A search for new variable objects in the field of OB81 association in M31 galaxy

Mitko Churalski[1], Petko Nedialkov[2]
and Antoniya Valcheva[2]

[1]Institute of Astronomy with NAO, Bulgarian Academy of Science
[2]Department of Astronomy, Sofia University

Overview of the talk

1. Introduction

2. The main goal and tasks

3. Observational material

4. Results

5. Discussion

6. Conclusions

Why variables in M31 ?

The closest grand design spiral, similar to the Milky way.

A Local group spiral galaxy with the highest metallicity – the third most important parameter for stellar evolution, after mass and age..

Huge angular extent on the sky (advantages and difficulties).

The variables are equidistant objects i.e. relationships like ‘period-luminosity’ are derived directly

The main goal and tasks

The main goal:

To find optically variable objects in the field of the stellar complex OB81 in M31 galaxy on the base of photometry from different sources: Berkhuijsen (1988), Magnier (1992), Kurtev (2002), Massey et al. (2016) and future original observations with the telescopes of NAO Rozhen (Derector's cut) .

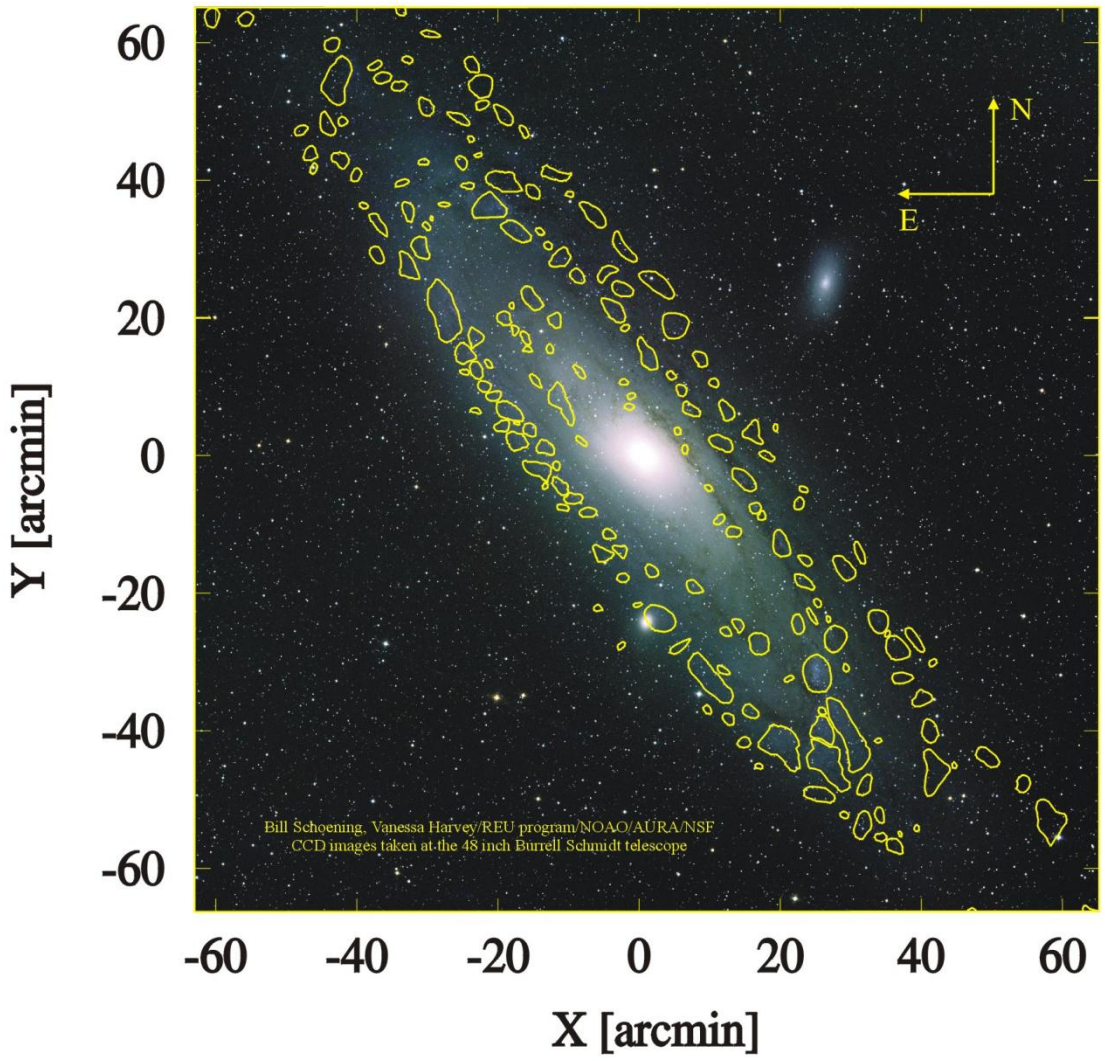
Tasks:

– astrometric solution for the sample of Kurtev (2002);

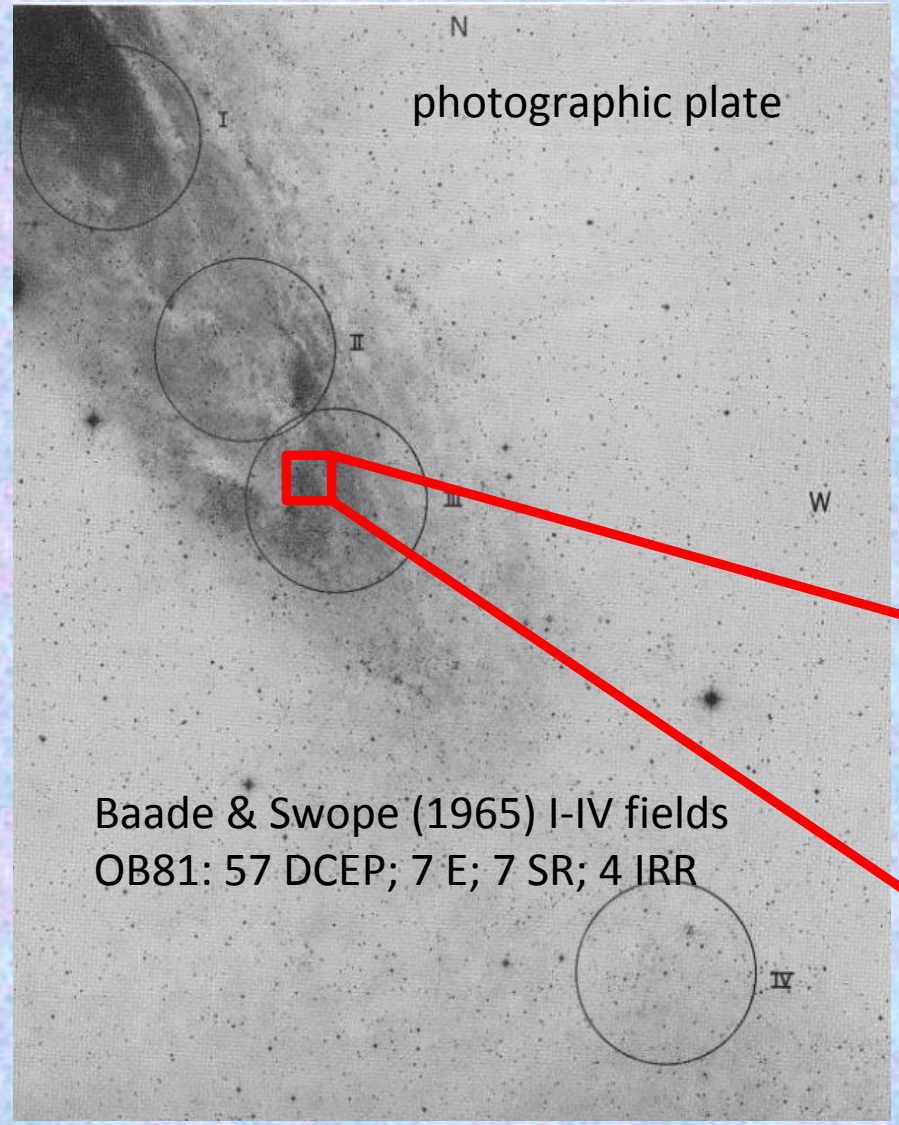
– zero-points comparison between the photometries in UBVRI bands;

