

APOP - Absolute Proper motions Outside the Plane

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Abstract

Most of the exoplanets discovered to date are close to our sun. Usually their host star has large proper motions, which is an important parameter for exoplanet searching. The first version of an absolute proper motions catalog achieved based on Digitized Sky Survey Schmidt plates outside the galactic plane ($|b| \geq 27^\circ$) is presented. The resulting zero point error is less than 0.6 mas/yr, and the precision better than 5.0 mas/yr for objects brighter than $R_F = 19.0$, rising to 10.0 mas/yr for objects with magnitude $19.0 < R_F < 20.0$. The systematic errors of absolute proper motions related to the position, magnitude and color are practically all removed. The sky cover of this catalog is 22,525 *degree*², the mean density is 6444 objects/*degree*² and the magnitude limit is around $R_F = 20.8$. This catalogue is a step towards the production of proper motions for the Guide Star Catalog and the procedures will be useful in other reductions to dispel astrometric magnitude- and color-dependent systematic errors.

Plate data

The Schmidt plate data are from a database (Lasker et al., 2008, AJ) which is derived from the uncompressed Digitized Sky Surveys that the Space Telescope Science Institute has created from the Palomar and UK Schmidt survey plates and made them available to the community. These data include all the basic information for each plate, such as plate scale, observation time, measured coordinates, equatorial coordinates, magnitude and classification etc.

Principle of calibration

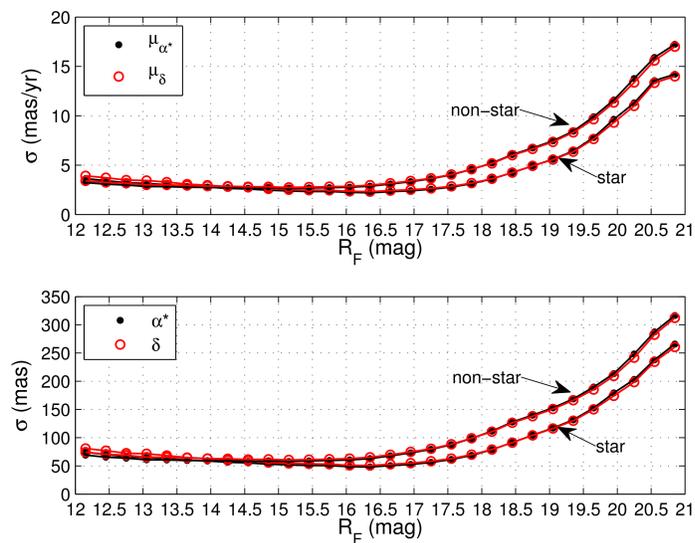
The calibration of absolute proper motion is based on the hypothesis that objects (stars and galaxies) with close positions, magnitudes and colors have similar systematic errors; the absolute proper motions of galaxies are always zero and not dependent on their positions on plates, magnitudes or colors. Based on this assumption and the conditions of the available plate data, the basic idea of this work is that the plates with good quality will be chosen as reference plates, and the stellar objects with good image quality on the reference plates will be used to unify the program plates to reference plates; a new kind of moving mean method is adopted to remove the Position dependent systematic Errors via stellar objects; galaxies will be chosen from the extended objects by utilizing the motion characteristics of galaxies, and then the Magnitude and Color dependent systematic Errors of all objects are removed by referring to those galaxies; finally, the absolute proper motions of stellar objects are calibrated by combing all of the plate data in different epochs.

