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CORRECTED μ_δ FOR STARS OF HIPPARCOS CATALOGUE FROM INDEPENDENT LATITUDE OBSERVATIONS OVER MANY DECADES

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SUMMARY: During the last century, there were many so-called independent latitude (IL) stations with the observations which were included into data of a few international organizations (like Bureau International de l'Heure – BIH, International Polar Motion Service – IPMS) and the Earth rotation programmes for determining the Earth Orientation Parameters – EOP. Because of this, nowadays, there are numerous astrometric ground–based observations (made over many decades) of some stars included in the Hipparcos Catalogue (ESA 1997). We used these latitude data for the inverse investigations – to improve the proper motions in declination μ_δ of the mentioned Hipparcos stars. We determined the corrections $\Delta\mu_\delta$ and investigated agreement of our μ_δ and those from the catalogues Hipparcos and new Hipparcos (van Leeuwen 2007). To do this we used the latitude variations of 7 stations (Belgrade, Blagoveschtschensk, Irkutsk, Poltava, Pulkovo, Warsaw and Mizusawa), covering different intervals in the period 1904.7 – 1992.0, obtained with 6 visual and 1 floating zenith telescopes (Mizusawa). On the other hand, with regard that about two decades have elapsed since the Hipparcos ESA mission observations (the epoch of Hipparcos catalogue is 1991.25), the error of apparent places of Hipparcos stars has increased by nearly 20 mas because of proper motion errors. Also, the mission lasted less than four years which was not enough for a sufficient accuracy of proper motions of some stars (such as double or multiple ones). Our method of calculation, and the calculated μ_δ for the common IL/Hipparcos stars are presented here. We constructed an IL catalogue of 1200 stars: there are 707 stars in the first part (with at least 20 years of IL observations) and 493 stars in the second one (less than 20 years). In the case of μ_δ of IL stars observed at some stations (Blagoveschtschensk, Irkutsk, Mizusawa, Poltava and Pulkovo) we find the formal errors less than the corresponding Hipparcos ones and for some of them (stations Blagoveschtschensk and Irkutsk) even less than the new Hipparcos ones.

Key words. Astrometry – Reference systems

1. INTRODUCTION

During the last century, the latitude data φ_i were used to monitor the Earth orientation by a few international organizations: Bureau International de l'Heure (BIH), International Polar Motion Service (IPMS), etc. These data formed the base for the Earth rotation programmes to determine the Earth Orientation Parameters (EOP). Nowadays, these data can also be used to check the Hipparcos satellite data, for example to obtain the corrections of proper motions in declination of the observed Hipparcos stars.

The idea to construct the Earth Orientation Catalogue (EOC) by using the data obtained during the Hipparcos mission and observations concerning the latitude, universal time and altitude variations was outlined by Vondrák and Ron (2003) at the Astronomical Institute in Prague. Soon, at the Belgrade Astronomical Observatory we started similar investigations, but with different methods (Damljanović 2005, Damljanović and Pejović 2005). In cooperation with the group in Prague we compared the results obtained by the two groups (Damljanović and Vondrák 2005, Damljanović et al. 2006).

A few versions of the EOC appeared and some papers about it have been published (Ron and Vondrák 2001, Vondrák 2004, Vondrák and Ron 2003). The Belgrade group has published its results on μ_δ obtained from observations of ten Photographic Zenith Tubes – PZT (Damljanović and Pejović 2008, 2010) and seven visual Zenith Telescopes (ZT) of the International Latitude Service – ILS (Damljanović 2008, Damljanović and Pejović 2006).

The interval covered by the Hipparcos observations was less than 4 years, which is not enough to achieve a good accuracy of proper motions (especially for double and multiple stars). Besides, with regard that about two decades have elapsed since the Hipparcos ESA mission observations (the epoch of Hipparcos catalogue is 1991.25), the error of apparent places of Hipparcos stars has increased by nearly 20 mas because of proper motion errors. This is remarkably bigger than 1 mas (which is the error of the Hipparcos star positions).

Because of these reasons, the new Hipparcos Catalogue (van Leeuwen 2007) appeared as a result of the new reduction made with the raw observations of the Hipparcos mission (ESA 1997). The star positions, proper motions and parallaxes of new Hipparcos were improved by a factor 2 on average (van Leeuwen 2007). However, the processing of binary stars for the new reduction has only been partly completed and further improvement is possible. Also, double and multiple stars (Vondrák 2004, Vondrák et al. 1998), show mostly larger errors of proper motions compared to the single stars.

