The XMM-LSS project

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and

first results

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Plan of the talk

1. Short introduction
2. Motivations and design of the XMM-LSS
3. Current results (on galaxy evolution)

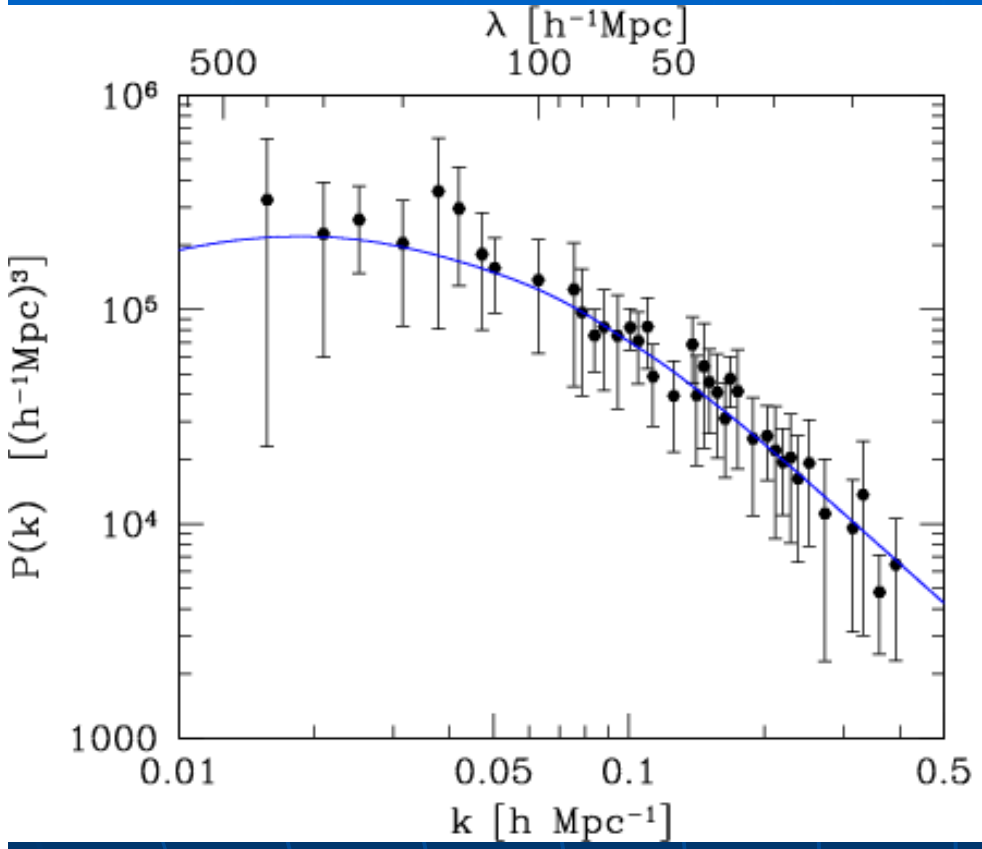
A European/Chilean Consortium

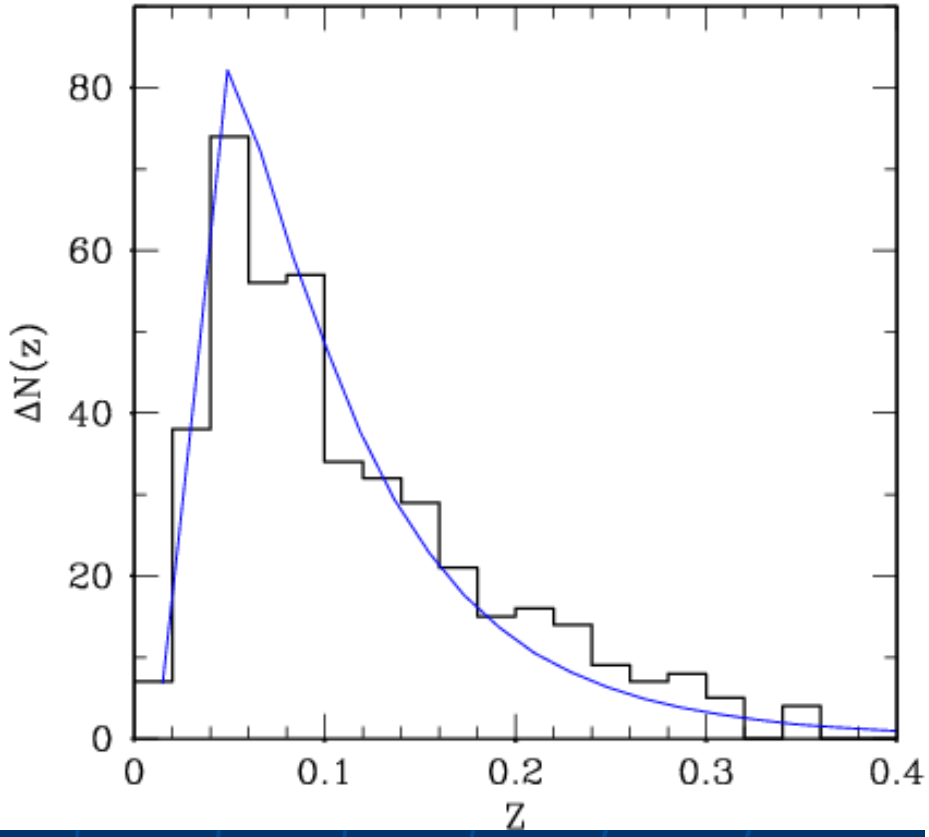
- Birmingham
- Bristol
- Copenhagen
- Dublin
- ESO/ Santiago
- Leiden
- Liège
- Marseille (LAM)
- Milano (AOB)
- Milano (IFCTR)
- Munich (MPA)
- Paris (IAP)
- Saclay (CEA), PI.
- Santiago (Uni. Cato.)

For X-ray beginners: X-ray cluster surveys …

- Detect hot gas trapped in the cluster potential (bremsstrahlung~ n^2)
- Little projection effects
- X-ray sky: clean (~ 300 sources/deg^2)
  - AGN : point like
  - Clusters : extended
- Probe z >>1 universe (in principle)

Results from the RASS (REFLEX)





Cluster correlation function + Cluster abundance

break the degeneracy between:

Ω_m **= 0.34** σ_8 **= 0.71** +/- 10%

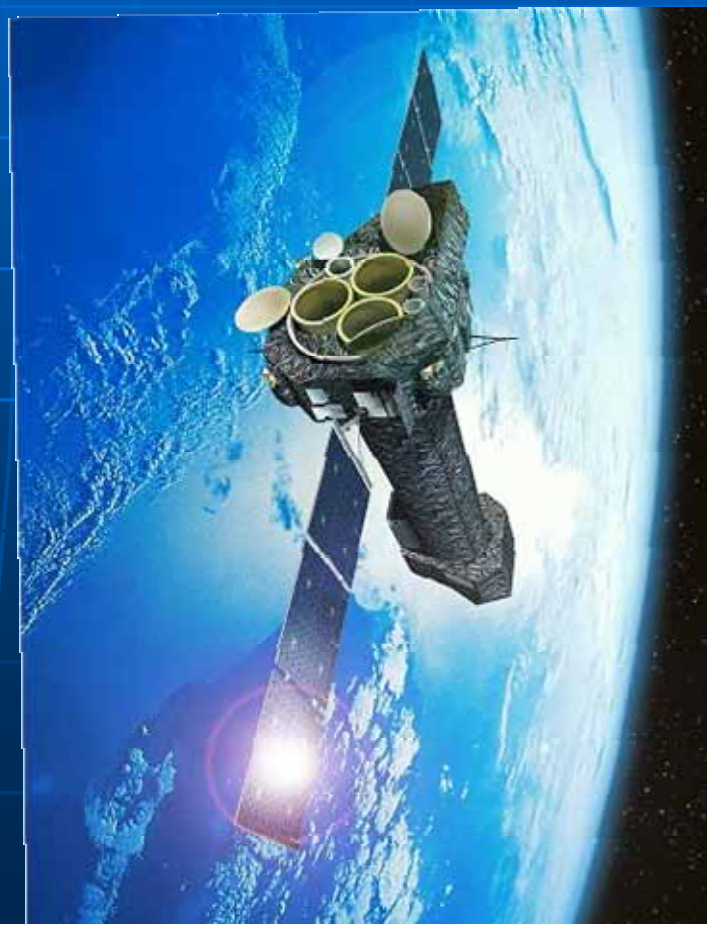
Schuecker et al 2003

XMM

Sensitivity (extended sources):

~ 6x Chandra,

~ 10x Rosat



FoV = 30 arcmin

on-axis PSF ~ 6” FWHM

➔ Clusters detected as extended sources out to z ~ 1-2

Launched: Dec 1999

Thanks to its

- unrivalled sensitivity
- large field of view
- good PSF

XMM is ideally suited for cluster LSS surveys

2. The new generation of X-ray cluster LSS surveys

- So far : the REFLEX sample from the ROSAT All Sky Survey . S = 3 10^{-12} erg/s/cm^2 *(Böhringer et al)*

  $z < 0.2$

  => the cluster correlation function with ~ 450 clusters

- Our goal : determine the cluster correlation function :

  in two redshift bins $0 < z < 0.5$ $0.5 < z < 1$

  each bin containing 450 clusters.

The XMM-LSS Survey

This has fixed the XMM-LSS survey characteristics:

a 8x8 deg2 area covered by 10 ks XMM pointings.

