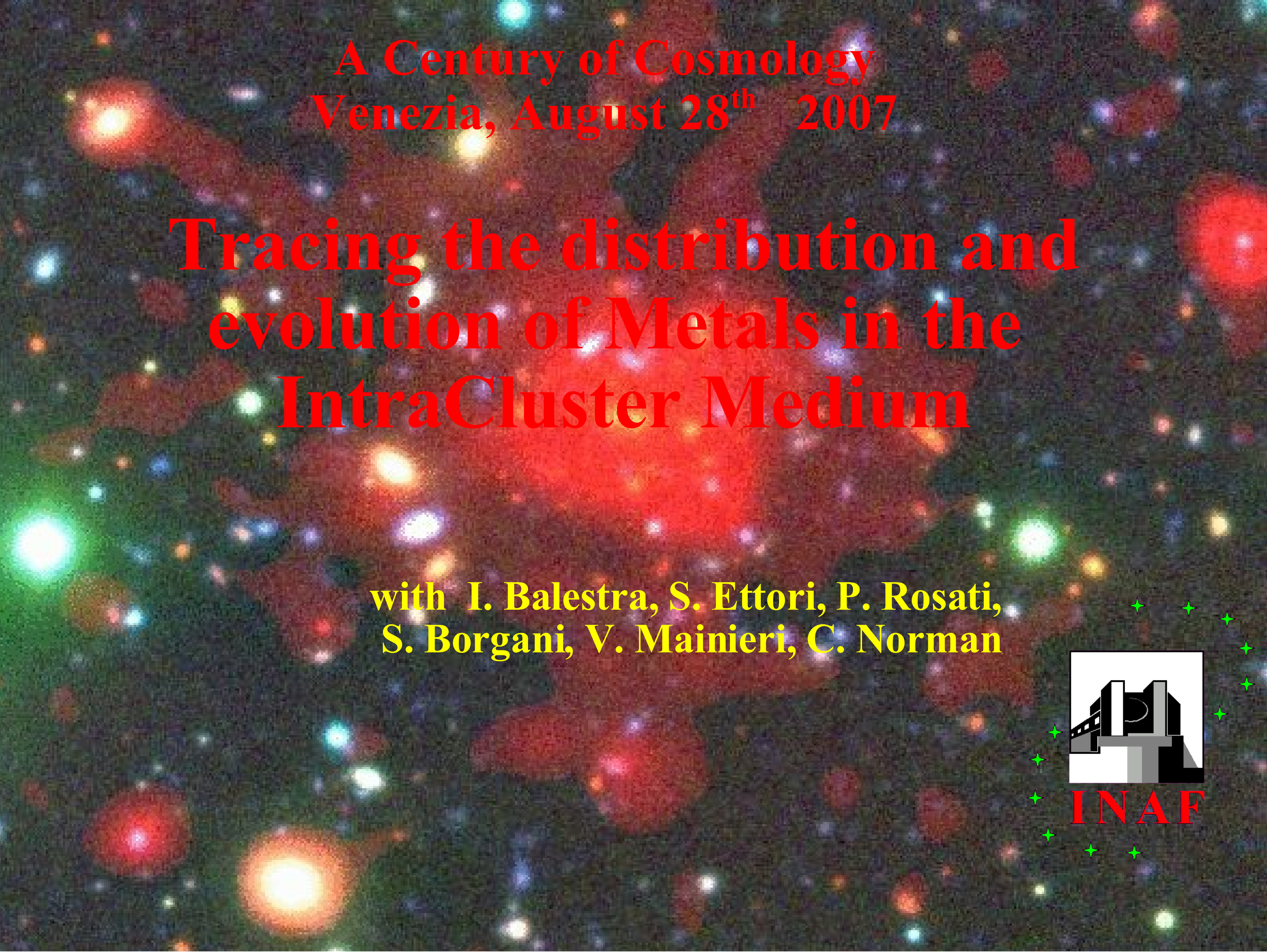
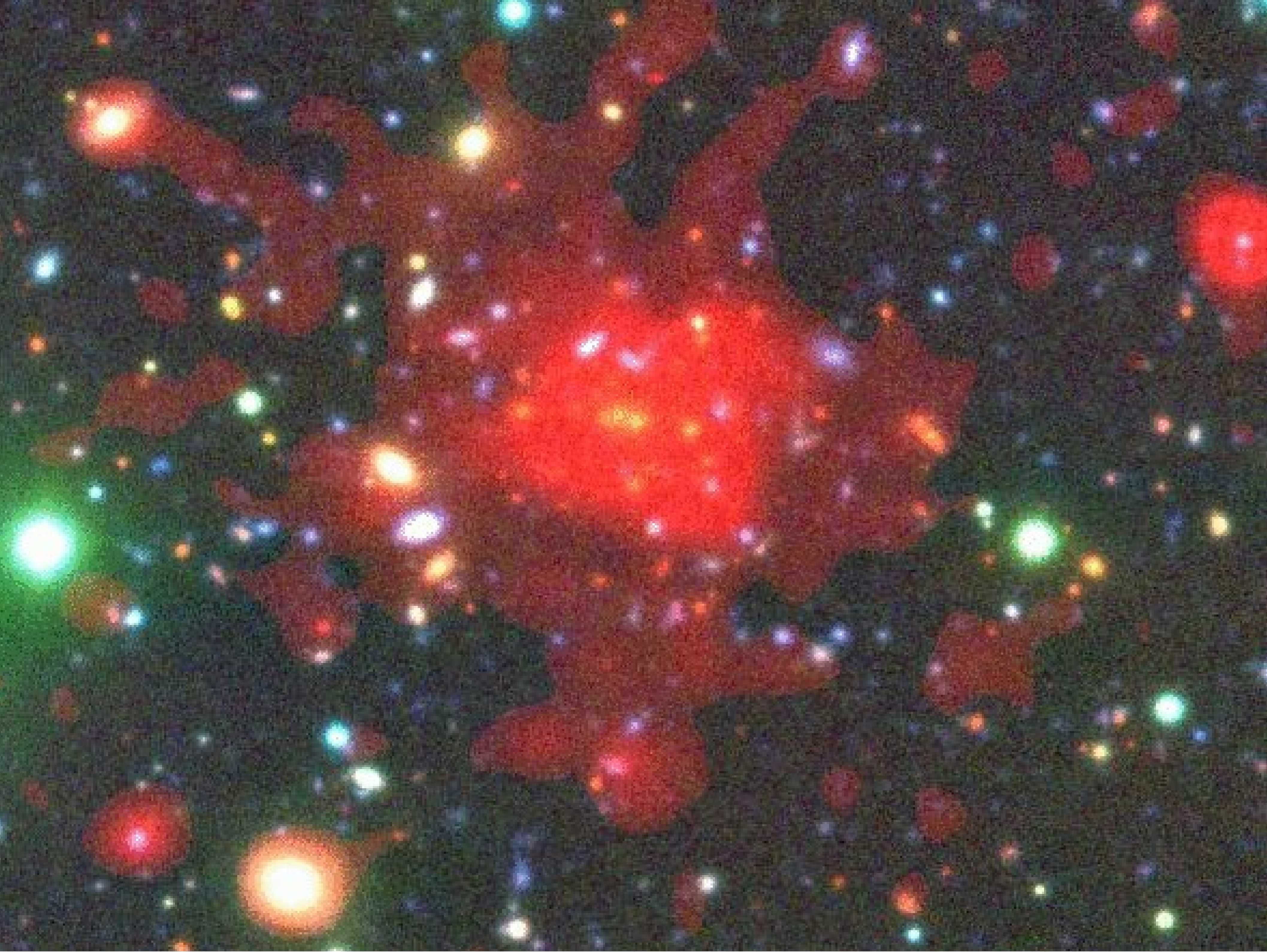


