

10 new variable stars discovered from digitized archival photographic plates of the Moscow Plate Archive

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#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1			22 34 48.441 +57 07 10.33	EB	15.23	15.67	zr	0.549619	2458386.7761	Min		<a href="#">Comm. 1</a>	<a href="#">lc1.png</a>	<a href="#">fc1.jpg</a>	<a href="#">mpa1.txt</a> <a href="#">zg1.txt</a> <a href="#">zr1.txt</a>
2			22 36 17.664 +56 48 04.72	EB	16.18	17.00	g	0.5957448	2460227.6465	Min		<a href="#">Comm. 2</a>	<a href="#">lc2.png</a>	<a href="#">fc2.jpg</a>	<a href="#">g2.txt</a>
3			22 38 28.068 +57 19 18.28	LB	13.98	14.12	zr			other		<a href="#">Comm. 3</a>	<a href="#">lc3.png</a>	<a href="#">fc3.jpg</a>	<a href="#">zg3.txt</a> <a href="#">zr3.txt</a>
4			22 41 47.892 +50 17 10.79	EA	14.60	14.94	zr	1.008090	2458681.8779	Min		<a href="#">Comm. 4</a>	<a href="#">lc4.png</a>	<a href="#">fc4.jpg</a>	<a href="#">zg4.txt</a> <a href="#">zr4.txt</a>
5			22 42 16.885 +50 04 04.60	LB	13.47	13.80	zr			other		<a href="#">Comm. 5</a>	<a href="#">lc5.png</a>	<a href="#">fc5.jpg</a>	<a href="#">zg5.txt</a> <a href="#">zr5.txt</a>
6			22 42 37.328 +50 37 37.69	EB	15.84	16.42	zg	0.4653865	2458439.7487	Min		<a href="#">Comm. 6</a>	<a href="#">lc6.png</a>	<a href="#">fc6.jpg</a>	<a href="#">zg6.txt</a> <a href="#">zr6.txt</a>
7			22 48 55.096 +57 15 19.82	EA	15.43	15.86	g	2.594317	2460560.8137	Min		<a href="#">Comm. 7</a>	<a href="#">lc7.png</a>	<a href="#">fc7.jpg</a>	<a href="#">mpa7.txt</a> <a href="#">g7.txt</a>
8			22 51 05.667 +57 33 21.17	L	13.70	14.00	zg			other		<a href="#">Comm. 8</a>	<a href="#">lc8.png</a>	<a href="#">fc8.jpg</a>	<a href="#">zg8.txt</a>
9			22 56 35.784 +55 26 53.93	EA	15.49	16.59	zr	1.3309038	2458269.925	Min		<a href="#">Comm. 9</a>	<a href="#">lc9.png</a>	<a href="#">fc9.jpg</a>	<a href="#">mpa9.txt</a> <a href="#">g9.txt</a> <a href="#">zg9.txt</a> <a href="#">zr9.txt</a>
10			22 57 45.304 +56 24 24.59	LB	13.40	13.57	zr			other		<a href="#">Comm. 10</a>	<a href="#">lc10.png</a>	<a href="#">fc10.jpg</a>	<a href="#">zg10.txt</a> <a href="#">zr10.txt</a>

Comments:

1. GAIA DR3 2007659858120992896. Min II = 15.45 zr.
2. GAIA DR3 2006886386051006464. Min II = 16.47 g.
3. GAIA DR3 2007290422213768192. J = 12.508, H = 12.052, K = 11.924 (2MASS).
4. GAIA DR3 1989494998308806784. Twice longer period is highly possible.
5. GAIA DR3 1989476753287806720. J = 11.068, H = 10.223, K = 10.009 (2MASS).
6. GAIA DR3 1989573201075344384. Min II = 16.05 zg.
7. GAIA DR3 2007136799822425600.
8. GAIA DR3 2007164768650338816. J = 12.425, H = 12.250, K = 12.036 (2MASS).
9. GAIA DR3 2002954188866388096. Min II = 15.58 zr.
10. GAIA DR3 2009804111948440064. J = 11.375, H = 10.703, K = 10.557 (2MASS).

Remarks:

We report the discovery of 10 new variable stars in the data extracted from the photographic plates of the [Moscow Photographic Plate Collection](#) (Samus et al. 2005). We inspected 127 scanned plates with the field center  $\alpha$ =22h40m  $\delta$ =+54°00'(J2000.0). The initial astrophotographs were taken between 1983 and 1996. The field of view is 10° × 10°, the exposures were 45 minutes. The limiting magnitude is between 17<sup>m</sup> to 17<sup>m</sup>.5 pg depending on weather or technical conditions.

The description of the plates digitization technique is published by Antipin et al. (2018). The plates were scanned with the help of Epson Expression 11000XL scanner at the Sternberg Astronomical Institute at 2400dpi resolution, processed, aligned and stacked. The scanned image-stack was further divided into nearly 100 subfields. Each subfield contained up to 127 data points for hundreds of stars. The subfields were analysed by means of the [VaST](#) software package (Sokolovsky and Lebedev 2018). Candidates for variable stars were shortlisted, a search through the General Catalogue of Variable Stars (Samus et al. 2017) and the [VSX](#) was conducted and then previously unknown variable stars were brought forward out of many hundreds of stars that were analysed. These discoveries were confirmed with data mining by looking up the Zwicky Transient Facility (ZTF) photometric data (Bellm et al. 2019; Masci et al. 2019) via the [SNAD ZTF viewer](#) (Malanchev et al. 2023), bringing the total to 10. Also for some cases we inspected publicly available photometry from [the ASAS-SN Sky Patrol](#) (Shappee et al. 2014; Kochanek et al. 2017). To find periods, we applied the [online light curve analysis tool](#) developed by Dr. K.V. Sokolovsky.

The coordinates of the stars were drawn from the Gaia DR3 catalogue (Gaia Collaboration et al. 2023). The infrared JHK magnitudes were drawn from the 2MASS catalogue (Skrutskie et al. 2006).

The abbreviations in the data files are as follows: 'mpa' stands for the Moscow Plate Archive, 'zg' and 'zr' - for ZTF g and r bands respectively, 'g' - for ASAS-SN g band.

**Note added in proof.** The study was finished before GAIA DR3 variables were added to the VSX.

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