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Preliminary report

# IMPROVEMENT OF HIPPARCOS PROPER MOTIONS IN DECLINATION

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**SUMMARY: More than a decade elapsed after the HIPPARCOS ESA mission (ESA 1997) observations have been collected. This first astronomical satellite mission was less than 4 years long so that 1991.25 is the epoch of the HIPPARCOS Catalogue. Many other projects have checked or improved HIPPARCOS data. Also, a long series of ground – based optical observations of some stars included in HIPPARCOS Catalogue, made with Photographic Zenith Tubes (PZT) are useful for the task of improving the proper motions of these stars. The ARIHIP Catalogue (after ACT, TYCHO – 2, FK6, GC+HIP, TYC2+HIP) is a combination of the HIPPARCOS and some ground – based data, and the ARIHIP proper motions are more accurate than the HIPPARCOS ones. Here we present a new step of our procedure of calculation; between PZT data we added the HIPPARCOS position with suitable weight – the point with the coordinates (1991.25, $0\overset{''}{.}0$) in our case. The method was applied to 202 stars observed at Richmond PZTs in the course of a few decades. The result is better proper motions in declination for these HIPPARCOS stars, and a good agreement with ARIHIP proper motions (we found 128 common Richmond and ARIHIP stars to check our result). Also, we present the result for other 74 Richmond stars which are not found in ARIHIP.**

**Key words. Astrometry – Reference systems**

## 1. INTRODUCTION

The ICRF (International Celestial Reference Frame) materializes the ICRS (International Celestial Reference System) from 1998 via a catalogue of 608 compact radio sources (Ma et al. 1998); the internal accuracy of these sources was between 0.3 and 0.5 mas (milliarcsecond). This list of radio sources has been updated by the ICRF – Ext.1 with 59 new ones (IERS Annual report 1999). The HIPPARCOS Catalogue (ESA 1997) was adopted as the optical counterpart of the ICRF.

The HIPPARCOS Catalogue offers important astrometric data (positions $\alpha$ and $\delta$ at 1991.25 – the epoch of the catalogue, proper motions $\mu_\alpha$ and $\mu_\delta$, parallaxes) for 118218 stars brighter than magnitude 12. It was linked to ICRS with the precision of 0.6 mas in orientation and 0.25 mas/year in rotation (Kovalevsky et al. 1997). The period of HIPPARCOS satellite observations was shorter than four years which was not enough to obtain a satisfactory accuracy of proper motions for some stars. For the purpose of improving these HIPPARCOS data other catalogues have appeared, such as ACT, TYCHO – 2, FK6, GC+HIP, TYC2+HIP, ARIHIP (Wielen et al. 2001), Earth Orientation Catalogue – EOC (Vondrák and Ron 2003), etc.

ARIHIP contains 90842 stars and it represents a compilation of stars with the most accurate data from the catalogues: FK6(I), FK6(III), GC+HIP, TYC2+HIP, and HIPPARCOS. Their proper motion data are more accurate than the HIPPARCOS ones, and because of this ARIHIP is interesting to us (to compare our results with ARIHIP proper motions in declination). Also, ARIHIP contains other data: for the proper motions and their mean errors there are SI (the single – star), LTP (the long – term prediction), STP (the short – term prediction) and HIP (HIPPARCOS Catalogue) mode (difference = other mode - SI mode), the coefficient $K_{ae}$ with flag for 'astrometrically excellent stars' 3 – astrometrically excellent star with rank ***, 2 – with rank **, 1 – with rank * and blank – star not classified as astrometrically excellent. In ARIHIP, the SI mode is given and the mentioned differences have to be added to the values of the SI mode in order to obtain the values of the other modes.

The values of SI and other modes (in mas/year) refer to the epoch and equinox J2000.0 in the ICRS/HIPPARCOS system. The afore mentioned mean errors (in mas/year) are not the errors of the differences, but those of the full quantities in the other modes.

## 2. DATA

Even though the accuracy of HIPPARCOS positions is about 1 mas and of proper motions ($\mu_\alpha \cos\delta$, $\mu_\delta$) is nearly 1mas/year, the PZTs periods of observation are much longer than the HIPPARCOS one and can give better proper motion data than the HIPPARCOS ones. The PZTs were the part of the different Earth rotation programmes in the interval 1899.7 – 1992.0 (Vondrák et al. 1998).

We use the Richmond (Florida, USA) PZT data (Vondrák 2002). Two instruments were located at the longitude $\lambda_W = 80\overset{\circ}{.}4$ and the latitude $\varphi = +25\overset{\circ}{.}6$, and collected the data in the course of nearly 40 years (1949.8 – 1989.4): RCP operated in the period 1949.8 – 1987.5 and RCQ in 1981.9 – 1989.4 one (during a several years period observations were done simultaneously). The RCP and RCQ data were used for polar motion and universal time UT0 investigations (Vondrák 2004). The code RCP/RCQ is from the monograph (Vondrák et al. 1998).

As input data we use Vondrák's OA00 solution (Ron and Vondrák 2001). The performances of the instruments have been described by Vondrák et al. (1998). The latitude variations $\varphi_i$ (obtained by RCP and RCQ) around the mean latitude are a part of the OA00 data. We use the RCP and RCQ data because of the long observational period, which provides a good possibility to check our results via the ARIHIP ones. The mean latitude and tectonic plate motion were removed from the RCP and RCQ latitude data for the period 33224 – 47660 MJD (1949.8 – 1989.4) by using $25°36'47\overset{''}{.}116 + 0\overset{''}{.}008/century \cdot (t - t_1)$, where $(t - t_1)$ is in centuries and $t_1$ is counted from 32000 MJD.

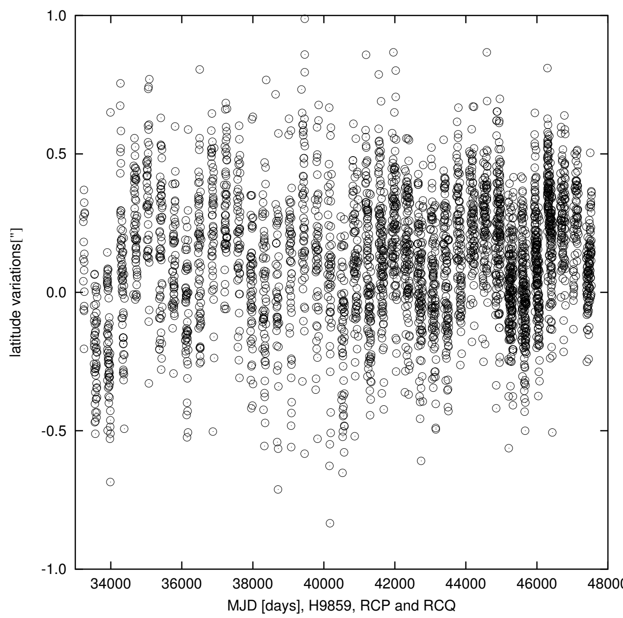


**Fig. 1.** *RCP and RCQ latitude variations $\varphi_i$ with time (MJD) for the HIPPARCOS star H9859.*

## 3. CALCULATIONS

To show the input data, we present in Fig. 1 the latitude variations $\varphi_i$ with time (MJD) for star H9859 observed for about 40 years with RCP and RCQ. Within each observational year, there are from only a few to a few hundreds of observations of the same star with a standard error of the order of a few tenths of an arcsecond. Also, in Fig. 1, a latitude variation of RCP and RCQ is because of the polar motion and other changes with time clearly seen.

