RI Nikolaev Astronomical Observatory

Results of Double Stars Observations at RI NAO Telescopes

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Why Stars with High Proper Motions?

These stars are important because :
- These are our neighbors - the nearest star - the first candidates in the lists to determine the stars parallax
- Data source for study population of nearest vicinities of the Sun
- Search for brown dwarfs and extrasolar planets (based on the comparison of IR review DENIS – 2mass-WISE)
- The good candidates for microlensing events
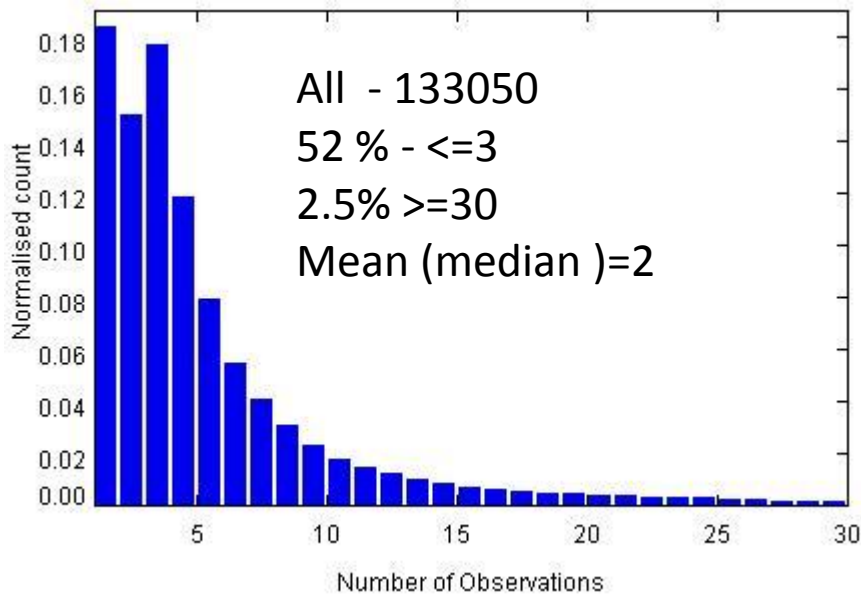
BUT!!!
Poor observation history
Non-availability of the high precision positions
Relative proper motions
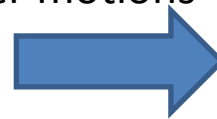
possible to observe via small telescopes

The Washington Double Star Catalog

All - 133050
52 % - <=3
2.5% >=30
Mean (median)=2

Sixth Catalog of Orbits of Visual Binary Stars
As of 11 September 2014, the Sixth Catalog included 2,518 orbits of 2,413 systems

No Proper Motions – Main Component 1.5%
Second Component 20%

Number of Observations

Magnitude from WDS (red - main, blue - second)