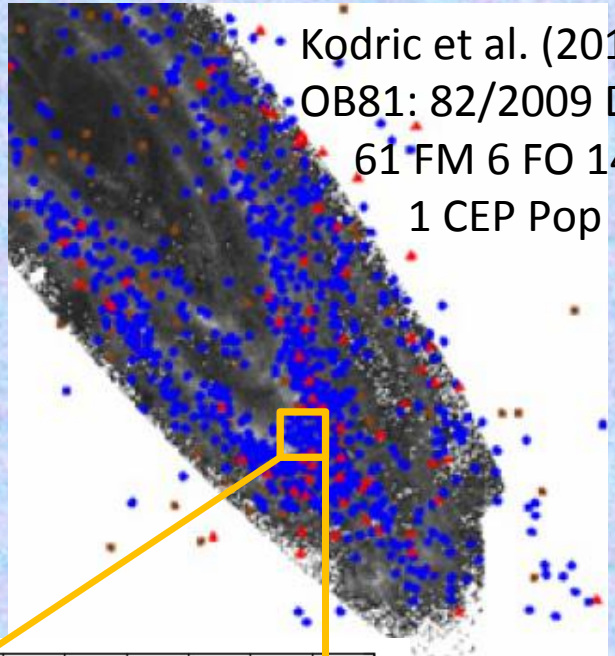
– search for candidate variables at level, greater than 3σ.

OB associations in M31 galaxy (van den Berg 1968)

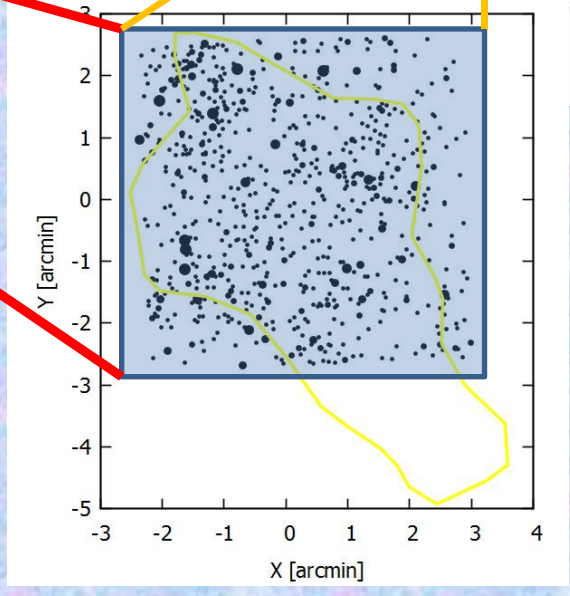


Preceding studies of variables in the field of OB 81



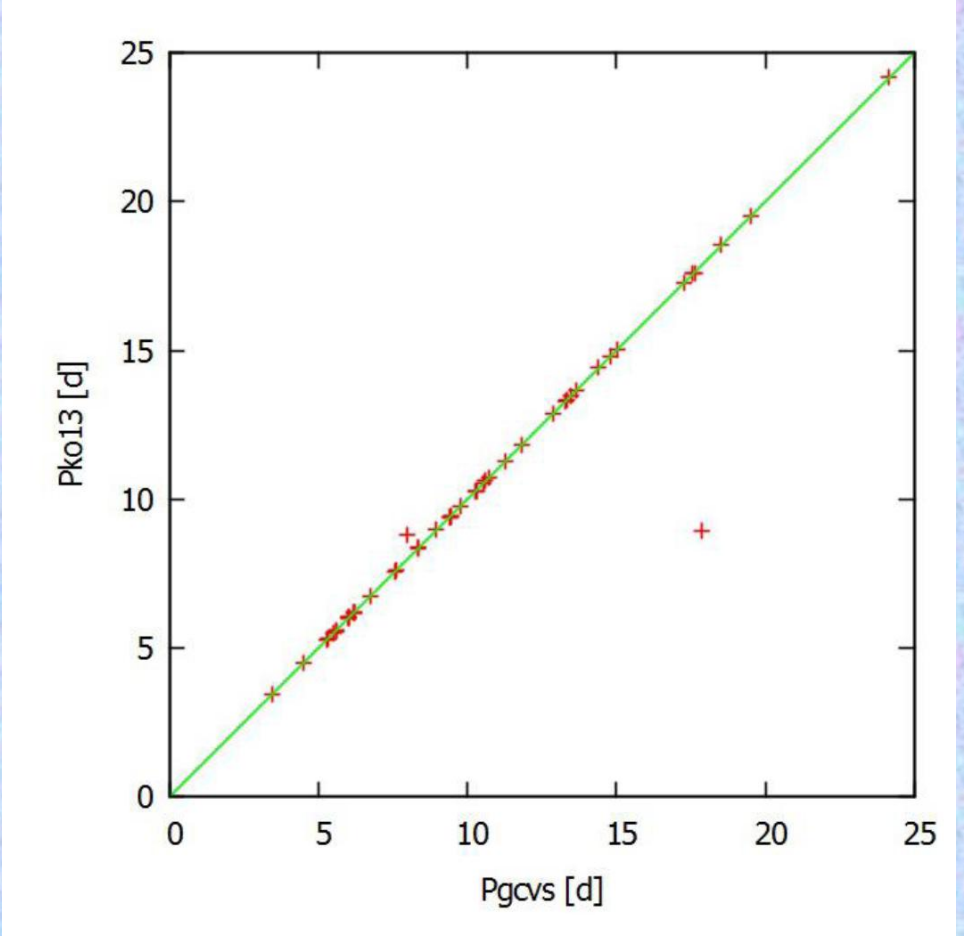


Kodric et al. (2013)
OB81: 82/2009 DCEP
61 FM 6 FO 14 UN
1 CEP Pop II



map of Montalto et al. (2009).

