HIPPARCOS AND GROUND-BASED PROPER MOTIONS OF NPZT STARS

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ABSTRACT

The ground-based observations of NPZT stars (Northern Photographic Zenith Tube stars, $NPZT_{74}$ catalogue) are combined with the Hipparcos Catalogue to derive the long time baseline proper motions of NPZT stars. The derived proper motions are compared with Hipparcos proper motions to investigate the systematic differences between the two sets of proper motions.

Key words: proper motions; NPZT stars; reference frame.

1. $NPZT_{74}$ POSITIONS IN THE FK5 SYSTEM

The positions of the NPZT stars given in the $NPZT_{74}$ catalogue (Yasuda et al. 1982) are based on the FK4 system and referred to B1950 equinox. We first transfer the cataloged positions to those of the FK5 system and equinox J2000. The transfer was performed according to the method given in the FK5 Catalogue (Fricke et al. 1988). Then, position differences, $NPZT_{74}$ – Hipparcos (at epoch 1974), were constructed for 1709 NPZT stars. The Hipparcos positions at 1974 were calculated by using Hipparcos proper motions of individual stars. Shown in Figure 1 and Figure 2 are the differences in right ascension and declination, respectively, plotted against right ascensions.

In Figure 1 and Figure 2 some large conspicuous systematic differences are noticed both in $\Delta\alpha\cos\delta$ and $\Delta\delta$. The trends of the systematic variations are in good agreement with those found for the FK5 stars (Lindegren et al. 1995). The systematic differences are expected to be caused by the systematic errors in the FK5 proper motions.

2. NPZT PROPER MOTIONS

In this paper we define the $NPZT_{74}$ proper motions as $\mu_\alpha(\mathrm{NPZT}_{74}) \equiv [\alpha(\mathrm{NPZT}_{74}) - \alpha(\mathrm{Hipparcos\ at\ observation\ epoch\ of\ NPZT}_{74})]/\Delta t$, and $\mu_\delta(\mathrm{NPZT}_{74}) \equiv [\delta(\mathrm{NPZT}_{74}) - \delta(\mathrm{Hipparcos\ at\ observation\ epoch\ of\ NPZT}_{74})]/\Delta t$, where $\Delta t = 1991.25$ – observation epoch of $NPZT_{74}$.

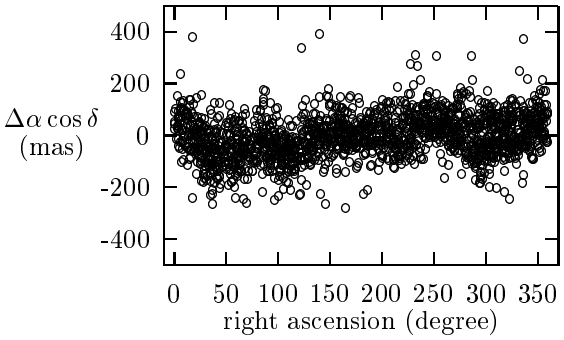

Figure 1. Position differences, $\alpha\cos\delta(NPZT_{74})$ – $\alpha\cos\delta$(Hipparcos at epoch 1974), are plotted against right ascension.

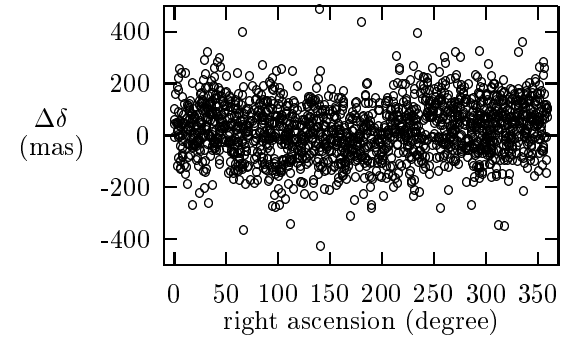

Figure 2. Position differences, $\delta(NPZT_{74})$ – δ(Hipparcos at epoch 1974), are plotted against right ascension.

The derived values are not the pure ground-based proper motions, but they give the proper motions derived from two observations of a relatively long time baseline compared to the Hipparcos mission life. The differences between the two determinations of proper motions, $NPZT_{74}$ proper motions (above definition) and Hipparcos proper motions, of NPZT stars are shown in Figure 3 and Figure 4 in the case of right ascension. It is noted that the $NPZT_{74}$ catalogue is of northern PZT stars, and therefore the distribution

of the stars along declination is grouped around the selected declination zones.

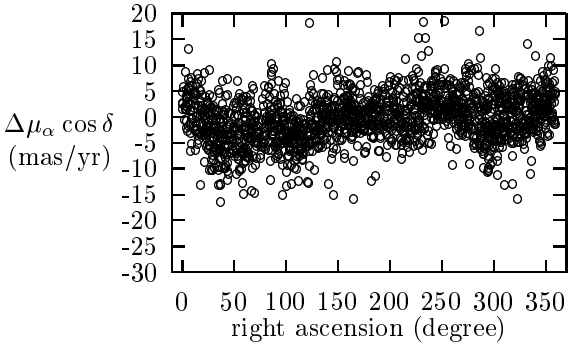

Figure 3. Proper motion differences, $\mu_\alpha \cos\delta$(NPZT$_{74}$) − $\mu_\alpha \cos\delta$(Hipparcos), plotted against right ascension.

