Gaia Alerts and Bulgarian-Serbian cooperation from 2014 to 2022

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Introduction

- 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:

<table>
<thead>
<tr>
<th>Astronomical Station Vidojevica (ASV)</th>
<th>Rozhen National Astronomical Observatory (NAO)</th>
<th>Belogradchik Astronomical Observatory (AO, Bulgaria)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Astronomical Observatory Belgrade (AOB, Serbia)</td>
<td>- Bulgarian Academy of Sciences (BAS, Bulgaria)</td>
<td></td>
</tr>
<tr>
<td>Telescopes:</td>
<td>Telescopes:</td>
<td>Telescope 60 cm.</td>
</tr>
<tr>
<td>“Milankovic” 1.4 m;</td>
<td>2 m;</td>
<td></td>
</tr>
<tr>
<td>“Nedeljkovic” 60 cm;</td>
<td>60 cm;</td>
<td></td>
</tr>
<tr>
<td>Meade 40 cm, soon!</td>
<td>50/70 cm Schmidt-cam.</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Telescope D/F [m]</th>
<th>Camera</th>
<th>Chip size [pixel]</th>
<th>Pixel size [μm]</th>
<th>Scale [arc sec/pixel]</th>
<th>Field of View [arc min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4/11.42 ASV</td>
<td>Apogee Alta U42</td>
<td>2048 x 2048</td>
<td>13.5 x 13.5</td>
<td>0.243</td>
<td>8.3 x 8.3</td>
</tr>
<tr>
<td>1.4/6.70</td>
<td>Andor iKon-L</td>
<td>2048 x 2048</td>
<td>13.5 x 13.5</td>
<td>0.39</td>
<td>13.3 x 13.3</td>
</tr>
<tr>
<td>2/15.774 Rozhen</td>
<td>VersArray 1300B</td>
<td>1340 x 1300</td>
<td>20 x 20</td>
<td>0.261</td>
<td>5.6 x 5.6</td>
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<tr>
<td></td>
<td>Andor iKon-L</td>
<td>2048 x 2048</td>
<td>13.5 x 13.5</td>
<td>0.176</td>
<td>6.0 x 6.0</td>
</tr>
<tr>
<td>0.6/6 ASV</td>
<td>Apogee Alta U42</td>
<td>2048 x 2048</td>
<td>13.5 x 13.5</td>
<td>0.465</td>
<td>15.8 x 15.8</td>
</tr>
<tr>
<td></td>
<td>SBIG ST10 XME</td>
<td>2184 x 1472</td>
<td>6.8 x 6.8</td>
<td>0.23</td>
<td>8.4 x 5.7</td>
</tr>
<tr>
<td>0.6/7.5 Rozhen</td>
<td>FLI PL09000</td>
<td>3056 x 3056</td>
<td>12 x 12</td>
<td>0.33</td>
<td>16.8 x 16.8</td>
</tr>
<tr>
<td>0.6/7.5 Belogradchik</td>
<td>FLI PL09000</td>
<td>3056 x 3056</td>
<td>12 x 12</td>
<td>0.33</td>
<td>16.8 x 16.8</td>
</tr>
<tr>
<td>0.5/0.7/1.72 Rozhen</td>
<td>FLI PL16803</td>
<td>4096 x 4096</td>
<td>9 x 9</td>
<td>1.08</td>
<td>73.7 x 73.7</td>
</tr>
</tbody>
</table>
ASV (Serbia)
1.4 m telescope
since mid-2016

40 cm MEADE telescope
since 2021 (?)
NAO Rozhen telescopes

Schmidt-camera 50/70cm

60cm
Observed objects in 2021(5) and 2022(5):

- ASV telescopes (60cm and 1.4m):
  - 10 times Gaia19dke,
  - 13 times Gaia21azb,
  - 1-time Gaia21awo, Gaia21ehu, Gaia21efs.

- Five objects in 2022 (until 1st Oct.2022): Gaia21cg, Gaia22aeu, Gaia22atp, Gaia22btj, Gaia22btc. Usually 1-time per object, about 60 CCD images. ASV telescopes (60cm and 1.4m) were used.
Published papers:

- ~4000 objects per year (2022); from supernovae and CVs to rare phenomena like microlensing events or pair-instability supernovae.
  - Szegedi-Elek, E., …, Damljanovic, G. et al.: 2020, ApJ 899:130(8pp); Gaiadvy, in the Cygnus OB3 (~1.88kpc), consistent with FU Orionis-type young eruptive stars, the outburst>4mag.

- Workshops and conferences (15).
Conclusions

- **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~20 mag by using 2 m Rozhen or 1.4 m ASV (Exp.time. ~5min), or down to V~19mag 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.
Thank you!