INTERMEDIATE STARS IN EXTRAGALACTIC RADIOSOURCE FIELDS

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Abstract. The present paper joins the astrometric efforts to determine the connection between the optical reference frame and the radio one. The final product of this survey will be the astrometric catalogue of the intermediate stars in the neighbourhood of extragalactic radiosources. The statistic analysis of the O–C for the RRS2 standard stars for 188 extragalactic radiosource fields situated between –20° and +70° declination are presented. These results were performed in Bucharest Observatory.

Key words: astrometry – reference frames – radiosources.

1. INTRODUCTION

During the last decade several optical astrometric surveys provided us their results. The observations are performed using either instruments on board of space missions (like Hipparcos satellite), or the ground-based ones. The products of such surveys consist of high-accuracy astrometric catalogues for a large number of stars, including faint stars. We talk frequently now about the astrometric sub-milliarcsecond era (see, e.g., Kovalevsky 1994).

The great importance of an ideal reference system in astronomy is very well known. A reference system better connected with the inertial reference system can be obtained if we take into account the farthest objects on the sky: extragalactic radiosources. Unfortunately, the extragalactic radiosources are very faint in the optical domain; the astrometric positions are based on the radiointerferometric observations for most of them. For this reason, we need to find the mathematical form of passing through the optical reference system(s) on the radio reference system.

The astrometric survey from Bucharest Observatory was started within the framework of the former CONFOR program.

The CONFOR survey was an astrometric joint program of several institutes from the Eastern Europe. Acronym of Connection of Frames in Optical and Radio regions, its aim was to establish a link between the fundamental system FK5 and the radioastronomical coordinate system.

For this pourpose, the catalogue of extragalactic radiosources (Argue and de Vegt 1984), was taken into consideration. The main concept in the CONFOR program was to use the optical fixed system of reference stars in the vicinity of the extragalactic radiosources. Thus, a reliable basis for a good astrometric reduction of the extragalactic radiosources will be created. For a consistent presentation of the CONFOR program, see, for instance, Gubanov et al. (1990).

Two major steps of the program were considered:

- astrometric accuracy for the standard and intermediate neighbouring stars;
- astrometric final measurements for the extragalactic radiosource of each area in the optical domain.

For the first step, one of the instruments used for the observations was the Merz-Prin double astrograph (f = 6 m, D = 38 cm) from the Bucharest Observatory. The instrumental field of 2° × 2° allowed us to reach the stars of 13–14th magnitude on astrophotographic plates with the exposure time varying between 30 and 50 minutes.

A total number of 188 extragalactic radiosource fields were observed between 1992–1999 with this instrument.

2. OBSERVATIONS

The observations were carried out on 24 cm × 24 cm astrophotographic plates. The major parts of the observations were made when the stellar field crossed the meridian. The exposure time was established as function of the field position in the sky: up to 50 minutes for the fields of –20° to 0° declination, and 30 minutes for the fields around 45° in declination.

The observations were reduced taking into account two intermediate catalogues acronym RRS2 and PIRS.

2.1. RRS2-STARS

The RRS2 catalogue contains astrometric positions for 2575 stars lying in the region –20° to +90° declination. The average number of RRS2-stars one degree around the extragalactic radiosources is 10. Theirs coordinates are reported to the mean epoch 1990.5 in the FK5 system, and their proper motions are known.

2.2. PIRS-STARS

The Photographic Intermediate Reference Stars (PIRS) catalogue contains stars from 11th to 14th visual magnitude, located in the 30-arcminute area neighbouring the radiosources. The origin of the PIRS-stars astrometric positions was the GSC catalogue. Thus, an average number of 25 PIRS-stars for each extragalactic radiosource field is measured. The 30-arcminute area choice was decided taking into account the field of the Merz-Prin refractor. For the instrumental field of $2^{\circ} \times 2^{\circ}$, we consider that the light sources measured 30-arcmin around the center are not affected by aberrations due to the optical system.

The importance of the intermediate PIRS catalogue was emphasized at the 22nd IAU General Assembly, held in the Hague in 1994. On this occasion, the idea of a standard list of intermediate stars in the extragalactic radiosource fields was enounced. This aspect can be found also in the B6, and B7 resolutions adopted by the Working Group for the reference frames (Kovalevsky, 1994).

3. RESULTS

Both RRS2 and PIRS measurements were performed with an ASCORECORD measuring machine. Then, the measurements were reduced using several catalogues: PPM, TYCHO, CAMC for the RRS2-stars astrometry, and GSC for the PIRS-stars. A total number of 1943 PPM stars and 1295 TYCHO stars were measured for the 188 considered areas. The presence of the proper motions in the reference catalogues stars, allowed us the determination of the standard errors in right ascension and declination, as well as the (O–C) analysis.

