THE XPM CATALOGUE AS A REALISATION OF THE EXTRAGALACTIC REFERENCE SYSTEM IN OPTICAL AND NEAR INFRARED RANGE

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New challenges for reference systems and numerical standards in astronomy PARIS-2010
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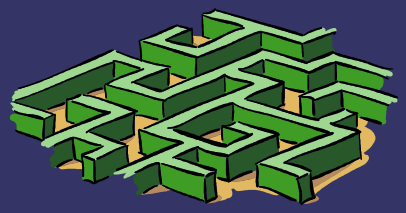
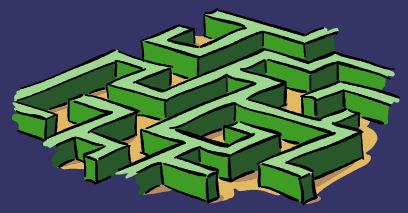


Introduction

We combined data from the Two-Micron All Sky Survey (2MASS) and United States Naval Observatory (USNO-A2.0) catalogues in order to derive the absolute proper motions of about 300 million stars distributed all over the sky in the magnitude range 10<B<22 mag. We called the generated catalogue the XPM.

Below we present some results of investigation of the XPM catalogue and information for possible users of the Catalogue. The XPM Catalogue will be available via CDS in Strasbourg in 2010.



The creation of the catalogue XPM is based mainly on the following three important procedures:

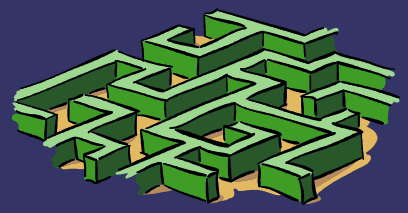
(i) cross-identification,allowed to identify and compare positions ofobjects in USNO-A2.0 and 2MASS;

(ii) reduction of systematic errors in the positions of USNOA2.0 objects and reference of the coordinates of all the USNO-A2.0 objects into the coordinate system defined by the 2MASS positions of stars in any particular field;

(iii) determination of the absolute proper motions of stars.

See: *Mon. Not. R. Astron. Soc. 393, 133–138 (2009)*

Mon. Not. R. Astron. Soc. 406, 1734–1744 (2010)



The XPM catalogue is an independent realization of the extragalactic reference system in optical and near infrared range, whose rate of rotation with respect to distant extragalactic objects is less than 1 mas/yr.

The XPM contains > 300 millions objects, including stars, galaxies and other entries.

The positions in the XPM are referred to the International Celestial Reference System (ICRS) for the J2000 epoch as far as the positions of stars from the 2MASS catalogue are given in this system.

The absolute proper motions of XPM cover the whole sky without gaps, including the areas which are named the zone of avoidance. In the fields, which cover the zone of avoidance or which contain less than of 25 galaxies the so-called quasi absolute calibration was performed.

The zero-point of the absolute proper motion frame (the absolute calibration) was derived by using more than 1 million galaxies from 2MASS and USNO-A2.0.

The formal error of absolute calibration is $\varepsilon = \sigma / (\Delta T \sqrt{N}) =$ *0.3 mas/ yr for the northern hemisphere and 1 mas/ yr for the southern one. The rms error of proper motions varies from 3 to 10 mas/ yr.*

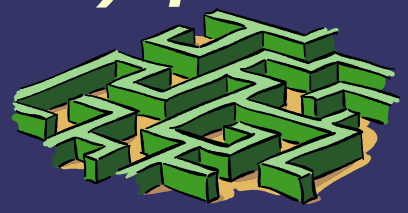
Photometry of theXPM

Magnitudes of stars have been taken from:

USNO-A2.0 10m < B < 22m B (0.35-0.54), R(0.61-0.69) μm

USNO-B1 B (0.35-0.54), R (0.61-0.69) μ, I (0.715-0.90) μm

2MASS 9 m < J < 17m J (1.15), H (1.65), K (2.15) μm

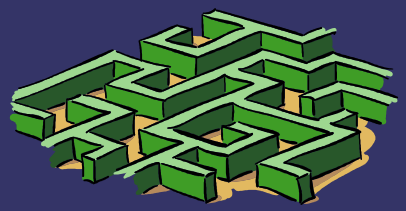


The investigation of absolute proper motions of the XPM Catalogue

The XPM external comparisons

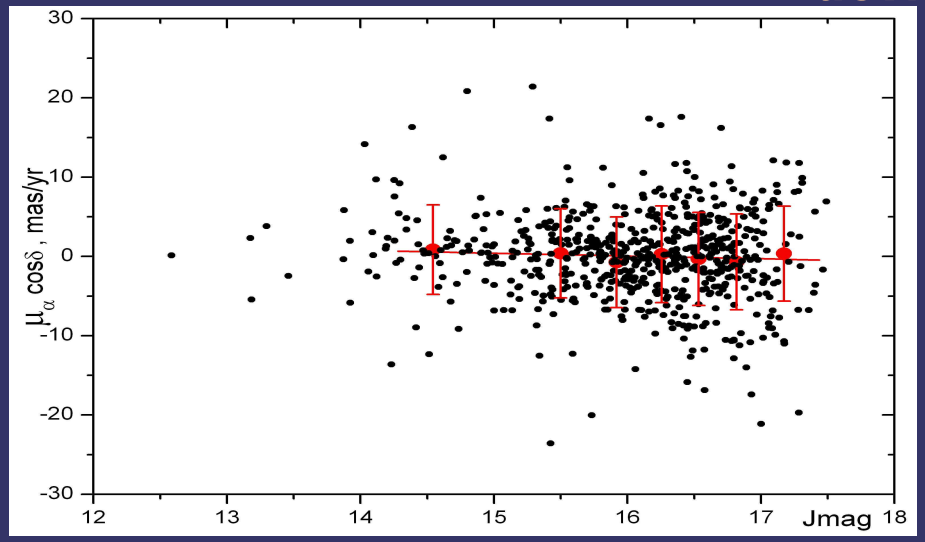
In order to estimate the XPM 'external' errors, various comparisons were performed:

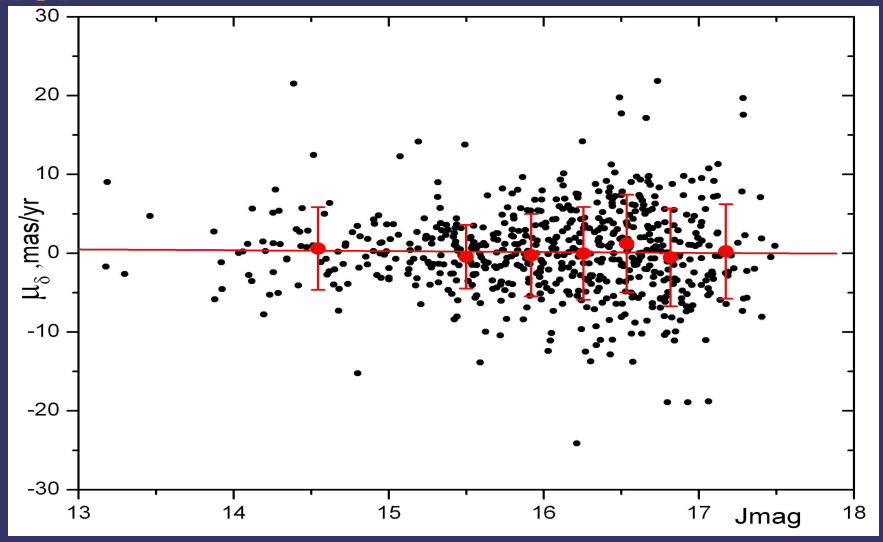
- *1. Scatter of individual formal proper motions of the ICRF2 sources,the LQAC quasars and galaxies as a function of magnitude J was studied;*
- *2. Comparison of the XPM proper motions with other catalogues:*
- *(i) The individual differences of proper motions of stars*
- *in the selected fields were calculated.*
- *(ii) The systematic differences of proper motions as well*
- *as their dispersions, depending on the magnitude were computed.*

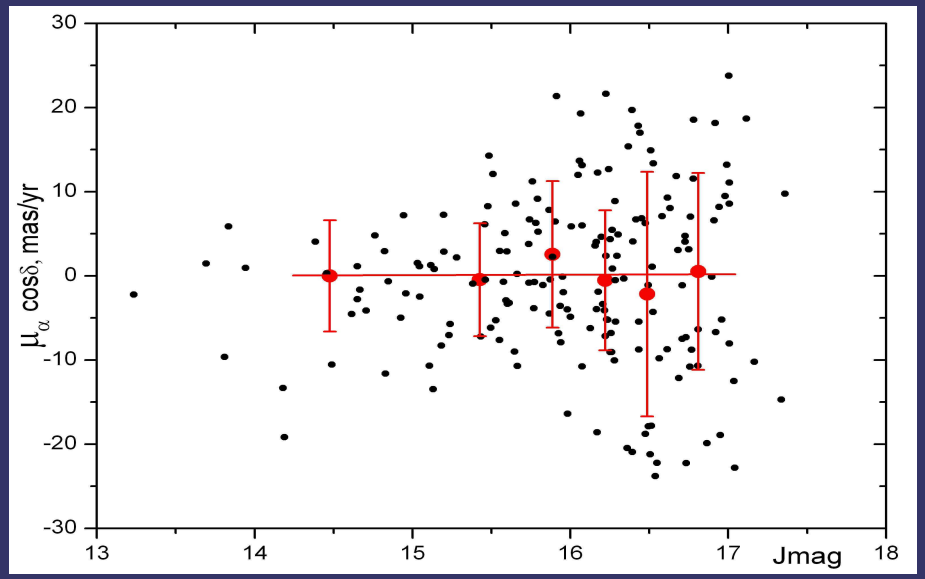


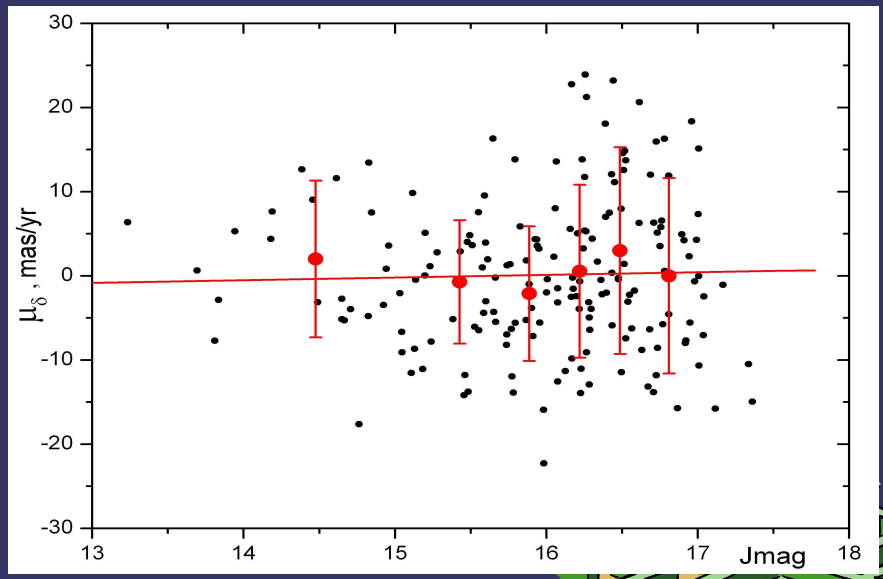
Mon. Not. R. Astron. Soc. 393, 133–138 (2010)

Scatter of individual formal proper motions μRAcosδ (left) and μDec (right) of optical counterparts of ICRF2 sources (C. Ma et al., 2009) as a function of magnitude J. Top panels: Northern hemisphere. Bottom panels: Southern hemisphere. The red solid circles and lines show the mean values and standard deviations.