A Century of Cosmology
Venezia, August 28th 2007

Tracing the distribution and evolution of Metals in the IntraCluster Medium

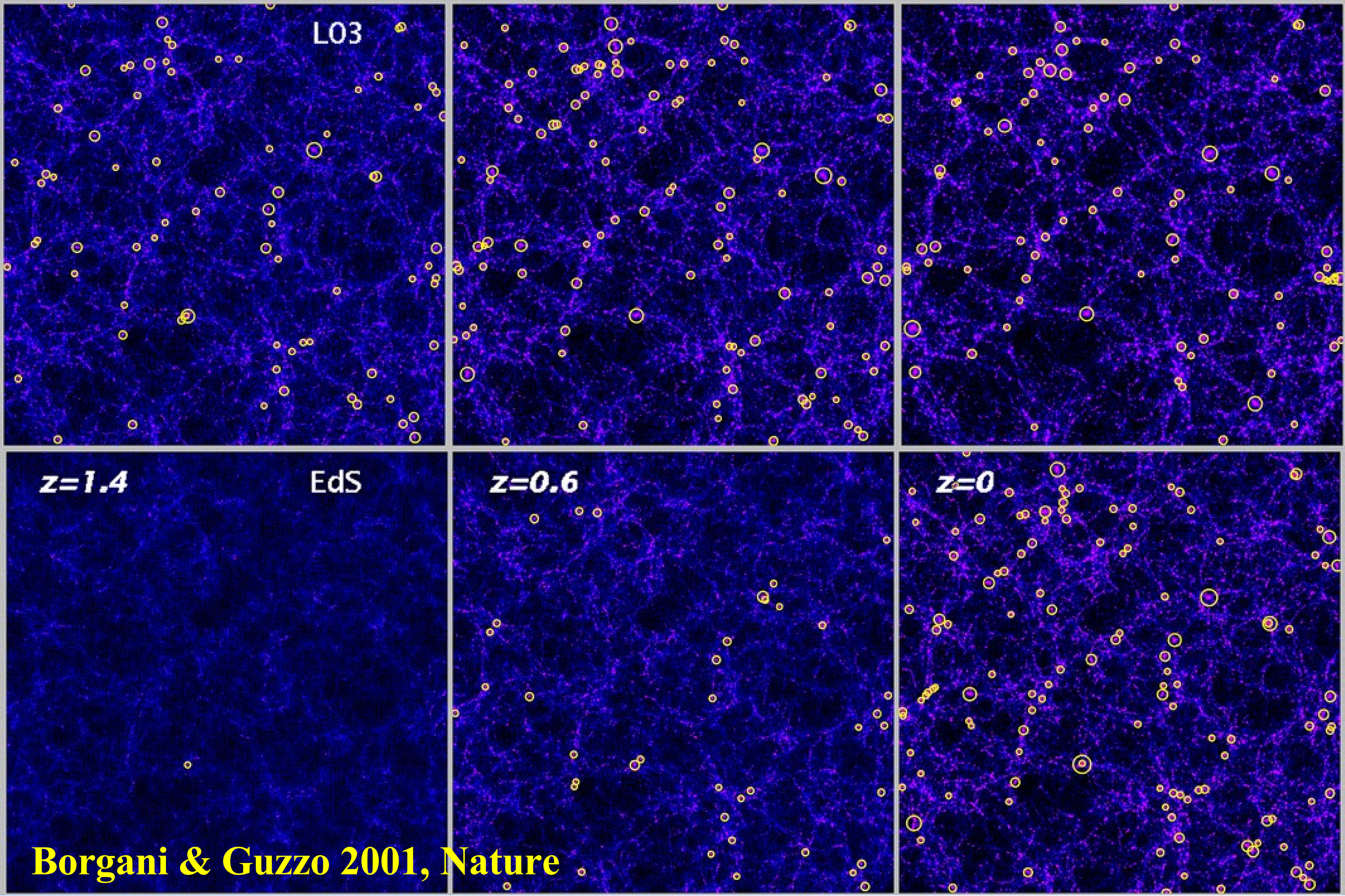
with I. Balestra, S. Ettori, P. Rosati, S. Borgani, V. Mainieri, C. Norman

INAF




XMM2235: z=1.4 – record!
180 ks with Chandra, PI Chris Mullis

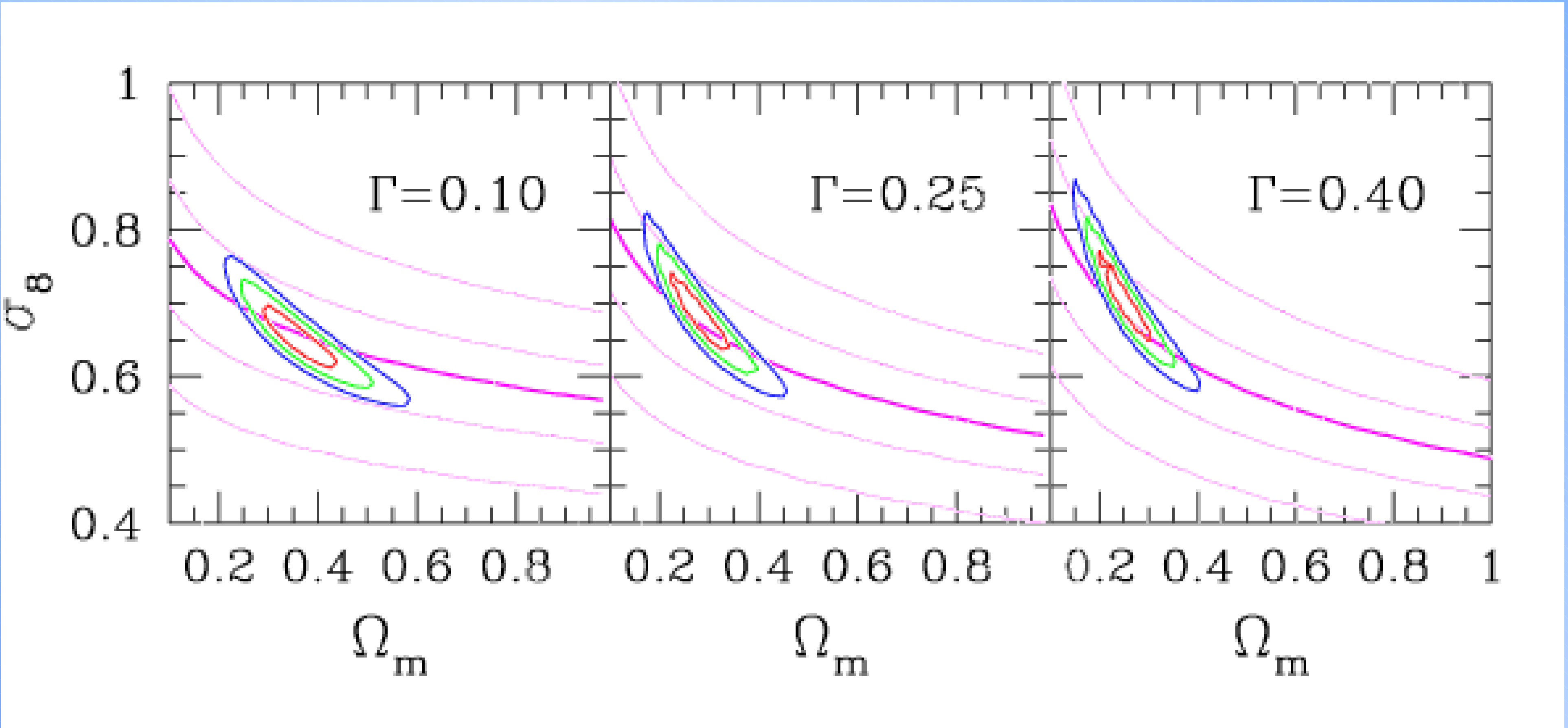
Evolution of T> 3 keV clusters



Borgani & Guzzo 2001, Nature

Cosmological constraint of the normalization of the power spectrum σ_8 and Ω

Weak dependence on the shape of the spectrum



Borgani et al. 2001

WMAP, σ_8 and X-ray clusters

FIRST-YEAR *WILKINSON MICROWAVE ANISOTROPY PROBE* (*WMAP*)[1] OBSERVATIONS: DETERMINATION OF COSMOLOGICAL PARAMETERS

D. N. Spergel,[2] L. Verde,[2,3] H. V. Peiris,[2] E. Komatsu,[2] M. R. Nolta,[4] C. L. Bennett,[5] M. Halpern,[6] G. Hinshaw,[5] N. Jarosik,[4] A. Kogut,[5] M. Limon,[5,7] S. S. Meyer,[8] L. Page,[4] G. S. Tucker,[5,7,9] J. L. Weiland,[10] E. Wollack,[5] and E. L. Wright[11]

