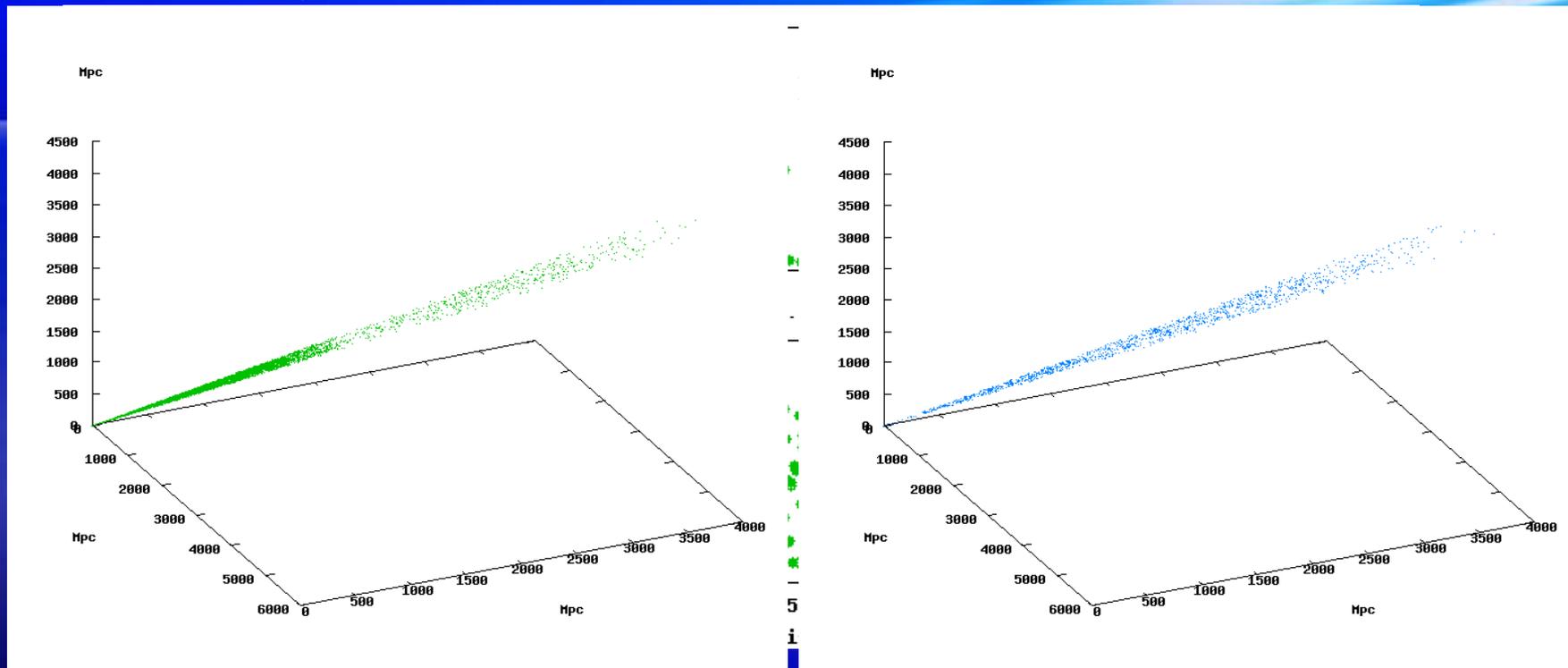
SCDM

LCDM

Jenkins et al., 1998 (ApJ, 499, 20-40)