$\Rightarrow$ sensitivity 5 10^{-15} erg/s/cm^2 in the [0.5-2] keV band

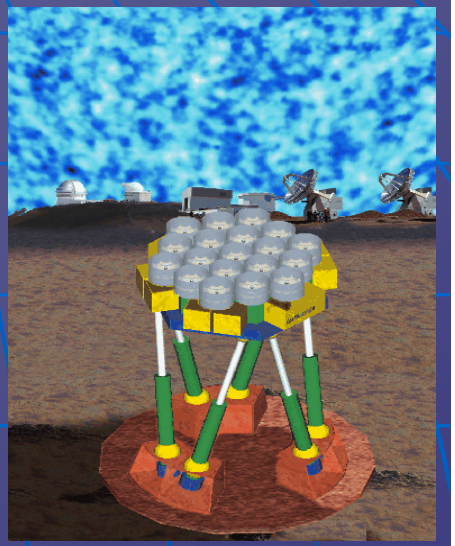
GOAL

Map the evolution of LSS of the universe out to z = 1

with the galaxy cluster and QSO populations

GALEX Galaxy Evolution Explorer

XMM-LSS field:
2^h24^m -7^d (8x8 deg)



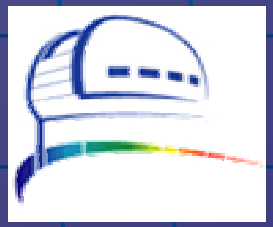
AmiBA

Multi-λ coverage, including SZ

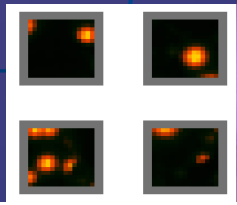
MegaPrime
CFH
MegaCam
Legacy Survey
CFHTLS

XMM

Spitzer



NOAO



UKIDSS

Expected numbers of objects

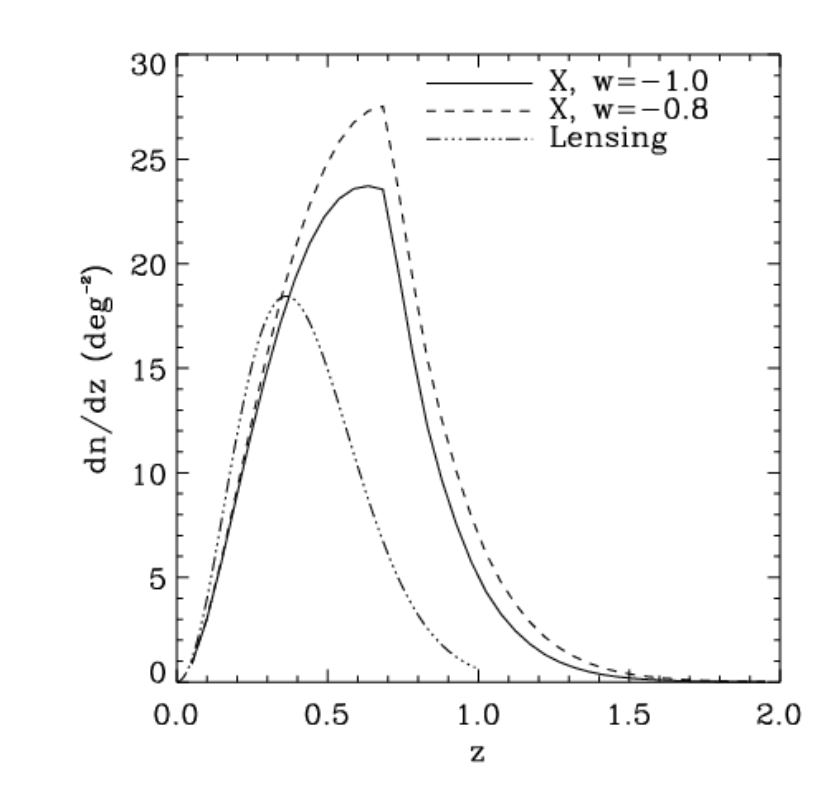
At the survey sensitivity: ~ 5E-15 erg/s/cm2 in [0.5-2] keV

~ 300 X-ray sources per square degree:

- 250 QSO/AGN (40% z < 1)
- 15 clusters z<1
- 1-5 clusters 1< z <2 ?
- Galaxies + stars

Expected number of clusters

over a 8x8 sq.deg area



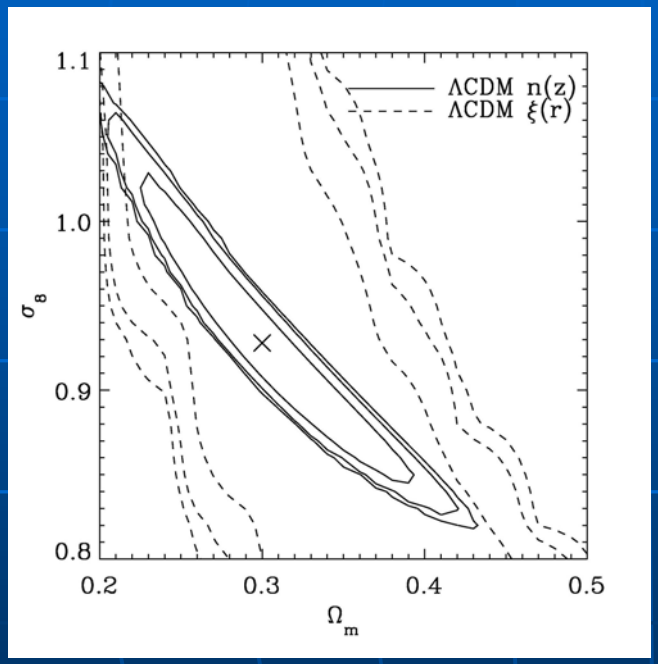
~ 900 clusters 0 < z < 1 for ΛCDM

~ 50 clusters z > 1 ?

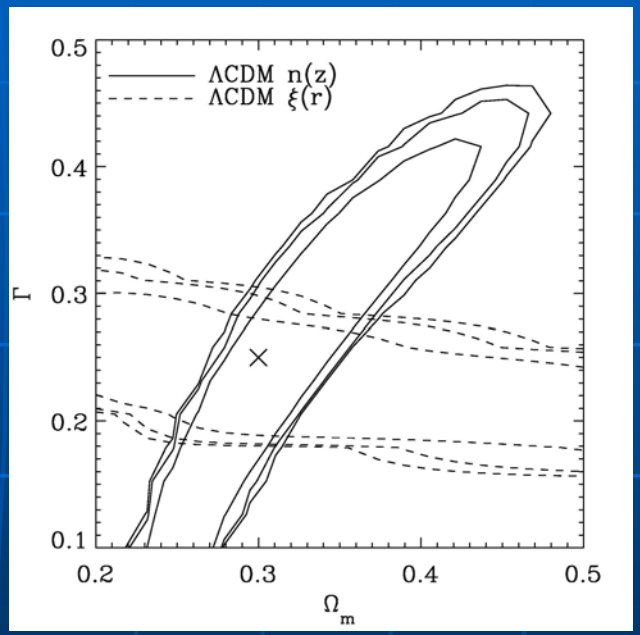
Refregier et al 2004

Cosmology with clusters 0<z<1

σ_8 / Ω_m



Γ / Ω_m



Confidence levels: 68%, 90%, 95%

___ cluster aboundance

----- cluster-cluster correlation fct.

Refregier, Valtchanov & Pierre 2001

Cosmology with clusters
1<z<2

Probability to find a Coma-type cluster in the XMM-LSS (64 sq.deg.)

within 1.5<z<2 : 6.5×10^{-7}

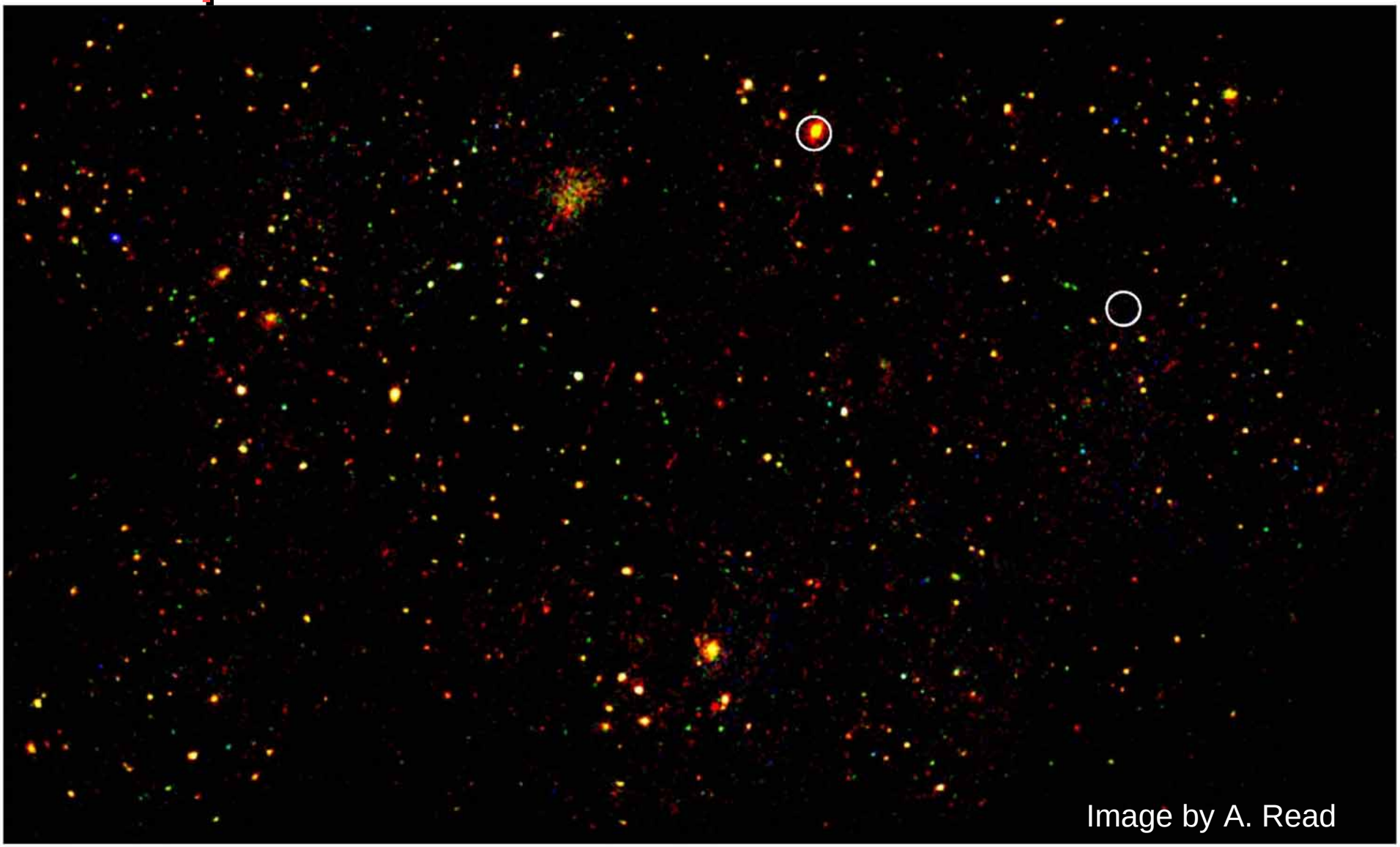
(ΛCDM universe)

“Secondary” science goals:

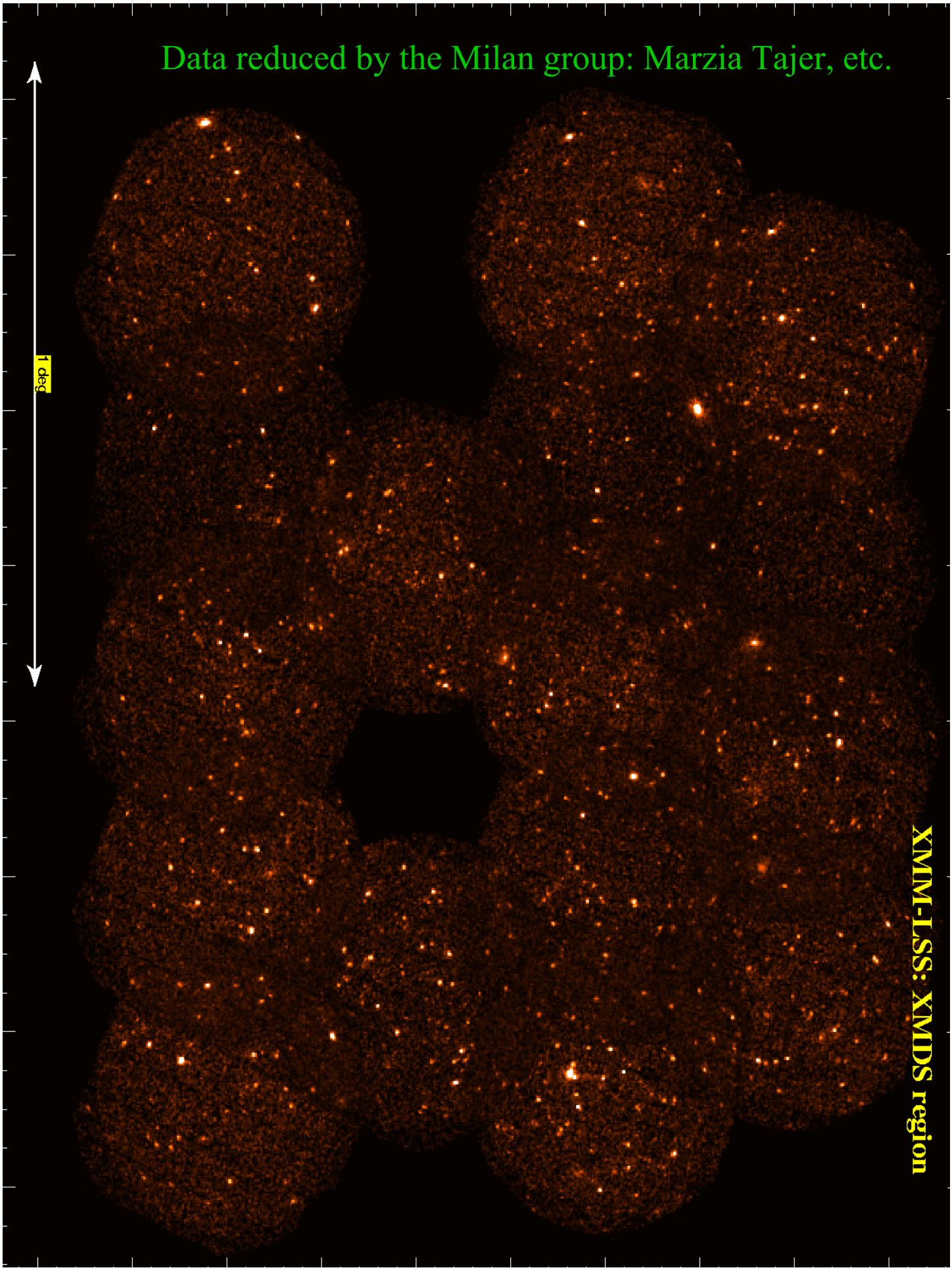
- Study the combined x-ray/optical evolution of clusters and AGNs
- Compute the AGN/QSO correlation function with a high degree of accuracy out to z ~ 4 (density = 6x 2dF)
- Measure the evolution of galaxies in clusters

