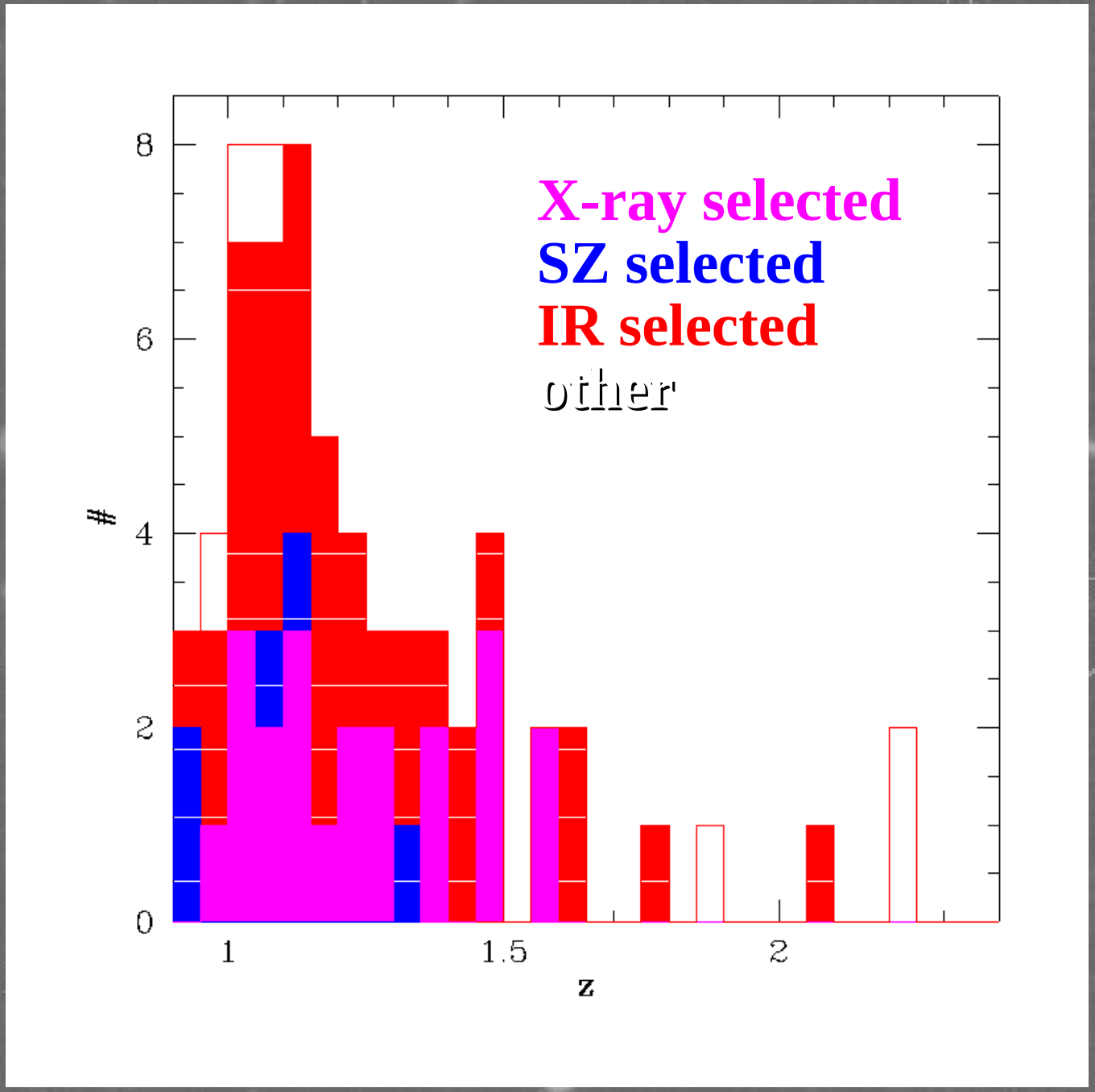
Paolo Tozzi – INAF OATs

A scientific case for future X-ray Astronomy: galaxy clusters at high redshifts

X-ray Astronomy: towards the next 50 years! Milano, October 1st – 5th , 2012

Clusters of galaxies @ z>1



X-ray cluster surveys in the Chandra/XMM-Newton era

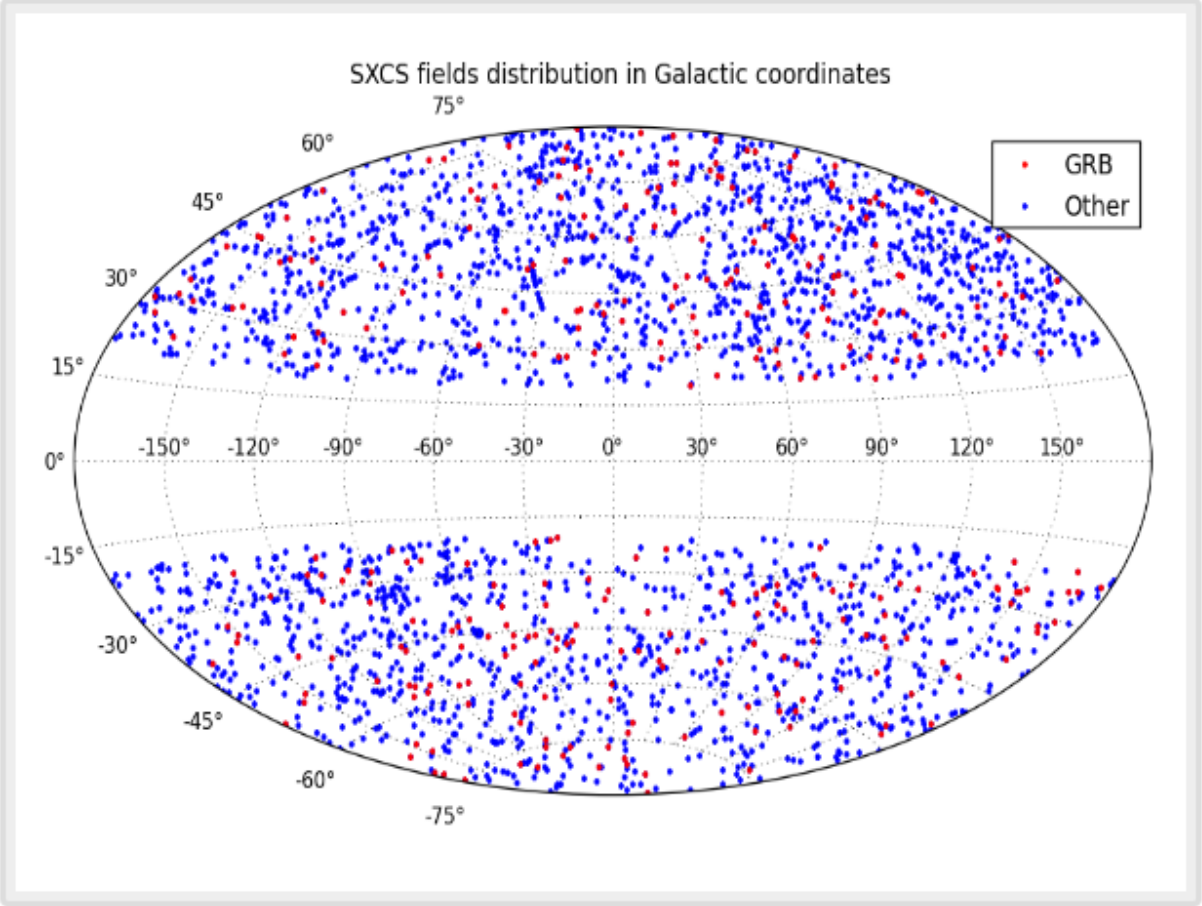
Name	Flux limit cgs (0.5–2 keV)	Solid angle deg^2	Number of sources	Reference
SEXCLAS	0.6×10^{-14} (min)	2.1	19	Kolokotronis et al. (2006)
DCS	0.6×10^{-14} (min)	5.55	36	Boschin (2002)
ChaMP	1.0×10^{-14} (min)	13.0	49	Barkhause et al. (2006)
SXCS	1.0×10^{-14} (**min**)	**40.0**	**72**	**This work**
XDCP	1.0×10^{-14} (average)	76.0	22 ($z > 0.9$)	Fassbender et al. (2011)
XCLASS	2×10^{-14} (min)	90.0	347	Clerc et al. (2012)
Peterson09	$\sim 0.3 \times 10^{-14}$ (min)	163.4	462	Peterson et al. (2009)
XCS	>300 net cts	410.0	993	Lloyd-Davies et al. (2011)
SXDF	0.2×10^{-14} (min)	1.3	57	Finoguenov et al. (2010)
COSMOS	0.2×10^{-14} (min)	2.1	72	Finoguenov et al. (2007)
XMM-BCS	0.6×10^{-14} (min)	6.0	46	Suhada et al. (2012)
XMM-LSS	$\sim 10^{-14}$ (min)	11.0	66	Adami et al. (2011)

Tundo et al. 2012

http://adlibitum.oats.inaf.it/sxcs/

SXCS

Swift X-ray Cluster Survey



The Swift X-ray Cluster Survey (SXCS) is an ongoing project aimed at finding serendipitously galaxy clusters in the Swift X-ray Telescope (XRT) archive.

