SERBIAN-BULGARIAN MINI-NETWORK TELESCOPES AND GAIA-FUN-TO FOR THE PERIOD 2014-2017

G. DAMLJANOVIĆ[1], S. BOEVA[2], O. VINCE[1], G. LATEV[2], R. BACHEV[2], M. D. JOVANOVIĆ[1], Z. CVETKOVIĆ[1], R. PAVLOVIĆ[1]

[1]Astronomical Observatory, Volgina 7, 11060 Belgrade, Serbia
[2]Institute of Astronomy with NAO, BAS, Tsarigradsko Shosse 72, 1784 Sofia, Bulgaria

E-mail: gdamljanovic@aob.rs

1. Introduction

The Gaia is a space mission of the European Space Agency – ESA.It is operating since 2014 (astrometrically, photometrically and spectroscopically surveying the full sky). The Gaia-based results are useful for all the relevant scientific communities. It is doing revolution in astrometry, our understanding of the Milky Way galaxy, stellar physics and the Solar system bodies. The main goal of Gaia is to collect the high-precision astrometric data (positions, proper motions, and parallaxes) of sources in the G magnitude range 3 to 21. The Gaia catalogue is an important step in the realization of the Gaia reference frame in future. The second Gaia data release - DR2 (~1.7 billion sources) has been made publicly available on April 2018.

The Gaia scans the sky multiple times, and provides near-real-time photometric data. These data are used to detect some changes in brightness from all over the sky (or appearance of new objects), and the Gaia Science Alerts system produces alerts on some interesting objects. The Gaia Photometric Science Alerts published first alerts at October 2014. Three years after that, the Gaia Science Alerts is among the leading transient surveys in the world. The transients are: supernovae, cataclysmic variables, microlensing events, other rare phenomena. During three years, more than 3000 transients were discovered (until October 2017).

The installation of first telescope (the 60 cm one) at Serbian new site , the Astronomical Station Vidojevica - ASV of Astronomical Observatory in Belgrade - AOB, was in 2010. At mid-2016 there is a new one, 1.4 m ASV telescope, via the Belissima project. Also, we used 4 instruments in Bulgaria.

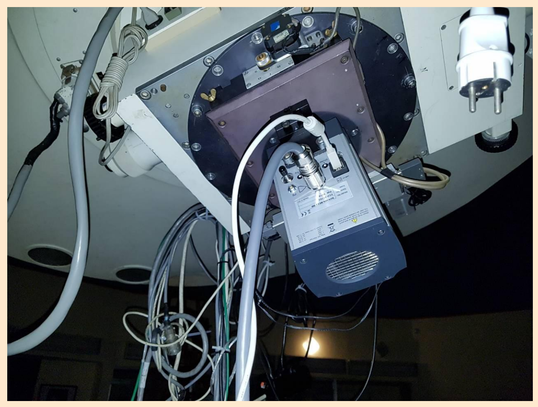

Fig.1. The 2 m Rozhen with new CCD Andor iKon-L

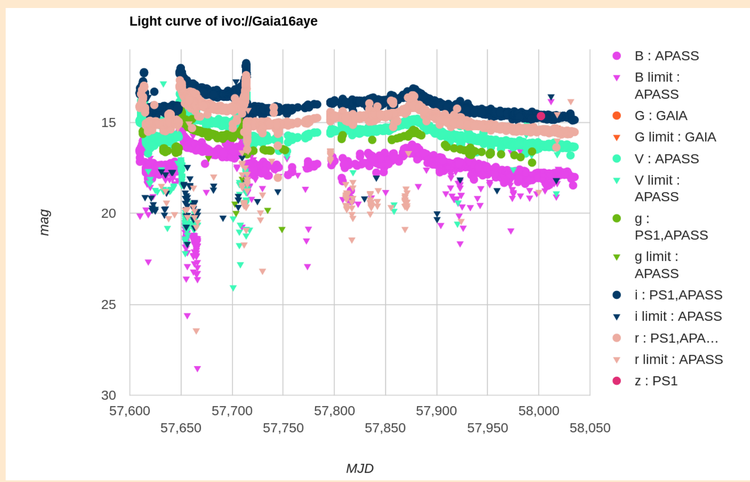

Fig.2. The light curve of Gaia16aye or Ayers Rock (mid-2016 - 9th October 2017)