Aimed at obtaining better proper motions some new star catalogues have appeared (ARIHIP, TYCHO-2, EOC, etc.) with the accuracy of star positions and proper motions close to or better than that of the Hipparcos; both the ground-based and Hipparcos data were used. In line with this approach, we calculated the new set of μ_δ for the common IL/Hipparcos stars and produced our IL catalogue. We combined the Hipparcos data with the ground–based observations (the values of latitude variations φ_i of IL stations) performed for tens of years to get μ_δ with a very good accuracy.

2. DATA

From the latitude variations over many decades it is possible to determine corrections of proper motions in declination $\Delta\mu_\delta$ of observed stars. We collected latitude values obtained at 6 IL stations with ZTs (Belgrade – BLZ, Blagoveschtschensk – BK, Irkutsk – IRZ, Poltava – POL, Pulkovo – PU/PUZ and Warsaw – VJZ) and 1 floating zenith telescope (FZT, Mizusawa – MZL). By using these instruments it was possible to obtain φ_i only, and consequently to determine $\Delta\mu_\delta$ only. We received the φ_i data from Dr. Vondrák via private communication. The IL data cover a very long interval (1904.7 – 1992.0, see Table 1), but each instrument covers a different observation period.

Table 1. Information on IL stations.

IL station, code, instrument and N	Long. λ_W (°)	Mean latitude (°)	Observation period (Year)	(MJD)	Tectonic plate motion (″/100 yr)
1. Belgrade, BLZ ZT, 142 pairs	339.5	44.8	1949.1-1986.0	32935.9-46422.8	$0.041(t-t_1)$
2. Blagoveschtschensk, BK ZT, 96 p.	232.5	50.3	1959.2-1992.0	36629.6-48619.7	$-0.048(t-t_1)$
3. Irkutsk, IRZ ZT, 32 p.	255.7	52.3	1958.2-1991.0	36263.8-48253.7	$-0.033(t-t_1)$
4. Mizusawa, MZL FZT, 72 p.	219.9	39.1	1967.0-1984.8	39498.6-46008.6	$-0.045(t-t_1)$
5. Poltava, POL ZT, 59p.(+3)	325.5	49.6	1949.7-1990.4	33183.9-48049.8	$0.031(t-t_1)$
6. Pulkovo, PU/PUZ ZT, 314 p.	329.7	59.8	1904.7-1992.0	16743.8-48621.7	$0.034(t-t_1)$
7. Warsaw, VJZ ZT, 141 p.	339.0	52.1	1961.8-1992.0	37598.9-48606.9	$0.041(t-t_1)$

Table 1 lists some basic information on IL stations. In the first column, the IL station, its code, the instrument and number of star pairs N are presented. The codes (BLZ, BK, IRZ, POL, PU/PUZ, VJZ and MZL) are from the monograph by Vondrák et al. (1998). The west longitude λ_W and the mean latitude of IL station are given in the next two columns. The observation interval (in years and in days, Modified Julian Date – MJD) is in column 4. In the last column the tectonic plate motion is presented, where the value $(t-t_1)$ is in centuries and t_1 is counted from 32000 MJD.

