# OPTICAL COUNTERPARTS OF EXTRAGALACTIC RADIO SOURCES IN THE SOUTHERN SKY: POSITIONS OBTAINED FROM SCHMIDT PLATES

H.G. Walter
Astronomisches Rechen-Institut
Heidelberg, Fed. Rep. of Germany

ABSTRACT

The usefulness of Schmidt plates for measuring astrometric positions of extragalactic radio sources with an average uncertainty of less than 0.3 arcseconds is emphasized in the discussion of the results on 50 optical counterparts and by the comparison with corresponding positions obtained through radio interferometry.

## 1. INTRODUCTION

Optical counterparts of extragalactic radio sources are recognized as intermediaries for connecting the radio reference frame to the fundamental reference system of stellar positions and proper motions. Representatives of the radio reference frame are among others the source position catalogues issued by the Jet Propulsion Laboratory during the last years. Out of this series the Catalog 1980-1 (Fanselow et al., 1981) is chosen as a basis of extragalactic sources for further work in the optical domain. The study undertaken deals with the verification of the existance of optical counterparts and with the generation of astrometric positions at the level of a few tenths of an arcsec by means of Schmidt plate measurements. Reference stars are provided by the Catalogue Perth 70 (Høg and von der Heide, 1976). Therefore the program is restricted to radio sources south of +5° declination of which 52 are included in the position catalogue JPL 1980-1.

Failing the identification of optical counterparts of the sources 0727-116 and 2149+056 (= OX 082) accurate and homogeneous coordinates have been determined for 50 sources during a plate measurement campaign abbreviated by WW in the following. Among them, however, 4 results are affected by still unexplained off-sets compared with the positions of JPL 1980-1.

The celestial coordinates of the optical counterparts were determined by a method similar to that described in an earlier paper by



*H. K. Eichhorn and R. J. Leacock (eds.), Astrometric Techniques, 223–228.*

Walter and West (1980). All plates were measured in two positions differing by an azimuthal rotation of 180° (direct and reverse).

Table 1. Comparison of radio and optical positions

| | Radio minus Optical | Mean error | Number of sources | Remarks |
|---|---|---|---|---|
| $\overline{\Delta\alpha \cos\delta}$ | -0".022 | 0".052 | 46 | Ref.NRAO 140 |
| | 0".008 | | | Ref.3C273B (de Vegt and Gehlich, 1981) |
| $\overline{\Delta\delta}$ | -0".006 | 0".050 | 46 | |

## 2. RESULTS

In the course of the plate measurements optical images of the radio sources 0104-408, 1144-379 and 1313-334 have been identified, for which no optical identification had been reported in the literature so far. Finding charts and astrometric celestial coordinates are published elsewhere (Walter and West, 1980; Walter and West, 1982).

The comparison of the optical positions with the corresponding ones in JPL's source position catalogue 1980-1 is reflected in Table 1, and the residuals are plotted in Fig.1. Concerning the zero points of right

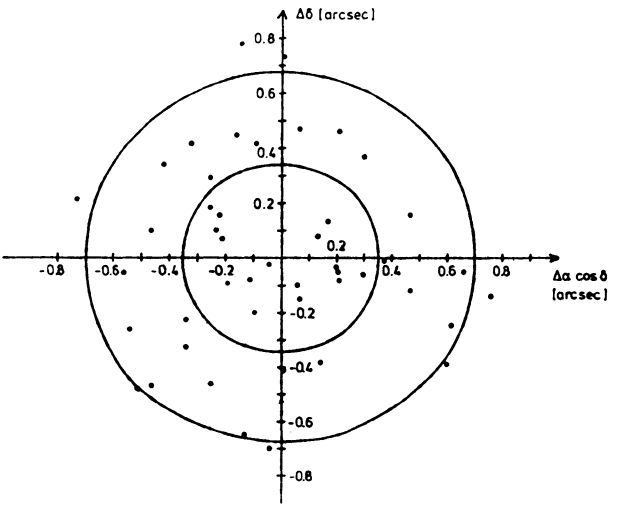


Fig.1. Residuals in RA and Dec [JPL(1980-1) minus WW (1982/83)]

https://doi.org/10.1017/S0074180900076609 Published online by Cambridge University Press

ascension and declination noticeable systematic differences are not inferable from the results. Also, most of the residuals lie in the 2σ range as indicated in Fig.1.