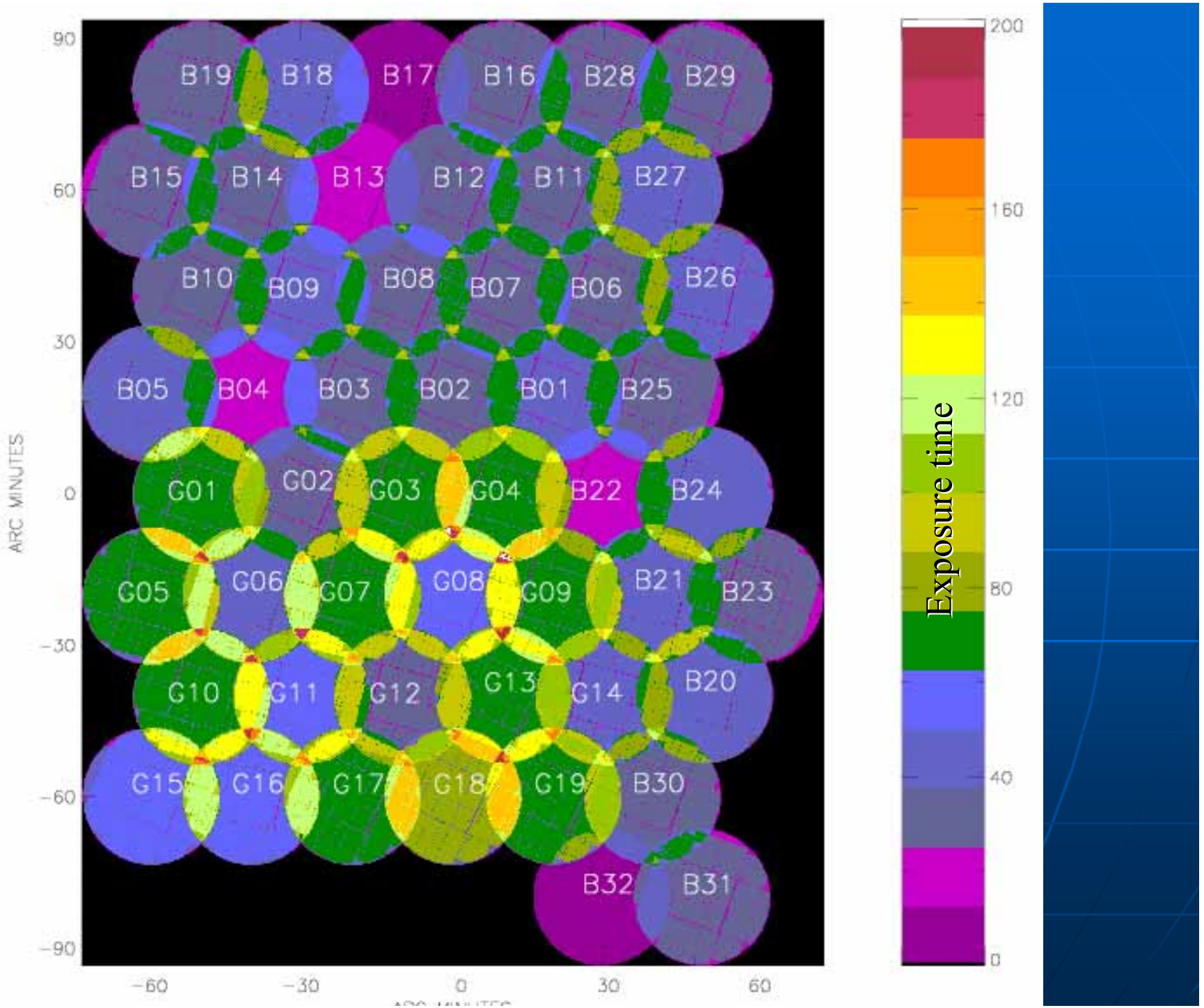
3. Results

A piece of the XMM-LSS mosaic

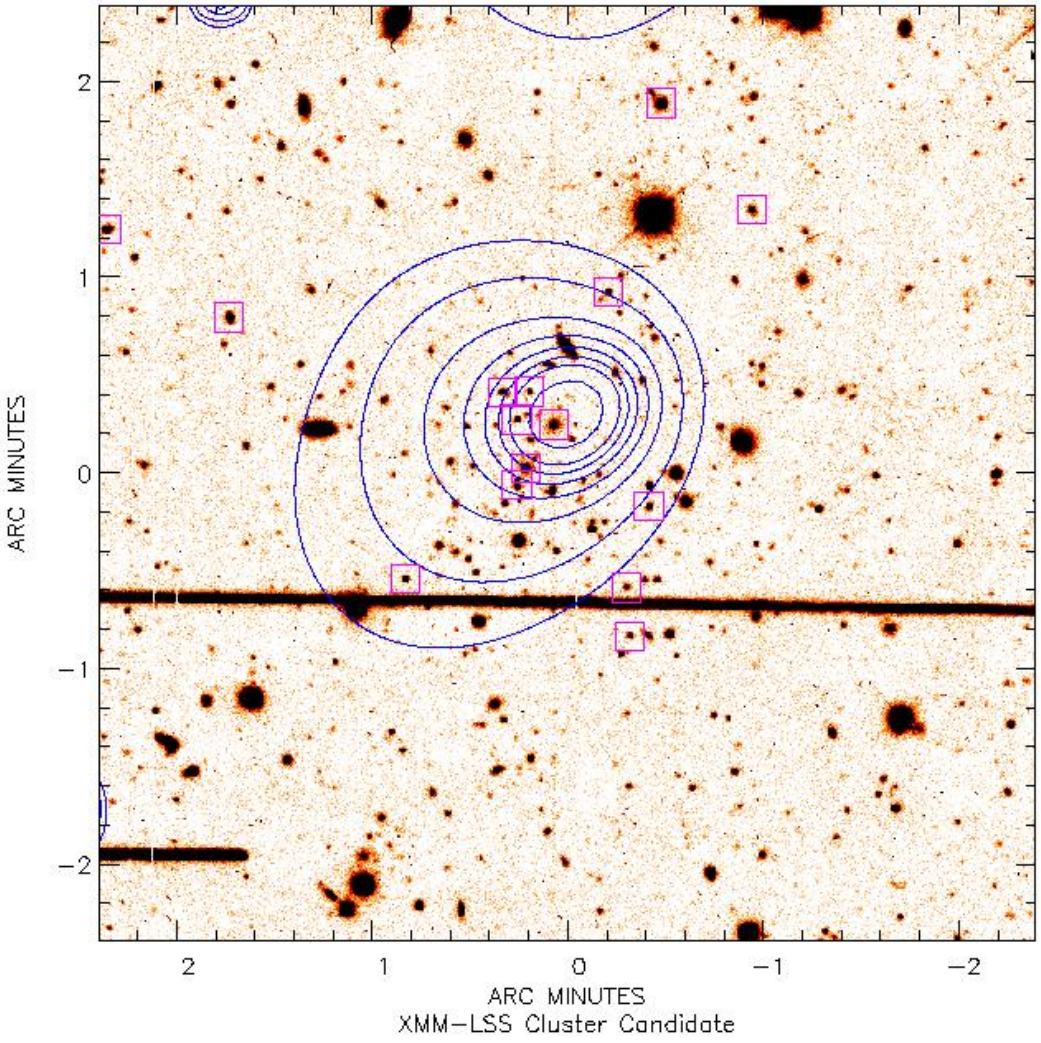


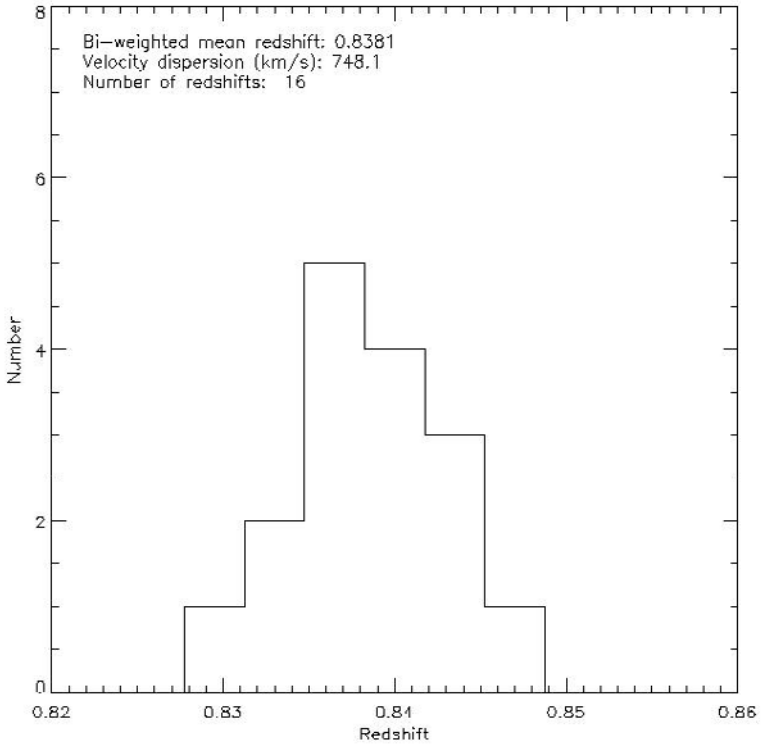
10 ks exp. red [0.3-1] keV green [1-2.5] keV blue [2.5-10]keV


Data reduced by the Milan group: Marzia Tajer, etc.
1 deg
XMM-LSS: XMDS region

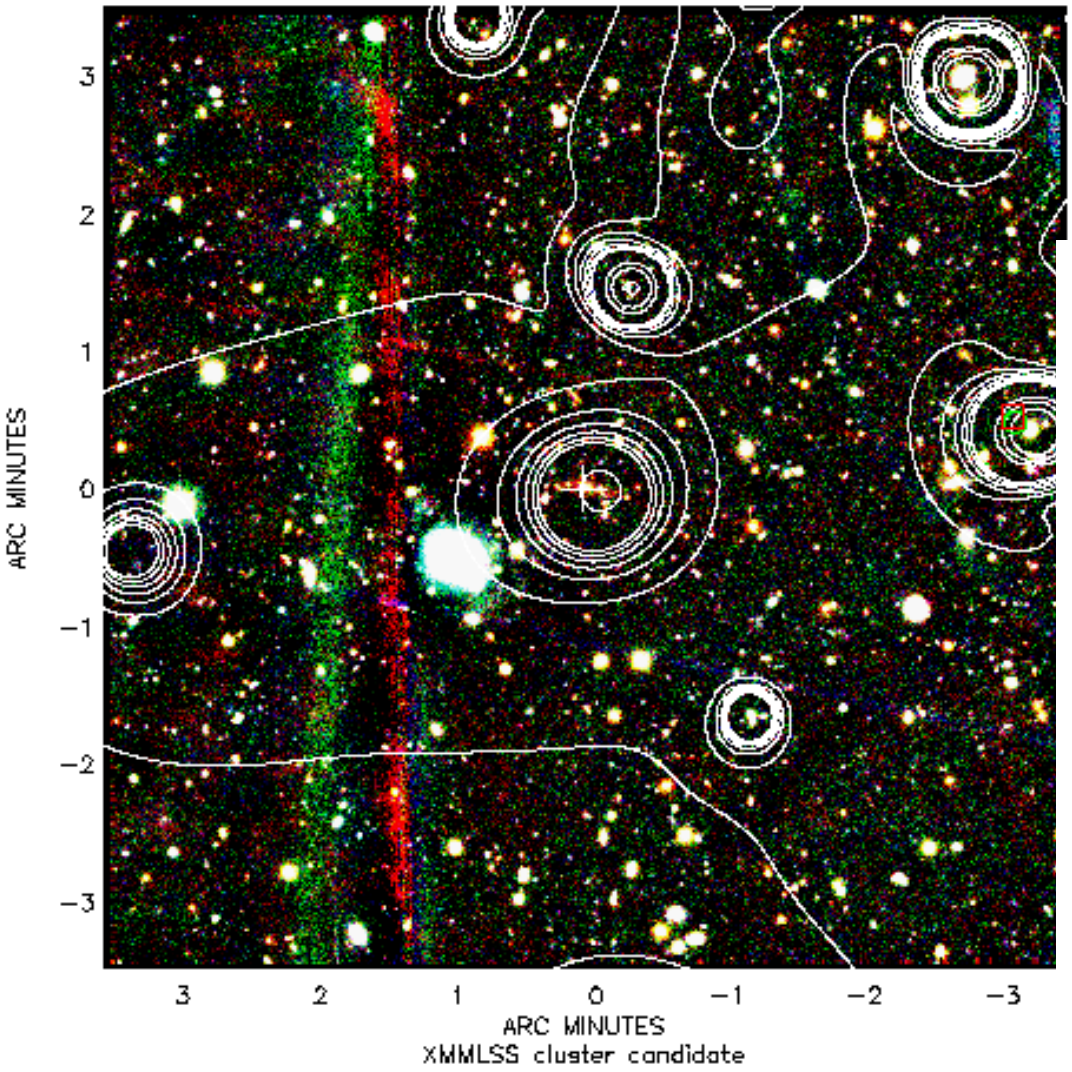

B19
B18
B17
B16
B28
B29
B15
B14
B13
B12
B11
B27
B10
B09
B08
B07
B06
B26
B05
B04
B03
B02
B01
B25
G01
G02
G03
G04
B22
B24
G05
G06
G07
G08
G09
B21
B23
G10
G11
G12
G13
G14
B20
G15
G16
G17
G18
G19
B30
B32
B31
90
60
30
0
−30
−60
−90
ARC MINUTES
−60
−30
0
30
60
200
160
120
80
40
0
Exposure time

