AGN - field galaxies association at high redshifts

Andrzej M. Sołtan

Nicolaus Copernicus Astronomical Center
Warszawa

AGN luminosity is directly proportional to the accretion rate onto the SMBH.

The more 'chaotic' velocity field of the intragalactic matter, especially close to the galaxy center, the more matter approach the central SMBH and the more intense AGN phenomena are expected.

That's why AGNs are believed to be found more frequently in the interacting galaxies or close pairs.

Here we try to verify this effect using a statistical approach. Also, a redshift dependence is investigated.

Thus, we need a 'good' sample of galaxies at relatively high redshifts (where the AGNs are more abundant than in the local Universe).

AGN are efficiently identified by their X-ray emission.

Almost all extragalactic X-ray sources are identified with the various classes of AGN (with the exception for the weakest sources).

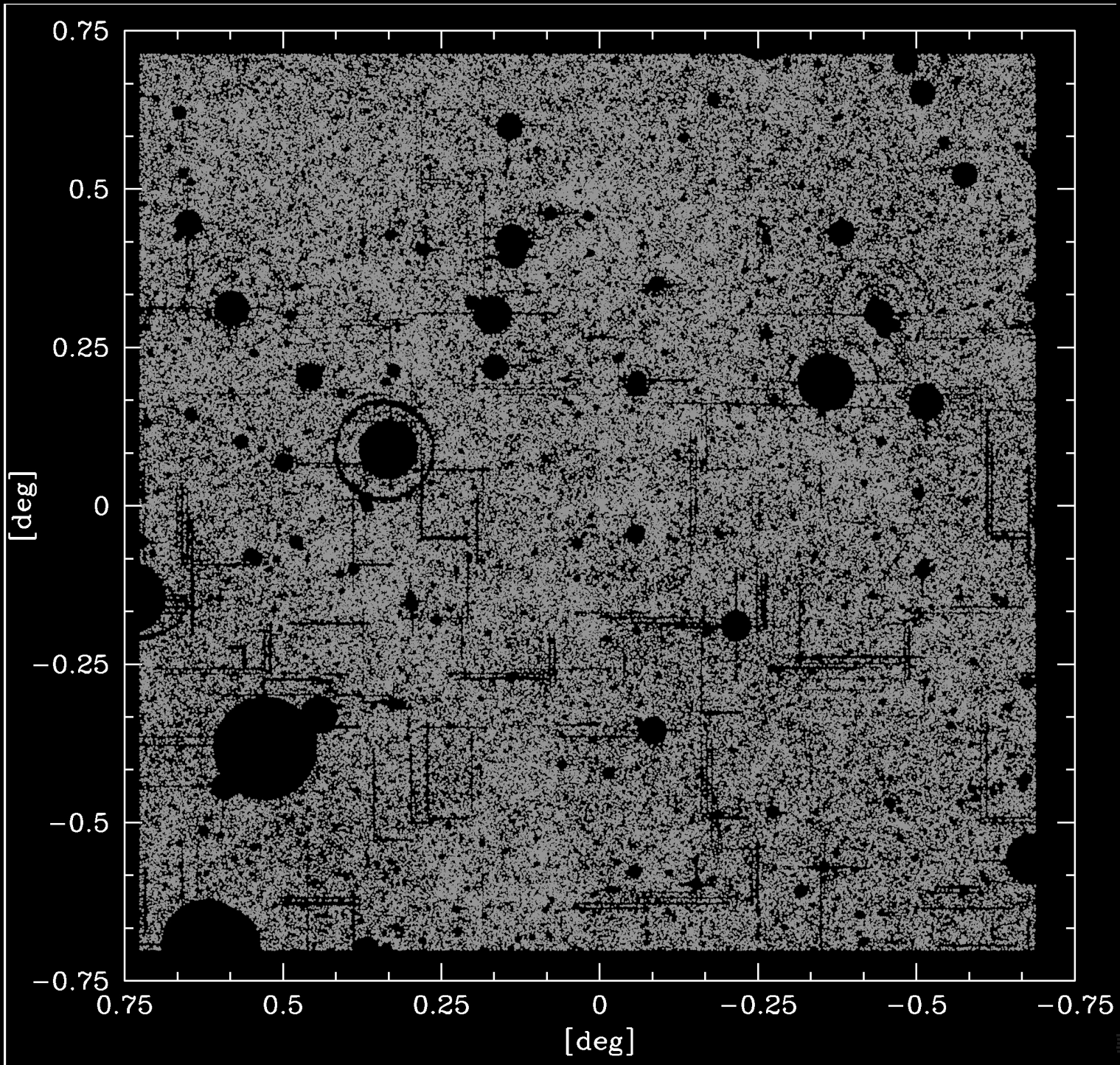
Deep X-ray observations of a field covered by the VERY deep galaxy survey provides adequate statistical material.