On occasions a deviation of the Catalogue Perth 70 from the FK4 system has been surmised. In order to demonstrate that this effect, if any, does hardly account for the size of the residuals the differences $\Delta\alpha_\delta \cos\delta$ and $\Delta\delta_\delta$ are depicted in Figs.2 and 3 with a dotted line

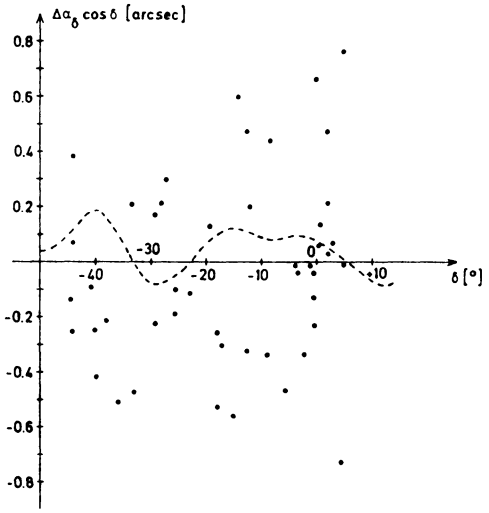


Fig.2. $\Delta\alpha_\delta \cos\delta$ [JPL(1980-1) minus WW (1982/83)]

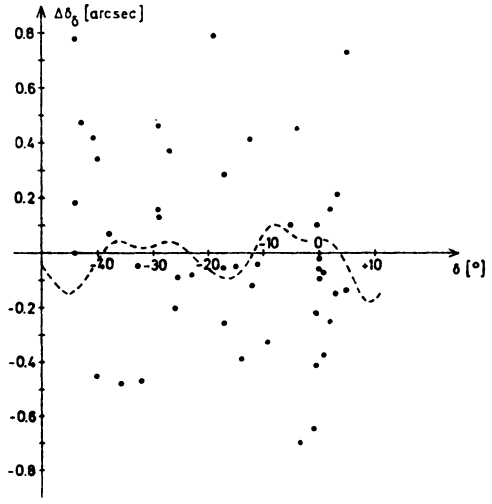


Fig.3. $\Delta\delta_\delta$ [JPL(1980-1) minus WW (1982/83)]

https://doi.org/10.1017/S0074180900076609 Published online by Cambridge University Press

inserted which is characteristic for the catalogue differences Perth 70 - FK4 (Schwan, 1983). On adding these differences to the plotted residuals one arrives at the position differences JPL 1980/1 - FK4. At first glance the pattern is as noisy as prior to the application of the correction; if, however, sources associated with evidently gross measurement errors are omitted, i.e. with off-sets larger than roughly 1 $\sigma$ , the remaining residuals concentrate more satisfactorily around zero, especially in the case of right ascension. This supports the assumption that the JPL source position catalogue refers closely to the FK4 system.

A vague indication of a sinusoidal wave is recognizable in the plot of the differences $\Delta\delta_\alpha$ (Fig.4). The amplitude amounts to about -0".4,

