Outskirts of Galaxy Clusters: Intense Life in the Suburbs
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Radio imaging of head-tailed galaxies from an in-falling filament of the Horologium-Reticulum supercluster

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Abstract. We present a multi-wavelength study of a pair of head-tailed radio galaxies in an in-falling filament of the A3125/A3128 cluster complex which is located at the centre of the massive Horologium Reticulum Supercluster (HRS). We compare the large-scale structure evident from extensive optical observations of the region with the dynamical information gleaned from the morphology of the radio jets. We argue that in addition to the acceleration produced by in-fall toward the centre of A3125, the closest galaxy cluster, the radio jets show some evidence of bulk motion along the major filament of the HRS.

1. Introduction

The Horologium Reticulum Supercluster (HRS) is one of the most massive cluster concentrations observed in the nearby universe. It is second only to the Shapley Supercluster in the local 300 Mpc and provides a valuable opportunity to study the effect of the cluster environment on its constituent galaxies. Recently optical data have revealed a wealth of sub-structure in the A3125/A3128 cluster complex at the heart of the HRS, showing that hierarchical merging is taking place (Rose et al. 2002). In addition examinations of the inter-cluster regions have demonstrated a bi-modality to the entire structure (Fleenor et al. 2004) suggesting a complex dynamical evolution.

With such a wealth of activity evident in the kinematic data it is unsurprising to see evidence of dynamical activity associated with individual galaxies. In this paper we present results of radio imaging of a pair or bent-tailed sources found on the outskirts of the A3125/A3128 cluster complex. These galaxies are associated with a known in-falling filament close to A3125.

2. In-falling filament

Rose et al. (2002) have used spectroscopic data to identify several in-falling groups and clusters in the central regions of the HRS. Radio images of the region containing the in-falling filament and group structures "F2"and "G2", which have a combined total of around 25 members, were taken with the Australia Telescope Compact Array (ATCA) at 1.4 and 4.8 GHz. The 4.8 GHz data were obtained in 2×12 hours in the 6A configuration. The final image has a synthesised beam of $9''.9\times7''.9$ at P.A. 3.2° and a continuum image rms noise of 12 μJy beam^{-1}. The 1.4 GHz image was obtained from a larger 40 point mosaic of the region in the 1.5, 6A and 6D configurations with total integration time of

39 hours. The final mosaic image has a synthesised beam of $11''.7 \times 7''.5$ at P.A. 72.2° and a continuum image rms noise of 60 μJy beam^{-1}. In order to detect the low surface brightness extensions, the 1.4 GHz data were also tapered to give a lower resolution image with synthesised beam $23''.2 \times 21''.4$ and rms noise of 7.9 mJy beam^{-1}.

Figure 1 shows the radio contours going from lowest to highest resolution overlaid on the DSS image; blue contours are the tapered 1.4 GHz data, purple the untapered 1.4 GHz data and red the 4.8 GHz data, in addition known members of the filament have been marked with boxes.

Three radio sources are identified in the data; these are labelled as source A, B and C in Figure 1. Source A and B have been identified with members of the filament, whereas source C has no optical counterpart visible in the DSS and is thus likely a chance projection of a background radio galaxy.

3. Radio images

Objects A and B have been identified as PKS J0327−532 and SUMSS J032752-532613 respectively. The 1.4 GHz data shows that the jets of both galaxies have been bent and the data for PKS J0327−532 are particularly striking with multiple turns and bends present. The projected lengths have been measure at 7.75' and 5.75' for the Northern and Southern jets in PKS J0327−532 and at 5.25' for both jets in SUMSS J032752-532613. At the redshift of the host galaxies this corresponds to tail lengths of 480 and 356 kpc for PKS J0327-532 and 325 kpc for SUMSS J032752-532613. From the 1.4 GHz data it can be seen that the jet in PKS J0327-53 is at its peak brightness some distance from the optical host galaxy which is consistent with emission from a Fanaroff-Riley Class II source (Fanaroff & Riley 1974). By comparison the emission in SUMSS J032752-53261 is brightest at the location of the optical host galaxies which is consistent with a Fanaroff-Riley Class I source (Fanaroff & Riley 1974).