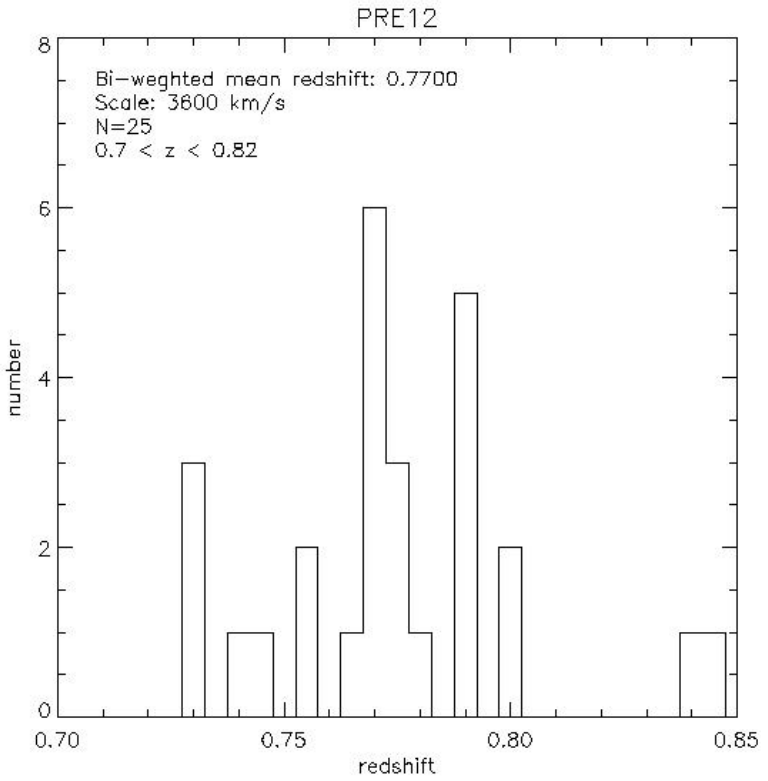
A relaxed medium cluster at z ~0.84

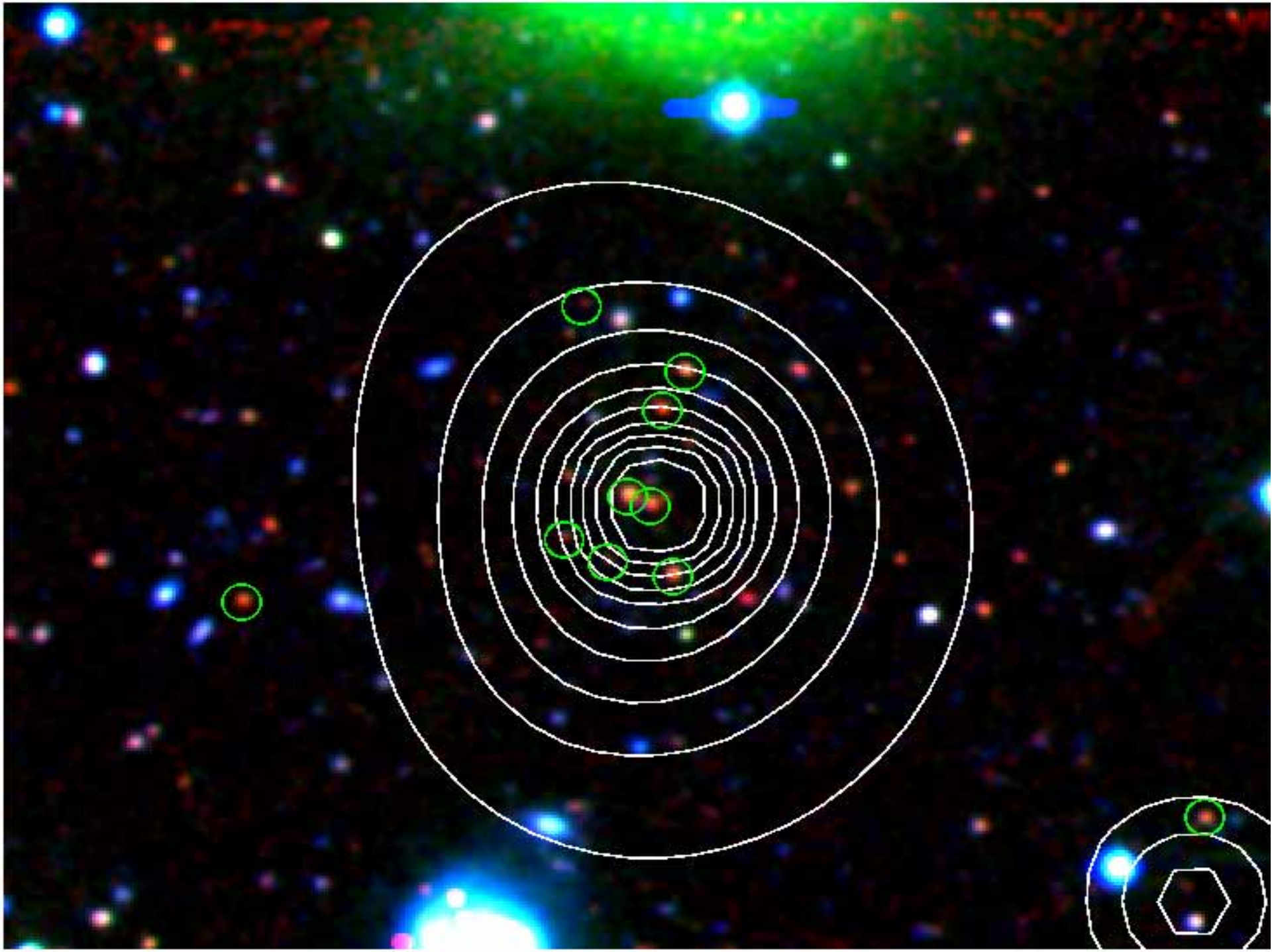


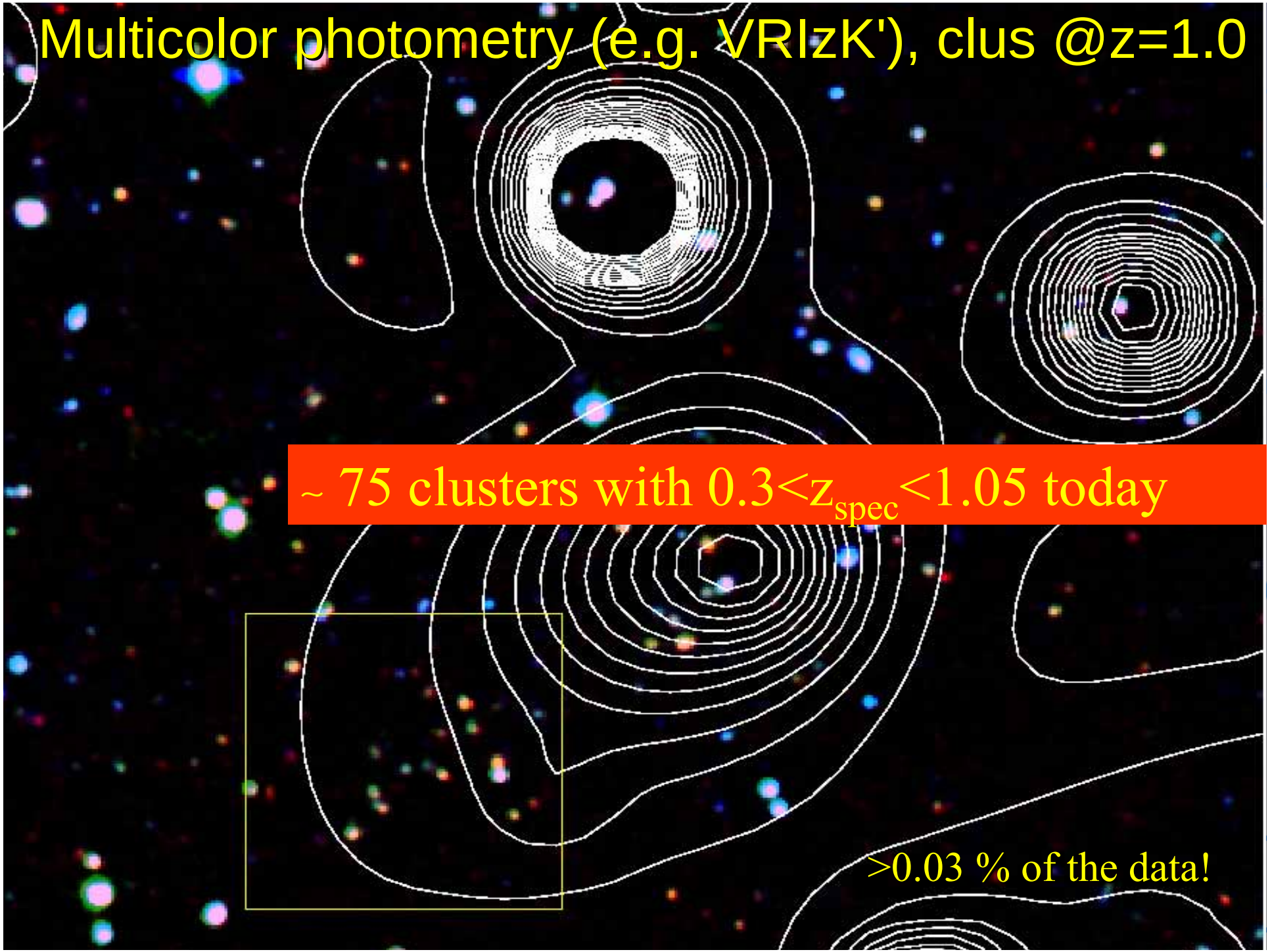


A collapsinpg cluster at z ~ 0.77



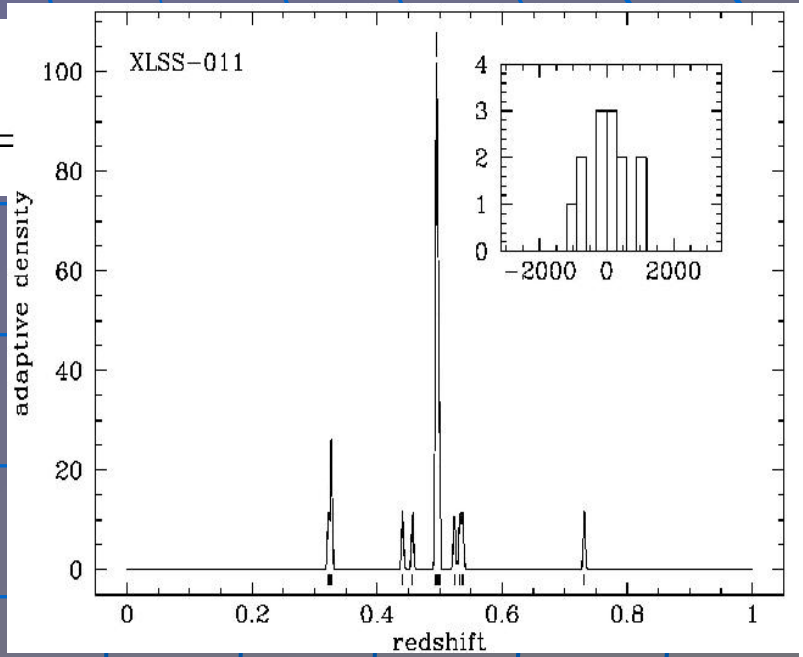


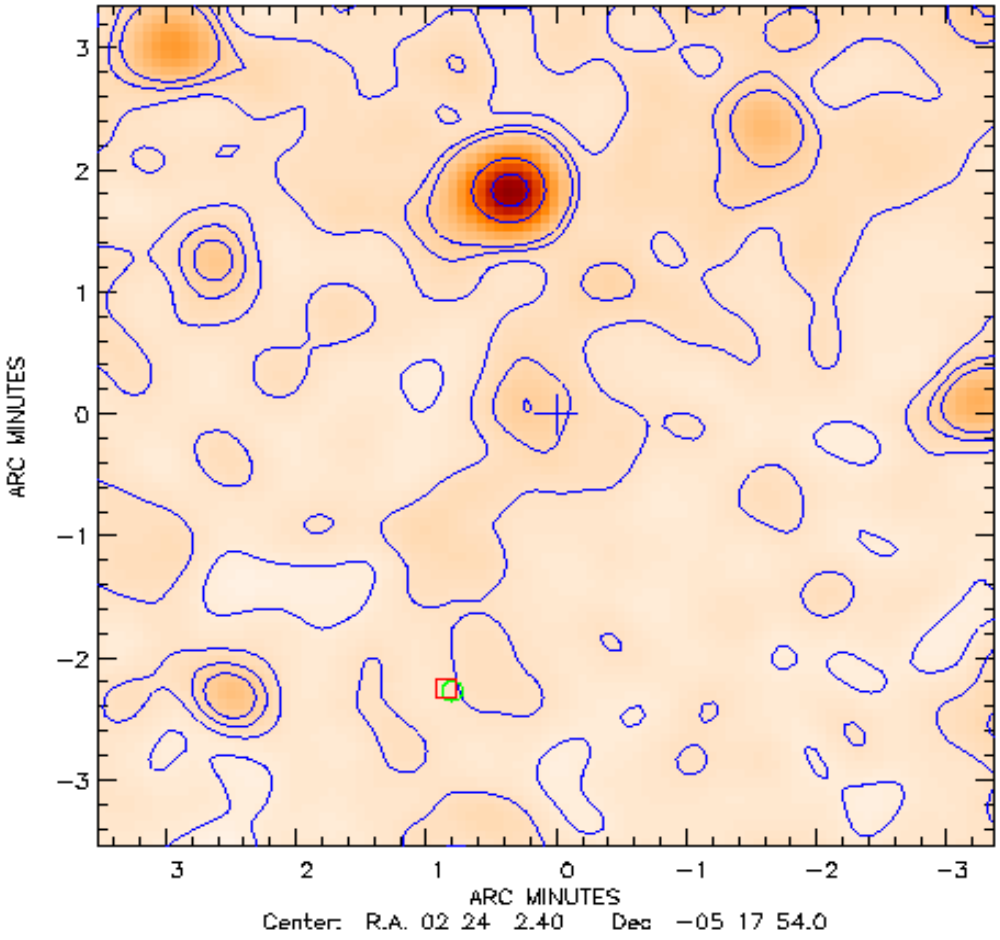



Multicolor photometry (e.g. VRIzK'), clus @z=1.0
~ 75 clusters with 0.3<z_spec<1.05 today
>0.03 % of the data!