* * * * *

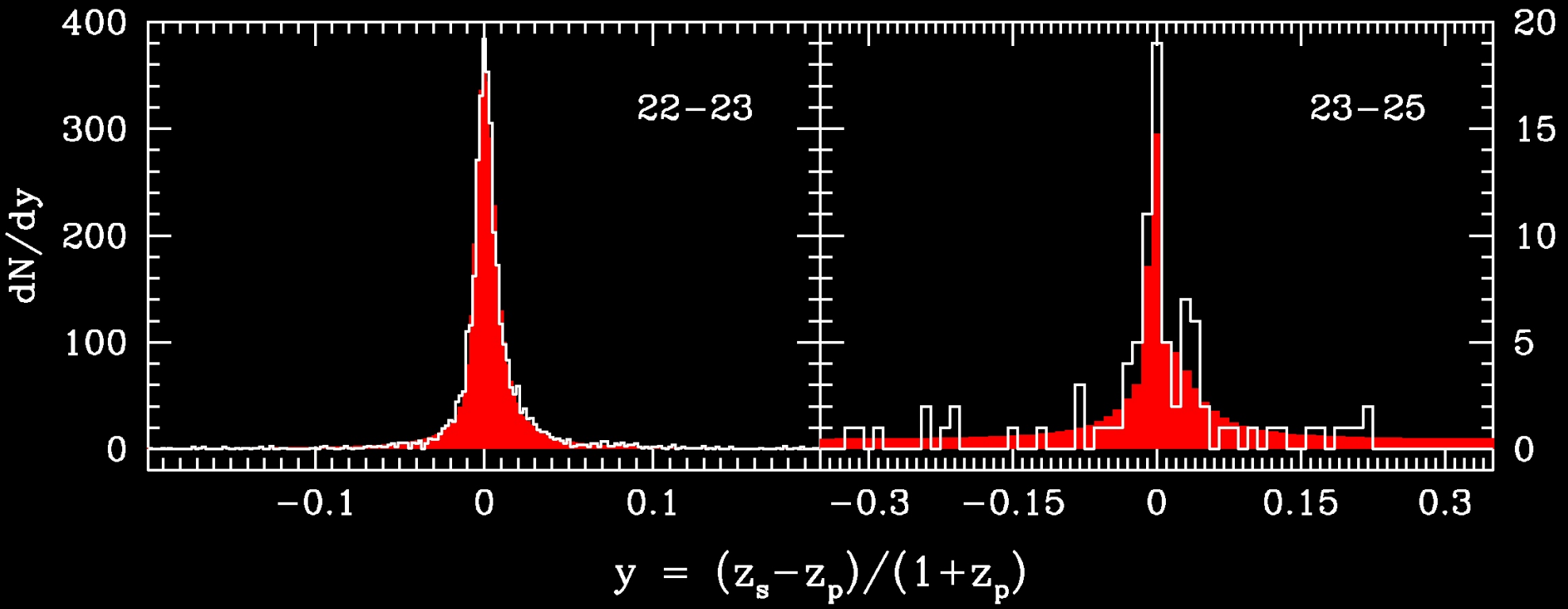
COSMOS/Subaru deep field:

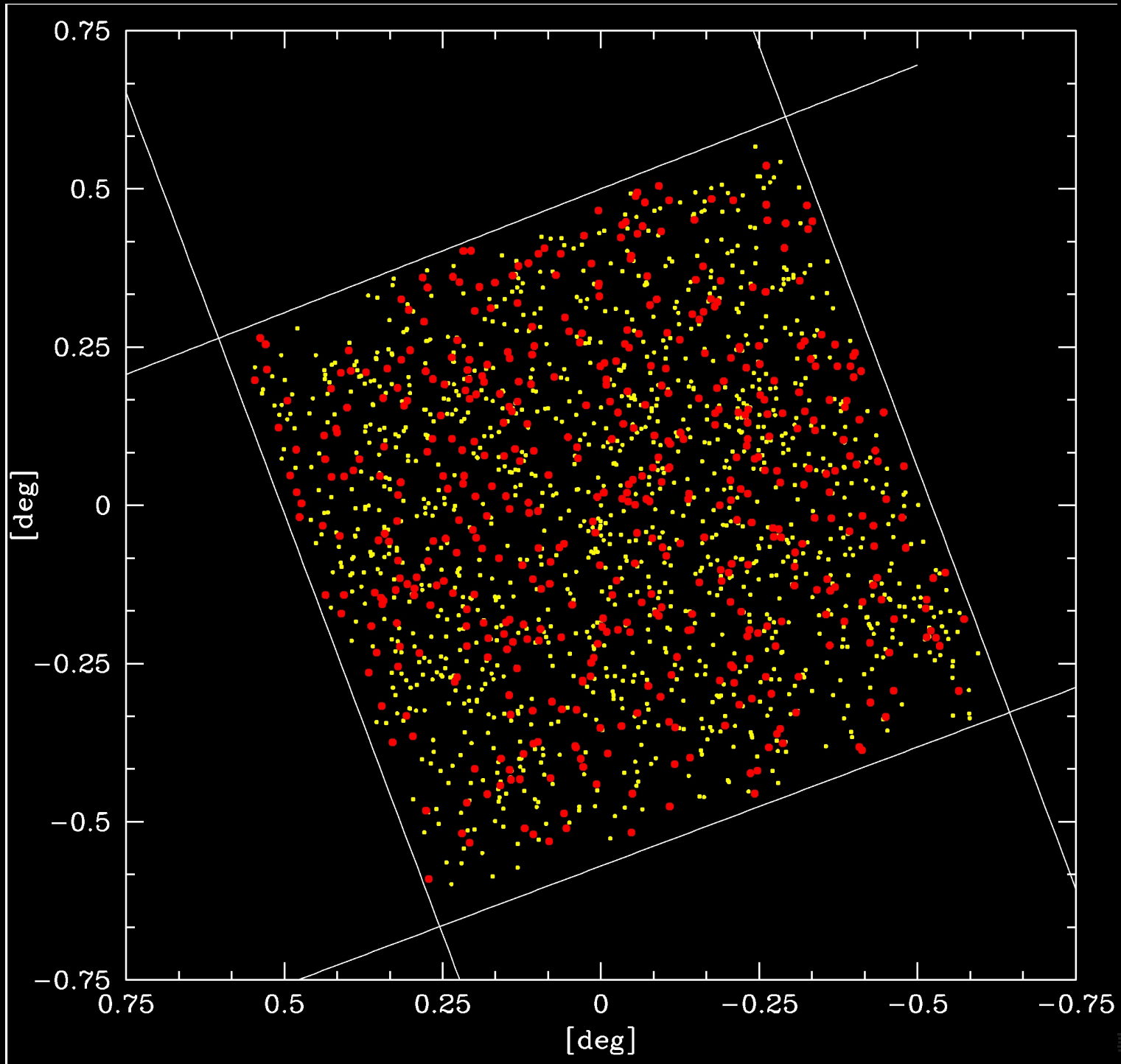
2 sq. deg., 250 000 galaxies, $\mathrm{i}^{+} < 25$