The Swift mission, launched in 2004, is dedicated to the study of Gamma-ray bursts (GRBs), which are detected and localized by the Burst Alert Telescope (BAT) and then followed-up by the

News and Updates

Aug-01-2012: Catalog I released

X-ray Cluster Surveys

ROSAT 400d

ROSAT MACS

ROSAT WARPS

ROSAT REFLEX

Chandra ChaMP

XMM XCS

XMM LSS

XMM XDCP

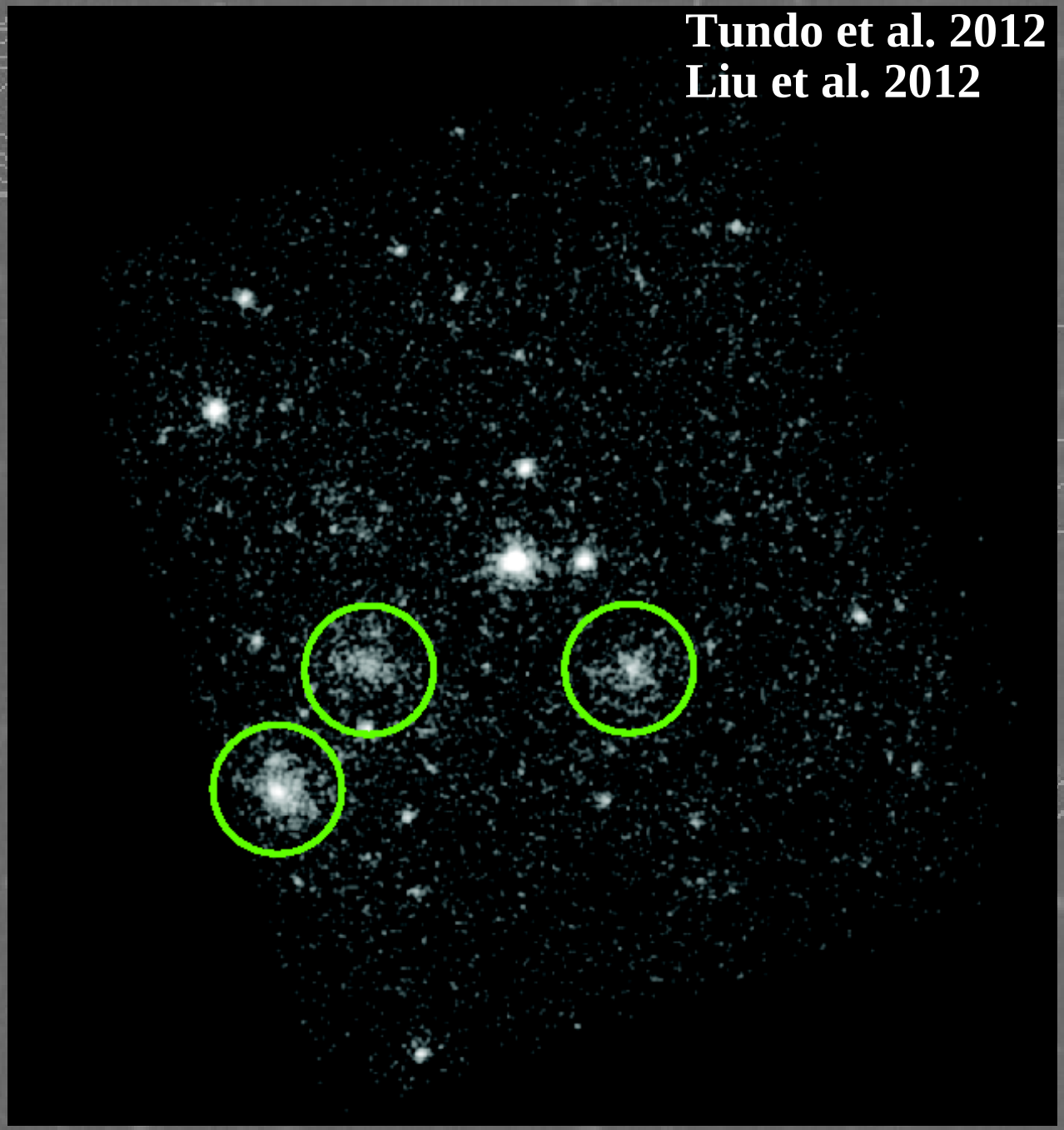
XMM X-CLASS