Received 2003 February 11; accepted 2003 May 20

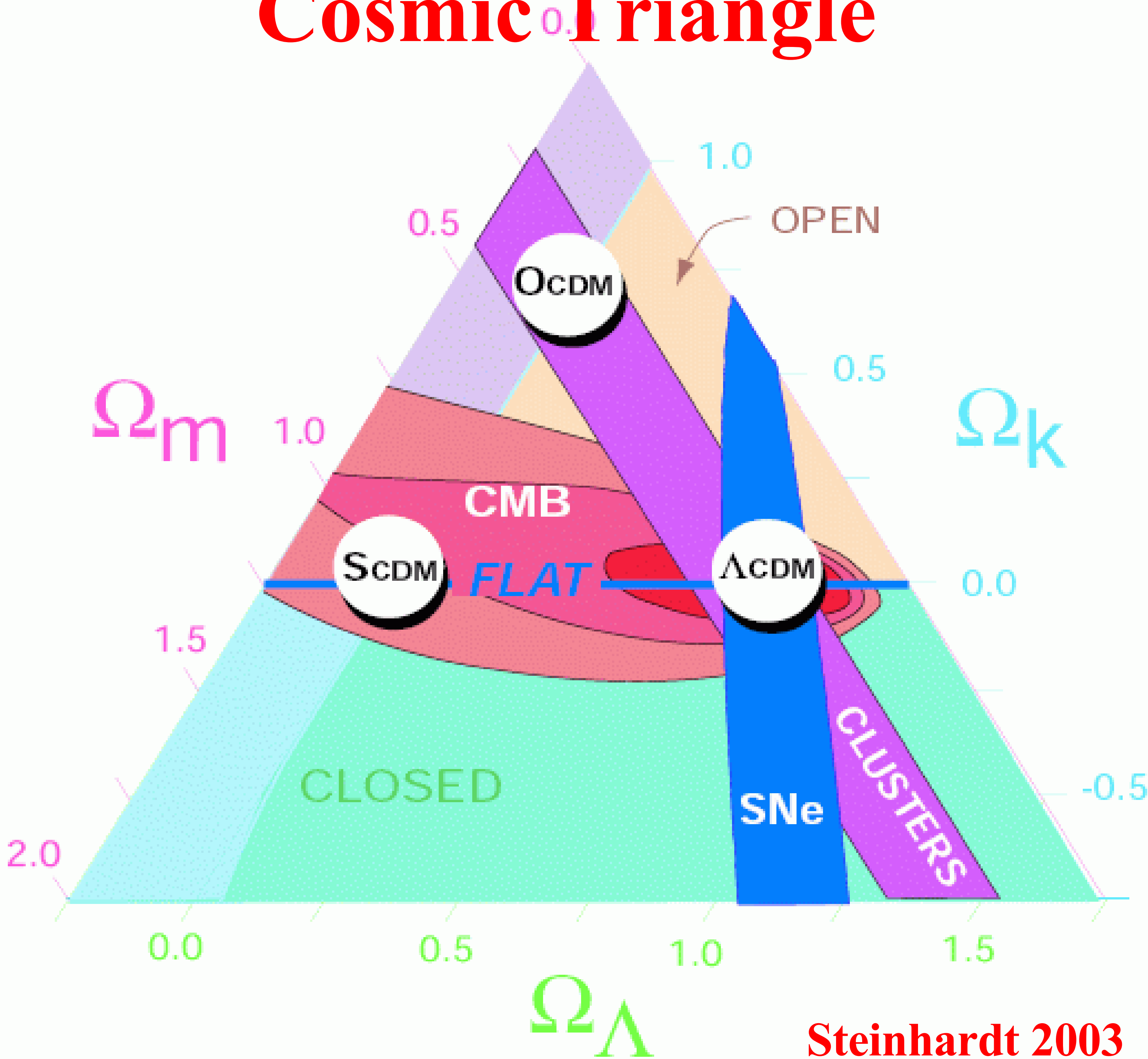
$h = 0.71^{+0.04}_{-0.03}$, $\Omega_b h^2 = 0.0224 \pm 0.0009$, $\Omega_m h^2 = 0.135^{+0.008}_{-0.009}$, $\tau = 0.17 \pm$ and $\sigma_8 = 0.84 \pm 0.04$. *WMAP*'s best determination of $\tau = 0.17 \pm 0.04$ a

Wilkinson Microwave Anisotropy Probe (WMAP) Three Year Results: Implications for Cosmology

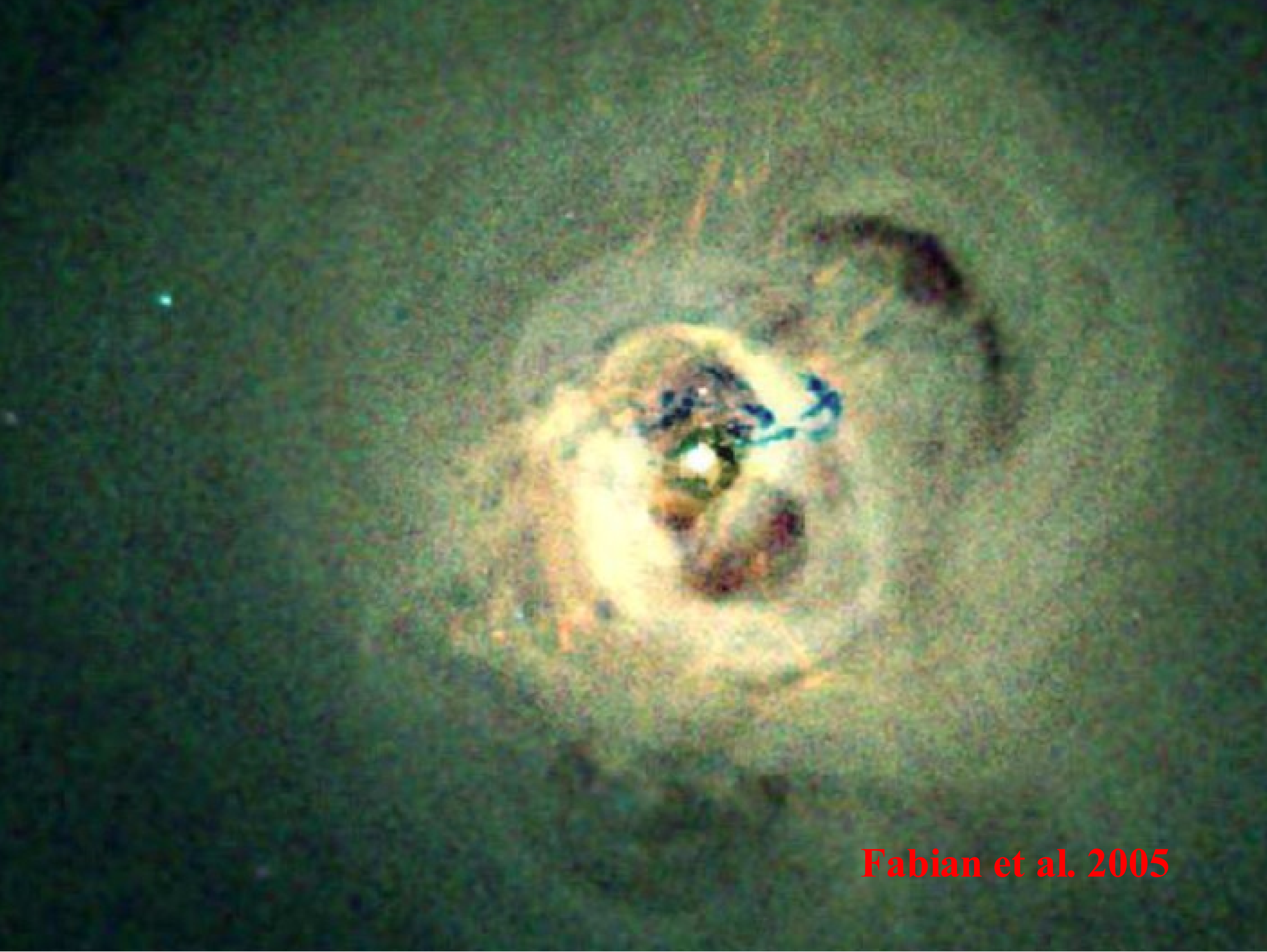
D. N. Spergel[1,2], R. Bean[1,3], O. Doré[1,4], M. R. Nolta [4,5], C. L. Bennett[6,7], G. Hinshaw[6], Jarosik [5], E. Komatsu [1,8], L. Page[5], H. V. Peiris [1,9,10], L. Verde [1,11], C. Barnes[5], M. Halpern [12], R. S. Hill[6,15], A. Kogut [6], M. Limon [6], S. S. Meyer [9], N. Odegard [6,15], G. S Tucker [13], J. L. Weiland[6,15], E. Wollack [6], E. L. Wright [14]

ship. Using WMAP data only, the best fit values for cosmological parameters for the power-law flat ΛCDM model are $(\Omega_m h^2, \Omega_b h^2, h, n_s, \tau, \sigma_8) = (0.127^{+0.007}_{-0.013}, 0.0223^{+0.0007}_{-0.0009}, 0.73^{+0.03}_{-0.03}, 0.951^{+0.015}_{-0.019}, 0.09^{+0.03}_{-0.03}, 0.74^{+0.05}_{-0.06})$ The three year data dramatically shrinks the allowed volume in this six dimensional parameter space.

