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A COMPARISON OF POSITIONS AND PROPER MOTIONS OF DS-PROGRAMME STARS WITH HIPPARCOS-CATALOGUE DATA

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Abstract. From 1980 to 1987 visual meridian observations of DS (Double Stars) programme were performed. The positions of these stars have been derived from seven observational catalogues, whereas the proper motions have been determined from the differences with the corresponding positions obtained during the thirties of this century. In the present paper the authors analyse a comparison of the derived positions and proper motions with the corresponding values from the Hipparcos Catalogue.

1. INTRODUCTION

The Catalogue of preliminary derived positions of DS stars (Cvetković, 1992) was compiled at the Belgrade Observatory from seven observational catalogues obtained by visual meridian observations between 1980 and 1897. The Catalogue contains derived right ascensions and declinations for 930, i.e. 1225 double stars, respectively. The positions are given in the FK4 system for the equinox of B1950.0 and observational epochs. The mean epoch of the Catalogue is 1982.91 in right ascension, i.e. 1983.19 in declination. The accuracies are: $\varepsilon_\alpha \cos\delta = \pm 0^s.019$ - for the derived right ascensions - and $\varepsilon_\delta = \pm 0''.27$ for the declinations.

The visual meridian observations of double stars were for the first time undertaken in the thirties of this century to be published as Appendix to the AGK2 Catalogue. For double stars common to AGK2 and "A Preliminary Compilation of DS-Programme Star Positions" the proper motions μ_α and μ_δ were computed and their values were printed in Cvetković's MsC thesis (1991). The total number of computed proper-motion components is 422 in right ascension and 462 in declination; there are 421 stars with both μ_α and μ_δ. The epoch difference for computing the proper motions here exceeds 50 years.

The Hipparcos Catalogue contains, among others, positions and proper motions for more than 100 000 stars. The positions are given for the J2000.0 equinox and epoch of J1991.25. The proper motions are derived from an interval of about three years which was the duration of the Hipparcos mission. The accuracies for the positions and proper motions is of the order of 1 mas. Hipparcos Catalogue contains a large number of visual double stars, among them many also belonging to the DS-Programme. This

circumstance allows a comparison comprising the positions and proper motions of the stars common to these two catalogues.

The accuracy of the positions in the derived catalogue is significantly lower than that of Hipparcos. Besides, in the former case the proper motions were computed over a long time interval, whereas the corresponding interval in the case of Hipparcos is much shorter. Because of this it is of interest to compare the positions and proper motions from these two catalogues. Out of 421 stars with computed proper motion 329 are identified in Hipparcos Catalogue. For the comparison we take into account only them.

2. THE COMPARISON OF POSITIONS AND PROPER MOTIONS

Since the positions in the catalogue of preliminary derived positions for DS-Programme stars are given for the mean observational epoch, they, with the proper motions, are reduced to the epoch of B1950.0 to be transferred afterwards from the system of FK4 into that of FK5 and standard equator and J2000.0 equinox by applying a matrix algorithm (Foster and Boksenberg, 1996). In this way both positions and proper motions are obtained in the FK5 system. For the need of the comparison with Hipparcos Catalogue these positions are reduced by using the proper motions to this Catologue's own epoch - J1991.25.