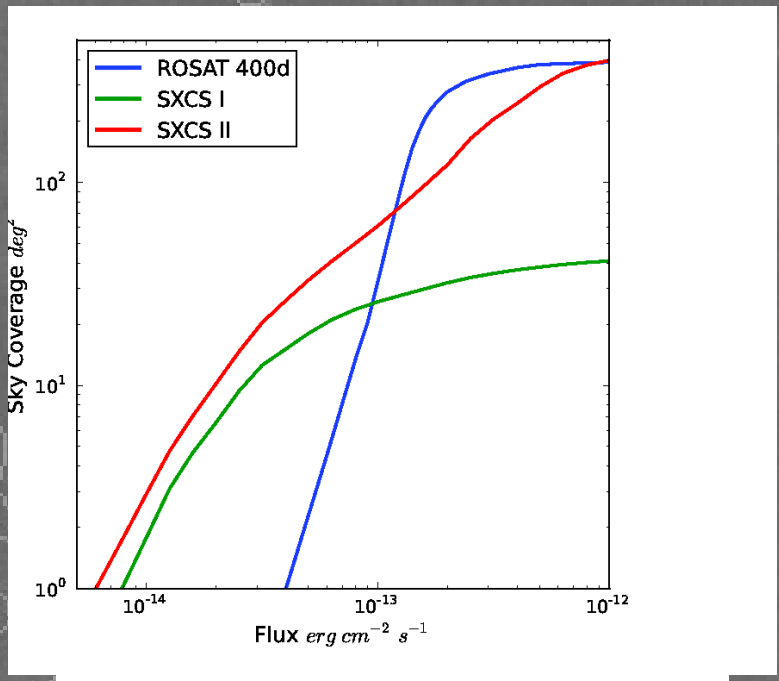
Useful Links

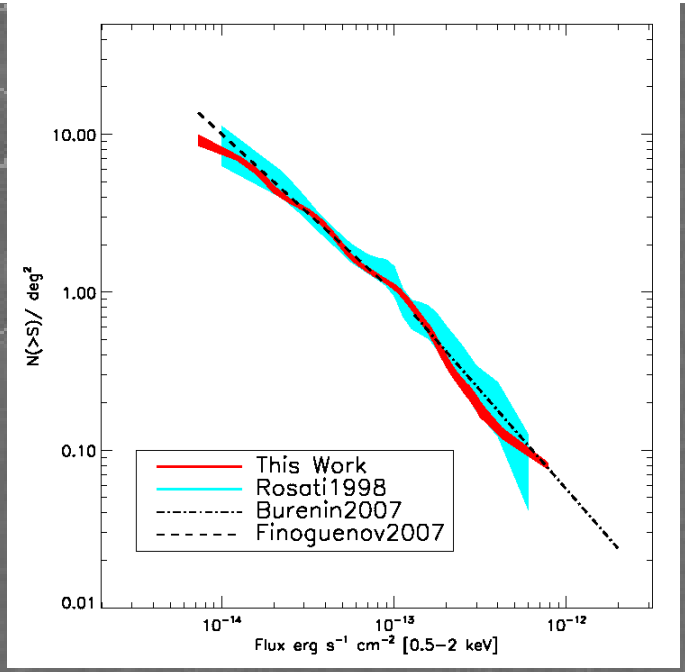
SWIFT-XRT

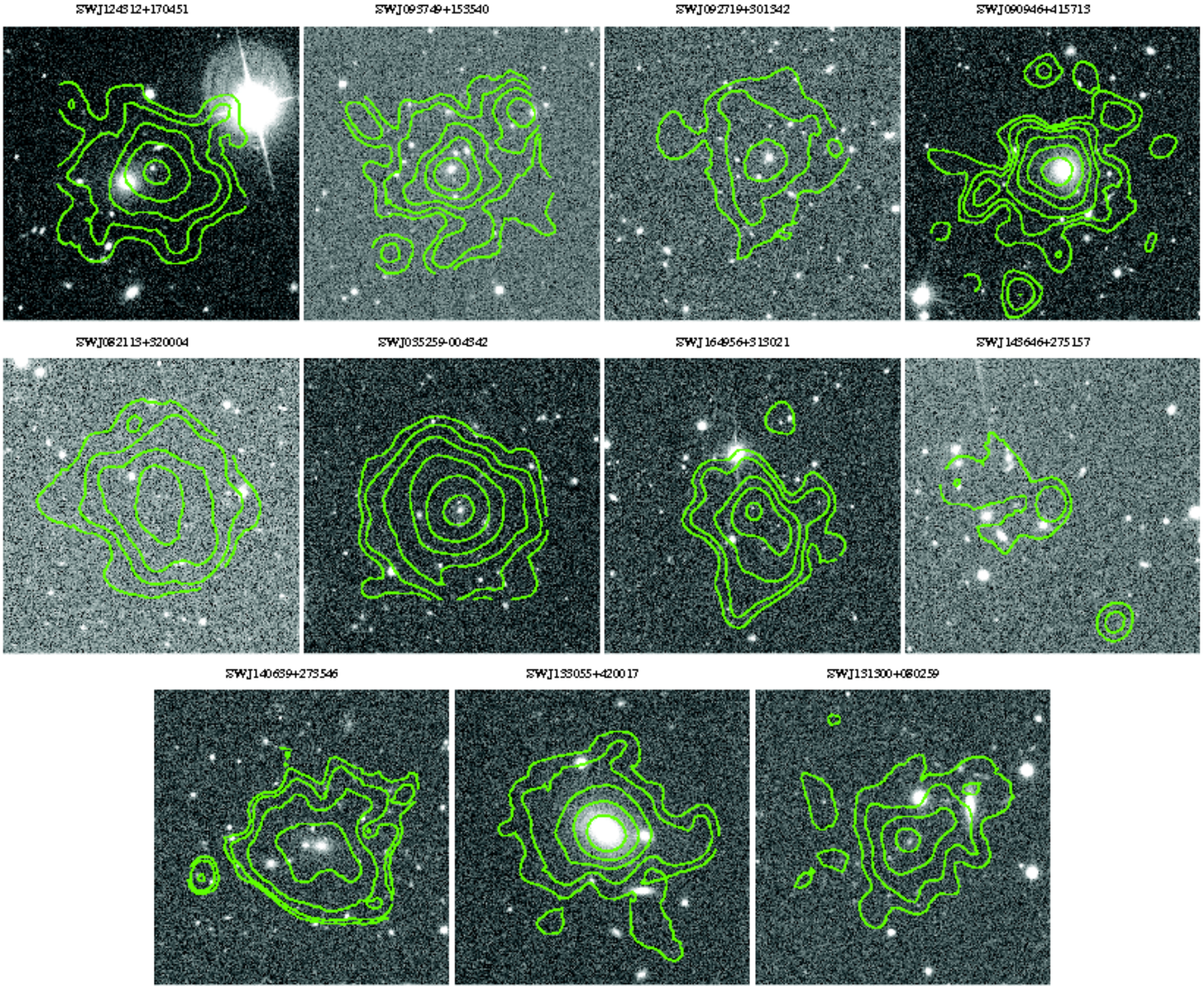
WFXT

Swift X-ray Cluster Survey








SWJ124812+170451
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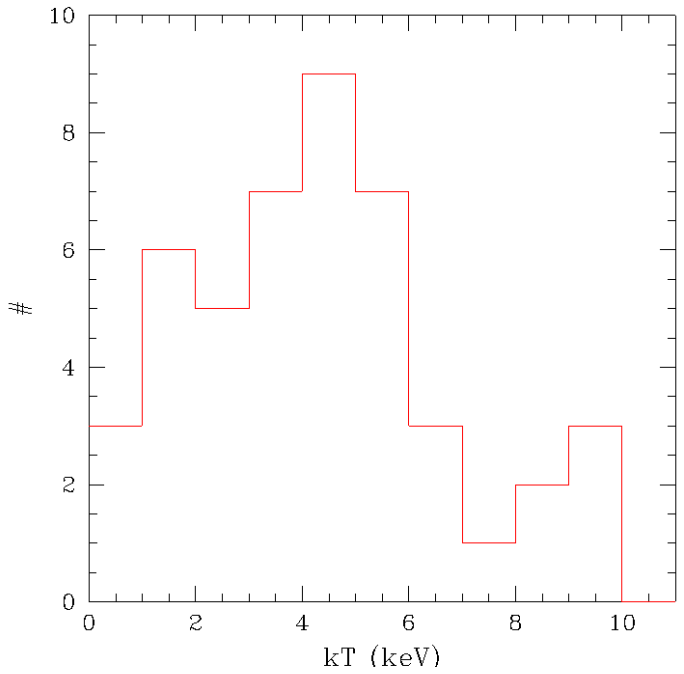
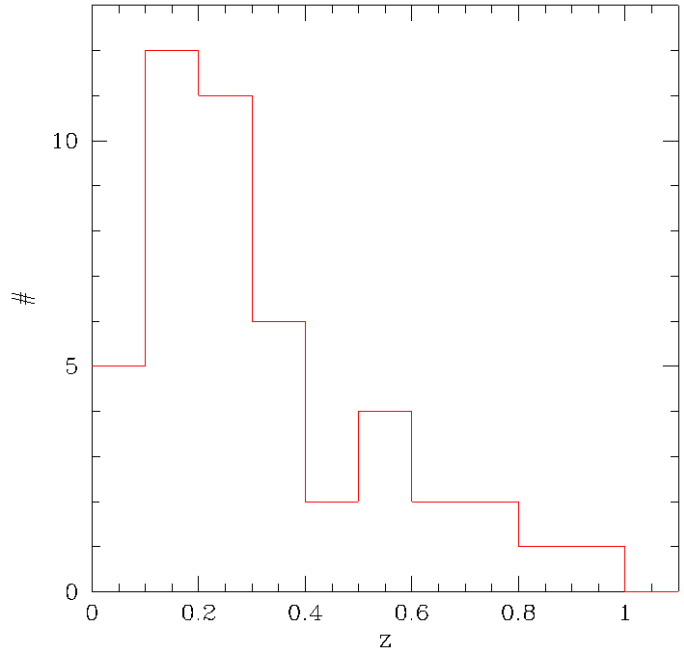
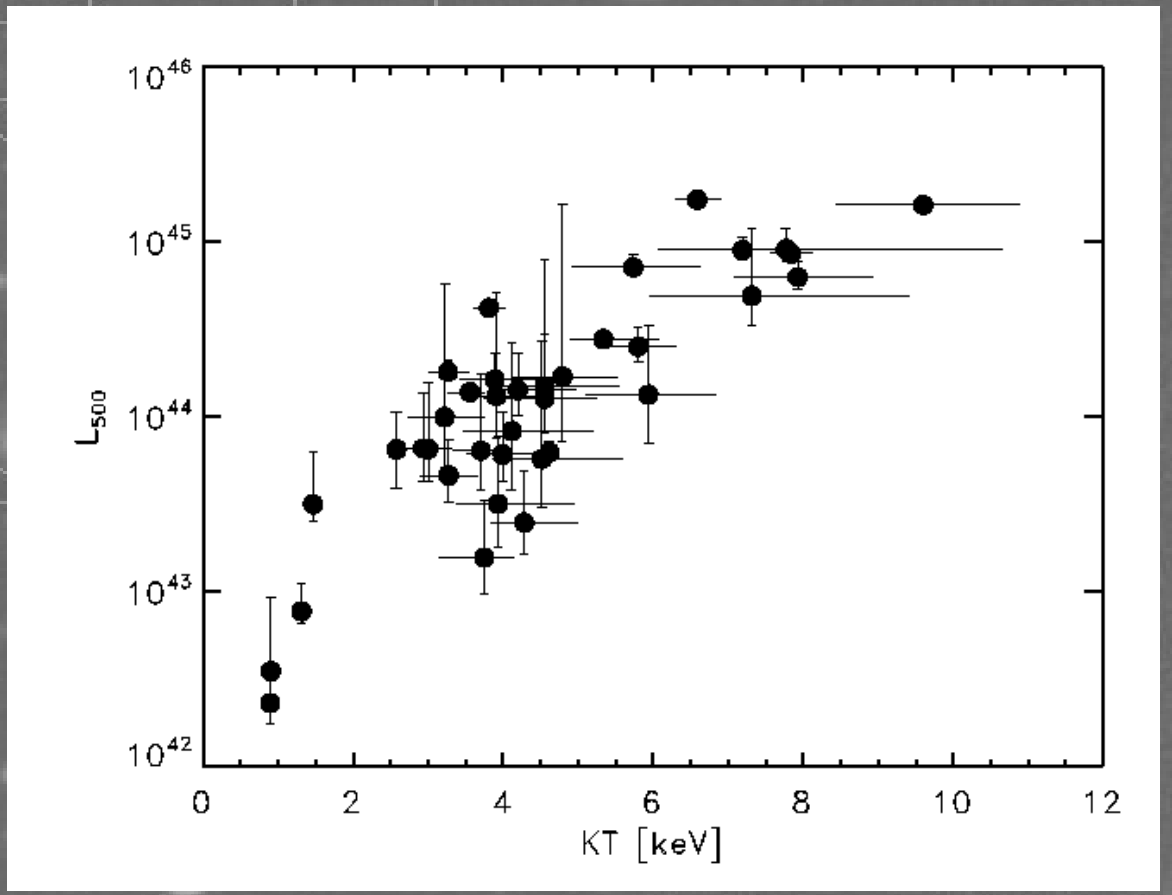
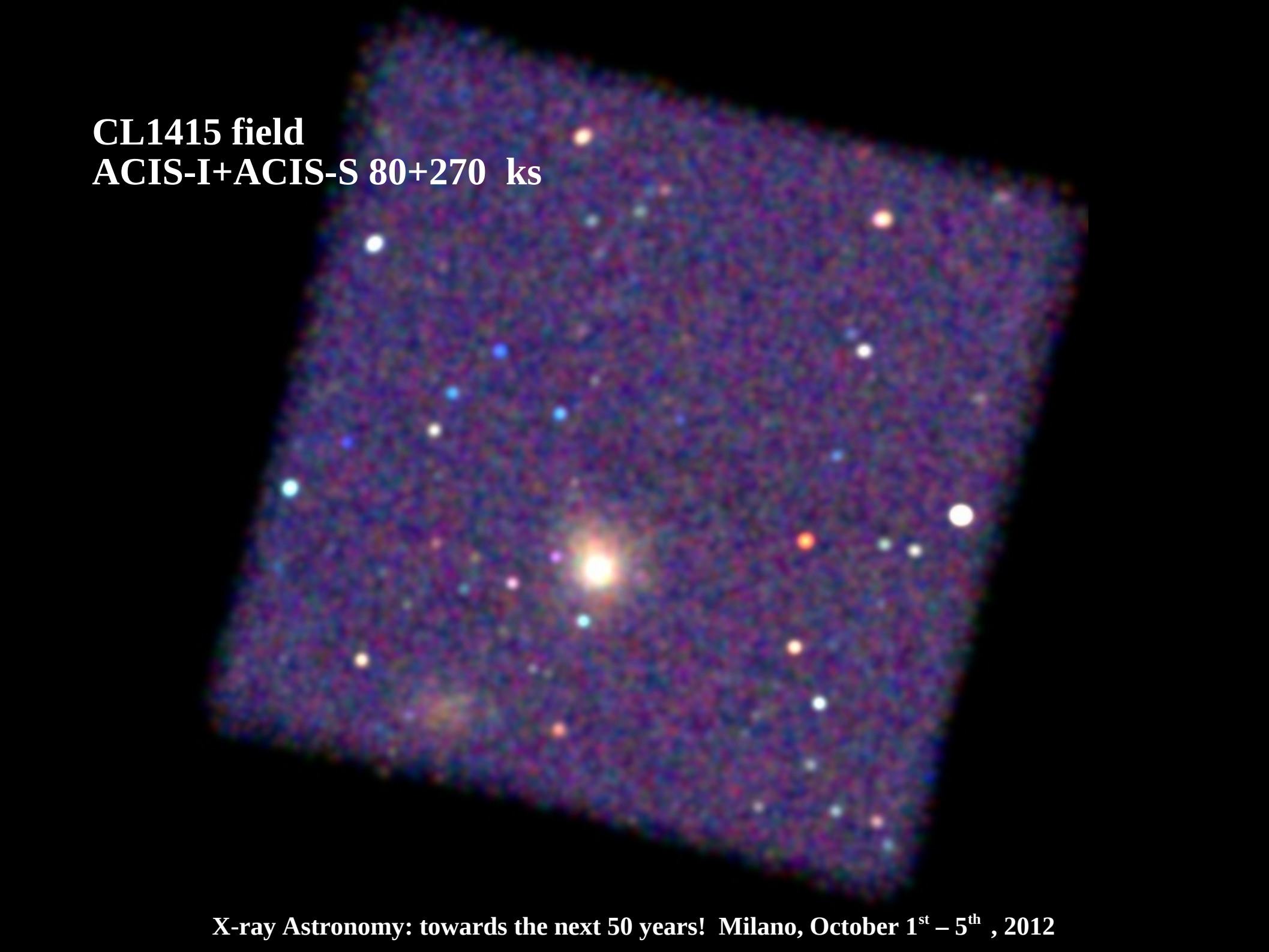