The main steps of the calculation have been already described in Damljanović and Pejović (2005) and Damljanović and Vondrák (2005). Here, we have improved the calculation procedure and instead of the linear approximation for systematic changes with time (local, instrumental, etc.) we take into account more complex variations which are closer to the real situation; some results have been presented by Damljanović (2005). In this paper, we have included in the calculation (for each Richmond star) one new point, the HIPPARCOS position via latitude variation which is with the value $0\overset{''}{.}0$ (in our case here) for 1991.25 (the epoch of HIPPARCOS Catalogue). The weight of this point is 19, defined as the ratio between the HIPPARCOS position error (near 1 mas) and the mean value of errors of points $r'_n$ (see below). The other points are with the weight of 1. With that additional point, we expect to get better results (especially for the stars observed for just a few years). This new point with a large weight is of importance for a better consistency of PZT and HIPPARCOS data, too.

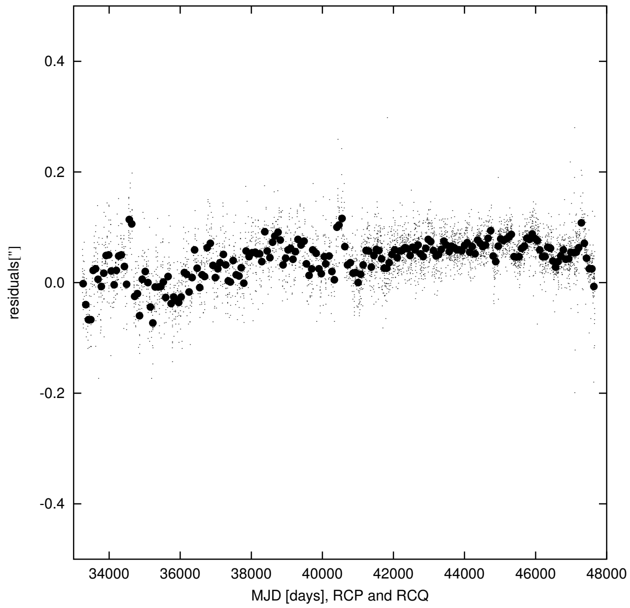


**Fig. 2.** *Residuals (RCP and RCQ) vs. time (MJD) before elimination of systematic changes: the gray dots $r_n$ are the averaged values of $r_i$, the black circles are the averaged values of $r_n$ within a 0.2 yr interval (for all 202 stars).*

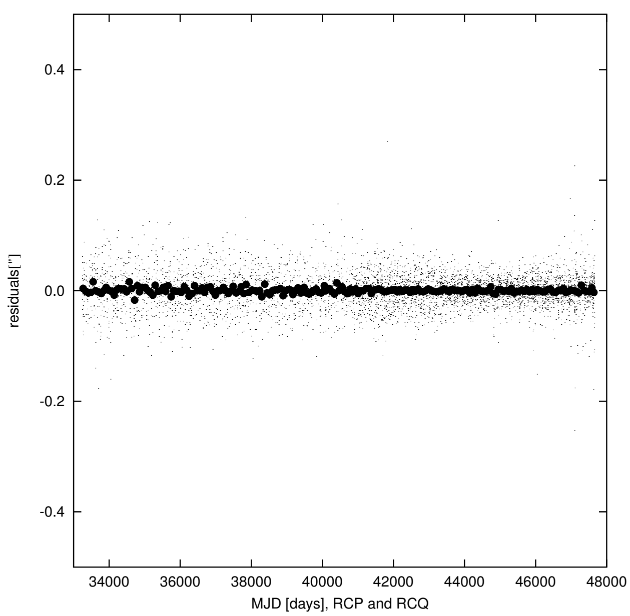


**Fig. 3.** *The same as in Fig. 2, but after elimination of systematic changes.*

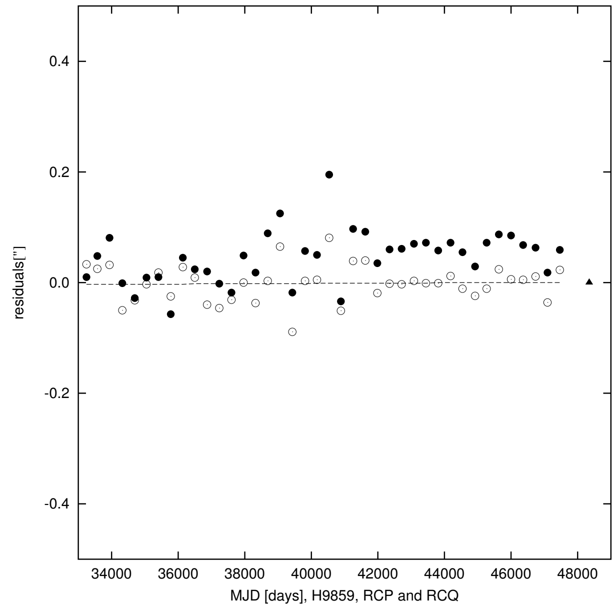


**Fig. 4.** *Averaged residuals $r_n^{'}$ (white circles, without systematic changes), $r_n$ (black ones, with systematic changes included) vs. time for star H9859; two very similar linear trends of white circles are seen as a single line (one was calculated with and the other without a new point denoted with a triangle).*

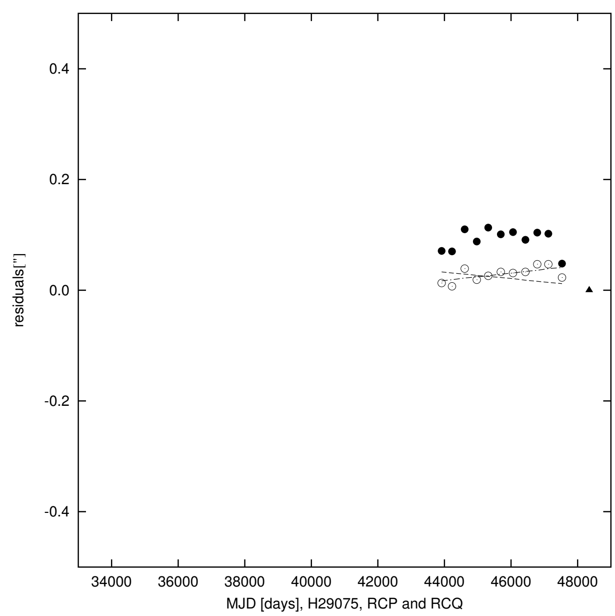


**Fig. 5.** *The same as in Fig. 4, but for H29075; two different linear trends, calculated with and without new point (triangle), are well separated, here.*

In the first step, the polar motion $\Delta\varphi_i$ was removed from the available $\varphi_i$ data of the OA00 solution $r_i = -(\varphi_i - \Delta\varphi_i)$ to get the residuals $r_i$. This was described by Damljanović (2005). The $2.7 \cdot \sigma$ statistical criterion was used to remove the outlier values $r_i$. It is about one $r_n$ value per year, and $r_n$ are the averaged values of $r_i$. Then, the systematic changes (local, instrumental, etc.) were removed from the $r_n$ values. These changes were determined by using the observations of all 202 stars.