Right Ascension
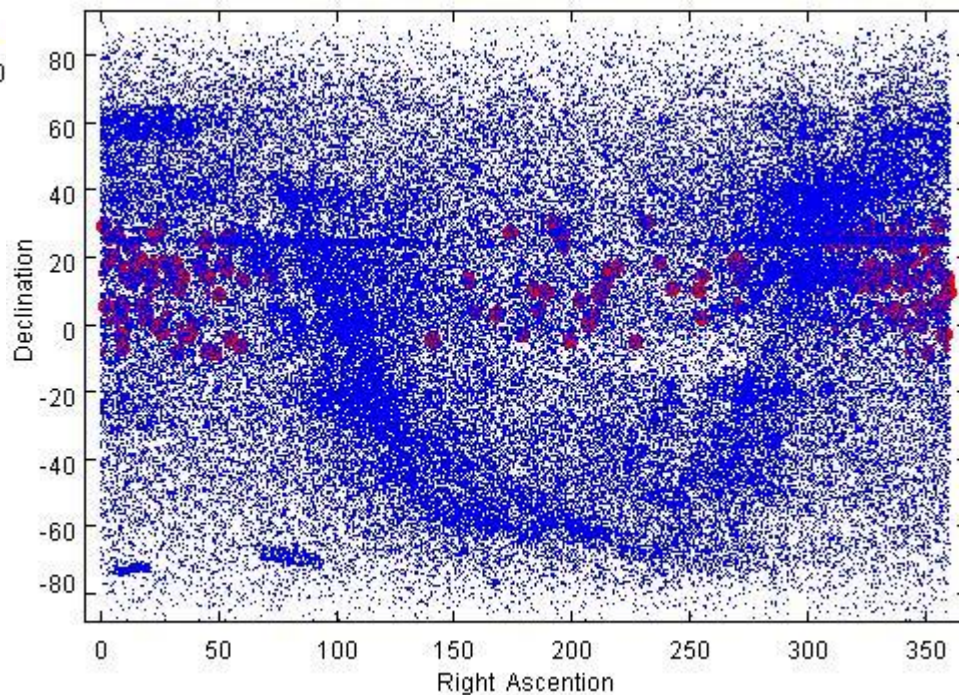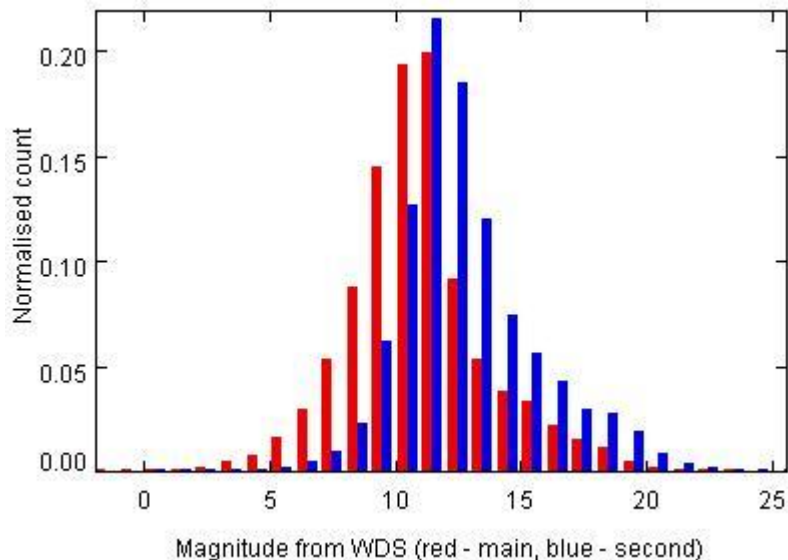
B/WDS
The Washington Double Star Catalog, Mason+ 2001-2014
maintained by the US Naval Observatory
http://ad.usno.navy.mil/proj/WDS/
The WDS Catalog contains positions (J2000), discoverer designations, epochs, position angles, separations, magnitudes, spectral types, proper motions, and, when available, Durchmusterung numbers and notes for the components of 133,050 systems based on 914,408 means (as of 1 August 2015). The catalog is updated nightly.

I/274 CCDM
The **Catalog of Components of Double and Multiple Stars**, Dommanget, J.; Nys, O. (2002) 105,838 components of 49,325 double and multiple stars. The catalog lists positions, magnitudes, spectral types, and proper motions for each component.

I/276 TDSC
The Tycho Double Star Catalogue
Fabricius+ 2002
103 259 entries:
Tycho double star solutions;
Tycho-2 stars identifyed in WDS;
Tycho-2 pairs separated by less than 10 arcsec

Compiling the program of observations

Alf - AMC List Formation – software for automatically generate list of night observations

Settings:

Source catalogs (WDS);
Declination zone (-10-+30°);
Magnitude range (8-15 for AMC, 12-17 for Mobitel)
Updating the list is performed based on the weights of the catalogs, results of previous astrometric processing (number of positions, and its mean square error (MSE))

Also:
The program for calculation of stars mean positions array for compilation catalog **«wxDev»**
The program for cross-identification and search systems with invisible companions **«peto»**

Axial meridian circle RI NAO

Horizontal telescope
in the prime vertical
(D=180 mm, F=2500 mm), 1995

CCD-camera S1C
(1040×1160, 16×16 μ^2 ,
 1.32"/px, 23'x25'
Drift-scan mode with
102^s/cos(δ))
(St. Petersburg, Russia)

GPS-receiver
V - filter in
Bessel-Johnson-Cousins

Mobile multi-channel automatic telescope(2010)