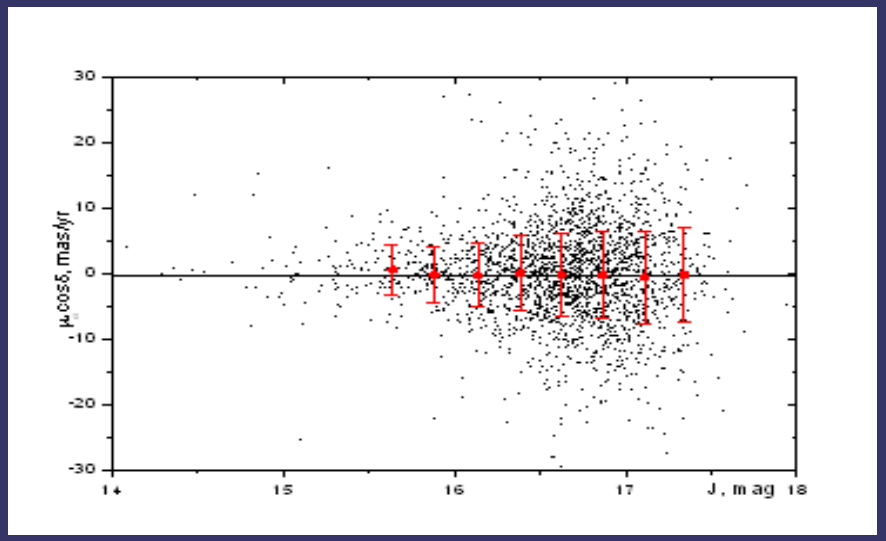


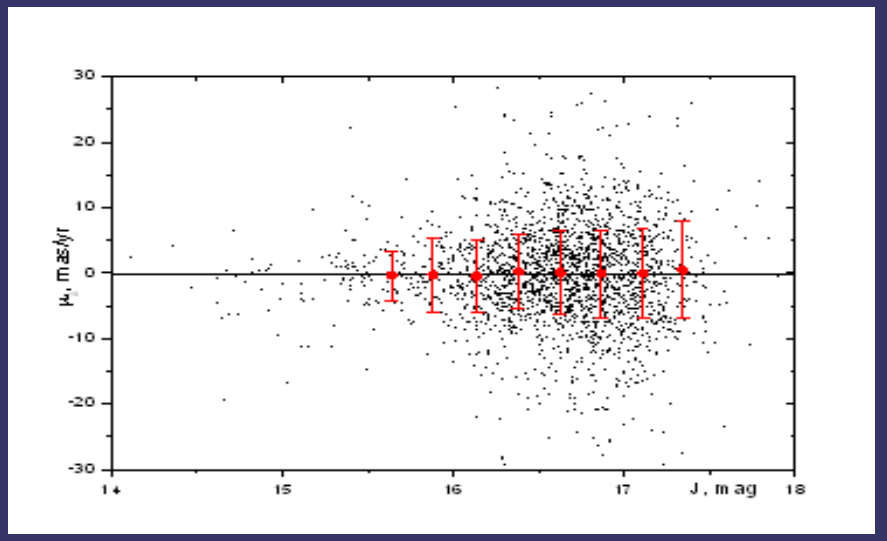


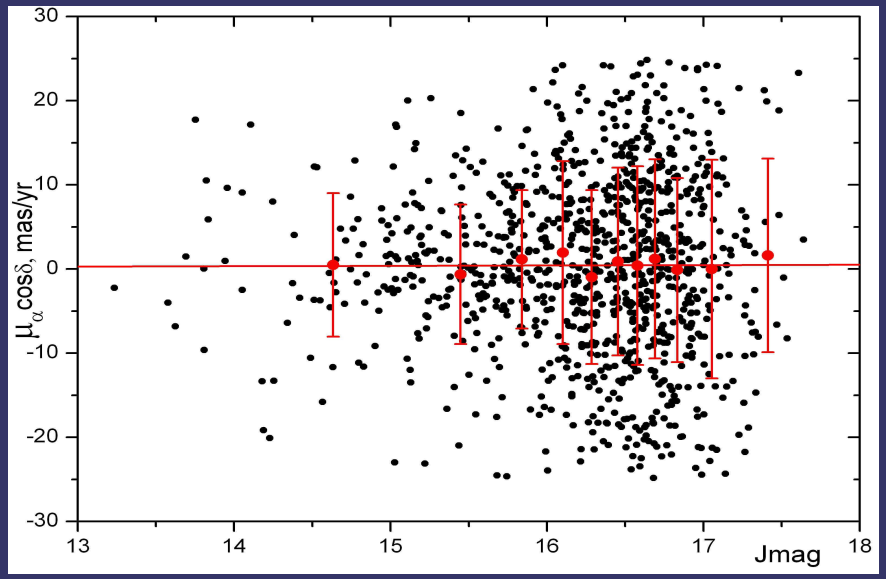


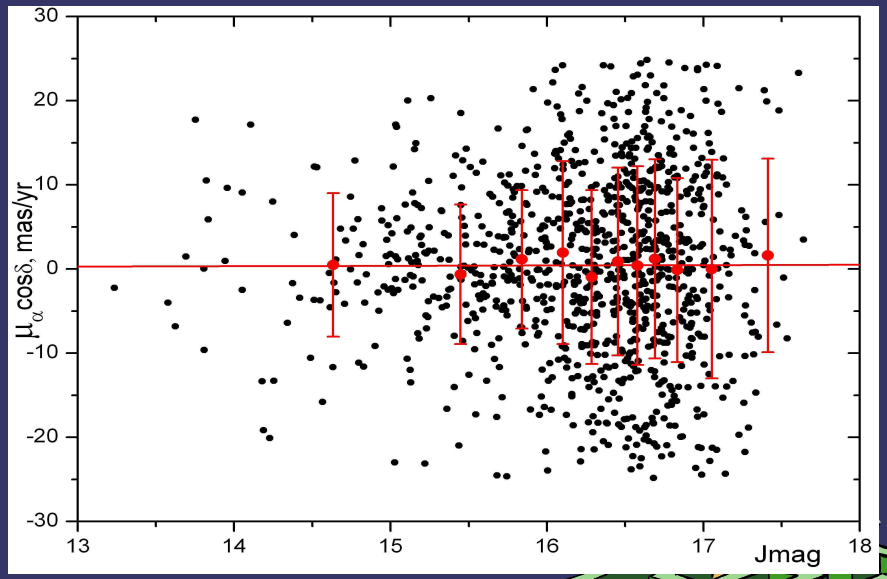
The mean value of formal proper motions of ICRF2 sources are less than 0.2 mas/yr for μRAcosδ and μDec, respectivelly. The standard deviations of μRAcosδ and μDec are estimated to be approximately from 4 -7.5 mas/yr (north) to 6 -10 mas/yr (south)

Scatter of individual formal proper motions μRAcosδ (left) and μDec (right) of LQAC quasar (J. Souchay et al., 2009) as a function of magnitude J. Top panels: Northern hemisphere. Bottom panels: Southern hemisphere. The red solid circles and lines show the mean values and standard deviations.



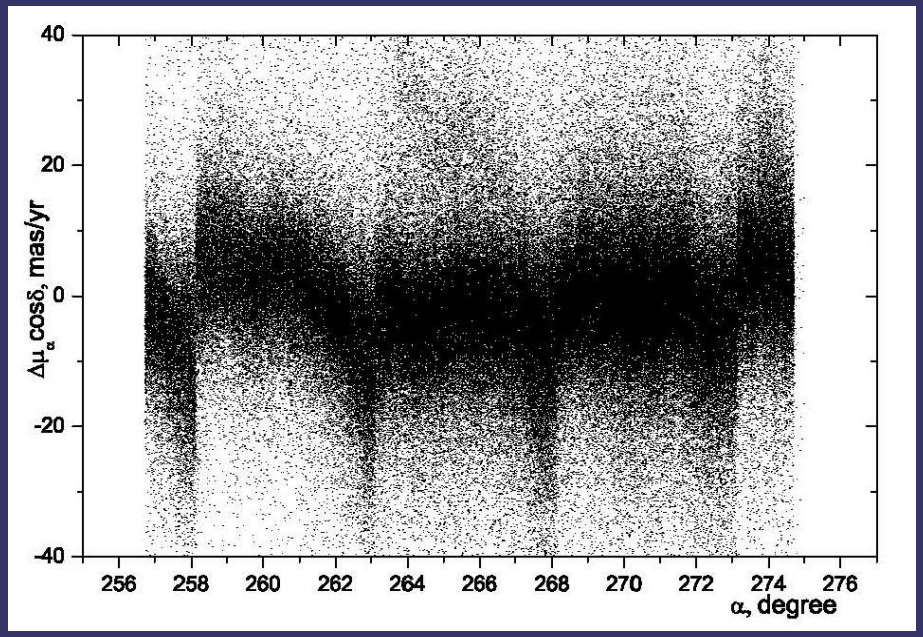




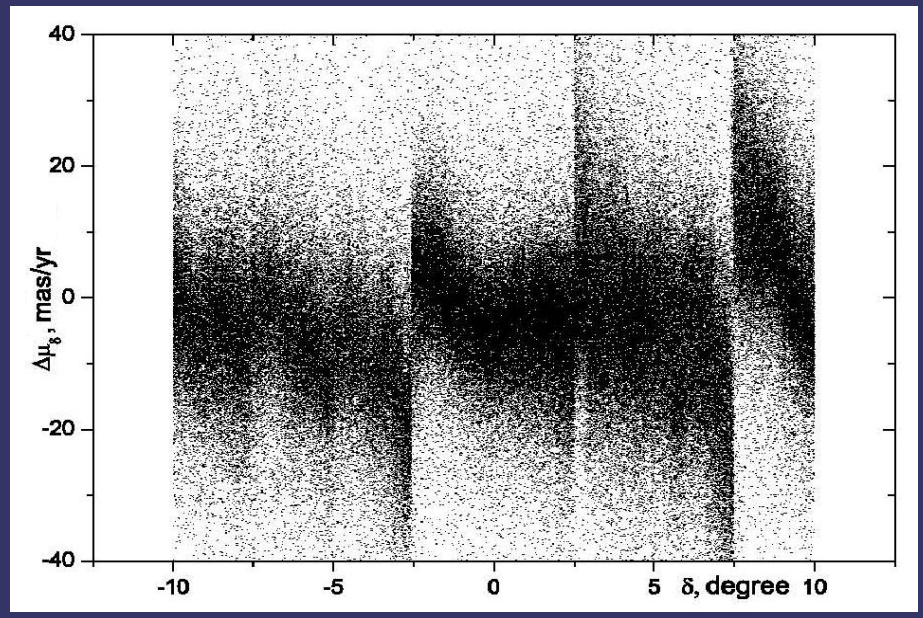


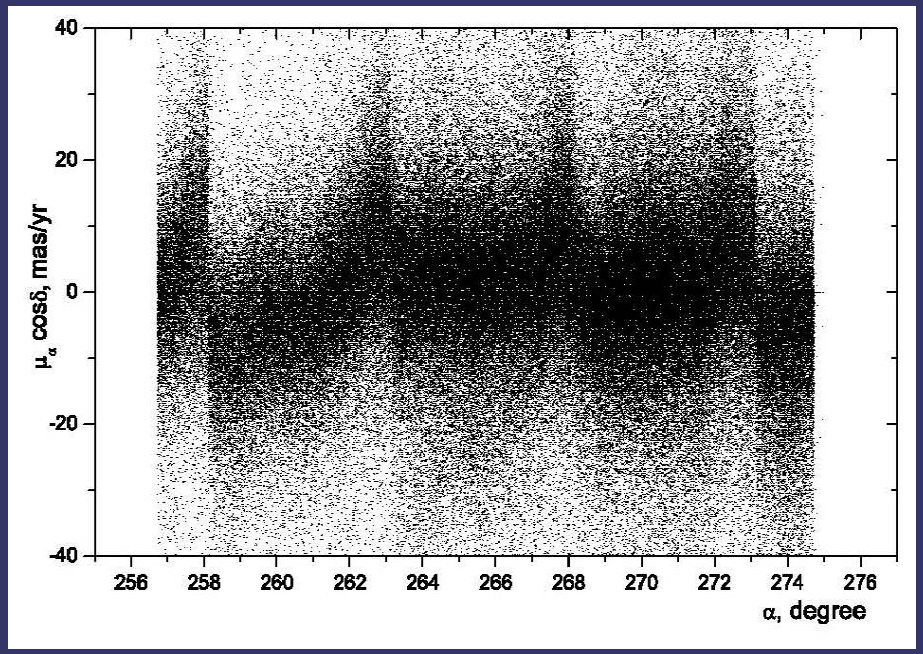
The mean value of formal proper motions of LQAC sources are less than 0.2 mas/yr for μRAcosδ and μDec, respectivelly. The standard deviations of μRAcosδ and μDec are estimated to be approximately from 3 -8 mas/yr (north) to 7 -12 mas/yr (south)

The individual differences of proper motions of stars (XPM - UCAC-3.0) in selected fields as a function of RA end Dec