The calculation procedure for determining and removing the values of the systematic changes was developed by Damljanović (2005). The dots (Fig. 2) are the values $r_n$ which are the averaged values of $r_i$ ones, and the black circles are the averaged values of $r_n$ for all the 202 stars over the subperiod of 0.2 yr which is an optimal one for our case. On one side, it was necessary to find a subperiod, as short as possible, to get real systematic variations with time, and on the other side, with enough points (several tens) $r_n$ in it (several tens of stars observed during this subperiod).

To show the efficiency of the determination of the systematic changes, we present in Fig. 3 the same points as in Fig. 2, but after the elimination of the previously systematic part. The proper motion corrections in declination are applied to each star individually. All steps of our method are valid for any other calculation (not only RCP and RCQ instruments). This is of importance because we want to apply the method described here to other input data.

We use the averaged values over subperiods of 0.2 yr (black circles in Fig. 2 – the systematic variations), and for each star, we remove the systematic changes from $r_i$ by using $r'_i$. Then, we determine the values of $r'_n$ from the $r'_i$ ones, similarly as the $r_n$ ones were determined from $r_i$ ones; see in Fig. 4 the values $r'_n$ (white circles) for star H9859 as an example.

The difference between the values with (the black circles – $r_n$ values in Fig. 4) and without (the white circles – $r'_n$ ones) systematic changes is evident. Our final residuals, RCP and RCQ data without systematic and polar motion variations, are the values $r'_n$. For each star, we use $r'_n$ in the calculation of the corrections of the proper motions in declination of the observed HIPPARCOS stars.

## 4. RESULTS

We applied the Least Squares Method (LSM) to $r'_n$ values for each star (the numerical values of white points, see in Fig. 4), and found that the straight line fits the data. Our corrections of proper motions in declination of the mentioned 202 HIPPARCOS stars are the $b$ values calculated by using LSM according to the equation

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

where $t_n$ is the epoch instant of $r'_n$. The results for all 202 RCP and RCQ stars are presented in Table 2.

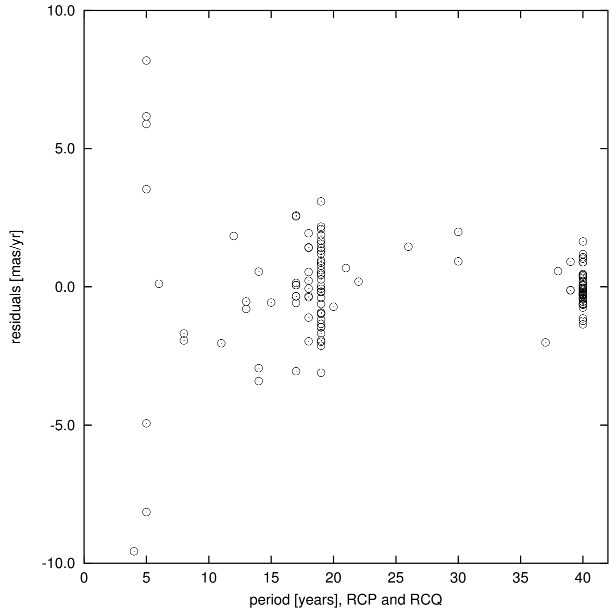


**Fig. 6.** *Differences $r_{HIP}$ between our and ARIHIP SI mode results (for 125 HIPPARCOS stars observed with Richmond PZTs) vs. observational period $n$.*

**Table 1.** Already corrected HIPPARCOS stars.

| HIP | bias (mas) | drift (mas/yr) |
|---|---|---|
| 10053 | -23 | -3.07 |
| 45278 | 88 | 0.00 |
| 70310 | 0 | 2.01 |
| 73768 | 0 | -4.21 |
| 75350 | 0 | -2.35 |
| 81781 | -44 | -4.07 |
| 84821 | 0 | 3.76 |
| 89847 | 0 | -36.82 |
| 97077 | 0 | -6.20 |
| 100088 | 0 | -2.52 |
| 106872 | -81 | -12.05 |

The order of presented stars is in line with the HIPPARCOS one (HIP is the HIPPARCOS number of star, the first column of Table 2), $\mu_\delta$ is our proper motion in declination (the HIPPARCOS one plus our correction $b$), $\varepsilon_b$ is the standard error of $b$ (and of $\mu_\delta$). The value $n$ is the number of input PZT points $r'_n$ (close to the number of years covered by the PZT observations of every star). The LTP, STP and HIP are the ARIHIP modes (see Section 1) with errors ($\varepsilon_{LT}$, $\varepsilon_{ST}$ and $\varepsilon_{HI}$, respectively). We put the values of $\varepsilon_{HI}$ for all 202 stars from HIPPARCOS Catalogue for the purpose of comparison. The $K_{ae}$ is ARIHIP value. The $r_{LTP}$, $r_{STP}$ and $r_{HIP}$ are the residuals between our value $b$ and suitable ARIHIP modes (we adapted the differences $LTP$, $STP$ and $HIP$ in the way that they can be added to the HIPPARCOS

**Table 2.** The values $\mu_\delta$ and $b \pm \varepsilon_b$, $LTP \pm \varepsilon_{LT}$, $STP \pm \varepsilon_{\mathrm{ST}}$, $HIP \pm \varepsilon_{HI}$ modes, $K_{ae}$, residuals, and comment C.