Period comparison: Kodric et al. (2013) vs. Baade & Swope (1965)



Observational data on OB81 – a comparison

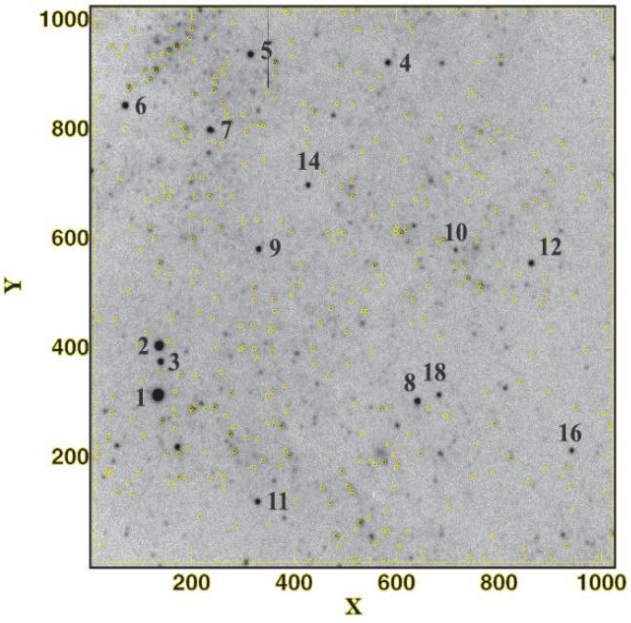
Photometry source	Total number of stars	Date	Seeing	Number of stars with UB photometry	Photometric accuracy	Exponation	Detector size	Telescope
Kurtev (2002)	678	6/7 Aug. 2000	1.5"–1.8"	678	<0.15 mag B~21.0 mag	900 s = 15 min= 1/4 h	CCD 1kx1k	2m RCC NAO-Rozhen
Massey (2016)	5046	Sept /Oct. 2001/ 2002	0.8"–1.4"	3946	<0.015 B~21.0 mag	6x1800 s = 3 h	CCD mosaic 8x (4kx2k)	4m Mayall Kit Peak NAO

NAO Rozhen observational data on OB81

Kurtev R.G., 2002, Publications of the Astronomical Observatory of Belgrade, **73**, 163

List with the physical coordinates (x,y) and UB magnitudes of 678 stars:

№	x	y	U–B	U
1	327.4	633.2	-1.345	21.260
2	101.4	576.7	-1.291	21.322
.....				
678	666.9	565.7	1.726	21.551



Data

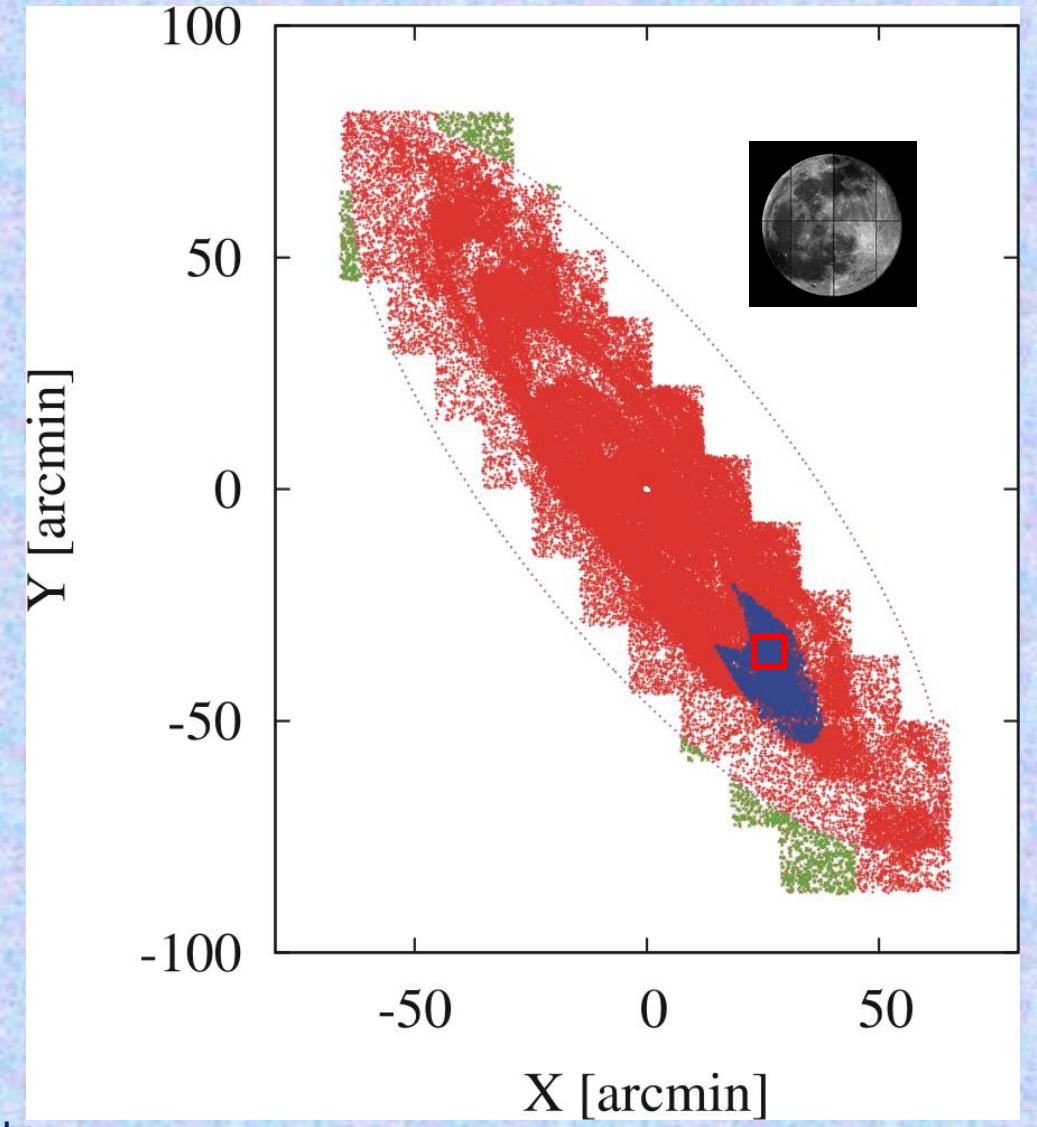
Photometric catalog of Massey et al. (2016)

Local group survey:
KPNO 4 m telescope+
NOAO/KPNO
Mosaic Wide Field Imager
(8K x 8K CCD)