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Internal accuracy

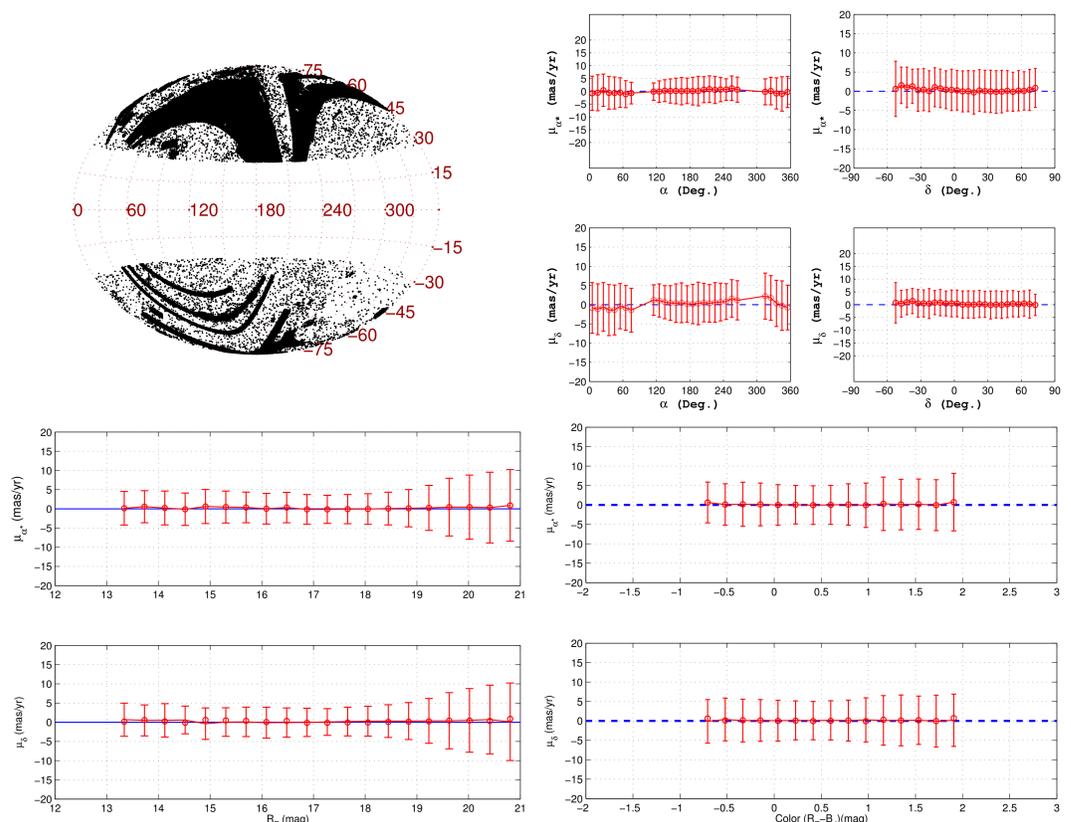
For each object, we could obtain the calibrated absolute proper motions and positions by fitting a equation with all its measures in different epochs. Meanwhile, we could also get the median standard errors of the calibrated parameters ($\mu_{\alpha*}, \mu_\delta, \alpha, \delta$), which could be as an internal check of the qualities of the catalogue APOP.



This figure shows the mean formal errors of the absolute proper motions ($\mu_{\alpha*}, \mu_\delta$) and positions (α, δ) of stars and non-stars as a function of R_F magnitude in catalogue APOP. The magnitude bin for this statistics is 0.3 mag, which make sure there are at least 100,000 objects in each bin. The marker * followed the μ_α and α means projecting them onto the the great circle direction (i.e times the $\cos \delta$). Top panel: the formal errors of absolute proper motions, the unit is milli-arcsec per year; bottom panel: the formal errors of positions, the unit is milli-arcsec.

External accuracy

Quasi-stellar objects (QSOs) have stellar-like images and since they are extragalactic, their proper motions could be considered as zero. Thus the dispersions of their measured proper motion will be a very good measure of the zero point and overall accuracy of absolute proper motions of the stellar objects. Here we use them as an independent and direct determination of the quality of this APOP catalogue. The Large Quasar Reference Frame (LQRF) (Andrei et al., 2009, A&A) is chosen as the source list for known QSOs.



The **top-left** panel shows the distribution of 108,521 QSOs found in the APOP. The rest panels show the systemic and random values of absolute proper motions ($\mu_{\alpha*}, \mu_\delta$) of QSOs as a function of their magnitude, color, α and δ .

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