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ON THE SYSTEMATIC ERRORS OF DECLINATIONS AND PROPER MOTIONS FROM THE BELGRADE ZENITH-TELESCOPE OBSERVATIONS IN THE PERIOD 1960-1985

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SUMMARY: We prepared the results of the observations with Belgrade ZT made in the period 1960-1985 in a computer- readable form in order to make their new reduction in the FK5 reference frame. Positions and proper motions of our stars were taken from PPM Star Catalogue. The results of determination of the systematic errors of declinations and proper motions of subgroups and Talcott's pairs in that period are presented.

INTRODUCTION

At the XXI IAU General Assembly, Buenos Aires 1991 , Commission 19 of the International Astronomical Union, "Rotation of the Earth", formed the Working Group on Earth Rotation in the HIPPARCOS reference frame-WG ERHRF to collect the past observations and to analyse them in that reference system. The Hipparcos (ESA 1989) had observed the sets of reference stars used by most of the astronomical stations. The Hipparcos program is expected to provide star coordinates, proper motions and parallaxes at the $0\overset{''}{.}002$ level of accuracy or better at the epoch of observation. It opens new possibilities for the analysis of the existing astronomical observations. It was necessary to collect the data and create a central data bank of optical astrometric observations. The WG ERHRF has set up a list of the best observations performed in the past (or are still in progress, as with Belgrade ZT). We cooperate and this investigation is in conformity with it. The Belgrade Observatory is on that list with the observations in the period 1949-1990 obtained with ZT (visual zenith-telescope Bamberg 110 mm).

At the beginning of 1990 we started the preparation of the observations made with the ZT in a computer-readable form in order to make their new reduction in the FK5 reference frame. The PPM catalogue was used. The HIPPARCOS catalogue had not been finished yet.

The PPM Star Catalogue (Röser & Bastian 1991), Vol.I and Vol.II , of 181731 stars north of -2.5 degrees of declination for the equinox and epoch J2000.0 is a rerpesentation of the FK5 system at higher star densities and fainter magnitudes and replaces two older catalogues which served for the same purpose in the past: AGK3 and the SAO Catalogues. The PPM Star Catalogue gives the original FK5 data for the stars contained in FK5 Part I and in FK5

Part II (the Basic Fundamental Stars and the Bright Extension Stars). Flag "F" indicates stars that are contained in FK5 (Part I and Part II), flag "H" denotes the stars contained in AGK3R and/or one of the CMC (The Carlsberg Meridian Circle, nos. 1 to 4) catalogues, flag "D" denotes the double star, and flag "P" the problem case.

56% of stars from New Belgrade Latitude Programme - NP (Ševarlić & Teleki 1960) are with flag "F" or "H", 16% with flag "D" or "P"(one star). This means that numerous stars of our programme have got very precise coordinates and proper motions. But NP's "D" stars did make some problems in the observations and the reduction, because their coordinates and proper motions are of lower accuracy than that of single stars and their observations with ZT are difficult.

Four NP's stars (BD48320 (I group, pair 1, star 2), BD41395 (I6-1), BD34469 (I8-1), and BD371005 (II1-2)) were not found in PPM. For these stars we used the SAO Catalogue and transformed their coordinates and proper motions from FK4 to the FK5 system (the mean positions for J2000.0). The systematic errors FK5 - FK4 for J2000.0 are added. By this the coordinates and proper motions of these four stars are brought into the FK5 frame.

$$(\Delta\delta)_{1950} = [\Delta\delta_\delta + \Delta\delta_\alpha]_{1950}$$

$$\Delta\mu' = \Delta\mu'_\delta + \Delta\mu'_\alpha$$

$(\Delta\delta)_T$ is the systematic error FK5 - FK4 for the epoch T (in centuries),

$$(\Delta\delta)_T = (\Delta\delta)_{1950} + \Delta\mu'(T - 19.50)$$

$$(\Delta\delta)_{2000} = (\Delta\delta)_{1950} + \Delta\mu'(20.00 - 19.50).$$

The transformation from FK4 to the FK5 system :

$$\delta(FK5) = \delta(FK4) + (\Delta\delta)_T$$

$$\mu'(FK5) = \mu'(FK4) + \Delta\mu'.$$

All the changes (in re-reduction) are in accordance with MERIT standards. The new IAU(1976) coordinate system (as defined by FK5) of astronomical constants, the IAU(1980) nutation model, and the new dynamical reference system (JPL DE200/LE200 ephemeris) are used. The FORTRAN programme for refraction is like that used in forming the "Refraction Tables of Pulkovo Observatory" (V, 1985).

