Plana Student Astronomical Observatory: First results and perspectives

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Abstract. We present a new Bulgarian professional optical observatory initiated by the Department of Astronomy at the University of Sofia. The observatory is located in the Plana mountain at an altitude of 1240 m and about 30 km to the southeast of Sofia. It is situated on the premises of the Plana Geodetic Observatory operated by the National Institute of Geophysics, Geodesy and Geography of the Bulgarian Academy of Sciences. Plana Student Astronomical Observatory (SAO) is equipped with a 0.35 m $f/4.6$ Newtonian telescope and an SBIG STL-11000M CCD camera with Bessel $UBVRI$ filters. The photometric accuracy reached with a single five-minute exposure is 0.2 mag at B=20.0 mag. In this article we present some of the first observational results obtained at Plana SAO – photometric measurements of novae in M31 and AGNs. The list of observed novae includes M31N 2013-10a, M31N 2013-10d, M31N 2013-10g, M31N 2013-10h, M31N 2013-12a and M31N 2013-12b. Broadband $BVRI$ photometry of BL Lac near its historical maximum in the autumn of 2013 is presented as well.

Key words: telescopes, site testing, light pollution, novae, BL Lacertae objects

Introduction

Small ground-based observatories are very useful for many studies that cannot be carried out in larger ones. Telescopes with apertures in the range of 0.3-0.6 m equipped with professional CCD cameras are suitable for observations of exoplanets, novae and supernovae, variable stars, asteroids and comets, galaxy clusters and bright AGNs (Hatzidimitriou et al. 2007, Valcheva et al. 2010, Bachev et al. 2014).

The realization and development of Plana SAO will give students an opportunity to gain a substantial practical and theoretical experience while working on modern topics in observational astronomy. The equipment at Plana SAO will be used for many observational tasks and for the practical courses included in the curriculum adopted by the Department of Astronomy at the University of Sofia.

Plana SAO has the potential to produce an astronomical output comparable to that of the other professional observatories in Bulgaria.

1. The Observatory

Plana SAO has been established and tested between October 2011 and October 2013. It is managed by the Department of Astronomy, Faculty of Physics,

University of Sofia, Bulgaria. The observatory is located in the Plana mountain, inside the science complex of the Plana Geodetic Observatory, BAS (Bulgarian Academy of Sciences), at an altitude of 1240 m, longitude 23.4269 E and latitude +42.4764 N. Although it is only about 30 km southeast of Sofia, Plana mountain is known for the high percentage of clear nights. The mountain blocks out the city lights and the atmospheric pollution over the observatory is minimal because of favorable airflows.

The telescope is a 0.35 m Orion Optics VX14 Newtonian (350/1600 mm, f/D=4.6) on an equatorial mount. It is placed inside a suitable room with a sliding roof, inside the small building of Plana SAO. An SBIG STL-11000M CCD camera with 9μm pixels is currently being used. The field of view is 78 $\times$ 52 arcmin^2 with a circle of 40 arcmin in diameter free from coma aberration. The camera is equipped with Bessell $UBVRI$-filters.

2. Photometric accuracy

Calibration and tests were performed during several nights in the period April – July 2013. Standard fields (Stetson 2000) were observed in order to determine the photometric accuracy in BVR bands. Results based on five-minute exposure images of the NGC 188 field are shown in Fig.1. The images were obtained at an airmass of 1.4 in the night of 17/18 July 2013. The FWHM of point sources on these images is 3.5-4 arcsec.

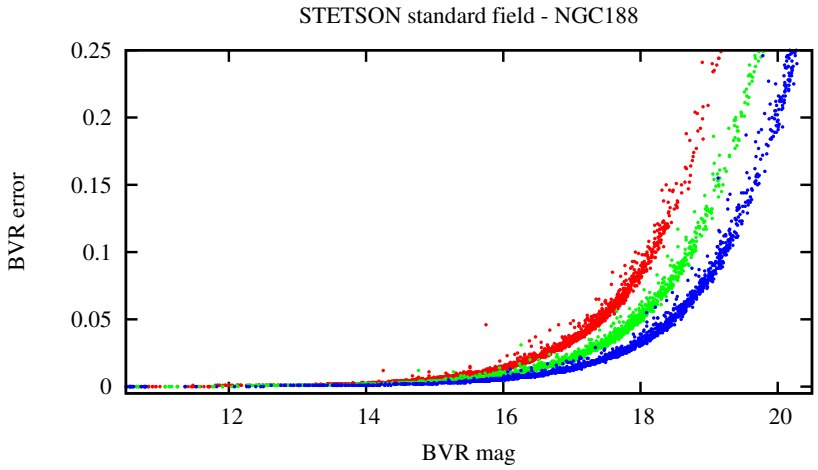

Fig. 1. The BVR standard magnitudes and their errors from single 300 sec exposures. Blue, green and red stand for B, V and R-band magnitudes, respectively.

A considerably higher photometric precision could be reached in better atmospheric conditions and also by image stacking.