The Maksutov system lens, D=500mm, F=3000mm

GPS-reciever
CCD-camera: Alta U9000, 3k x 3k pix^2
Size of pixel 12 x 12 мкм^2
FOV   42.5′ x 42.5′
Mode – drift scan
Filter R (on base OC-12)

Statistic of the observations

Period	Instrument	DEC Zone	Total position	Mean N *
2013	АМК	-10 - +30	2420	4
2014	АМК	-10 - +30	1848	3.5
2013	Мобител	-5 - +33	124859	8
2014	Мобител	-10 - +30	87767	8

The results of search WDS stars

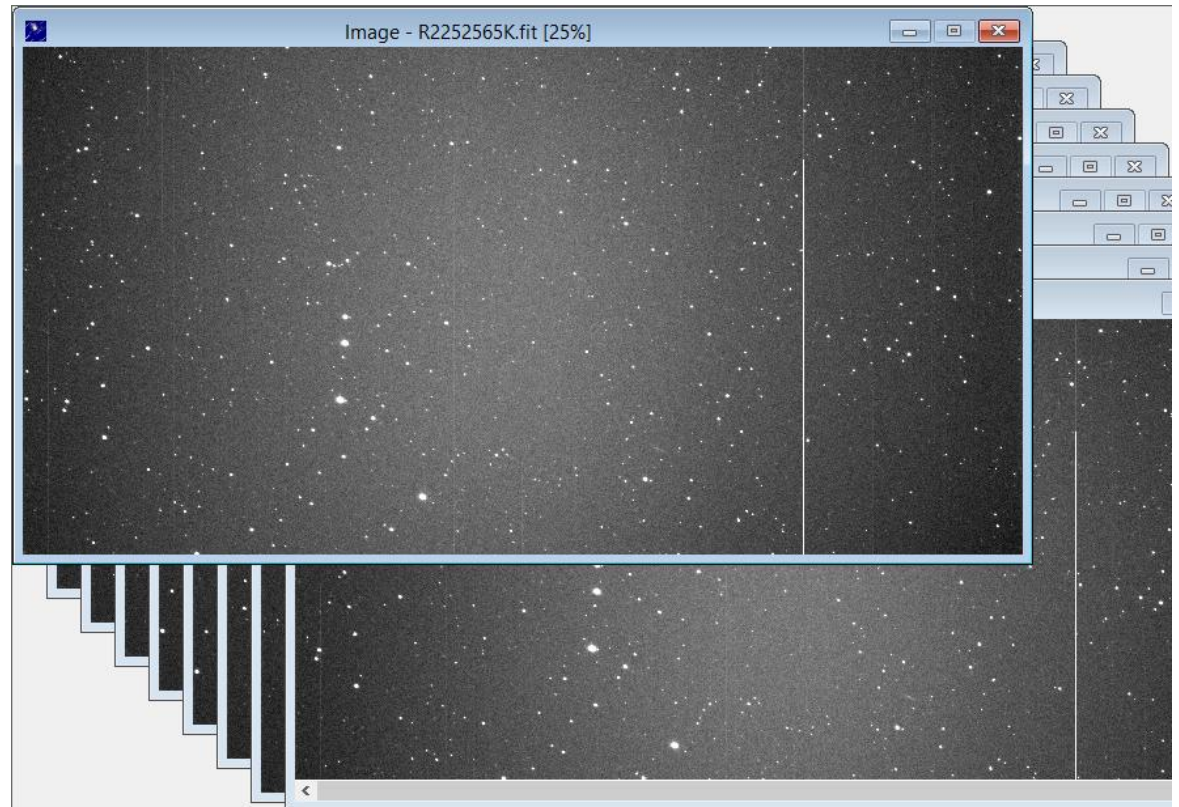| Period	Instrument	Primary/Sec	Mean N *
2013	АМК	67/40	3.5
2014	АМК	60/14	3.5
2013	Мобител	63/155	8
2014	Мобител	171/190	9

*The average number of observations of a star

Processing and Reductions

Astrometrica
- Align background image;
- Detection of objects for which the signal/noise ratio S/N >= 4.0 ;
- Getting instrumental coordinates of the detected objects in the system matrix;

