The Chandra 3C Snapshot Survey for Sources with z < 1

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1 Introduction

The 3CR catalogue is the best studied sample of radio-loud AGNs in existence. It spans a wide range in redshift and in radio power. Here we report the preliminary results obtained on the 3CR sources pointed during Chandra Cycle 15, previously unobserved in the X-rays.

Our sample lists 22 radio sources lying in the redshift range between 0.5 and 1.

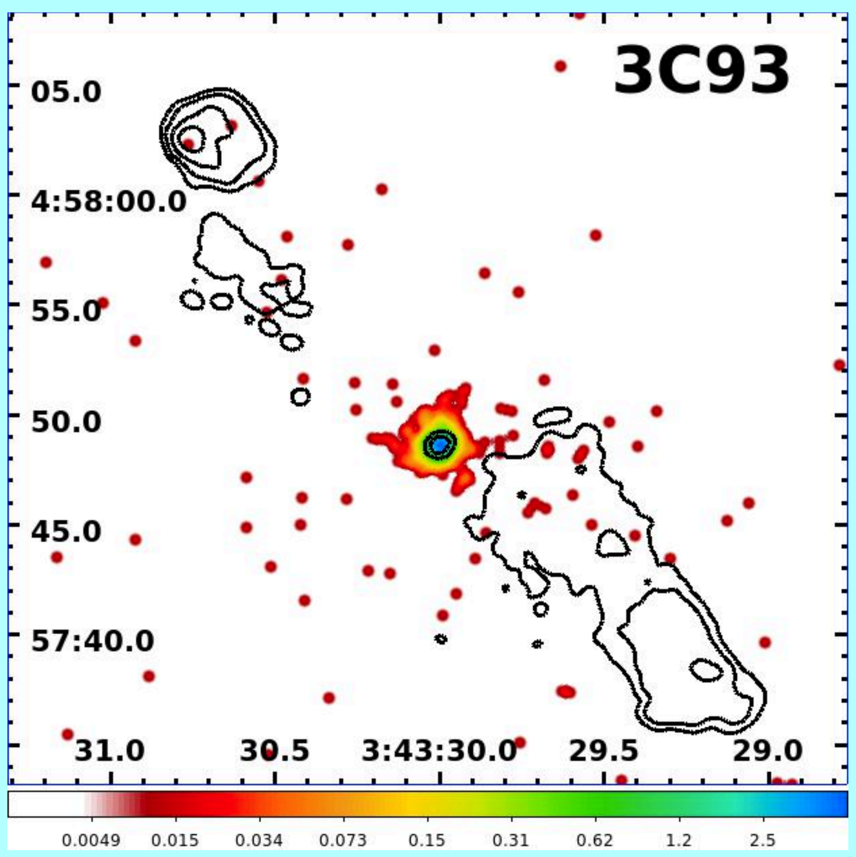
We compared the X-ray observations with the radio maps available in the VLA and in the MERLIN archives. Chandra is the only X-ray facility with an angular resolution comparable to radio data and thus sufficient to resolve the radio extended components.

For the numerical results we used cgs units, unless stated otherwise. We assume a flat cosmology with $H_0 = 69.6$ km/(s Mpc), $\Omega_M = 0.286$ and $\Omega_\Lambda = 0.714$.

2 X-ray fluxmaps

The data reduction was performed following the standard procedure described in the Chandra Interactive Analysis of Observations (CIAO) threads[a], using CIAO v4.6 and the Chandra Calibration Database (CALDB) version 4.6.2.

Three different flux maps were created in the energy ranges: 0.5 – 1 keV (soft), 1 – 2 keV (medium), 2 – 7 keV (hard). Flux maps, as implemented in CIAO, are corrected for exposure time and effective area and our implementation used monochromatic exposure maps. Each band is assigned a nominal energy; in our case the nominal energies are 0.75, 1.4, and 4 keV for the soft, medium and hard band, respectively and the exposure maps are constructed for these nominal values.



The X-ray fluxmap in the total energy range between 0.5 and 7 keV is shown here. Radio contours from the VLA archival image are overlaid in black.

Since the natural units of X-ray flux maps are counts/sec/cm^2 we converted them to cgs units by multiplying each event by the nominal energy of each band, thereby assuming that every event in the band has the same energy.

