

# Gaia Alerts and Bulgarian-Serbian cooperation from 2014 to 2022

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# Introduction

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❖ Gaia mission is scanning full sky to create 3D map of our Galaxy. The ESA space mission: the satellite was launched in December 2013, with the first observations in mid-2014, and the first alerts after that. Goal: astrometry and photometry for >1 billion sources (down to 21 mag in Gaia G-band), spectroscopy for about 150 million objects (down to 16 mag).

Gaia EDR3 (3 Dec.2020) ~ 1.8 billion sources, Gaia DR3 (13 June 2022).

❖ Optical Gaia Celestial Reference Frame (Gaia CRF) - in the future (it is based on QSOs). Link Gaia CRF-ICRF, via QSOs visible in optical and radio domains.

❖ “Serbian-Bulgarian mini-network telescopes” have been established in 2013.

❖ We started observations for Gaia-FUN-TO from October 2014.



# Mini-network = 3 sites, 6 (7) telescopes:

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*Astronomical Station  
Vidojevica (ASV)*  
– Astronomical  
Observatory Belgrade  
(AOB, Serbia)

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*Rozhen National  
Astronomical Observatory  
(NAO)*  
– Bulgarian Academy of  
Sciences (BAS, Bulgaria)

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*Belogradchik  
Astronomical Observatory  
(AO, Bulgaria)*

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Telescopes:  
“Milankovic” 1.4 m;  
“Nedeljkovic” 60 cm;  
**Meade 40 cm, soon!**

Telescopes:  
2 m;  
60 cm;  
50/70 cm Schmidt-cam.

Telescope 60 cm.

- ❖ Plus telescope 1.31m of Aryabhata Research Institute of observational sciences (ARIES, Manora Peak, Nainital, India).
- ❖ Johnson UBV and Cousins RclC filters.
- ❖ The SASA-BAS joint research project “Gaia Celestial Reference Frame (CRF) and fast variable astronomical objects” 2020-2022 (G.Damljanović and R. Bachev).



# Instruments - Telescopes & Cameras

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1. **60 cm Cassegrain (ASV: long=21.5°, lat=43.1°, alt=1140m)**  
CCD Apogee Alta U42 (E47), SBIG ST-10 XME, FLI PL230;
2. **1.4 m Ritchey-Chrétien (ASV: 21.6, 43.1, 1150m)**  
Nasmyth, Cassegrain, CCD Apogee Alta U42, Andor iKon-L;
3. **2 m Ritchey-Chrétien (Rozhen NAO: 24.7°, 41.7°, 1730m)**  
CCD VersArray 1300B, Andor iKon-L;
4. **60 cm Cassegrain (Rozhen NAO: 24.7°, 41.7°, 1760m)**  
CCD FLI PL09000;
5. **50/70 cm Schmidt-camera (Rozhen NAO: 24.7°, 41.7°, 1760m)**  
CCD FLI-New PL16803;
6. **60 cm Cassegrain**  
(Belogradchik AO: 22.7°, 43.6°, 650m)  
CCD FLI PL09000.



# Instruments - Telescopes & Cameras

Telescope D/F [m]	Camera	Chip size [pixel]	Pixel size [ $\mu\text{m}$ ]	Scale [arc sec/pixel]	Field of View [arc min]
1.4/11.42 ASV	Apogee Alta U42	2048 x 2048	13.5 x 13.5	0.243	8.3 x 8.3
1.4/6.70	Andor iKon-L	2048 x 2048	13.5 x 13.5	0.39	13.3 x 13.3
2/15.774 Rozhen	VersArray 1300B	1340 x 1300	20 x 20	0.261	5.6 x 5.6
	Andor iKon-L	2048 x 2048	13.5 x 13.5	0.176	6.0 x 6.0
0.6/6 ASV	Apogee Alta U42	2048 x 2048	13.5 x 13.5	0.465	15.8 x 15.8
	SBIG ST10 XME	2184 x 1472	6.8 x 6.8	0.23	8.4 x 5.7
0.6/7.5 Rozhen	FLI PL09000	3056 x 3056	12 x 12	0.33	16.8 x 16.8
0.6/7.5 Belogradchik	FLI PL09000	3056 x 3056	12 x 12	0.33	16.8 x 16.8
0.5/0.7/1.72 Rozhen	FLI PL16803	4096 x 4096	9 x 9	1.08	73.7 x 73.7

# ASV (Serbia)

1.4 m telescope  
since mid-2016



40 cm MEADE telescope  
since 2021 (?)



# NAO Rozhen telescopes

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Schmidt-camera 50/70cm



60cm



# Observed objects in 2021(5) and 2022(5) :

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- ❖ Five objects in 2021: Gaia19dke, Gaia21awo, Gaia21azb, Gaia21ehu, Gaia21efs; about 350 CCD images .
- ❖ ASV telescopes (60cm and 1.4m):
  - 10 times Gaia19dke,
  - 13 times Gaia21azb,
  - 1-time Gaia21awo, Gaia21ehu, Gaia21efs.
- ❖ Five objects in 2022 (until 1<sup>st</sup> Oct.2022): Gaia21cgt, Gaia22aeu, Gaia22atp, Gaia22btj, Gaia22btc. Usually 1-time per object, about 60 CCD images. ASV telescopes (60cm and 1.4m) were used.





# Published papers:

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- ❖ ~4000 objects per year (2022); from supernovae and CVs to rare phenomena like microlensing events or pair-instability supernovae.
- ❖ - Damjanovic, G., Vince, O., Boeva, S.: 2014, SAJ 188, 85-93.
  - Campbell, H.C., ..., Damjanovic, G. et al.: 2015, MNRAS 452, 1060-1067; about Gaia14aae, eclipsing AM CVn-system (stellar binaries, WD).
  - Wyrzykowski, L., ..., Damjanovic, G. et al.: 2020, A&A 633, A98; Gaia19aye, binary system ( $P=2.88$ years,  $d\sim 780$ pc), microlensing event.
  - Damjanovic, G., Boeva, S., Latev, G., Bachev, R., Vince, O., Jovanovic, M.D., Cvetkovic, Z., Pavlovic, R.: 2020, BAJ 32, 108-112.
  - Szegedi-Elek, E., ..., Damjanovic, G. et al.: 2020, ApJ 899:130(8pp); Gaiaadv, in the Cygnus OB3 ( $\sim 1.88$ kpc), consistent with FU Orionis-type young eruptive stars, the outburst  $> 4$ mag.
  - Hodgkin, S.T., ..., Damjanovic, G. et al.: 2021, A&A 652, A76.
- ❖ Workshops and conferences (15).



# Conclusions

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- ❖ Gaia-FUN-TO: ~110 objects in total for 2014-2022 using 6 telescopes, and BVRcIc filters. Usually, ~15 objects per year, but 11 in 2020, 5 in 2021, and 5 in 2022; ~3400 images from October 2014 to Oct.2022.
- ❖ The seeing varies from 1."0 to 3."5 (mean ~1."2 at ASV, but there are some nights with 0."7 at Rozhen and ASV).
- ❖ It is possible to observe the objects down to  $V \sim 20$  mag by using 2 m Rozhen or 1.4 m ASV (Exp.time. ~5min), or down to  $V \sim 19$  mag with smaller telescopes.
- ❖ The 1.4 m at ASV from mid-2016 (new dome 2018), 40 cm MEADE, new CCD Andor iKon-L 936 (also, for 2 m Rozhen since April 2018), new EMCCD Andor iXon 897 for lucky imaging, aluminization at 2 m Rozhen (done in 2017), etc.



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*Thank you!*