Tundo et al. 2012
Moretti et al. 2012
Liu et al. 2012

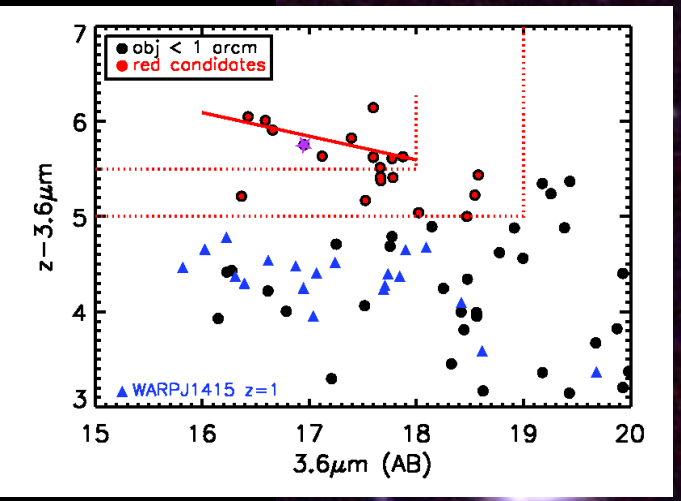
Redshift measurement from X-ray spectra (Yu et al. 2012).




CL1415 field
ACIS-I+ACIS-S 80+270 ks

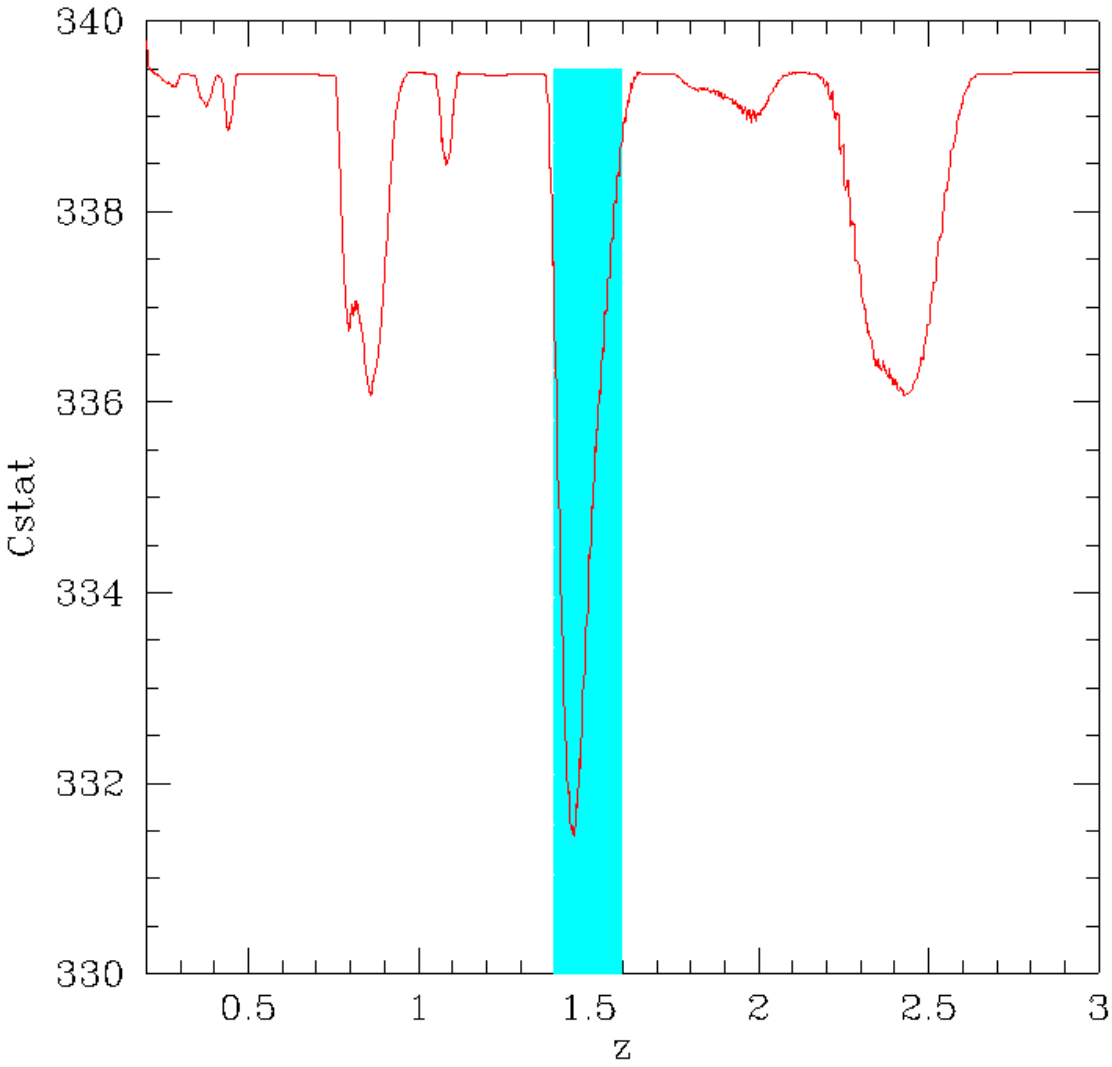
Tozzi et al. (2012)

CXO1415
About 600 net photons
kT = 5 ∓ 1 keV
$M_{200} = (2.0 \mp 1.0) \cdot 10^{14}\ M_{\odot}$