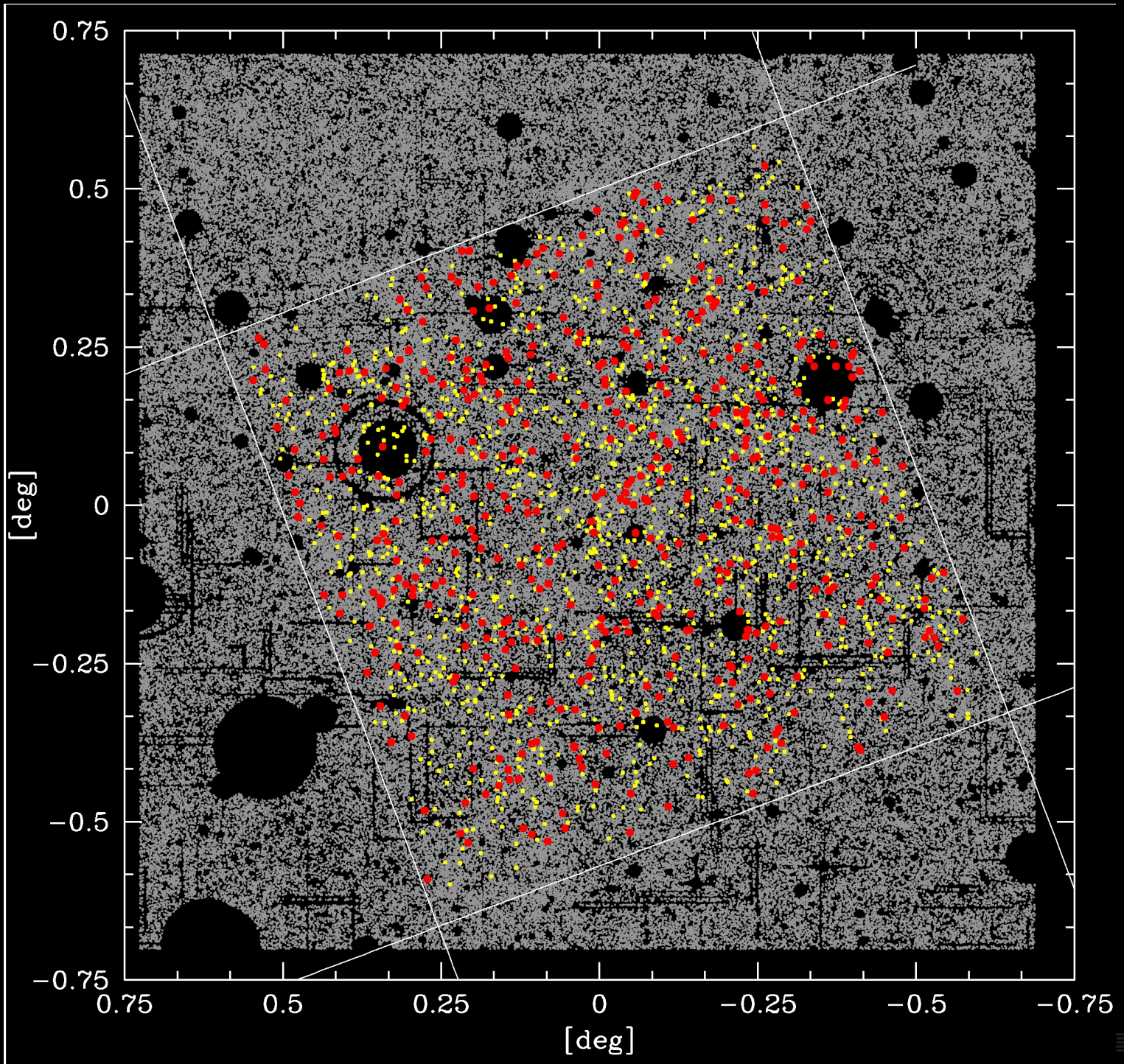
1 sq. deg., 1761 X-ray sources, Chandra + XMM