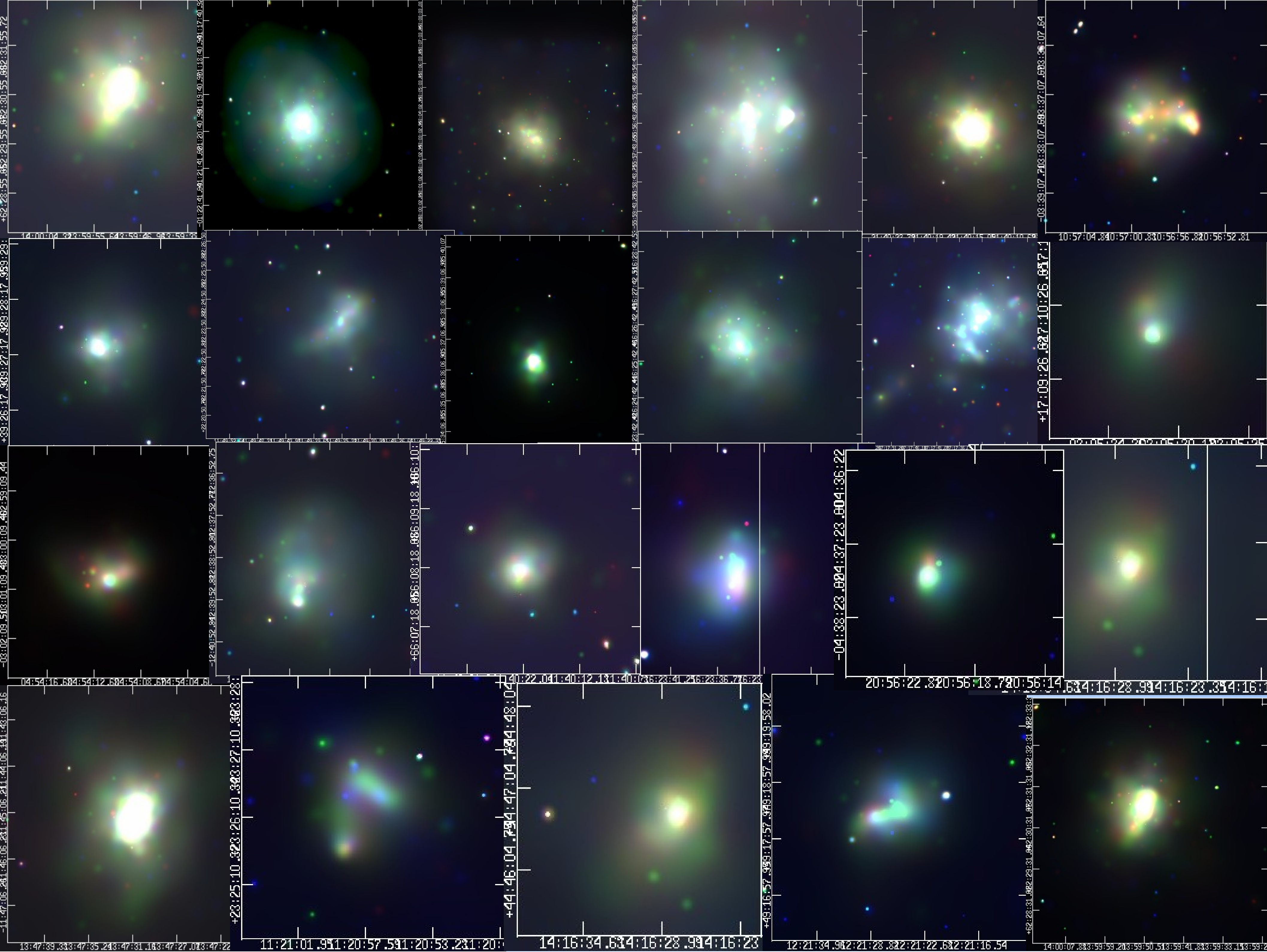
Cosmic Triangle



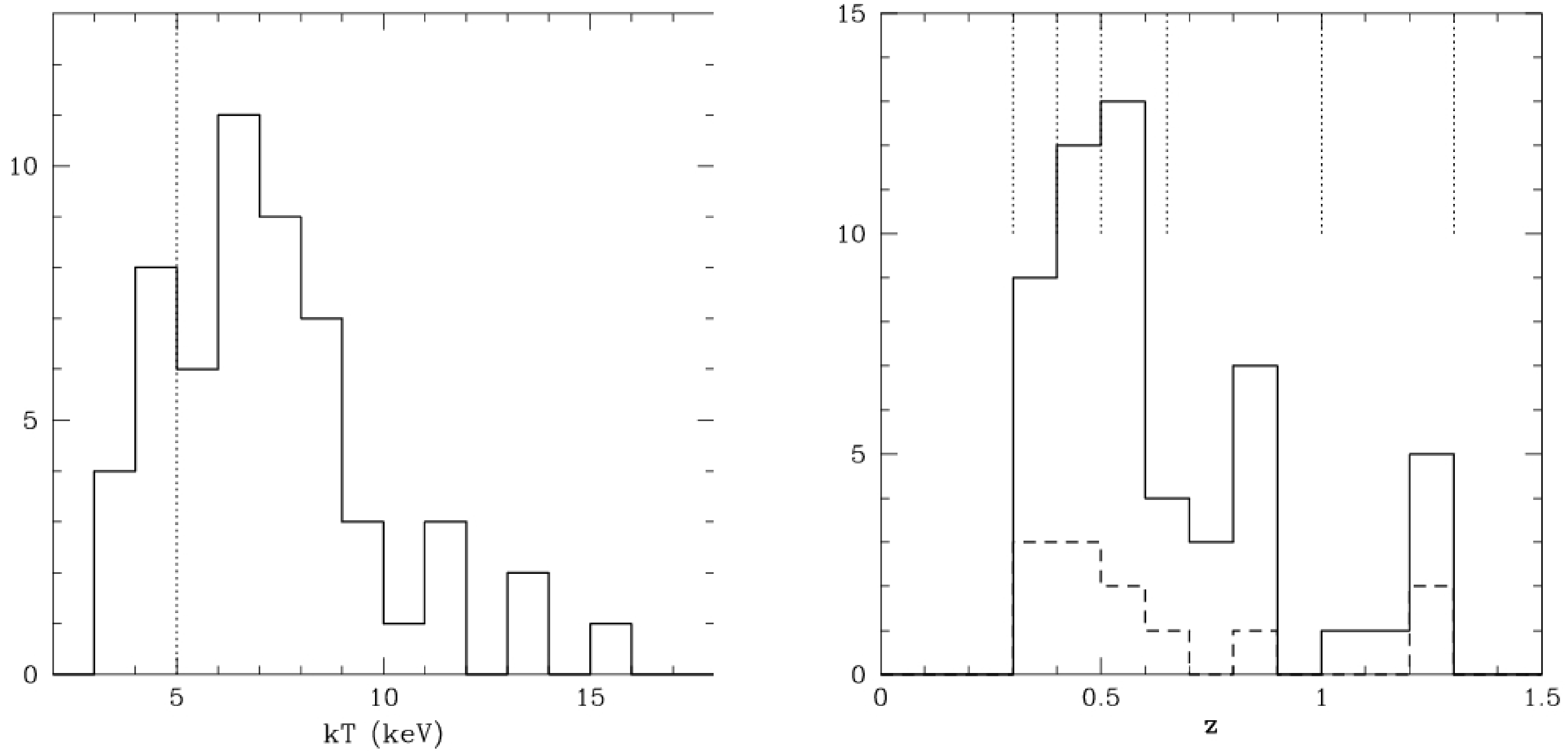
Steinhardt 2003



Fabian et al. 2005



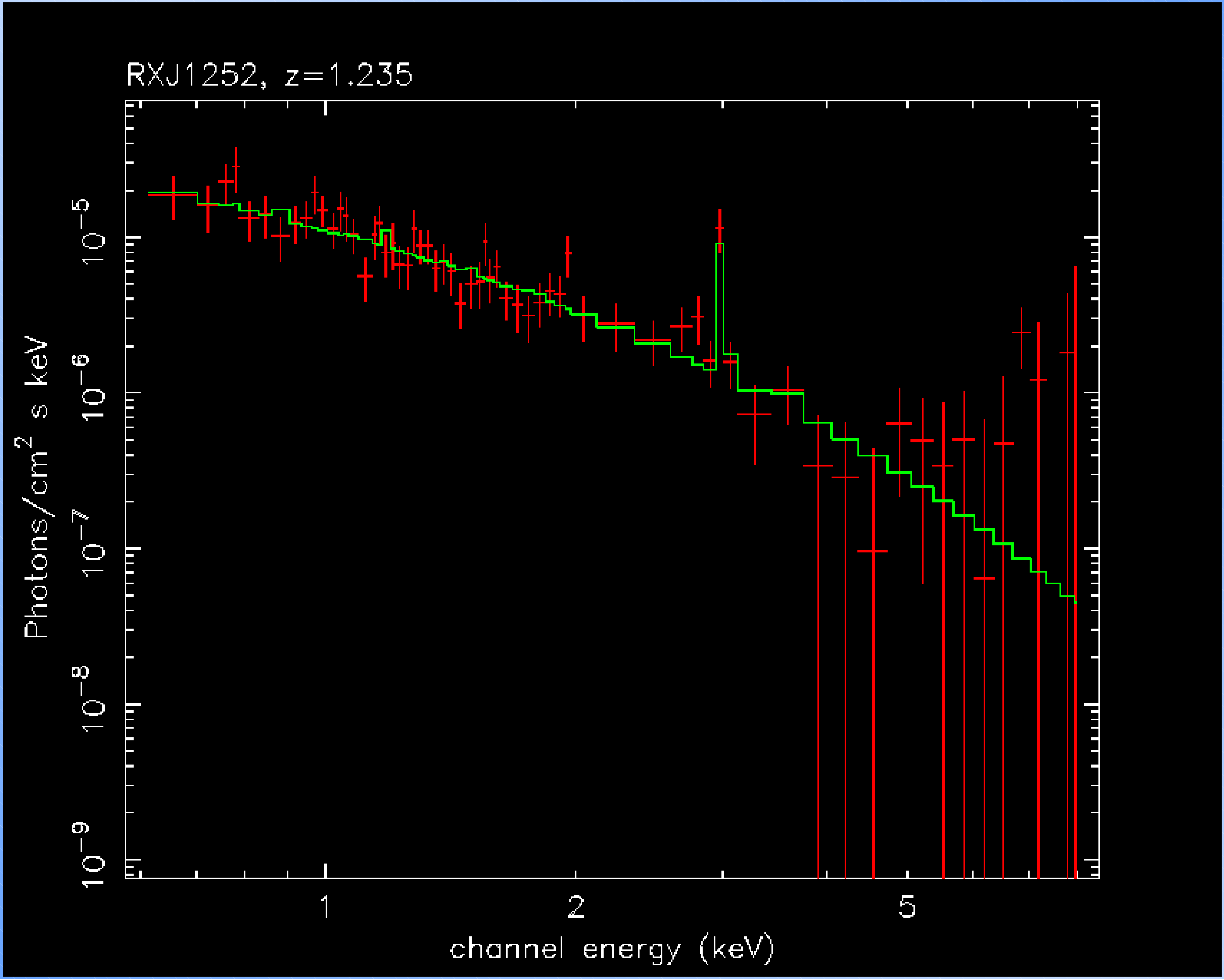
Distribution with temperature and redshift of the sample



