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Multiwavelength view of merging clusters

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Abstract. We present new observations of the A3558 complex, an example of major merging with a radio halo in an early phase of formation. Combining the information from radio and X-ray bands we will obtain a picture with an unprecedented level of details.

Key words. Galaxies: clusters – Radioastronomy

1. Introduction

The radio emission is one of the distinctive features of clusters of galaxies, together with the thermal Bremsstrahlung X-ray emission of the intergalactic medium and the dark matter. All these components are strongly perturbed during a merger between clusters, when the collision energy release has detectable consequences both on the hot gas distribution and on the diffuse emission in the radio band. Observational indications support the idea that radio halos and relics are related to cluster collisions even if not all merging clusters present these sources, lacking a definite model for the reacceleration of electrons. From the observational point of view, there is no example of merging (with or without halos and relics) where all the components of the problem have been extensively studied. For such a study, we need the comprehensive knowledge of the hot gas structure (shocks, cold fronts, temperatures..), the dynamics of the system (collision times, galaxy distribution...) and radio emission (point and diffuse sources).

In order to address this important point we are presently studying a number of merging clusters characterized by different merging stages and parameters. In this contribution we focus on the radio halo found at the center of A3562 in the A3558 complex, an example of major merging. The optical/radio/X-ray study allows us to depict a coherent scenario for its formation.

2. The A3558 complex

The A3558 complex (A3558 is the richest cluster of the region) is a structure elongated for

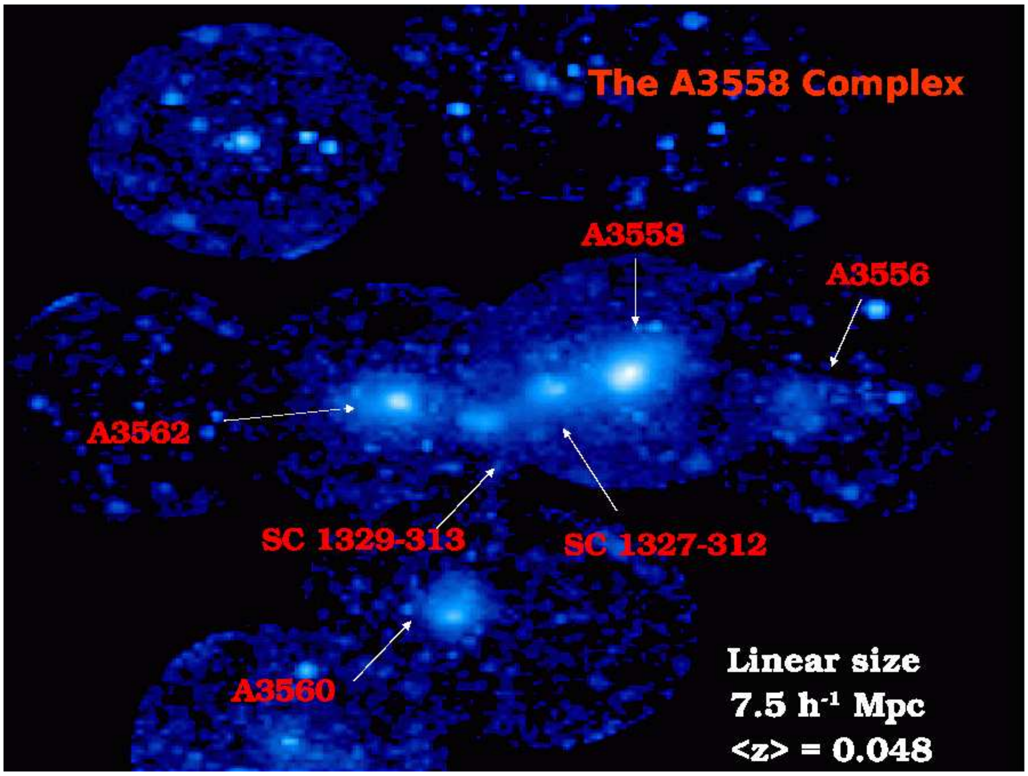

Fig. 1. ROSAT-PSPC mosaic of the A3558 complex, in the Shapley Supercluster. In these proceedings we focus on A3562 and SC1329-313, in the Eastern region.

