The 610 MHz GMRT Radio Halo Survey was designed to address the issue of the occurrence of radio halos in clusters of galaxies at intermediate redshift ($z=0.2–0.4$). A sample of 50 clusters was selected, and 34 of them were observed in 2005–2006. This project was very successful, and provided strong observational support to the re-acceleration model for the origin of radio halos, and to the statistical expectations on their occurrence. A number of new radio halos and relics were found, and a new procedure was developed to place firm upper limits to the undetected clusters.

1 Summary

In the framework of the re-acceleration model, Mpc–size cluster radio halo sources are expected to form as a consequence of the re-acceleration of seed electrons in the intracluster medium due to turbulence injected in the cluster volume during merger events. According to the re-acceleration model, only very energetic cluster mergers are able to inject the necessary amount of turbulence to produce giant radio halos. Starting from the model, statistical calculations on the expected occurrence of giant radio halos as a function of the cluster mass and redshift were developed. In order to test the statistical expectations, we selected 50 clusters in the redshift range $0.2–0.4$, so as to complete the redshift interval considered in the statistical approach ($z=0–0.4$, the information in the redshift bin $z=0–0.2$ being provided by literature data). We observed 34/50 clusters with the GMRT at 610 MHz, i.e. all those clusters with no high sensitivity information at the time of our first proposal (GMRT AO7). This project has been carried out in a number of observing runs, i.e. AO7, AO8 and AO10. The GMRT observations were of very good quality, and we managed to image the clusters with high sensitivity, typically in the range $1\sigma_{610\text{ MHz}} = 35 – 100 \mu\text{Jy/b}$.

2 Main results

The project has just been completed, and turned out to be very successful. The results have provided strong observational support to the re-acceleration model. Our project showed that not all merging galaxy clusters develop a giant radio halo. We discovered a number of new giant radio halos, but we also found that the majority of clusters surveyed at the GMRT do no host radio emission extended on the cluster scale. We developed a procedure to place firm limits to the radio power upper limit of non detections. Our results show that galaxy clusters either host a radio halo, whose radio power correlates with the X-ray luminosity of the cluster, or they do not have any detectable cluster scale emission at power levels at least one order of magnitude lower that the $\log P–\log L_X$ correlation. Furthermore, comparison between the observational data and the statistical expectations on the occurrence of radio halos has been very successful, and indeed it has been confirmed that the fraction of clusters with radio halos increases with cluster mass. Finally, our GMRT data were compared to the X–ray properties of the clusters, by means of a re–analysis of archival Chandra and XMM data. Our analysis reinforced earlier findings that all clusters with radio halos and relics are dynamically active. We further concluded that clusters with no radio halos may be relaxed and active. This is another result expected in the light of the re–acceleration model, since only energetic cluster mergers are able to develop the amount of turbulence necessary to re–accelerate the existing electrons in the intra cluster medium.
3 References


A number of papers have been published so far, and few more on individual clusters are in progress. The reference list is the following:

Venturi T., Giacintucci S., Dallacasa D., Cassano R., Brunetti G., Bardelli S., Setti G., GMRT Radio Halo Survey in galaxy clusters at z=0.2–0.4. II. the eBCS clusters and analysis of the complete sample, 2008, ready for submission to A&A