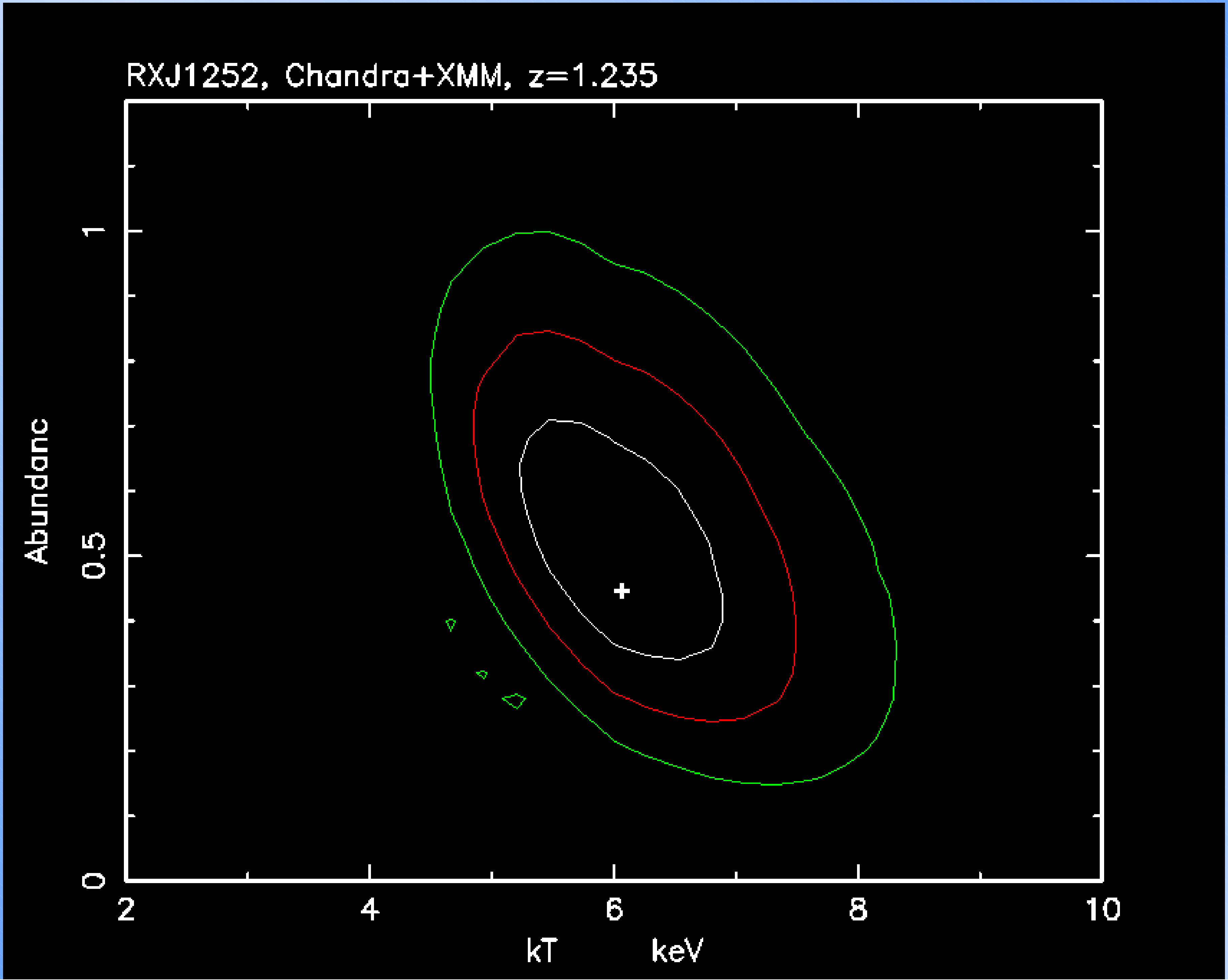
Balestra et al. 2007

We select from the Chandra archive
56 clusters at z>0.3
(among them 7 clusters at z>1)

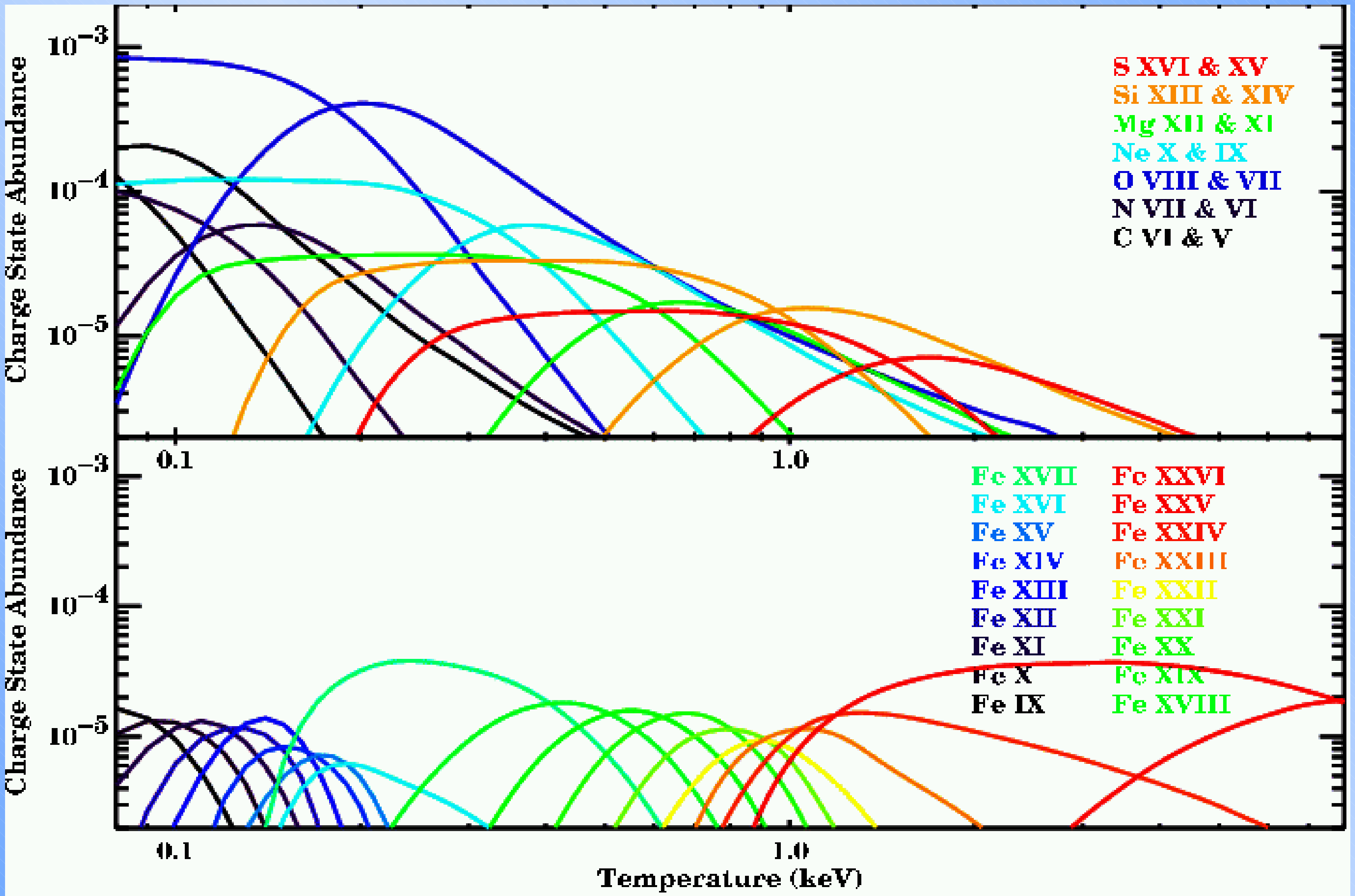
RXJ1252: highest z detection of the Fe line in the ICM