~ 7 h^{-1} Mpc in the East-West direction, including also A3562, A3556, SC1329-313 and SC1327-312. Dynamical studies by Bardelli et al. (2000) and Reisenegger et al. (2000) concluded that this structure (with mass of a few 10^{15} $M_{\odot}$) is in the collapse phase. In fact, the complex represents a major merger at an advanced stage. Clusters belonging to this structure are embedded in a continuous envelope of both hot gas and galaxies (Bardelli et al. 1998a) on a scale of ~ 7 h^{-1} Mpc , i.e. surrounding the entire structure. The hot gas did not originate from the cosmological filament (or "wall") seen in the redshift survey, but probably from intracluster gas expelled from the clusters by the merging (see the spatial analysis of A3562 in Ettori et al. 2000). Also the galaxy envelope has had the same origin, being formed by the the gas stripped during the merger from less bounded cluster objects, and shared afterwards by the whole structure.

ROSAT (Bardelli et al. 2002) and Beppo-SAX (Ettori et al. 2000) X-ray studies of this region did not detect shocks, although the gas distribution shows clear signs of disturbance. Only between A3562 and SC1329-313, in the Eastern part of the structure, a hotter region is detected. Furthermore, SC1329-313 has a gas distribution particularly disturbed with a comet-like shape (Bardelli et al. 2002). Recent analyses of XMM pointings (Finoguenov et al. 2004) suggest that SC1329-313 already encountered A3562.

This spectacular major merging represents a unique opportunity to study the effect of merging at radio wavelengths. In particular, a peculiar radio feature has been detected: it is formed by a radio halo and by a diffuse radiosource; the only other known case is in the Coma cluster. The radio halo, detected at the center of A3562, is close to an head-tail ra-

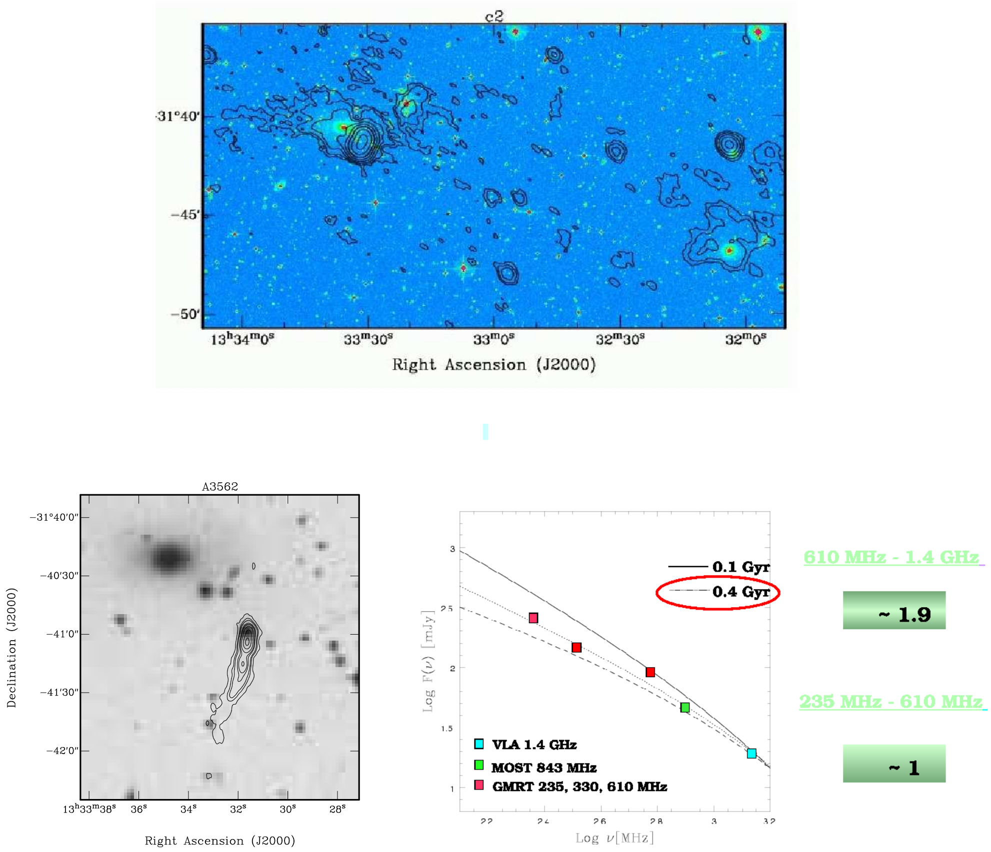

Fig. 2. Upper panel: GMRT 90cm radio isophotes superimposed on the Digital Sky Survey, in the A3562 region. On the left the system radio halo plus head-tail radiogalaxy (not resolved) is visible. Note the peculiar radiosource on the right. Lower left panel: the head-tail radiogalaxy seen at higher resolution. This object produced the electrons responsible for the halo emission. Lower right panel: radio spectrum of the halo. Solid lines are models with different reacceleration times.