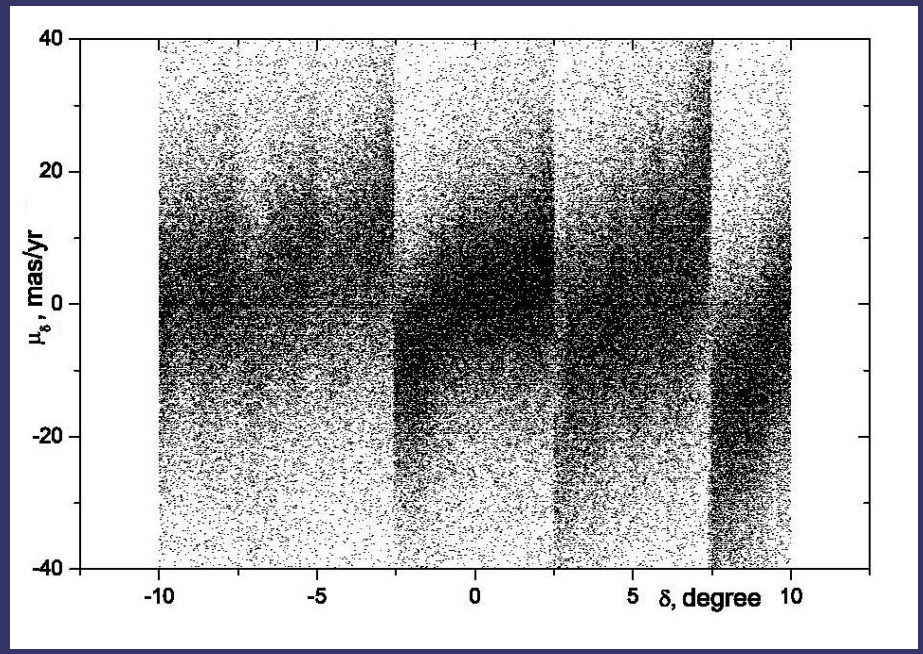


XPM - UCAC-3.0





UCAC-3.0



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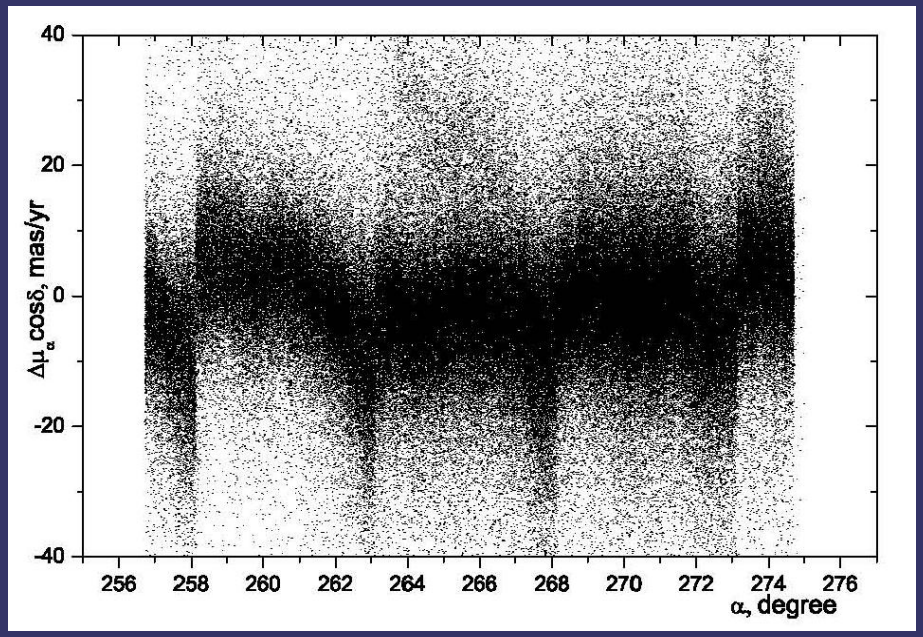
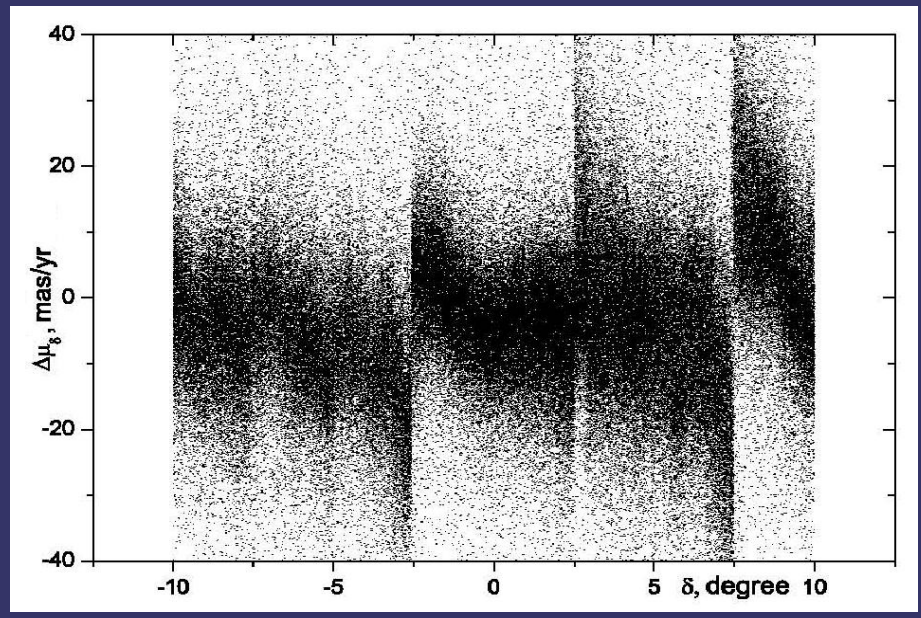
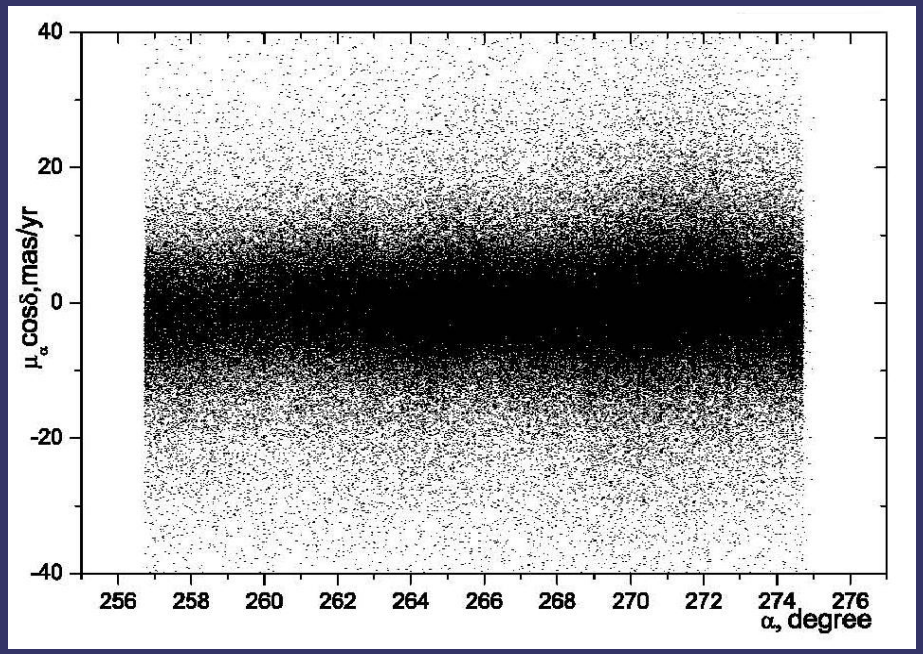
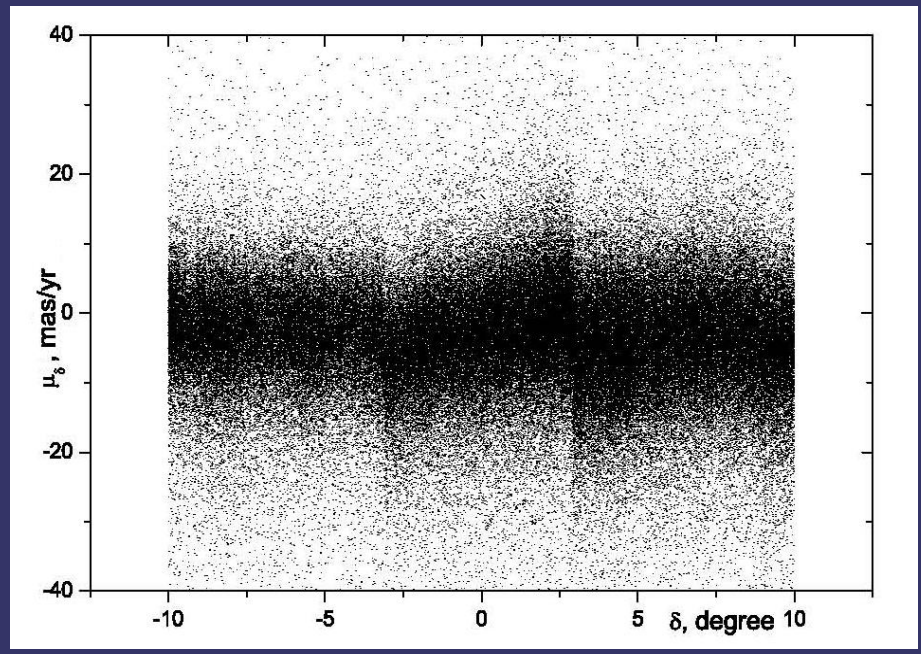


XPM - UCAC-3.0

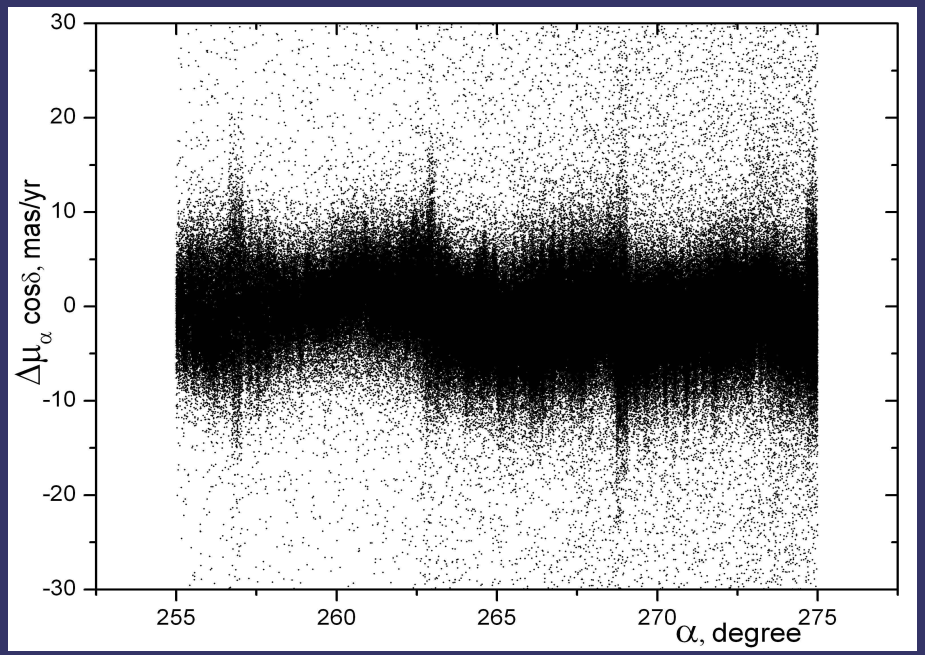


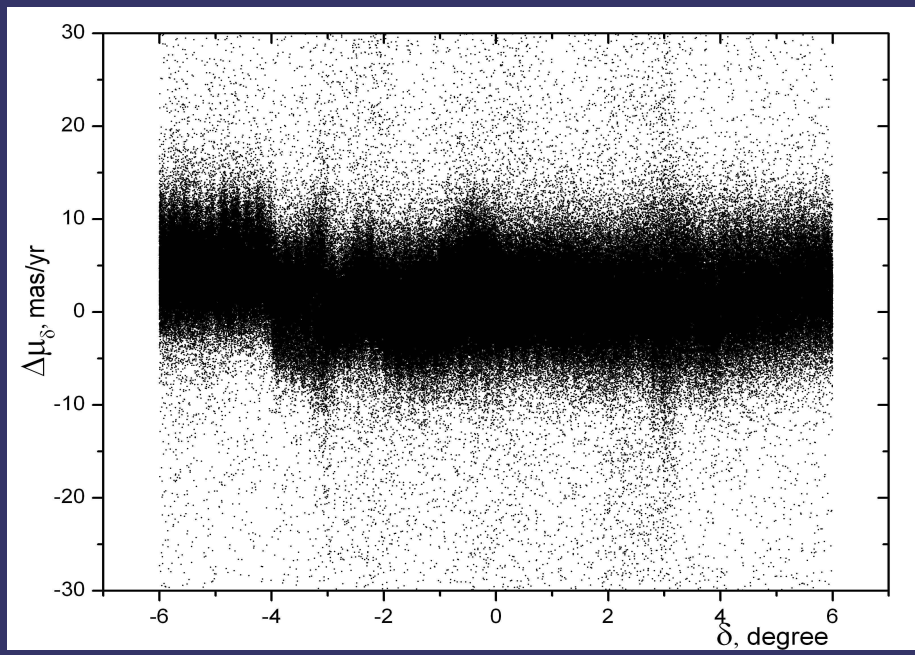


XPM

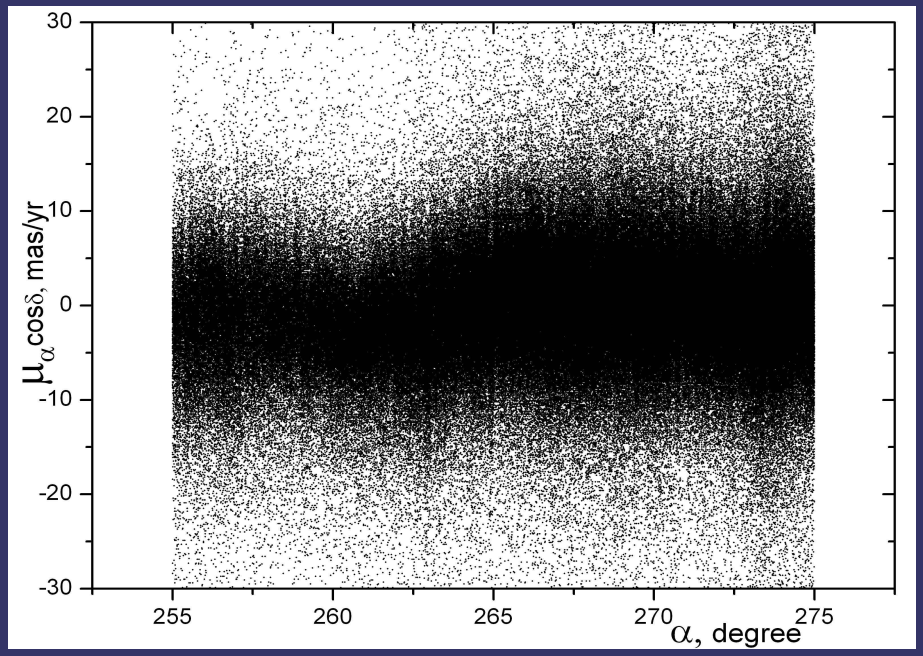


The individual differences of proper motions of stars XPM — PPMXL (S. Roeser, M. Demleitner and E. Schilbach al. 2010) in selected fields as a function of RA end Dec

