Mem. S.A.It. Vol. 82, 670

Memorie della

A statistical investigation of the radio emission of clusters: role of AGNs

J. Lanoux[1,2], E. Pointecouteau[1,2], and M. Giard[1,2]

[1] Universite de Toulouse (UPS-OMP), Institut de Recherche en Astrophysique et Planetologie, 9 Av. colonel Roche, BP 44346, F 31028 Toulouse cedex 4, France
e-mail: `lanoux@cesr.fr`

[2] CNRS, UMR 5277, 9 Av. colonel Roche, BP 44346, F 31028 Toulouse cedex 4, France

Abstract. Radio emission in the direction of galaxy clusters is due to the individual emission of AGN, and to the diffuse non-thermal emission of the intracluster medium (ICM). The population of AGN in clusters is correlated to the overall halo properties, and likely impacts their evolutions. In order to better understand this connection (which will also leads to constraints on the non-thermal ICM emission for lower mass systems), we are conducting a statistical analysis of the radio emission in the direction of a large X-ray cluster sample. By means of their stacked radio emission, we are investigating the radio luminosities in clusters of galaxies with respect to their mass, with the goal to better understand their link to and their imprint on the intra-cluster gas physics.

Key words. Radio: galaxies: clusters – X-rays: galaxies: clusters – Radio: galaxies – Intergalactic medium – Diffuse radiation – Cosmology: observations

1. Introduction

The ICM is mainly constituted of diffuse hot gas that cools down via thermal Bremsstrahlung emission observed at X-ray wavelengths. But it is also populated by non-thermal relativistic electrons observed at radio wavelengths due do their synchrotron emission. The radio non-thermal emission of galaxy clusters is due to point-like sources (AGN, radio galaxies) and diffuse extended sources (halos, relics, mini-halos, e.g. Ferrari et al. 2008 for a review).

Diffuse radio emission has now been observed in a few tens of massive merging galaxy clusters. Giovannini et al. (1999) and Liang et al. (2000) were the first to show the existing correlation between radio and X-ray luminosities in clusters. This result was confirmed by latter works such as Giovannini et al. (2009) or Brunetti et al. (2009).

Here, we investigated this correlation down to a lower mass regime of clusters, together with the contribution of AGN to the total radio luminosity. So far, we have been limited by the sensitivity of radio surveys to directly detect diffuse emission.

Therefore, we investigated the correlations by means of statistical and stacking tools applied to X-ray (RASS) and radio (NVSS) all-sky surveys. We used the Meta-Catalogue of X-ray detected Clusters of galaxies (MCXC, 1743 clusters, Piffaretti et al. 2011). From maps extracted at each cluster position, we

Send offprint requests to: J. Lanoux

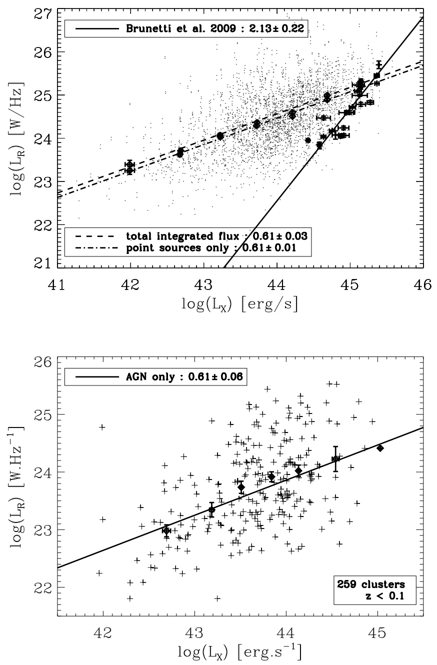

Fig. 1. $L_R - L_X$ correlations for total integrated radio luminosities within R_{500} and for luminosities of point sources only (top). $L_R - L_X$ correlation for radio luminosities of AGN for a sub-sample of 259 clusters with redshift $z < 0.1$ (bottom).

computed count rates and fluxes within R_{500}. We derived corresponding X-ray and radio luminosities. From the NVSS source catalogue (Condon et al. 1998) and the 2MASS extended source catalogue (Jarrett et al. 2000), we selected AGN associated with clusters and we derived their summed radio luminosities within R_{500} for each cluster. We then fitted the $L_R - L_X$ correlations with BCES orthogonal regression method (Akritas et al. 1996).

2. Results

We found a $L_R - L_X$ correlation with a slope of $\sim$ 0.6 for total integrated radio luminosities within R_{500} (Fig. 1, top). This slope is flatter compared to other works which investigated the relation between detected diffuse radio emissions and L_X (i.e. ~2.1 for Brunetti et al. 2009 or ~1.7 for Giovannini et al. 2009).

We found that the summed radio luminosities of selected point sources within R_{500} compares very well to the total integrated radio luminosities within this aperture. This likely shows that the component of point sources (i.e. AGN) is dominant in our aperture.

This conclusion is reinforced by the strong $L_R - L_X$ correlation we found for radio luminosities associated to AGN only for a subsample of 259 galaxy clusters of the MCXC with redshift $z < 0.1$ (Fig. 1, bottom). We derive a slope of ~ 0.6 compatible with the previous correlation found for total integrated radio luminosities. This strengthened our result for a flatter $L_R - L_X$ with respect to the correlation found for diffuse radio emission in clusters.

3. Conclusion and perspectives

We have proven the radio emission of a large number of X-ray clusters, and we have shown that there is a strong $L_R - L_X$ correlation, and that the radio luminosity is mainly contributed by AGN in clusters. The provided statistical constraints will allow us to further investigate the overall nature of the radio emission seen in the direction of galaxy clusters.

References

Akritas, M. G. and Bershady, M. A. 1996, ApJ, 470, 706
Brunetti, G., Cassano, R., Dolag, K., and Setti, G. 2009, A&A, 507, 661
Condon, J. J., Cotton, W. D., Greisen, E. W., et al. 1998, AJ, 115, 1693
Ferrari, C., Govoni, F., Schindler, et al. 2008, Space Sci. Rev. 134, 93
Giovannini, G., Tordi, M., Feretti, L. 1999, New Astronomy, 4, 141
Giovannini, G., Bonafede, A., Feretti, L., et al. 2009, A&A, 507, 1257
Jarrett, T. H., Chester, T., Cutri, R., et al. 2000, AJ, 119, 2498
Liang, H., Hunstead, R. W., Birkinshow, M., and Andreani, P. 2000, ApJ, 544, 686
Piffaretti, R., Arnaud, M., Pratt, G. W., Pointecouteau, E., & Melin, J. 2011, A&A, submitted [arXiv:astro-ph/1007.1916]