2. Instruments and results

We started the regional cooperation “Serbian-Bulgarian mini-network telescopes” (now, 6 instruments) in 2013. It is in line with the SANU-BAN joint research project “Observations of ICRF radio-sources visible in optical domain” (for the period 2014-2016), and actual one “Study of ICRF radio-sources and fast variable astronomical objects” (2017-2019); head is Dr. G.Damljanovic. The main information about the instruments are:

1. ASV (AOB)	λ=21.º5E	CCD camera - Apogee Alta U42
Cassegrain	φ=43.º1N	2048x2048 pixels, scale=0."46
60cm/600cm	h=1140m	13.5x13.5μm pixel size, FoV=15.’8x15.’8
2. ASV (AOB)	21.5	Apogee Alta U42
Ritchey-Chrétien	43.1	2048x2048, 0.24
140/1142	1150	13.5x13.5, 8.3x8.3
3. Rozhen (NAO BAS)	24.7	VersArray 1300B
Ritchey-Chrétien	41.7	1340x1300, 0.26
200/1577	1730	20x20, 5.6x5.6
4. Rozhen (NAO BAS)	24.7	FLI PL09000
Cassegrain	41.7	3056x3056, 0.33
60/740	1760	12x12, 16.8x16.8
5. Rozhen (NAO BAS)	24.7	FLI PL16803
Schmidt-camera 50/70	41.7	4096x4096, 1.08
F=172	1759	9x9, 73.7x73.7
6. Belogradchik AO	22.7	FLI PL09000
Cassegrain	43.6	3056x3056, 0.33
60/740	650	12x12, 16.8x16.8

The site, telescope and D[cm]/F[cm] are in the first column. Then, the geographic coordinates (longitude - λ, latitude - φ) and altitude (h) of site are presented. The NAO BAS means National Astronomical Observatory of Bulgarian Academy of Sciences, SANU is Serbian Academy, FoV-field of view. Also, we used the 60 cm and 1.4 m ASV with other CCDs: the SBIG ST-10 XME (scale=0.“23 and FoV=8.’4x5.’7 using 60 cm ASV), Apogee Alta E47 (0.“45 and 7.’6x7.’6 using 60 cm ASV). Since April 2018, there is a new CCD, Andor iKon-L, on the 2 m Rozhen (see Fig. 1); before October 2017, a new aluminization was finished. The Johnson-Cousins BVRcIc filters were available. Usually, we did 3 CCD images per filter. The standard bias, dark and flat-fielded corrections are done (also, hot/dead pixels are removed). The Astrometry.Net and Source Extractor are used. The output is supposed to be submitted to the Cambridge Photometric Calibration Server (CPCS) for further calibration. We collected about 1850 CCD images of the Gaia-Follow-Up Network for Transients Objects (Gaia-FUN-TO, or Gaia Alerts) during about three years (October 2014 – end of 2017); or ~600 images per year.

In 2017, we observed **14 objects (56%)** using the **60cm ASV**: Gaia16aye (11 times), Gaia16bnz(2), Gaia17bsu(1), Gaia17bsp(1), Gaia17bsr(1), Gaia17bts(7), Gaia17bxh(1), Gaia17chf(1), Gaia17cgo(1), Gaia17che(1), Gaia17cpa(1), Gaia17cup(2), Gaia17cut(1), Kojimaevent(1). With the **1.4m ASV**, we did **5 objects (18%)**: Gaia16aye(11), Gaia17arv(1), Gaia17asa(1), Gaia17asc(1), Gaia17aru(1). With the **60cm Belogradchik**, just **1object(4%)** Gaia17ade(2). Also, **1 object(4%)** using the **2m Rozhen** (Gaia16aye(4)), but **5 objects(18%)** with **Schmidt-camera 50/70cm**:Gaia17asc(1),Gaia17arv(1), Gaia17asa(1), Gaia17chf (1), and Gaia17bts(1). The **60 cm Rozhen** telescope **(0%)** is under reconstruction from 2016.