| HIP | $\mu_\delta$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $b$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_b$ | $n$ (yr) | $LTP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{LT}$ | $STP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{ST}$ | $HIP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{HI}$ | $r_{LTP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $r_{STP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $r_{HIP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $K_{ae}$ | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | -6.79 | -.28 | .80 | 17 | .08 | .95 | -.04 | .55 | -.07 | .56 | -.43 | -.31 | -.35 | 2 | |
| 2152 | -24.39 | 2.64 | .50 | 17 | .04 | .80 | -.04 | .63 | -.06 | .66 | 2.54 | 2.62 | 2.58 | 2 | |
| 3713 | 6.16 | .34 | .51 | 17 | .85 | .89 | -.14 | .56 | -.28 | .57 | -.79 | .20 | .06 | 2 | |
| 4083 | 7.56 | .57 | .44 | 19 | -.29 | .93 | .08 | .49 | .20 | .50 | 1.06 | .69 | .77 | 1 | |
| 4262 | -36.67 | .75 | .29 | 19 | -.10 | .77 | .31 | .56 | .66 | .63 | 1.51 | 1.10 | 1.41 | 3 | |
| 5777 | -60.27 | .03 | .69 | 13 | 1.16 | .93 | -.40 | .60 | -.56 | .63 | -1.69 | -.13 | -.53 | | |
| 6830 | -9.52 | .00 | .74 | 17 | -.18 | .91 | .07 | .62 | .14 | .65 | .32 | .07 | .14 | 2 | |
| 7034 | 56.56 | .28 | .31 | 40 | -.90 | 1.02 | .08 | .52 | .09 | .52 | 1.27 | .29 | .37 | 3 | |
| 7874 | -41.33 | -.70 | .25 | 40 | | | | | | .61 | | | | | |
| 8151 | -48.58 | -.10 | .40 | 19 | .32 | 1.02 | -.06 | .64 | -.07 | .65 | -.49 | -.11 | -.17 | 2 | |
| 8285 | -112.35 | 1.56 | .31 | 39 | 2.25 | 1.02 | -.56 | .66 | -.65 | .68 | -1.34 | 1.47 | .91 | | |
| 8600 | -10.52 | .16 | .24 | 40 | | | | | | 1.20 | | | | | |
| 8857 | -42.09 | -.47 | .21 | 40 | -.35 | 1.00 | -.03 | .74 | -.07 | .77 | -.19 | -.51 | -.54 | 3 | |
| 9669 | -6.39 | 1.35 | .34 | 30 | .75 | .98 | -.19 | .59 | -.43 | .63 | .17 | 1.11 | .92 | 3 | |
| 9859 | -14.45 | .09 | .30 | 40 | | | | | | .66 | | | | | |
| 10378 | -67.05 | -1.29 | .48 | 17 | -.37 | 1.04 | .53 | .84 | .71 | .86 | -.21 | -1.11 | -.58 | 2 | |
| 10540 | -66.22 | .16 | .31 | 40 | .32 | .90 | -.17 | .70 | -.20 | .72 | -.36 | .13 | -.04 | 1 | |
| 10845 | -8.11 | -2.09 | .34 | 19 | -.40 | .85 | .43 | .93 | .75 | 1.07 | -.94 | -1.77 | -1.34 | 2 | |
| 11265 | 3.72 | .89 | .47 | 19 | | | | | | .92 | | | | | |
| 11405 | -38.39 | -.32 | .28 | 40 | -.09 | 1.42 | .01 | .66 | .03 | .68 | -.20 | -.30 | -.29 | | |
| 12524 | -5.04 | .54 | .48 | 21 | -.02 | .91 | .06 | .68 | .14 | .71 | .70 | .62 | .68 | | |
| 15273 | -30.43 | -1.85 | .49 | 17 | -.59 | 1.20 | .83 | 1.23 | 1.51 | 1.40 | .25 | -1.17 | -.34 | 2 | |
| 15557 | -91.22 | 2.10 | .57 | 19 | 1.78 | .85 | -2.09 | .81 | -3.08 | .88 | -2.76 | 1.11 | -.98 | | |
| 17812 | -5.89 | -.77 | .25 | 40 | .30 | .86 | -.25 | .84 | -.59 | .98 | -1.66 | -1.11 | -1.36 | 3 | |
| 18194 | -23.02 | -.94 | .55 | 20 | -.39 | 1.07 | .15 | .84 | .22 | .86 | -.33 | -.87 | -.72 | 2 | |
| 18201 | -34.97 | -.75 | .20 | 40 | -.67 | 1.01 | .31 | .70 | .56 | .74 | .48 | -.50 | -.19 | | |
| 19182 | .17 | -.08 | .15 | 40 | .30 | 1.07 | -.51 | .93 | -1.15 | 1.05 | -1.53 | -.72 | -1.23 | 2 | |
| 19341 | -2.51 | -1.18 | .70 | 19 | .19 | .88 | -.21 | .81 | -.76 | .95 | -2.13 | -1.73 | -1.94 | 2 | |
| 20258 | -9.22 | .29 | .22 | 40 | | | | | | .86 | | | | | |
| 20430 | -18.32 | -.44 | .23 | 40 | | | | | | .81 | | | | | |
| 20626 | -24.07 | 2.15 | .23 | 40 | .26 | .78 | -.40 | .89 | -.51 | .94 | 1.38 | 2.04 | 1.64 | 2 | |
| 21532 | -30.09 | -1.71 | .20 | 40 | -.53 | .74 | .39 | .69 | .57 | .75 | -.61 | -1.53 | -1.14 | 2 | |
| 26225 | -9.80 | 1.12 | .49 | 19 | -.32 | 1.08 | .25 | .69 | .75 | .73 | 2.19 | 1.62 | 1.87 | | |
| 26818 | -4.29 | -.04 | .21 | 40 | -.44 | .84 | .01 | .77 | -.07 | .90 | .33 | -.12 | -.11 | | |
| 26998 | -1.66 | 1.25 | .24 | 30 | -.99 | .88 | .36 | .66 | .74 | .72 | 2.98 | 1.63 | 1.99 | 3 | |
| 27353 | -7.55 | -.44 | .27 | 40 | -.54 | .74 | .25 | .67 | .49 | .76 | .59 | -.20 | .05 | 3 | |
| 27850 | -2.33 | -1.10 | .44 | 13 | -.37 | .86 | .12 | .68 | .30 | .74 | -.43 | -.92 | -.80 | 2 | |
| 27858 | -2.95 | -.04 | .51 | 19 | | | | | | .68 | | | | | |
| 28301 | -25.60 | .28 | .27 | 40 | .47 | .83 | -.25 | .49 | -.35 | .50 | -.54 | .18 | -.07 | | |
| 29075 | -5.34 | -2.52 | .93 | 11 | -.08 | .94 | .07 | .93 | .48 | 1.18 | -1.96 | -2.11 | -2.04 | 2 | |
| 30142 | -46.10 | 1.84 | .45 | 19 | -.16 | .72 | .09 | .61 | .25 | .67 | 2.25 | 2.00 | 2.09 | 3 | |
| 30452 | -1.27 | -.13 | .71 | 19 | .00 | .76 | .00 | .76 | -.83 | .88 | -.96 | -.96 | -.96 | 2 | |