Not only X-ray selected clusters: even X-ray dark clusters (R-z' color detected)

Cluster ID	Redshift[a]	# of members	σ_v[b] (kms^{-1})
011	0.494	13	462^{+89}_{-66}





Lx<~7 10^{42} [0.5-2] 1σ

CSLSSC 001

A few at 0.4<z<0.7

Control on the X-ray cluster selection function

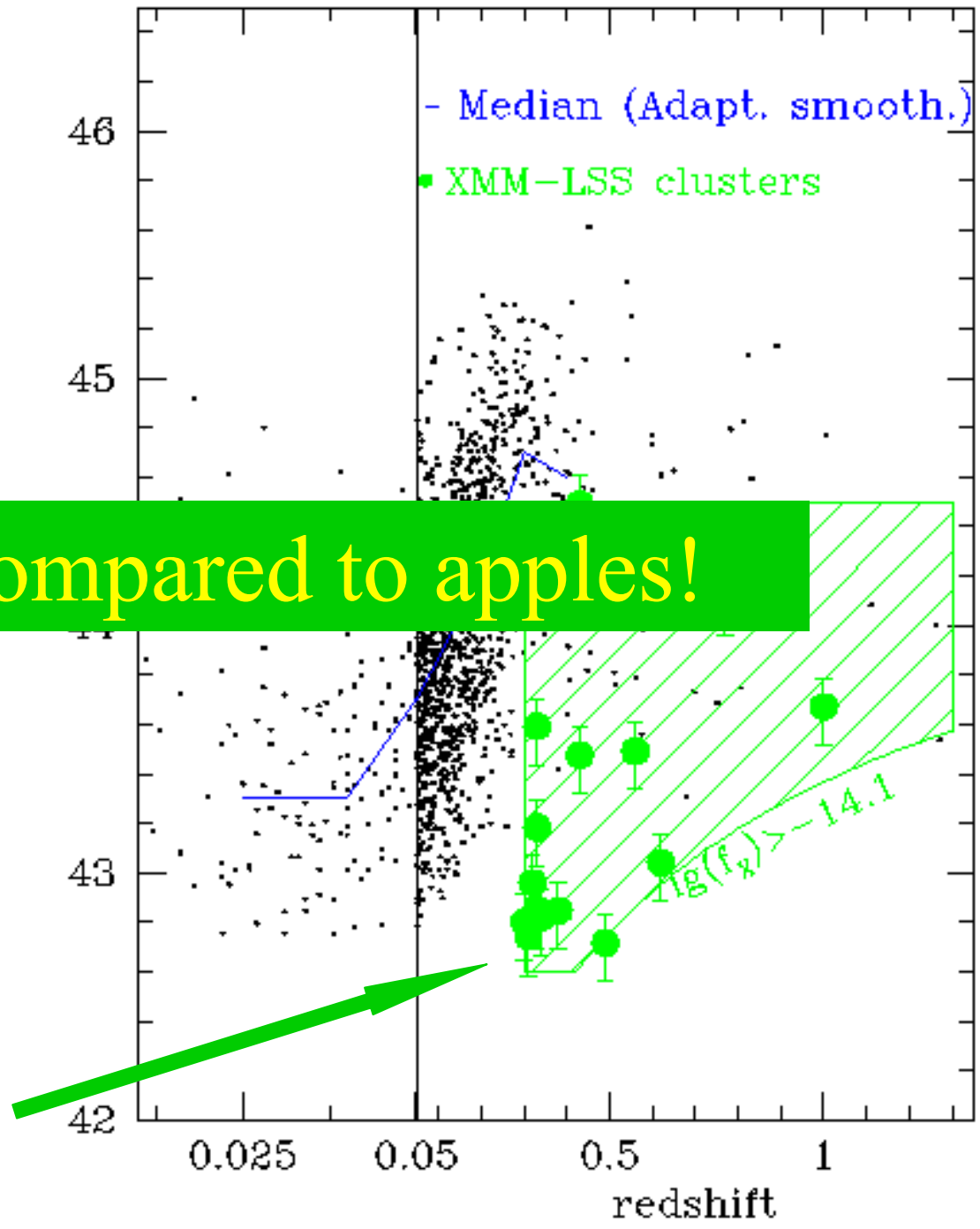
Unique sample!

Known selection criteria

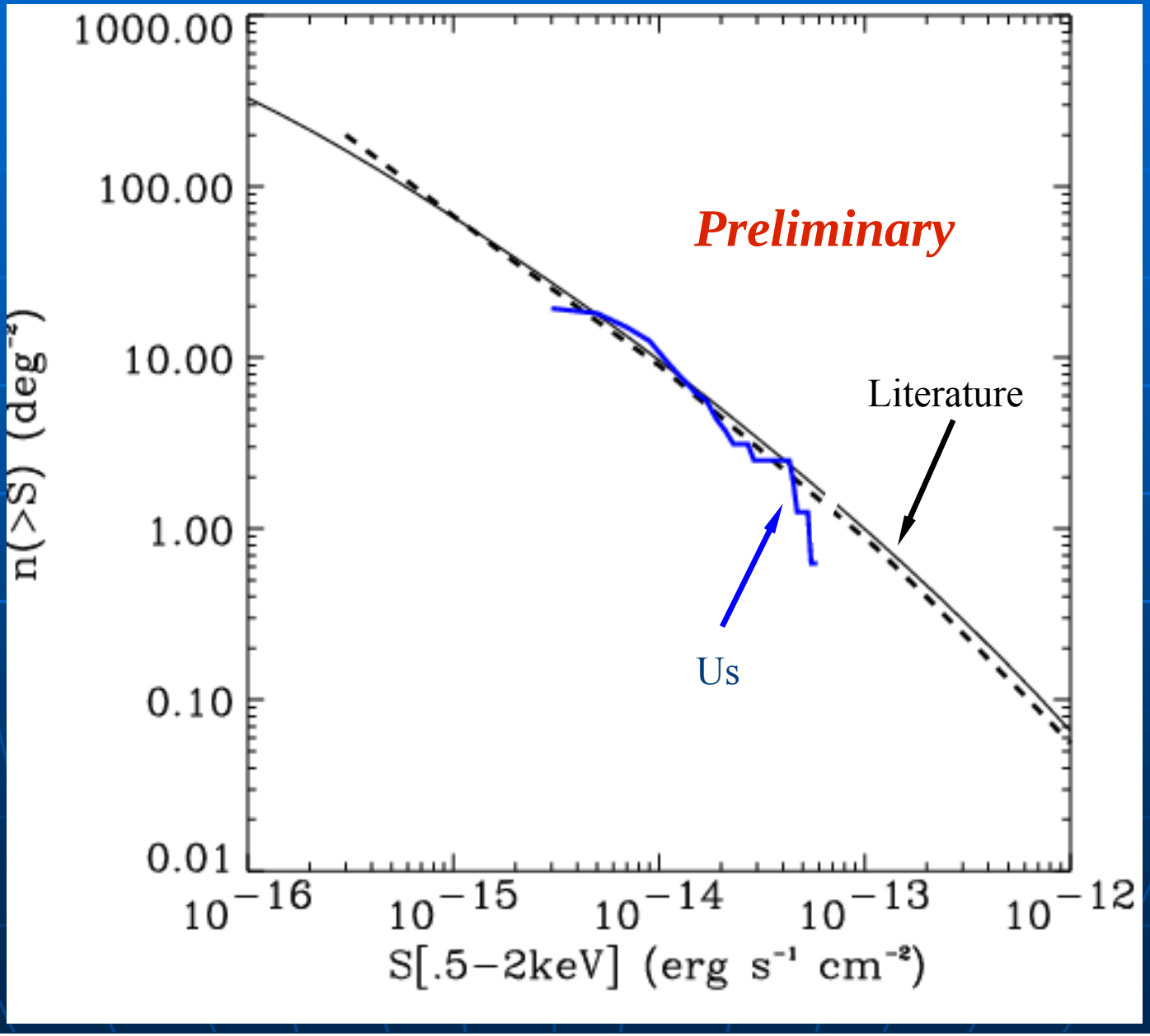
clusters of L_x similar to low redshift (studied) clusters over most of the *z* range

First 19 clusters analysed

Apples are compared to apples!



Log N-Log S

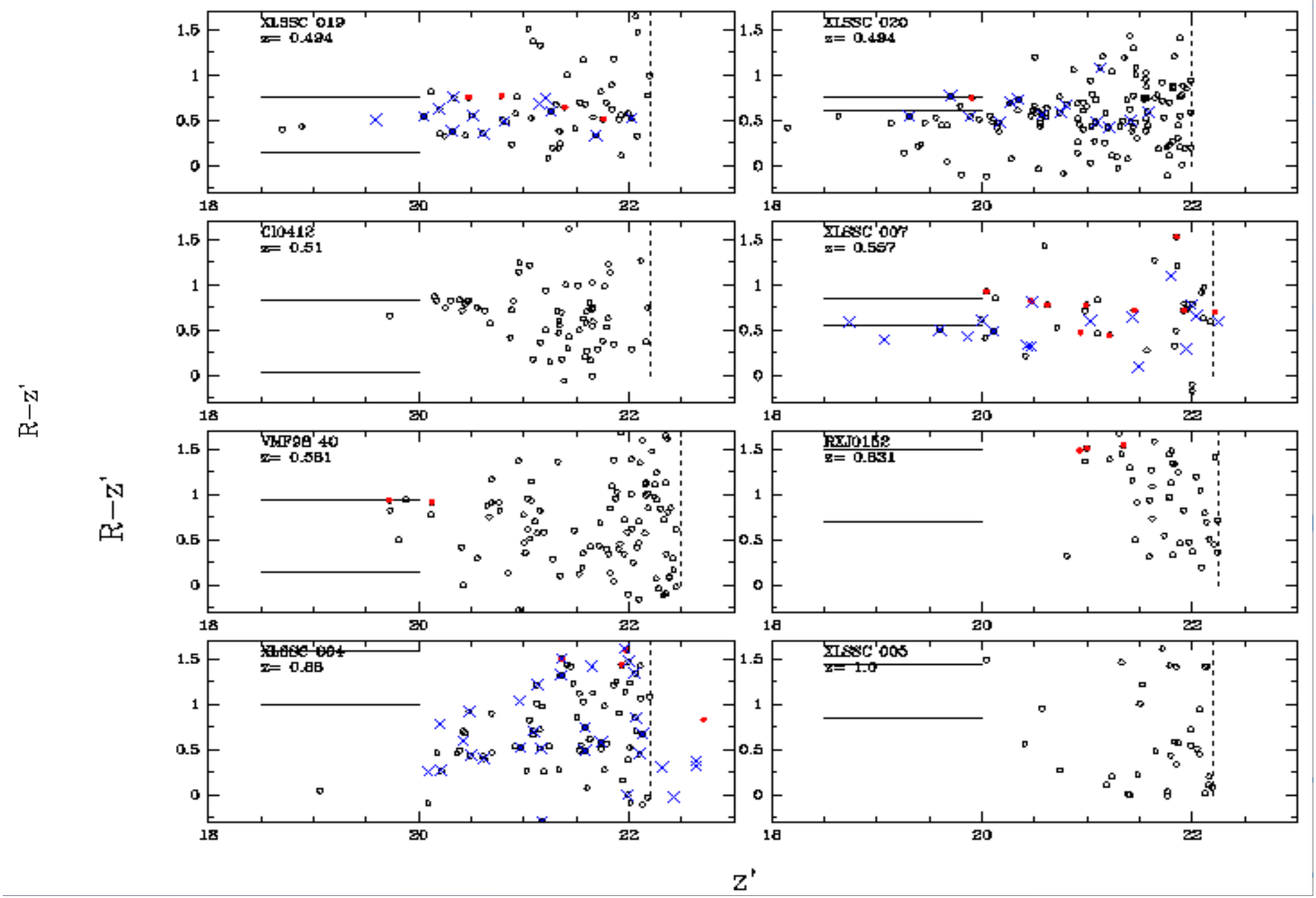

1000.00
100.00
10.00
1.00
0.10
0.01
n(>S) (deg⁻²)
10⁻¹⁶
10⁻¹⁵
10⁻¹⁴
10⁻¹³
10⁻¹²
S[.5−2keV] (erg s⁻¹ cm⁻²)
Preliminary
Literature
Us