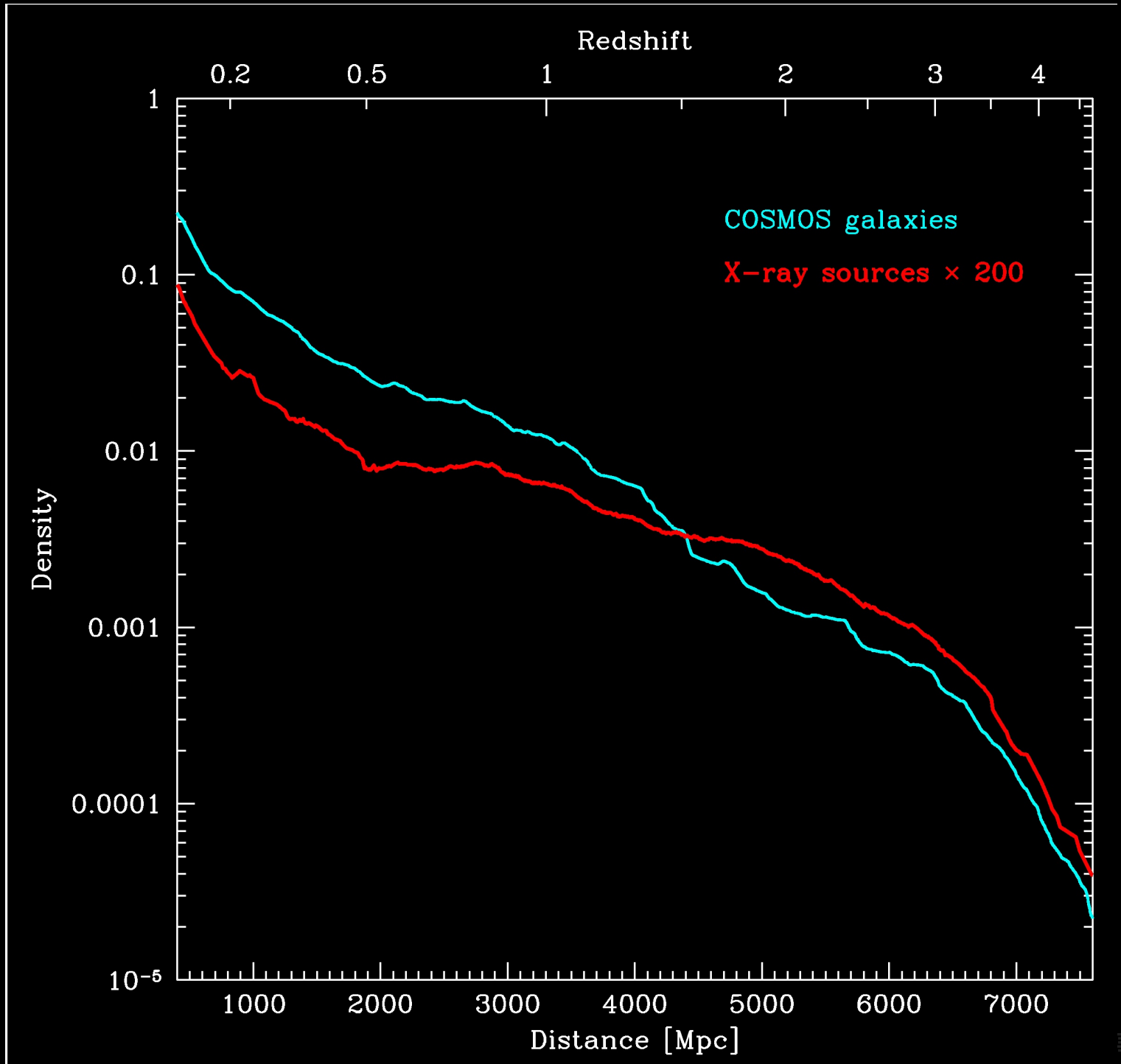

0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]
0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]