**Table 2.** (continued)

| HIP | $\mu_\delta$ ($\frac{\text{mas}}{\text{yr}}$) | $b$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_b$ | $n$ (yr) | $LTP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{LT}$ | $STP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{ST}$ | $HIP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{HI}$ | $r_{LTP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{STP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{HIP}$ ($\frac{\text{mas}}{\text{yr}}$) | $K_{ae}$ | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30622 | -3.99 | -1.17 | .25 | 40 | .00 | .74 | .00 | .74 | .42 | .88 | -.75 | -.75 | -.75 | 2 | |
| 30857 | -2.33 | .06 | .28 | 39 | .03 | .75 | -.01 | .72 | -.19 | .83 | -.16 | -.12 | -.13 | 2 | |
| 32086 | -11.47 | 2.44 | .90 | 11 | | | | | | .73 | | | | | |
| 32743 | -36.74 | -1.13 | .34 | 31 | | | | | | .90 | | | | | |
| 32964 | 8.28 | 1.40 | .22 | 40 | 1.41 | .79 | -1.18 | .72 | -1.73 | .78 | -1.74 | .85 | -.33 | | |
| 33027 | -8.96 | .04 | .58 | 19 | -.45 | 1.17 | .15 | .90 | .23 | .93 | .72 | .12 | .27 | 2 | |
| 33277 | 24.26 | -.88 | .22 | 40 | -.56 | .68 | .64 | .58 | .74 | .59 | .42 | -.78 | -.14 | | |
| 33855 | -1.93 | .38 | .66 | 19 | -.10 | .95 | .08 | .71 | .22 | .77 | .70 | .52 | .60 | 2 | |
| 33893 | 1.09 | -.74 | .28 | 40 | .37 | .90 | .07 | .51 | .10 | .52 | -1.01 | -.71 | -.64 | 3 | |
| 34567 | -175.78 | -.73 | .24 | 40 | | | | | | .67 | | | | | |
| 34582 | -23.53 | .52 | .57 | 17 | | | | | | .69 | | | | | |
| 34861 | -3.38 | -.94 | .30 | 40 | -.16 | .75 | .19 | .79 | .31 | .85 | -.47 | -.82 | -.63 | 3 | |
| 37704 | -22.68 | -1.47 | .48 | 19 | .54 | .65 | -.17 | .46 | -.21 | .48 | -2.22 | -1.51 | -1.68 | 3 | |
| 39191 | 7.41 | .92 | .32 | 40 | -.08 | .38 | -.22 | .47 | -.46 | .53 | .54 | .68 | .46 | | |
| 40023 | -347.69 | .37 | .22 | 40 | | | | | | .43 | | | | | |
| 41791 | -24.00 | .80 | .64 | 14 | .79 | 1.07 | -.17 | .72 | -.25 | .73 | -.24 | .72 | .55 | 2 | |
| 42035 | -18.00 | 1.73 | .46 | 24 | | | | | | .81 | | | | | |
| 44089 | -140.05 | 1.72 | .48 | 19 | 1.69 | 1.15 | -1.46 | 1.05 | -1.91 | 1.09 | -1.88 | 1.27 | -.19 | | |
| 44806 | -7.52 | .57 | .44 | 19 | 1.68 | 1.20 | -.39 | .75 | -.64 | .79 | -1.75 | .32 | -.07 | | |
| 47382 | 16.24 | -.05 | .23 | 40 | -.93 | .99 | .18 | .53 | .26 | .55 | 1.14 | .03 | .21 | | |
| 47602 | -5.52 | -.78 | .46 | 19 | -.49 | .77 | .11 | .57 | .16 | .60 | -.13 | -.73 | -.62 | | |
| 48511 | -42.29 | -2.08 | .43 | 19 | -.48 | .95 | .06 | .47 | .09 | .48 | -1.51 | -2.05 | -1.99 | 3 | |
| 50321 | -23.26 | -1.39 | .65 | 17 | | | | | | .69 | | | | | |
| 50336 | 2.78 | -.40 | .25 | 40 | .42 | 1.07 | -.03 | .48 | -.05 | .49 | -.87 | -.42 | -.45 | 3 | |
| 50915 | -56.30 | -1.44 | .44 | 19 | -.33 | .97 | .00 | .46 | -.01 | .46 | -1.12 | -1.45 | -1.45 | 3 | |
| 52270 | 3.71 | .60 | .47 | 19 | .45 | .90 | -.08 | .57 | -.17 | .59 | -.02 | .51 | .43 | 2 | |
| 52998 | -84.21 | -.16 | .44 | 15 | 1.63 | 1.15 | -.29 | .72 | -.41 | .73 | -2.20 | -.28 | -.57 | 2 | |
| 53355 | .93 | 1.35 | .44 | 19 | .98 | .93 | -.27 | .55 | -.40 | .57 | -.03 | 1.22 | .95 | 1 | |
| 53492 | -8.14 | -.24 | .25 | 40 | .40 | .95 | -.13 | .52 | -.18 | .53 | -.82 | -.29 | -.42 | 3 | |
| 54196 | -60.61 | 1.72 | .30 | 26 | .26 | .71 | -.24 | .83 | -.27 | .90 | 1.19 | 1.69 | 1.45 | 3 | |
| 54906 | 49.64 | 1.39 | .45 | 19 | .70 | 1.21 | -.15 | .68 | -.19 | .69 | .50 | 1.35 | 1.20 | 2 | |
| 55166 | -29.12 | 1.15 | .22 | 40 | -.23 | 1.00 | .03 | .67 | .03 | .68 | 1.41 | 1.15 | 1.18 | 2 | |
| 56690 | 19.36 | -.59 | .26 | 40 | -.51 | .93 | .44 | .90 | .63 | .96 | .55 | -.40 | .04 | 2 | |
| 57240 | 9.06 | -.69 | .34 | 31 | | | | | | .90 | | | | | |
| 58135 | -9.60 | -.58 | .21 | 40 | -.36 | 1.00 | .09 | .63 | .18 | .67 | -.04 | -.49 | -.40 | 3 | |
| 58364 | -2.63 | -.05 | .42 | 18 | .64 | 1.07 | -.19 | .53 | -.29 | .54 | -.98 | -.15 | -.34 | 2 | |
| 59165 | -54.92 | .69 | .21 | 40 | | | | | | .62 | | | | | |
| 59957 | -9.39 | .10 | .33 | 22 | -.41 | 1.01 | .07 | .61 | .09 | .61 | .60 | .12 | .19 | 2 | |
| 61500 | -40.77 | .80 | .20 | 40 | -.44 | .89 | .18 | .69 | .27 | .72 | 1.51 | .89 | 1.07 | 2 | |
| 62102 | 11.91 | 1.56 | .32 | 19 | -.10 | 1.20 | .00 | .61 | .00 | .61 | 1.66 | 1.56 | 1.56 | 2 | |
| 62778 | -1.65 | -2.77 | .69 | 13 | | | | | | .86 | | | | | |
| 64551 | -38.66 | 1.28 | .50 | 19 | -1.14 | 1.14 | .02 | .42 | .03 | .42 | 2.45 | 1.29 | 1.31 | 2 | |