The longitude λ_W is west of the zero meridian, according to the Kostinski formula (Kulikov 1962). The tectonic plate motion and the mean latitude were removed from the IL data. The value N is the number of Talcott star pairs included in the observational programme of an IL station. Each of the IL stations has a different mean latitude (unlike the ILS stations where that value is the same for all stations) and hence they are called independent latitude stations. Also, the IL instruments are slightly different among themselves: BLZ was with ZT $Askania-Bamberg$ 110/1287 mm, BK and IRZ with ZT $ZTL-180$, POL with ZT $Zeiss$ 135/1760 mm, PU/PUZ with ZT $ZTF-135$ 135/1760 mm. Out of 142 BLZ star pairs, two observational programmes of BLZ data (Damljanović 1997), we took into account 139 ones; the stars belonging to 3 star pairs are not in the Hipparcos catalogue. One BLZ programme covered the period 1949.0 – 1961.0 and the other 1960.0 – 1986.0. Out of 96 star pairs of the BK programme we used 94 ones. All 32 star pairs of IRZ programme were included in our calculations. Out of 59 POL star pairs and 3 triple stars 53 pairs and all 3 triple stars were used. A few star pairs were with a small number of data. The triple stars were treated by using a slightly different method than in the case of star pairs (Damljanović 2007). In the POL data, the observations of ZT POZ ($Zeiss$ 135/1760 mm, 1950.2 – 1968.8) and ZT POY ($ZTL-180$, 1967.9 – 1980.8) of two bright stars (H15863 and H67301) were included (Damljanović 2007). The location of PU is close to the PUZ one, and the instrument is the same. The period 1941.5 – 1948.7 was without any data (the consequence of the WWII war), but the PU/PUZ is one with a very long series of latitude observations. There were 314 star pairs, but 306 ones were used here. The stars of the other star pairs are not in the Hipparcos catalogue. The VJZ list was with 141 star pairs, but we used 134 ones, and all of the 72 ones of MZL programme were used.

3. CALCULATION

For the proper motion calculation in declination the well–known formula $\mu_\delta = \frac{\delta_1-\delta_2}{t_1-t_2}$ was used. It is necessary to have at least two values of declination (δ_1 and δ_2 for the epochs t_1 and t_2, respectively) in the same system. In our method, for each common IL/Hipparcos star, we used a lot of obtained latitude values φ_i obtained at considered IL stations over many decades. On the average, for each star, there were several tens of φ_i values per year. We expect to calculate μ_δ values for these stars with a good accuracy because of a long interval of observations. Also, we add the Hipparcos point (1991.25, 0″.0) as the input one. A priori, we can show it by using the error of μ_δ which is $\varepsilon_{\mu_\delta} = \frac{\sqrt{\varepsilon_1^2+\varepsilon_2^2}}{t_2-t_1}$ (Eichhorn 1974). The quantities ε_1 and ε_2 are the standard errors of δ_1 and δ_2, respectively. The value ε_{μ_δ} is inversely proportional to $\Delta t = t_2 - t_1$. This means that with an observational interval t which is long enough, it is possible to achieve a good accuracy and a small ε_{μ_δ} value for an observed IL star. Using long interval IL data Damljanović (2008) showed that some of ε_{μ_δ} are even less than the corresponding Hipparcos ones in spite of the high ratio between the standard errors of the Hipparcos star positions and φ_i values of IL observations. That ratio is almost 100.

With the ZT/FZT instruments the star pairs were observed to get the values φ_i for the epoch of measurements, following the Horrebow – Talcott method (Yumi and Yokoyama 1980)
$\varphi_p = \frac{\delta_S+\delta_N}{2} + \frac{\Delta z}{2}$.

The values δ_S and δ_N are the apparent declinations of stars of a Talcott pair. The δ_N is for the northern star and the δ_S is for the southern one at the epoch t. Both values are referred to the Hipparcos catalogue. Δz ($\Delta z = z_S - z_N$) is the measured value of the zenith-distance difference (Yumi and Yokoyama 1980). From the φ_i (one φ_i value per one Talcott star pair) data the corresponding corrections of the proper motions in declination for star pairs can be determined, but not for single stars of those pairs. To solve this problem we added some equations (see below) to get the corrections for each star separately.

The first step of our method is to calculate the polar motion component and the systematic variations with time (local, instrumental, etc.), and then to remove these values from the φ_i ones. We calculated the polar motion term by using the EOP of the OA00 solution (Ron and Vondrák 2001). More about this and the systematic variations with time was described by Damljanović (2007). In this way we obtained the residuals r'_i in which the catalogue errors are dominant (Damljanović and Vondrák 2005, Damljanović et al. 2006, Damljanović and Pejović 2006, Damljanović 2008).

In the next step, the star pair residuals r'_n were calculated as average values of r'_i ones for subperiods nearly one year long. So, there is about one r'_n point per year.