Chandra+XMM (MOS) combined fit

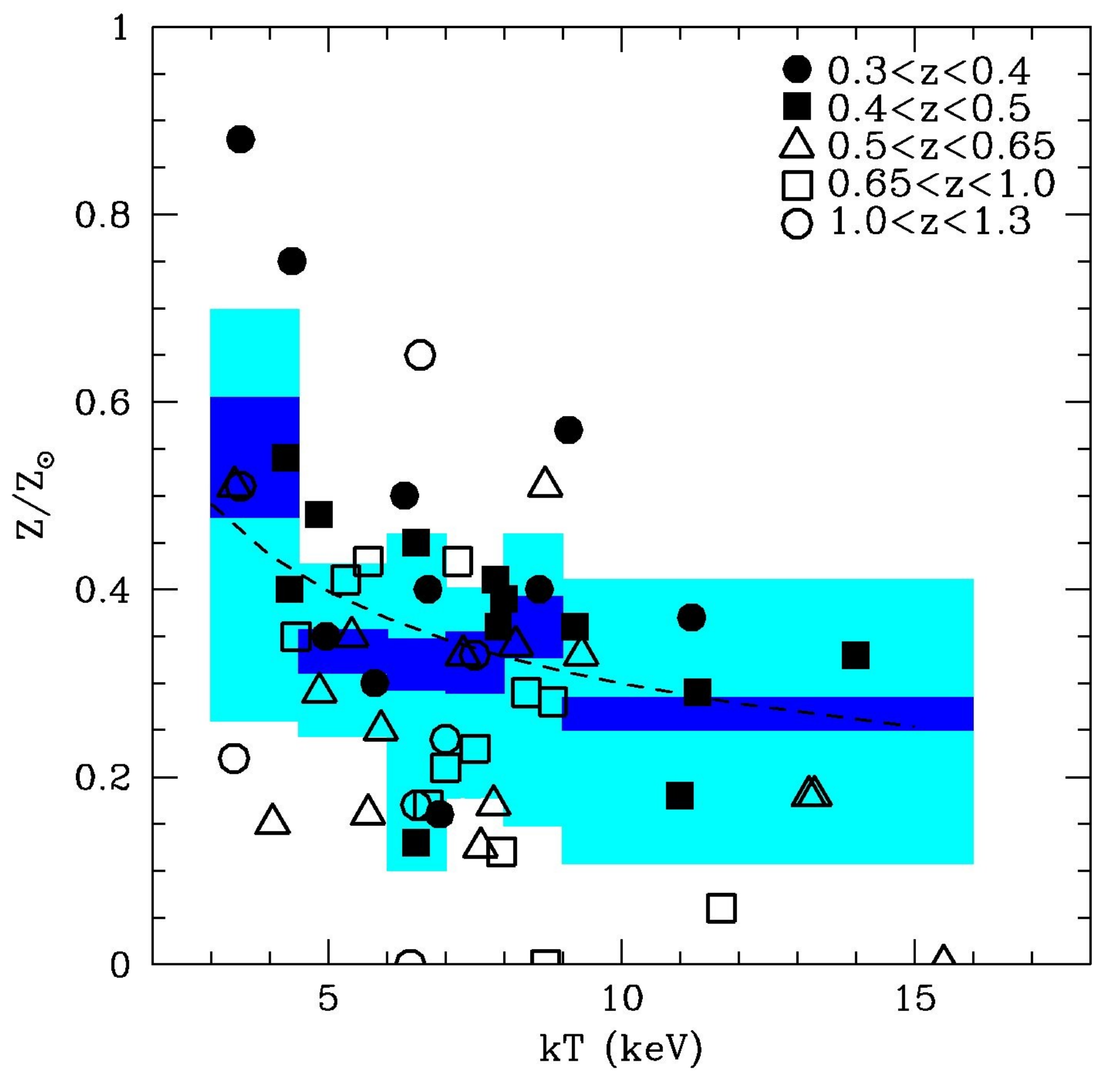


Ions concentration as a function of the ICM temperature

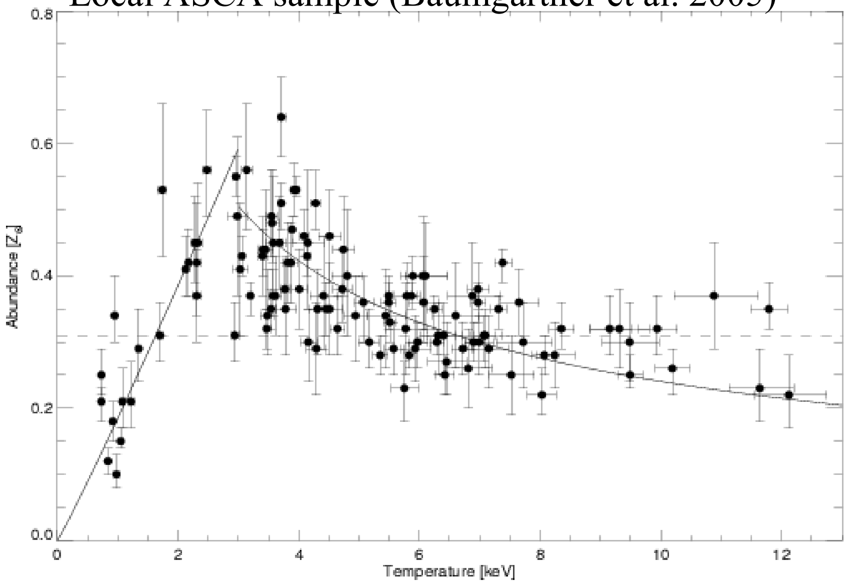


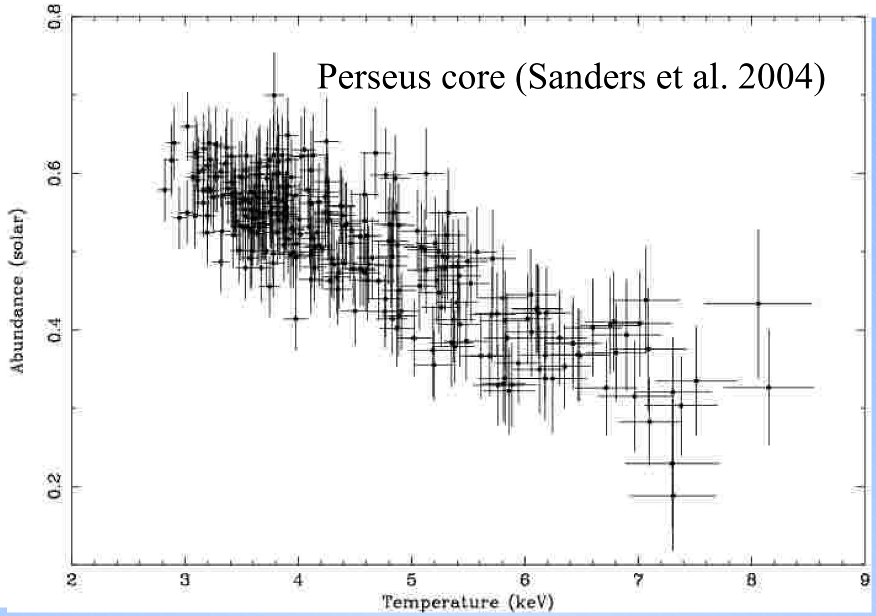
The Iron abundance is determined almost uniquely by the K-shell complex at 6.7-6.9 keV rest-frame