**Table 2.** (continued)

| HIP | $\mu_\delta$ ($\frac{\text{mas}}{\text{yr}}$) | $b$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_b$ | $n$ (yr) | $LTP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{LT}$ | $STP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{ST}$ | $HIP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{HI}$ | $r_{LTP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{STP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{HIP}$ ($\frac{\text{mas}}{\text{yr}}$) | $K_{ae}$ | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65366 | 10.84 | -.26 | .23 | 40 | -.57 | .92 | .02 | .56 | .01 | .58 | .32 | -.27 | -.25 | 2 | |
| 65495 | -3.79 | 1.79 | .49 | 18 | -.18 | .82 | .10 | .72 | .15 | .77 | 2.12 | 1.84 | 1.94 | 2 | |
| 67239 | -57.82 | 1.64 | .62 | 19 | | | | | | .47 | | | | | |
| 70259 | -17.12 | .57 | .23 | 40 | -1.75 | 1.00 | .34 | .62 | .45 | .64 | 2.77 | .68 | 1.02 | 2 | |
| 73178 | 23.14 | .34 | .35 | 40 | .23 | 1.09 | .05 | .61 | .07 | .62 | .18 | .36 | .41 | 2 | |
| 74249 | 24.64 | -.76 | .46 | 19 | .35 | .99 | -.25 | .88 | -.43 | .96 | -1.54 | -.94 | -1.19 | 2 | |
| 74678 | -2.21 | .15 | .18 | 40 | -.68 | .94 | -.09 | .69 | -.18 | .72 | .65 | .06 | -.03 | 3 | |
| 74954 | -125.10 | .01 | .58 | 14 | 2.32 | 1.03 | -2.22 | .86 | -2.95 | .91 | -5.26 | -.72 | -2.94 | | |
| 75233 | -9.65 | -.96 | .68 | 11 | | | | | | .86 | | | | | |
| 76639 | 3.53 | -.04 | .51 | 19 | | | | | | .76 | | | | | |
| 77504 | 6.68 | .63 | .81 | 10 | | | | | | 2.31 | | | | | |
| 77676 | -12.89 | 1.01 | .25 | 38 | .47 | .94 | -.24 | .71 | -.44 | .75 | .10 | .81 | .57 | 2 | |
| 78319 | 21.07 | 2.80 | .74 | 19 | .00 | .68 | .00 | .68 | .29 | .79 | 3.09 | 3.09 | 3.09 | 3 | |
| 79225 | 12.40 | .49 | .28 | 40 | .10 | .94 | -.03 | .72 | -.06 | .76 | .33 | .46 | .43 | 2 | |
| 81061 | -81.39 | -3.36 | 1.82 | 14 | .06 | 1.20 | -.03 | 1.00 | -.05 | 1.05 | -3.47 | -3.38 | -3.41 | 2 | |
| 82235 | 44.33 | -.36 | .32 | 40 | .26 | .93 | -.19 | .78 | -.25 | .81 | -.87 | -.42 | -.61 | 2 | |
| 82506 | -3.75 | -3.33 | .51 | 19 | -3.78 | 1.30 | .74 | .62 | 1.20 | .64 | 1.65 | -2.87 | -2.13 | | |
| 82780 | -19.88 | -.46 | .23 | 40 | | | | | | .58 | | | | | |
| 82987 | 16.52 | .67 | 1.24 | 19 | .22 | .68 | -.13 | .54 | -.18 | .57 | .27 | .62 | .49 | 3 | |
| 83367 | 98.96 | -.29 | .24 | 40 | -.53 | .76 | .29 | .59 | .38 | .62 | .62 | -.20 | .09 | | |
| 83643 | 5.62 | -1.57 | .77 | 19 | -.07 | .88 | .03 | .78 | .10 | .87 | -1.40 | -1.50 | -1.47 | 2 | |
| 84574 | 4.28 | .09 | .55 | 18 | -.82 | 1.12 | .61 | 1.04 | 1.32 | 1.15 | 2.23 | .80 | 1.41 | 2 | |
| 85842 | 42.83 | -3.65 | .58 | 19 | -.35 | .89 | .29 | .86 | .54 | .95 | -2.76 | -3.40 | -3.11 | 2 | |
| 86160 | -9.70 | .73 | .19 | 40 | .46 | .86 | -.23 | .72 | -.41 | .77 | -.14 | .55 | .32 | 2 | |
| 87001 | -43.42 | -.19 | .27 | 40 | .03 | 1.35 | -.01 | .56 | -.02 | .57 | -.24 | -.20 | -.21 | 3 | |
| 87194 | -39.09 | -.58 | .35 | 40 | -.12 | .53 | .14 | .52 | .16 | .53 | -.30 | -.56 | -.42 | 3 | |
| 87705 | -11.59 | .50 | .47 | 19 | -.42 | .91 | .19 | .72 | .38 | .77 | 1.30 | .69 | .88 | 2 | |
| 88275 | -.73 | -.08 | .26 | 40 | .43 | .89 | -.06 | .64 | -.20 | .65 | -.71 | -.22 | -.28 | 2 | |
| 88651 | -1.34 | -1.38 | .55 | 19 | -1.08 | 1.06 | .31 | .70 | .45 | .72 | .15 | -1.24 | -.93 | 2 | |
| 89139 | 14.12 | -.68 | .25 | 40 | -.22 | 1.37 | .01 | .57 | .03 | .58 | -.43 | -.66 | -.65 | 3 | |
| 90480 | -3.57 | -1.86 | .61 | 19 | | | | | | 1.45 | | | | | |
| 90906 | 15.22 | -.01 | .47 | 19 | -.09 | .88 | .02 | .61 | .05 | .63 | .13 | .02 | .04 | 2 | |
| 91168 | -21.13 | .44 | .28 | 40 | .29 | .95 | -.15 | .76 | -.26 | .80 | -.11 | .33 | .18 | 2 | |
| 91496 | -3.41 | 2.27 | .45 | 17 | -.03 | 1.01 | .11 | .89 | .28 | .97 | 2.58 | 2.44 | 2.55 | 2 | |
| 91799 | -4.98 | 2.73 | .52 | 19 | .72 | .92 | -.23 | .70 | -.55 | .74 | 1.46 | 2.41 | 2.18 | 2 | |
| 92127 | -7.00 | -.30 | .25 | 40 | -.05 | .97 | .01 | .63 | .02 | .64 | -.23 | -.29 | -.28 | 2 | |
| 92896 | -4.68 | .59 | .23 | 40 | -.91 | 1.02 | .18 | .68 | .30 | .69 | 1.80 | .71 | .89 | 2 | |
| 93553 | -4.19 | -2.19 | .30 | 37 | -.25 | .93 | .04 | .60 | .18 | .63 | -1.76 | -2.05 | -2.01 | 3 | |
| 93726 | 4.78 | .12 | .50 | 17 | .46 | 1.10 | -.03 | .64 | -.06 | .64 | -.40 | .09 | .06 | 2 | |
| 94485 | 2.50 | .72 | .24 | 40 | -.29 | .90 | .03 | .54 | .17 | .56 | 1.18 | .86 | .89 | 3 | |
| 94828 | 7.82 | 1.55 | .50 | 19 | -.11 | .88 | .03 | .71 | .12 | .76 | 1.78 | 1.64 | 1.67 | 2 | |
| 95147 | -4.88 | -.93 | .50 | 19 | -.48 | .99 | .07 | .71 | .53 | .75 | .08 | -.47 | -.40 | | |