[a] http://cxc.harvard.edu/ciao/guides/index.html

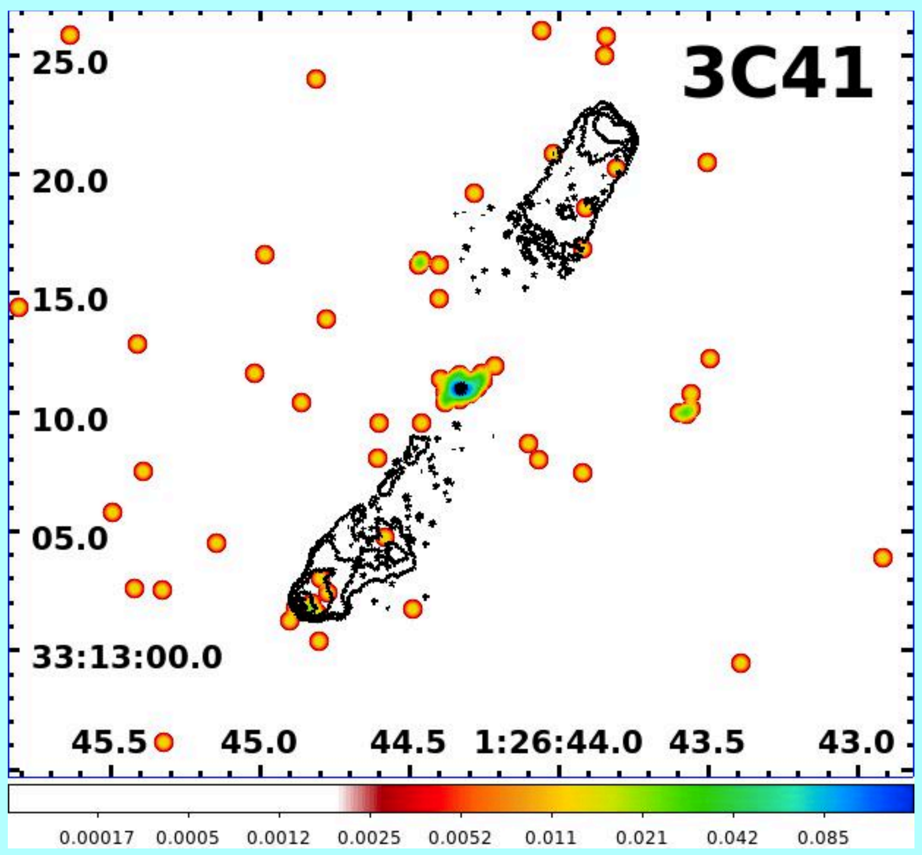
3 Nuclear emission

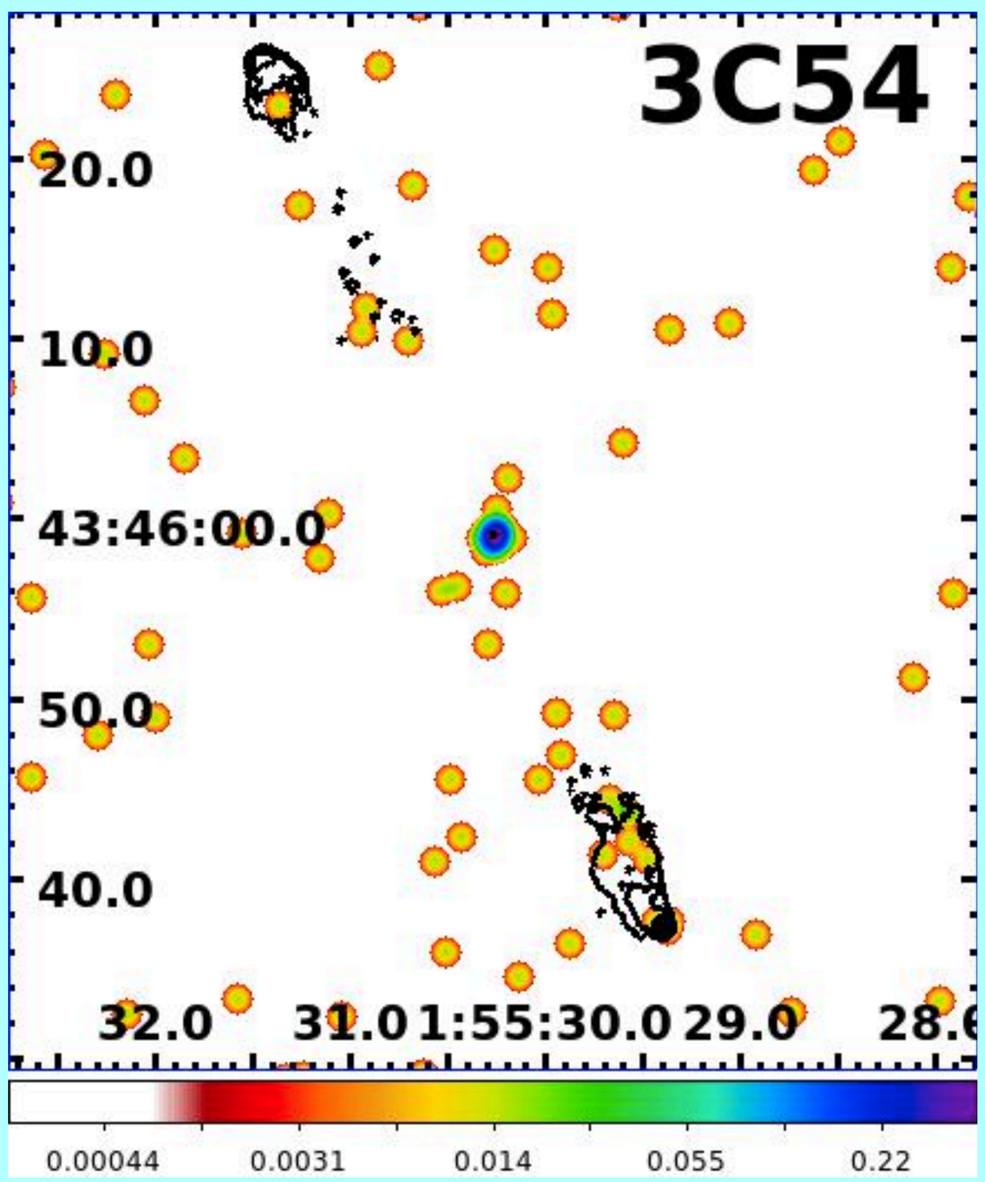
We detected the X-ray emission arising from the all nuclei in our sample.