Iron abundance vs temperature



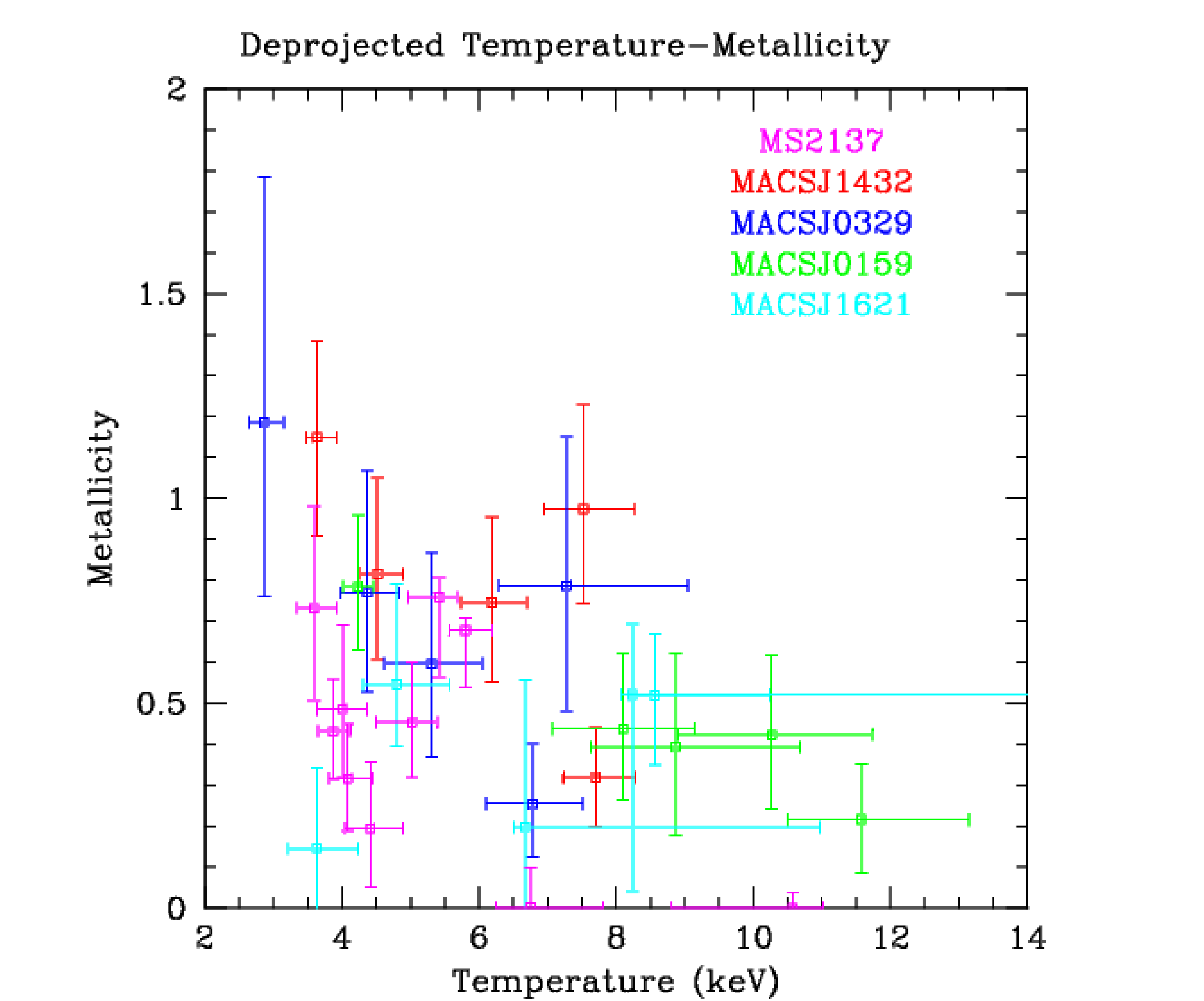
Local ASCA sample (Baumgartner et al. 2005)





