ASTROMETRIC CCD POSITIONS FOR EXTRAGALACTIC RADIO SOURCES[*]

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ABSTRACT

Extragalactic radio source positions referred to Hipparcos or Tycho catalogues are useful for the determination and checking of the orientation between the reference frames defined by those catalogues and the International Celestial Reference Frame (ICRF), which represents the new astrometric fundamental system. We have employed a method that uses secondary reference frames, formed by Guide Star Catalog and fainter stars, corrected towards more precise reference systems, to derive astrometric positions from CCD observations. The primary reference catalogue used is a Tycho-like catalogue, the Twin Astrographic Catalogue, TAC (Zacharias et al. 1996). Here we present the optical position determinations for 18 quasars, all belonging to the ICRF, referred to TAC. The final precision on the quasar positions was 0.05 arcsec on average. The comparison with the radio positions shows good agreement with previous determinations for those sources.

Key words: CCD astrometry; catalogues; reference frames.

1. INTRODUCTION

The extragalactic sources defining the ICRS have their position defined in the radio domain. To obtain positions for their optical counterparts a step process is usually adopted. Such a process is required in order to place the faint image of the extragalactic source on the catalogues formed by relatively bright stars. The observations that the process entails are usually time and resource consuming (Zacharias et al. 1996).

We recently presented a method to abbreviate this step process, by using Guide Star Catalog (GSC) stars (Russell et al. 1990) to build the intermediate frame between the stars around the extragalactic source and the catalogue stars (Assafin et al. 1997a). Although the results previously obtained using the method have been quite satisfactory, it remains to be investigated whether the lack of knowledge for the

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GSC stars proper motions would hamper the determination of positions relatively to precise catalogues, like Tycho or Hipparcos.

Thus, in order to verify whether the method can be usefully be used for Tycho-like catalogues, in deriving precise astrometric positions in limited fields, we obtained the positions of 12 and 6 quasars, on northern and southern declinations respectively. The reductions were made relatively to the Twin Astrographic Catalogue (TAC). This catalogue has density and accuracy comparable to the Tycho Catalogue (≈ 30 stars/degree^2), while its proper motion precisions are on the the Hipparcos Catalogue level (2.5 to 4 mas/yr), therefore enabling a comprehensive test of the method's capabilities.

2. REDUCTION AND RESULTS

CCD observations were carried out during 1995-96 at the 1.60m telescope at Laboratório Nacional de Astrofísica (LNA)–Brazil. Auxiliary digital images were taken from the Digital Sky Survey of the ST ScI (White et al. 1992). They provide GSC and fainter secondary frames of 11–18 magnitude stars, allowing to materialize TAC onto the CCD fields, on which the sources were imaged. An important phase is the correction of GSC positions to the TAC frames. This is done on the tangent plane, through classic photographic procedures using the standard coordinates of reference stars common to TAC and GSC. The CCD frames are finally reduced and the optical positions then obtained. For the GSC correction the third-degree polynomial model was employed and for the CCD field reductions a simpler four constant model was required.

For the northern and southern quasars reduced, the average deviation for the TAC and the GSC corrected positions was 0.12 arcsec, in $4° \times 4°$ fields with an average of 165 stars. Therefore, the north and south GSC parts enabled homogeneous reductions. Table 1 summarizes the results. The quasars $1111 + 149$, $1116 + 128$, $1252 + 119$ and $1354 + 195$ present optical minus radio offsets much above the rest of the set. This has been previously noted when comparing their radio positions against PPM and ACRS based optical positions (Assafin et al. 1997b). A slight dependence on magnitude is found for the GSC correc-

tion residuals in position 'GSC minus TAC', as shown on Figure 1.

The final precision on the quasar positions was 0.05 arcsec on average. This means an improvement by a factor of 2 on the precisions previously obtained in alike reductions with PPM and ACRS, formerly the only representatives of dense astrometric catalogues. The method was thus able to attain the new, more demanding requirements for precision of Tycholike catalogues such as TAC.

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Table 1. Results for reductions of 18 extragalactic radio source positions.

