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# The PMA Catalogue as a realization of the extragalactic reference system in optical and near infrared wavelengths

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**Abstract.** We combined the data from the *Gaia* DR1 and Two-Micron All Sky Survey (2MASS) catalogues in order to derive the absolute proper motions more than 420 million stars distributed all over the sky in the stellar magnitude range 8 mag < G < 21 mag (Gaia magnitude). To eliminate the systematic zonal errors in position of 2MASS catalogue objects, the 2-dimensional median filter was used. The PMA system of proper motion has been obtained by direct link to 1.6 millions extragalactic sources. The short analysis of the absolute proper motion of the PMA stars Catalogue is presented in this work. From a comparison of this data with same stars from the TGAS, UCAC4 and PPMXL catalogues, the equatorial components of the mutual rotation vector of these coordinate systems are determined.

**Keywords.** astrometry, catalogue, surveys, reference systems.

## 1. Introduction

The Hipparcos Celestial Reference Frame (HCRF), according to IAU Resolution B1.2 of the XXIVth IAU GA, has been the optical realization of the International Celestial Reference System (ICRS, ( Arias *et al.* 1995)). The Tycho-2 catalogue (Høg *et al.* 2000) that contains positions and proper motions of about 2.5 million stars, is the HCRF extension towards the large stellar magnitudes domain, approximately up to $V = 11.5$ mag. The PPMXL (Roeser *et al.* 2010), UCAC4 (Zacharias *et al.* 2013), SPM4 (Girard *et al.* 2011), 2MASS (Skrutskie *et al.* 2006) and others catalogues which extend the HCRF system towards the faint of the stellar magnitudes range, use the Hipparcos (Kovalevsky *et al.* 1997), (van Leeuwen, 2007) and Tycho-2 stars as the reference ones. In this work, we investigate the problem of mutual rotation of the Hipparcos/Tycho-2 system with respect to absolute proper motion of the PMA stars.

## 2. Comparison of the PMA with other catalogues data

In September 2016 the first *Gaia* data were released based on the first 14 months of regular in-orbit operations (Gaia Collaboration *et al.* 2016a). *Gaia* Data Release 1 (DR1) contains astrometric results for more than one billion stars brighter than magnitude 20.7. The PMA Catalogue (Akhmetov *et al.* 2017) has been derived from a combination of two catalogues - 2MASS and *Gaia* DR1 (Gaia Collaboration *et al.* 2016b). The difference of epochs of observations for these catalogues is approximately 15 years. In order to eliminate the distortions we used a two-dimensional median filter that provided corrections by eliminating systematic errors in the 2MASS positions and, reducing them to the *Gaia* DR1 system. The absolute calibration procedure (zero-pointing of the proper motions) was fulfilled with the use of about 1.6 million positions of extragalactic sources. To creation the sample of extragalactic sources, we intersected the sample of SSA galaxies

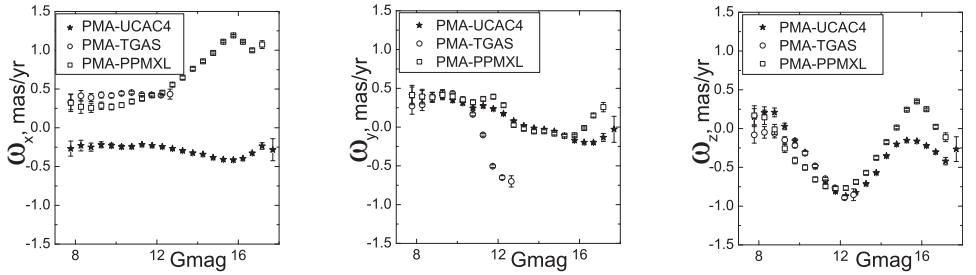


**Figure 1.** Components $w_x$, $w_y$ and $w_z$ of the mutual rotation vector of the Hipparcos/Tycho-2 system with respect to absolute proper motion of the PMA stars catalogue.

(Hambly *et al.* 2001a, Paper I), (Fedorov *et al.* 2014) with the WISE Catalogue (Wright *et al.* 2010). The colour diagram $(B-I)$ versus $(j_m - W1)$ has been used to separation stars and extragalactic sources. The mean formal error of the absolute calibration is less than 0.35 mas/yr.

To determine the value of the solid-body rotation of the Hipparcos/Tycho-2 system with respect to absolute proper motion of the PMA stars we use the well-known equations (Lindegren & Kovalevsky, 1995). The PMA-UCAC4, PMA-TGAS(Michalik *et al.* 2015) and PMA-PPMXL stellar proper motion difference have been used for solved by the least-squares method. The obtained components of the mutual rotation vector (Fig. 1) were made with the aim only of demonstrating their existence in the stellar proper motion these catalogues. For analysis and interpretation of the results of the comparison are need a separate and comprehensive investigation.

## 3. ACKNOWLEDGEMENTS

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