To calculate the correction of proper motion in declination of a Talcott pair, the Least Squares Method (LSM) with the linear model was used (Damljanović 2008, Damljanović and Pejović 2006)

$$r'_n = a + b(t_n - 1991.25), \qquad (1)$$

where t_n is the corresponding epoch of r'_n, a and b pertain to $\frac{\Delta\delta_S+\Delta\delta_N}{2}$ and $\frac{\Delta\mu_{\delta_S}+\Delta\mu_{\delta_N}}{2}$, respectively. This is in accordance with the relation presented in the monograph by Vondrák et al. (1998)

$$\Delta\varphi_p + \frac{d\varphi_p}{dt}t \approx \frac{\Delta\delta_S + \Delta\delta_N}{2} + t\frac{\Delta\mu_{\delta_S} + \Delta\mu_{\delta_N}}{2}, \quad (2)$$

where $\Delta\delta_S$ and $\Delta\delta_N$ are the corrections of declinations, whereas $\Delta\mu_{\delta_S}$ and $\Delta\mu_{\delta_N}$ are the corrections of proper motions in δ; t is the observational epoch.

The values a and b, for an IL Talcott star pair correspond to the epoch of 1991.25. As we have mentioned, the input points r'_n and the Hipparcos one are with appropriate weights (Damljanović 2008, Damljanović and Pejović 2006).

Thus, we determined the value b (the correction of proper motion in declination for a star pair), but we need to do this for each star of a pair separately. There is one equation $b = \frac{\Delta\mu_{\delta_S}+\Delta\mu_{\delta_N}}{2}$ in line with formula (2), but with two unknowns ($\Delta\mu_{\delta_S}$ and $\Delta\mu_{\delta_N}$). It is necessary to introduce one more equation, and to determine both unknowns. We used

$$\Delta\mu_{\delta_S} - \Delta\mu_{\delta_N} = (\mu_{\delta_{S1}} - \mu_{\delta_{S2}}) - (\mu_{\delta_{N1}} - \mu_{\delta_{N2}}), \quad (3)$$

where $\mu_{\delta_{S1}}$ and $\mu_{\delta_{N1}}$ are from the EOC-2 catalogue, and $\mu_{\delta_{S2}}$ and $\mu_{\delta_{N2}}$ from the Hipparcos one.

Similarly, to calculate the values of errors $\varepsilon_{\Delta\mu_{\delta_S}}$ and $\varepsilon_{\Delta\mu_{\delta_N}}$ of determined $\Delta\mu_{\delta_S}$ and $\Delta\mu_{\delta_N}$, respectively, it is necessary to introduce one more equation. We already have $\frac{1}{2}(\varepsilon^2_{\Delta\mu_{\delta_S}} + \varepsilon^2_{\Delta\mu_{\delta_N}}) = \varepsilon^2_b$, and we add Eq. (4) to solve the system of equations. In this way it is possible to calculate the values of $\varepsilon_{\Delta\mu_{\delta_S}}$ and $\varepsilon_{\Delta\mu_{\delta_N}}$,

$$\frac{\varepsilon_{\Delta\mu_{\delta_S}}}{\varepsilon_{\Delta\mu_{\delta_N}}} = \frac{\varepsilon_{\Delta\mu_{\delta_{S1}}}}{\varepsilon_{\Delta\mu_{\delta_{N1}}}}, \quad (4)$$

where the $\varepsilon_{\Delta\mu_{\delta_{S1}}}$ and $\varepsilon_{\Delta\mu_{\delta_{N1}}}$ are from EOC-2. These are the errors of S and N stars of an IL star pair.

In this way, we can calculate the values of $\Delta\mu_{\delta_S}$ and $\Delta\mu_{\delta_N}$ from (5a) and (5b), and their errors ($\varepsilon_{\Delta\mu_{\delta_S}}$, $\varepsilon_{\Delta\mu_{\delta_N}}$) from (6a) and (6b):

$$\Delta\mu_{\delta_S} = \frac{1}{2}[2b + (\mu_{\delta_{S1}} - \mu_{\delta_{S2}}) - (\mu_{\delta_{N1}} - \mu_{\delta_{N2}})], \quad (5a)$$

$$\Delta\mu_{\delta_N} = 2b - \Delta\mu_{\delta_S}, \quad (5b)$$

$$\varepsilon_{\Delta\mu_{\delta_S}} = \varepsilon_{\Delta\mu_{\delta_N}} \cdot \frac{\varepsilon_{\Delta\mu_{\delta_{S1}}}}{\varepsilon_{\Delta\mu_{\delta_{N1}}}}, \quad (6a)$$

$$\varepsilon_{\Delta\mu_{\delta_N}} = \frac{\varepsilon_b\sqrt{2}}{\sqrt{\frac{\varepsilon^2_{\Delta\mu_{\delta_{S1}}}}{\varepsilon^2_{\Delta\mu_{\delta_{N1}}}} + 1}}. \quad (6b)$$