The instrument's constants, applied in the re-reduction, are:

- the angular values of the micrometer screw revolution-R (see Table 1.),
- the angular division values of the Talcott's levels (L) were:1 $''\!.$ 2684 for the upper level and 1 $''\!.$ 1798 for the lower one in the period 1960-1968, while 1 $''\!.$ 1737 for the upper level and 1 $''\!.$ 0377 for the lower one in the period 1969-1985,
- the temperature coeficients: −0 $''\!.$ 0016 for the upper level and 0 $''\!.$ 0057 for the lower one in the period 1960-1985,
- the temperature term, the progressive and the periodic errors of the micrometer screw revolution are not applied (Milovanović et al. 1981).

Table 1. The angular values of the micrometer screw revolution (R) in the period 1960-1985

Period	R
1960-63	40 $''\!.$ 1080
1964	.0570
1965-67	.0796
1968	.0992
1969-70	.1078
1971-74	.0733
1975-76	.0709
1977-83	.0660
1984-85	40 $''\!.$ 0570

The General Catalogue of Stellar Radial Velocities (Wilson 1953) and The General Catalogue of Trigonometric Stellar Parallaxes (Jenkins 1952) are used fo the calculation of the apparent places of NP stars.

Eight systematic errors are taken into account (the wind effect, the E-W effect-the error due to the clamp position of the teleskope, the effect of the statistical parallaxes for the stars without trigonometric parallaxes, the personal equation, the effect of the level bubble lenght variation, the correction for the curvature of the parallel, the temperature terms of the levels, the deviation of the vertical). In the period 1960-1985 there were two permanent observers (R. Grujić and M. Djokić) with some short interruptions. The excessive instantaneous latitudes resulting from some Talcott's pairs were eliminated using of the Student-Fisher criterion. Thereupon the polar motion was eliminated from the material and the observations were brought in accordance with the mean pole BIH1979, and prepared for determinations of the systematic errors of declinations and proper motions of Talcott's pairs and subgroups of NP.

CALCULATIONS AND RESULTS

1. For every year (for the period 1960-1985) the values φ_{it_0} are determined:

$$\varphi_{it_0} = \frac{1}{n}\sum_{l=1}^{n} \varphi_{lit},$$

where: φ_{it_0} is the annual mean value for every pair i, φ_{lit} is the instantaneous latitude of pair i at the epoch t, t - the epoch of observation of pair i, t_0 - the mean epoch of n observations of pair i, n - the annual number of observations of pair i.

We then derive, also for every year,

$$\varphi_{kt'_0} = \frac{1}{N}\sum_{j=1}^{N}(\frac{1}{5}\sum_{i=1}^{5}\varphi_{it}),$$

where $\varphi_{kt'_0}$ denotes the mean latitude (from N annual values of the mean latitude of subgroup k), N - the number of annual values of the mean latitude of subgroup k. We used only the mean latitudes of subgroup k resulting from all five observed pairs of subgroup k. t'_0 is the mean epoch of observations of subgroup k. There are no cases of $N = 0$, and it is always $N \leq n$.

Hence $t_0 \approx t'_0$, for each year (for each subgroup k and every pair i in subgroup k) we derive,

$$r = \varphi_{kt'_0} - \varphi_{it_0},$$

where: $k = 1, 2, ..., 12$, and $i = 1, 2, ..., 5$.