Galaxies in the Cosmic Web

Survey Results (0 < z < 5)
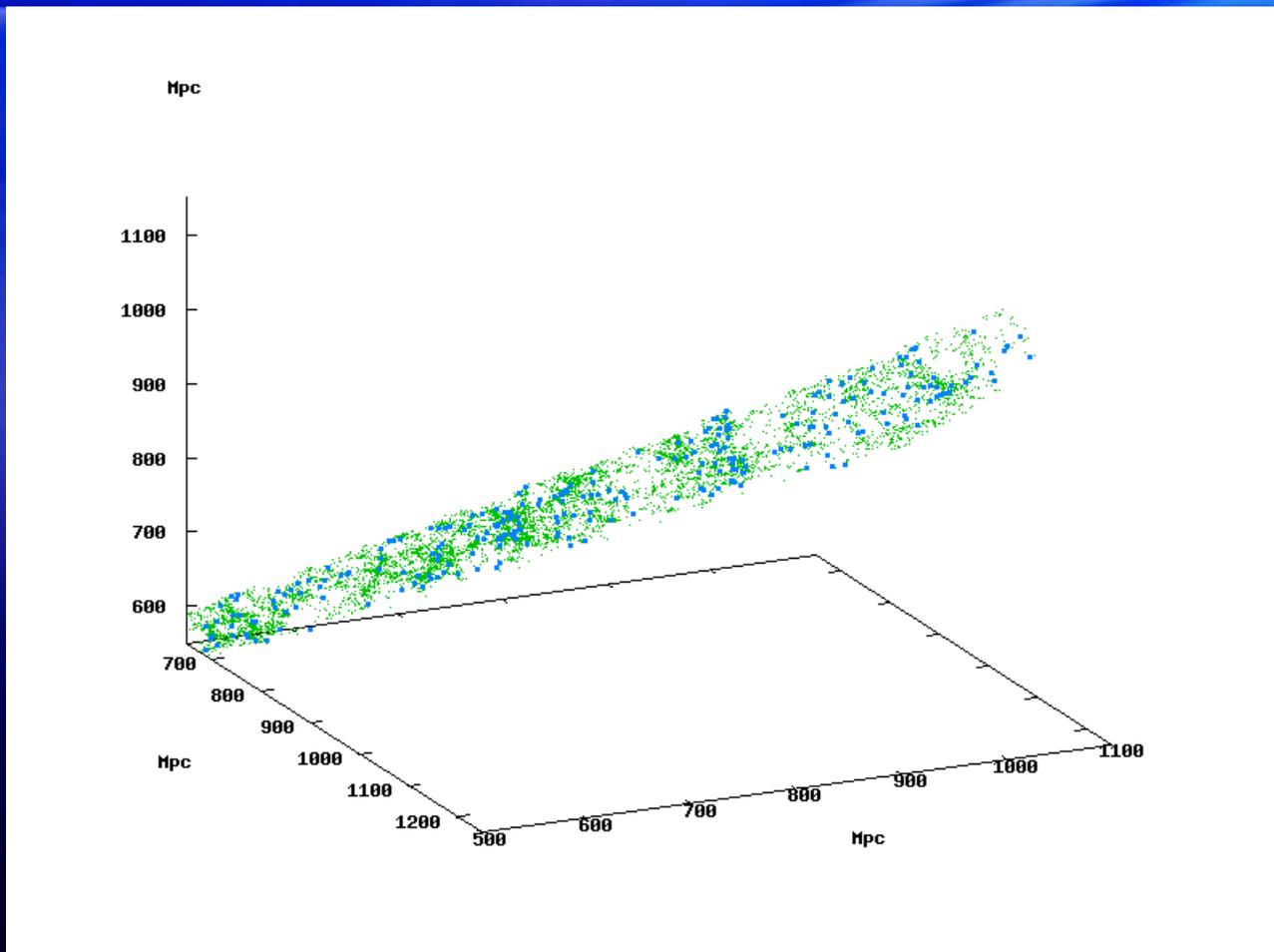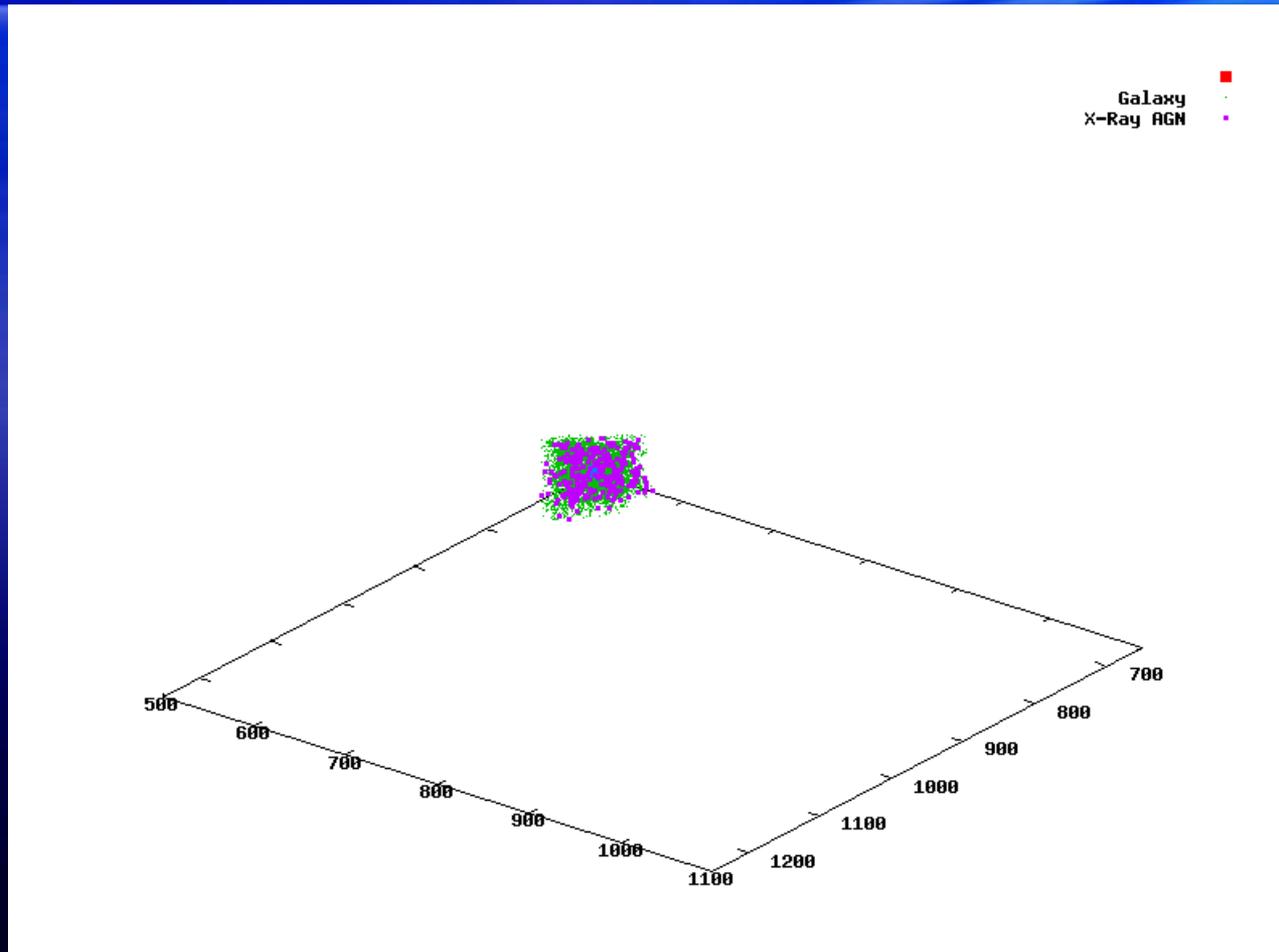