3. Photometry of M31 novae and AGNs

Several observational campaigns were carried out during the last three months of 2013. The selected observational targets were novae in M31 and AGNs. Six novae in M31 were visible in the obtained images and some of the photometric points are already published (Ovcharov et al. 2013c, 2014). In two consecutive nights we performed optical photometry of the quasar B2 2308+34 (Carrasco et al. 2013, Buson 2013, Denisenko at al. 2013) and MASTER OT J234843.23+250250.4 (Shurpakov et al. 2013). The $BVRI$-band magnitudes are published in Ovcharov et al. (2013b). Observations of some blazars from the list of the GLAST-AGILE Support Program (GASP) of the Whole Earth Blazar Telescope (WEBT) (Villata et al. 2008, 2009, Raiteri et al. 2011, 2012 and 2013) were also performed. The obtained photometric results were sent to GASP-WEBT collaborators. A part of the $BVRI$-band photometry partially encompassing the brightening of BL Lac in the end of 2013 was published in Ovcharov et al. (2013a).

The BVR-band data for the six novae in M31 visible on the images from Plana SAO from October – December 2013 are summarized in Table 1. Secondary standards used for magnitude calibration of the objects are taken from Stanev et al. (2010). Detailed analysis with the addition of observations from Rozhen NAO and other data will be published soon.

Table 1. BVR-band data from Plana SAO for six novae in M31

Nova	Sp.Type	UT start	Magnitudes	number of images×exp	Reference
		yyyy-mm-dd.ddd	mag±err (filter)		
M31N 2013-10a	FeII	2013-10-27.003	19.074±0.250 (R)	11×90s	1
		2013-10-27.003	19.074±0.250 (R)	11×90s	1
M31N 2013-10d	He/N	2013-10-27.003	18.049±0.066 (R)	11×90s	1
M31N 2013-10g	FeII	2013-10-27.003	17.761±0.072 (R)	11×90s	1
		2013-10-27.955	17.568±0.081 (R)	11×90s	1
		2013-10-29.906	18.976±0.121 (B)	7×60s	1
		2013-10-29.917	18.368±0.113 (V)	8×60s	1
		2013-10-29.882	17.697±0.077 (R)	30×60s	2
		2013-11-02.905	18.148±0.069 (B)	9×60s	1
		2013-11-02.916	17.536±0.058 (V)	9×60s	1
		2013-11-02.883	17.371±0.070 (R)	30×60s	2
M31N 2013-10h	FeII	2013-11-02.905	15.994±0.012 (B)	9×60s	1
		2013-11-02.916	15.670±0.014 (V)	9×60s	1
		2013-11-02.883	15.646±0.024 (R)	30×60s	2
M31N 2013-12a	He/N	2013-12-20.767	17.392±0.208 (R)	19×60s	3
M31N 2013-12b	He/N	2013-12-20.767	16.594±0.091 (R)	19×60s	3
M31N 2013-12b	He/N	2013-12-20.795	17.287±0.144 (B)	60s	3
M31N 2013-12b	He/N	2013-12-20.798	17.161±0.169 (B)	60s	3
M31N 2013-12b	He/N	2013-12-20.878	17.003±0.186 (B)	60s	3

References – (1) first published here; (2) Ovcharov et al. (2013c); (3) Ovcharov et al. (2014).

In Table 2 we summarize the $BVRI$-band magnitudes of the blazar BL Lac observed at Plana SAO in four nights in October and December 2013. During that period the object was near the observed historical light curve maximum (Larionov et al. 2013). The comparison stars are taken from Bertaud et al. (1969) and Fiorucci & Tosti (1996).

Table 2. $BVRI$-band data for BL Lac from Plana SAO

UT start	Magnitudes	number of images×exp	Reference
yyyy-mm-dd.ddd	mag±err (filter)		
2013-10-27.850	14.756±0.005 (B)	120s	1
2013-10-27.853	14.763±0.005 (B)	120s	1
2013-10-27.858	13.697±0.003 (V)	90s	1
2013-10-27.838	13.134±0.004 (R)	60s	1
2013-10-27.839	13.139±0.004 (R)	60s	1
2013-10-27.841	13.122±0.003 (R)	60s	1
2013-10-29.798	14.765±0.009 (B)	5×60s	2
2013-10-29.803	13.702±0.007 (V)	4×60s	2
2013-10-29.787	13.094±0.006 (R)	3×60s	2
2013-10-29.792	12.330±0.007 (I)	3×60s	2
2013-11-02.827	14.688±0.010 (B)	5×60s	2
2013-11-02.833	13.599±0.008 (V)	2×60s	2
2013-11-02.821	13.045±0.007 (R)	2×60s	2
2013-11-02.823	12.271±0.008 (I)	3×60s	2
2013-12-20.733	15.106±0.014 (B)	60s	1
2013-12-20.736	15.108±0.016 (B)	60s	1
2013-12-20.737	14.055±0.010 (V)	60s	1
2013-12-20.738	14.045±0.010 (V)	60s	1
2013-12-20.740	14.048±0.011 (V)	60s	1
2013-12-20.740	13.457±0.009 (R)	60s	1
2013-12-20.742	13.468±0.009 (R)	60s	1
2013-12-20.744	12.656±0.012 (I)	60s	1
2013-12-20.745	12.686±0.011 (I)	60s	1
2013-12-20.746	12.674±0.010 (I)	60s	1

References – (1) first published here; (2) Ovcharov et al. (2013a).

Conclusion

Some significant astronomical results based on observations from the Plana Student Astronomical Observatory are presented. It provides observational data of significant quality for a variety of astronomical objects. The expected output is comparable to that of the other professional observatories in Bulgaria and worthy for publication in prestigious astronomical journals. The proximity of the observatory to the University of Sofia increases its strong educational impact. Further development of the observatory will favor national and international cooperation and will hopefully lead to important scientific results.

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