Equation of condition is (for each pair there are 26 equations)

$$\sqrt{n}\Delta_{i_1}\delta + \sqrt{n}\Delta_{i_1}\mu'(t' - 1973.0) = \sqrt{n}r$$

for ($i_1 = 1, 2, ..., 60$),

$$t' = \frac{1}{2}(t_0 + t'_0)$$

$$1973.0 = 1960.0 + \frac{1}{2}(1986.0 - 1960.0).$$

where: $\sqrt{n}$ is the weight, $\Delta_{i_1}\delta$ and $\Delta_{i_1}\mu'$ are the unknowns derived by the least square method (the results are displayed in Table 3.), t' is the epoch of value r. $\varepsilon_{\Delta_{i_1}\delta}$ and $\varepsilon_{\Delta_{i_1}\mu'}$ are the mean errors for $\Delta_{i_1}\delta$ and $\Delta_{i_1}\mu'$.

2. For two subgroups k and k+1 observed on the same night we have (for every year):

$$\varphi_{kt_0} = \varphi_{t_0} + \Delta\delta_k + \Delta\mu'_k(t_0 - 1973.0) + z_{t_0}$$

$$\varphi_{k+1t'_0} = \varphi_{t'_0} + \Delta\delta_{k+1} + \Delta\mu'_{k+1}(t'_0 - 1973.0) + z_{t'_0}$$

where: φ_{kt_0} is the mean latitude of subgroup k observed at the epoch t_0 (with the polar changes only), φ_{t_0} is the observed mean latitude of subgroup k (z_{t_0} and the systematic errors $\Delta\delta_k$, $\Delta\mu'_k$ are not eliminated), z_{t_0} is the local non-polar change at t_0, $\Delta\delta_k$ and $\Delta\mu'_k$ are the unknowns of subgroup k.

$$\varphi_{kt_0} - \varphi_{k+1t'_0} = (\varphi_{t_0} - \varphi_{t'_0}) + (\Delta\delta_k - \Delta\delta_{k+1}) +$$

$$+(\Delta\mu'_k - \Delta\mu'_{k+1})(t - 1973.0) + (z_{t_0} - z_{t'_0})$$

$$t = \frac{1}{2}(t_0 + t'_0)$$

$$t_0 \approx t'_0.$$

Since (for four hours of observations)

$$\varphi_{kt_0} - \varphi_{k+1t'_0} \approx 0''.001$$

$$z_{t_0} - z_{t'_0} \approx 0''.01$$

we obtain the equation of condition (for each subgroup k and k+1 there are 26 equations) with unknowns ε_k and ν_k :

$$\Delta\varphi_{kt} = \varepsilon_k + \nu_k(t - 1973.0)$$

where

$$\Delta\varphi_{kt} = -(\varphi_{t_0} - \varphi_{t'_0})$$

$$\varepsilon_k = \Delta\delta_k - \Delta\delta_{k+1}$$

$$\nu_k = \Delta\mu'_k - \Delta\mu'_{k+1}$$

for $k = 1, 2, ..., 12$. $\Delta\varphi_{kt}$ is the annual mean value from m values $-(\varphi_{t_0} - \varphi_{t'_0})$, and t is the mean epoch for $\Delta\varphi_{kt}$.

There are some years when subgroups k and k+1 were not observed in the same night ($m = 0$). For those cases we took for $\Delta\varphi_{kt}$ and t the mean values from the rest values for years when subgroups k and k+1 were observed in at least one night conjointly. We used also the condition $\sum_{k=1}^{12}\Delta\delta_k = 0$.

The least square metod gives the solution for ε_k and ν_k with their mean errors $\varepsilon_{\varepsilon_k}$ and ε_{ν_k}, k = 1, 2,..., 12. After using the conditions $\sum_{k=1}^{12}\varepsilon_k = 0$, and $\sum_{k=1}^{12}\nu_k = 0$ we get results set forth in Table 2. The systematic errors of declinations and proper motions of subgroups are calculated according to:

$$\Delta\delta_k = \frac{1}{12}(\varepsilon_{k+1} + 2\varepsilon_{k+2} + 3\varepsilon_{k+3} + ... + 11\varepsilon_{k+11})$$

$$\Delta\mu'_k = \frac{1}{12}(\nu_{k+1} + 2\nu_{k+2} + 3\nu_{k+3} + ... + 11\nu_{k+11})$$

($k = 1, 2, ..., 12$), and these results are presented in Table 2. $-0''.1097 \leq \Delta\delta_k \leq 0''.1235$, and $-0''.00572 \leq \Delta\mu'_k \leq 0''.00493$. The mean errors of $\Delta\delta_k$ and $\Delta\mu'_k$ are: less than $\pm 0''.0317$ for $\Delta\delta_k$, and less than $\pm 0''.0042$ for $\Delta\mu'_k$.