| Source	Mag	α (J2000)		δ (J2000)		E_α	E_δ	Opt $-$ $\Delta\alpha\cos\delta$	Radio $\Delta\delta$	GSC $-$ σ_α	TAC σ_δ	TC/GC Stars
		hh	mm	$^\circ$	$'$	(arcsec)	(arcsec)	(arcsec)	(arcsec)	(arcsec)	(arcsec)	
0607−157	17.0	06	09	−15	42	0.02	0.01	−0.23	−0.24	0.14	0.13	570
1038+064	16.8	10	41	+06	10	0.06	0.06	+0.06	−0.13	0.12	0.13	133
1040+123	17.3	10	42	+12	03	0.06	0.05	−0.08	+0.17	0.14	0.12	112
1111+149	18.0	11	13	+14	42	0.07	0.07	−0.57	+0.08	0.12	0.11	090
1116+128	19.3	11	18	+12	34	0.04	0.04	−0.47	−0.05	0.12	0.11	114
1252+119	16.6	12	54	+11	41	0.05	0.06	+0.50	−0.05	0.11	0.13	179
1302−102	14.9	13	05	−10	33	0.01	0.01	+0.27	−0.48	0.13	0.13	202
1334−127	17.2	13	37	−12	57	0.03	0.03	+0.15	−0.01	0.13	0.12	252
1354+195	16.0	13	57	+19	19	0.06	0.06	+0.96	−0.35	0.13	0.14	050
1502+106	18.6	15	04	+10	29	0.04	0.04	−0.06	+0.24	0.15	0.16	094
1504−167	18.5	15	07	−16	52	0.01	0.01	+0.11	−0.47	0.13	0.13	275
1511−100	14.4	15	13	−10	12	0.02	0.02	−0.02	−0.12	0.14	0.15	301
1538+149	15.5	15	40	+14	47	0.05	0.03	−0.13	−0.24	0.12	0.12	139
1606+106	15.9	16	08	+10	29	0.04	0.05	+0.14	−0.11	0.13	0.12	143
1717+178	18.5	17	19	+17	45	0.03	0.03	+0.16	+0.20	0.11	0.11	243
1730−130	18.5	17	33	−13	04	0.03	0.03	+0.15	−0.00	0.14	0.13	487
1821+107	17.3	18	24	+10	44	0.02	0.03	+0.18	+0.13	0.13	0.13	283
2029+121	17.3	20	31	+12	19	0.03	0.03	+0.36	+0.04	0.11	0.11	399
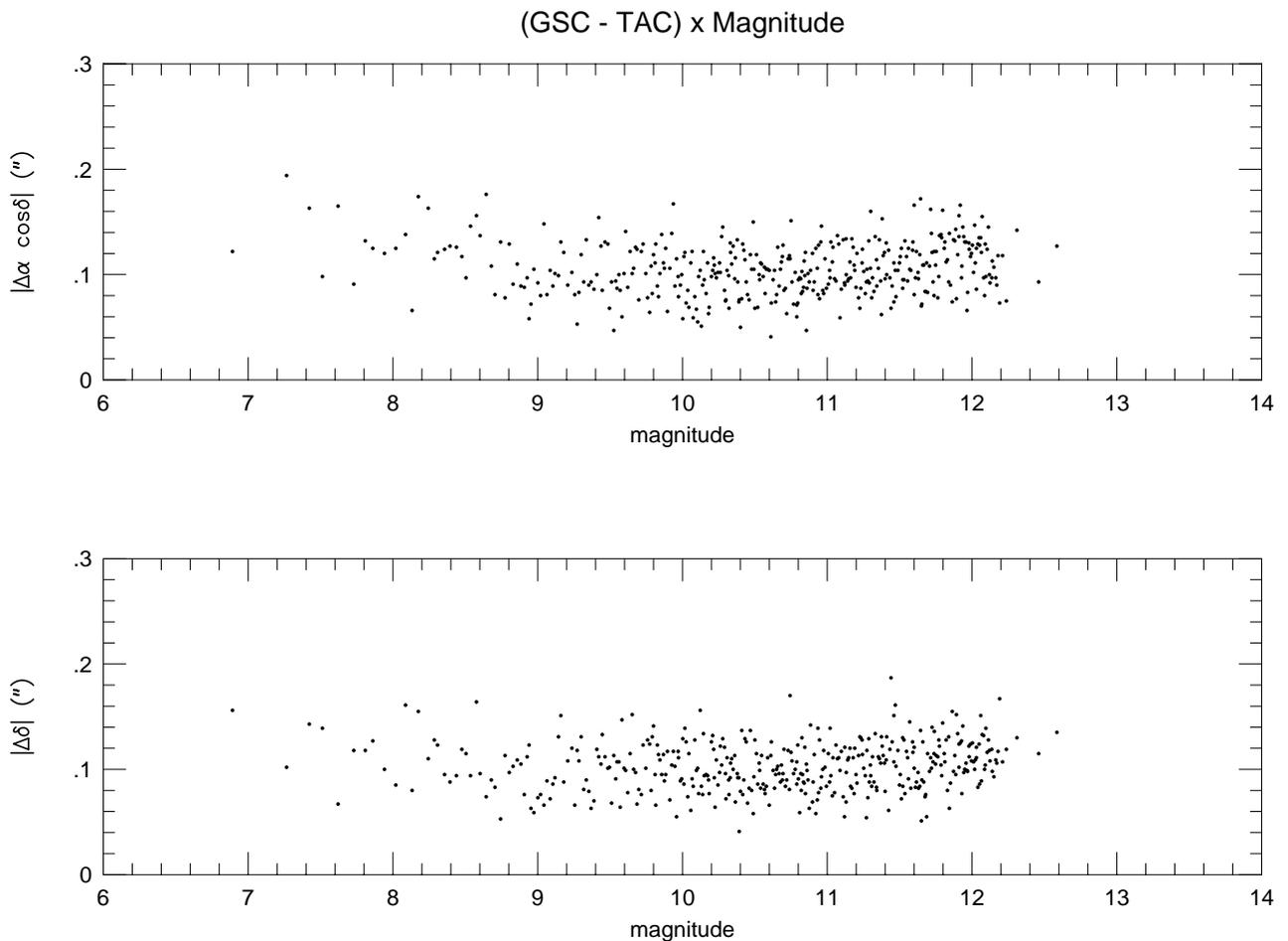
Figure 1. Absolute values of 'GSC minus TAC' positional residuals, as function of magnitude. A slight magnitude equation is found, mainly in right ascension. Notice that there is a loss of accuracy at both magnitude ends.