Probing the intra-cluster medium around high redshift radio galaxies -ideas

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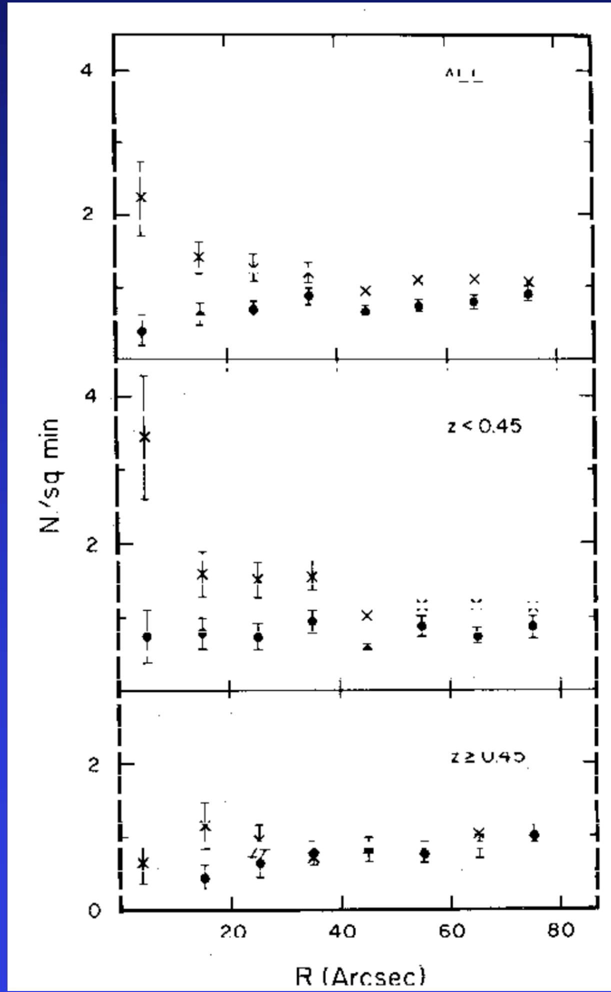
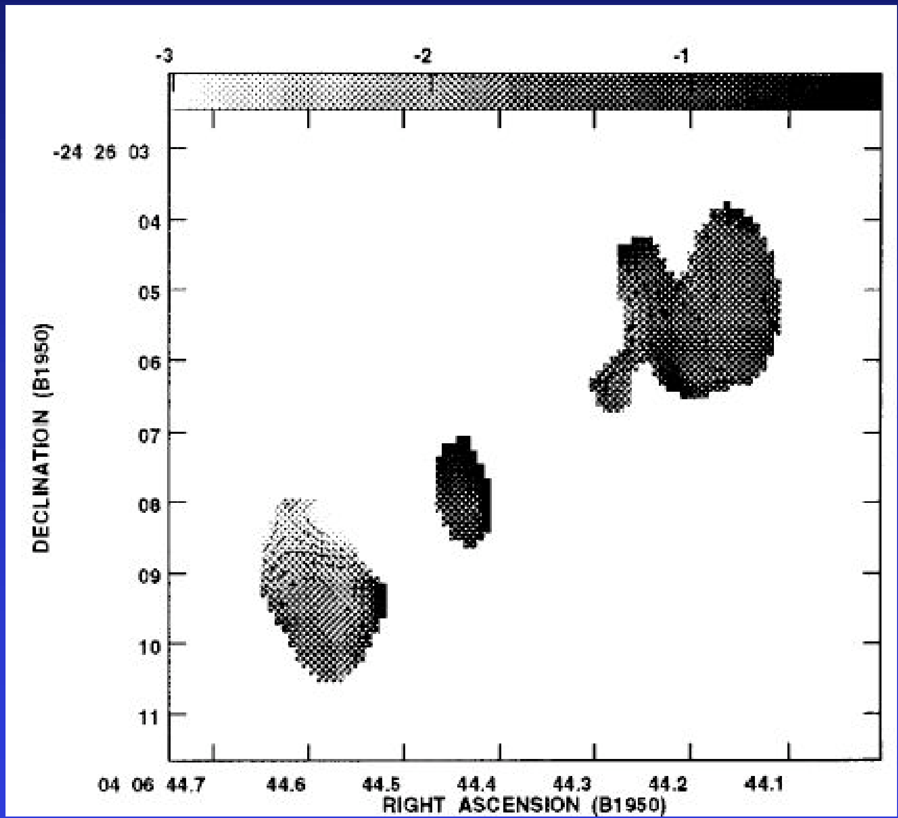
Probing the intra-cluster medium around high redshift radio galaxies

