The Chandra 3C Snapshot Survey for Sources with z < 0.3

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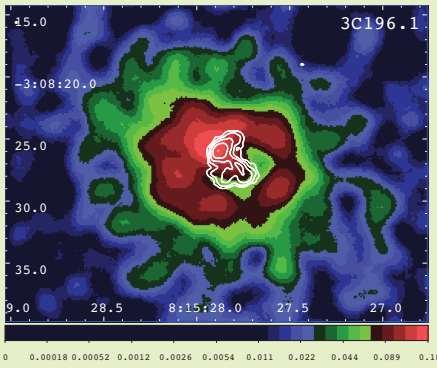
1 Introduction

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. During the last few years a snapshot survey of 3CR sources using the Hubble Space Telescope has been performed. Radio maps are readily obtained from the VLA and MERLIN archives as well as from colleagues. This poster summarizes results from the Chandra (AO9/AO12) survey which consists of 55 3C sources with z$\leq$ 0.3 (see also Massaro et al. 2010 ApJ, 714, 589).

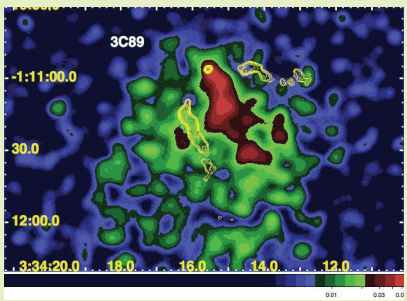
2 Galaxy cluster association

In our sample of 3C sources, we have few cases radio galaxies associated with galaxy clusters. Our best example is 3C 196.1 (galaxy cluster CIZA J0815.4-0308).



The X-ray emission associated with the X-ray galaxy cluster around 3C 196.1 (8GHz radio emission overlaid in white).

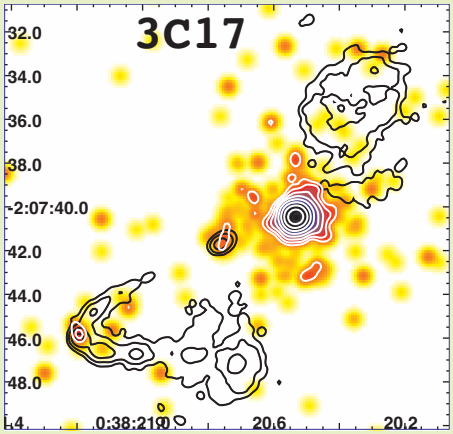
Another interesting case is the thermal emission of the galaxy cluster RS 17 associated with 3C 89, where the brighter filaments of X-ray emitting gas lie between the arms of this Wide Angle Tail (WAT) radio galaxy.



The X-ray galaxy cluster emission associated to the WAT 3C 89. The 8 GHz radio emission of the 3C 89 is also shown (yellow contours)

3 Large scale X-ray jets

The source 3C 17 represents the best example in our sample of an X-ray jet detection. The VLA radio map shows a curved jet (Morganti et al. The first knot lies at about 3.7" (12.8 kpc) from the nucleus while the other detected knot is about 11.3" (39.5 kpc) away. An optical counterpart has been detected for both knots.

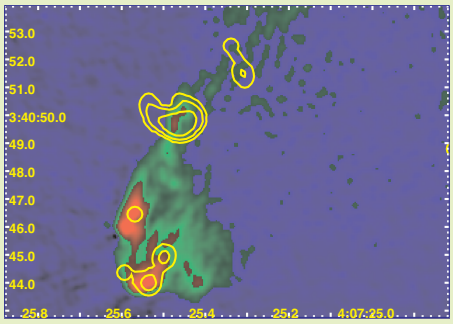


The X-ray detection of the radio curved jet in 3C 17 (VLA radio and HST optical contours overlaid in black and white, respectively).

We have suggested how the ratio of X-ray to radio intensities for the knots of curved jets can be used as a diagnostic for the X-ray emission process. IC/CMB emission, being more tightly beamed than synchrotron emission would be manifest by a larger ratio for a knot moving closer to the line of sight than its neighbors (see Massaro et al. 2009, ApJ, 696, 980).

4 Hotspots

The detections of X-ray emission associated with the SE hotspot of 3C 105 is shown.



The radio emission of the southern hotspot in 3C 105 (X-ray contours overlaid).

It represents a very rare case in which the brighter X-ray emission coincides with a radio feature which could be described as the jet entering the hotspot region. Its distance from the galaxy corresponds to about 0.274 Mpc, projected.
A detailed description of the radio-optical-X-ray emission of the hotspot in 3C 105 can be found in Orienti et al. (2011, MNRAS submitted).

Acknowledgments
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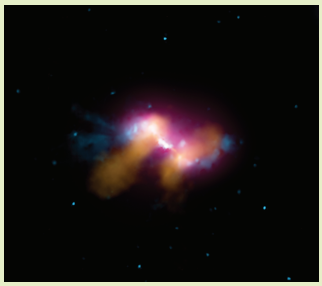
5 Thermal diffuse emission

Evidence of a clear spatial association between the optical emission line region (ELR) and the soft X-ray (0.5-2.0 keV) diffuse radiation has been clearly identified in at least two radio galaxies of our sample. 3C 171 (Hardcastle et al. 2010 MNRAS, 401, 2697) and 3C 305 (Massaro et al. 2009, ApJ, 692L, 123). The origin of this extended X-ray structure has two different interpretations: as due to the interaction between matter outflows and shock-heated ambient gas, or as due to gas photoionized by nuclear emission (Balmaverde et al. 2011 in prep.).



The extended structure in 3C 305. The radio emission is in yellow, the X-rays are in magenta, while the [O III] emission line region is in cyan.

• 3C 305 is a clear case of a Compact Steep Spectrum (CSS) radio galaxy, in which the X-ray radiation appears to be associated with the optical emission line region, dominated by the [O III]5007. Comparing the X-rays, the optical and the radio emission, we argue that the high energy emission has a thermal nature and it is not directly linked to the radio jet and hotspots of this source (Massaro et al. 2009, ApJ, 692L, 123).
• 3C 171: in this radio galaxy, the X-ray thermal emission more likely originates from a collisionally ionized material, shock-heated by the passage of the radio jet. This hot plasma is also responsible for the depolarization at low frequencies of the radio emission from the jet and hotspots.

6 Nuclear absorption

Most nuclei of AGN have X-ray spectra which are well described by power laws with α_x mainly ranging from 0.5 to 1.5 . For the stronger nuclei, we have employed the usual spectral analysis. As expected, we find a sizable fraction ($\sim$1/3) of our sources showing evidence for significant absorption ($N_H > 5 \times 10^{22}$ cm^{-2}). The detailed analysis of the X-ray nuclei for the sources not affected by strong pileup ($\leq$ 10%)and with S/N>3 is still ongoing. For 3C 105 the Chandra spectrum reveals that the core is absorbed, there is a marginal detection of a Fe Ka line and evidence of a soft excess (Torresi et al. 2011 in prep.), in agreement with the XMM-Newton data analyzed (Massaro