POSSIBILITIES OF ICRF2 ERS OBSERVATIONS USING ASV 60 cm TELESCOPE

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Abstract

Using ASV-Astronomical Station Vidojevica (of Belgrade Astronomical Observatory), telescope with equatorial mount and a Cassegrain optical system (D=60cm, F=600cm), we observed about 40 extragalactic radio sources (ERS which are visible in optical domain) from ICRF2 list during 2011 and 2012. The observations of ERS are of importance to compare the ERS optical and radio positions (VLBI ones) and to investigate the relation between optical and radio reference frames. Also, the ERS observations using the ASV 60 cm are useful to check the possibilities of that instrument. At the ASV 60 cm we used the CCD camera Apogee U42 (2048x2048 pixels, the pixel size is 13.5x13.5 μm). The observations, reduction and preliminary results of some ERS are presented here.

Introduction

The adoption of the International Celestial Reference System (ICRS) based on VLBI observations of ERS. The first realization of ICRS was the International Celestial Reference Frame (ICRF) since 1998 January 1 (after XXIII GA of IAU, 1997) . The ICRS and the corresponding frame, the ICRF, replaced the Fundamental Catalog (FK5) based on positions and proper motions of bright stars. At XXVII GA IAU (2009), the second realization of the ICRF (ICRF2) was adopted with the list of precise positions for 3414 compact radio astronomical sources. The investigation of a relation between optical and radio reference frames is of importance for improving properties of the ICRF. Because of that , we need to make the observations of some ICRF2, ERS which are visible in the optical domain, and to compare their optical and radio VLBI positions. The optical positions (α and δ) could be calculated using reference stars from big star catalogues. For that comparison we use our CCD observations of ERS made at the ASV 60 cm instrument. Here, we presented the possibilities of ASV telescope using CCD camera Apogee U42 on example of 6 observed ERS. The results are useful.

Figure 1: Telescope Cassegrain 60cm, ASV

Data

We used ASV 60 cm telescope (Fig. 1.) in order to calculate the optical positions of observed ERS and to determine the differences between optical and radio positions of ERS. The goal is to investigate the precise link between the radio and optical frames. And it is possible via ERS visible in optical domain. The CCD fields were done using camera Apogee U42, and with ASV 60 cm it is 0.46 arcsec/pixel (the field of view-FOV is about 15.8x15.8 arcmin). The positions of ERS were calibrated with respect to the XPM catalogue (Fedorov et al. 2010). The XPM contains the positions and proper motions for 314 million stars distributed all over the sky for the epoch J2000.0. We observed about 40 ERS from ICRF2 list (Fey at al. 2009) during 2011 and 2012. One of them is presented in Fig. 2. Some XPM stars are marked with circles and ERS is marked with the direction arrow and circle. There are 6 frames per ERS (3 at R filter and 3 at V one) and the magnitudes ranged from 14.2 to 17.0 (V domain). The exposure time was 60 sec. All exposures were guided. Because of small FOV the corrections for apparent displacements, as differential refraction (Aslan et al. 2010, Kiselev 1989), did not apply. The reduction on bias, dark and flat-field were not done.