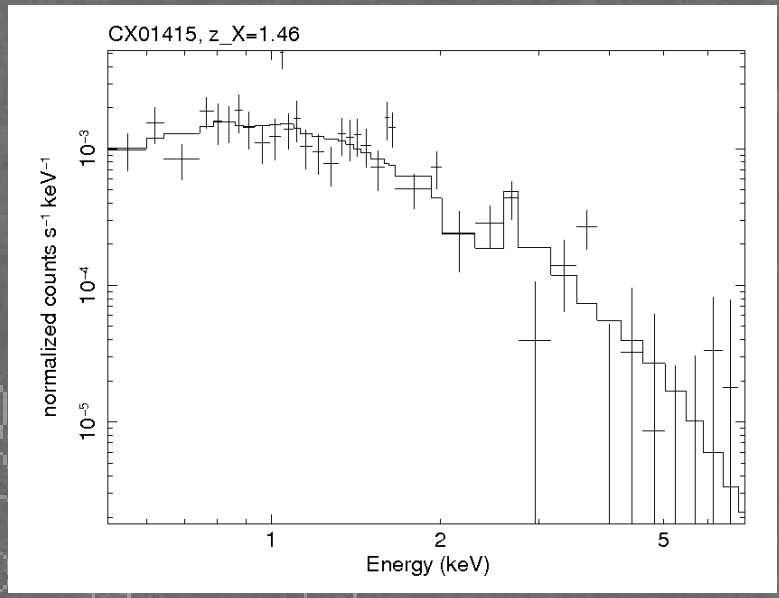


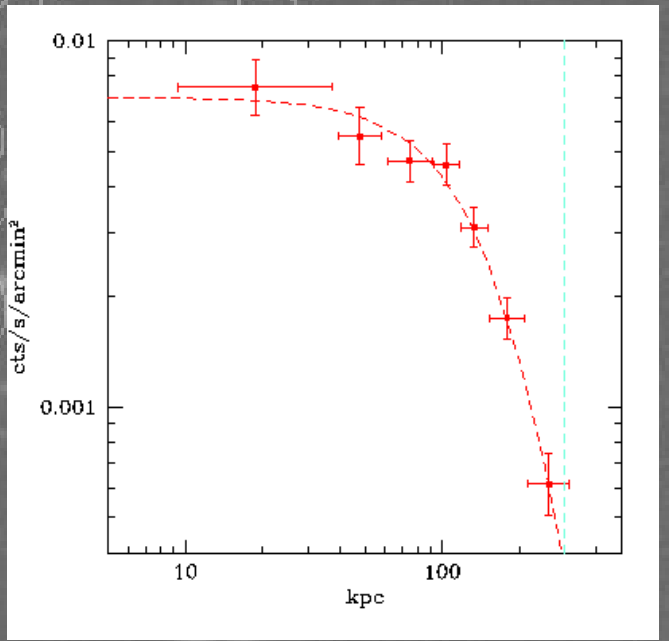
CXO1415, z_X ~ 1.5

Redshift measurement from X-ray spectra Yu et al. 2012

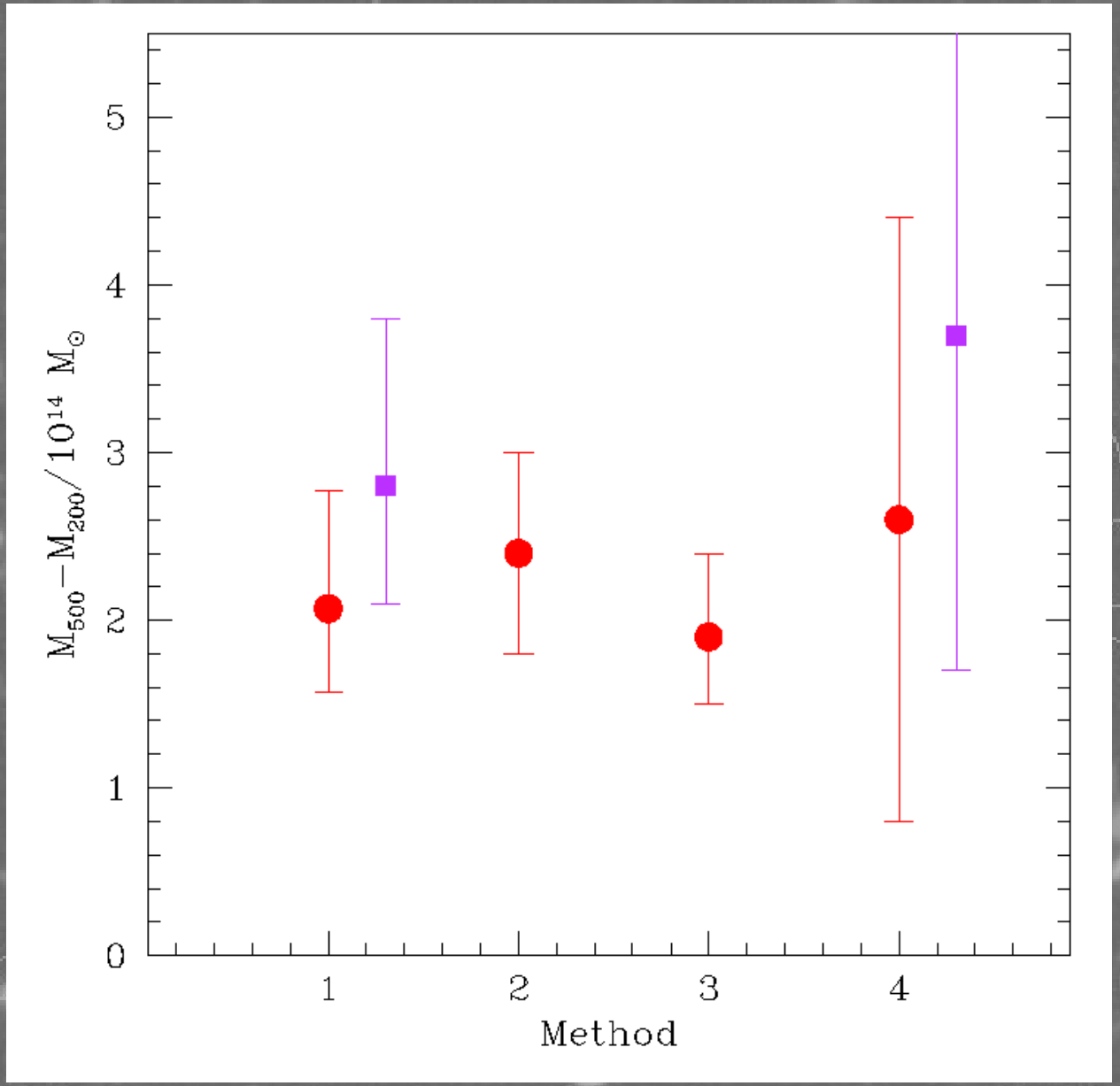


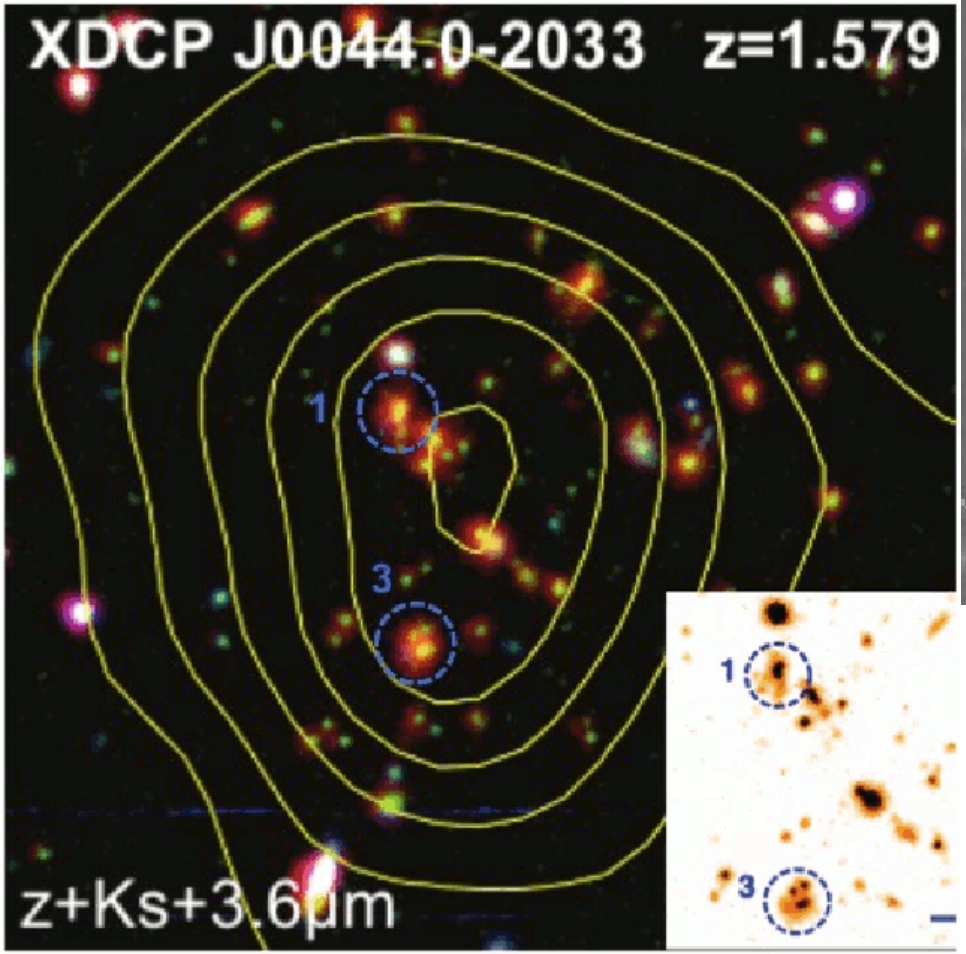
Tozzi et al. (2012)



