# NPM2 AND HIPPARCOS PROPER MOTIONS

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ABSTRACT. Comparing the Hipparcos proper motions with those of the Lick NPM2 Catalog, which provides absolute proper motions of objects measured directly relative to external galaxies, we found that the two components of the spin vector, $\omega_x$ and $\omega_y$, are apparently less than the value of 0.25 mas yr$^{-1}$ for the uncertainty of the Hipparcos inertiality, while the component $\omega_z$ is about three times that value. Inspecting the magnitude- and color-dependent pattern of the proper-motion difference, we found that there is no strong systematics existing in the NPM2 with respect to the Hipparcos proper-motion system.

## 1. INTRODUCTION

The recent released NPM2 Catalog is the second part of the Lick Northern Proper Motion program (http://www.ucolock.org/~npm/NPM2; Klemola et al. 1987) which contains absolute proper motions, accurate positions, and BV photometry for 232062 stars from 8 magnitude to 18 magnitude in B band. There are 347 NPM2 fields in total covering from +83 degree to −23 degree in declination. The RMS errors of the NPM2 absolute proper motions are about 6 mas yr$^{-1}$ in each coordinate, comparable to the NPM1 errors. The preliminary version of the NPM2 gives 196639 stars, which includes 4395 Hipparcos stars and about 80000 stars in the Tycho-2 Catalogue.

The purpose of this study was to compare the NPM2 proper-motion system with Hipparcos in order to examine the inertiality of the Hipparcos system. In particular, we analyzed the possible sources of systematic errors in the NPM2 system which might infect our solution of the proper-motion systematics.

## 2. SYSTEMATIC DIFFERENCE IN PROPER MOTIONS

Considering the possible complications arising from the Hipparcos observations of binary, multiple, and suspected non-single systems, we excluded all of these stars found in the Hipparcos Catalogue in our analysis. Thus, only 3768 single stars remain for the analysis, which are common to both NPM2 and Hipparcos catalogues.

In our previous work, we have compared the SPM 2.0 proper motions with those of the Hipparcos (Zhu 2001). In a similar way, the spin vector ($\omega_x$, $\omega_y$, $\omega_z$), which represents the rotational difference between the two frames, are determined by a generalized least-squares method. It is noticed that some proper-motion data, both from the NPM2 Catalog and from the Hipparcos Catalogue, might have large measurement errors. To exclude extremely erroneous

proper motions, the $2.6\sigma$ principle is introduced to our procedure. Thus, all stars that contribute large residuals to the solution will be rejected, and then, we obtain a more reliable result. The corresponding spin solution was obtained and is listed in table 1.

Table 1. Systematic differences of the NPM2 and SPM 2.0 relative to the Hipparcos proper-motion system.

| | Number of stars | $\omega_x$ | $\omega_y$ | $\omega_z$ |
|---|---|---|---|---|
| NPM2-HIP | 3519 | $+0.11\pm0.20$ | $+0.19\pm0.20$ | $+0.75\pm0.28$ |
| SPM2-HIP | 9356 | $-0.10\pm0.17$ | $-0.48\pm0.14$ | $+0.17\pm0.15$ |

It is shown that the two components of the spin vector, $\omega_x$ and $\omega_y$, are apparently less than the value of 0.25 mas yr$^{-1}$ for the uncertainty of the Hipparcos inertiality, while the component $\omega_z$ is about three times that value. The differences between the SPM 2.0 and Hipparcos are not the same as NPM2-HIP, though both the SPM2.0 and NPM2 proper motions were measured directly in an inertial reference system with respect to extragalactic radio sources. A possible reason might be the systematic shift between the NPM2 and SPM 2.0.

In order to examine the magnitude- and color-dependent differences in proper motions between the NPM2 and Hipparcos, we have checked the systematic differences of the proper motions. It indicates that no significant magnitude- and color-depended systematics are found in the NPM2 proper-motion system. It is noticed the magnitude-dependent systematic errors for the brightest NPM2 stars were already removed in the NPM2 reduction. Furthermore, the present range of magnitude is too low to check the magnitude equation of the NPM2 proper-motion system.

## 3. REMARKS

The Hipparcos Catalogue is a realization of the ICRS system, which was finalized via a specific link program by various observational techniques (Lindegren & Kovalevsky 1995; Kovalevsky et al. 1997). Its proper-motion system is believed to be quasi-inertial to within $\pm0.25$ mas yr$^{-1}$ for all three axes with respect to distant extragalactic objects. The proper motions of the NPM2 Catalog are absolute, measured directly in an inertial reference system, the two proper-motion system should be coincident.

Analyzing the proper-motion differences between the NPM2 and Hipparcos catalogues, we found that components $\omega_x$ and $\omega_y$ are apparently less than 0.25 mas yr$^{-1}$ in absolute value, while the component $\omega_z$ is as large as three times this value. It is confirmed that no significant magnitude- and color-equation is existed in the NPM2 proper motions, compared with the Hipparcos proper motions, in the range from 8 to 12 magnitude.

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## 4. REFERENCES

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