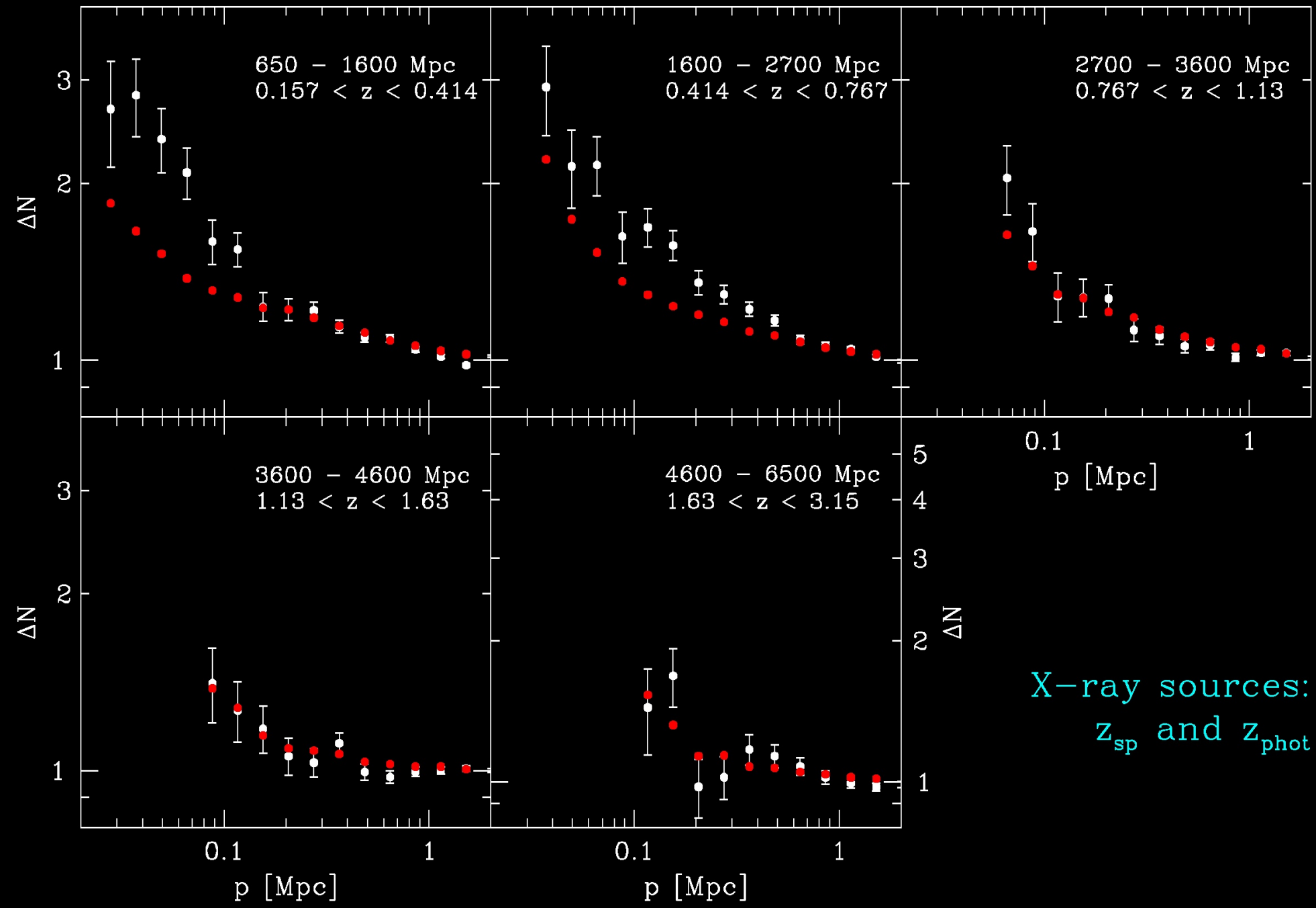
Redshifts: photometric vs. spectroscopic