Extended sources

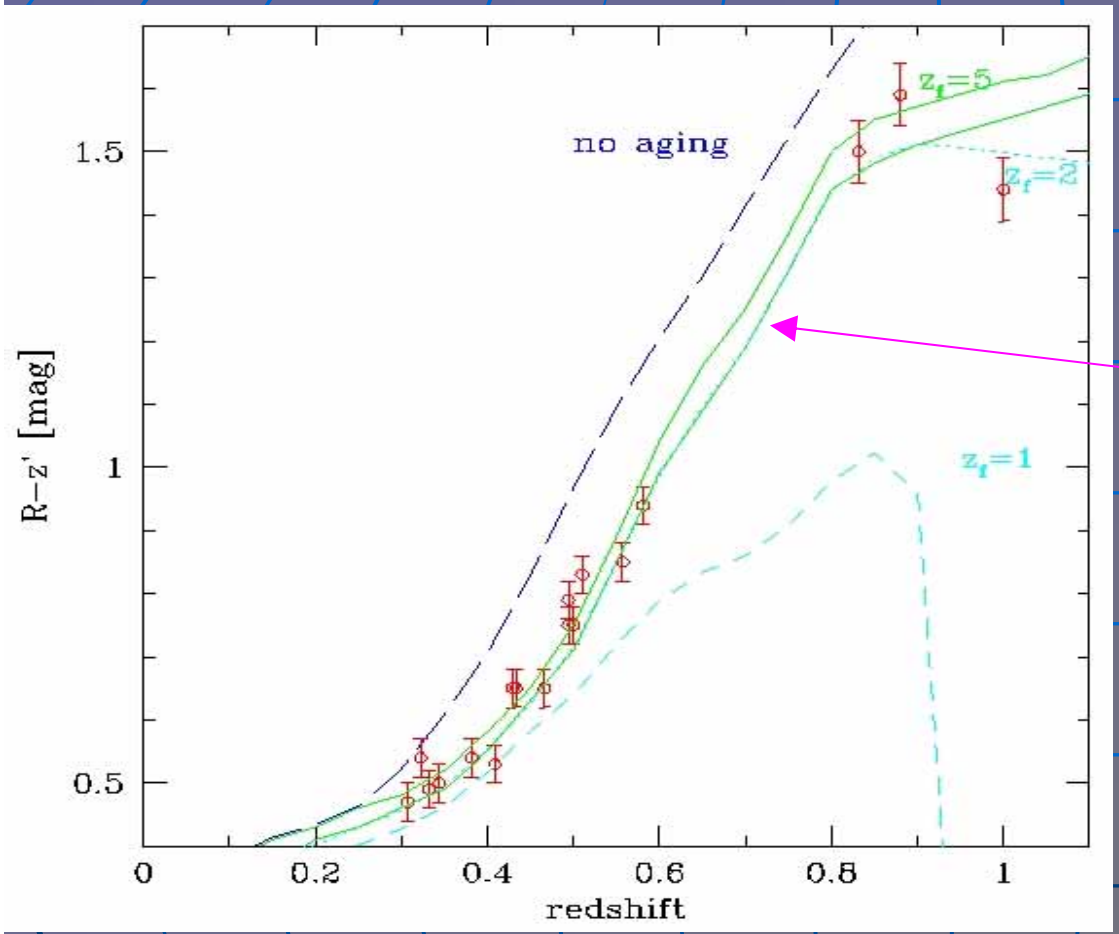
- We find a preliminary cluster density of ~ 15-20 per sq.deg. (z<1)

Galaxy evolution, first results

C-M diagrams for the first 18 clusters ... (fall 2002)



The red population



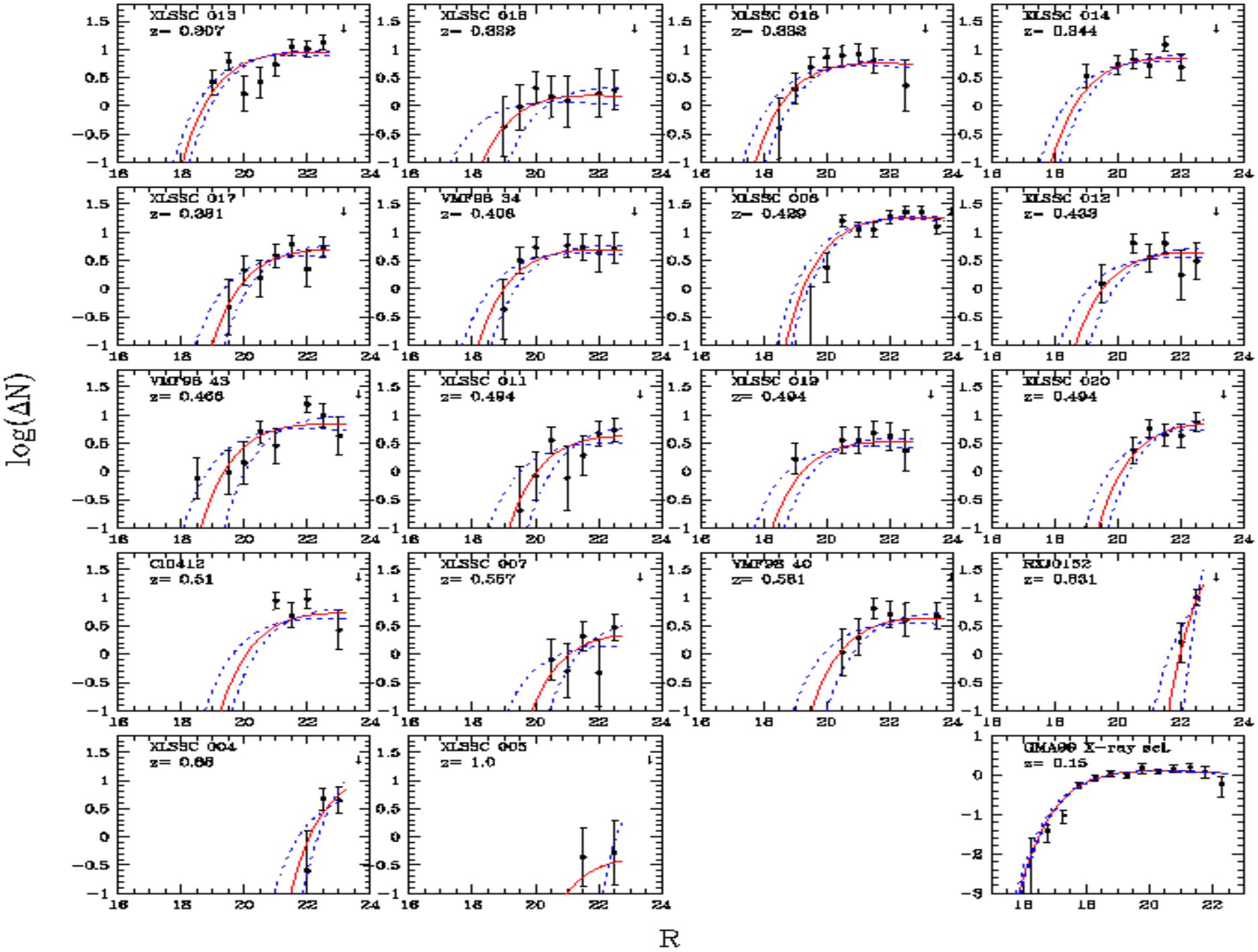
The red population: passive evolving ($z_{formation}$~2-5)