Table 2. The values ε_k and ν_k with their mean errors, and the systematic errors of declinations $\Delta\delta_k$ and propre motions $\Delta\mu'_k$ of subgroups

Subgr.	ε_k	$\varepsilon_{\varepsilon_k}$	ν_k	ε_{ν_k}	Subgroup		$\Delta\delta_k$	$\Delta\mu'_k$
1- 2	0.″0889	±0.″0081	-0.″0005	±0.″0011	Ia	1	-0.″1097	0.″00241
2- 3	.1198	.0144	-.0002	.0019	Ib	2	-.0207	.00190
3- 4	-.0154	.0102	.0009	.0014	IIa	3	.0991	.00173
4- 5	-.0124	.0251	-.0084	.0033	IIb	4	.0837	.00267
5- 6	.0521	.0148	.0031	.0020	IIIa	5	.0713	-.00572
6- 7	-.1275	.0143	-.0001	.0019	IIIb	6	.1235	-.00259
7- 8	-.0226	.0097	.0011	.0013	IVa	7	-.0041	-.00267
8- 9	-.0296	.0111	.0002	.0015	IVb	8	-.0266	-.00156
9-10	-.0425	.0055	.0007	.0007	Va	9	-.0562	-.00140
10-11	.0366	.0113	.0017	.0015	Vb	10	-.0987	-.00070
11-12	.0625	.0065	.0039	.0009	VIa	11	-.0620	.00101
12- 1	-0.″1101	±0.″0108	-0.″0025	±0.″0014	VIb	12	0.″0004	0.″00493

$\Delta\delta_k$ have been calculated previously (Milovanović et al. 1970, Grujić et al. 1975) while $\Delta\mu'_k$ have not been. Our values $\Delta\delta_k$ are remarkably less than the old ones. This is because the GC Catalogue (whose accuracy is lower than PPM's one) was used in the past.

Since

$$\Delta\delta_{i_1} = \Delta\delta_k + \Delta_{i_1}\delta$$

$$\Delta\mu'_{i_1} = \Delta\mu'_k + \Delta_{i_1}\mu'$$

($i_1 = 1, 2, ..., 60$), we have the final systematic errors of declinations and proper motions ($\Delta\delta_{i_1}$ and $\Delta\mu'_{i_1}$) of Talcott's pairs for NP (Table 3.). $-0.''2976 \leq \Delta\delta_{i_1} \leq 0.''3338$ except the value $-0.''8184$ for Ia1 (the star Ia1(1) is with flag "D", the star Ia1(2) is from SAOC which is of lower accuracy than that of PPM), and $-0.''01086 \leq \Delta\mu'_{i_1} \leq 0.''01008$. The large values of $\Delta\delta_{i_1}$ are from Talcott's pairs whose stars are from SAO or from PPM but with flag "D". They are (except Ia1): IIa5 (first star is with flag "D"), Ib8 (first star is from SAO), Ia3 (second star is with flag "D"), Ib6 (first star is from SAO, second star is with flag "D"), IVa3 (second star is with flag "D"). We can use both, $\Delta\delta_{i_1}$ and $\Delta\mu'_{i_1}$, because they are well estimated (the estimate for $\Delta\delta_{i_1}$ is better than the estimate for $\Delta\mu'_{i_1}$). The values $\Delta\delta_{i_1}$ and $\Delta\mu'_{i_1}$ are close to the mean errors of all PPM's stars because the mean err.pos.1990 is $0.''27$, and the mean err.prop.mt. for mean epoche 1930.7 is $0.''0042$ (Röser & Bastian 1991), and less than the mean errors of SAOC,north, because the mean err.pos.1990 is $0.''9$, and the mean err.prop.mt. for mean epoch 1930 is $0.''015$ (Röser & Bastian 1991). The mean errors for $\Delta\delta_{i_1}$ and $\Delta\mu'_{i_1}$ are: less than $\pm 0.''0389$ for $\Delta\delta_{i_1}$, and less than $\pm 0.''00537$ for $\Delta\mu'_{i_1}$.