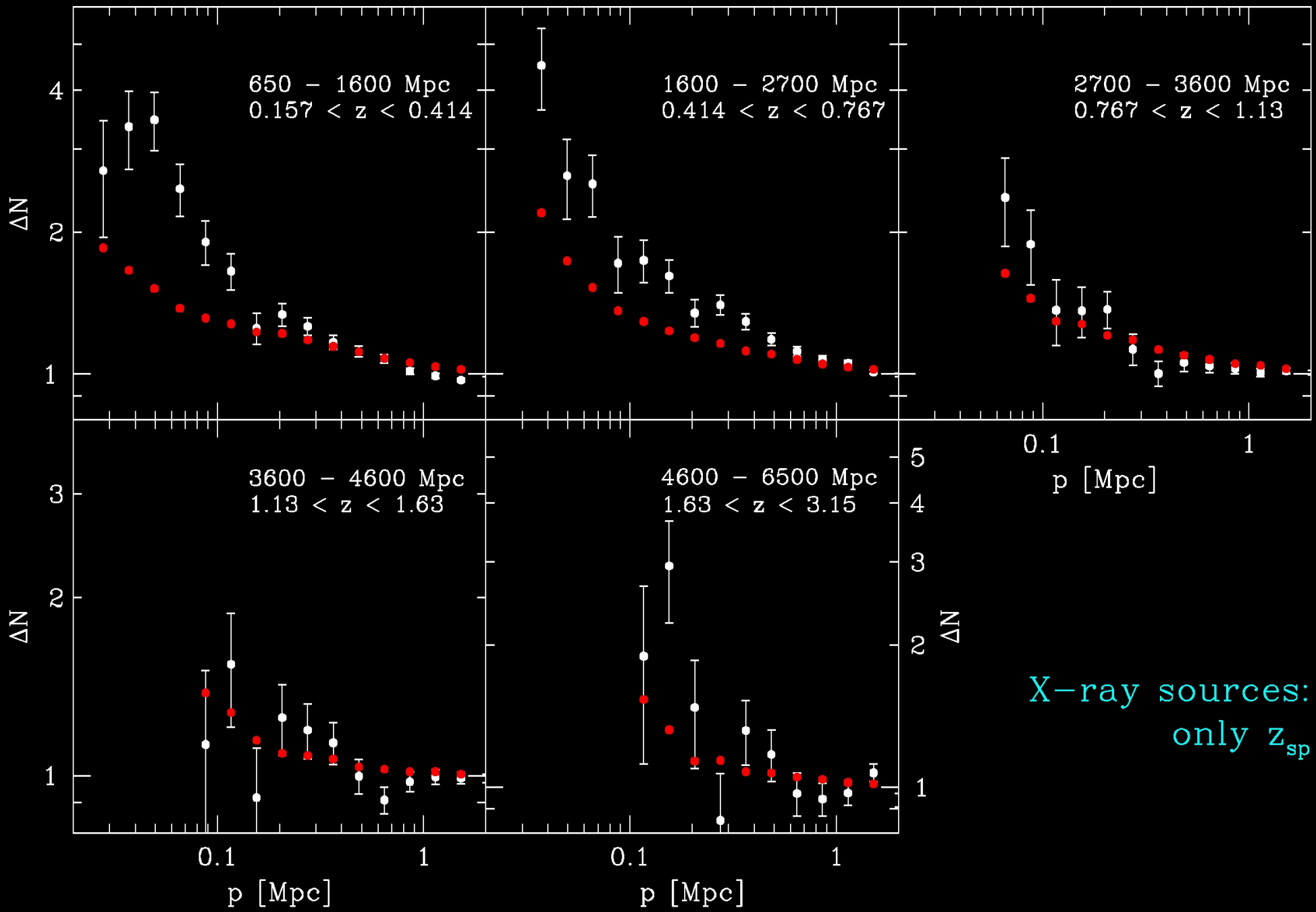



0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]
0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]


0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]
0.75
0.5
0.25
0
−0.25
−0.5
−0.75
[deg]


Redshift
0.2
0.5
1
2
3
4
1
0.1
0.01
0.001
0.0001
10^{-5}
Density
COSMOS galaxies
X-ray sources × 200
1000
2000
3000
4000
5000
6000
7000
Distance [Mpc]


650 − 1600 Mpc
0.157 < z < 0.414
1600 − 2700 Mpc
0.414 < z < 0.767
2700 − 3600 Mpc
0.767 < z < 1.13
3600 − 4600 Mpc
1.13 < z < 1.63
4600 − 6500 Mpc
1.63 < z < 3.15
ΔN
p [Mpc]
0.1
1
X−ray sources:
z_{sp} and z_{phot}


650 − 1600 Mpc
0.157 < z < 0.414
1600 − 2700 Mpc
0.414 < z < 0.767
2700 − 3600 Mpc
0.767 < z < 1.13
3600 − 4600 Mpc
1.13 < z < 1.63
4600 − 6500 Mpc
1.63 < z < 3.15
ΔN
p [Mpc]
0.1
1
X−ray sources:
only z_{sp}

Conclusions ...

... are clear for redshifts below ~ 1:

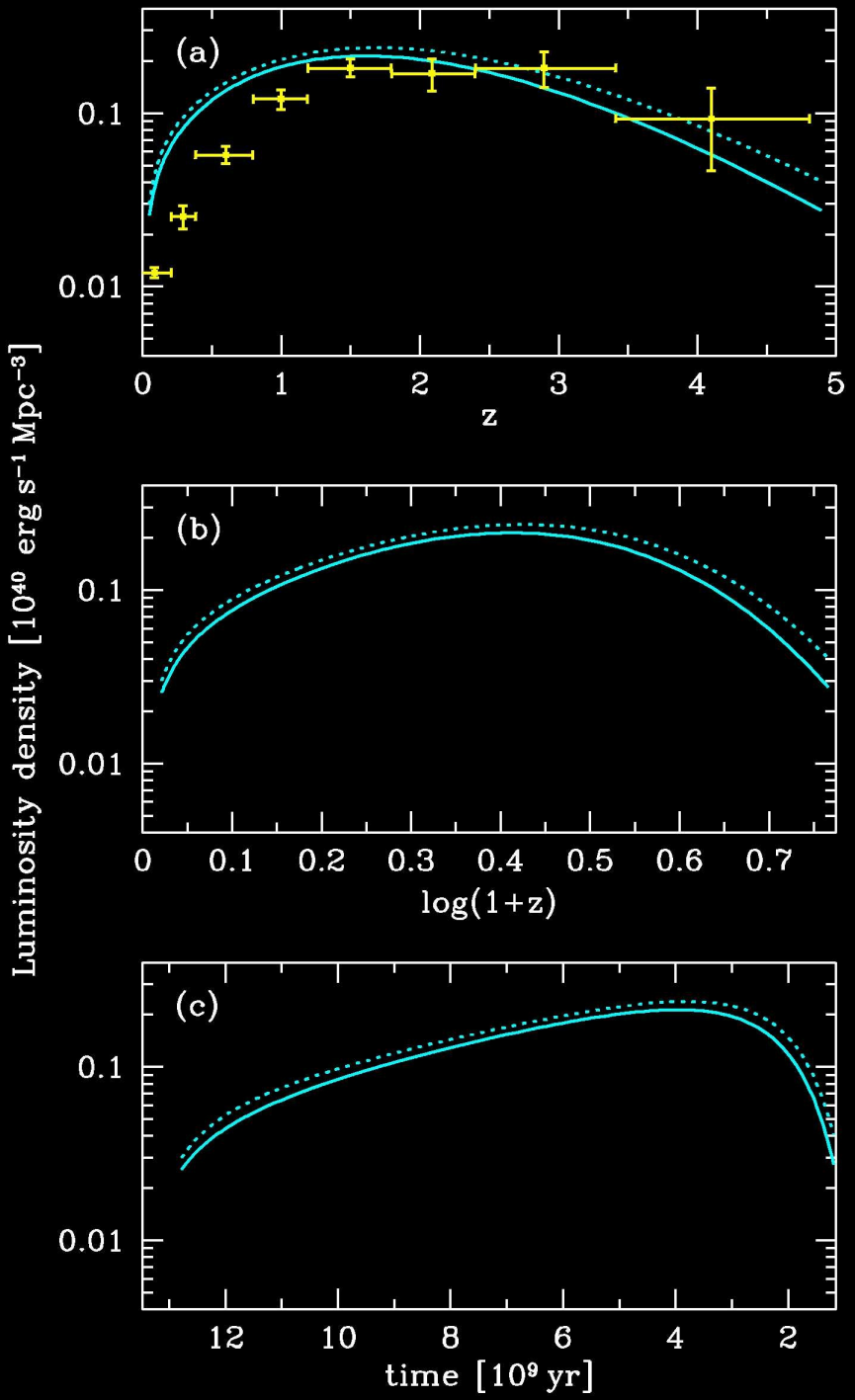
AGNs ($\approx$ X-ray sources) have more close neighbors than normal galaxies (this confirms previous assessments).