Performing astrometric reductions for equatorial coordinates of objects:
Reference catalog   UCAC2
Connection model between the tangential and the measured coordinates:
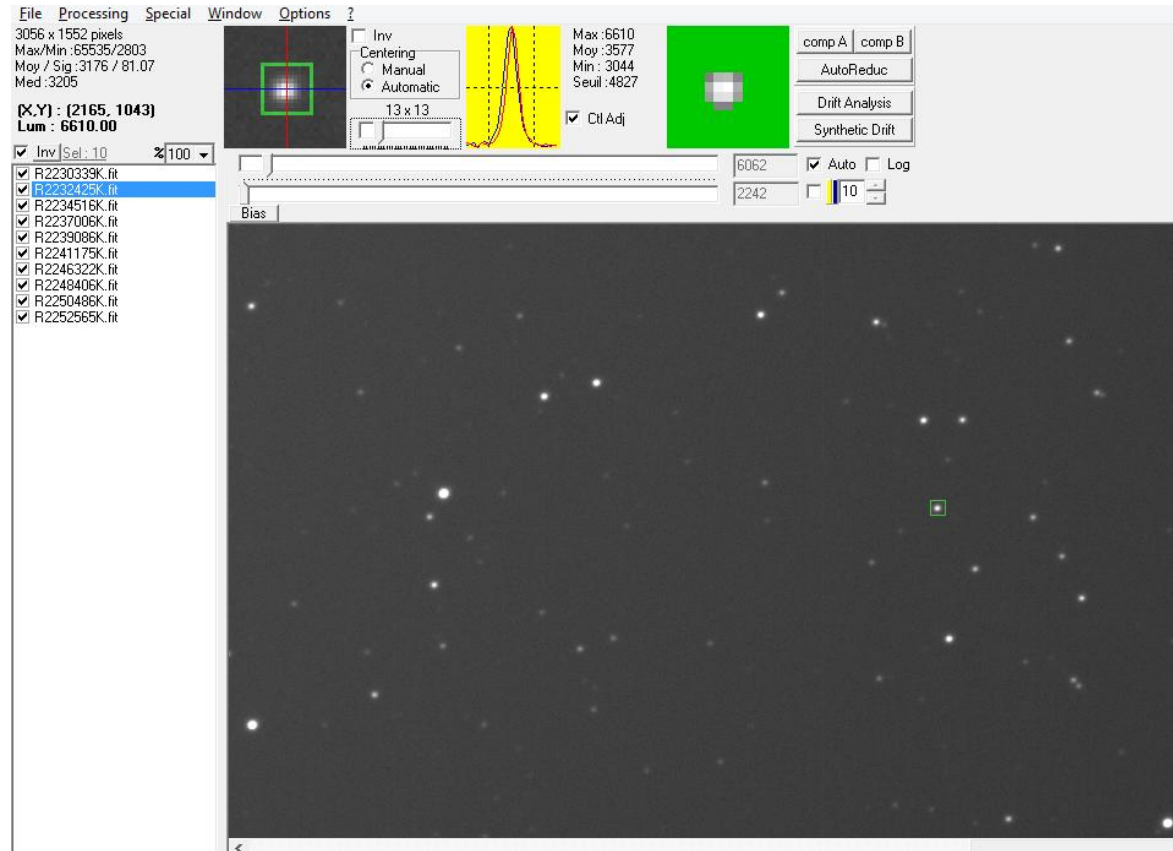AMC - polynomial 2nd order
Mobitel - polynomial 4th order

Processing and Reductions
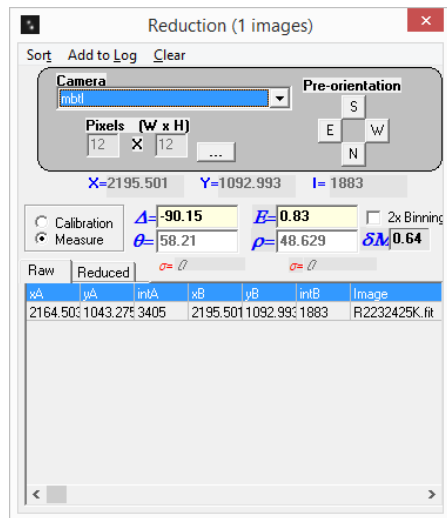
Reduc

Program automatically:

- determines the center of the star (on the basis of max pixel luminosity or S/N rate)
- calculates a position angle, a double star separation and a difference of magnitude estimation
- calculates position angle and separation standard deviation

Processing and Reductions

Program needs to know:

- camera pixel size
- image orientation
- image inclination regarding the celestial equator
- pixel sampling (angular scale)


```
************************************************************
Date : 20140915
Instrument : MBT
Camera : mbtl        (pixels : 12 x 12)
Sampling : 0.83
Delta Matrix : -90.15

-=-= 180_MBT_2013_0808_20478+1109 =-=-

theta =    58.3  (sigma:0.15  Med:58.35)
rho   =  48.625  (sigma:0.09  Med:48.6085)
deltaM=0.64
Nb :10


----------------------------------------------------------
Detailed Reduced Data :
----------------------------------------------------------
   Theta       Rho        dM       rThe      rRho     Image
   58.36     48.766     0.64       0.06     0.141 R2230339K.fit
   58.21     48.629     0.64      -0.09     0.005 R2232425K.fit
   58.05     48.593     0.58      -0.25    -0.032 R2234516K.fit
   58.38     48.592     0.56       0.08    -0.032 R2237006K.fit
   58.52      48.6      0.69       0.22    -0.025 R2239086K.fit
...
```

Measurements results log-file fragment

Results

A fragment of the table which represents the measured data

star_name	theta	ro	sigma theta	sigma rho	num
00109+1705	98.59	13.462	1.13	0.315	4
00146+2508	130.74	7.972	0.74	0.152	9
00152+2454	200.47	31.272	0.21	0.151	10
…					
20363+2321	134.09	21.572	0.34	0.191	9
20397+1415	147.08	32.537	0.25	0.127	10
20397+1406	285.62	6.459	1.76	0.579	10
20400+2503	272.02	20.397	*	*	1
20401+2509	288.94	10.36	0.44	0.105	10
20401+2458	24.08	16.112	1.14	0.3	9
20401+2450	34.51	5.627	1.61	0.224	10
…					

Errata
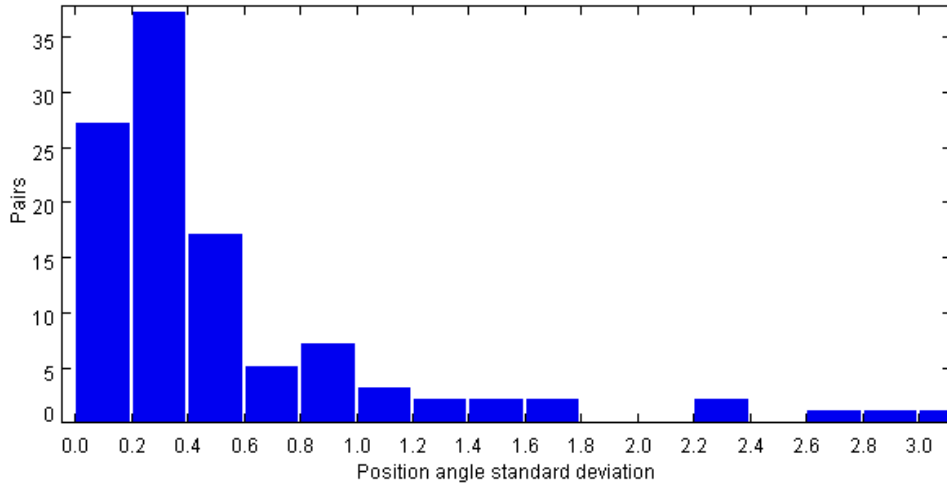
Average standard deviation:
σ theta = 0.54°
σ rho = 0.163"
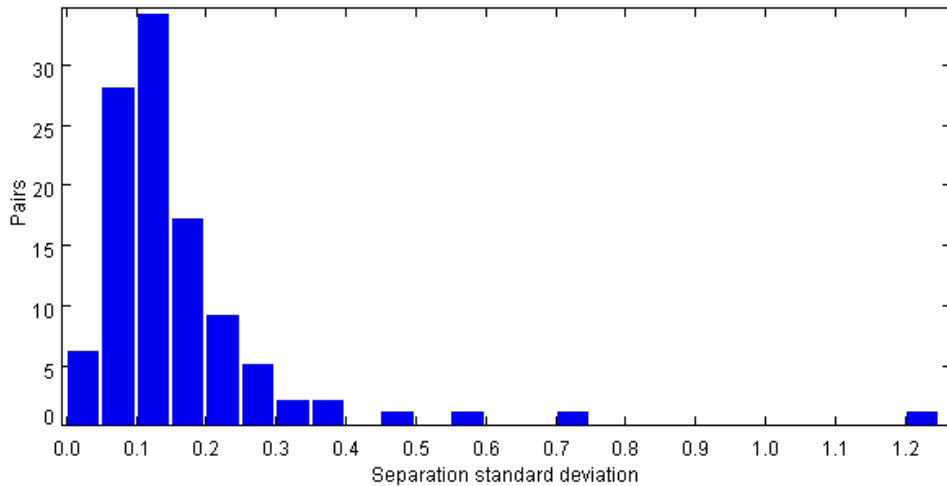
The results of cross-identification with USNO A2.0 catalog