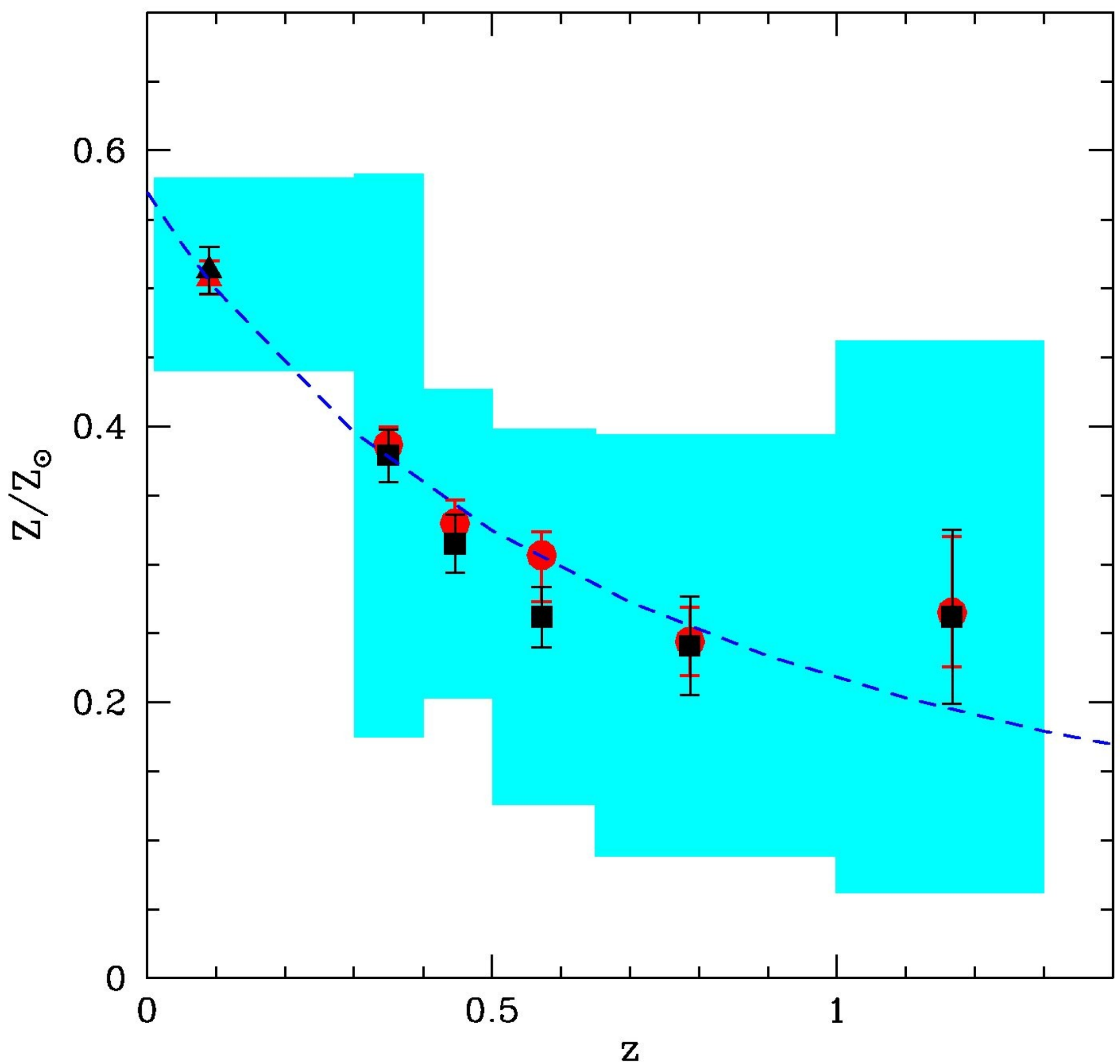
Balestra et al. 2007

Cool core clusters at z ~ 0.6



Garbari et al., in prep

Iron abundance vs redshift



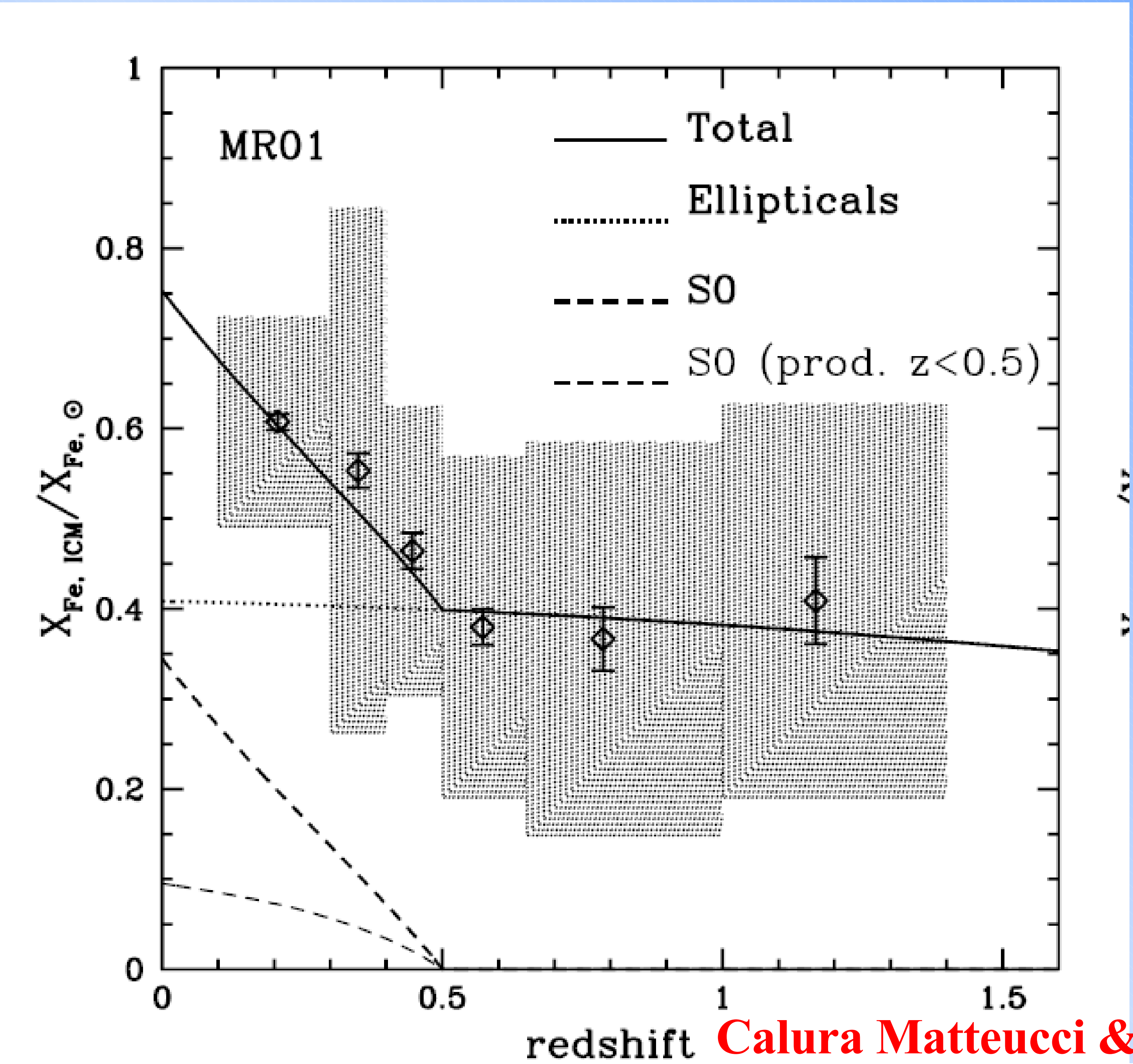
Balestra et al. 2007

See also Maughan et al. in press

The association of high Fe abundance with low temperature/high density (low entropy) gas can be explained with ram pressure + dynamical processes on metal rich disk galaxies or sink of enriched gas in small groups/halos (Cora et al. 2007).
This can also account for Fe abundance evolution at z>0.5 and for a possible decrease of cool cores at high redshifts (Vikhlinin et al. 2006, Santos et al. 2007).

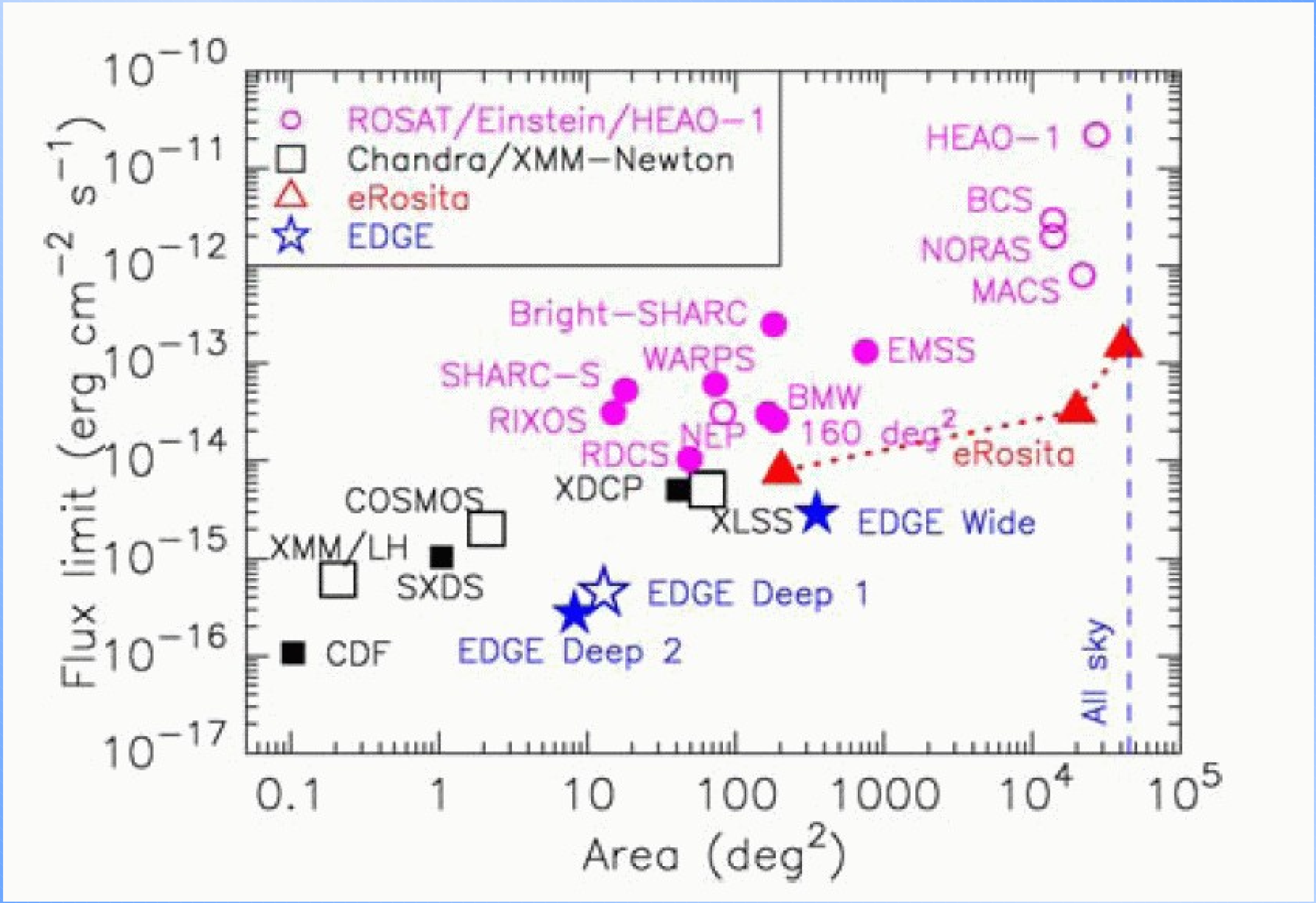
This shows how the Fe distribution within clusters and as a function of epoch can constrain the thermal and chemical history of the ICM and the evolution of cluster galaxies.

Fe abundance evolution and S0 fraction evolution



Calura Matteucci & Tozzi 2007

The future of X-ray surveys



den Herder, Piro Ohashi et al. + EDGE proposal, see poster by L. Amati

EDGE combines high spectral resolution (~ 3 eV) with high good spatial resolution (15'' HPD) on a large Field of view (1.4 sq deg) to study thermo and chemodynamical properties of the ICM up to the virial radius and of diffuse baryons (WHIM) in emission and absorption against GRB and, at the same time, perform a Deep (12 sq deg) and Medium Deep (300 sq deg) survey to search for clusters and groups up to high z (hundreds expected at z>1).

1 MS pointings will reach 1.e-16 cgs in 0.5-2.0, comparable to Chandra deep Surveys on solid angle of 1 sq. deg.

in addition:
cosmology with GRB
and AGN physics: 3000 objects per sq. deg. , mostly absorbed AGN - about 100 or so above z>4
X-ray clustering and its evolution.
other...

Summary

High-redshift clusters of galaxies observed in the X-ray band are relevant for understanding cosmological parameters, large scale structure evolution and SF formation and nuclear activity in clusters galaxies and interactions with the ICM at the same time!

First evidence of evolution in the average Fe abundance, a factor of 2 from z~0.5 to z=0. ICM was already enriched at z>1. Z-kT relation holds at high-z. Both observations possibly explained by the sink of low entropy, high-metallicity gas associated with small halos and/or galaxies.

To capitalize what we have learned so far with Chandra and XMM we must have both a wide-area, medium-deep survey and a mission devoted to properties of the ICM, AND a future X-ray mission with the same spatial resolution of Chandra!! The technological challenge for the mirrors and for high res X-ray spectroscopy is crucial.