4. RESULTS

By using the input set of data (the residuals r'_n and the Hipparcos one), we calculated the corrections of proper motions in declination for each of the observed IL/Hipparcos stars. These corrections were added to the corresponding Hipparcos proper motions in declination to get the corrected values of μ_δ from latitude observations over many decades. Here, we present an example for star pair No 26 of Pulkovo station (Fig. 1). The stars of this pair have got the Hipparcos numbers (37111 and 37609), and the magnitudes are 7.00 and 4.93, respectively. The calculated value $b \pm \varepsilon_b$ for this star pair, with 82 input points r'_n, is
(-1.06 ± 0.13) mas/yr.

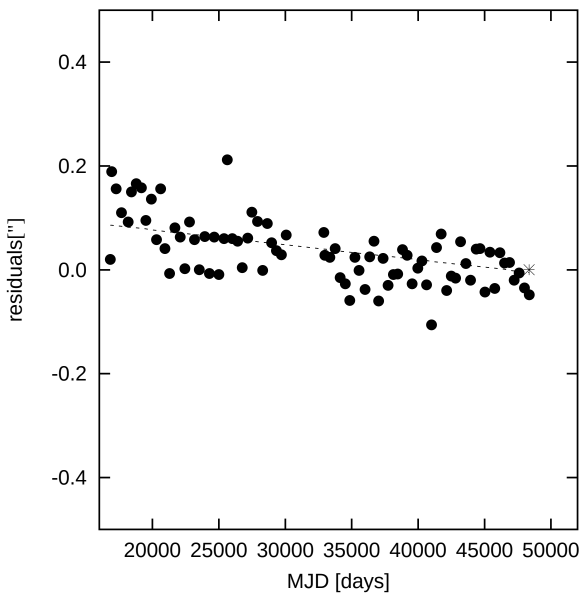

Fig. 1. *Residuals r'_n (filled circles), Hipparcos point (asterisk) and linear trend of star pair No 26 of PU/PUZ station.*

In Fig. 1, the residuals r'_n of star pair No 26 of PU/PUZ station are presented with the filled circles, the Hipparcos point with the asterisk, and the dashed line shows the linear trend. The observations were made during an interval of more than 80 years long as can be seen from Table 1 and Fig. 1.

The corrected proper motions in declination with their errors, for each star of pair separately, were calculated by formulas (5a), (5b), (6a) and (6b), and we get the following results
H37111: $\mu_\delta = (3.29 \pm 0.47)$ mas/yr,
H37609: $\mu_\delta = (-52.68 \pm 0.09)$ mas/yr.

Table 2. The IL catalogue of proper motions in declination: our ($\mu_\delta \pm \varepsilon_{\mu_\delta}$), Hipparcos ($\mu_{\delta_H} \pm \varepsilon_{\mu_{\delta_H}}$) and new Hipparcos ($\mu_{\delta_{NH}} \pm \varepsilon_{\mu_{\delta_{NH}}}$) ones.

HIP	$\mu_\delta \pm \varepsilon_{\mu_\delta}$(mas/y)		$\mu_{\delta_H} \pm \varepsilon_{\mu_{\delta_H}}$(mas/y)		$\mu_{\delta_{NH}} \pm \varepsilon_{\mu_{\delta_{NH}}}$(mas/y)		Notes
43	-23.77	0.18	-24.07	0.49	-23.64	0.28	2(30) 6(26)
128	-12.79	0.41	-12.36	0.49	-13.03	0.27	6(41)
274	-1.17	0.33	-1.83	0.49	-1.36	0.34	3(33)

The corresponding Hipparcos values are (4.76 ± 0.62) mas/yr and (-52.11 ± 0.46) mas/yr, respectively.

