Outskirts of Galaxy Clusters: Intense Life in the Suburbs
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Multiple merging in the Abell cluster 1367

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Abstract. We present a dynamical analysis of the central ~ 1.3 square degrees of the galaxy cluster Abell 1367, based on 272 redshift (of which 118 are new measurements). From the analysis of the 146 confirmed cluster members Abell 1367 appears as a young cluster currently forming at the intersection of two filaments.

1. The cluster sample

The line of sight (LOS) velocity distribution of the 146 cluster members (4000 km s^{-1} < V < 10000 km s^{-1}) results significantly non gaussian with a mean location $C_{BI} = 6484 \pm 81$ km s^{-1} and a scale $S_{BI} = 891 \pm 58$ km s^{-1} (Fig. 1, left). The structure of the cluster appears elongated from the North-West to the South-East with two main density peaks (Fig. 2). The North-West region has lower LOS and dispersion velocity than the South-East region and it is probably in the early phase of merging into the main cluster (Fig. 3). These results are in agreement with X-ray observations. The region between the two major galaxy density peaks coincides with a strong gap in the gas temperature observed for the first time by ASCA (Donnelly et al. 1998) and recently confirmed by *Chandra* (Sun & Murray 2002). This abrupt temperature change is strongly suggestive of a shock which has generated during a collision between two substructures, probably associated with the SE and the NW galaxy density peaks. We use the position of the gas temperature gap, shown by the straight line in Fig. 2 (right), to divide our sample into two regions and to study separately the dynamical properties of the two subclusters.

2. The North-West subcluster

The LOS velocity distribution of the North-West subcluster results consistent with a gaussian distribution, suggesting that this subcloud is a relaxed system (Fig. 1, center). However this subcluster presents some evidence that supports a multiple merging scenario. The Brightest Galaxy of this cloud CGCG97-095 (NGC3842), located 2 arcmin SE from the NW galaxy density peak, is a Narrow Angle Tail radio galaxy. The tail orientation suggests that this galaxy (and the associated substructure) is moving from north-west to south-east toward the main cluster core. Moreover the presence of a radio relic associated with two head-tail radio galaxies (CGCG97-073 and CGCG97-079) is consistent with a merging scenario in which the sub-group associated with these galaxies is falling into the NW cloud, compressing the plasma ejected from CGCG97-095 and originating the observed radio relic.

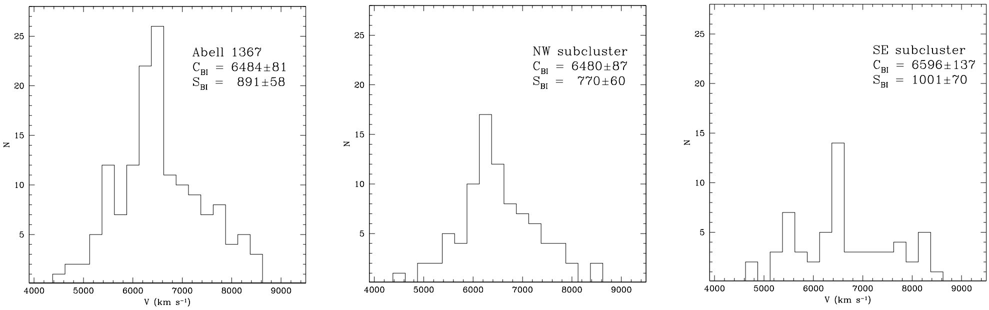

Figure 1. The LOS velocity distribution of the 146 cluster members (left), of galaxies belonging to the North-West subcluster (center) and of galaxies belonging to the South-East subcluster (right).