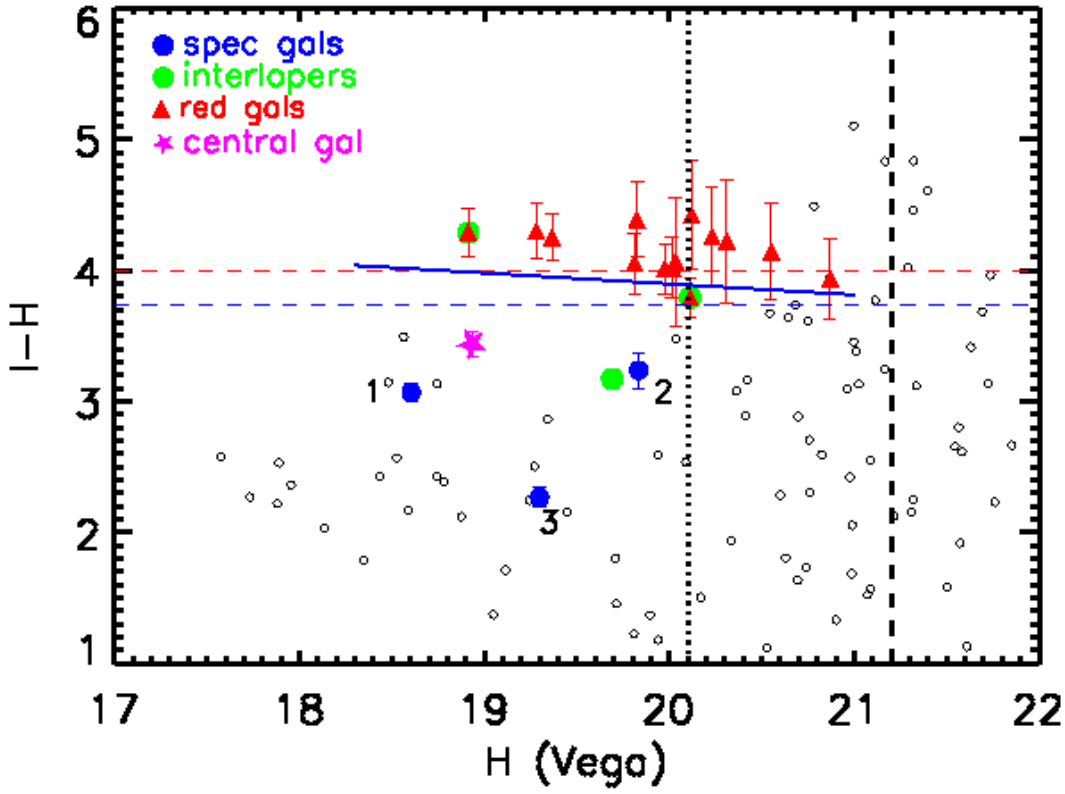


CXO1415 mass measurements



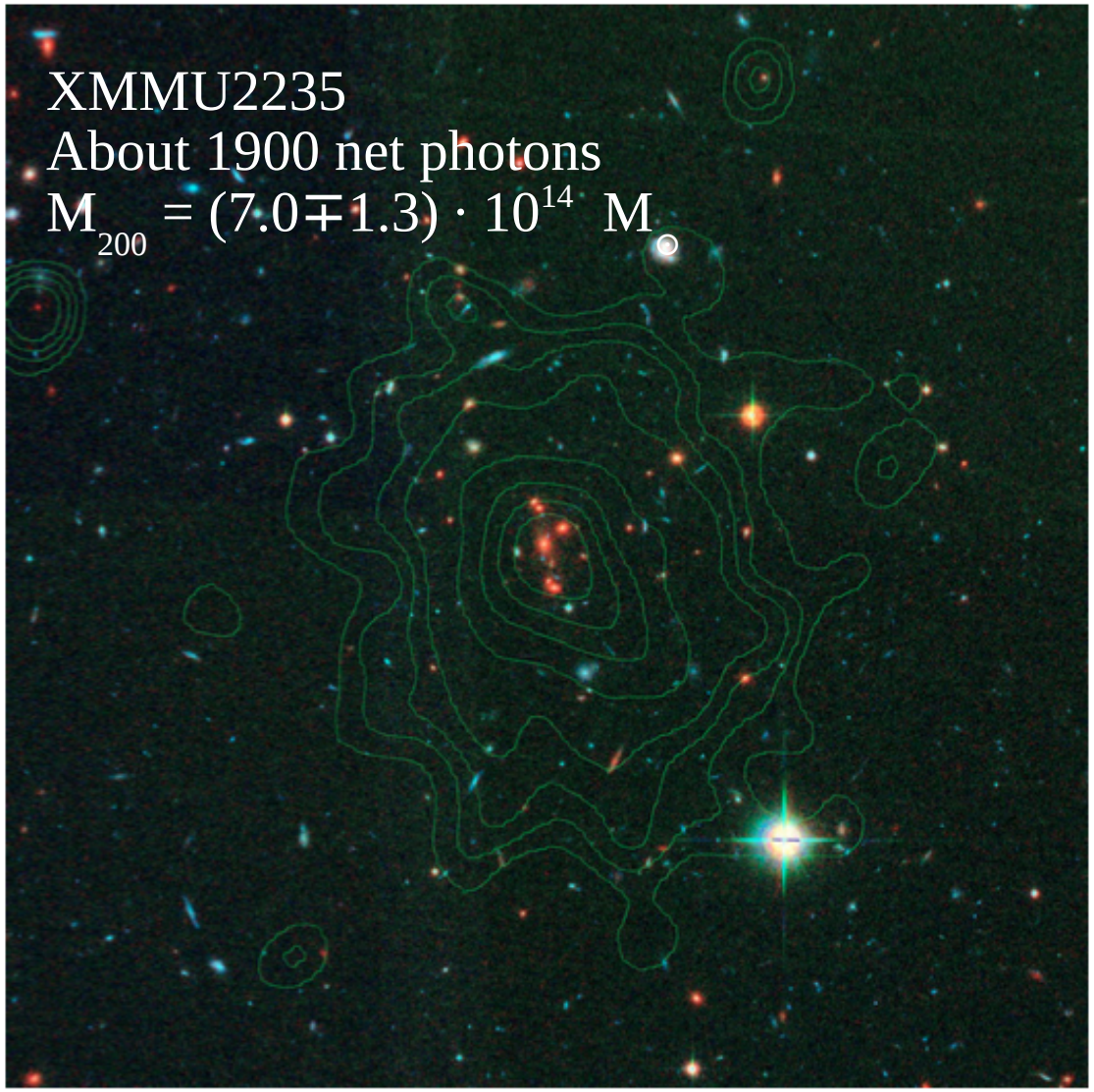


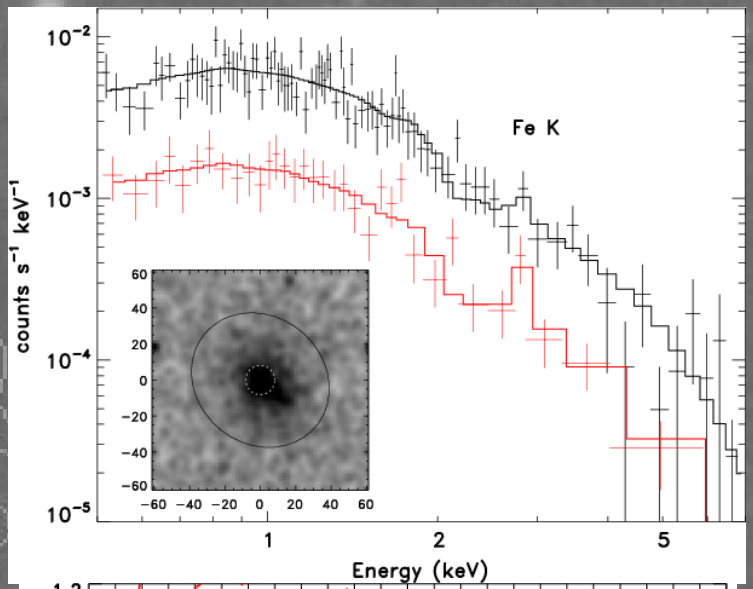
The best candidate for the most massive X-ray cluster at z~1.5
Selected in the XDCP survey (Fassbender et al. 2012)

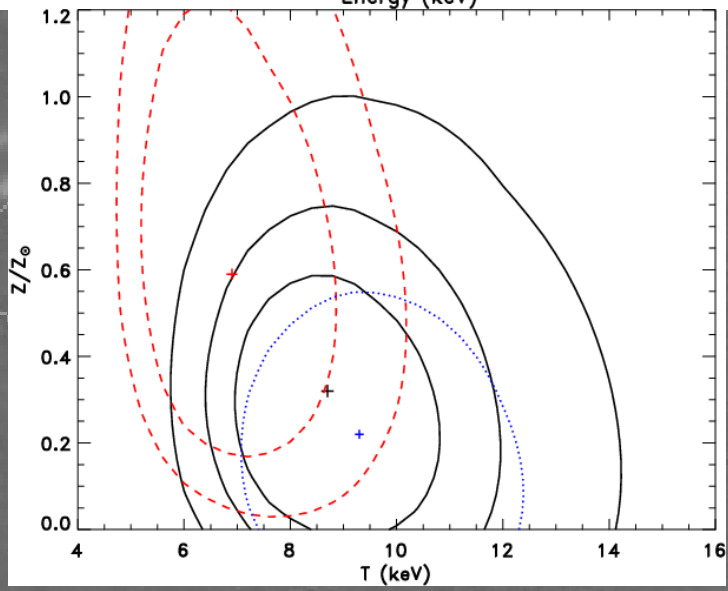


Chandra proposal (PI PT, AO14) to obtain ~1500 net photons

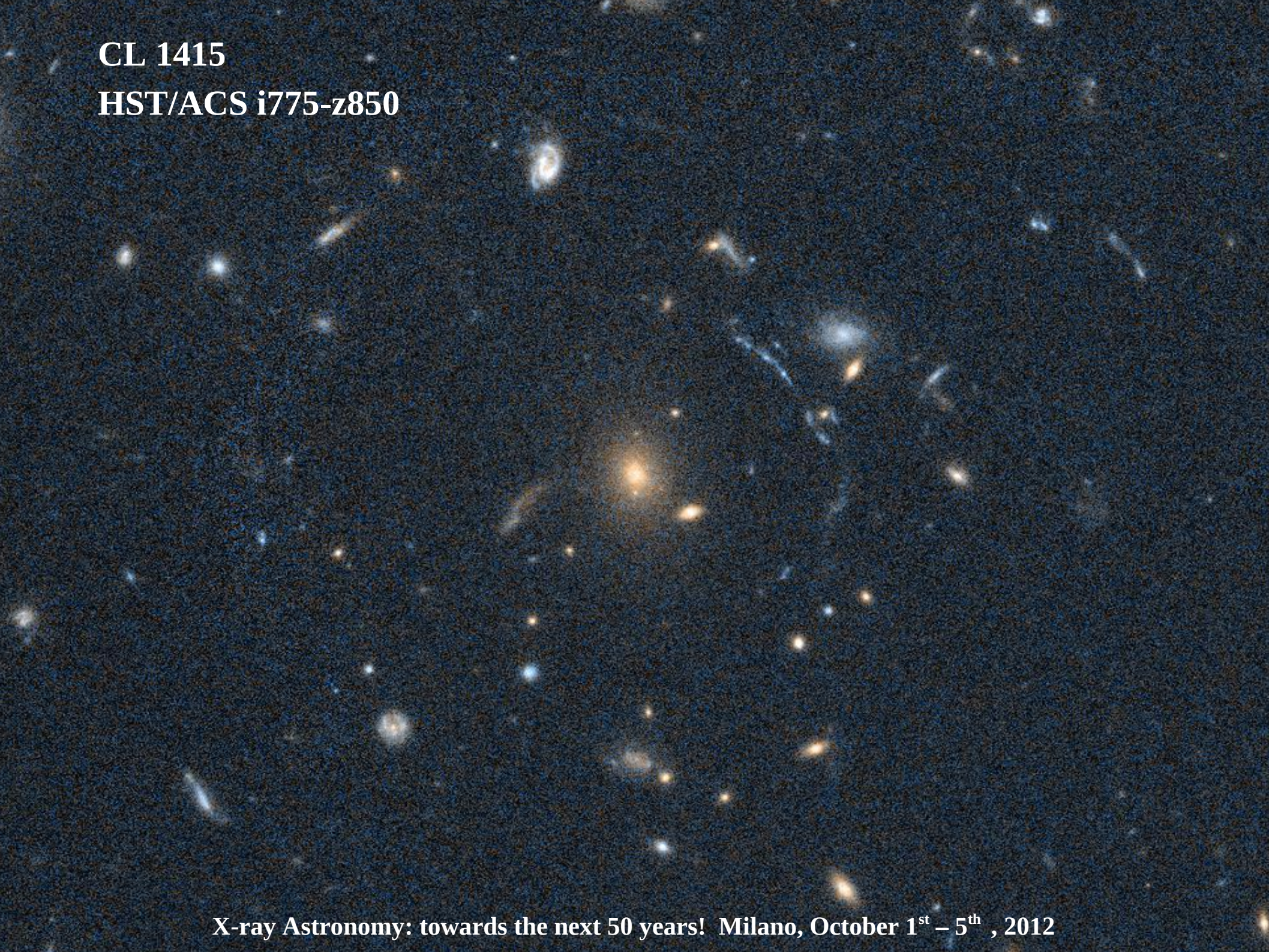
Color image of XMM2235 from the combination of *i*, *z* (HST/ACS) and *Ks* (VLT/ISAAC) filters. Overlaid X-ray contours from *Chandra* (196 ks)