Our results (the IL catalogue) for all IL/Hipparcos stars are presented in Table 2. The complete Table 2 is given at the website http://saj.matf.bg.ac.rs/182/pdf/Table2.dat. The Hipparcos number is in the first column. The next three columns list the proper motions in declination with corresponding errors: ours, Hipparcos and new Hipparcos, respectively. In the last column there are notes. There are a few notes: the first number is the code (1 – BLZ, 2 – BK, etc., see Table 1), between the parentheses is the number of input points r'_n for formula (1), the asterisk concerns a Talcott pair where the first star is the same as the second one (zenith star). Some stars were observed within more than one programme, and with more than one instrument. The IL catalogue contains 1200 stars divided into two parts: there are 707 stars in the first part, and 493 stars in the second one, according to the number of input points r'_n. The first part contains the stars with at least 20 input points r'_n which corresponds to at least 20 years of IL observations. The second part contains stars with less than 20 years of observations. This division is due to results of an F-test application (Damljanović and Pejović 2008). As can be seen from the first part of Table 2, for a large number of stars we found smaller errors of μ_δ than the Hipparcos ones. Moreover, some of these errors are less than the corresponding new Hipparcos ones (see also Table 3).

Table 3. The average values of errors of μ_δ: our $\bar{\varepsilon}_{\mu_\delta}$, Hipparcos $\bar{\varepsilon}_{\mu_{\delta_H}}$ and new Hipparcos $\bar{\varepsilon}_{\mu_{\delta_{NH}}}$.

Code	$\bar{\varepsilon}_{\mu_\delta}$ (mas/y)	$\bar{\varepsilon}_{\mu_{\delta_H}}$ (mas/y)	$\bar{\varepsilon}_{\mu_{\delta_{NH}}}$ (mas/y)
1.BLZ, 106 stars	0.74	0.61	0.39
108 stars	0.74	0.64	0.44
2.BK, 169	0.40	0.61	0.41
0	-	-	-
3.IRZ, 58	0.35	0.57	0.38
0	-	-	-
4.MZL, 5	0.47	0.57	0.36
97	0.85	0.58	0.27
5.POL, 37	0.49	0.58	0.34
51	0.74	0.56	0.34
6.PU/PUZ, 274	0.44	0.58	0.38
103	0.24	0.58	0.36
7.VJZ, 58	1.00	0.61	0.43
134	3.98	0.62	0.44

The programmes of IL stations are mutually independent. As said above, some stars were observed within more than one programme and with more than one instrument (see notes of Table 2). For each station, we calculated the average values of errors: $\bar{\varepsilon}_{\mu_\delta}$, the Hipparcos ones $\bar{\varepsilon}_{\mu_{\delta_H}}$ and the new Hipparcos ones $\bar{\varepsilon}_{\mu_{\delta_{NH}}}$. The results are given in Table 3. In the first row the average values of errors for stars observed for at least 20 years are given, and the second row contains the average values of errors for stars observed for less than 20 years.

For stars observed for at least 20 years it is evident that the average errors of μ_δ of BK, IRZ, MZL, POL and PU/PUZ data are significantly smaller than the corresponding Hipparcos ones (see Table 3). The average errors of ε_{μ_δ} from BK and IRZ data are about 65% of the corresponding Hipparcos ones and even better than the new Hipparcos ones. In the case of the PU/PUZ data it is 76% of the corresponding Hipparcos one (83% from MZL and POL data) and close to the new Hipparcos ones. The VJZ period is nearly 30 years long, but a lot of VJZ star pairs were not observed during the full period. They were observed for less than 20 years which is not enough to get very good results concerning μ_δ. In this case the average error is bigger than the Hipparcos one. The BLZ data (Damljanović 1997) belong to two programmes, the first one (Old, 12 years duration) and the second one (New, 26 years). In both cases the average errors are somewhat bigger than the corresponding Hipparcos ones. The average error from the MZL data exceeds the Hipparcos one (in the case when the MZL data cover period shorter than 20 years) because this station is in the seismically active region, and the observation period is not too long. In the case of stars observed for less than 20 years, we get good values for μ_δ (small errors) from the PU/PUZ data only.

The reduction of IL observations was made by using the Hipparcos data. This is the main reason for smaller errors in $\mu_{\delta_{NH}}$ of new Hipparcos than our ones in some cases. We expect better μ_δ from IL observations when the reduction is made with the new Hipparcos data.