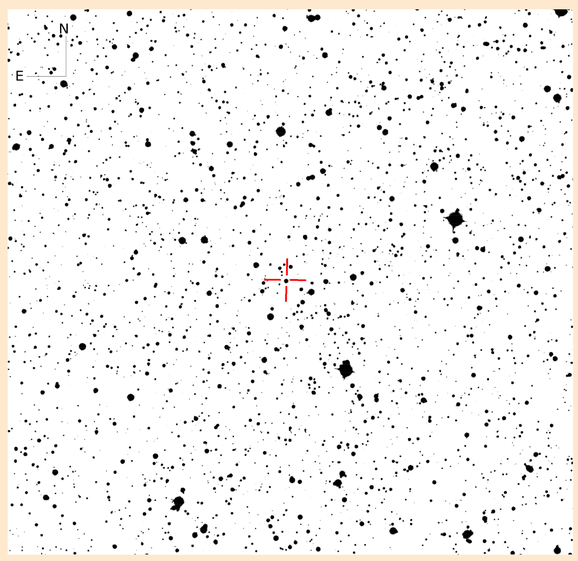

Fig.3. The Gaia16aye using the 1.4 m ASV telescope

For example, the CCD image of Gaia16aye, after standard reduction (bias/dark/flat, hot/dead pixels, etc.), is presented in Fig. 3; the object is marked with red cross. That image was made at 19th June 2017 using the 1.4 m ASV telescope with CCD Apogee Alta U42: R-filter, Exp.=40sec, FoV=8.’3x8.’3 , binning=1x1, scale=0.“243 . The Gaia16aye was published on Gaia Science Alerts webpage on 9 Aug 2016. The star has a counterpart in the 2MASS as 2MASS 19400112+3007533 towards the Cygnus constellation.

That object is the binary microlensing event and the first discovered in the Northern Galactic Disk. Lot of points in Fig. 2 (light curve of Gaia16aye) are the results of our observations. We observed the Gaia16aye 18 times (epochs) during second half of 2016 and 26 times during 2017. At 25th October 2016 we did it using 3 instruments: 2m Rozhen, 50/70cm Schmidt-camera (Rozhen) and 1.4m ASV. Together paper about that object is under preparation in the A&A journal (with other co-authors); we hope it will be done, soon.

In line with our cooperation with Dr. Alok Gupta (India) that object was observed 5 nights (21st-25th November 2016) with the 1.31 m ARIES telescope (Aryabhatta Research Institute of observational sciencES, Manora Peak, Nainital) in the central Himalayan region: λ=79.º7E, φ=29.º4N, h=2420 m. The CCD Andor DZ436 was used: 2048x2048 pixels, 13.5x13.5μm pixel size, scale=0.“54, FoV=18.’5x18.’5 . That instrument is modified R.-C. system Cassegrain; it is Devasthal Fast Optical telescope (DFOT).

3. Conclusion

The Gaia satellite (ESA mission) was launched at the end of 2013, and the first astronomical observations were in mid-2014. Since October 2014, the Gaia Photometric Science Alerts started to publish alerts. Until October 2017 about 3000 alerts (cataclysmic variables, supernovae, candidate microlensing events, etc) have been issued by the Gaia Science Alerts group. Using 6 telescopes (via our regional cooperation “Serbian-Bulgarian mini-network telescopes”) we observed few objects during the test phase in 2013 and 2014 (Damljanović et al. 2014). Then, we continued the observations of the Gaia-Follow-Up Network for Transients Objects (Gaia-FUN-TO, or Gaia Alerts) from the end of 2014. As result, we observed about 50 objects until the end of 2017 (more than 3 years of observations); ~1850 CCD images were collected or ~600 per year. It was done in Johnson BV and Cousins RcIc filters; usually we did 3 images per filter. The paper (Campbell et al. 2015) about rare object, the eclipsing AM CVn Gaia14aae one, was published. Also, some our results were presented at few conferences. From mid-2016, we took part in observations of the Gaia16aye (Ayers Rock), binary microlensing event, the first discovered in the Northern Galactic Disk; we hope it will be a published paper about that object, soon. Our plan is to continue with our activities about the Gaia-FUN-TO.

Acknowledgements

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