Up to z=0.5: correlation between radio galaxies and cluster like environment (Yee & Green1984, Yates et al. 1989,Hill & Lilly 1991 ....)



Probing the intra-cluster medium around high redshift radio galaxies

Faraday rotation measurements of high z (z>1) radio galaxies indicate that these sources are embedded in dense environments (Carilli et al. 1997)



Probing the intra-cluster medium around high redshift radio galaxies

Optical studies around high redshift (z>1) radio galaxies indicate presence of galaxy overdensities (Le Fevre et al.1996; Pascarelle et al.1996)
(HST image from Pascarelle: radio galaxy at z=2.4-- 53W002)

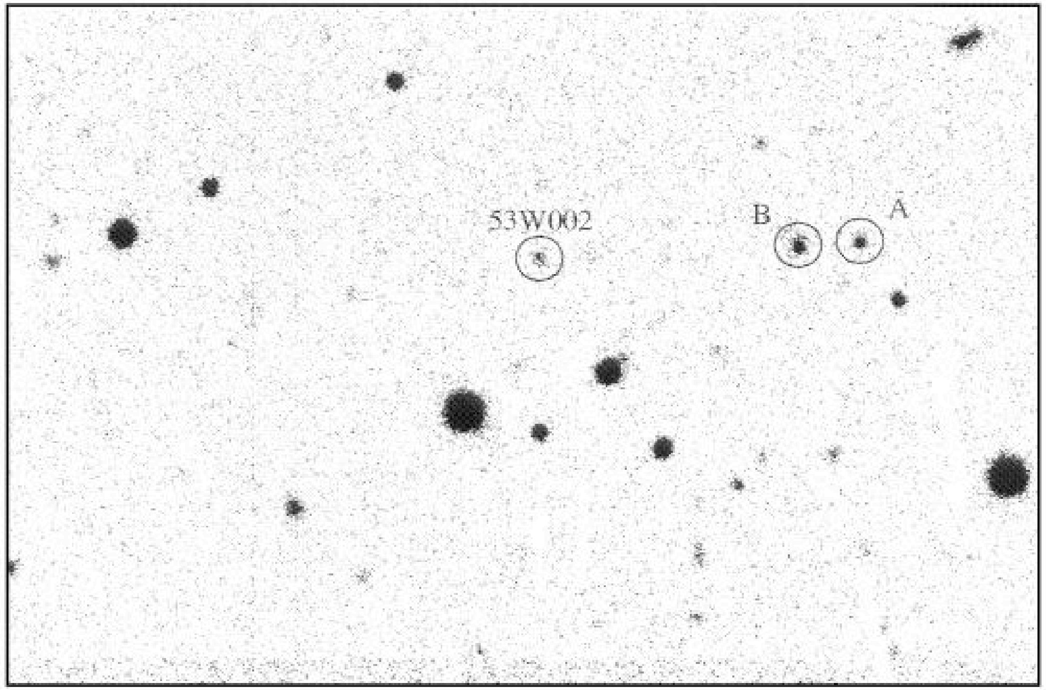


Fig. 3a

Probing the intra-cluster medium around high redshift radio galaxies

ROSAT: extended X-ray emission around distant radio galaxies

(Hardcastle & Worrall 1999) ICM emission

=> assumption: the trend of correlation holds up to high z

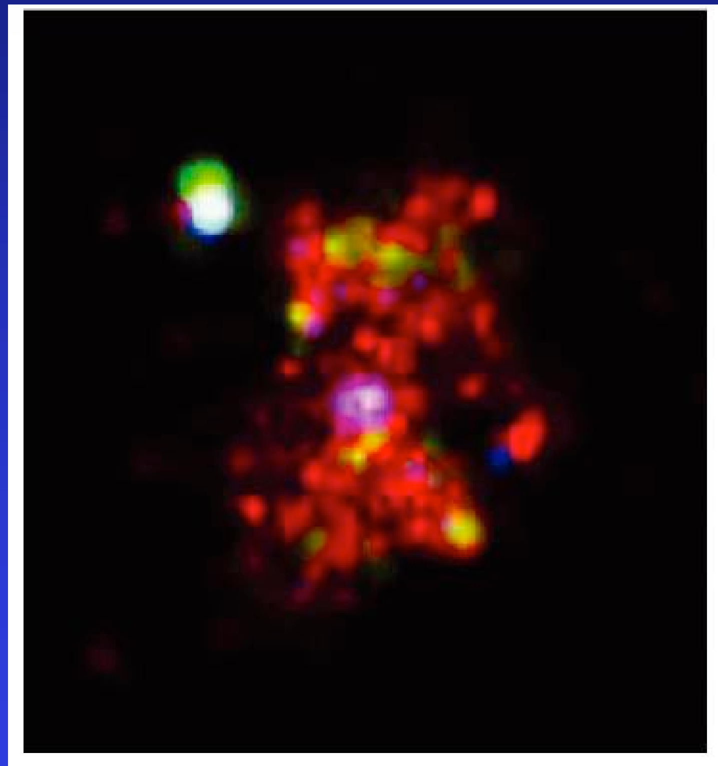
Table 2. Results of radial profile fitting for extended sources.

Source	Luminosity distance (Gpc)	Source radius (arcsec)	Background radius (arcsec)	χ^2	dof	β	Core radius (arcsec)	Central surface brightness (10^{-6} count s^{-1} $arcsec^{-2}$)	Counts in point model	Counts in β-model