5. CONCLUSIONS

Since the period of IL observations is long, it is possible to obtain the values of μ_δ with smaller errors than those of the Hipparcos and smaller even than those of the new Hipparcos. As we have established earlier (Damljanović et al. 2006), for smaller errors of μ_δ than the Hipparcos ones we need the

ZT/FZT observations covering more than 20 years (approximately). The PU/PUZ data gave us good values μ_δ (with small formal errors) even with less than 20 years of ZT observations.

Anyway, it is evident that the IL data are useful and it is possible to improve the proper motions in declination for many IL/Hipparcos common stars. As we demonstrated here, by using the ground–based IL data we can obtain good results for the modern astrometry, and to check the present reference frame derived from the Hipparcos catalogue data. It is because of the large number of IL observations per year and the long time interval of IL observations.

We presented the main steps of our method and constructed the IL catalogue of μ_δ for 1200 stars (Table 2). For the 707 stars of the first part (the stars observed for at least 20 years) we obtain formal errors of μ_δ better than or close to the Hipparcos ones, whereas in the case of the 493 stars of the second part (observed for less than 20 years) the errors obtained here generally exceed the Hipparcos ones. In the case of some data (BK, IRZ) the errors of μ_δ found here are less than even the new Hipparcos ones. We obtain good results also for the μ_δ values from the POL and PU/PUZ data.

We are planning to submit the IL catalogue to the CDS. At present the IL catalogue data are available at the URL:http://saj.matf.bg.ac.rs/182/pdf/Table2.dat, or upon request.

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ПОПРАВЉЕНА СОПСТВЕНА КРЕТАЊА У ДЕКЛИНАЦИЈИ ЗВЕЗДА HIPPARCOS КАТАЛОГА ДОБИЈЕНА ИЗ ВИШЕДЕЦЕНИЈСКИХ ШИРИНСКИХ ПОСМАТРАЊА

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Оригинални научни рад

Током прошлог века рађена су обимна астрометријска посматрања на тзв. независним ширинским (IL) станицама која су слата међународним организацијама (нпр. Bureau International de l'Heure – BIH, International Polar Motion Service – IPMS) и чинила део програма Земљине ротације, а у циљу одређивања параметара Земљине оријентације (Earth Orientation Parameters – EOP). Зато данас постоји велики број класичних астрометријских посматрања која су сваке ведре ноћи вишедеценијски вршена на истим звездама (у оквиру одређеног посматрачког програма) и чија је нова обрада урађена користећи Hipparcos каталог. Сада тај ширински материјал користимо за обрнут задатак – да поправимо сопствена кретања у деклинацији (μ_δ) за посматране звезде које су у Hipparcos каталогу. Наши резултати (добијене поправке $\Delta\mu_\delta$ за одговарајуће Hipparcos вредности μ_δ) су и једна независна провера μ_δ звезда из Hipparcos и новог Hipparcos каталога (van Leeuwen 2007). Користили смо ширинске промене добијене из посматрања рађених на седам IL станица (Belgrade, Blagoveschtschensk, Irkutsk, Poltava, Pulkovo, Warsaw, Mizusawa) у периоду 1904.7 – 1992.0, при чему су на шест станица били визуелни (ZT) а на једној (Mizusawa) пливајући зенит–телескопи (FZT). Са друге стране, како је од епохе Hipparcos каталога 1991.25 и HIPPARCOS ESA мисије (ESA 1997) протекло скоро две деценије, грешка привидних положаја звезда са подацима из Hipparcos каталога достигла је близу 20 лучних милисекунди (значајно изнад грешака звезданих позиција каталога које су око 1 лмс). Затим, посматрачка мисија је трајала краће од четири године што је недовољно за одговарајућу тачност сопствених кретања одређених звезда (нарочито двојних и вишеструких). Овде је описана метода коју смо користили, као и добијени резултати (вредности μ_δ у IL каталогу који смо формирали) за 1200 заједничких IL/Hipparcos звезда: у првом делу је 707 звезда (са најмање 20 година IL посматрања) и 493 звезда у другом делу (мање од 20 година IL посматрања). Из посматрања неких IL станица (Blagoveschtschensk, Irkutsk, Mizusawa, Poltava, Pulkovo) добили смо формалне грешке за μ_δ великог броја звезда које су мање од одговарајућих из Hipparcos каталога, а за неке од станица (Blagoveschtschensk, Irkutsk) мање и од одговарајућих из новог Hipparcos каталога.