As done in our previous investigations we also computed an 'extended emission' parameter defined as the ratio of the net counts in the r = 2 arcsec circle to the net counts in the r = 10 arcsec circular region surrounding the core of each 3CR source. Values significantly less than 0.9 indicate the presence of extended emission around the nuclear component and these were found in 7 cases.

4 Hotspots

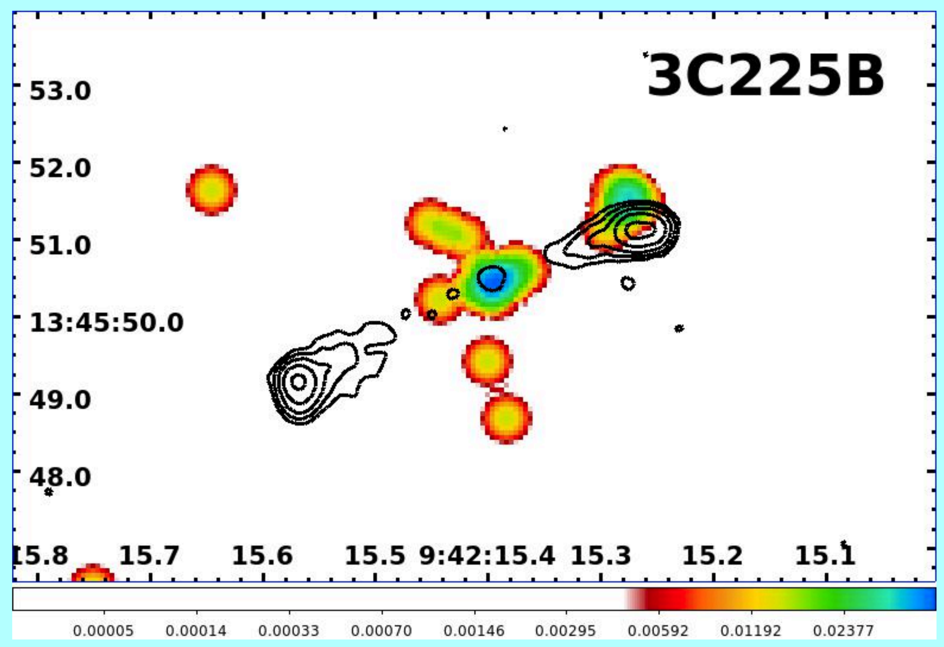
We detected and report here, the X-ray emission of three hotspots in 3 different sources, namely: 3CR 41, 3CR 54 and 3CR 225B, while no emission arising from jet knots and/or lobes was found.





The hotspots detected in our sample for 3CR 41 and 3CR54. Radio contours overlaid to X-ray images are shown in black.