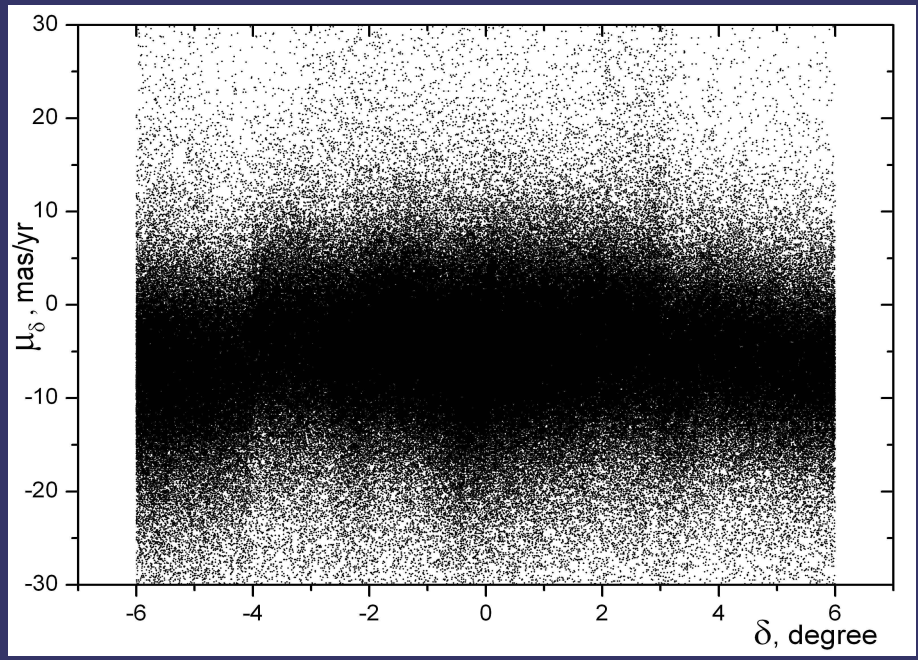




XPM - PPMXL



PPMXL



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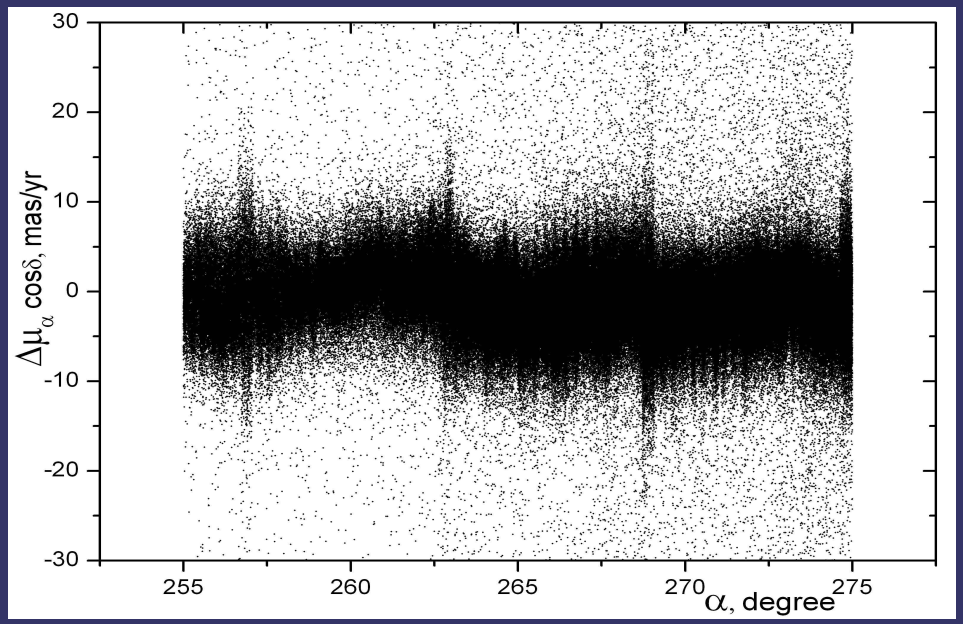
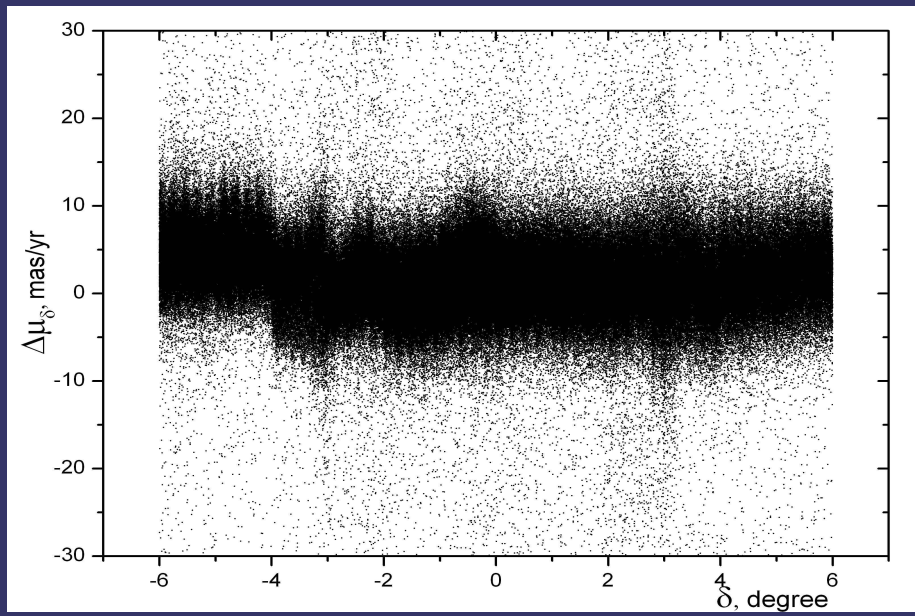
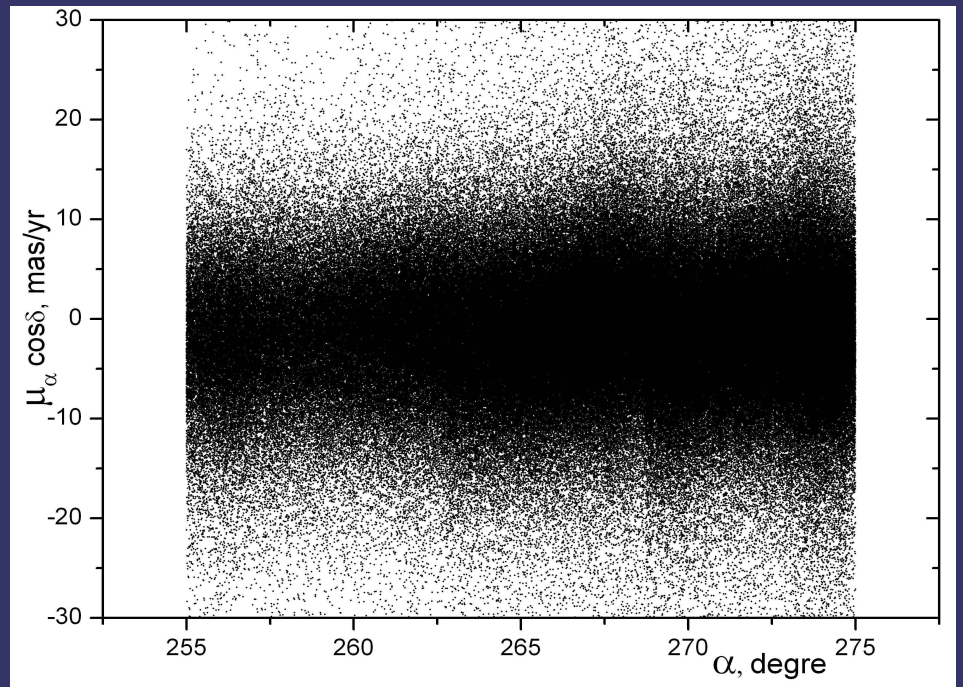
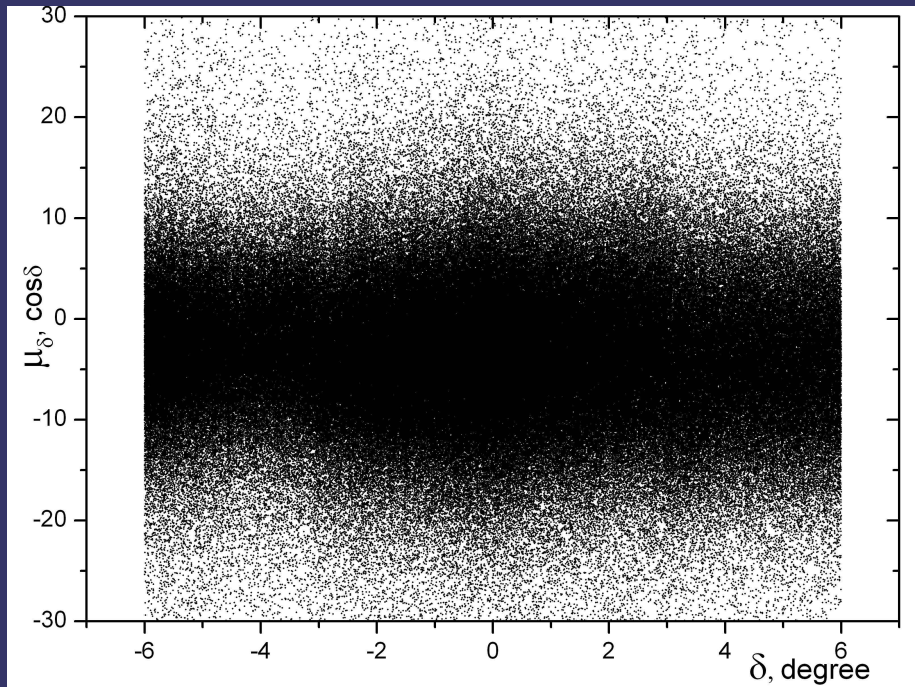