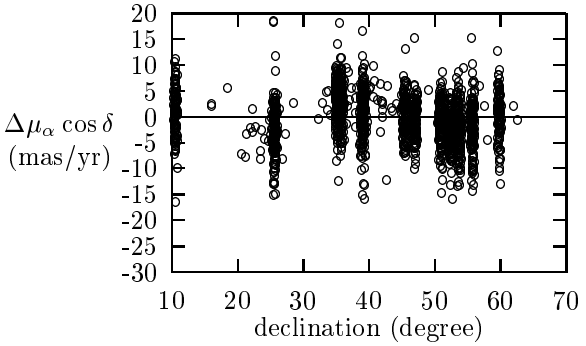

Figure 4. Proper motion differences, $\mu_\alpha \cos\delta$(NPZT$_{74}$) − $\mu_\alpha \cos\delta$(Hipparcos), plotted against declination.

Comparing Figure 1 and Figure 3, we suspect that the systematic deviations of NPZT$_{74}$ positions from Hipparcos positions at the NPZT$_{74}$ epochs resulted in the systematic trends of μ(NPZT$_{74}$) − μ(Hipparcos) along right ascension and declination.

3. RANDOM COMPONENTS OF NPZT$_{74}$ PROPER MOTIONS

Correlations (μ_α(NPZT$_{74}$) − μ_α(Hipparcos))$\cos\delta$ and μ_δ(NPZT$_{74}$) − μ_δ(Hipparcos) are plotted in Figure 5.

In Figure 5 we see no significant systematic correlation between the proper motion differences in α and in δ. If we neglect the small errors in the Hipparcos proper motions (≈1 milliarcsec per year (mas/yr), the rms error in μ(NPZT$_{74}$) is about 5 mas/yr in right ascension, and about 7 mas/yr in declination, including the contribution from the systematic variation along right ascension and declination.

4. COMPARISON BETWEEN HIPPARCOS AND NPZT$_{74}$ PROPER MOTIONS

$\mu_\alpha \cos\delta$(NPZT$_{74}$) is plotted in Figure 6 against $\mu_\alpha \cos\delta$(Hipparcos) in order to examine the presence of large systematic deviation between them.

Except for small (maybe a few mas/yr) systematic differences along right ascension and declination, the Hipparcos proper motions which were observed throughout the 3.5-year mission and NPZT$_{74}$ proper motions which are determined with about a 17 year time span, are consistent to each other at the level of ±5 mas/yr.

5. CONCLUSIONS

The conclusions of the present first-step analysis of the proper motions of the NPZT stars are that the random part of μ(NPZT$_{74}$) ∼ ±5 mas/yr, while the systematic part − the systematic deviation of μ(NPZT$_{74}$) from μ(Hipparcos) − is at the most ∼ 5 mas/yr (in most part of the celestial sphere ≤ 3 mas/yr).

It is absolutely necessary to remove the systematic error $\Delta\mu$(FK5) for the derivation of reliable ground-based proper motions which are to be compared with the Hipparcos proper motions.

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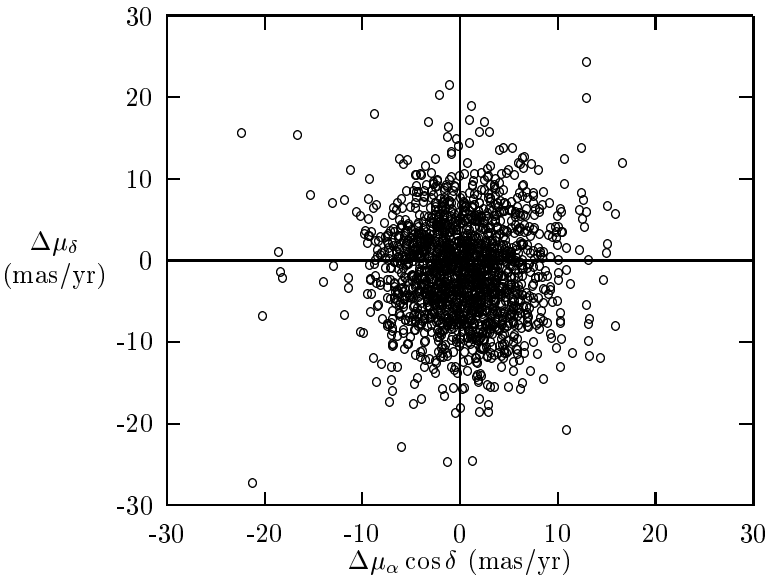

Figure 5. Correlation between (μ_α (NPZT$_{74}$)–μ_α (Hipparcos))$\cos\delta$ and μ_δ (NPZT$_{74}$)–μ_δ (Hipparcos).

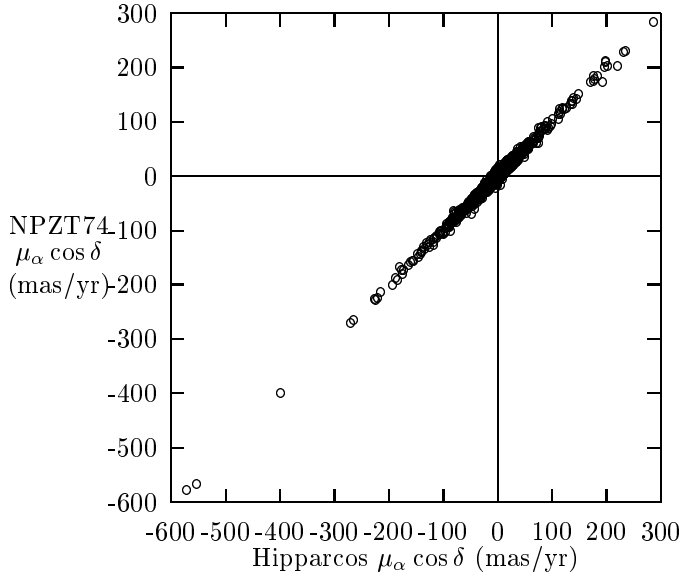

Figure 6. $\mu_\alpha \cos\delta$ (NPZT$_{74}$) plotted against $\mu_\alpha \cos\delta$ (Hipparcos).