FIRST-radio sources in clusters of galaxies

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Abstract

The detailed identifications of the FIRST and NVSS radio sources with optical objects in APM and in DSS surveys are carried out for 26 rich Abell clusters of galaxies. 99 radio sources are identified with optical objects, 40 have probable identifications, and 187 are not identified from 326 radio sources in the considered fields (within Abell radius of each cluster of galaxies). 20 radio sources are definitely in clusters and 34 can be clusters members with high confidence. Therefore, ≈30-40% of the FIRST radio sources can be identified with optical objects on the base of APM and of DSS data. On average, one can find 2 identified sources per cluster.

In the framework of previously announced project (A.G.Gubanov et al. 1997, in “Problems of modern radioastronomy”, XXVII Radio Astronomy conference, St.Petersburg, V.1, P.168), we present detailed identifications of the FIRST (and NVSS) radio sources with objects from APM and DSS surveys for 26 rich Abell clusters of galaxies (Table 1).

Identifications are performed for all radio sources within Abell radius of cluster of galaxies (3 Mpc for the Hubble constant of 50 km/s/Mpc). The clusters selected within the processed zone of the FIRST survey are part of a larger sample of rich clusters (with richness ≥2) and of clusters containing cD-galaxies.
Table 1. List of clusters.

| ACO     | RA(J2000) | DEC(J2000) | z   | ACO     | RA(J2000) | DEC(J2000) | z   |
|---------|-----------|------------|-----|---------|-----------|------------|-----|
|         | h m s o   |            |     |         | h m s o   |            |     |
|         |           |            |     |         |           |            |     |
| A0586   | 07 32 17.8| +31 37 34  | 0.1710 | A1033   | 10 31 33.8| +35 04 34 | 0.1258 |
| A0642   | 08 19 05.7| +30 02 34 | 0.2063e | A1035   | 10 32 07.3| +40 12 33 | 0.0785 |
| A0690   | 08 39 14.3| +28 51 24 | 0.0788 | A1068   | 10 40 47.2| +39 58 20 | 0.1375 |
| A0705   | 08 47 38.7| +30 00 56 | 0.1138e| A1073   | 10 42 26.6| +36 38 17 | 0.1390 |
| A0715   | 08 54 44.4| +35 24 33 | 0.1685e| A1081   | 10 44 49.5| +35 34 14 | 0.1585 |
| A0727   | 08 59 13.1| +39 26 19 | 0.0992e| A1094   | 10 47 32.8| +27 31 10 | 0.2004 |
| A0781   | 09 20 23.2| +30 26 16 | 0.1763e| A1120   | 10 53 15.5| +30 48 02 | 0.2218e |
| A0800   | 09 28 30.0| +37 47 53 | 0.2223e| A1175   | 11 09 13.7| +33 10 44 | 0.2487 |
| A0812   | 09 32 35.4| +37 53 42 | 0.1452e| A1178   | 11 09 50.1| +34 35 43 | 0.2596 |
| A0908   | 09 59 35.8| +22 25 36 | 0.2026e| A1182   | 11 10 19.0| +31 46 43 | 0.1660e |
| A0943   | 10 12 12.2| +33 37 10 | 0.1485e| A1190   | 11 11 46.2| +40 50 42 | 0.0763 |
| A0961   | 10 16 29.5| +33 37 01 | 0.1241 | A1198   | 11 12 48.0| +30 22 40 | 0.1660e |
| A0963   | 10 17 09.7| +39 01 00 | 0.2060 | A1258   | 11 26 08.7| +25 26 30 | 0.1469e |

We obtained the following results:

1. Among 326 radio sources in the considered fields of 26 clusters (and within Abell radius), 99 radio sources are confidently identified with optical objects in the APM and DSS surveys, 40 sources have probable identifications, and 187 are not identified.

Among identified radio sources, 20 are definitely in clusters and 34 can be clusters members with high probability.

Therefore, the expectations to identify ≈30-40% FIRST radio sources and to find, on average, 2 sources per cluster are coming true.

One can expect to obtain ≈8000 identifications of the galaxies in ACO-clusters with the FIRST-type radio sources in all Abell clusters.

2. Only 11 radio sources consist of one component (within the FIRST-survey resolution of about 5") and only 5 are compact (with diameter ≤5") among 20 definitely lying in clusters.
Morphology of identified radio sources is typical for clusters radio-galaxies:

5 have WAT structure;
5 – HT;
5 - extended FR I-type radio sources (with uncertain morphological type);
5 - compact.

Centers of radio sources are often essentially displaced from the positions of host galaxies in our sample and, therefore, visual analysis of radio-optical maps is needed for correct identification. Graphical interface of the database of clusters created at the Astronomical Institute of the SPbSU (A.G.Gubanov, V.B.Titov, 1997, in “Problems of modern Radio Astronomy”, XXVII Radio Astronomy conference, St.Petersburg, V.1, P.320) is an excellent and useful tool for such purposes (URL [http://future.astro.spbu.ru/Clusters.html](http://future.astro.spbu.ru/Clusters.html)).

3. In most cases the identified radio sources have radio luminosities, \( \log(L_r \text{[erg/sec]}) \), typical for radio galaxies – 40.5-42 within frequency diapason 10 MHz – 10 GHz and are identified with bright elliptical galaxies.

4. It seems interesting that dynamically active clusters (consisting of subclusters of comparable richness) often contain several radio galaxies with comparable power (for instance, A1033, A1035, A1068, A1081, A1190, A1258). This is not typical for more regular clusters.

5. It should be noted that the flux densities in the FIRST, NVSS catalogues and apparent magnitudes in the APM-survey are contain often significant systematic and random errors and cannot be useful for correct statistical analysis. Careful individual reduction of the data of digitized surveys and special measurements are highly needed.

Several examples of identified radio sources are presented in Fig.1–3.

This research is supported by the Federal Programme “Integration” (project N 578) and by the Russian Foundation for Basic Research (grant N 97-02-18212).
Figure 1: One from two brightest galaxies in cluster center, HT radio galaxy. Faint compact detail in the tail of this radio source coincides in position with other cluster galaxy (i.e. possible cluster radio galaxy too).
Figure 2: The pair of close galaxies, probably, eastern is radio galaxy.
Figure 3: HT radio source is identified with second bright galaxy in cluster center.