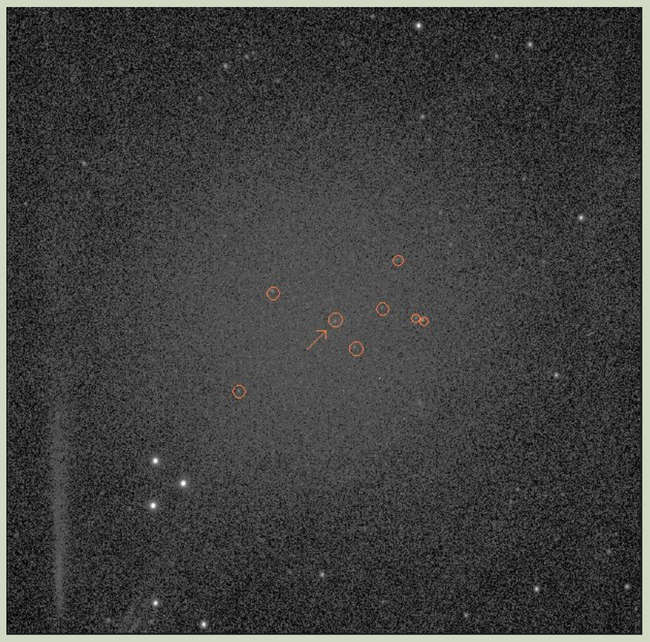

Figure 2: ERS ICRF J001031.0+105829, G 0007+106, 14.2 mag

Procedure

For processing the CCD images, the first step is to detect the star-like object (ERS) and reference stars. The program for reduction of stellar apparent coordinates (in Fortran) is written with some procedures of SOFA packages (Standards of Fundamental Astronomy). We used the VLBI radio ERS coordinates from IERS Technical Note No. 35. The next step is the measuring the CCD positions of centers (x,y) of ERS and stars. The linear model was used, as a standard astrometric "plate" reduction with the available reference stars: $\xi=ax+by+c$ and $\eta=dx+ey+f$ (Kiselev 1989) to transform the measured CCD coordinates (x,y) to tangential ones (ξ,η). Because of small FOV, tangential coordinates of reference stars and ERS are equal to equatorial ones. The unweighted Least-Square Method (LSM) was applied to calculate the unknown values of parameters a, b, c to get α and d, e, f to get δ. To do that we need at least 3 reference stars. The AIP4WIN (Berry & Burnell 2002) image processing package was applied for CCD images. So, the optical coordinates of 6 observed ERS objects were determined. Finally, we compared the optical (O) positions of ERS with the radio (R) ones to determine the values (O-R) in α and δ (see the results in Table).

Results

ERS, V mag	(O-R)α["]	(O-R)δ["]	σ_α["]	σ_δ["]
L 0109+224, 16.4	-0.049	-0.036	0.138	0.158
A 0059+581, 16.1	0.026	0.317	0.226	0.495
Q 2250+190, 16.7	-0.181	0.224	0.400	0.120
G 0007+106, 14.2	-0.115	0.053	0.038	0.076
L 2254+074, 17.0	0.145	0.180	0.381	0.556
G 0309+441, 16.5	0.064	-0.353	0.315	0.263

Conclusion

The presented preliminary offsets (in α and δ) and their standard errors of 6 observed ERS objects are acceptable and comparable with the other observations and results (as Rozhen 2 m telescope ones, for example). This results also can be useful for improving the coordinates and proper motions of reference stars presented in the XPM catalogue and to calculate the unknown positions of every star in the neighborhood of ERS. Using dark, bias, flat and stacking during the reduction of our CCD images, we expect better results of (O-R) in positions of ERS. Also, the ASV results could be improved by using star guider (to use the exposures longer than 90 sec). The XPM catalogue is a good densification of Hipparcos reference frame and can be used as reference astrometric catalogue even in a small CCD fields, but we need bigger catalogues in the future. The optical observation of ERS are possible by using the ASV 60 cm telescope and a good CCD camera. Some preliminary results were done in the paper (Damljanović & Milić 2012). Several problems of ERS optical CCD observations and reduction of CCD data can be: the optical counterparts of ERS objects are faint ones, atmospheric influences and technical problems.

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References

Aslan, Z., Gumerov, R., Jin, W., Khamitov, I., Maigurova, N., Pinigin, G., Tang, Z., Wang, S.: 2010, A&A, 510, A10
Berry, R., Burnell, J.: 2002, "The Handbook of Astronomical Image Processing, Includes AIP4WIN Software", Willmann-Bell, Inc., Richmond, USA
Damljanović, G., Milić, I. S.: 2012, in the Proceedings of the Journées 2011, in press.
Fedorov, P. N., Akhmetov, V. S., Bobylov, V. V., Bajkova, A. T.:2010, MNRAS, 406, 1734-1744.
Fey, A. L., Gordon, D., Jacobs, C. S.: 2009, IERS Technical Note 35
Kiselev, A. A.: 1989, "Theoretical foundations of photographic astrometry", Nauka, Moskva