In Figs. 1 and 2, the ratio between the measured (O–C) and the latter's number is presented graphically for the PPM stars under the form of histograms for right ascension (Fig. 1) and declination (Fig. 2). In abscissa the (O–C) values are represented with the step of 0.001 time-second for ascension, and respectively 0.01 arc-second for declination; in the ordinate is represented the number of the values ranging between the respective intervals. In both graphics one can observe a good focusing in relation with the origin. In the ascension the Gaussian obtained is also symmetric, whereas in the declination the range of the negative values number is greater than that of the positive ones.

Fig. 3 presents for the TYCHO stars (in right ascension) the same ratio between the values O–C and their number. The Gaussian is centered in the origin and is also relatively symmetric. Fig. 4 presents, also for the TYCHO stars, the same ratio in declination. One can observe a slight shift of the top of Gauss' bell towards negative values and also a stranger range of the negative values of the (O–C)'s.

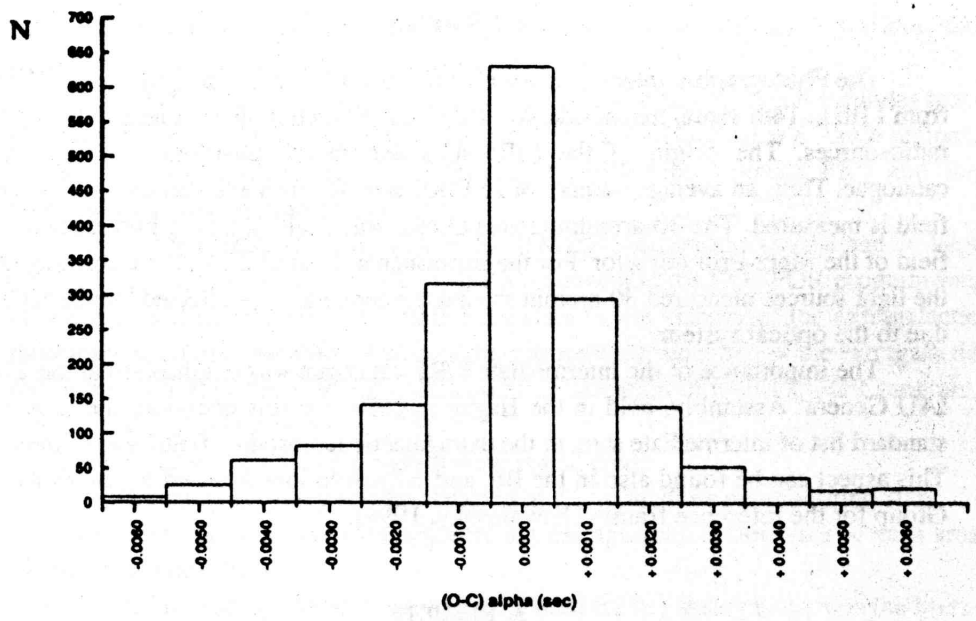

Fig. 1 – (O–C) in right ascension for the PPM stars measured on the 188 analyzed extrgalactic radiosource areas.

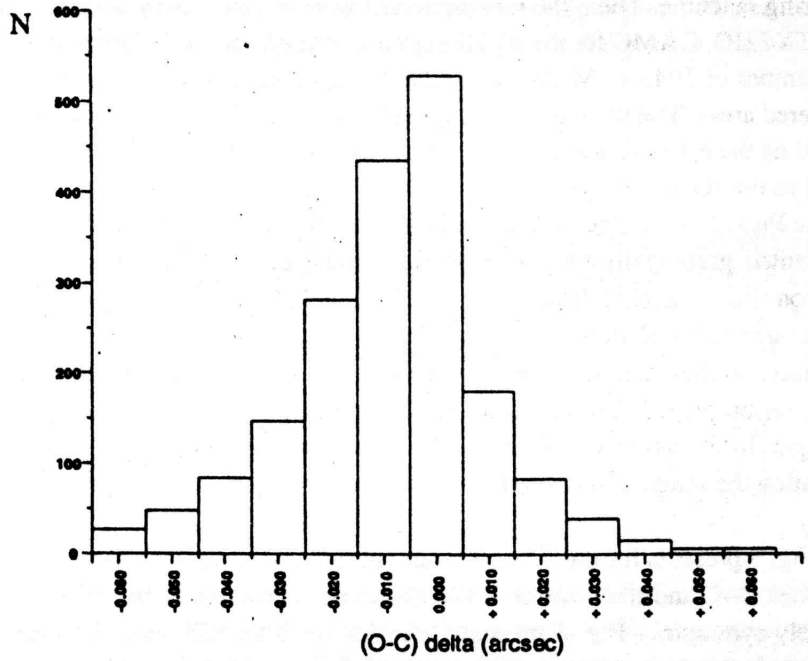

Fig. 2 – (O–C) in declination for the PPM stars measured on the 188 analyzed extragalactic radiosource areas.