- Not X-ray Selected (18,820)

- Most galaxies with z<0.7

- 531 z>1, must be AGN, but not detected in shallow x-ray survey

- X-ray Selected (1531)

- 306 "galaxies"

- 50 "narrow emission line"

- 1175 "AGN'
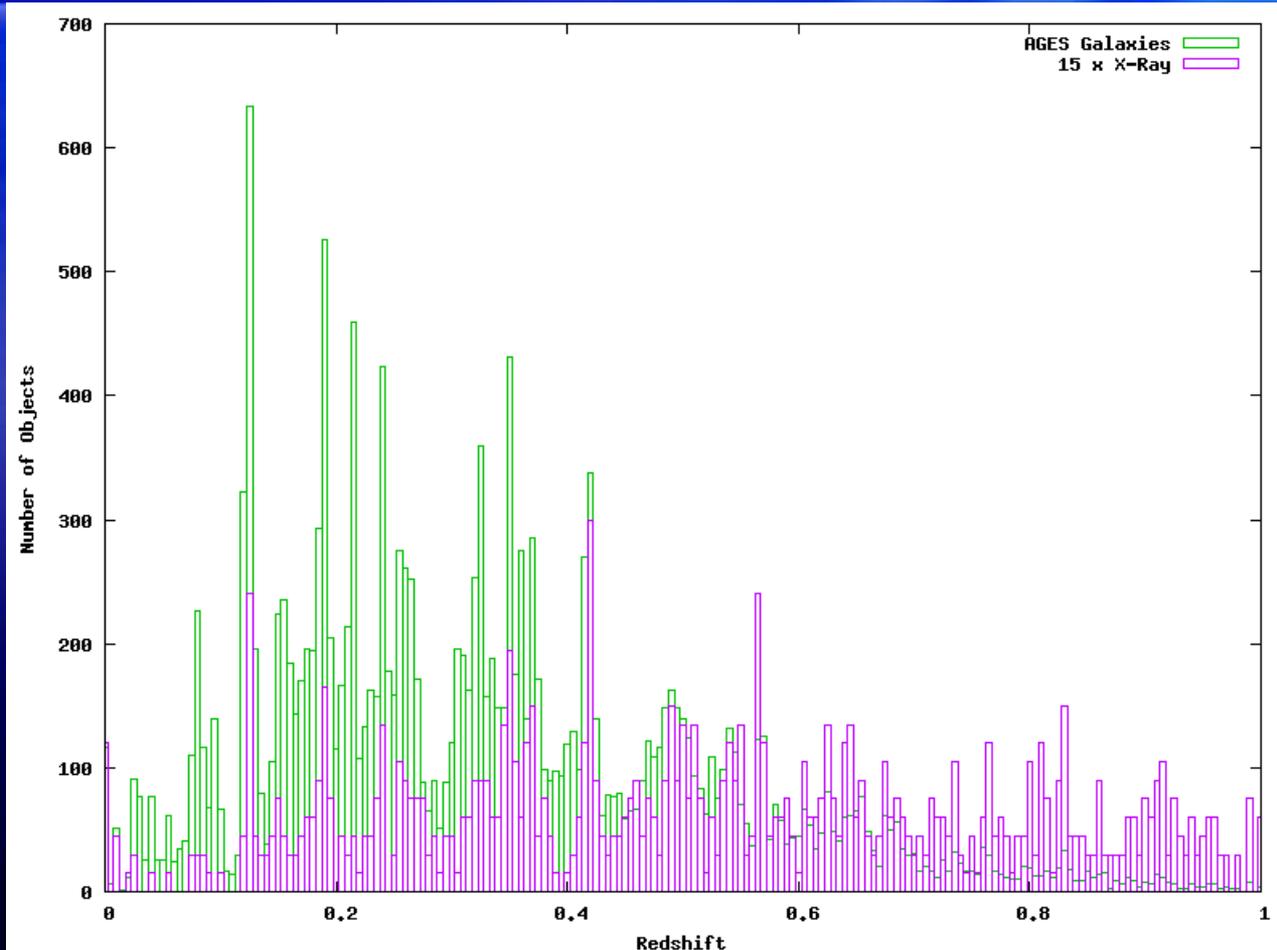
Structure (0.25 < z < 0.50)

Structure (0.25 < z < 0.50)

X-ray Selected AGN

At low z (<0.7), map the same structures as seen using galaxies

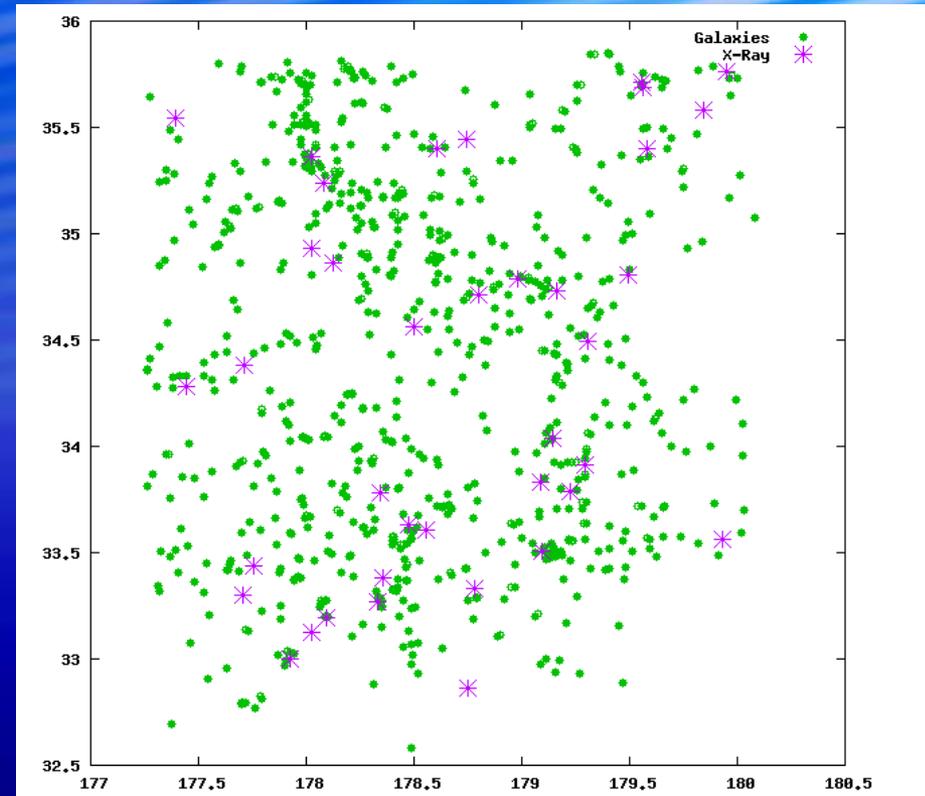At higher z, similar X-ray AGN structures continue to be seen