In the case of PKS J0327-532 the surface brightness drops dramatically about half way along the total jet length trailing away into lower surface brightness extensions which are not visible in the higher frequency data. The brighter of these low surface brightness features is associated with the southern tail and is also clearly detected in a Molonglo Observatory Synthesis Telescope image at 843 MHz (not shown). In both cases the jets in PKS J0327-532 maintain a collimated appearance the entire length of the jet. In contrast the jets in SUMSS J032752-532613 terminate in flairs of low surface brightness which are roughly circular about the jet. This is particularly evident for the southern most jet.

In the highest resolution images at 4.8 GHz the extended tails are too faint to observe and so the images only reveal the brightest parts of each source. In the case of PKS J0327-532 the 4.8 GHz image conclusively gives source APMUKS(BJ) B032601.62-533543.5 as the optical counterpart while APMUKS(BJ) B032629.42-533630.0 is determined as the optical identification for SUMSS J032752-532613 in both the 1.4 and 4.8 GHz data. This shows definitively that these sources are members of the group.

4. Relation to large-scale structure

The angular separation of the optical host galaxies is too great to consider these as a binary pair, thus we can not look to an orbital motion to explain the direction of bending of the radio tails (for comparison see Klamer et al. 2004). It is striking that both galaxies show some signs of bending toward the northwest which is roughly 90° away from the direction of in-fall to the closest cluster, A3125, but toward the main axis of the HRS. On the other hand the fainter tail of PKS J0327-532 shows bending along the line of

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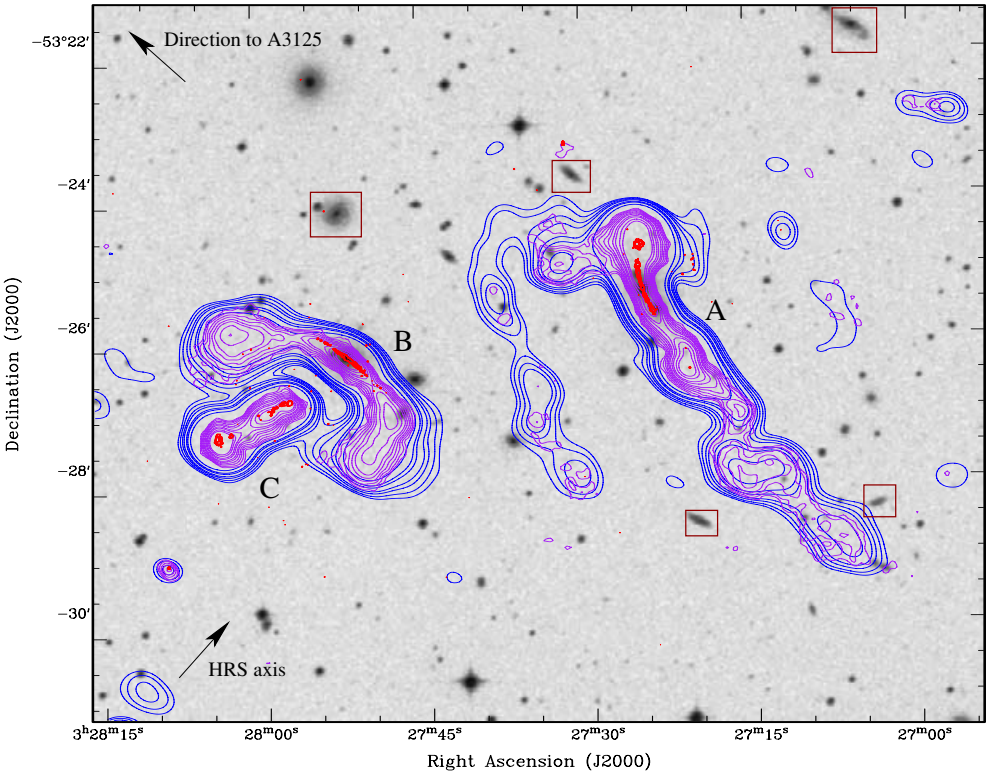

Figure 1. Image of tailed galaxies in an in-falling group: radio contours of increasing resolution are shown over an optical image from the DSS. Galaxies with boxes and those marked A and B are some of the members of the in-falling objects from Rose et al (2002). Arrows show the direction to both the nearest galaxy cluster, A3125 and the HRS main axis.

in-fall to A3125. Thus, we see evidence for motion along both the line of in-fall to the closest galaxy cluster and the main axis of the HRS which could be an indication of bulk gas flow along the main filament of the supercluster.

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