3C 28	1.286	64	128	14.57	9	0.67	15	33.0 (H)	29	2040
3C 48	2.61	150	210	6.42	13	0.9	15	12.9 (H)	5892	285
3C 98	0.186	180	240	8.67	7	0.9	100	0.1418 (H)	20	136
3C 215	2.97	150	210	7.68	14	0.9	20	2.494 (H)	3915	301
3C 219	1.138	112.5	150	2.6	8	0.9	30	12.8 (P)	360	129
3C 220.1	4.8	60	90	0.689	6	0.9	13	9.72 (H)	117	152
3C 254	6.02	150	210	14.3	16	0.9	35	5.403 (P)	1474	333
3C 264	0.126	120	180	21.6	14	0.67	10	18.5 (P)	3722	1257
3C 272.1	0.019	100	150	8.96	8	0.9	20	48.06 (H)	84	1301
3C 275.1	4.27	150	210	1.9	12	0.9	25	1.96 (H)	367	81
3C 280	8.95	120	260	–	7	0.67	65	0.16 (P)	43	149
3C 295	3.407	150	210	16.7	12	0.67	8	59.4 (H)	23	675
3C 310	0.333	320	370	7.17	9	0.5	75	0.912 (H)	93	1190
NGC 6109	0.180	60	120	1.45	5	0.9	25	1.01 (H)	59	46
3C 334	4.25	60	120	4.84	9	0.9	20	1.689 (H)	1075	48
3C 346	1.05	180	210	15.5	14	0.67	60	1.60 (P)	767	454
3C 388	0.570	210	240	16.6	14	0.5	13	13.3 (H)	99	2211
3C 449	0.103	700	1000	7.7	11	0.35	35	3.09 (P)	33	1807

An H in column 9 denotes a surface brightness derived from HRI observations; a P denotes PSPC results.

What did Chandra and XMM-Newton find so far?