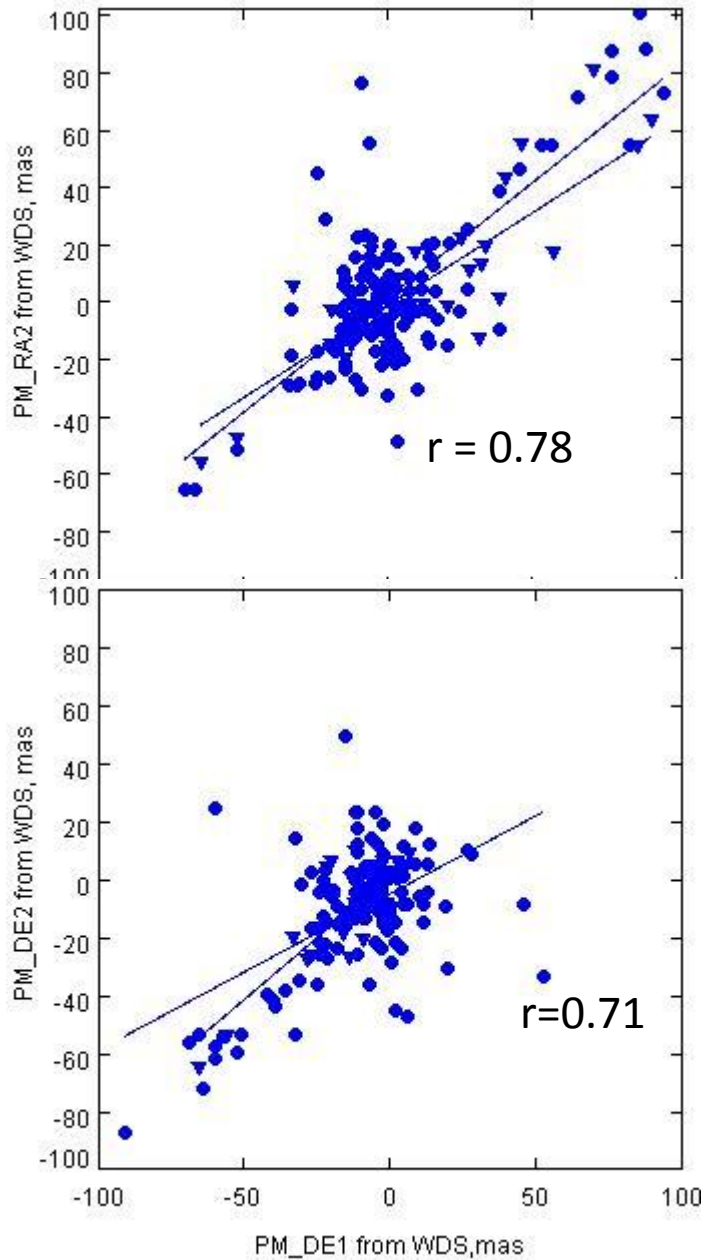| Telescope	Primary	Sec	New
Mobitel	234/211	345/318	61
AMK	127/119	54/51	35

The results of comparison of proper motions with PPMXL catalog

Differences	dPM_RA, mas/yr	dPM_DE, mas/yr	N
(WDS - PPMXL)	2±16	-4.0±17	457
(WDS- NAO)	-0±14	0±15	457