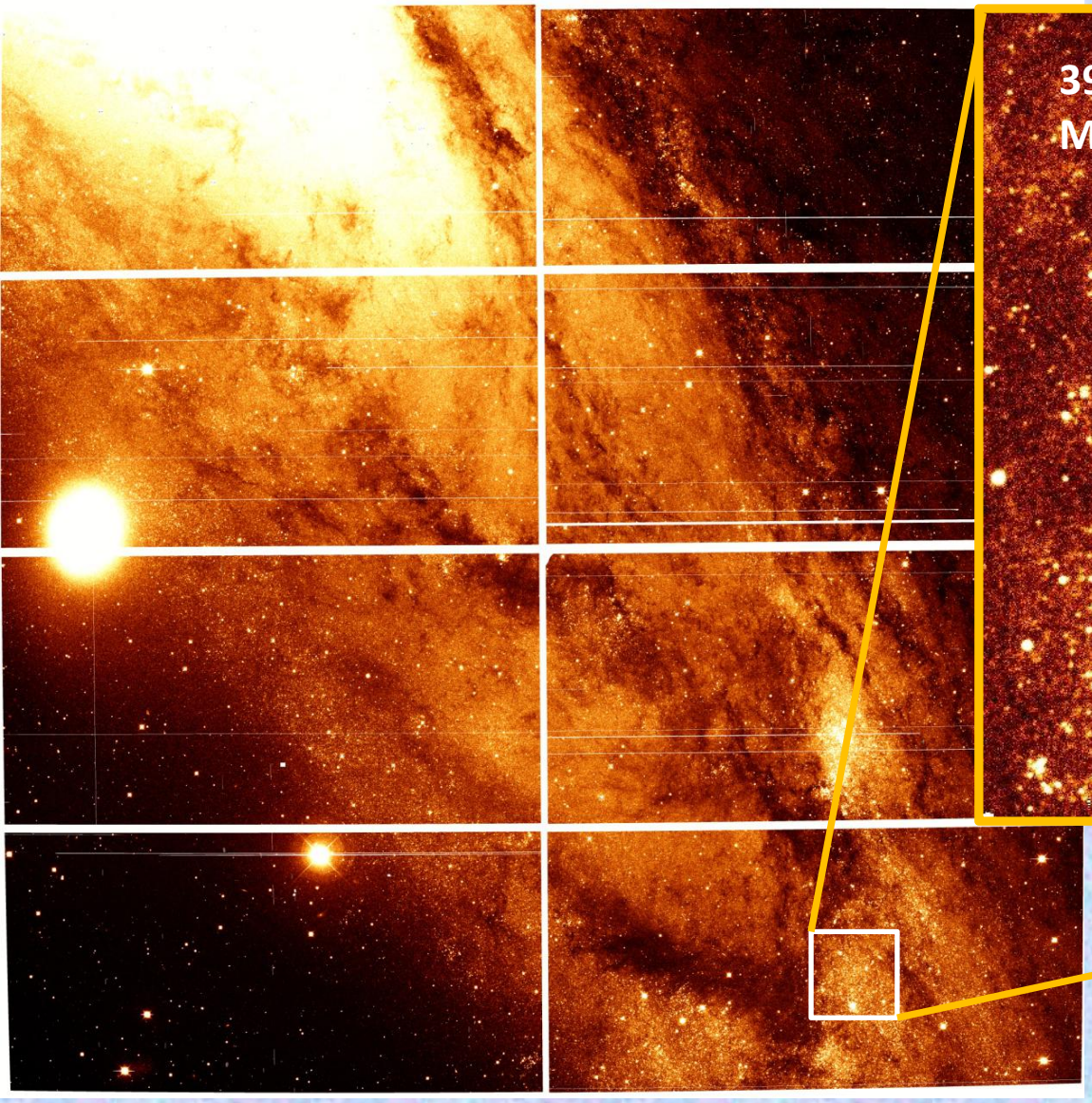
371,781 stars in M31
down to 23th R magnitude

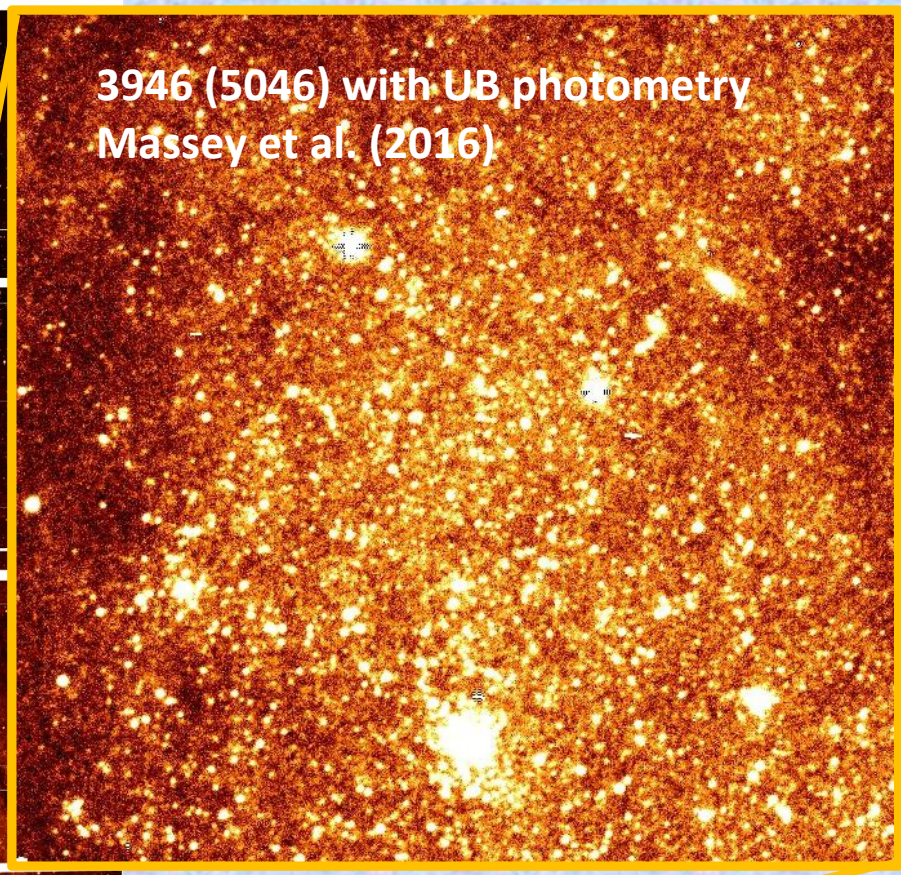
The paper:
A Survey of Local Group Galaxies
Currently Forming Stars. I. UBVRI
Photometry of Stars in M31 and M33

Published in Massey et al. (2006)
AJ 131, 2478
Revised version of the catalog:
Massey et al. (2016)
190 000 UBV stars
Blue fragment: spiral arm S4
Red quadrate: Kurtev(2002) UB photometry



KPNO 4: real data (a raw B band frame)

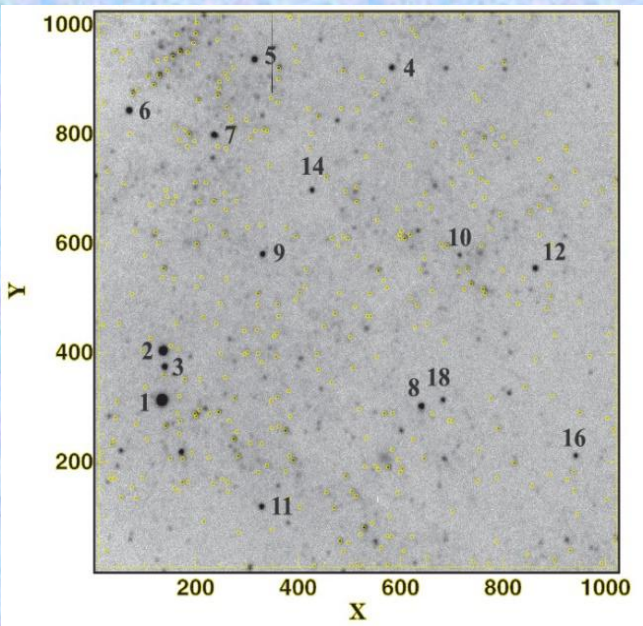




Date of observation
2002-09-10
2001-09-19

Astrometric solution:

1. Standards from Vizier http://vizier.u-strasbg.fr/viz-bin/VizieR



# от Фиг. 7	X [pixels]	Y [pixels]	RA h m s	DEC ° ′ ″
3	137.9	372.9	00:40:34.89	40:31:35.1
4	581.7	918.7	00:40:23.22	40:34:28.1
5	313.5	933.6	00:40:30.53	40:34:30.5
6	68.5	840.5	00:40:37.14	40:33:59.5
7	234.3	796.1	00:40:32.58	40:33:47.2
8	639.4	300.7	00:40:21.20	40:31:17.0
9	329.1	578.1	00:40:29.85	40:32:40.4
10	713.8	576.5	00:40:19.37	40:32:43.1
12	861.7	552.2	00:40:15.35	40:32:36.9
14	425.7	695.3	00:40:27.31	40:33:17.6
16	940.6	210.3	00:40:12.94	40:30:51.3
18	681.4	311.9	00:40:20.06	40:31:20.8

2. $(\alpha, \delta) \rightarrow (\xi, \eta)$

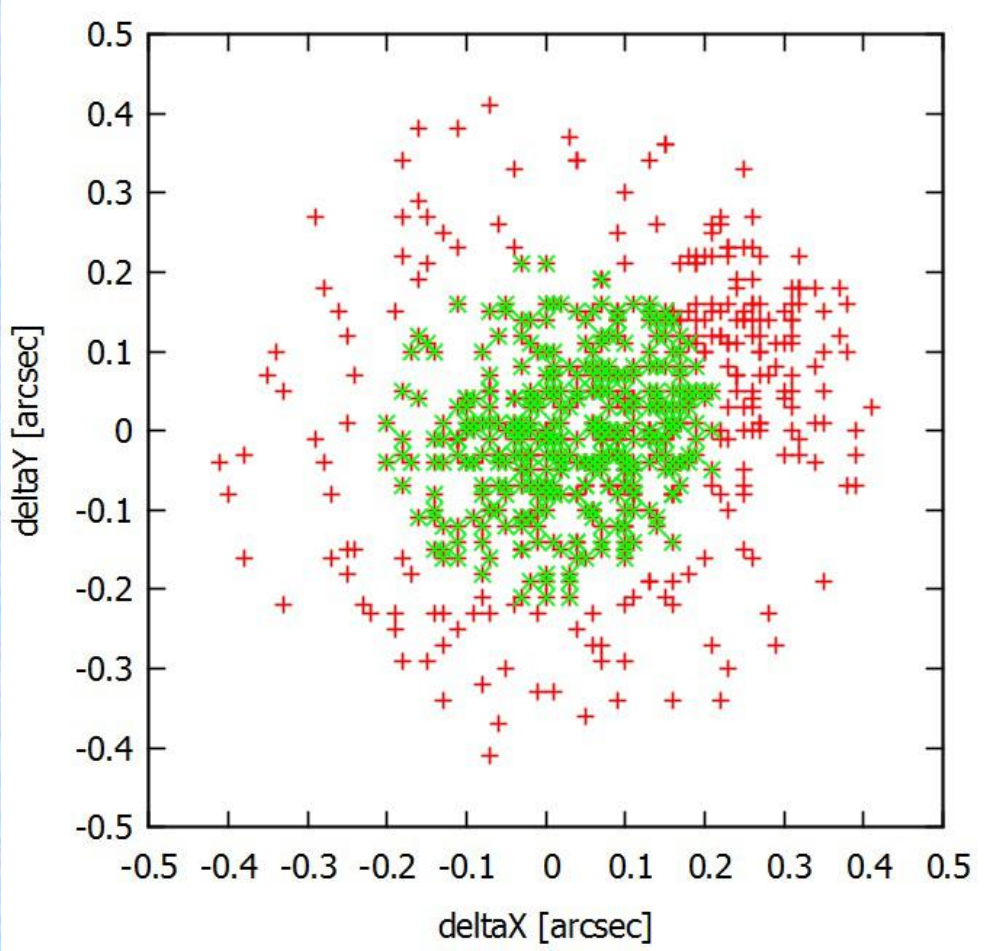
$$\xi = a + cos\theta X - sin\theta Y$$

$$\eta = b + sin\theta X + cos\theta Y$$

3. $(x,y) \rightarrow (\xi, \eta) \rightarrow (\alpha, \delta)$

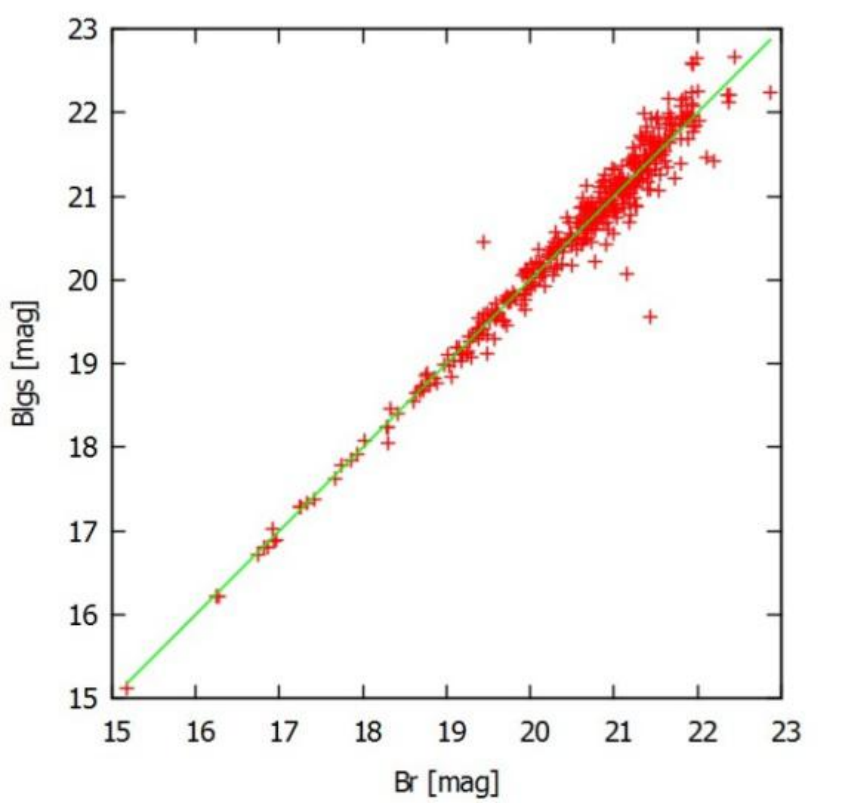
Coordinates error: 0.05" both on RA and DEC