Table 3. The components $\Delta_{i_1}\delta$ and $\Delta_{i_1}\mu'$ with their the mean errors, and the final systematic errors of declinations and proper motions

Gr.	Pair	Subgr.	$\Delta_{i_1}\delta$	$\varepsilon_{\Delta_{i_1}\delta}$	$\Delta_{i_1}\mu'$	$\varepsilon_{\Delta_{i_1}\mu'}$	$\Delta\delta_{i_1}$	$\Delta\mu'_{i_1}$
I	1	1	-0.″7087	±0.″0115	-0.″00570	±0.″00167	-0.″8184	-0.″00329
I	2	1	.0486	.0095	-.00431	.00138	-.0611	-.00190
I	3	1	.3854	.0070	.00517	.00101	.2757	.00758
I	4	1	.1580	.0076	.00319	.00110	.0483	.00560
I	5	1	.0983	.0089	.00510	.00128	-.0114	.00751
I	6	2	.2559	.0087	.00612	.00132	.2352	.00802
I	7	2	-.0825	.0066	-.00227	.00100	-.1032	-.00037
I	8	2	-.2769	.0070	-.00348	.00106	-.2976	-.00158
I	9	2	.1707	.0099	.00102	.00151	.1500	.00292
I	10	2	-.0826	.0152	.00213	.00230	-.1033	.00403
II	1	3	-.0595	.0186	.00271	.00288	.0396	.00444
II	2	3	-.0888	.0138	-.00580	.00214	.0103	-.00407
II	3	3	-.1386	.0127	.00094	.00198	-.0395	.00267
II	4	3	.0515	.0176	.00367	.00277	.1506	.00540
II	5	3	.2347	.0140	.00260	.00220	.3338	.00433
II	6	4	-.0304	.0141	-.00495	.00222	.0533	-.00228
II	7	4	.0111	.0157	-.00052	.00246	.0948	.00215
II	8	4	-.1033	.0133	.00014	.00209	-.0196	.00281
II	9	4	.0475	.0095	-.00244	.00149	.1312	.00023

Table 3 (continued)