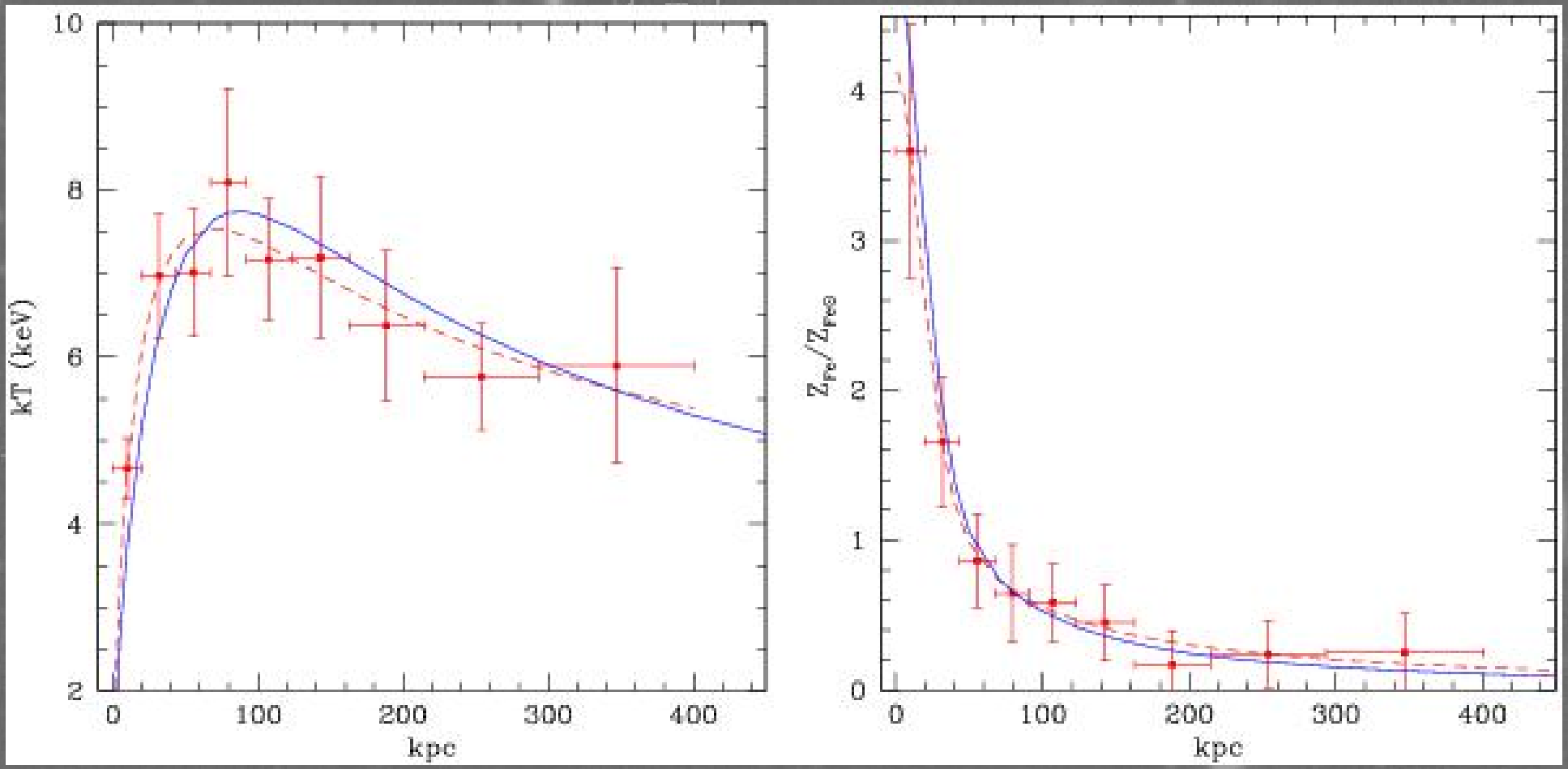
Rosati et al. 2009


CL 1415
HST/ACS i775-z850

CL1415 @ z=1, a CC in the distant Universe

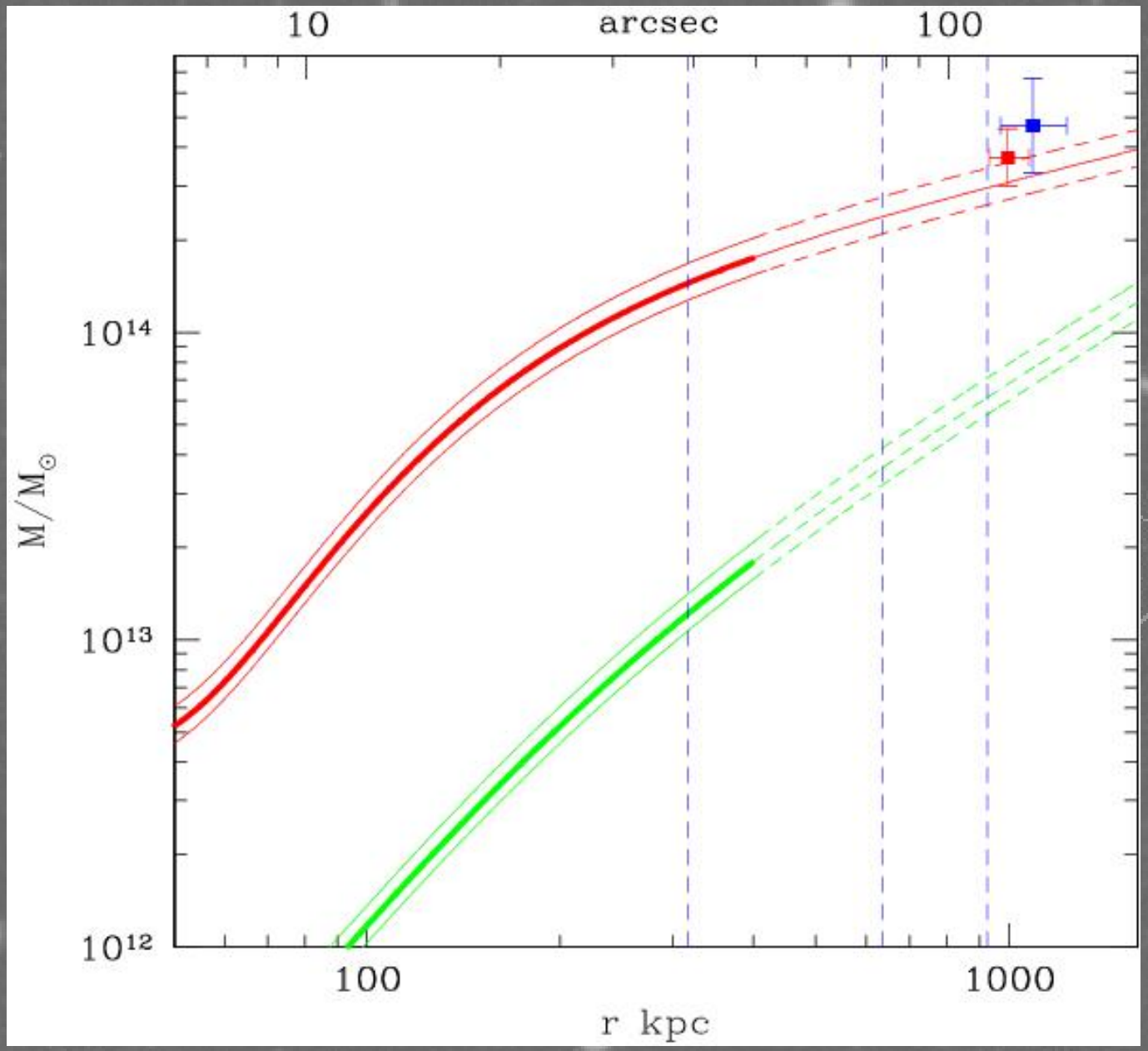
Angular resolution ~ 25 kpc in the inner regions
About 7000 net photons with Chandra

Santos et al. (2012)

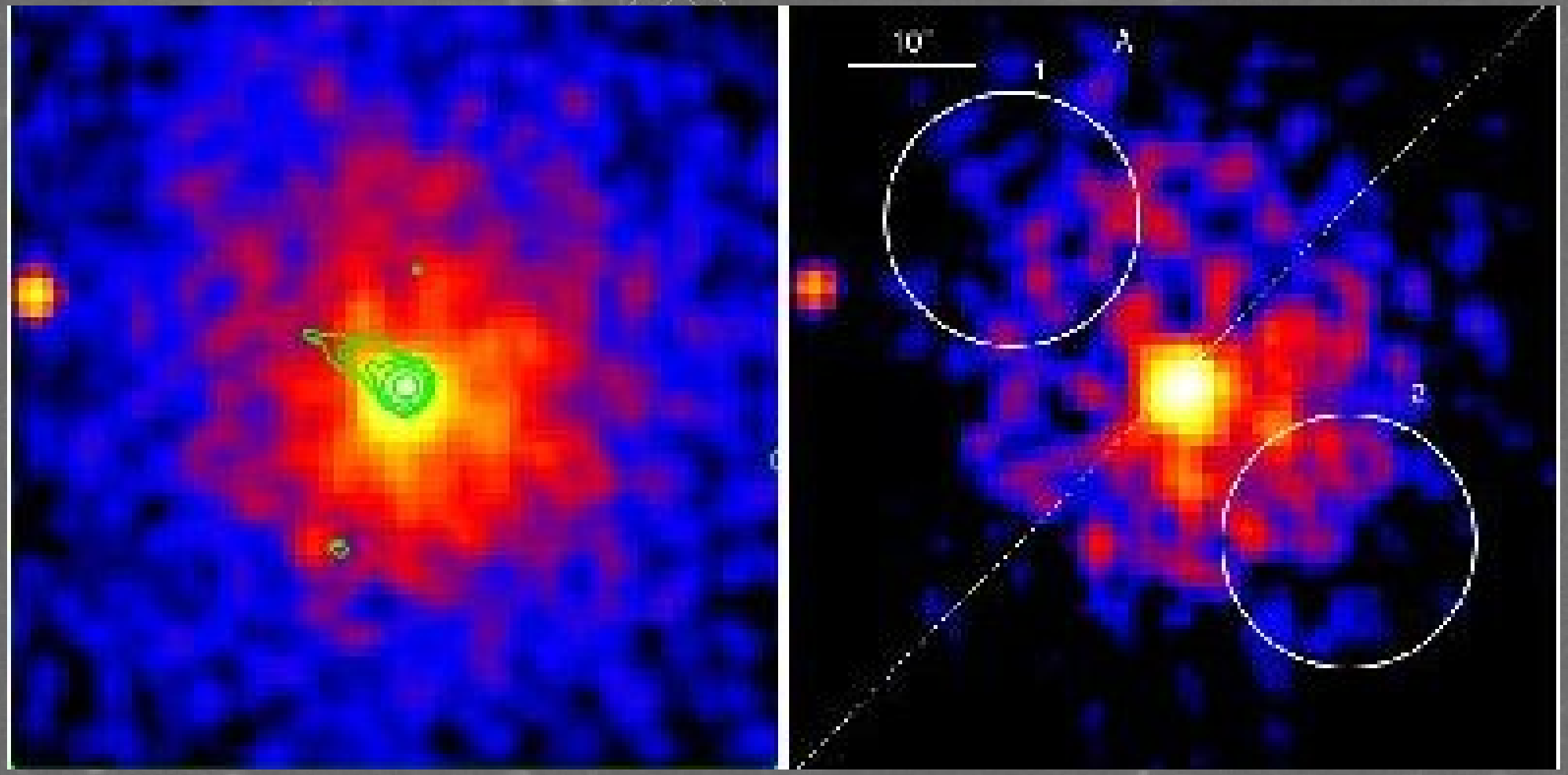


CL1415 @z=1, a CC in the distant Universe

Santos et al. (2012)