XPM - PPMXL

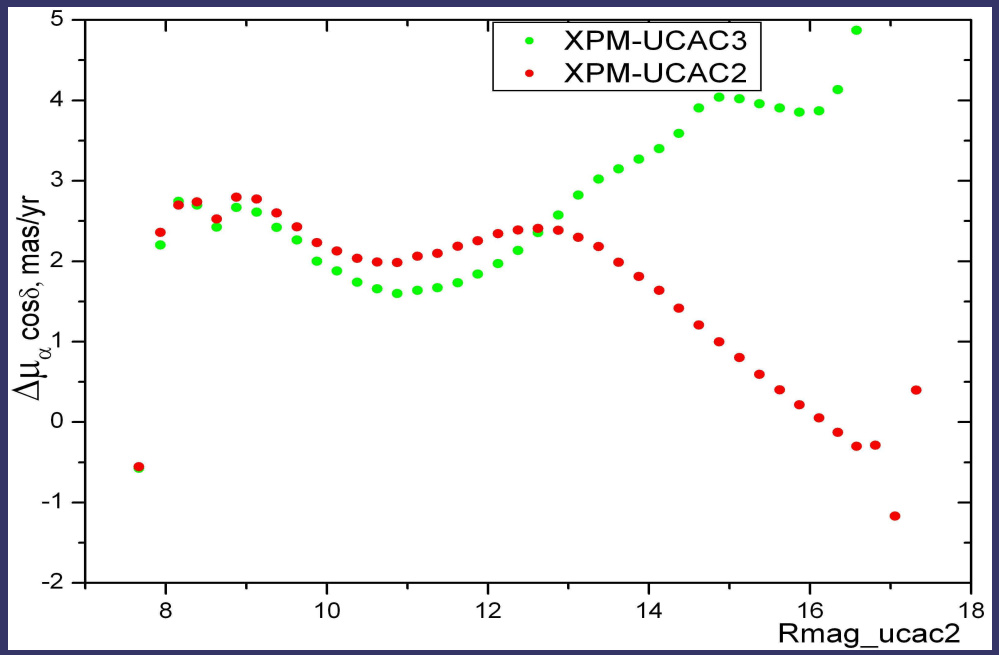


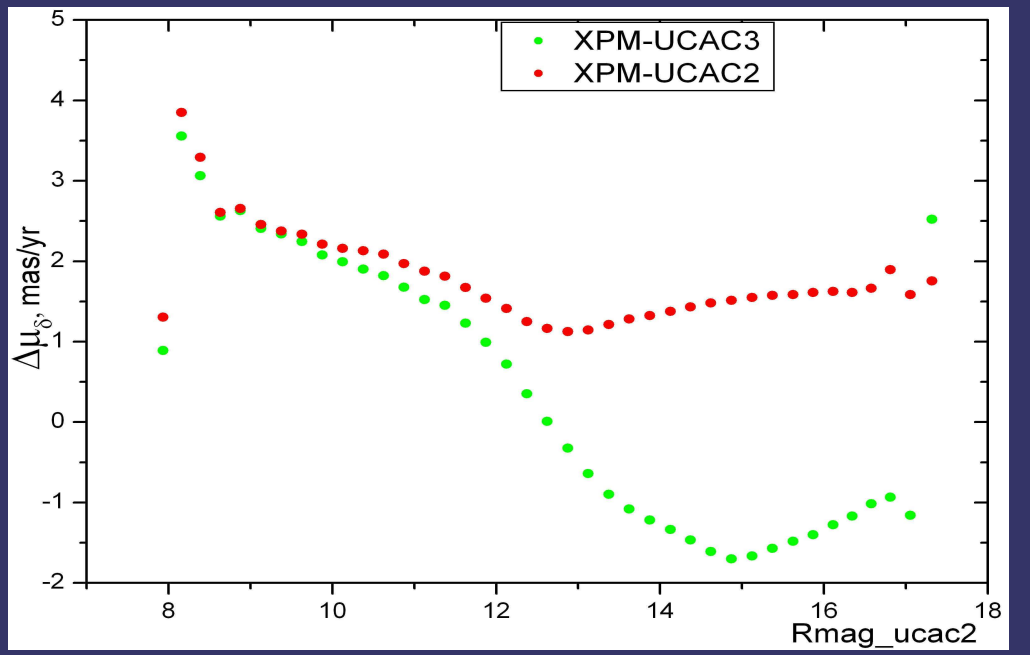


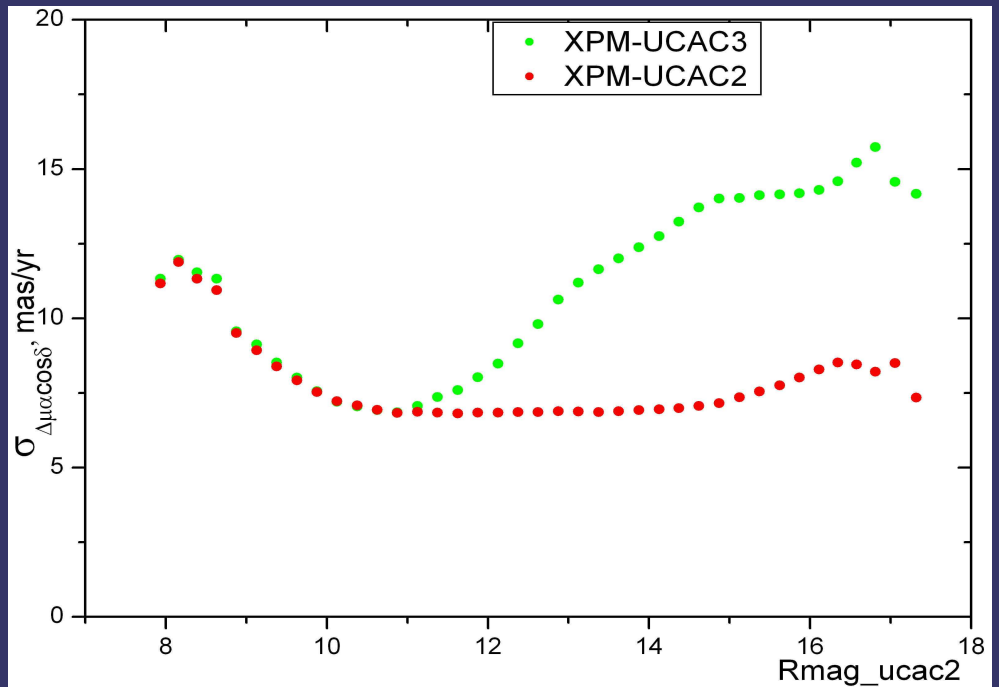
XPM

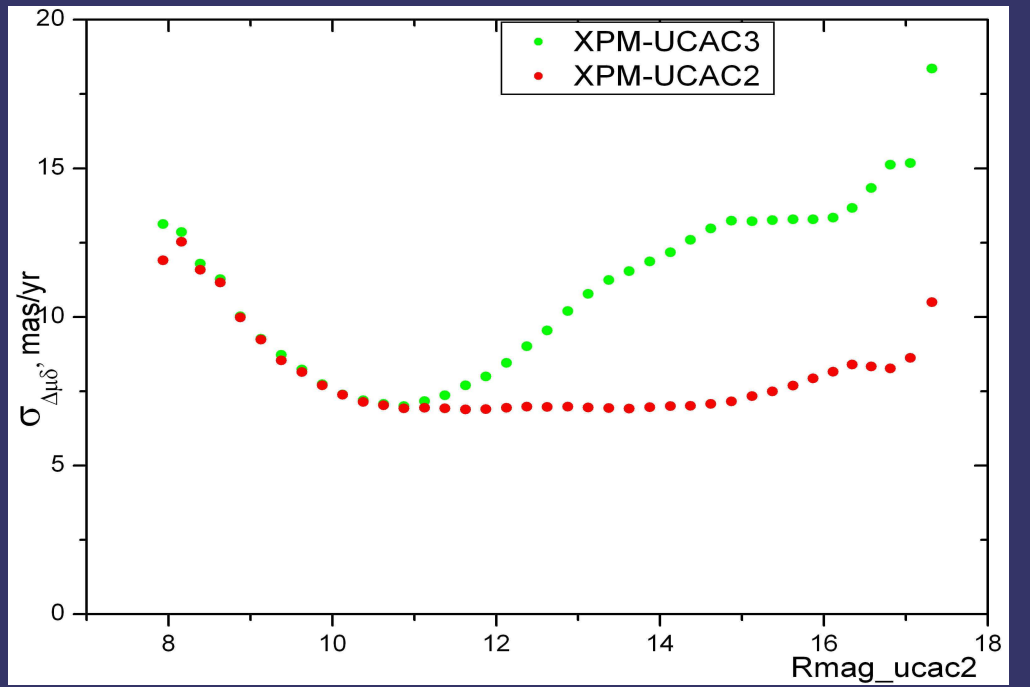


The systematic differences of proper motions and their standard deviations (XPM - UCAC-3.0, XPM - UCAC-2.0) in the northern hemisphere as a function of magnitude R UCAC−2.0