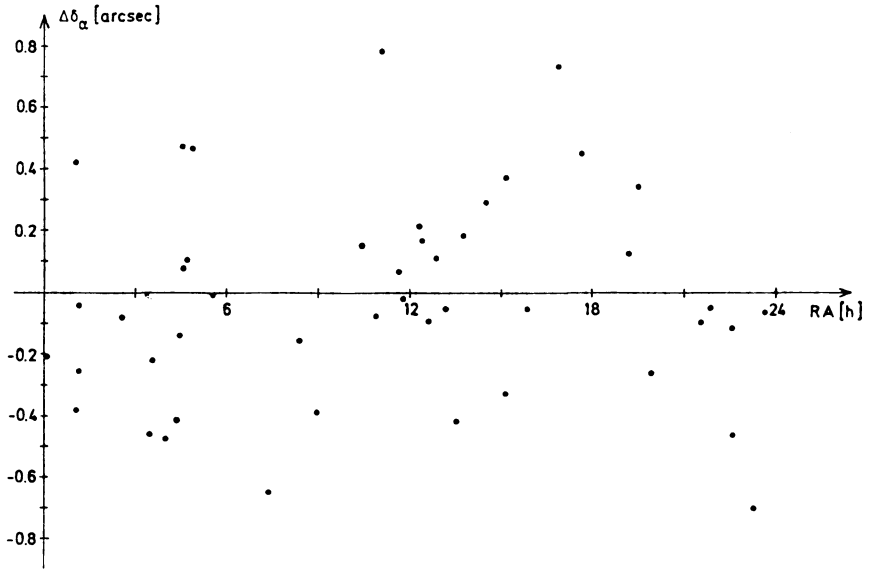


Fig.4. $\Delta\delta_\alpha$ [JPL(1980-1) minus WW (1982/83)]

and it is not clear yet whether this deviation should be attributed to diverse procedures of data reduction. For instance, an explanation could be the application of different terms of nutation in the course of the current transition to the new theory of nutation.

## 3. CONCLUSION

Position measurements of extragalactic objects on Schmidt plates with reference to stars of an extensive and consistent catalogue are instrumental to the determination of a homogeneous set of celestial coordinates of optical counterparts of radio sources with an internal accuracy at the 0".2 level. It is noteworthy that the efforts to be

https://doi.org/10.1017/S0074180900076609 Published online by Cambridge University Press

invested in this kind of coordinate determination are relatively modest, never exceeding three hours per object including the time needed for preparatory measurements. Furthermore, this technique facilitates the identification of optical counterparts of objects in radio source catalogues and provides economically the respective finding charts.

Although the internal position accuracy obtained from Schmidt plates does not match the high precision of long focus photographic astrometry and, all the more, of radio interferometry a set of such positions is an expedient to detect at least possible systematic differences by comparing with other series of measurements. Thus, circumstances permitting, the procedure aids the pointing to peculiarities inherent in the observing technique or in the data reduction method.

ACKNOWLEDGEMENTS

It is a pleasure to thank Dr. R. M. West for technical assistance and the support provided in the use of the S-3000 Plate Measuring Machine of ESO in Munich.

REFERENCES

de Vegt, C. and Gehlich, U.K.: 1981, Astron. Astrophys. 101, 191
Fanselow, J.L., Sovers, C.J., Thomas, J.B., Bletzacker, F.R., Kearns, T.J., Purcell, Jr., G.H., Rogstad, D.H., Skjerve, L.J. and Young, L.E.: 1981, in Reference Coordinate Systems for Earth Dynamics, eds. E.M. Gaposchkin and B. Kolaczek, D. Reidel, Dordrecht, p.351
Høg, E. and von der Heide, J.: 1976, Perth 70. A Catalogue of Positions of 24 900 Stars, Hamburger Sternwarte, 334 pp
Schwan, H.: 1983, private communication
Walter, H.G. and West, R.M.: 1980, Astron. Astrophys. 86, 1
Walter, H.G. and West, R.M.: 1982, Astron. Astrophys. 111, 357

Discussion:

**MURRAY:** Do your positions depend on global solutions for the plates or local reduction with stars around each source?
**WALTER:** I used the ESO plates for objects south of -30°, otherwise I used Palomar plates. I made a global solution for each entire plate.
**JOHNSTON:** The previous speaker has shown that the discrepancy between the optical and radio positions for sources in the northern hemisphere is 0".2. Your figures for the comparison of optical and radio positions in the southern hemisphere show the scatter of the differences as 0".4. Is this discrepancy between the northern and southern hemisphere due to your optical technique for measuring positions or due to the poor quality of the optical reference frame in the southern hemisphere?

**WALTER:** I believe the measurement technique accounts for this. The southern regions are not that much worse than the northern ones.

**STRAND:** You don't think this has anything to do with the discrepancy between the FK4 and the various catalogues which we saw this morning?

**WALTER:** I don't think so. We used Perth 70 to correct the FK4 system.

https://doi.org/10.1017/S0074180900076609 Published online by Cambridge University Press