Gr.	Pair	Subgr.	$\Delta_{i_1}\delta$	$\varepsilon_{\Delta_{i_1}\delta}$	$\Delta_{i_1}\mu'$	$\varepsilon_{\Delta_{i_1}\mu'}$	$\Delta\delta_{i_1}$	$\Delta\mu'_{i_1}$
II	10	4	.0810	.0133	.00741	.00208	.1647	.01008
III	1	5	-.0332	.0108	.00089	.00162	.0381	-.00483
IH	2	5	-.1572	.0082	-.00176	.00121	-.0859	-.00748
III	3	5	.0869	.0118	.00531	.00176	.1582	-.00041
III	4	5	.0970	.0084	-.00158	.00124	.1683	-.00730
III	5	5	.0172	.0183	-.00514	.00273	.0885	-.01086
III	6	6	.1197	.0225	-.00249	.00335	.2432	-.00508
III	7	6	-.0137	.0134	.00222	.00199	.1098	-.00037
III	8	6	.0444	.0099	.00165	.00149	.1679	-.00094
III	9	6	.0447	.0146	.00166	.00218	.1682	-.00093
III	10	6	-.2092	.0150	-.00387	.00222	-.0857	-.00646
IV	1	7	.1403	.0132	.00686	.00198	.1362	.00419
IV	2	7	.0471	.0221	-.00208	.00334	.0430	-.00475
IV	3	7	-.2204	.0110	-.00287	.00165	-.2245	-.00554
IV	4	7	-.0398	.0104	-.00057	.00157	-.0439	-.00324
IV	5	7	.0357	.0110	-.00198	.00165	.0316	-.00465
IV	6	8	-.0332	.0155	-.00312	.00237	-.0598	-.00468
IV	7	8	.0541	.0176	.00238	.00267	.0275	.00082
IV	8	8	-.1546	.0148	-.00389	.00224	-.1812	-.00545
IV	9	8	.0352	.0097	-.00038	.00147	.0086	-.00194
IV	10	8	.0958	.0075	.00662	.00114	.0692	.00506
V	1	9	.0881	.0084	-.00031	.00113	.0319	-.00171
V	2	9	-.0097	.0078	.00069	.00105	-.0659	-.00071
V	3	9	.0394	.0082	.00069	.00112	-.0168	-.00071
V	4	9	-.0491	.0090	-.00271	.00120	-.1053	-.00411
V	5	9	-.0648	.0078	.00327	.00106	-.1210	.00187
V	6	10	.0408	.0079	.00163	.00106	-.0579	.00093
V	7	10	.1117	.0078	.00290	.00104	.0130	.00220
V	8	10	-.0502	.0076	-.00326	.00102	-.1489	-.00396
V	9	10	-.0111	.0069	-.00042	.00093	-.1098	-.00112
V	10	10	-.1046	.0072	-.00186	.00095	-.2033	-.00256
VI	1	11	-.0063	.0069	-.00117	.00094	-.0683	-.00016
VI	2	11	.0020	.0077	.00329	.00105	-.0600	.00430
VI	3	11	.0271	.0081	-.00010	.00110	-.0349	.00091
VI	4	11	-.0169	.0048	-.00018	.00066	-.0789	.00083
VI	5	11	-.0010	.0085	-.00002	.00117	-.0630	.00099
VI	6	12	-.0424	.0084	-.00337	.00110	-.0420	.00156
VI	7	12	.1483	.0062	.00241	.00081	.1487	.00734
VI	8	12	.0398	.0077	.00331	.00101	.0402	.00824
VI	9	12	-.1093	.0074	-.00061	.00097	-.1089	.00432
VI	10	12	-0".0498	±0".0102	-0".00255	±0".00134	-0".0494	0".00238

$\Delta\mu'_k$, $\Delta_{i_1}\mu'$, and $\Delta\mu'_{i_1}$ are in ("/year).

CONCLUSION

The 26 years period (1960-1985) is long enough to derive final systematic errors of declinations and proper motions of the subgroups and the Talcott's pairs comprised in NP. The whole material is corrected by them and the mean error (of the instantaneous latitude from one Talcott's pair) is less than before. For example: the mean error was $\pm0''.272$ (1960-1965.5) and $\pm0''.146$ (1969-1974) (Grujić et al. 1989), after our re-reduction the mean error is $\pm0''.164$ (1960-1963), $\pm0''.171$ (1964-1967), $\pm0''.151$ (1968-1970), $\pm0''.137$ (1971-1972) and $\pm0''.115$ (1973-1976). This is also a contribution to Hipparcos program. With the Hipparcos Catalogue (in future) we shall get better possibility to find out the systematic errors and obtain result with better accuracy. In that case the old observations (made with classical instruments) will be in better accordance with the new ones (made with new techniques). It will afford a new insight into precession and nutation. The Belgrade Observatory with its ZT observations can take part in that work and this was the reason for the present re-reduction of the old ZT observations.

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REFERENCES

***: 1966, *Smithsonian Astrophysical Observatory - SAO Star Catalog*, Reprinted 1971, Prepared by the Staff, Smithsonian Astrophys. Obs., Cambridge, Massachusetts, Smithsonian Institution Washington, D.C.

***: 1977, *IAU Transaction*, Reidel Publ., **XVIB**, Dordrecht.

***: 1979 – 1986, *Annual Report*, BIH, Paris.

***: 1984, *JPL DE200/LE200 Ephemeris*, USNO Tapes NA0109 & NA0110.

***: 1989, *Hipparcos mission*, ESA, SP-1111, Vol. II, 252.

Abalakin, V. K., ed.: 1985, *Refraction Tables of Pulkovo Observatory* (V edition), NAUKA, Leningrad, GAO AN SSSR.