**Table 2.** (continued)

| HIP | $\mu_\delta$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $b$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_b$ | $n$ (yr) | $LTP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{LT}$ | $STP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{ST}$ | $HIP$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $\varepsilon_{HI}$ | $r_{LTP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $r_{STP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $r_{HIP}$ $(\frac{\mathrm{mas}}{\mathrm{yr}})$ | $K_{ae}$ | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95476 | -5.45 | .65 | .67 | 19 | | | | | | 1.25 | | | | | |
| 96081 | 42.86 | -1.87 | .30 | 33 | | | | | | .81 | | | | | |
| 96225 | -20.71 | -.05 | .25 | 40 | .31 | .92 | -.10 | .81 | -.22 | .89 | -.58 | -.17 | -.27 | 3 | |
| 96405 | .14 | .16 | .48 | 18 | -.14 | .92 | .09 | .86 | .38 | .98 | .68 | .45 | .54 | 2 | |
| 97532 | -16.77 | .16 | .56 | 18 | -.09 | .80 | .01 | .64 | .06 | .65 | .31 | .21 | .22 | 2 | |
| 98188 | 8.74 | -1.96 | .43 | 18 | .04 | .89 | .00 | .60 | -.01 | .61 | -2.01 | -1.97 | -1.97 | 2 | |
| 98392 | -17.84 | -.99 | .38 | 18 | -1.59 | 1.11 | .38 | .70 | .61 | .72 | 1.21 | -.76 | -.38 | 2 | |
| 98828 | -39.20 | -.16 | .21 | 39 | -.19 | 1.04 | .03 | .57 | .04 | .57 | .07 | -.15 | -.12 | 2 | |
| 99023 | -5.97 | -3.03 | .37 | 17 | .14 | 1.02 | -.01 | .57 | -.02 | .57 | -3.19 | -3.04 | -3.05 | | |
| 99353 | 40.95 | 1.94 | .74 | 12 | .39 | .86 | -.03 | .54 | -.10 | .56 | 1.45 | 1.87 | 1.84 | 2 | |
| 99824 | -4.04 | .98 | .43 | 39 | | | | | | .48 | | | | | |
| 100083 | -27.82 | 1.52 | .48 | 18 | .08 | 1.08 | -.05 | .69 | -.09 | .71 | 1.35 | 1.48 | 1.43 | 2 | |
| 100093 | -.64 | -.05 | .37 | 18 | .06 | .95 | .00 | .68 | -.01 | .69 | -.12 | -.06 | -.06 | 2 | |
| 100832 | -6.72 | -1.00 | .40 | 18 | -.01 | 1.03 | -.06 | .67 | -.11 | .68 | -1.10 | -1.05 | -1.11 | 2 | |
| 101485 | -7.28 | .87 | .92 | 17 | | | | | | .79 | | | | | |
| 101641 | 12.51 | .55 | .29 | 39 | | | | | | .52 | | | | | |
| 102012 | -4.24 | -.53 | .22 | 39 | | | | | | .63 | | | | | |
| 102271 | -5.87 | .22 | .19 | 39 | | | | | | .51 | | | | | |
| 102728 | 9.66 | 1.43 | .35 | 17 | | | | | | .86 | | | | | |
| 102740 | 9.22 | .61 | .23 | 39 | | | | | | .53 | | | | | |
| 103252 | -1.99 | -.43 | .45 | 19 | | | | | | .64 | | | | | |
| 105247 | -8.28 | -.52 | .48 | 17 | | | | | | .87 | | | | | |
| 105484 | 2.36 | .78 | .33 | 19 | | | | | | .65 | | | | | |
| 105724 | -2.36 | -.39 | .24 | 39 | | | | | | .50 | | | | | |
| 106036 | -15.99 | -1.61 | .62 | 16 | | | | | | .49 | | | | | |
| 107237 | -14.40 | -1.59 | .36 | 12 | | | | | | .63 | | | | | |
| 107462 | -5.02 | .85 | .40 | 21 | | | | | | .67 | | | | | |
| 107694 | 3.98 | -.47 | .29 | 39 | | | | | | .94 | | | | | |
| 108966 | -14.02 | -2.57 | .24 | 38 | | | | | | 1.64 | | | | | |
| 109276 | -36.95 | -.04 | .46 | 17 | | | | | | .58 | | | | | |
| 109696 | -145.34 | -.62 | .38 | 36 | | | | | | .61 | | | | | |
| 110152 | .88 | .52 | .25 | 39 | | | | | | .79 | | | | | |
| 110733 | -8.16 | -.43 | .27 | 38 | | | | | | .58 | | | | | |
| 112453 | -9.54 | 1.07 | .34 | 17 | | | | | | .71 | | | | | |
| 114025 | -3.43 | .60 | .60 | 10 | | | | | | .70 | | | | | |
| 114809 | 15.21 | 1.74 | .43 | 19 | | | | | | .54 | | | | | |
| 115389 | -11.35 | -.39 | .34 | 30 | | | | | | .48 | | | | | |
| 115583 | -1.63 | -1.80 | .49 | 19 | | | | | | .52 | | | | | |
| 117332 | -9.80 | 1.91 | 1.02 | 15 | | | | | | .56 | | | | | |
| 716 | 60.67 | 5.90 | 1.78 | 5 | .25 | .91 | -.01 | .51 | -.01 | .51 | 5.64 | 5.90 | 5.89 | | |
| 5494 | -105.68 | 8.07 | 2.20 | 5 | -.45 | .91 | .09 | .42 | .12 | .43 | 8.64 | 8.10 | 8.19 | 1 | |
| 6529 | -41.61 | -9.69 | 11.02 | 4 | -.26 | 1.00 | .07 | .67 | .12 | .69 | -9.31 | -9.64 | -9.57 | 2 | |

**Table 2.** (continued)

| HIP | $\mu_\delta$ ($\frac{\text{mas}}{\text{yr}}$) | $b$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_b$ | $n$ (yr) | $LTP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{LT}$ | $STP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{ST}$ | $HIP$ ($\frac{\text{mas}}{\text{yr}}$) | $\varepsilon_{HI}$ | $r_{LTP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{STP}$ ($\frac{\text{mas}}{\text{yr}}$) | $r_{HIP}$ ($\frac{\text{mas}}{\text{yr}}$) | $K_{ae}$ | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9851 | -1.59 | 3.94 | 1.60 | 5 | .51 | .83 | -.18 | .63 | -.41 | .69 | 3.02 | 3.71 | 3.53 | 3 | |
| 17583 | -39.63 | 6.77 | 9.53 | 5 | -.05 | .95 | -.32 | 1.01 | -.60 | 1.13 | 6.22 | 6.49 | 6.17 | 2 | |
| 29158 | -7.55 | -2.32 | .98 | 8 | -.04 | .87 | .04 | .85 | .63 | 1.10 | -1.65 | -1.73 | -1.69 | 3 | |
| 39835 | -14.95 | 1.23 | .92 | 8 | | | | | | .62 | | | | | |
| 40860 | -40.02 | -4.97 | 2.64 | 5 | -.63 | 1.10 | .08 | .98 | .03 | 1.10 | -4.31 | -5.02 | -4.94 | 2 | |
| 40890 | -3.63 | 10.40 | 5.13 | 5 | -.06 | .80 | -.02 | .84 | -.11 | 1.04 | 10.35 | 10.31 | 10.29 | | |
| 54063 | 3.12 | -8.76 | 1.46 | 5 | -1.56 | 1.13 | .44 | .65 | .61 | .68 | -6.59 | -8.59 | -8.15 | 3 | |
| 54347 | -16.78 | -2.40 | .77 | 8 | -.31 | .99 | .33 | .70 | .46 | .73 | -1.63 | -2.27 | -1.94 | 3 | |
| 86637 | -4.07 | .19 | 4.14 | 6 | .12 | .99 | -.03 | .64 | -.08 | .66 | -.01 | .14 | .11 | 2 | |
| 92701 | -17.67 | 8.47 | 3.68 | 5 | | | | | | .71 | | | | | |
| 93995 | -79.07 | .35 | 1.18 | 4 | | | | | | .82 | | | | | |
| 101883 | -13.51 | -1.16 | .28 | 5 | | | | | | .64 | | | | | |
| 103901 | 2.53 | -.85 | 4.15 | 4 | | | | | | .63 | | | | | |
| 105000 | -34.58 | 2.80 | 1.35 | 7 | | | | | | .59 | | | | | |
| 110247 | -27.77 | -.75 | .65 | 7 | | | | | | .75 | | | | | |
| 113542 | .06 | .59 | 1.41 | 7 | | | | | | .76 | | | | | |
| 114688 | .34 | 1.22 | 2.31 | 5 | | | | | | .63 | | | | | |
| 115672 | 19.40 | -1.75 | 1.57 | 5 | | | | | | .62 | | | | | |
| 117415 | -27.47 | -1.04 | .83 | 7 | | | | | | .52 | | | | | |
| 10053 | | -.37 | .33 | 38 | | | | | | 1.97 | | | | | 12 |
| 12744 | 4.45 | .07 | .40 | 39 | | | | | | .89 | | | | | 3 |
| 26947 | -13.29 | 6.37 | 5.95 | 7 | | | | | | 1.42 | | | | | 3 |
| 45278 | -21.22 | -.63 | .40 | 34 | -2.12 | .91 | .39 | .58 | .61 | .60 | 2.10 | -.41 | -.02 | | 2 |
| 56860 | -44.01 | .48 | .31 | 39 | | | | | | 1.50 | | | | | 3 |
| 70310 | | -.72 | .29 | 30 | .11 | 1.08 | -.05 | .52 | -.05 | .53 | | | | 3 | 1 |
| 73768 | | -.09 | .21 | 40 | | | | | | 1.64 | | | | | 1 |
| 75350 | | -.24 | .26 | 38 | -.33 | .93 | .39 | .99 | .66 | 1.12 | | | | 2 | 1 |
| 75883 | 4.21 | -3.89 | 1.17 | 3 | | | | | | 1.65 | | | | | 3 |
| 81781 | | -.57 | .47 | 23 | | | | | | 1.04 | | | | | 12 |
| 84821 | | -.32 | .21 | 40 | | | | | | .66 | | | | | 1 |
| 89847 | | 4.99 | 7.01 | 4 | | | | | | 2.07 | | | | | 13 |
| 97077 | | -.32 | .20 | 39 | | | | | | .65 | | | | | 1 |
| 100088 | | -.56 | .18 | 39 | | | | | | .59 | | | | | 1 |
| 106872 | | -.31 | .82 | 16 | | | | | | .48 | | | | | 12 |

ones, because our values $b$ were also calculated in that way). The last column is $C$ – comment: 1 – if our input data were already corrected for the proper motion in declination, 2 – if already corrected for declination, and 3 – for the stars that are contained in HIP, but being erroneously identified, instead other ones were observed.