X-ray selected AGN are an efficient means to study large scale structure in the redshift range 1-3
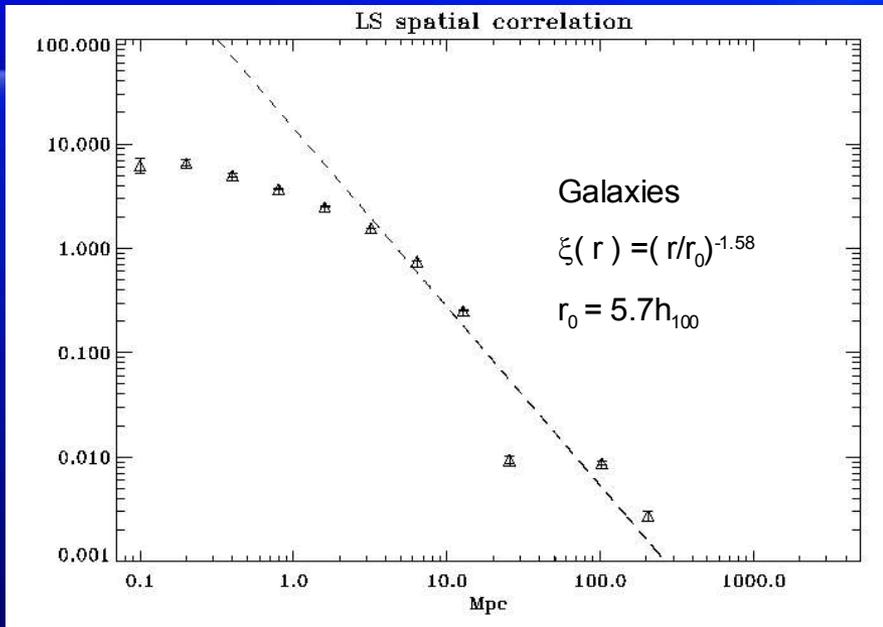
Redshift Distributions