Up to now a dozen of z>1 radio galaxies observed with Chandra up to now no prominent exteneded X-ray emission found (example 3C 294 by Fabian 2001; 2003)



Donahue, Daly & Horner (2003) extended X-ray emission detected in ROSAT data due to source confusion ; similar results with XMM: Hardcastle et al. 2004; Belsole et al. 2004

=> not a lot of indication for a hot ICM around distant radio galaxies

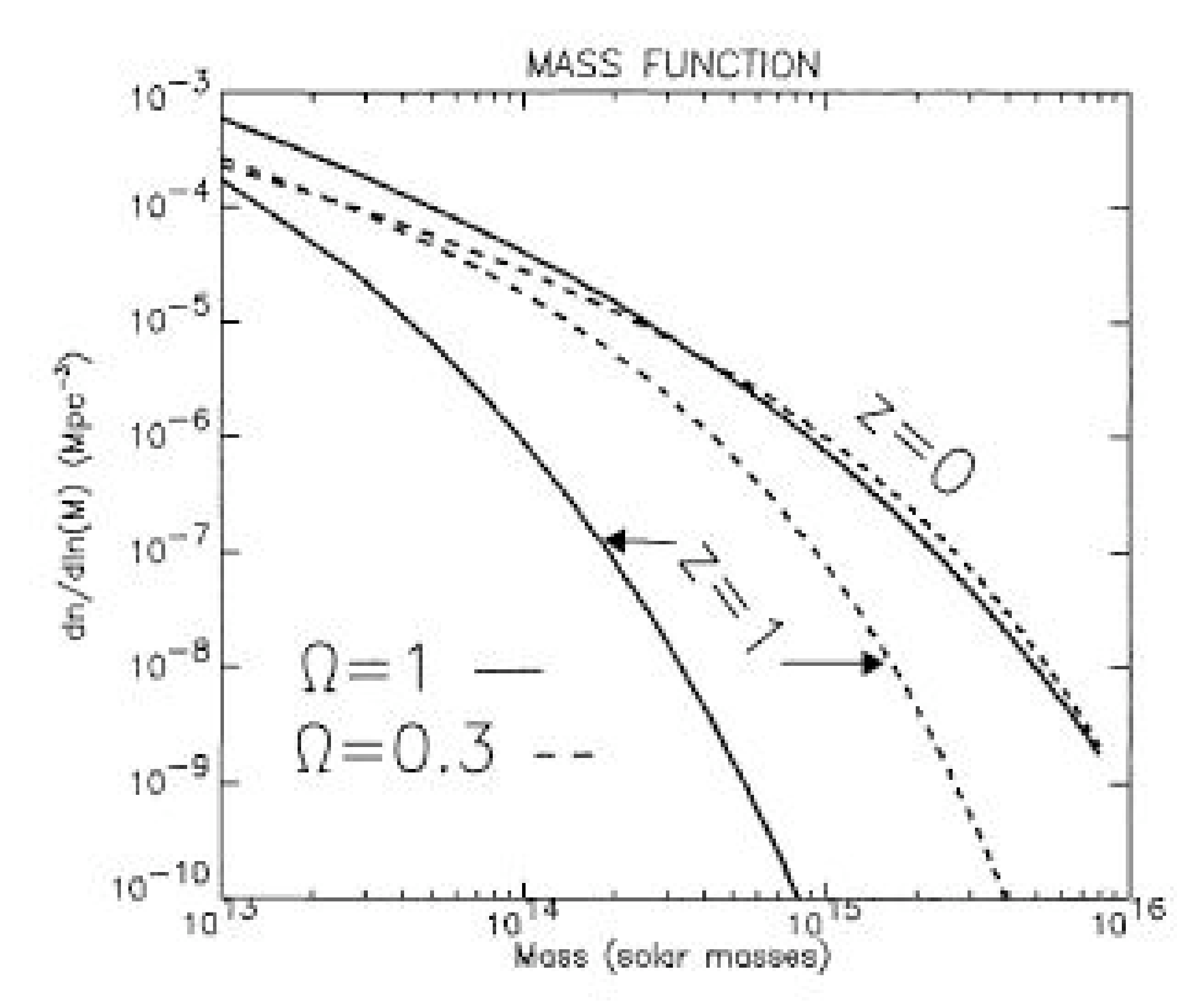
Explanation(s)?