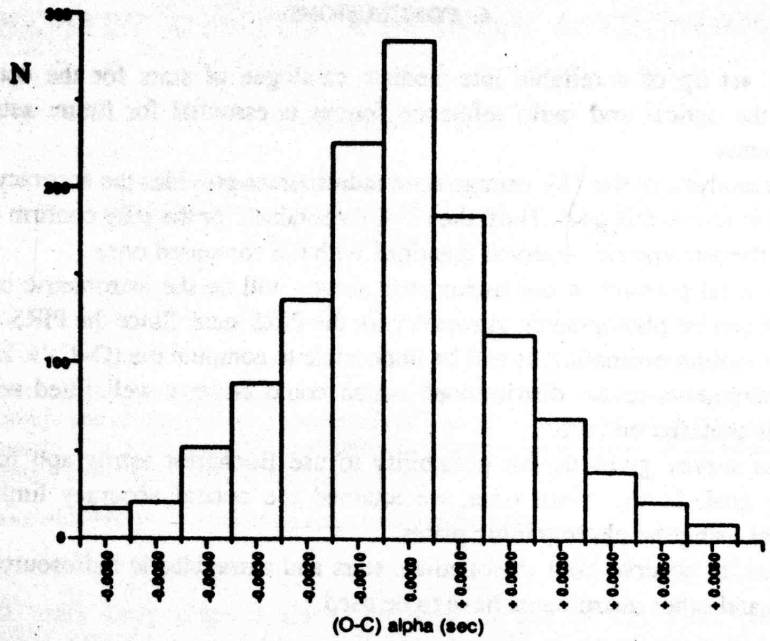

Fig. 3 – (O–C) in right ascension for the TYCHO stars measured on the 188 analyzed extragalactic radiosource areas.

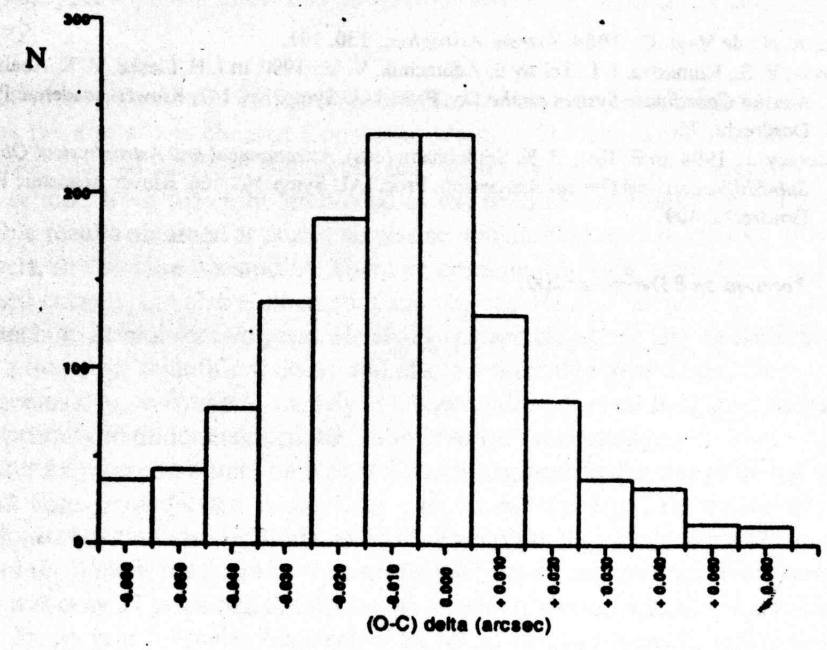

Fig. 4 – (O–C) in declination for the TYCHO stars measured on the 188 analyzed extragalactic radiosource areas.

6. CONCLUSIONS

The set up of a reliable intermediate catalogue of stars for the connection between the optical and radio reference frames is essential for future astrometric developments.

Our analysis of the 188 extragalactic radiosources provides the accuracy that we can reach to obtain this goal. Thus, the (O–C)'s obtained for the stars confirm the good match of the astrometric observed positions with the computed ones.

The final product of our astrometric survey will be the astrometric catalogue giving the precise photographic astrometry for the PIRS stars. Since the PIRS stars had no proper motion estimation, it will be impossible to compute the (O–C)'s. However, our measurements reveal distributions which could be very well fitted with three Gaussians centered on zero.

This survey gives us the possibility to use Bucharest astrograph for a new scientific goal. In the mean time, we attained the optical accuracy limit of this instrument using the photographic plates.

Thus, to observe both intermediate stars and extragalactic radiosources, CCD detectors and other instruments have to be used.

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