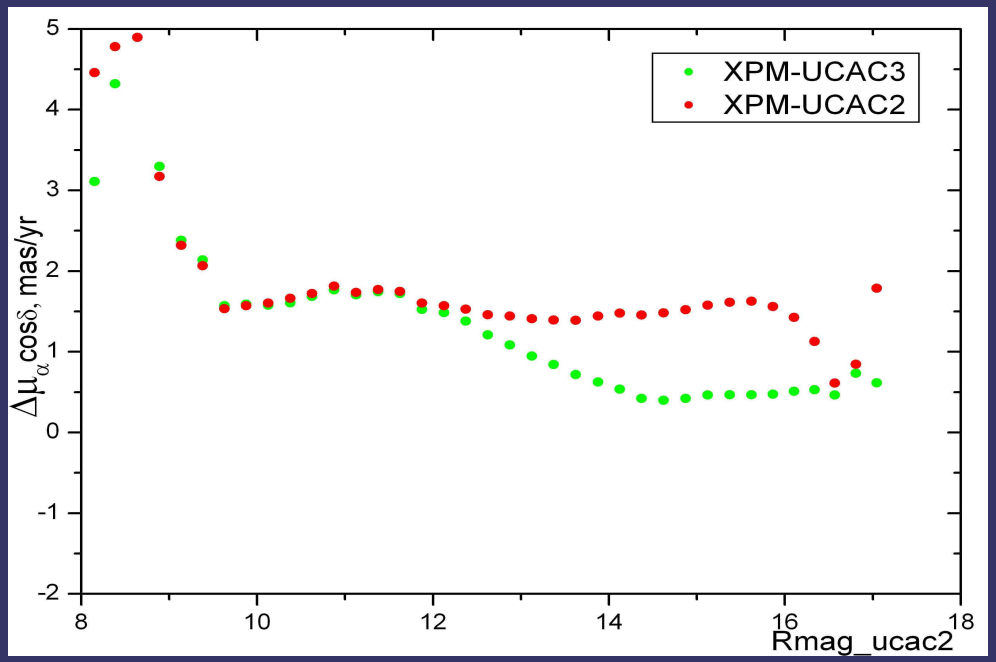


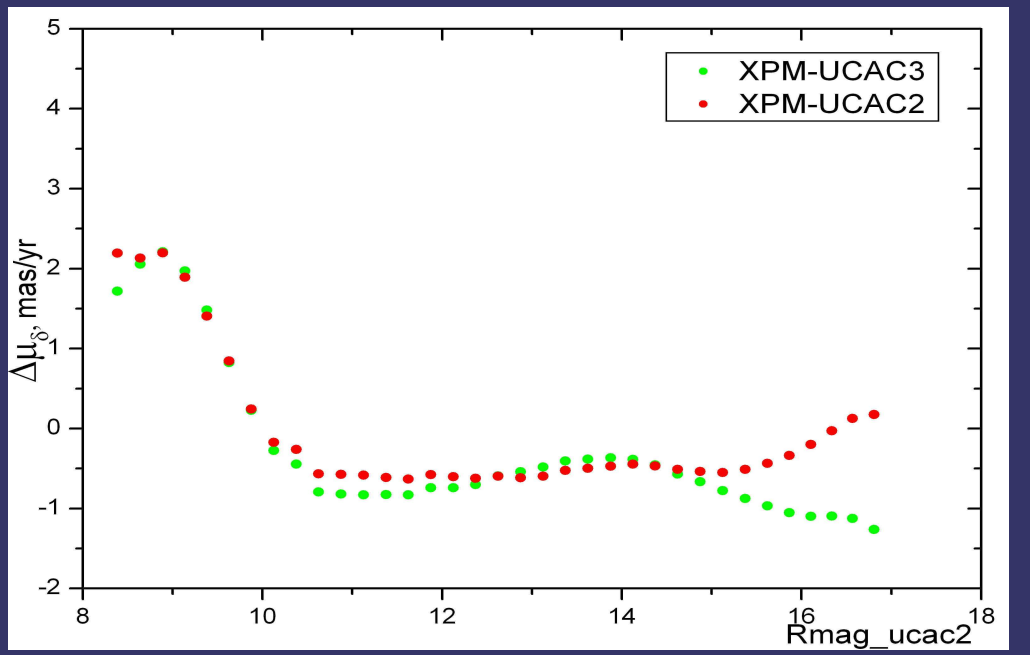


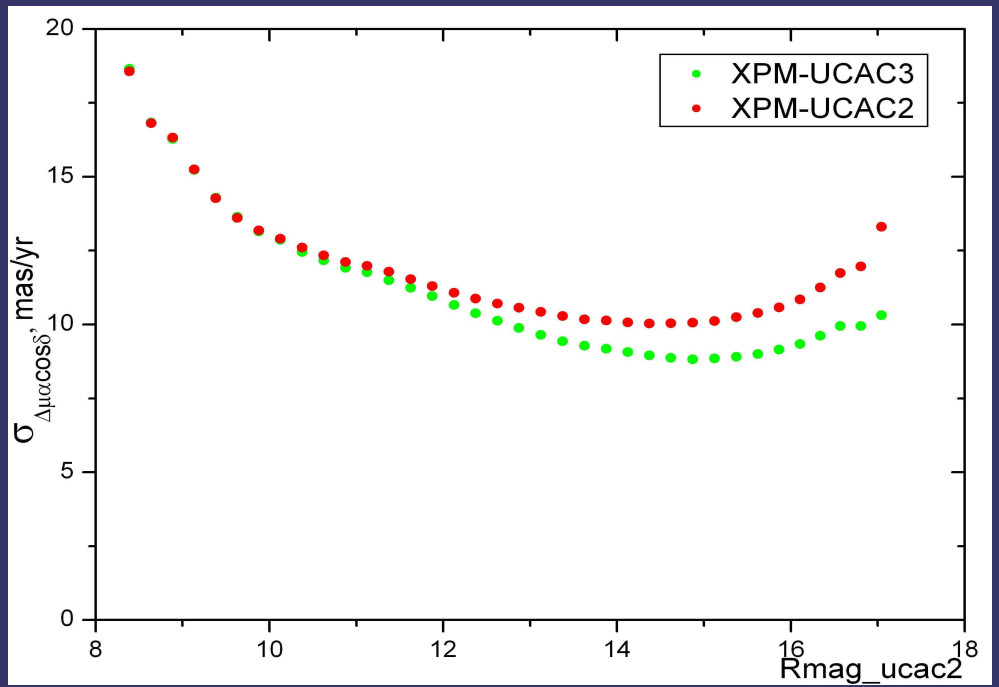


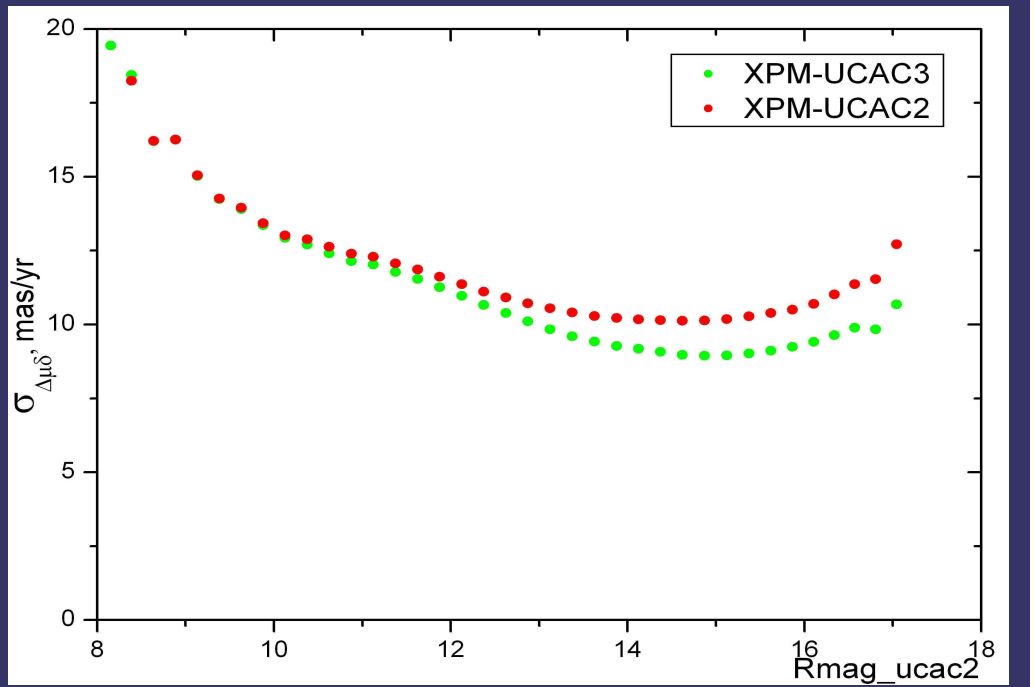


The systematic differences of proper motions and their standard deviations (XPM - UCAC-3.0, XPM - UCAC-2.0) in the southern hemisphere as a function of magnitude R UCAC−2.0

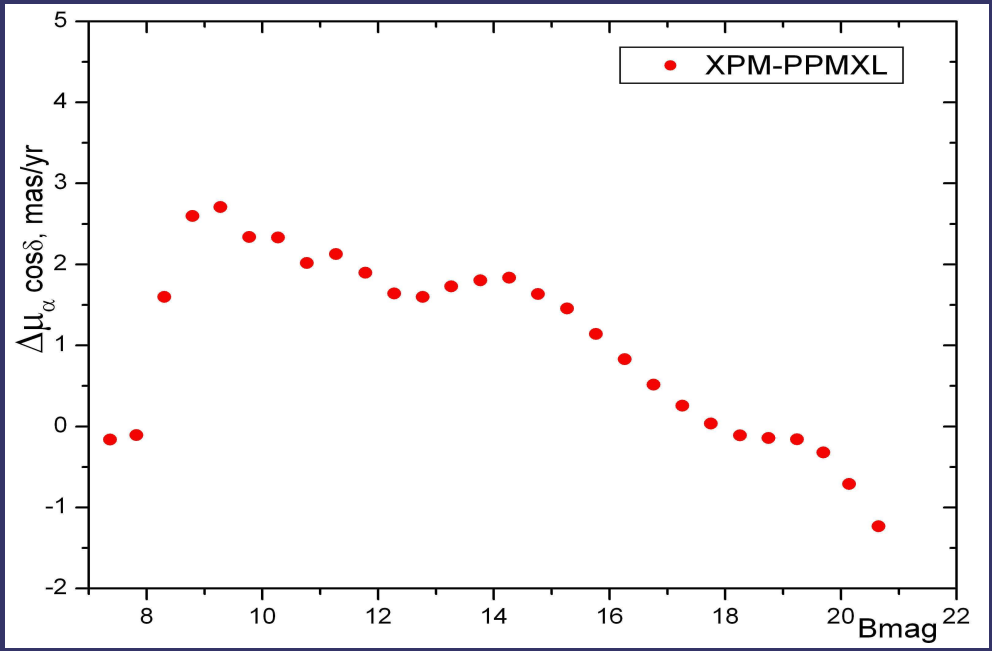


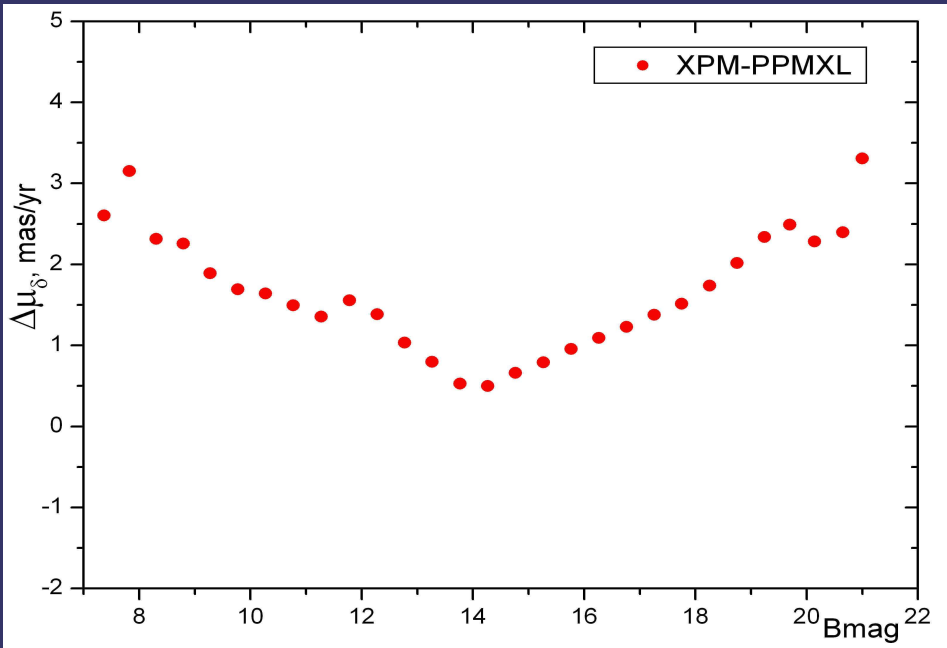


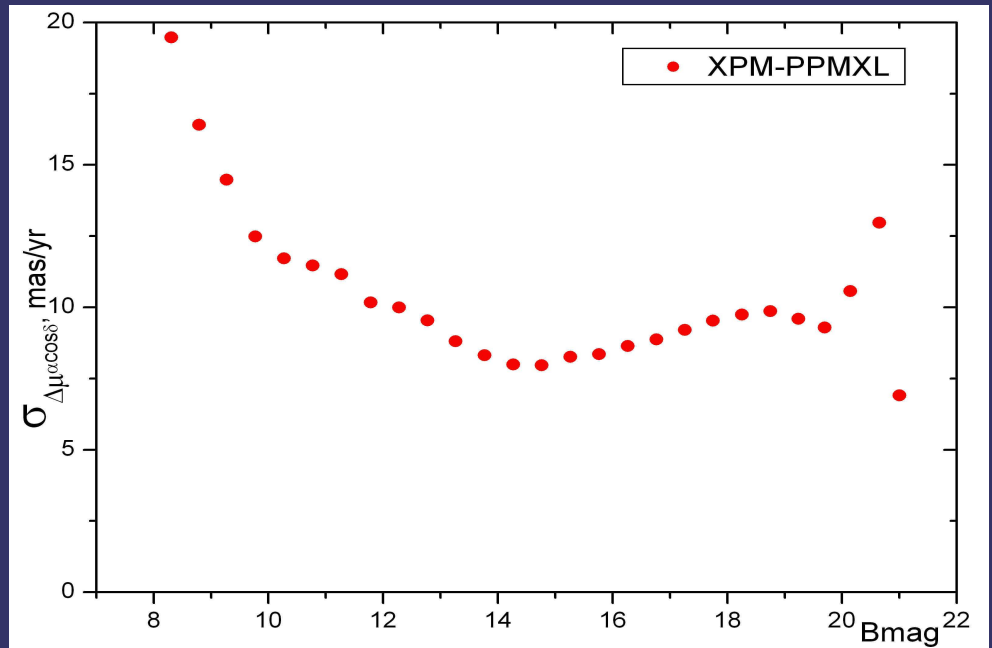


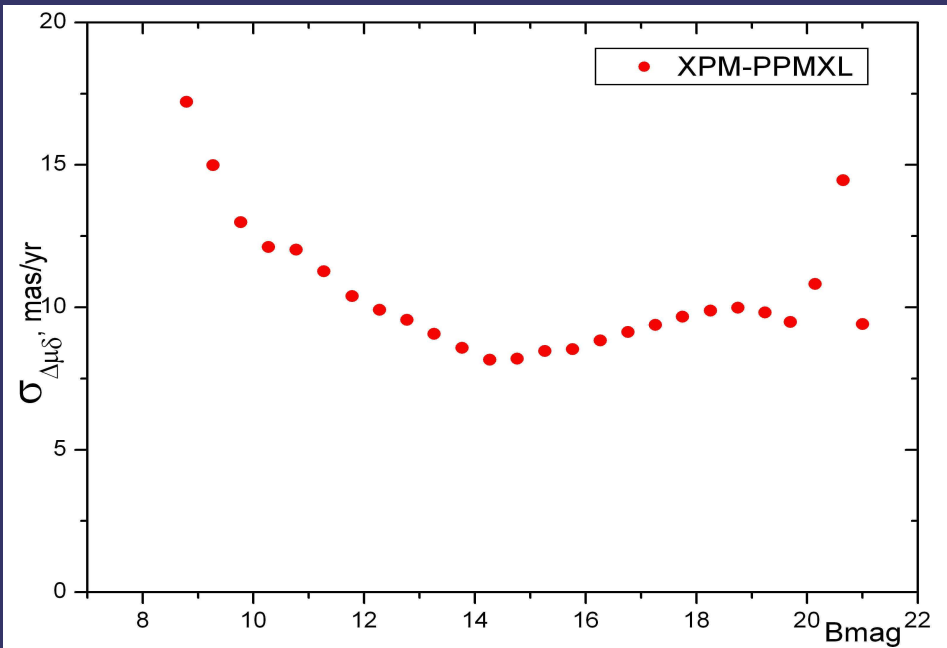


The systematic differences of proper motions and their standard deviations (XPM - PPMXL) in the northern hemisphere as a function of magnitude B