Cross-indentified stars: search radii 0.4/0.2″

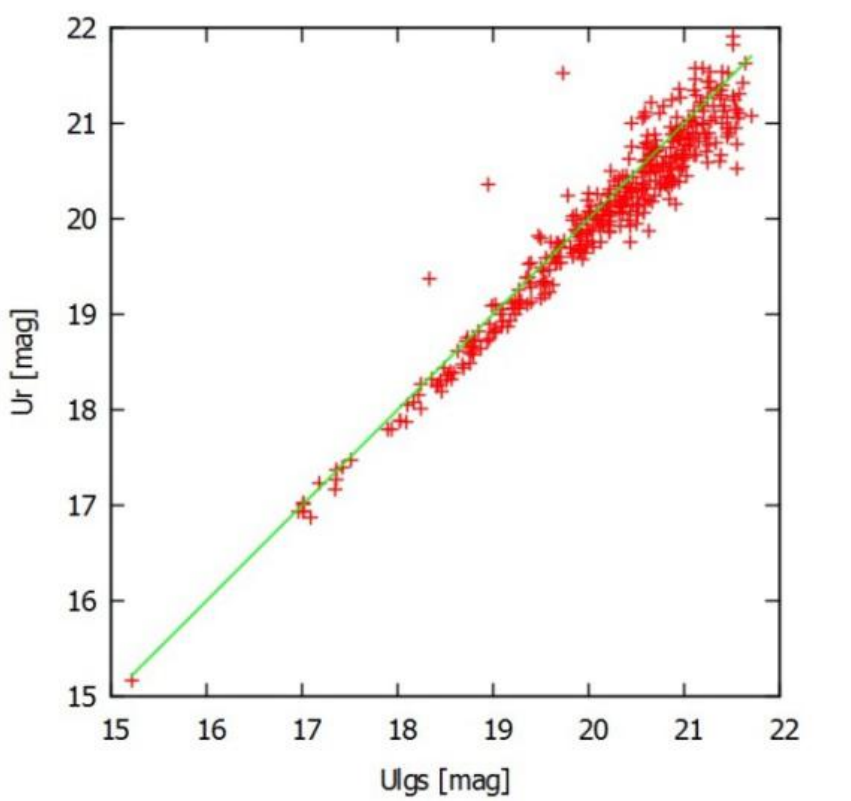


Comparison between the photometric systems

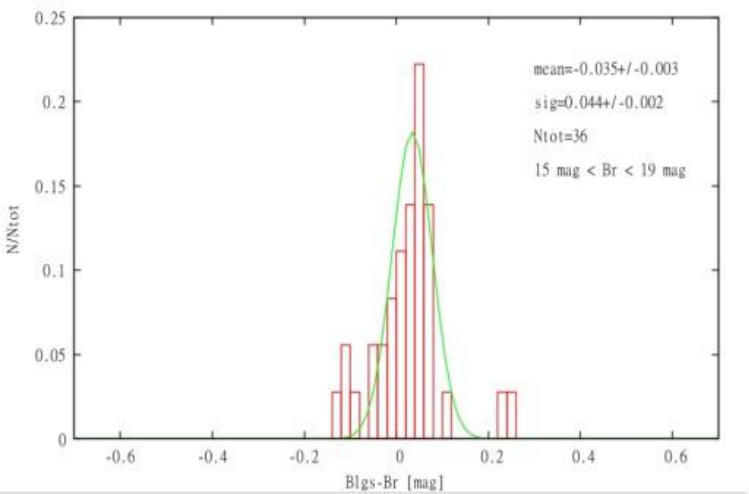
Band B

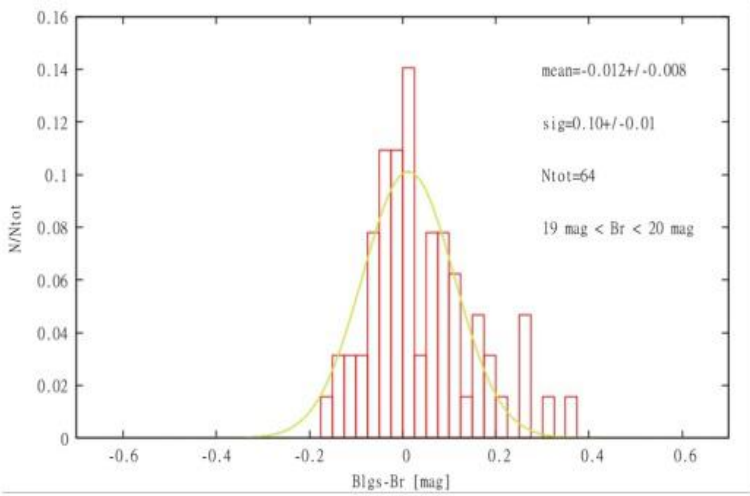


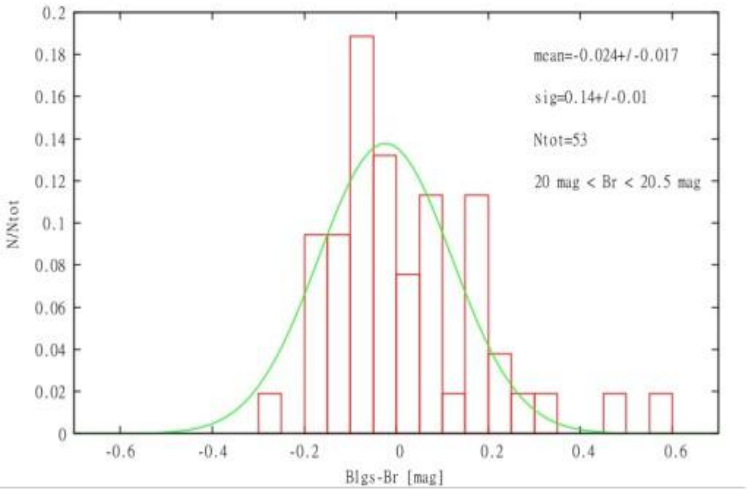
Band U

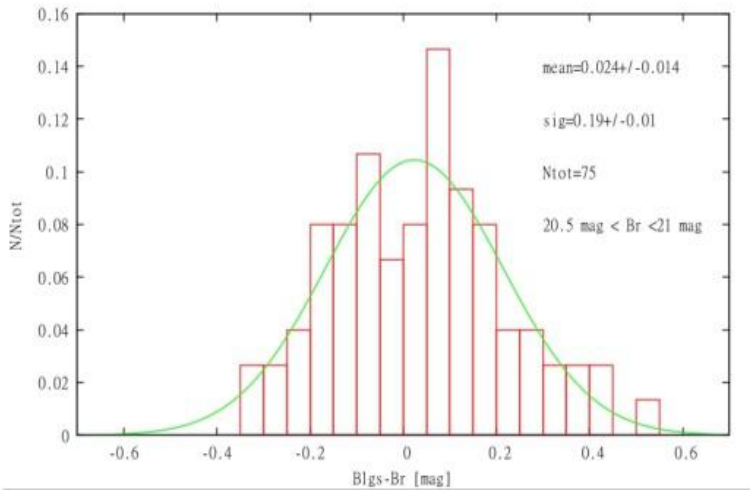


Approximation of the distributions of (B_{LGS}–B_R) in 4 different bins in B_{LGS} mags

