Letter to the Editor

50 kpc radio trails behind irregular galaxies in A 1367

G. Gavazzi and W. Jaffe

1 Istituto di Fisica Cosmica del CNR, via Bassini 15, I-20133 Milano, Italy
2 Sterrewacht, Wassenaarseweg 78, Leiden, The Netherlands

Received August 11, accepted September 11, 1987

1. Summary

We report the discovery of exceptionally bright and extended trails of radio emission behind three irregular galaxies in the periphery of the cluster A1367, in the Coma Supercluster. Turbulent interaction with the intergalactic medium or a past catastrophic collision between galaxies could have produced the observed phenomenon.

Key Words: galaxies - clumpy Irregulars; galaxies - radio continuum -

2. Results

To emphasize low surface brightness features in the galaxies we produced a 1.4 GHz continuum map of the NW periphery of the cluster A1367 with the VLA in its two smallest configurations (1.5 hours in C array and 2 hours in D array). Fig. 1 shows a contour map of the central 20x20 arcmin of the observed region. The diffuse low surface brightness component (H), discovered by Gavazzi (1978) is fully resolved, with ~90 kpc extent. Components labelled 73, 79 and 87 coincide with irregular cluster galaxies. We wish to draw attention to the radio emission trailing behind galaxies 73 and 79. The only previously known spiral/irregular galaxy with a similar morphology is galaxy 87 (Gavazzi et al, 1984). A conservative estimate of the projected length of these trails is 50 kpc (H_0=100 km sec^{-1} Mpc^{-1}). Component T attached to X could be associated with the double source or with either 73 or 79 raising the length of these tails to 75 kpc. The extended flux associated with these tails almost doubles the available estimates of the flux densities of these objects based only on the C array observations (Gavazzi and Jaffe, 1985). For galaxy 73 we obtain a total flux of ~25 mJy (previous 17), for galaxy 79 we measure ~15 mJy (previous 4 mJy). The measurement of galaxy 87 (60 mJy) is consistent with previous determinations.

Exposures in the V band of the three galaxies were obtained on February 26, 1987 with the Loiano 1.5 m telescope equipped with a CCD. Fig. 2 shows details of these frames. The three galaxies appear strongly disturbed and with some degree of asymmetry. In all of them the direction marked by the radio trails corresponds with the lower surface brightness side. Integrated colors are very blue (U-B)_{AB}=0.20,-0.29,-0.25 for galaxies 73, 79 and 87, and the H_α equivalent widths are among the highest observed in S/Irr galaxies indicating abnormal ongoing star formation (Kennicutt et al, 1984).

Multidiameter photometry in the near infrared bands J, H, K were obtained on March 5, 10 and on April 14, 1987 with the Tigr 1.5 m telescope. Far Infrared (FIR) measurements of the three objects were obtained with the IRAS satellite at 100μ, 60μ, 25μ and 12μ (Bica and Giovanelli, 1987). These data, as well as the radio data at 0.6, 1.4 and 5 GHz are plotted in Fig. 3 normalized to the near infrared flux H. K,H,J,V,B,U correspond to total magnitudes m^1, furthermore the fluxes in the visible are corrected for internal absorption according to Haynes and Giovanelli, 1984.

---

1 The VLA is a facility of the National Radio Astronomy Observatory which is operated by Associated Universities, Inc., under contract with the National Science Foundation.

---

Fig. 1: 1.4 GHz contour map of A1367. The three irregular galaxies with associated extended radio emission are indicated. The low-brightness radio halo is labelled H. The double radio source associated with a QSO candidate is marked X. The lowest level is 0.50 and the highest 25.00 mJy/beam.
Blackbody spectra at the temperatures of 50, 200, 3000 and 6000 K are superposed to the data in Fig. 3. The near infrared data indicate the existence of a dominant cold stellar component present in all the surveyed galaxies, irrespective of their morphology. A hotter stellar component is characteristic of galaxies of the later types. The FIR data indicate at least two temperature components: a colder one (50 K) which is usually attributed to the large scale dust emission and a hotter (200 K) component possibly associated with material concentrated in denser clouds, usually near the nucleus (Smith et al., 1987). This hot component dominates in 73 and might be associated with the giant H II regions revealed in the V frame.

The radio/H fluxes in these objects are among the highest observed in S/Irr galaxies in the Coma Supercluster, which are in general 10 to 100 times lower.

We know of no other S/Irr galaxies with a "head-tail" morphology. If the trails are remnants of radio activity taking place in galaxies travelling at ~1000 Km sec^-1, they could be used to trace the positions of these objects back to 5-7 ×10^7 years ago, a time close to the time scale for synchrotron losses in a magnetic field of ~10^-6 Gauss. 0.6 GHz observations (Gavazzi and Trinchieri, 1983) provide us with an estimate of the spectral index (-2<α<-1.6) in the trails, indicating ageing of the electrons responsible for the radio emission.

Current astrophysical models do not offer a convincing interpretation of the evidence presented in this Letter. The only possibilities that could account, at least qualitatively, for the observed high luminosity trailing radiation are 1) hydrodynamic interaction between the fast moving galaxies and the intracluster medium (Nulsen, 1982), and 2) Galaxy-Galaxy interaction. The first idea, inspired by the analogy with the well known head-tail radio sources associated with elliptical galaxies in clusters, is strengthened by the asymmetry observed in the optical morphology of the parent galaxies and possibly by the existence of a hot FIR component, but does not explain why the present case is unique to these three galaxies. Furthermore their rather peripheral location within the cluster does not strengthen the hypothesis.

2) If the trails behind galaxies 73 and 79 trace the trajectories of these objects, they might suggest a possible mutual collision which occurred some 10^8 years ago. In this case the extremely high activity in these galaxies might be connected with star formation excited by their past encounter. This hypothesis does not explain the third trail, 87, unless a 3-way collision took place, which seems unlikely.

3. References

Haynes, M., Giovanelli, R., 1984, Astron. J. 89, 758
Kennicutt, R., Bothun, G., Schommer, R., 1984, Astron.J. 89, 1279