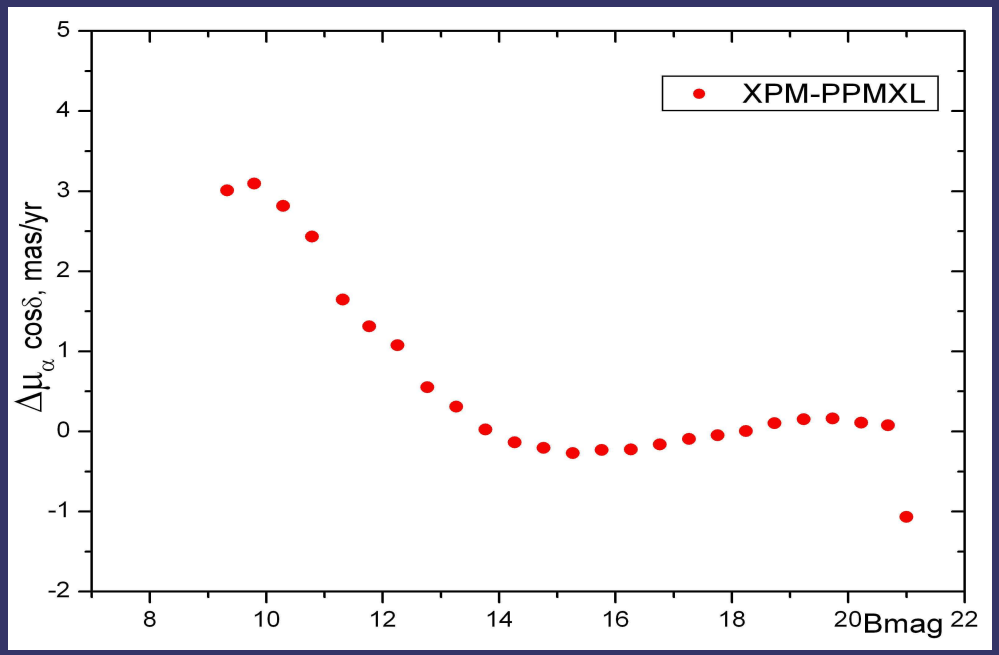


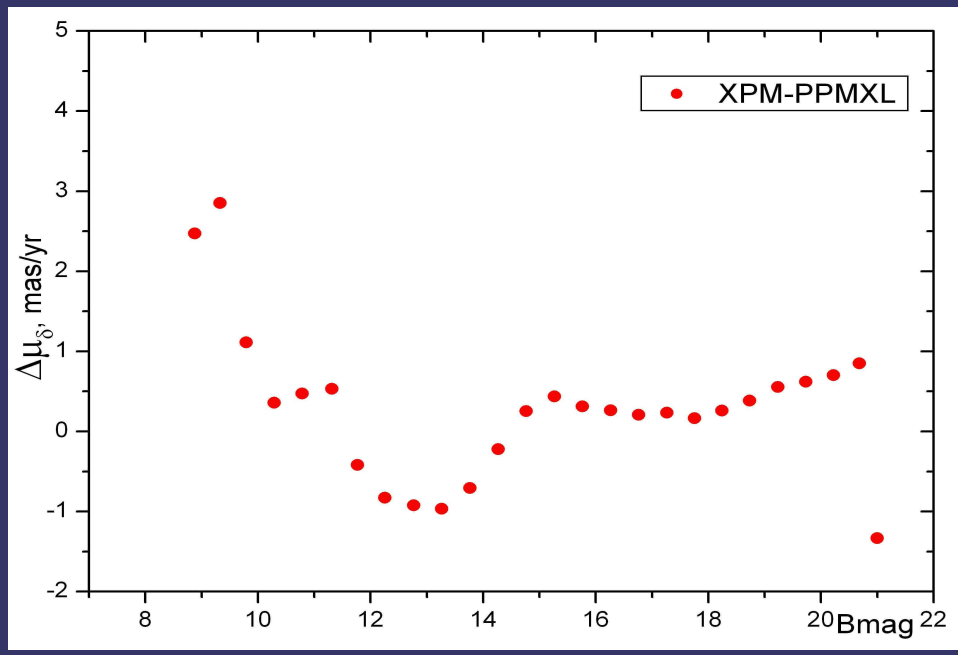


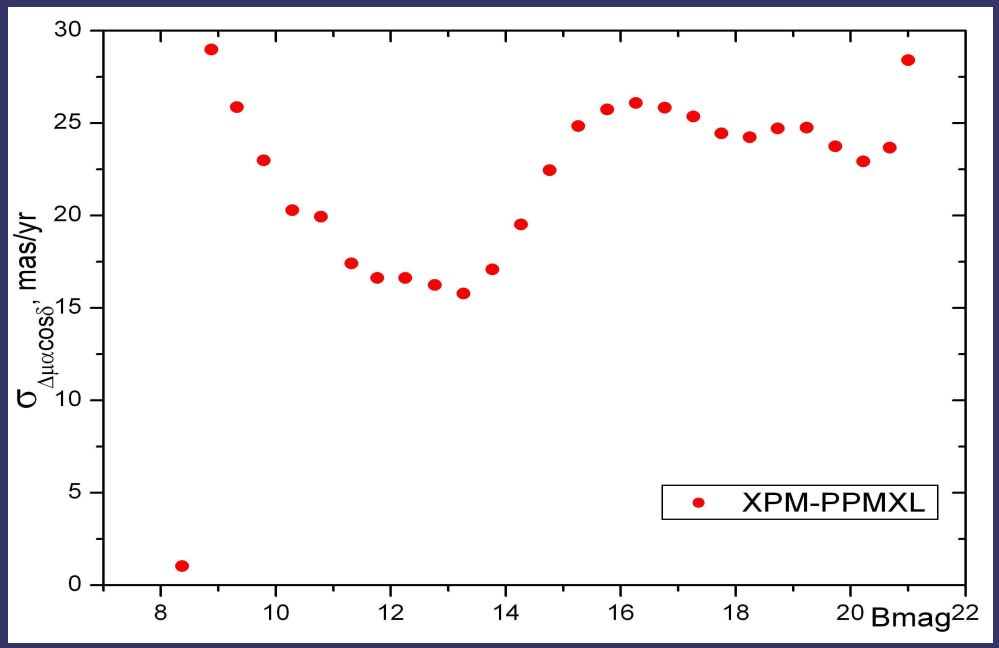


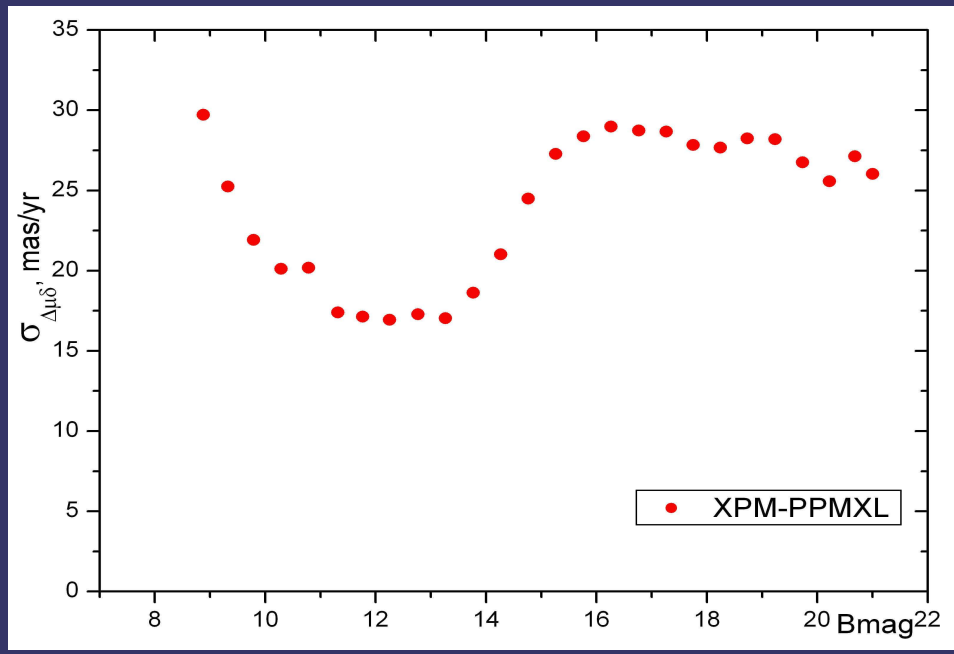


The systematic differences of proper motions and their standard deviations (XPM - PPMXL) in the southern hemisphere as a function of magnitude B









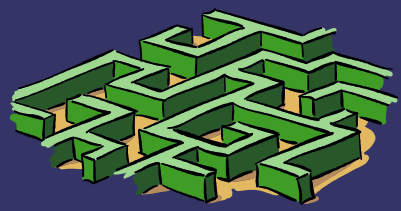
Estimate of the accuracy of the positions and proper motions in three independent sets of date

$$D_{12}^2 = \varepsilon_1^2 + \varepsilon_2^2 = < \Delta\mu_{12}^2 >$$
$$D_{13}^2 = \varepsilon_1^2 + \varepsilon_3^2 = < \Delta\mu_{13}^2 >$$
$$D_{23}^2 = \varepsilon_2^2 + \varepsilon_3^2 = < \Delta\mu_{23}^2 >$$

XPM, NPM1, KSZ, PUL2, UCAC2

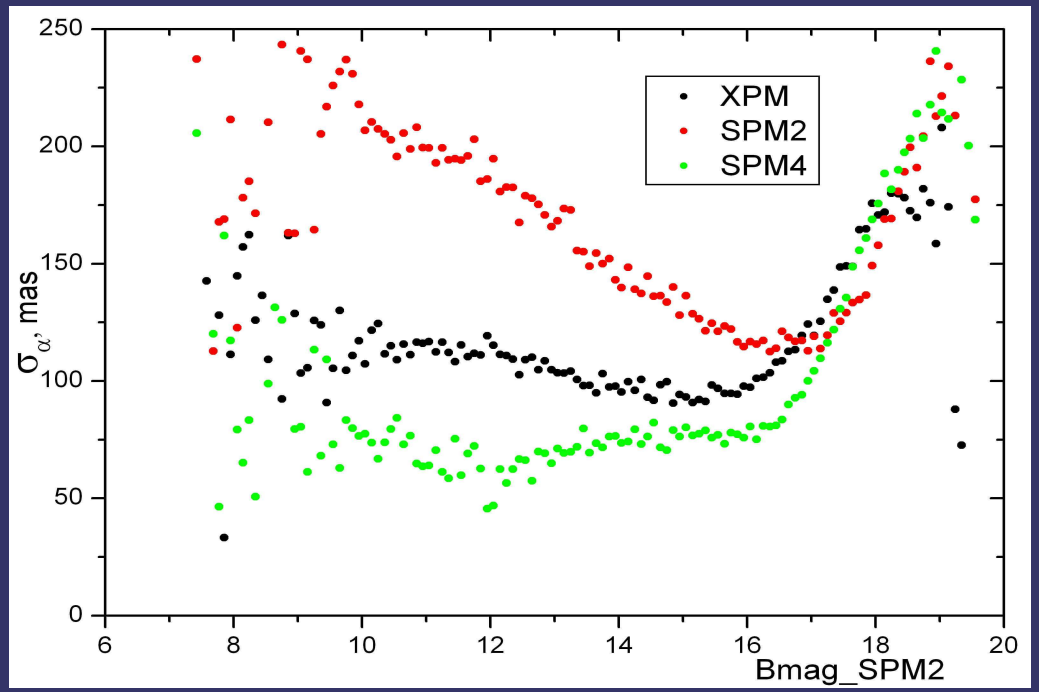
$$\varepsilon_1^2 = 0.5(D_{12}^2 + D_{13}^2 - D_{23}^2)$$
$$\varepsilon_2^2 = 0.5(D_{12}^2 + D_{23}^2 - D_{13}^2)$$
$$\varepsilon_3^2 = 0.5(D_{13}^2 + D_{23}^2 - D_{12}^2)$$