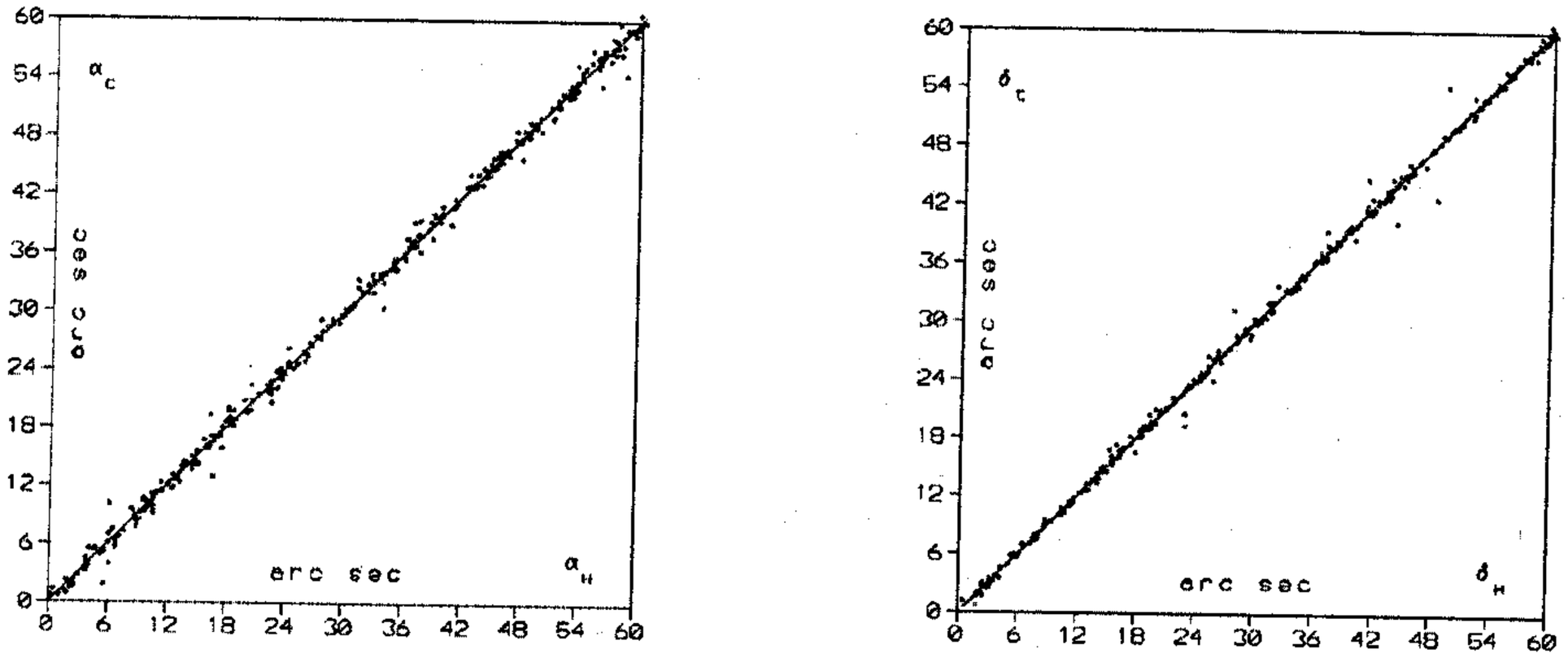

Fig. 1. The correlation between: a) the right ascensions α_C and α_H; b) the declinations δ_C i δ_H.

The differences in the positions are calculated according to the following formulae:

$$\Delta\alpha = \alpha_H - \alpha_C$$

$$\Delta\delta = \delta_H - \delta_C$$

where α_H and δ_H are the right ascension and declination in the Hipparcos Catalogue, and α_C and δ_C are the the equatorial coordinates in the derived catalogue.

The correlation between the right ascensions α_C and α_H is given in Fig.1-a. Fig.1-b presents the same for the declinations. In both cases the coordinates are given in arc units and only second parts are presented. A relatively good agreement between the coordinates is seen in both figures and it is confirmed by the amount of the correlation

coefficient which is in both right ascension and declination $\rho = 0.996 \pm 0.0004$.

The dependence of the coordinate differences $\Delta\alpha$ and $\Delta\delta$ on right ascension and declination is examined and the correlation coefficients ρ are also calculated. The preceding step was to calculate the mean values for all differences $\Delta\alpha$ - obtained $-0''.066$ - and $\Delta\delta$ - obtained $+0''.011$. The errors of a single difference are also calculated: $\sigma_{\Delta\alpha} = 0''.87$ and $\sigma_{\Delta\delta} = 0''.74$. In the next step gross deviations in $\Delta\alpha$ are eliminated; as such we take those whose the modulus exceeds $3\sigma = 2''.61$. In this way seven values are rejected so that the number of remaining $\Delta\alpha$ values is 322. The same principle is also applied for the $\Delta\delta$ differences. Those whose the modulus exceeds $3\sigma = 2''.22$ are rejected. Here the number of rejected values is also 7, thus 322 $\Delta\delta$ values remain. The following results are obtained:

for $\Delta\alpha_\delta$:	$\Delta\alpha = -0''.2366 + 0''.0041 \cdot \delta$,	$\rho = 0.080 \pm 0.055$
for $\Delta\alpha_\alpha$:	$\Delta\alpha = 0''.2002 - 0''.0015 \cdot \alpha$,	$\rho = -0.234 \pm 0.053$
for $\Delta\delta_\delta$:	$\Delta\delta = 0''.1107 - 0''.0024 \cdot \delta$,	$\rho = -0.074 \pm 0.055$
for $\Delta\delta_\alpha$:	$\Delta\delta = -0''.0329 + 0''.0002 \cdot \alpha$,	$\rho = 0.060 \pm 0.056$

The mean values for all differences, both $\Delta\alpha$ and $\Delta\delta$, indicate a relatively good agreement of the positions in both catalogues, especially if one bears in mind the significantly lower accuracy of the derived catalogue compared to Hipparcos. The presented results indicate a certain change of the position differences following the variation in right ascension, resp. declination. In the case of the $\Delta\alpha$ differences this change is somewhat more strongly expressed than in the $\Delta\delta$ case. The reason for this may be the remaining systematic errors in the derived catalogue. Besides, the procedure of transfering the mean positions from the FK4 system for B1950.0 into the FK5 system for J2000.0, mentioned above and carried out for the sake of the comparison, did not include the systematic corrections FK5–FK4.