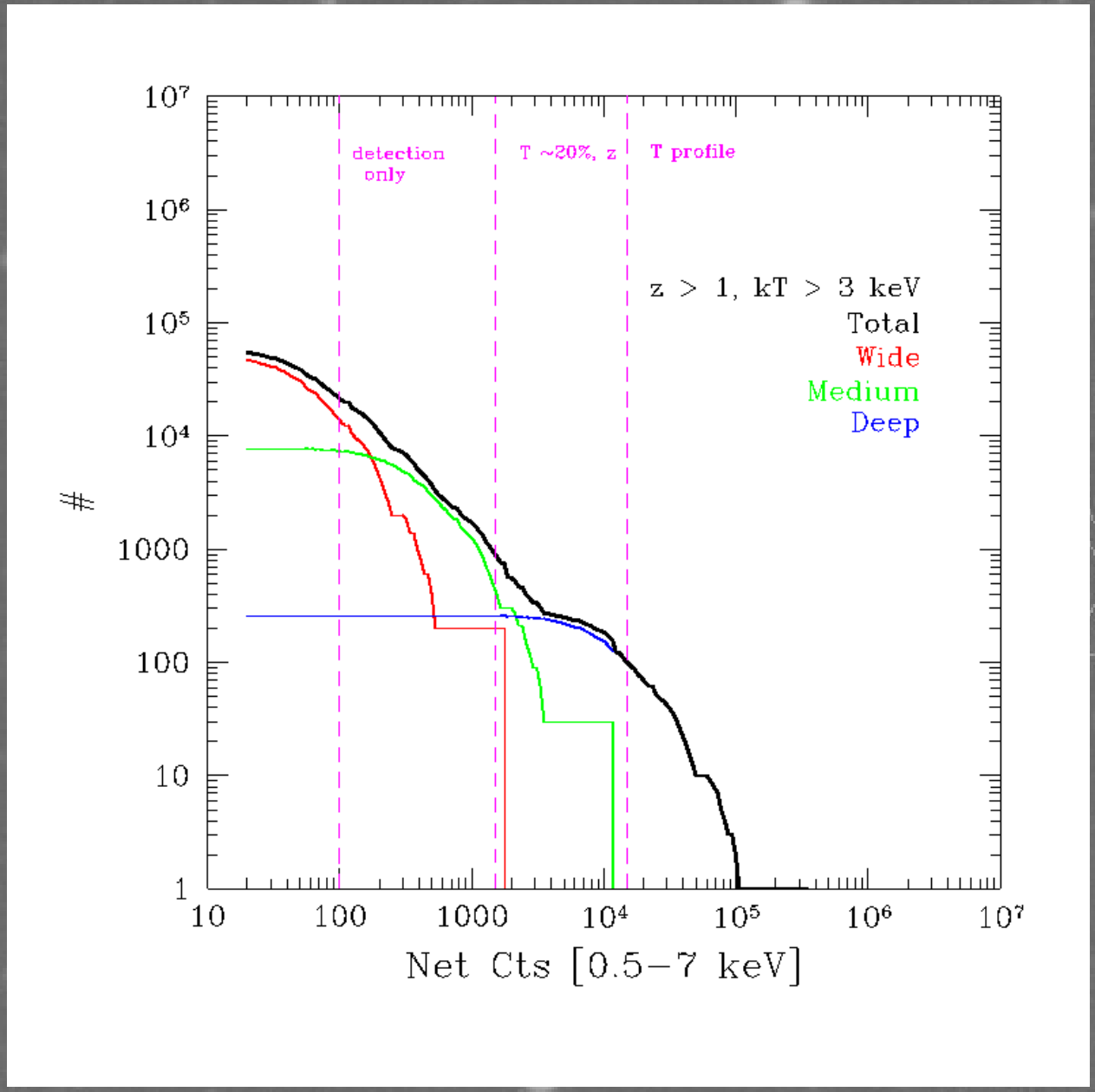


AGN radio feedback in action at z = 1



WFXT on high-z clusters: Source statistics and Spectral characterization

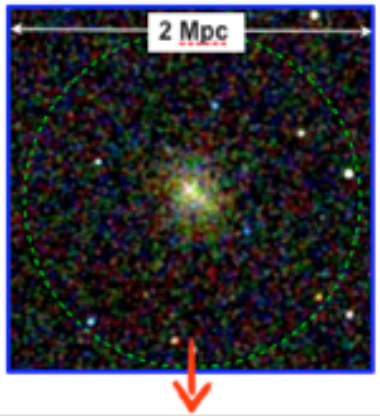
See The Wide Field X-ray Telescope (MemSAIt)
Murray et al. 2011
Rosati et al. 2011
Tozzi et al. 2011
Borgani et al. 2011

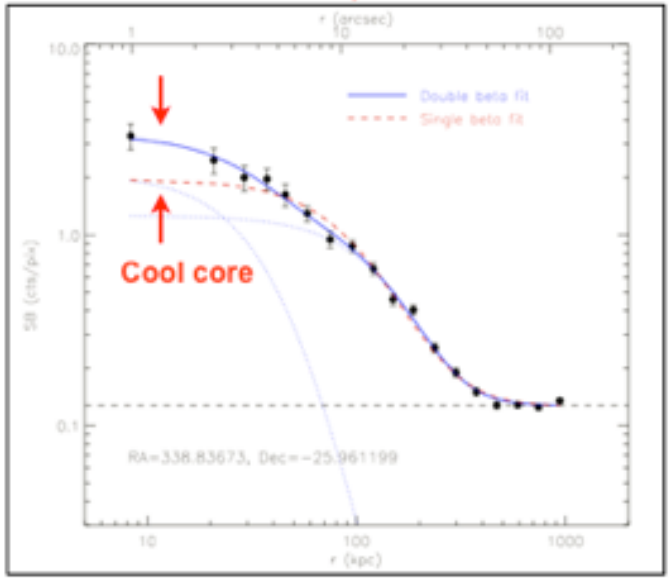


WFXT on high-z clusters: Morphology characterization, cc at high-z

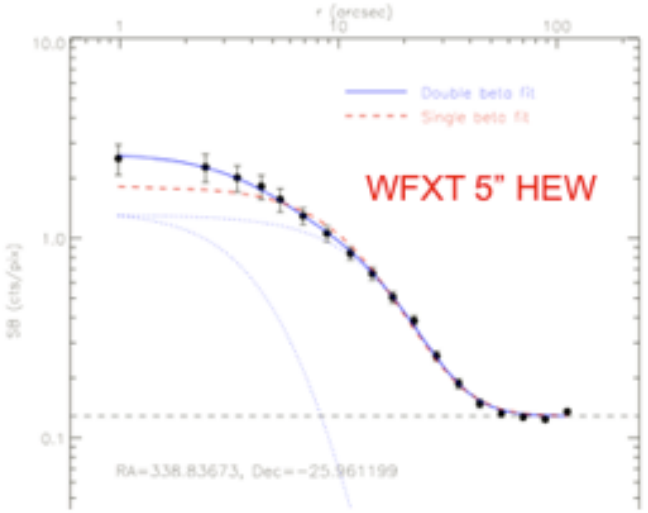
Massive z=1.39 cluster with Chandra (190 ks) (Rosati et al. 09)

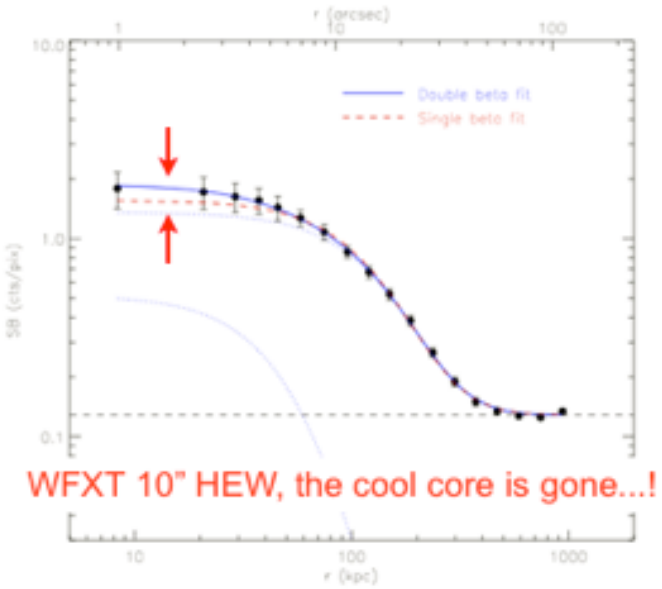
(10"=80 kpc at z=1)





Chandra observations





CONCLUSIONS

Finding high-z massive clusters

Discovery space of Chandra and XMM is limited – X-ray selection requires high (< 10" HEW) angular resolution down to ~10^{-14} cgs on ~100-200 deg^2

Identify and characterize massive clusters at high-z

A single temperature for a M> 10^{14} $M_{\odot}$ clusters needs about 200 ks exposure and good angular resolution

Study dynamics and thermodynamics of massive clusters at high-z

A detailed temperature, abundance and mass profile rquires more than 300 ks on the brightest high-z clusters, and at least 5 arcsec HEW resolution

The discovery space opened by Chandra and XMM can be explored only with a wide field, high angular resolution survey mission. Without a survey optimized mission (maximum discovery speed: minimum background, resolution ~5" HEW, large FOV, large collecting area) many scientific cases will be lost forever and the X-ray sky will not be competitive with the IR, optical, Radio sky.