* * * * *

At higher redshifts the neighbor excess seems to be absent.

In fact, it is expected because due to Hubble expansion, the space density of galaxies in the earlier cosmological epochs was greater than in the local Universe.

Frequent galaxy interactions at high redshifts are likely to be the prime source for both the more efficient star formation and the higher accretion rate on the SMBH.

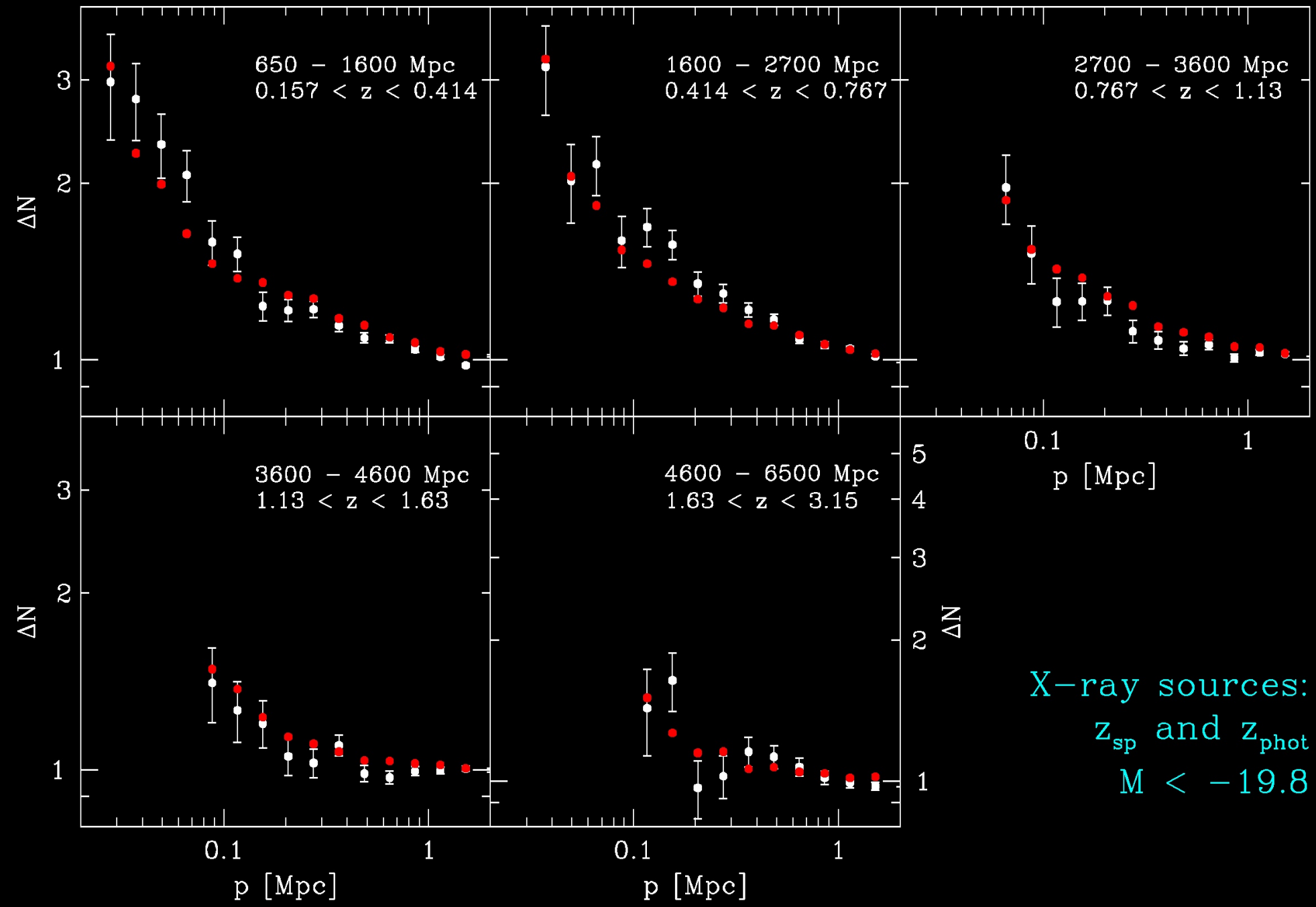

(a)
(b)
(c)
Luminosity density [10^{40} erg s^{-1} Mpc^{-3}]
0.1
0.01
0
1
2
3
4
5
z
0.1
0.2
0.3
0.4
0.5
0.6
0.7
log(1+z)
12
10
8
6
4
2
time [10^9 yr]