The corrections (for $\delta$ or/and $\mu_\delta$) were already applied for 11 RCP and RCQ stars (Vondrák 2002); see Table 1. The first part of Table 2 (165 Richmond stars, 114 ARIHIP ones) exhibits very good results ($n > 10$). The second one (22 Richmond stars, 11 ARIHIP ones) is for the case $n \leq 10$ and with bigger differences between our and ARIHIP results. The third part (15 Richmond stars, 3 ARIHIP ones) is in agreement with the comment $C$: some $\mu_\delta$ and other values are not presented because the value $b$ is a correction of the correction for some of these stars.

Both linear trends in Fig. 4, one calculated with the new point ($b = 0.09 \pm 0.30$ mas) and the other one without it ($b = 0.10 \pm 0.50$ mas), are close to each other and seen as a single line. The same situation is also for other stars observed for a few decades. But, a different situation is shown in Fig. 5. Star H29075, as an example ($n = 11$), with two different linear trends clearly separated; with the new point, a quite good value of $b = -2.52 \pm 0.93$ mas ($r_{HIP} = -2.04$ mas) is obtained, and without it, the value is $b = 2.50 \pm 1.00$ mas (which gives $r_{HIP} = 2.98$ mas, bigger than in the previous case). Fig. 6 shows 125 ARIHIP stars (with the third part of Table 2 excluded) by using the values $r_{HIP}$ which are in line with SI mode. To check our values $b$, we use the data of ARIHIP. It is clear that for the stars observed just for a few years with PZT it is not possible to get good results, and these values of $r_{HIP}$ are large (1 mas $< |r_{HIP}| <$ 10 mas), but if the observational period $n$ is about 20 yrs (central part of Fig. 6) the values $r_{HIP}$ are just a few mas. A very good consistency is evident in the right-hand side of Fig. 6 where some $r_{HIP}$ are of about 1 mas and mostly $|r_{HIP}| \leq 1$ mas. For the stars with a few decades of observations, the results $b$ are good (the values of $\varepsilon_b$ are small), and the agreement with ARIHIP data is good. Also, we calculate the average value of the residuals $r_{HIP}$, $r_{LTP}$ and $r_{STP}$ for 125 stars presented in Fig. 6 (and the standard errors) for both cases $n \leq 10$ (11 stars) and $10 < n \leq 40$ (114 ones), respectively:

$0.7 \pm 6.7$ mas/yr, $0.0 \pm 1.2$ mas/yr, from $r_{HIP}$,
$0.9 \pm 6.4$ mas/yr, $0.0 \pm 1.4$ mas/yr, from $r_{LTP}$,
$0.7 \pm 6.8$ mas/yr, $0.0 \pm 1.2$ mas/yr, from $r_{STP}$.

For the first and second parts of Table 2. (187 stars), we determined the mean value of our errors $\varepsilon_b$ and HIP ones $\varepsilon_{HI}$ for $n \leq 10$ (24 stars) and $n > 10$ (163 stars), respectively:

$2.5 \pm 2.7$ mas, $0.4 \pm 0.2$ mas, from $\varepsilon_b$,
$0.8 \pm 0.4$ mas, $0.7 \pm 0.2$ mas, from $\varepsilon_{HI}$.

For the case $n > 10$ (163 stars), it is evident that we end up with a better mean accuracy (0.4 mas) than the HIPPARCOS one (0.7 mas), but this is not the case for $n \leq 10$ (24 stars), as we expected. Also, our agreement with the ARIHIP data is much better for the case $n > 10$ (114 stars) than $n \leq 10$ (11 ones). These values are in agreement with our comments regarding Fig. 6. All the three ARIHIP modes are consistent with our results (in line with their errors and $\varepsilon_b$). In Table 2, we present the results for $b$ for all the 202 stars (74 stars are not present in ARIHIP), but the results of the first part of Table 2 are better than the others.

## 5. CONCLUSIONS

In the paper by Damljanović (2005) we used the data of other PZTs as input, and checked the obtained results in a way different from that used here. The method is slightly changed in this paper, but in both cases the results are good. We compare our results with the ARIHIP ones and for the stars with a long observational history (a few decades) the agreement is good. Because of this, we give the results for all the 202 RCP and RCQ stars. ARIHIP does not include the PZT data, and the 74 stars presented here are not found in ARIHIP. It is possible to get good corrections of proper motions in declination for HIPPARCOS stars observed long enough by using PZT instruments. This means, the long term ground – based observations of the Earth rotation programmes are sufficiently good for the task of improving even the HIPPARCOS $\mu_\delta$ and the corresponding reference frame.

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## ТАЧНИЈА СОПСТВЕНА КРЕТАЊА У ДЕКЛИНАЦИЈАМА НЕКИХ ХИПАРКОС ЗВЕЗДА

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*Претходно саопштење*

Укратко смо описали процедуру рачунања и ширинске улазне податке две Ричмонд фотографске зенитне тубе (RCP и RCQ за период 1949.8 – 1989.4), а затим презентовали резултате за 202 ХИПАРКОС звезде посматране са RCP и RCQ и упоредили наше са резултатима АРИХИП каталога. Од 202 звезде, у АРИХИП каталогу смо пронашли 128 звезда. Посматрања рађена на RCP и RCQ захватају период од око 40 година, али су многе од 202 посматране звезде са посматрањима од пар деценија а неке и свега неколико година. Због тога смо добили побољшања сопствених кретања у деклинацији посматраних Хипаркос звезда различите тачности, што се уочава и при поређењу са АРИХИП подацима. Наравно, најбоље је слагање наших са АРИХИП резултатима за звезде које су посматране свих 40 година, док је лошије за звезде које су посматране мање од 10 година. Хипаркос сателитска посматрања (ESA 1997) су трајала нешто краће од 4 године. Да бисмо поправили тачност сопствених кретања Хипаркос звезда потребно је више деценија класичних оптичких посматрања тих звезда са Земље. Таква посматрања постоје, јер су током периода 1899.7-1992.0 рађени посматрачки програми звезда у оквиру програма истраживања Земљине ротације. У овом раду, поређењем наших са АРИХИП резултатима, долазимо до доста доброг слагања за звезде које су довољно дуго посматране (више деценија), при чему су наша истраживања и улазни подаци потпуно независни и различити, а 74 RCP/RCQ звезде уопште нису у АРИХИП каталогу. Закључујемо, да се наведена дугогодишња посматрања у оквиру програма истраживања Земљине ротације могу користити за врло захтевне пројекте какав је провера и побољшање сопствених кретања Хипаркос каталога, а тиме и самог референтног система.