Aoki, S., Guinot, B., Kaplan, G. H., Kinoshita, H., McCarthy, D. D., Seidelmann, P. K.: 1982, *Astron. Astrophys.,* **105**, 359.

Fricke, W., Schwan, H., Lederle, T. :1988, *Fifth Fundamental Catalogue (FK5). Part I. The Basic Fundamental Stars.,* Veröff. Astron. Rechen-Institut, Heidelberg, Nr. 32.

Fricke, W., Schwan, H., Corbin, T., et al.: 1991, *Fifth Fundamental Catalogue (FK5). Part II. The FK5 Extension - New Fundamental Stars.,* Veröff. Astron. Rechen-Institut, Heidelberg, Nr. 33.

Grujić, R., Teleki, G.: 1982, *Hvar Obs. Bull. Suppl.,* **6**, No. 1, 71.

Grujić, R., Djokić, M., Milovanović, V., Djurović, L.: 1975, *Bull. Obs. Astron. Belgrade,* **126**, 22.

Grujić, R., Djokić, M., Jovanović, B.: 1989, *Bull. Obs. Astron. Belgrade,* **141**, 7.

Jenkins, L. F.: 1952, *Gen. Cat. of Trigonometric Stel. Parallaxes,* Yale University Obs.

Kapteyn, J. C.: 1920, *Astron. J.,* **52**, 23.

Lieske, J. H., Lederle, T., Fricke, W., Morando, B.: 1977, *Astron. Astrophys.,* **58**, 1.

Lieske, J. H.: 1979, *Astron. Astrophys.,* **73**, 282.

Mueller, I. I.: 1969, *Spherical and Practical Astronomy as Applied to Geodesy,* F. Ungar Publishing Co., Inc.

Milovanović, V., Grujić, R., Djokić, M.: 1970, *Bull. Obs. Astron. Belgrade,* **124**, F. 2, 159.

Milovanović, V., Teleki, G., Grujić, R.: 1981, *Publ. Astron. Obs. Sarajevo,* **1**, 131.

Melbourne, W., et al.: 1983, *Project Merit Standards*, USNO Circular, No. 167.

Roeser, S., Bastian, U.: 1991, *Positions and Proper Motions (PPM) Star Catalogue,* Astron. Rechen-Institut, Heidelberg.

Smart, W. M.: 1958, *Combination of Observations,* Cambridge, University Press.

Ševarlić, B.: 1961, *Publ. Obs. Astron. Belgrade,* **9**, 63.

Ševarlić, B., Teleki, G.: 1960, *Bull. Obs. Astron. Belgrade,* **24**, No. 3/4, 19.

Vondrák, J., Feissel, M., Essaifi, N.: 1992, *Astron. Astrophys.,* **262**, 329.

Wilson, R. E.: 1953, *Gen. Cat. of Stel. Radial Velocities,* Mount Wilson Obs., Carnegie Institution of Washington Publ. 601.

Yumi, S., Yokoyama, K.: 1980, *Results of the International Latitude Service in a homogeneous system 1899.9-1979.0,* Central bureau IPMS, Mizusawa.

СИСТЕМАТСКЕ ГРЕШКЕ ДЕКЛИНАЦИЈА И СОПСТВЕНИХ КРЕТАЊА ПОДГРУПА И ТАЛКОТОВИХ ПАРОВА НОВОГ ПРОГРАМА ИЗ ПОСМАТРАЊА НА БЕОГРАДСКОМ ЗЕНИТ-ТЕЛЕСКОПУ ЗА ПЕРИОД 1960-1985

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Дате су вредности систематских грешака деклинација и сопствених кретања подгрупа и Талкотових парова Новог Програма - НП из посматрања на Београдском зенит-телескопу. За њихово добијање коришћен је посматрачки материјал добијен у периоду 1960-1985.