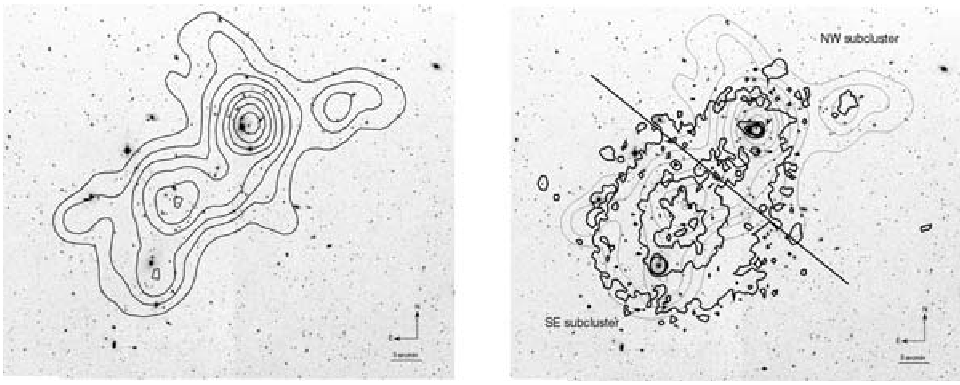

Figure 2. Left: Palomar DSS image of the central region (∼1.3 square degrees) of Abell 1367. In black are superimposed the iso-density contours (computed using the 10 nearest neighbors to each point) for the 146 confirmed cluster members. Right: The same as in the left figure. The ROSAT X-ray contours are superimposed in black. The straight line indicates the position of the abrupt gas temperature gap detected by ASCA (Donnelly et al. 1998) and used to divide our sample into two substructures.

3. The South-East subcluster

The LOS velocity distribution of the South-East subcluster results highly inconsistent with a gaussian distribution, supporting the idea that the cluster center is far from relaxation (Fig. 1, right). The velocity distribution presents three peaks at ~ 5500 km s^{-1}, ~ 6500 km s^{-1} and ~ 8200 km s^{-1} respectively, probably associated with three separate groups. The high-velocity group (V$\sim$ 8200 km s^{-1}) appears segregated in the northern part of the SE cloud and is associated with the infalling group of star-forming galaxies recently discovered by Sakai et al. (2002) and Gavazzi et al. (2003). Its spatial segregation and high star formation activity suggest that this group is a separate unit falling into the cluster, probably from the near side. It is remarkable that *Chandra* (Sun & Murray 2002) discovered a ridge-like structure around the cluster center, ∼6 arcmin south from the center of the high velocity group, probably associated with a compact subcluster penetrating the SE cluster core. The low-velocity group (V$\sim$ 5500 km s^{-1}) is partially segregated in the eastern part of the cloud, probably infalling from the eastern side into the cluster core. This scenario is supported by XMM observations (Forman et al. 2003), that detected cool gas streaming into the cluster core from the eastern side, probably

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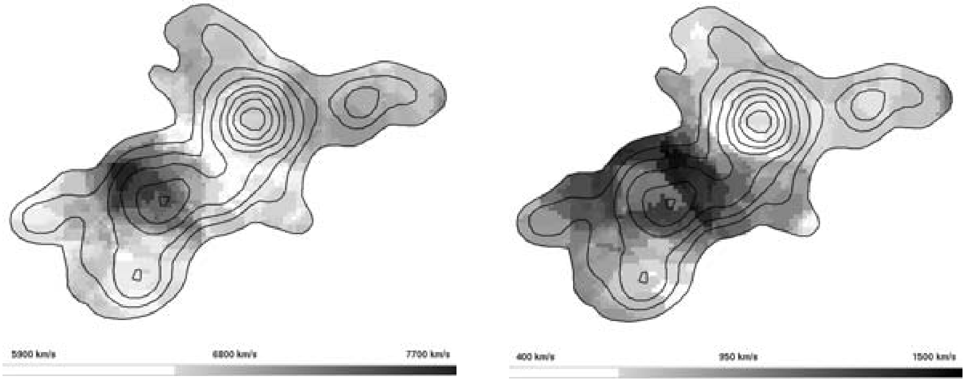

Figure 3. The LOS velocity field (left) and the dispersion velocity field (right) for the whole region studied in this work. The LOS velocity and the dispersion velocity values are calculated using the 10 nearest neighbors to each pixel of 36 arcsec size. The iso-density contours for the 146 confirmed cluster members are superimposed in black.

associated with this low velocity group of galaxies. Conversely the galaxies belonging to the main group (V$\sim$ 6500 km s^{-1}) are homogeneously distributed through the whole subcluster, representing its virialized galaxy population.
Finally the multiple merging scenario is also consistent with the particular position of Abell 1367. In fact this cluster lies at the intersection of two filaments, the first extending roughly 100 Mpc from A1367 toward Virgo (West & Blakeslee 2000) and the second extending between A1367 and Coma. Since the intersection of filaments are considered the natural place of cluster formation (Katz & White 1993), Abell 1367 might be at the first steps of its evolution into a rich relaxed cluster.

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