Optical Characteristics of the Astrometric Radio Sources

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Abstract

A new list of physical characteristics of 3914 astrometric radio sources, including all 717 ICRF-Ext.2 sources, observed during IVS and NRAO VCS sessions have been compiled. The list includes source type, redshift and visual magnitude (if available). In case of doubt detailed comment is provided. The list of sources with their positions was taken from the Goddard VLBI astrometric catalog with addition of two ICRF-Ext.2 sources. At this stage the source characteristics were mainly taken from the NASA/IPAC Extragalactic Database (NED). 667 sources from our list are included into the IERS list. Comparison has shown a significant difference in characteristics for about half of these 667 common sources. We compiled a list of frequently observed sources without known physical characteristics for urgent optical identification and spectrophotometric observations with large optical telescopes. This presented list of physical characteristics can be used as a supplement material for the ICRF-2, as well as a database for kinematic studies of the Universe and other related works, including scheduling of dedicated IVS programs.
1 Introduction

Information on physical characteristics of the geodetic radio sources is important for planning of VLBI experiments and analysis of VLBI data to do a research in cosmology, kinematics of the Universe, etc. In particular, the primary mainspring to this work was a support of the investigation of the systematic effects in apparent proper motion of geodetic radio sources. [1, 2].

The official list of the physical characteristics of the ICRF radio sources is supported by the IERS ICRS Product Center (3). The latest version of the IERS list is available in the Internet. However this list has some deficiencies:

- Not all the sources observed in the framework of geodetic and astrometric experiments are included in the IERS list.
- The characteristics of some sources in the IERS list are outdated or doubtful.

To overcome this problems, we performed a compilation of new list of the physical characteristics of geodetic radio sources using the latest information. In this paper we present our result of the first stage of this work.

The list of radio sources with their positions was taken from the Goddard VLBI astrometric catalogs, version 2007c, with removing duplicate source 1616+85A (L.Petrov, private communication) and addition of two ICRF-Ext.2 sources 1039-474 and 1329-665 not included in the Goddard catalog. It provides 3914 radio sources in total.

At this stage mainly the NASA/IPAC Extragalactic Database (NED) was scoured. Some sources were checked with the CfA-Arizona Space Telescope LEns Survey (CASTLES) and the HyperLeda databases. In this list we have included only the optical characteristics of geodetic radio sources: source type, redshift and visual magnitude. The flux parameters are not included in our list because they are available from other centers.

2 List Description

Our primary interest is to get redshift (z) for astrometric radio sources to develop the previous researches [1, 2]. In those papers, z values were taken from the ICRF list [3]. However, as rather tiny effects in the source motions are to be investigated, it is important to increase the number of sources involved in the processing. Searching the latest astrophysical databases, primarily the NED, we could considerably augment the list of geodetic radio sources with known z. Nevertheless, more than half of the geodetic radio sources have no determined redshift.

Evidently, the only direct way to get the redshift for other most frequently observed geodetic sources is to organize a dedicated observing program with large optical telescopes.

1http://hpiers.obspm.fr/icrs-pc/info/car_physique_ext1
2http://vlbi.gsfc.nasa.gov/solutions/astro
3http://nedwww.ipac.caltech.edu/
4http://cfa-www.harvard.edu/glensdata/
5http://leda.univ-lyon1.fr/
To help in preparation of such a program, we also collect the source type and its visual magnitude if this information is available. Also, it makes a sense to include in this observational program those sources with existing but uncertain redshift values.

It should be noted, that not all geodetic radio sources were reliably identified in the NED. We use the following procedure for identification. In the first step, we search for sources by source name using 'ICRF' and 'IVS' prefix. So, we rely on the source identification used in the literature and by the NED staff. Then about 500 sources, mostly from the VCS6 list, were searched by position. We take into account both the angular distance between the VLBI and NED positions as well as their uncertainty in the VLBI and NED positions. For some sources multiply NED objects within the error level were found. For 16 sources no appropriate object was found in the NED, which is mentioned in the comments. The problem of the source identification in the NED and other astrophysical data bases hopefully will be solved after official publication of the VCS6 catalog.

3 Statistics

The overall statistics of the new list is the following.

| Number of sources: |          |
|--------------------|----------|
| total              | 3914 (100%) |
| ICRF               | 717 (18.3%) |
| N                  | 2376 (60.7%) |
| S                  | 1538 (39.3%) |
| with known type    | 2369 (60.5%) |
| AGN                | 1581 (66.7%) |
| galaxy             | 461 (19.5%) |
| other              | 327 (13.8%) |
| with known redshift| 1790 (45.7%) |
| <= 1               | 825 (46.1%) |
| > 1                | 965 (53.9%) |
| N                  | 1185 (66.2%) |
| S                  | 605 (33.8%) |
| with known visual magnitude | 2300 (58.8%) |
| with known both z and magnitude | 1739 (44.4%) |
| with known z or magnitude | 2351 (60.1%) |
| with known magnitude and unknown z | 561 (14.3%) |
| without characteristics | 1563 (39.9%) |

Figures 1 and 2 show the distribution of the sources with known redshift.

Figure 3 shows the distribution of the visual magnitude. The right part of the figure gives an impression about the magnitude of the sources for which redshift yet is not determined.
Figure 1: Distribution of the redshift (left) and cumulative number of sources (right).

Figure 2: Distribution of the redshift over declination.

Figure 3: Distribution of the visual magnitude for all sources (left) and for sources without known redshift (right).
4 Comparison with the IERS List

We have compared our list with the IERS list. 667 common sources were found. All the sources are present in the IERS list. Comparison of these two lists results in rather large discrepancy.

- The first evident difference is in the number of radio sources. Our list contains 40 extra ICRF sources plus several hundreds other sources, 3914 vs. 667 objects in total, 2351 vs. 555 objects with known z or visual magnitude.
- Unlike the IERS list, we did not try to trace all the details of the Active Galactic Nuclei (AGN) classification that are not always stable and unambiguous. So, all the quasars and BL object are designated as AGN.
- Redshifts for 55 more ICRF sources were found; redshifts for 4 sources presented in the IERS list were not included in our list for various reasons; for 30 sources redshift differs more than by 0.01; the largest differences are 1.26 (1903-802), 1.20 (1600+431), 0.70 (0646-306).
- Visual magnitudes for 70 more ICRF sources were found; magnitudes for 2 sources were not confirmed in our list; for 195 sources magnitude differs more than by 0.5; the largest differences are 5.2 (1758-651), 5.0 (1156-094, 1322-427), 3.9 (0241+622).

Further investigation has to be made to clarify all found discrepancies between two lists. It should be mentioned that we consider as important and useful for a user to provide a detailed comment in case of doubtful or ambiguous published data.

5 Conclusion

A new list of the optical characteristics of geodetic radio sources has been compiled and available at http://www.gao.spb.ru/english/as/ac_vlbi/sou_car.dat.

This is only the first stage of our work. We are planning the following steps:

- To continue searching for the missing and checking out the ambiguous characteristics through literature and astronomical databases.
- To organize photometric and spectroscopy observations of geodetic radio sources with large optical telescopes. In particular, such observational program has been included in the plan of the Pulkovo Observatory for 2008. The application for observation time on the Russian 6-meter BTA telescope for the second half of 2008 was handed over in February in cooperation with Pulkovo astrophysicists Kirill Maslennikov and Alexandra Boldycheva.

The authors would be happy to know whether this new list is useful either as a database for VLBI data analysts or as a supplement material for the ICRF-2 compiling. We hope that this work will continue in cooperation with other interested groups.
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