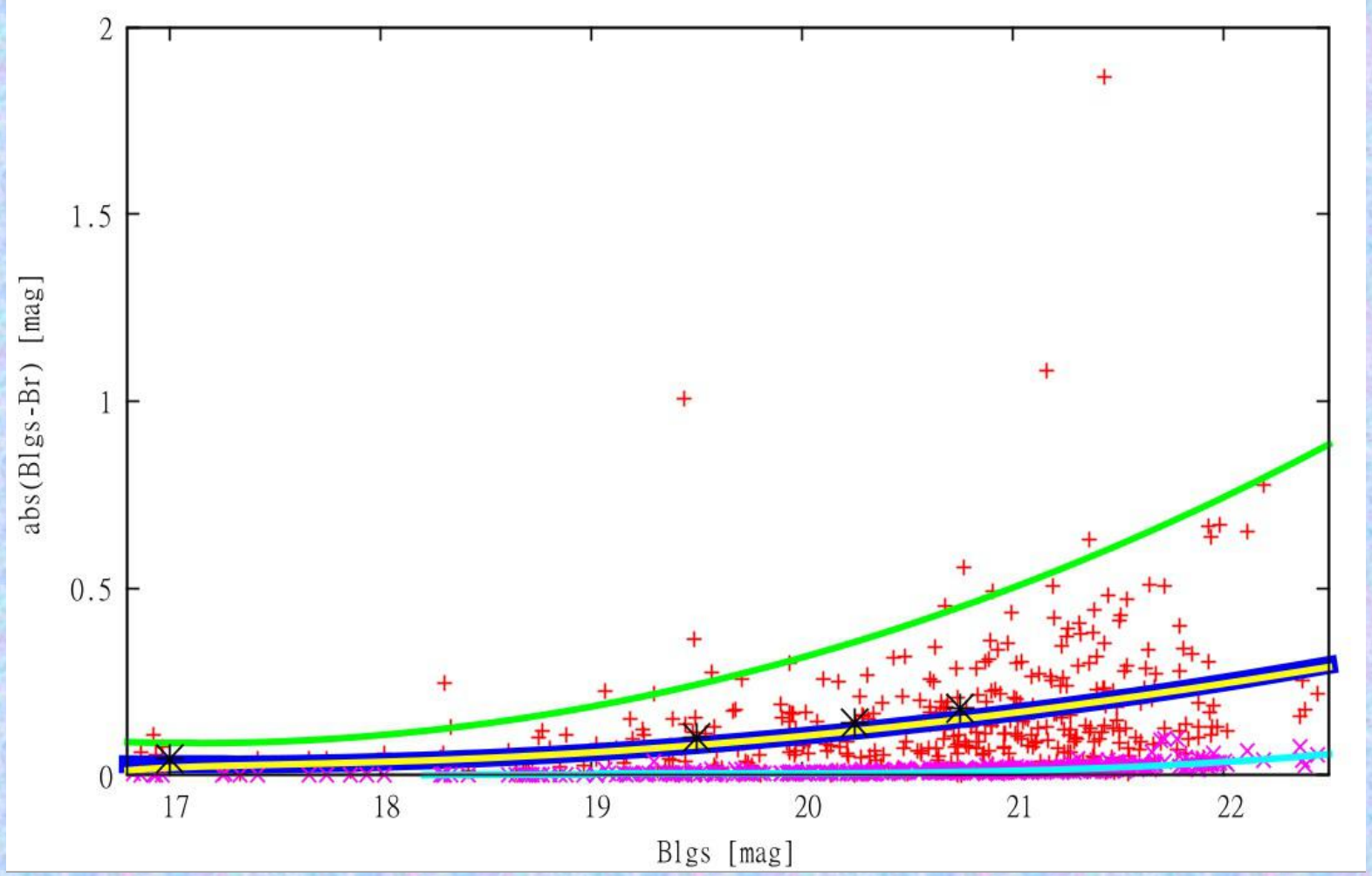








Modulus of the difference (B_{LGS}–B_R) with photometric error curves as a function of B_{LGS} mags