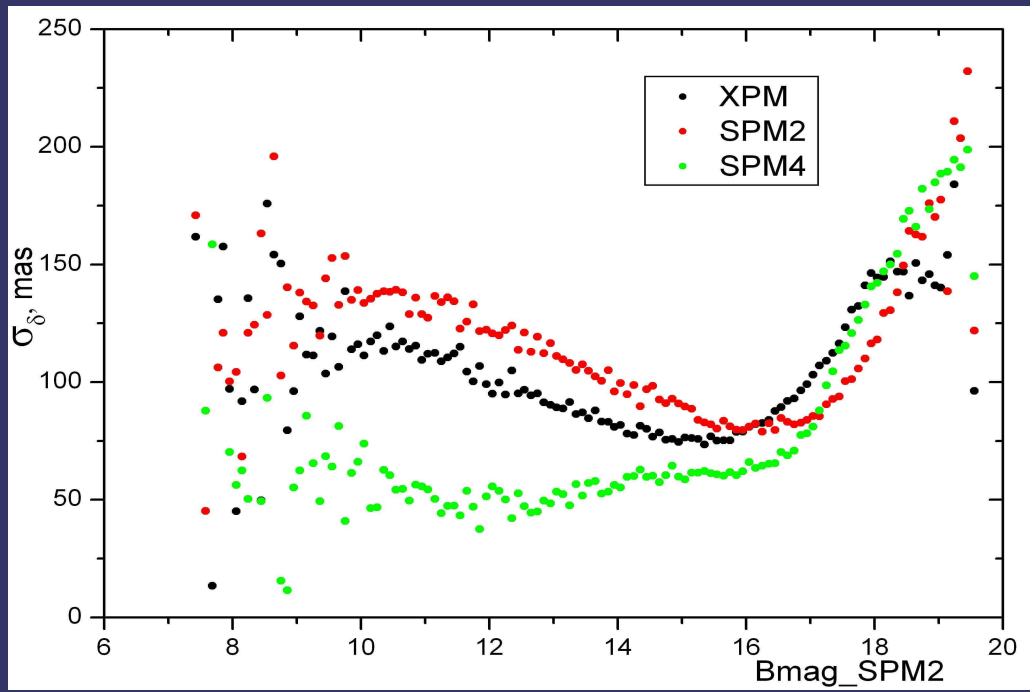
XPM, SPM2, SPM4, UCAC2

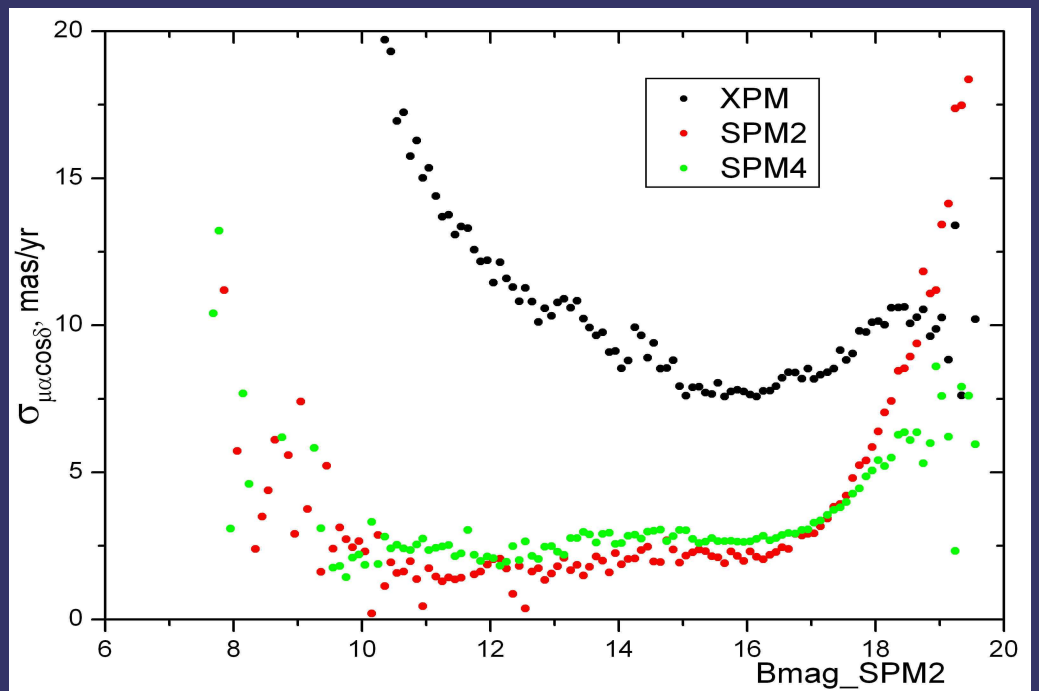


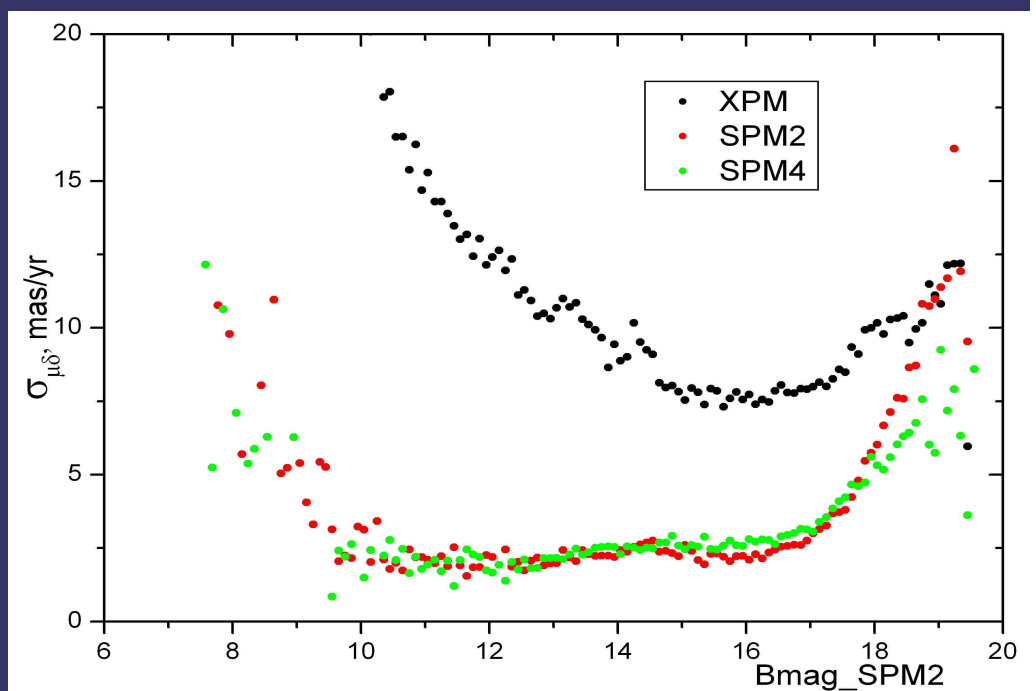
R. Wielen. A method for determining the individual accuracy of astrometric catalogues. Astronomy and Astrophysics, 302, 613-622 (1995).

Estimate of the accuracy of the positions and proper motions in three independent sets: XPM, SPM2 and SPM4

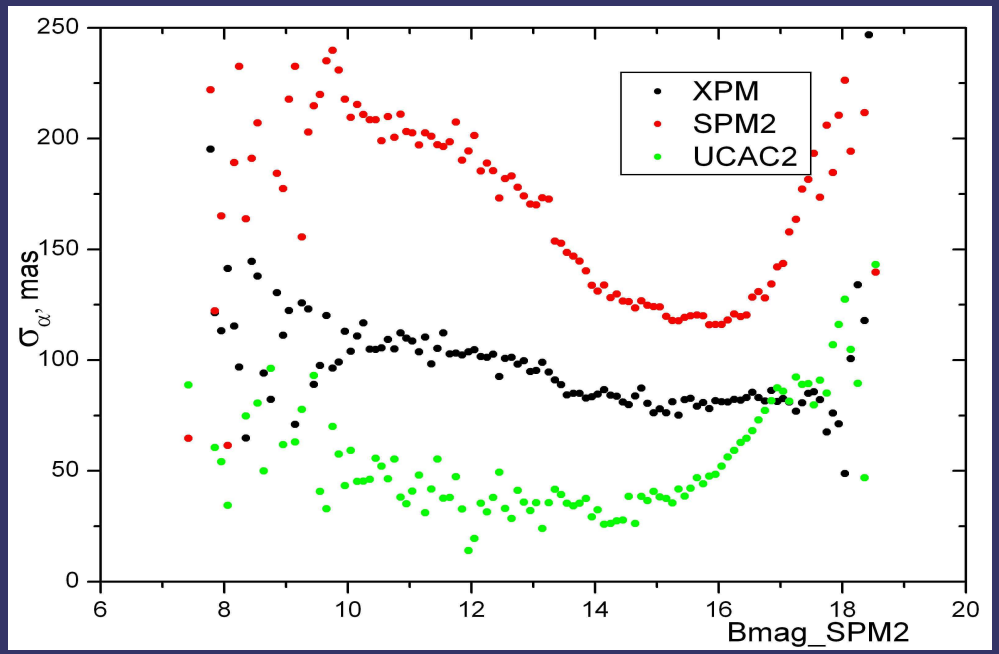


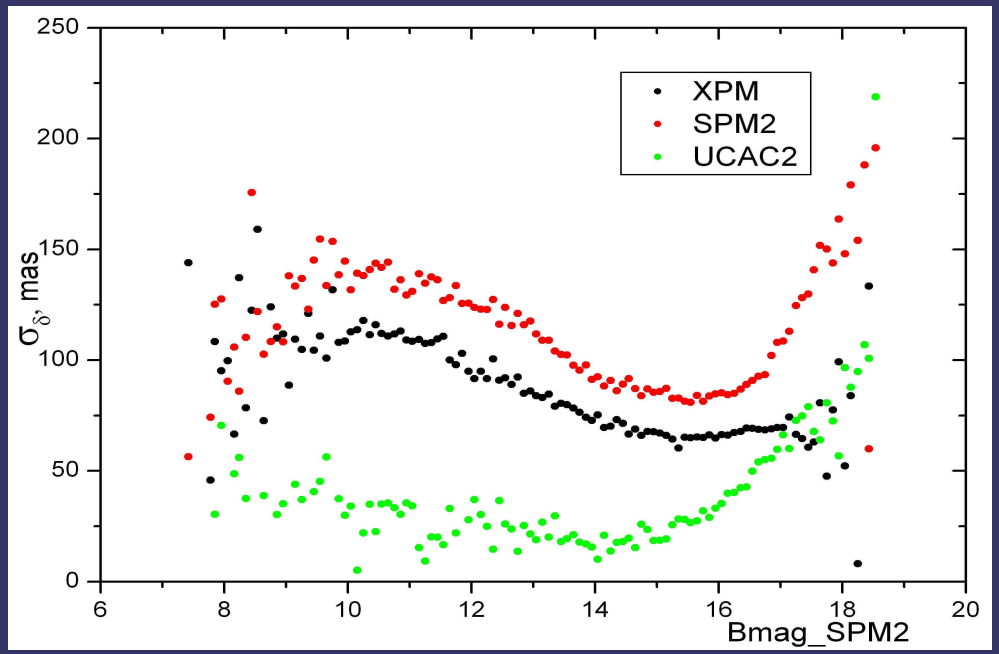


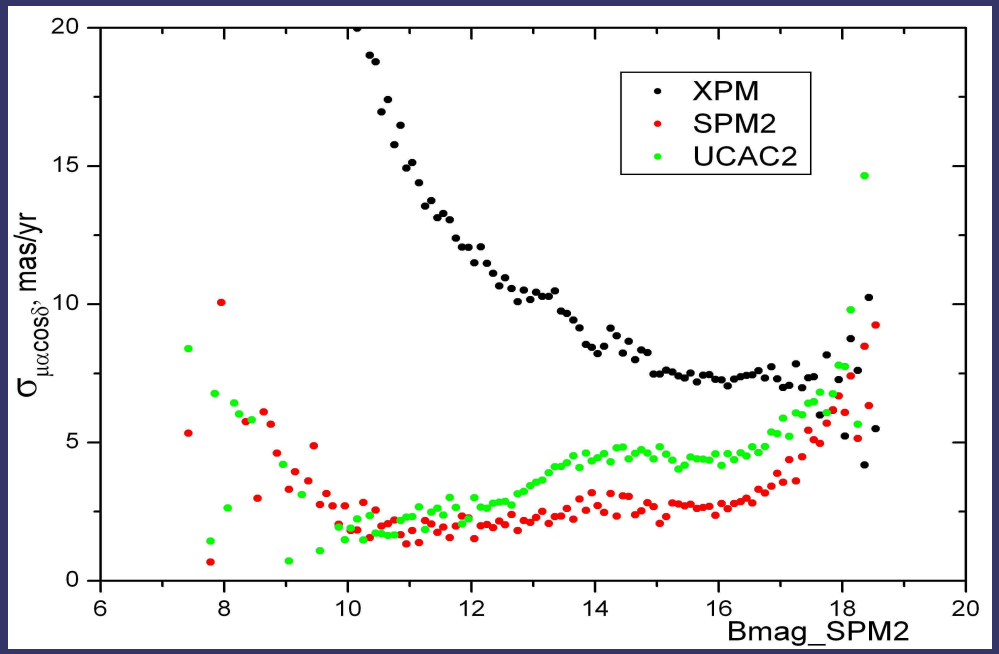


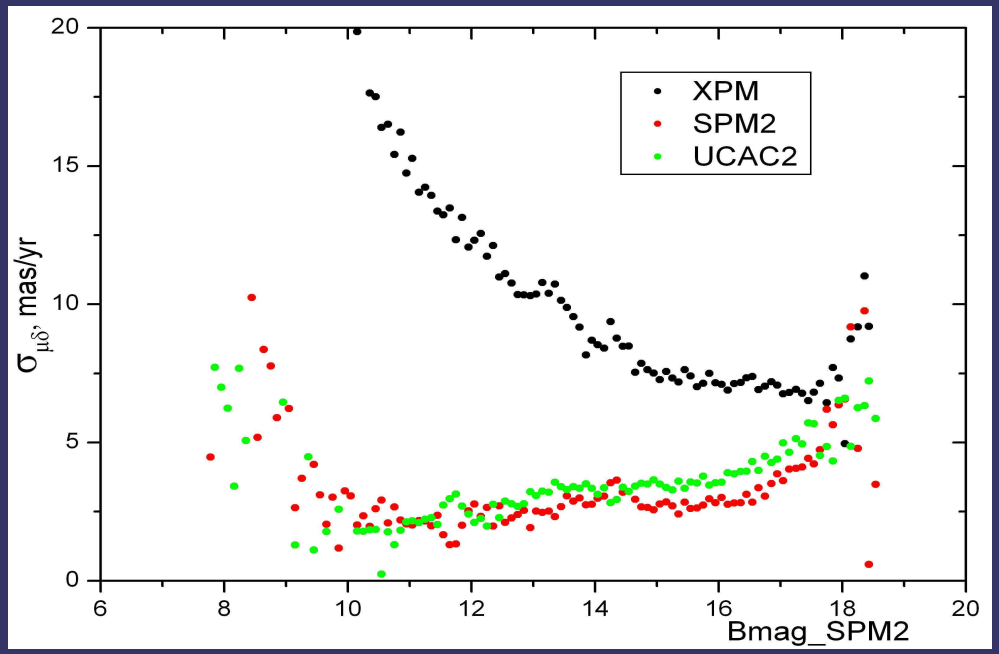


Estimate of the accuracy of the positions and proper motions in three independent sets: XPM, SPM2 and UCAC2



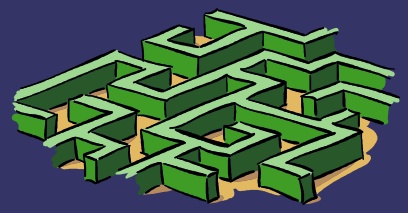






Summary

One can consider the XPM catalogue of absolute proper motions as those, which does not rotate with respect to galaxies. The data of this catalogue play a principal role in determining the kinematic parameters of the Galaxy, for example, in the framework of the Ogorodnikov–Miln model.



Thank You