4.11. Absolute proper motions of 280 millions stars from 2MASS and USNOA2.0 data

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We combined the data from 2MASS and dUSNO-A2.0 catalogues in order to derive absolute proper motions of about 280 millions stars fainter than 12^m, covering the all sky excluding a narrow zone along the galactic equator. The proper motions were derived from 2MASS Point Sources Catalog and USNO-A2.0 positions with mean epoch difference about of 45 years for northern hemisphere and about of 17 years for south. The absolutization was done using about 1.4 million galaxies from 2MASS Extended Sources

Catalog. Before deriving the proper motions, the most of intrinsic to USNO-A2.0 zonal systematic errors were corrected. Mean formal error of absolutization is less than 1 mas/yr. The catalog named XPM contains the ICRS positions of stars at the J2000 epoch, original absolute proper motions, as well as B, R, J, H, and Ks magnitudes.

The cross-identification, error correction, linking to extragalactic objects and deriving the proper motions were done for individual USNO-A2.0 fields. Each field has a size about of 5x5 degrees and has a constant value of epoch of observation. Because of very big difference of star density at different galactic latitudes, we used 2-step cross-identification procedure with circular window of adjustable size. This algorithm cannot guarantee right identification for all objects, but we believe that overwhelming majority of objects was identified correctly. Thus, the maximal value of proper motion varies from about 80 mas/yr in dense fields up to 350 mas/yr in low-density fields. After the cross-identification the 2MASS minus USNO-A2.0 coordinate differences for identified stars were analyzed inside each field in order to find out possible geometric distortions induced by both USNO-A2.0 and 2MASS systematic errors.

Systematic coordinate differences were approximated inside each field by a combination of low-power polynomial and high-frequency stepping function. Since we do not know which exactly part of systematic differences is introduced by real motion of the stars, we made corrections for coordinates of all USNO-A2.0 objects, with no distinct the stars and galaxies, and just reduced USNO-A2.0 into the coordinate system defined by 2MASS stars in the particular field, getting zero mean systematic differences between 2MASS and USNO-A2.0 stars. In order to get the reference to extragalactic objects, we search for 2MASS extended sources among USNO-A2.0 objects inside each field. The number *N* of identified extragalactic objects inside a field varies from a few tens at low galactic latitudes up to several thousands at high galactic latitudes. Because the most of extended sources are galaxies, the differences between their 2MASS and USNO-A2.0 coordinates at this stage just reflect the real star motions with opposite sign (postulating zero proper motion for galaxies).These differences inside each field were approximated by a simple linear reduction model and used for reduction whole USNO-A2.0 into coordinate system defined by 2MASS extended sources. The root-mean-squared deviation of differences is about 400-450 mas, so we expect the error of absolutization to be roughly $\varepsilon = \sigma / (\sqrt{N}\Delta T)$ = 0.2 … 3 mas/yr at the North, and 3 times larger at the South. The proper motions of stars were derived at the final stage by dividing the coordinate difference by epoch difference for the each star. In order to estimate external errors of the proper

motions derived, we identified about of 12000 quasars from DR5 and LEDA data sets among our stars, and analyzed their formal proper motions. As was expected, we see zero mean value of the formal proper motions and root-mean-squared value to be 3-8 mas/yr depending on magnitude. Figure 39 shows the distribution of stars from the catalogue XPM, which will be used for determination of kinematic characteristics of our Galaxy.

Today there is no a big full-sky catalogues of absolute proper motions for the faint stars, though there are many tasks where they are applicable. In this work we do not corrected the proper motions derived for the magnitude equation, but we believe that it should be negligible in faint magnitude range. The magnitude equation is seems to be considerable for stars brighter than 15^m. This fact hampers the comparisons of the proper motions of faint stars with those from most of modern catalogues, such as UCAC-2 and Tycho-2. Additionally we have suspicion that measured coordinates of extended objects can be shifted relative to measured coordinates of stars in 2MASS and USNO-A2.0 catalogues. This effect can be hard to detect and measure, but it can lead to problems with agreement of zero-points for different catalogues, referenced to extragalactic objects. At the moment we do detailed analysis of results obtained, as well as do the kinematics analysis of the catalogue.