The moduli of the proper motions are calculated with the annual μ_α and μ_δ by using the following formulae:

$$\mu_H = \sqrt{\mu_{\alpha H}^2 \cos^2 \delta_H + \mu_{\delta H}^2}$$

$$\mu_C = \sqrt{\mu_{\alpha C}^2 \cos^2 \delta_C + \mu_{\delta C}^2}$$

where the subscript H means that the data are from Hipparcos Catalogue, whereas C means the data obtained at the Belgrade Observatory.

The values in which the differences $\Delta\mu_\alpha = \mu_{\alpha H} - \mu_{\alpha C}$ and $\Delta\mu_\delta = \mu_{\delta H} - \mu_{\delta C}$ have moduli exceeding $0''.101$ are removed from the data because this is three times as high as $\sigma_{\Delta\mu_\alpha} = \sigma_{\Delta\mu_\delta} = 0''.0338$. In the case of μ_α 12 values are rejected and 317 remain; in the μ_δ case the number of rejected values is 10 so that 319 remain. As for the proper-motion moduli out of the initial 329 values there remained 310.

The correlations between the individual proper-motion components of these two catalogues, as well as the correlation concerning the moduli (derived at Belgrade and in Hipparcos) are presented in Fig. 2.

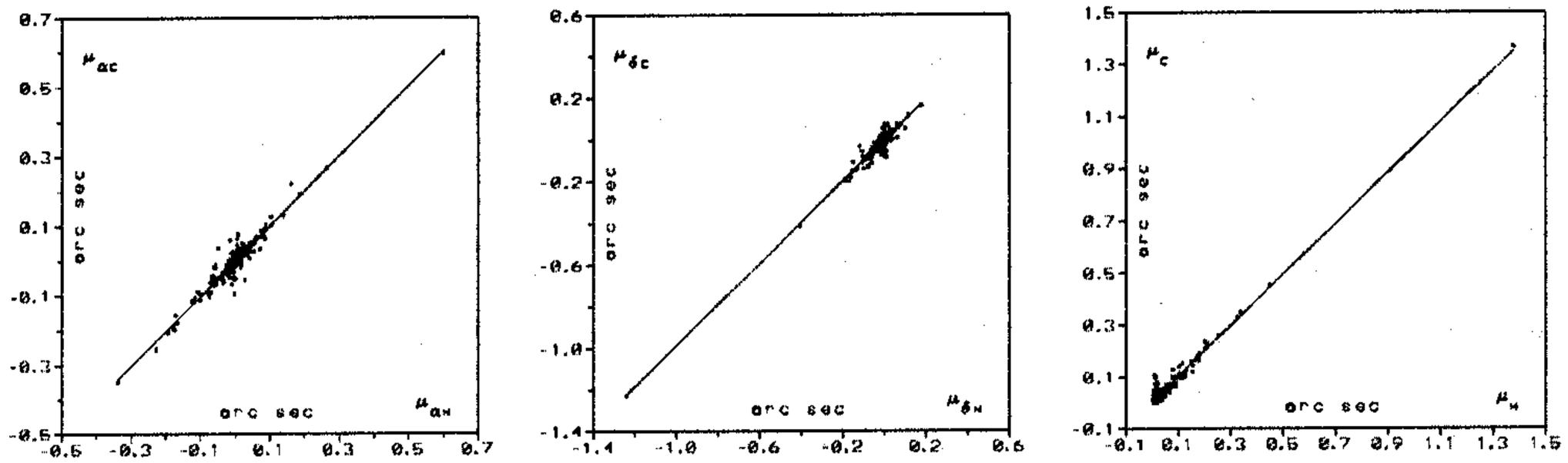

Fig. 2. correlation between: a) proper motions $\mu_{\alpha C}$ and $\mu_{\alpha H}$; b) proper motions $\mu_{\delta C}$ and $\mu_{\delta H}$; b) the proper motions μ_C and μ_H;

In all three Figures a relatively good agreement of proper motions is evident and this is true both the individual components and the modulus, this, being also confirmed by the values of the correlation coefficients: for μ_α $\rho = 0.958 \pm 0''.0046$, for μ_δ $\rho = 0.966 \pm 0''.0037$ and for μ $\rho = 0.979 \pm 0''.0023$. This is an indication that the proper motions computed at the Belgrade Observatory agree relatively well with those from Hipparcos.

3. CONCLUSION

With regard to the high accuracy of the Hipparcos positions and the small deviations of the derived positions of the considered common double stars obtained here one may say that the positions in the derived catalogue are free of noticeable systematic errors. On the other hand this statement is also confirmed by the good agreement of the proper motions from both catalogues. The proper motions obtained at the Belgrade Observatory were computed from the positions of lower accuracy, but the difference between the observational epochs was large (about 50 years) and this contributed to the agreement with the Hipparcos data.

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