diogalaxy: we verified (Venturi et al. 2003) that this radiogalaxy produced the electrons which, after the reacceleration by a merging 0.4 Gyrs ago, are responsible for the halo emission. Also the radio spectrum of the halo is consistent with the fact that the last electron acceleration happened 0.4 Gyrs ago. Moreover, we found that there is a significant lack of radiosources in this structure (Venturi et al. 2000): this signal is coming mainly from the cluster A3558 (Giacintucci et al. 2004) and could indicate that the merging could switch-off, at least for a period, the radiosource activity. Moreover, a relic radiosource has been found in the Westernmost part of the A3558 complex: a geometrical and dynamical reconstruction of this part of the structure leads to speculate that this relic had origin on the shock front (up to now undetected in X-rays), caused by a small group infalling onto the A3556 cluster (Venturi et al. 1998).A3556 itself presents peculiar characteristics, because of its very low X-ray surface brightness with respect to the optical richness: moreover, its optical luminosity function presents an unusual shape, with a pronouced excess of bright galaxies (Bardelli et al. 1998a).

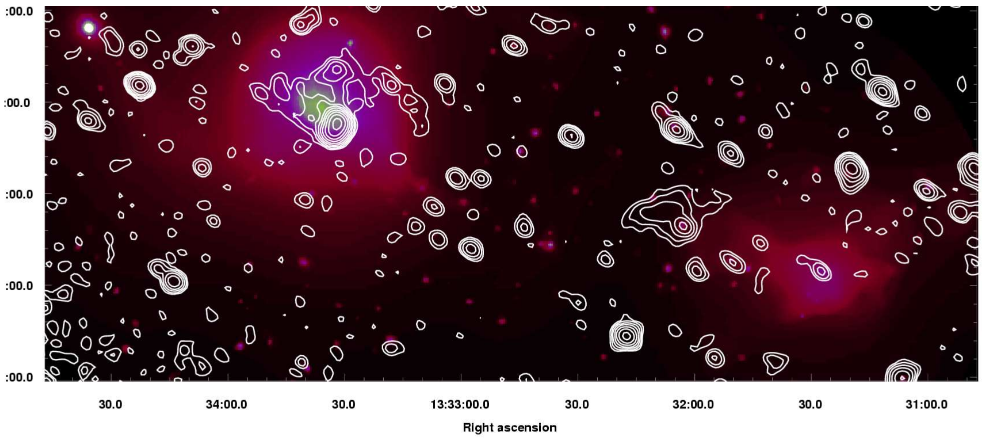

Fig. 3. GMRT 1400MHz radio isophotes superimposed on a mosaic of XMM observations in the A3562 and SC1329-313 region.

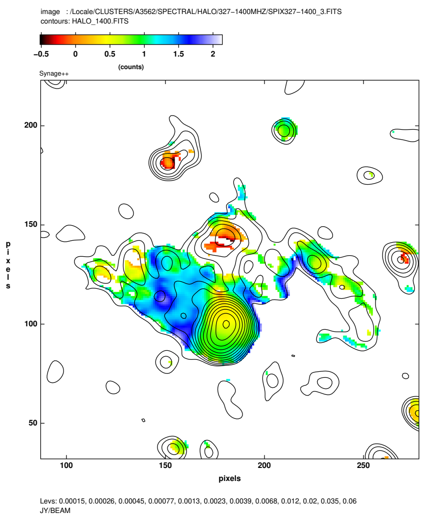

Fig. 4. Radio spectral index (determined from the 327MHz and 1400MHz GMRT observations). Isophotes are the flux distribution at 1400MHz.

3. The new observations

In order to better define the model for the radio halo formation and its relation with cluster merging, we obtained a large amount of new data. In the radio band, GMRT observations have been performed at 235, 327, 610 and 1400 MHz. In X-rays we are currently analysing both archive XMM and proprietary Chandra pointings. By combining the information of two bands we will have a picture of the A3562 halo formation with an unprecedented detail.

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