For the 3 hotspots detected in our sample we report In the following table (1) the 3CR name; (2) the component name; (3) the component class: "h" = hotspot - "k" = knot; (4) the number of counts column gives the total counts in the photometric circle together with the average of the 8 background regions, in parentheses; both for the 0.5 to 7 keV band; measured X-ray fluxes between 0.5 and 1 keV, 1 and 2 keV, 2 and 7 keV, and 0.5 and 7 keV and together with the X-ray luminosity in the range 0.5 to 7 keV with the 1σ uncertainties given in parenthesis. X-ray fluxes are given in units of 10^{-15}erg cm^{-2}s^{-1} and 1σ uncertainties are given in parenthesis.



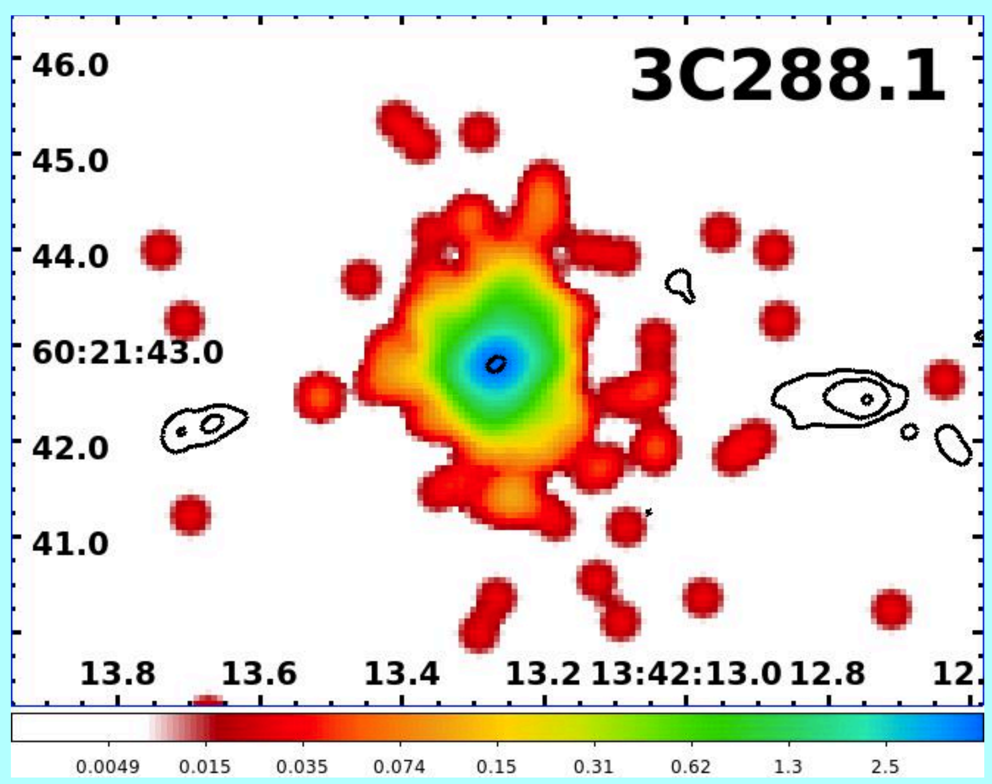
The northern hotspot detected for 3CR255B. Radio contours, overlaid to X-ray image, are shown in black.

X-RAY EMISSION FROM RADIO EXTENDED STRUCTURES (I.E., KNOTS AND HOTSPOTS).

3CR name	Component	class	Counts	$F^*_{0.5-1\ keV}$ (cgs)	$F^*_{1-2\ keV}$ (cgs)	$F^*_{2-7\ keV}$ (cgs)	$F^*_{0.5-7\ keV}$ (cgs)	L_X (10^{42}erg s^{-1})
41	s11.3	h	6 (0.0)	0.56 (0.56)	0.55 (0.55)	4.66 (2.69)	5.77 (2.8)	17.51 (8.5)
54	s9.3	h	3 (0.0)	0.0 (0.0)	0.91 (0.52)	0.0 (0.0)	0.91 (0.52)	3.05 (1.74)
225B	w2.0	h	4 (0.125)	0.0 (0.0)	0.79 (0.58)	0.69 (0.69)	1.48 (0.9)	2.1 (1.27)

5 Galaxy Clusters

We discovered the presence of X-ray thermal emission probably associated with the intra-cluster medium in the case of 3CR 288.1 rather than with extended emission around its nuclear regions.



This X-ray emission extends for about 7 arcsec that at redhsift z =0.962 as for 3CR 288.1 correspond to about 50 kpc.

Acknowledgments

Dan Harris passed away on December 6th, 2015. His career spanned much of the history of radio and X-ray astronomy. His passion, insight, and contributions will always be remembered.