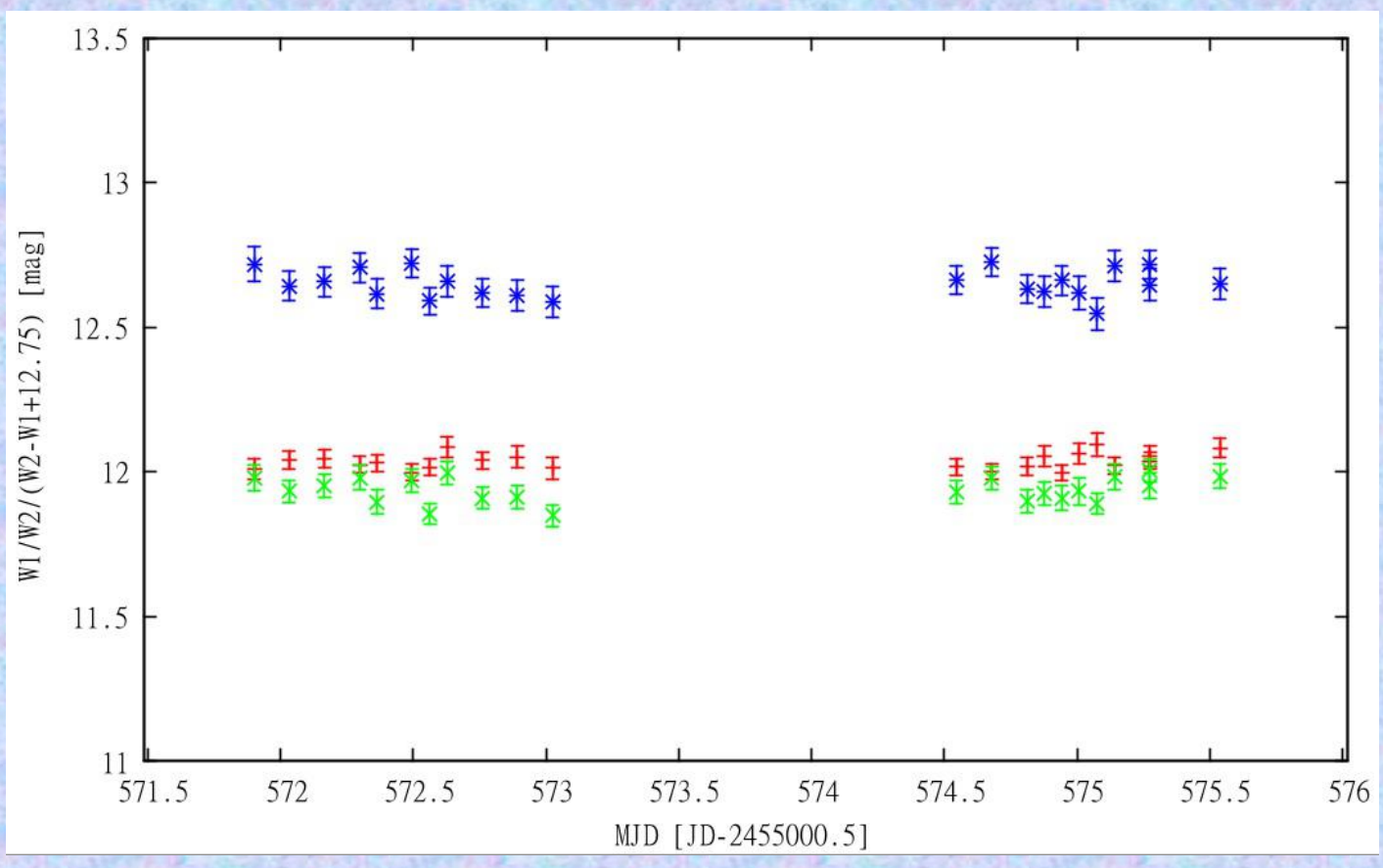


Candidate variables detected at level > 3σ

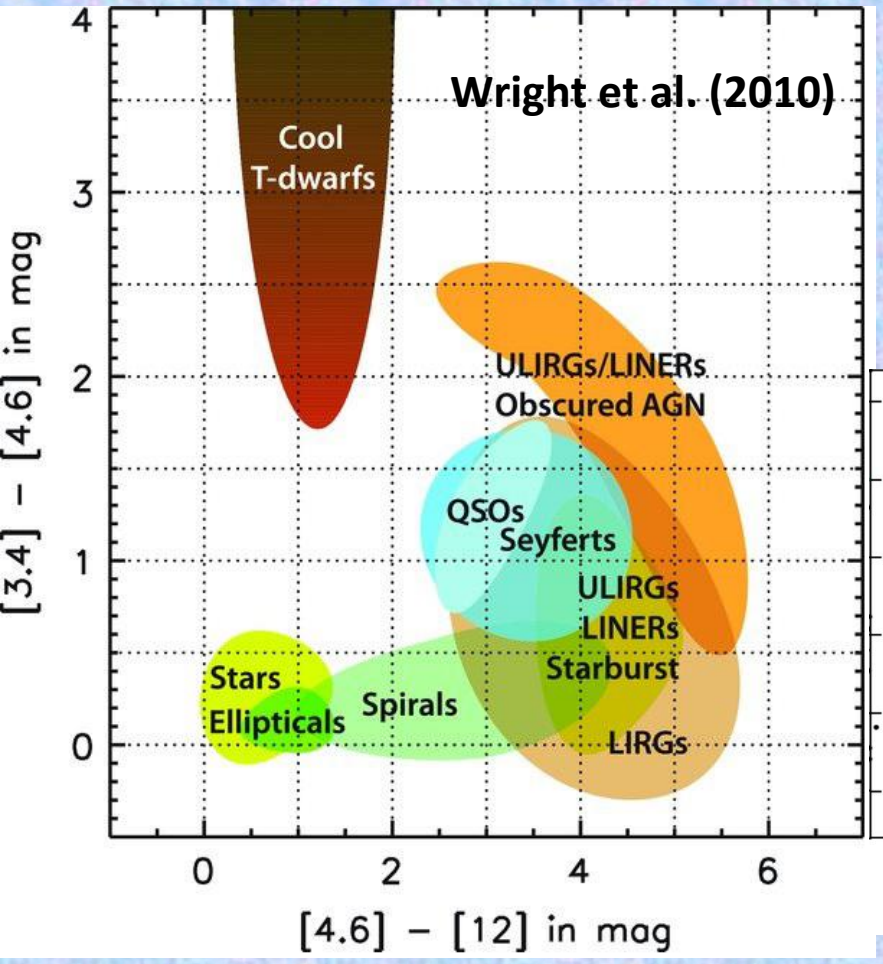
№	#NAO *Rozhen*	RA [deg]	DEC [deg]	dρ ["]	Br [mag]	Blgs [mag]	σ	Name	*Reference*	Var. Type
1	15	10.09802	40.51178	0.12	21.995	21.365	3.239	J004023.54+403042.4	LGGS	
2	170	10.13827	40.51916	0.09	19.126	19.490	4.530	J004033.12+403107.7	LGGS	
3	243	10.14069	40.51204	0.17	20.214	20.769	3.671	M31 V0418	GCVS	CEP:
4	324	10.08728	40.51318	0.15	20.415	20.907	3.063	J004020.96+403047.4	LGGS	
5	460	10.10084	40.53334	0.21	19.299	19.574	3.271	J004024.23+403200.2	LGGS	
6	508	10.08655	40.55610	0.06	19.080	19.299	3.027	M31 V0285	GCVS	DCEP
7	512	10.08293	40.51323	0.19	18.839	19.066	3.574	J004019.93+403047.7	LGGS	
8	569	10.08832	40.52137	0.06	17.030	16.923	3.689	J004021.21+403117.1	LGGS	
9	602	10.14698	40.55776	0.06	19.564	21.432	9.351	M31 V0438 J010.1469+40.5577	GCVS Kod13	DCEP FM
10	641	10.13570	40.51632	0.11	20.448	19.440	12.891	M31 V0411	GCVS	DCEP
11	643	10.09008	40.54896	0.20	18.462	18.333	3.057	J004021.64+403256.5	LGGS	
12	648	10.04950	40.50658	0.21	20.077	21.160	6.055	M31 V0215 J010.0495+40.5065	GCVS Kod13	DCEP FM
13	675	10.11720	40.50244	0.11	18.055	18.303	5.971	J004028.12+403008.5	AllWISE	high prob. var

Light curve WISE diagnostic of the candidate variable №13

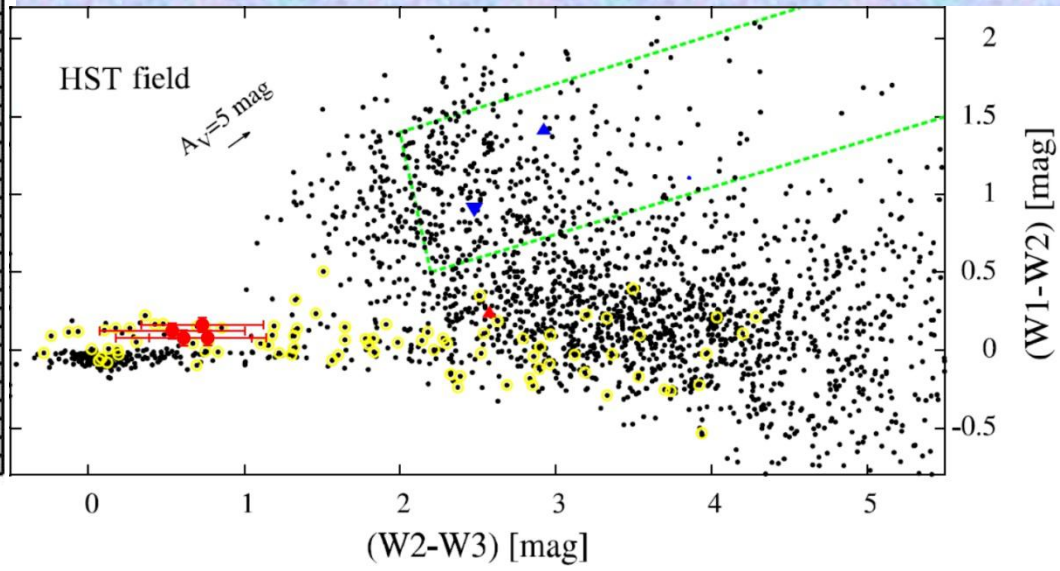
48 points (W1+W2) points at 3 substantially different epochs within 1 yr



TCD WISE diagnostic of the candidate variable №13



2354 All WISE objects within ~ 1 sq. deg. piece of M31 disk with Mateos et al. (2012) AGN wedge (green line) over plotted



Conclusions

We perform an astrometry with accuracy of ~0.05' for 678 stars with UB photometry in the 5.6'x5.6' field of OB81 association in M31 galaxy. Their photometry was carried out on CCD images, obtained with the NAO-Rozhen 2-meter telescope in Aug. 2000 (Kurtev 2002).

The comparison with the Sept 2001 – Oct.. 2002 stellar photometry within the same field, published in the M31 UBVRI catalog (Massey et al. 2016) showed no zero-point difference in B-band, whereas in U-band, a systematic difference of 0.13 ± 0.03 mag emerged.

A preliminary search leads to thirteen candidates for variable objects that have been detected at level, greater than 3 sigma. Five of them are known variables of the δ Cep type and one star has been detected as red variable by the WISE mission. The remaining 7 candidates are newly detected variables, but only one of them at detection level, greater than 4 sigma.