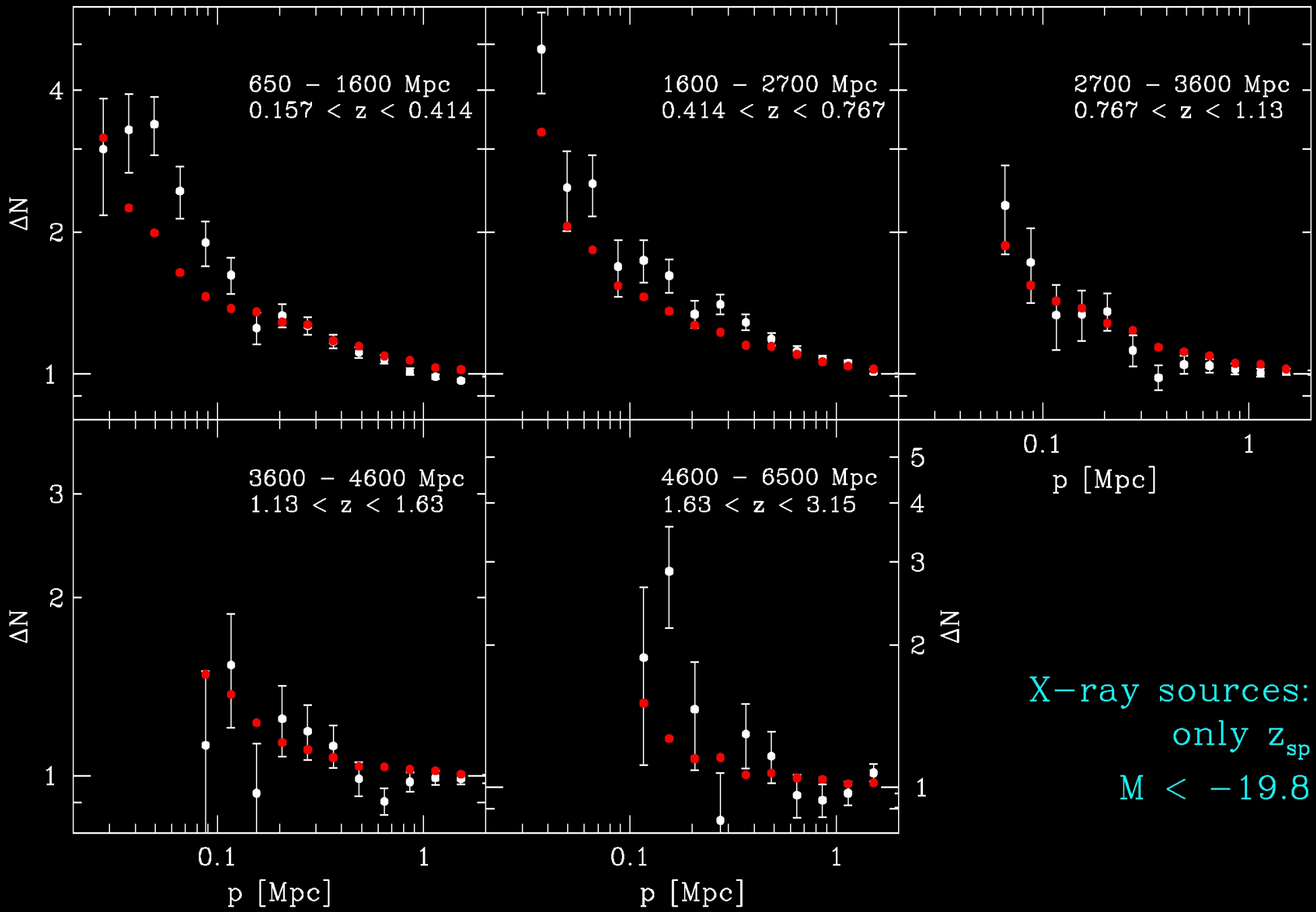
Corrections for $d = \pm 500$ Mpc

	Dist bin [Mpc]			N	p_x	p_{yz}
1	650	–	1600	66	0.9786	0.8955
2	1600	–	2700	117	0.9533	0.8707
3	2700	–	3600	108	0.8855	0.8086
4	3600	–	4600	78	0.8211	0.7525
5	4600	–	6500	84	0.8229	0.7598

$$\Delta N_{AGN-gal} = \Delta N_{AGN-gal}(obs)/p_x$$

$$\Delta N_{gal-gal} = \Delta N_{gal-gal}(obs)/p_{yz}$$


650 − 1600 Mpc
0.157 < z < 0.414
1600 − 2700 Mpc
0.414 < z < 0.767
2700 − 3600 Mpc
0.767 < z < 1.13
3600 − 4600 Mpc
1.13 < z < 1.63
4600 − 6500 Mpc
1.63 < z < 3.15
ΔN
p [Mpc]
0.1
1
X−ray sources:
z_{sp} and z_{phot}
M < −19.8


650 – 1600 Mpc
0.157 < z < 0.414
1600 – 2700 Mpc
0.414 < z < 0.767
2700 – 3600 Mpc
0.767 < z < 1.13
3600 – 4600 Mpc
1.13 < z < 1.63
4600 – 6500 Mpc
1.63 < z < 3.15
ΔN
p [Mpc]
0.1
1
X−ray sources:
only z_{sp}
M < −19.8