The mechanism of creating radio galaxies is different for low and high redshift radio galaxies: not logical since high z radio galaxies have same morphology as nearby ones

Other explanation: distant radio galaxies are embedded in cluster environments which did not yet collapse or are just about to collapse=> in agreement with observations (Faraday rotation, galaxy overdensities)

What are expected collapse times of clusters?

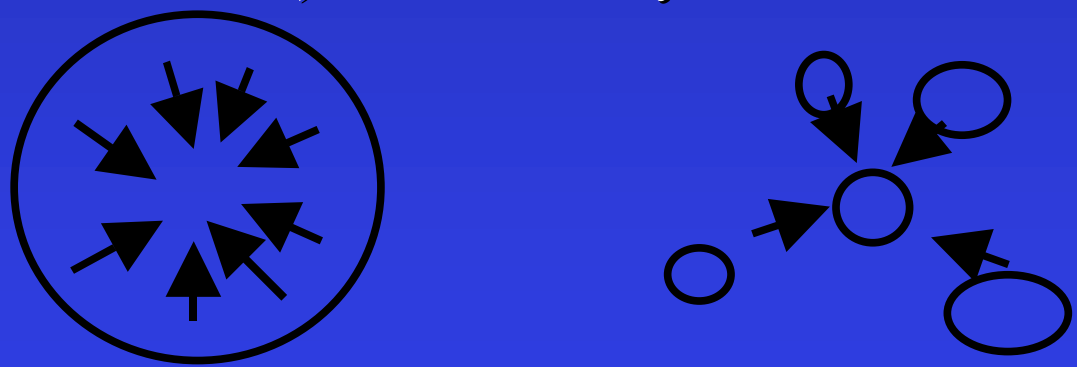
Mass function of clusters for different redshifts Bartlett 1996 at z=1 number density of massive clusters lower than at z=0 structures not entirely collapsed at z=1



Probing the collapse of clusters

If distant radio galaxies are embedded in cluster environments which did not yet collapse or are just about to collapse we can use the radio galaxies as light houses for birth places of clusters

Regarding in detail we can learn about the initial collapse from which clusters form.
2 possibilities:
1) spherical homogenous collapse
2) hierarchically from even smaller structures



What can we learn ?

If radio galaxies are light houses for cluster environments:

Probing the mass density distribution before the cluster collapse -> measuring fragmentation

Growing of large scale structures

- Constraints on initial conditions (for numerical simulations)

What can we learn ?

If radio galaxies are light houses for cluster environments:

Statistical approach: mapping radio galaxies at different redshifts and measuring X-ray luminosity of ICM with radio properties.

When correlation of radio X-ray properties of more nearby clusters is found => cluster is relaxed

Probing collapse time of clusters (maybe even as function of cluster mass-if large number of sources is observed)

What kind of observations do we need?

a) very high resolution to distinguish between radio galaxy emission and cluster emission

b) high sensitivity to get down to very low y for the SZ-signal

Alma will have high spatial resolution. Does it have the required sensitivity? Equivalent of groups with 1keV? If else, only statistical approach
high resolution is essential also for statistical approach to have a limit on source confusion

Comparison of future SZ/X-ray observations

Possibility of high resolution imaging with SZ only

No planned X-ray mission with subarcsecond resolution :
Constellation-X merged with XEUS: 3-5 arcsecond resolution
see comparison between ROSAT and Chandra, high spatial resolution is needed to eliminate source confusion

Alma and it potential for observing cluster environment of high redshift radio galaxies

Information on the initial collapse of clusters (fragmented or not)

Determining collapse times of clusters or the era of cluster collapse (statistical approach)