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Radio halos in a mass-selected sample of Galaxy clusters

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Abstract. Radio Halos are diffuse synchrotron radio sources observed in a number of galaxy clusters. To test the theoretical models proposed for their origin, mass-selected samples of GCs with adequate radio and X-ray data are necessary. We select from the Planck SZ catalogue clusters with $M \gtrsim 6 \times 10^{14} M_{\odot}$ and $0.08 < z < 0.33$. We use the NVSS and the Extended GMRT RH survey and find that RHs are preferentially found in massive/merging systems, while clusters without RH are less massive and relaxed.

Keywords : galaxies: clusters: general; radio continuum: general; X-rays: galaxies: clusters

1. Introduction

Radio Halos (RHs) are observed in a high fraction of merging galaxy clusters (GCs, e.g., Cassano et al. 2010). The RH-merger connection is naturally explained by the turbulence re-acceleration scenario, where RHs arise due to the acceleration of relativistic particles by turbulence generated by cluster mergers (e.g., Brunetti et al. 2001). In this scenario, the formation and evolution of RHs depend on the cluster merging rate at different epochs and on the mass of the hosting GCs themselves, which sets the energy budget available for the re-acceleration of relativistic particles. On the basis of this scenario, RHs are expected to be found preferentially in massive and merging GCs, they should be rarer in less massive systems and absent in relaxed systems (e.g. Cassano & Brunetti 2005). To test this prediction, mass-complete samples of GCs with adequate radio observations are necessary. Here, we present preliminary

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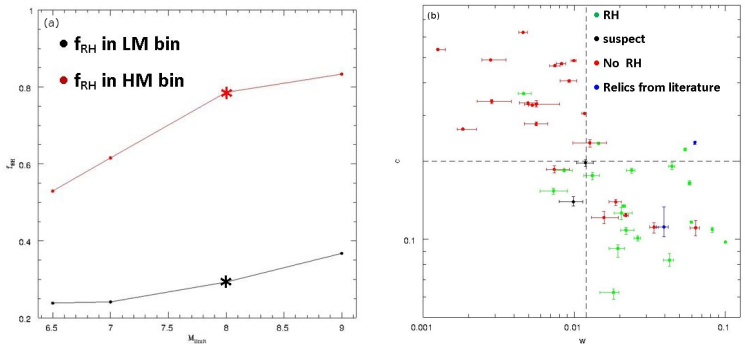

Figure 1. (a) f_{RH} as a function of the transition mass between the LM and the HM bins, asterisks mark the value corresponding to $M_{bound} = 8 \times 10^{14}\, M_{\odot}$. (b) $c - w$ morphological diagram.

results of our work, aiming at providing an unbiased measure of the fraction of clusters with RH, f_{RH}, and of its dependence on the cluster mass in a nearly complete sample of mass-selected GCs.

2. A mass-selected sample of galaxy clusters: first results

We select from the Planck SZ catalogue (Planck Collaborations, 2013) all clusters with $M_{500} \gtrsim 6 \times 10^{14}\, M_{\odot}$ and $0.08 < z < 0.33$. To check for the presence of RHs we use the NVSS (plus literature information) for clusters at $z \sim 0.08 - 0.2$, while for $z \sim 0.2 - 0.33$ we use the Extended GMRT RH survey (Kale et al. 2013 and references therein). This leads to a total sample of 54 clusters with available radio information with a completeness of ~65%. We split this sample in two mass bins and derive f_{RH} in the low-mass (LM) and in the high-mass (HM) bins as a function of the boundary mass, M_{bound} (Fig. 1, left panel). In general we find that $f_{RH} \sim 20 - 30\%$ in the LM bins and $f_{RH} \sim 60 - 80\%$ in the HM bins. We use Monte Carlo simulations to find the value of M_{bound} which maximizes the jump of f_{RH} and its reliability. We find that for $M_{bound} \approx 8 \times 10^{14}\, M_{\odot}$ $f_{RH} \approx 30 \pm 9\%$ in the LM bin and $f_{RH} \approx 79 \pm 24\%$ in the HM bin. We derive that the probability to observe this jump by chance is $< 0.8 \times 10^{-3}$, highlighting our result. We note that the increase of f_{RH} with the cluster mass is qualitatively in agreement with expectations from the turbulent re-acceleration scenario, but we plan to perform more detailed comparisons.

Following Cassano et al. (2010), we use the available archival Chandra data to derive information on the clusters dynamical status. We use two methods: the concentration parameter, c and the centroid shift, w. The $c - w$ morphological diagram (Fig. 1, right panel) shows that RH clusters are merging systems, while the great majority of clusters without RH or relic are relaxed objects, thus highlighting the importance of merging events in the generation of RHs.

References

Brunetti G., et al., 2001, MNRAS, 320, 365
Cassano R., Brunetti G., 2005, MNRAS, 357, 1313-1329
Cassano R., et al., 2010, ApJ, 721, L82
Kale R., et al., 2013, A&A, 557, 99
Planck Collaboration 2013, arXiv:1303.5089