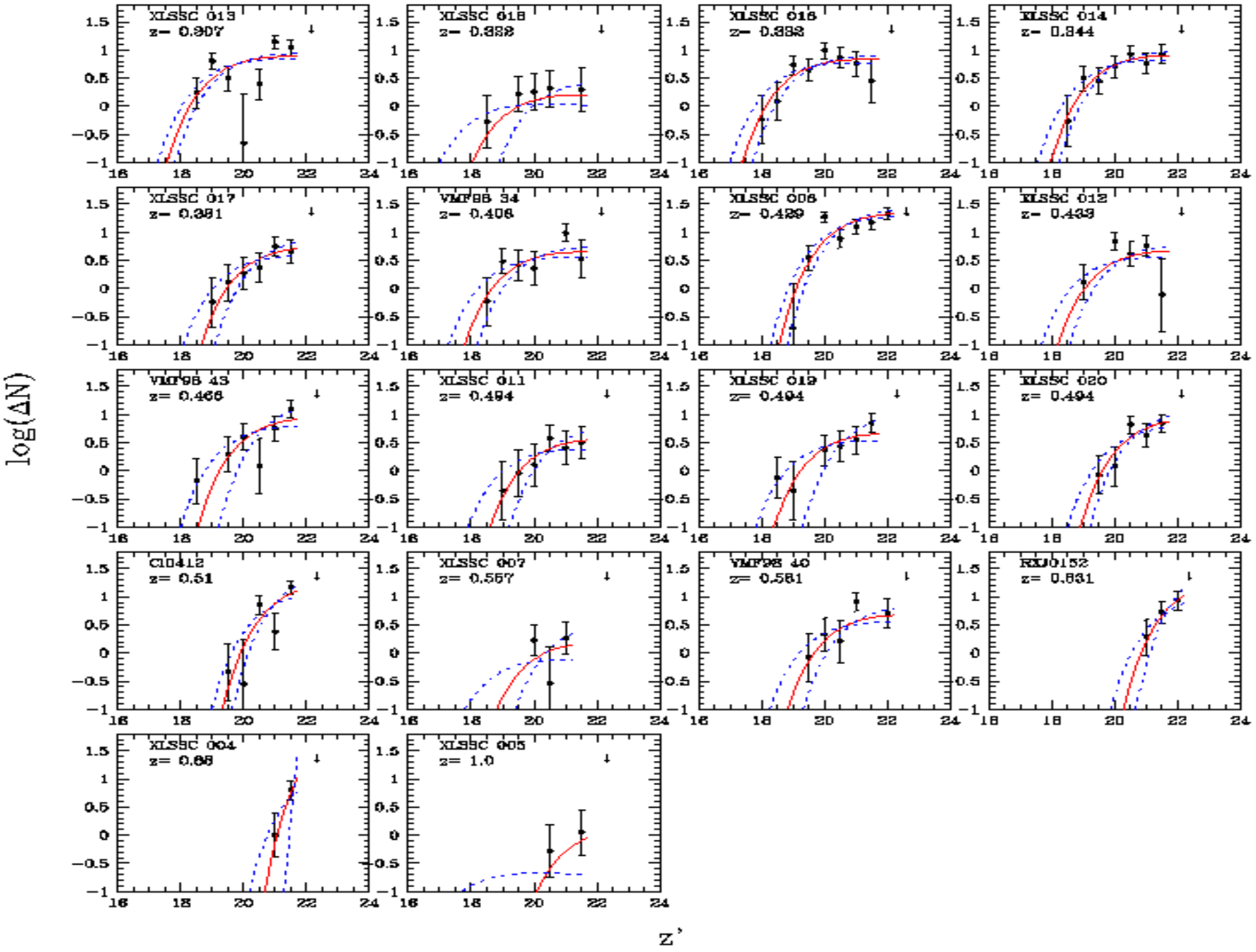
Passive evolution

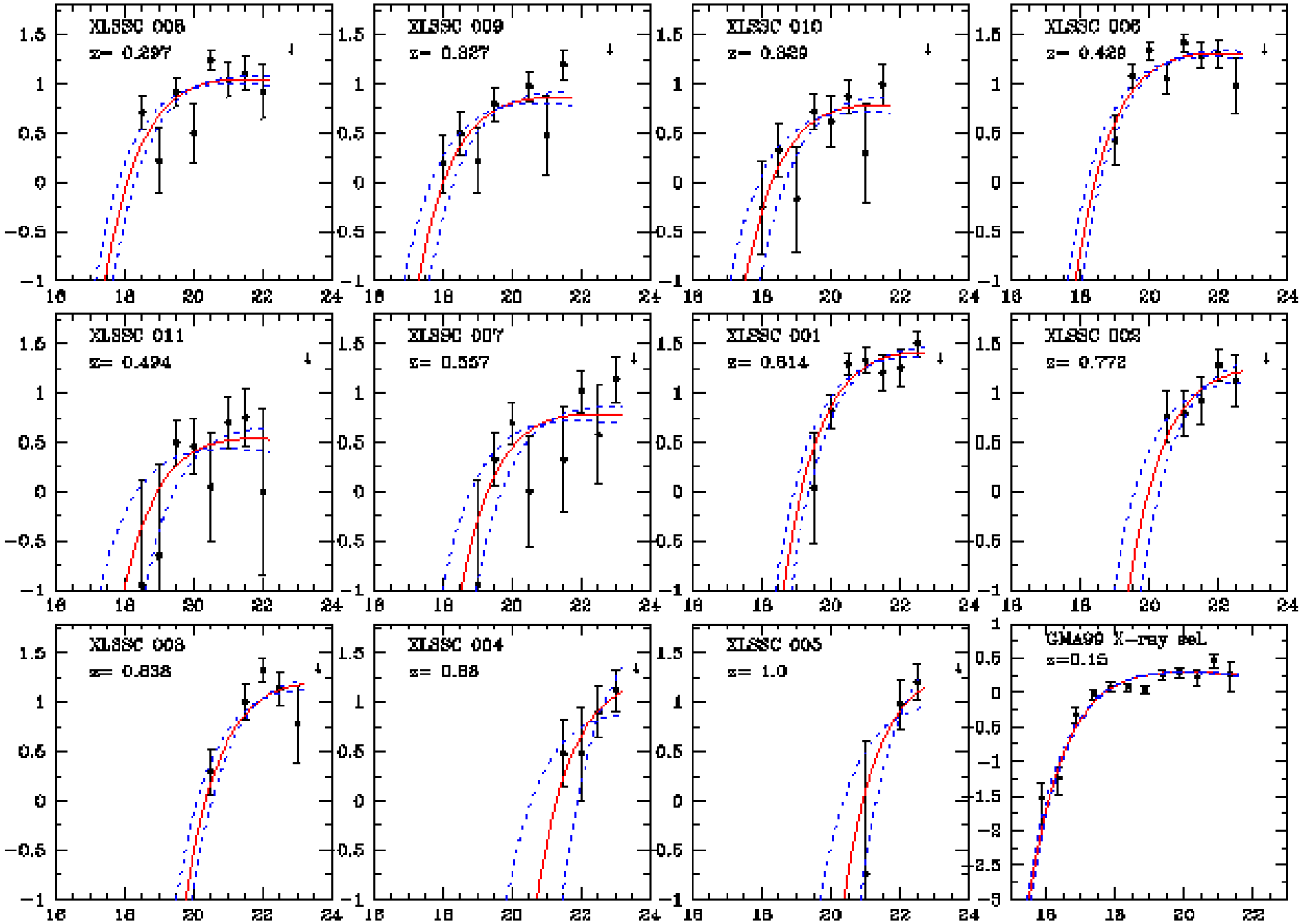
used Kodama spectral evolutionary model

larger $z_{formation}$ (~11) if SSP, or BC96, or Ω_Λ=0

Groups/intermediate mass clusters, where hierarchical and monolithic scenario of early-type galaxy formation differ.


XLSSC 019
z= 0.907
XLSSC 018
z= 0.888
XLSSC 016
z= 0.883
XLSSC 014
z= 0.844
XLSSC 017
z= 0.581
VMF98 34
z= 0.406
XLSSC 006
z= 0.429
XLSSC 012
z= 0.439
VMF98 43
z= 0.466
XLSSC 011
z= 0.494
XLSSC 019
z= 0.494
XLSSC 020
z= 0.494
C10412
z= 0.51
XLSSC 007
z= 0.567
VMF98 40
z= 0.581
RXJ0152
z= 0.831
XLSSC 004
z= 0.88
XLSSC 005
z= 1.0
GMA90 X-ray sel.
z= 0.15
log(ΔN)
R


XLSSC 013
z= 0.907
XLSSC 018
z= 0.888
XLSSC 016
z= 0.883
XLSSC 014
z= 0.844
XLSSC 017
z= 0.881
VMF98 34
z= 0.406
XLSSC 006
z= 0.429
XLSSC 012
z= 0.439
VMF98 43
z= 0.466
XLSSC 011
z= 0.494
XLSSC 019
z= 0.494
XLSSC 020
z= 0.494
C10412
z= 0.51
XLSSC 007
z= 0.567
VMF98 40
z= 0.581
RXJ0152
z= 0.831
XLSSC 004
z= 0.88
XLSSC 005
z= 1.0
log(ΔN)
z'


XLSSC 006
z= 0.297
XLSSC 009
z= 0.827
XLSSC 010
z= 0.829
XLSSC 006
z= 0.428
XLSSC 011
z= 0.494
XLSSC 007
z= 0.557
XLSSC 001
z= 0.814
XLSSC 002
z= 0.772
XLSSC 008
z= 0.838
XLSSC 004
z= 0.88
XLSSC 005
z= 1.0
GMA99 X-ray sel.
z=0.15

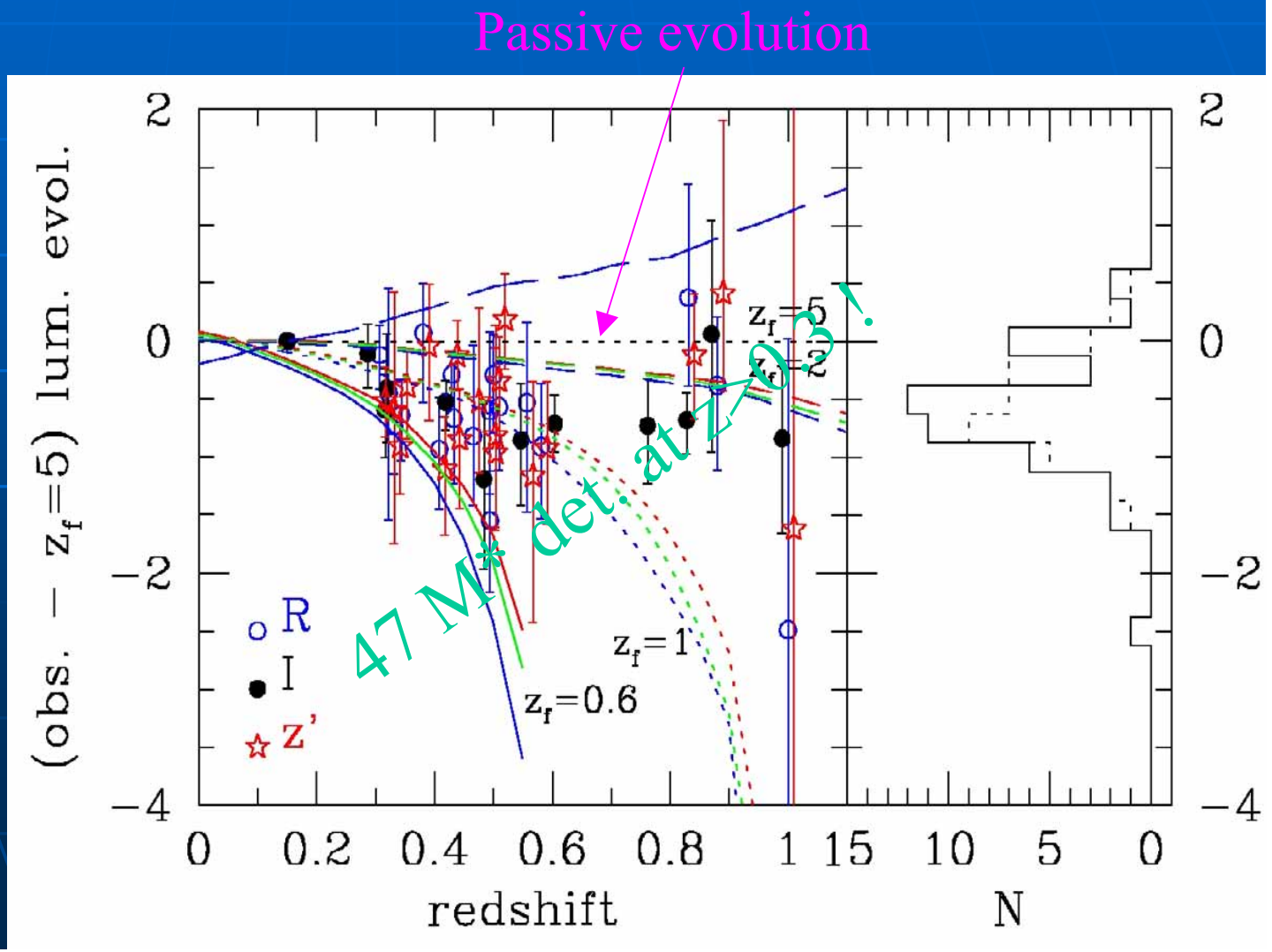
I

Whole galaxy population: Active!

No track well describes the data.

→ no simple description

characterization of the infall pattern with larger sample soon available



Conclusions on galaxy evolutions

(based on XMM-LSS data)

Two populations:

1. one passive evolving ($z_f > 2$-5), even in low mass clusters
2. one active. Related to environment?

The END, question time