Common Proper Motion

WDS Primary→ WDS Second   WDS Primary→ NAO Second
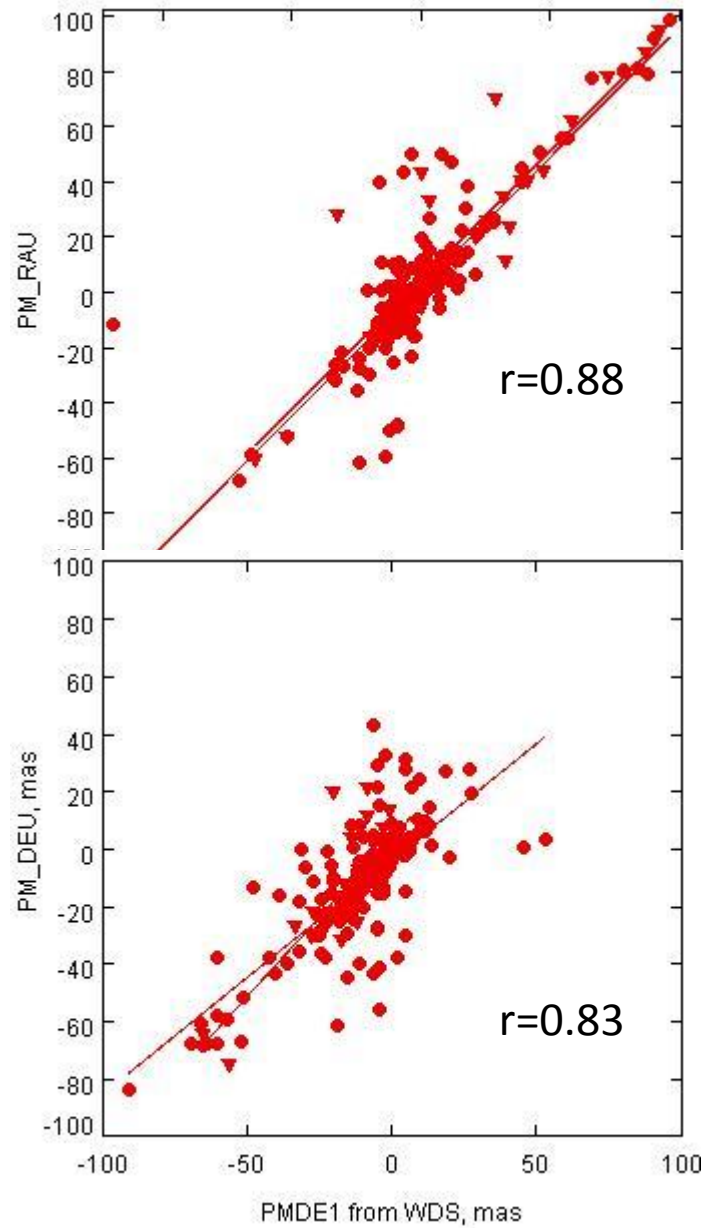
Conclusions

- The equatorial coordinates and proper motions of 744 WDS stars component were obtained based on CCD observations during 2013-2014 yr. Average accuracy of the reference star position is 20 and 30 mas in both coordinates for observations obtained at the telescope Mobitel and AMK, respectively.
- Parameters for 170 binary systems (position angles and separations) were obtained. The standard deviation is 0.54° for position angles and 0.163" for separation.
- The new proper motions for **96** secondary WDS star were calculated using USNO A2.0 as the first epoch (the epoch difference is more than 60 years, so it allows us to obtain proper motions with good accuracy). The accuracy of the proper motions is within 2-15 mas/yr.

Further plans:
- reduce other our observations (including old ones), which can contain WDS objects
- analyze proper motions to check the undeclared double and multiple star systems
- send and attach our results to WDS

THANKS

Some of the results of this work were obtained using services :

VizieR, CDS, Strasbourg, France
http://vizier.u-strasbg.fr/
NASA's Heasarc Tools
http://heasarc.gsfc.nasa.gov/docs/tools.html
Программы **TopCat** (Tool for OPerations on Catalogues And Tables)
http://www.star.bris.ac.uk/~mbt/topcat/

Дякую
Thank you!
感謝您的關注！