AGN Environment

- Local Galaxy Density may impact:
  - Activity
  - Type
  - Luminosity
  - …

Redshift Slice 0.41<z<0.43

2 Point 3-D Correlation
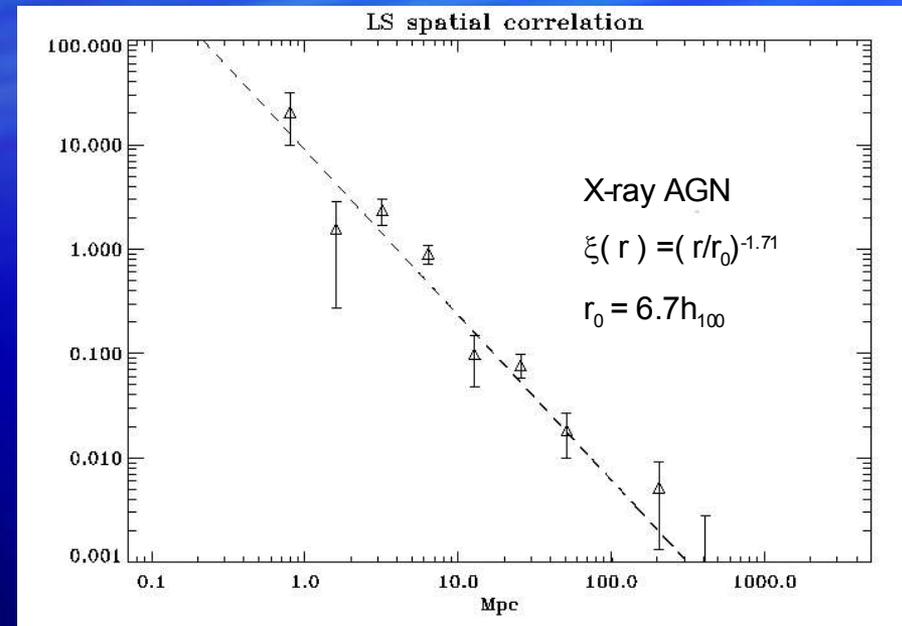

LS spatial correlation

Galaxies

$\xi(r) =(r/r_0)^{-1.58}$

$r_0 = 5.7h_{100}$

Galaxy correlation rolls off at small separations due to sample selection and fiber conflicts.

For X-ray selection, no such systematics.

LS spatial correlation

X-ray AGN

$\xi(r) =(r/r_0)^{-1.71}$

$r_0 = 6.7h_{100}$

Possible Evolution

Redshift	$r_0 h_{100}$
0.0 - 1.0	8.6
1.0 - 1.5	6.1
1.5 - 2.0	4.0

Future Plans

AO-7 GTO

- 330 ksec, 33 10 ksec overlap ~25% of Xbootes
- X3 sensitivity -> x5 sources -> 150/field (120 new)
- 1/3 with I<22.5 ?? -> 1300 additional Hectospec targets
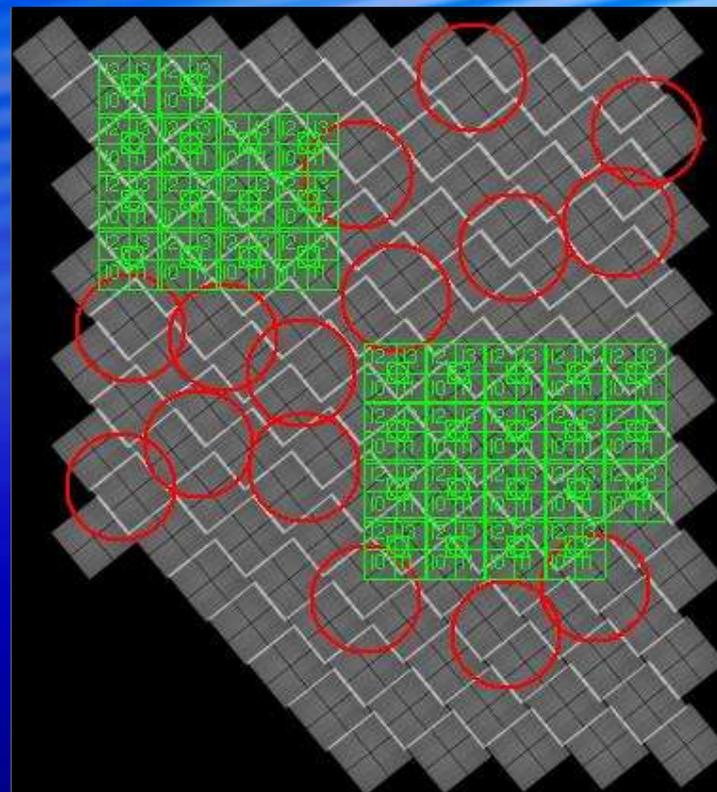
XMM Proposal

- Potential Hard Sources
- X-ray Spectra

MMT/Hecto

- 500 current left + 1300 new -> double current set to look at structure evolution

Legacy data set

- Could have ~10,000 X-ray sources in Xbootes for future spectroscopy and structure studies

Conclusions

Shallow survey covering 9.3 sq. deg yields 1200 X-ray selected AGN

AGN map the same structure at z<0.7 as do galaxies

X-ray selected AGN can map large scale structures out to z~3 and search for evolution of structure as predicted in numerical simulations