

New Variable Stars Discovered at Moscow Palace of Pioneers. Part 1. Eclipsing Binaries

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#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1		USNO-B1.0 0955-0346725	18 15 39.546 +05 34 22.02	EA	16.38	18.20	r	1.87526	2459017.8410	Min		Comm. 1	m8ph.png	m8brir.png	m8zg.txt m8zr.txt m8ac.txt m8ao.txt
2			18 16 27.991 +03 19 29.55	EA/WD	17.41	17.73	r	0.2428935	2458509.0900	Min		Comm. 2	m6ph.png	m6brir.jpg	m6zg.txt m6zr.txt
3		USNO-B1.0 0967-0400894	18 33 52.476 +06 44 49.35	EA	17.42	18.81	r	1.68741	2458667.1660	Min		Comm. 3	m5ph.png	m5brir.png	m5zg.txt m5zr.txt m5zi.txt
4		USNO-B1.0 1030-0398784	18 42 09.980 +13 05 21.71	EA	17.42	18.23	r	1.3870743	2458773.7527	Min		Comm. 4	m15ph.png	m15brir.png	m15zg.txt m15zr.txt
5		USNO-B1.0 1028-0439526	18 42 18.992 +12 53 09.21	EA	17.06	19.4:	r	3.2214	2459818.7100	Min		Comm. 5	m21ph.png	m21brir.png	m21zg.txt m21zr.txt m21ac.txt m21ao.txt
6		USNO-B1.0 1178-0517790	19 38 13.322 +27 53 03.81	EA	18.80	20.37	r	2.00372	2458247.9540	Min		Comm. 6	m4ph.png	m4brir.jpg	m4zg.txt m4zr.txt m4zi.txt
7		USNO-B1.0 1231-0433523	19 43 18.625 +33 10 08.00	EA	17.52	19.90	g	2.71291	2458342.4000	Min		Comm. 7	m23ph.png	m23brir.png	m23zg.txt m23zr.txt m23zi.txt
8		USNO-B1.0 1043-0516571	19 43 52.351 +14 21 33.58	EA	18.05	20.30	g	2.08702	2458645.9253	Min		Comm. 8	m19ph.png	m19brir.png	m19zg.txt m19zr.txt
9		USNO-B1.0 1234-0390122	19 45 14.053 +33 29 28.19	EA	18.31	20.73	g	2.64324	2458619.4120	Min		Comm. 9	m11ph.png	m11brir.jpg	m11zg.txt m11zr.txt m11zi.txt
10		USNO-B1.0 1299-0358589	19 50 10.140 +39 57 51.16	EA	19.62	21.5:	g	2.251375	2459174.2700	Min		Comm. 10	m20ph.png	m20brir.png	m20zg.txt m20zr.txt
11		USNO-B1.0 1286-0369685	19 53 44.553 +38 38 43.45	EA	17.51	18.77	r	5.18383	2458734.7050	Min		Comm. 11	m16ph.png	m16brir.png	m16zg.txt m16zr.txt m16ac.txt m16ao.txt
12		USNO-B1.0 1252-0417511	20 40 16.471 +35 12 45.62	EA	17.08	18.70	r	6.25293	2456520.0200	Min		Comm. 12	m17ph.png	m17brir.png	m17zg.txt m17zr.txt m17ac.txt m17ao.txt
13		USNO-B1.0 1221-0585747	20 43 52.872 +32 08 02.65	EA	18.17	20.7:	g	2.99299	2458618.6250	Min		Comm. 13	m18ph.png	m18brir.png	m18zg.txt m18zr.txt m18zi.txt
14		USNO-B1.0 1395-0396648	21 22 40.211 +49 35 39.19	EA	17.30	<21.0	r	43.102	2455433.600	Min		Comm. 14	g4ph.png	g4brir.jpg	g4zg.txt g4zr.txt g4ac.txt g4ao.txt

Comments:

1. = Minkovskiy 8. Eclipse on 1993-05-27 POSS-II red plate. Min II = 16^m.5 r. D = 0.18 P.

2. = Minkovskiy 6. Min II = 17^m.56 r. FUV-NUV = - 0.22 (GALEX).

3. = Minkovskiy 5. Min II = 17^m.59 r. D = 0.15 P.

4. = Minkovskiy 15. Min II = 17^m.88 r. D = 0.06 P.

5. = Minkovskiy 21. Min II = 17^m.19 r. D = 0.14 P.

6. = Minkovskiy 4. Eclipse on 1988-07-14 POSS-II blue plate. Min II = 18^m.91 r. D = 0.12 P.

7. = Minkovskiy 23. Min II = 17^m.60 g. D = 0.12 P.

8. = Minkovskiy 19. Min II = 18^m.36 g. D = 0.17 P.

9. = Minkovskiy 11. Min II = 18^m.42 r. D = 0.10 P. The variable Minkovskiy 12 from the chart will be discussed in a subsequent paper.

10. = Minkovskiy 20. D = 0.10 P.

11. = Minkovskiy 16. Min II = 17^m.63 r. D = 0.08 P.

12. = Minkovskiy 17. Min II = 17^m.19 r. D = 0.09 P.

13. = Minkovskiy 18. Min II = 18^m.26 g. D = 0.11 P.

14. = Gusev 4. ATLAS magnitudes partially contaminated by 2MASS J21224058+4935454 ($V = 17^m.4$; sep. 7"). D = 0.23 P. The differences of the eclipse's depth and width in different bands could not be explained so far. The variable Gusev3 from the chart will be discussed in a subsequent paper.

Remarks:

We report the discovery of the new variable stars by the students of after-school astronomy classes of the Moscow Palace of Pioneers at Vorobyovy Gory. The new variable objects were identified during 2021–2023 in the course of the PALEO project on the digitized Palomar Sky Survey plates (PALEO stands for PALomar Extinct Objects). This paper summarizes data on 14 eclipsing variable stars. Newly found cataclysmic and pulsating variables will be reported in parts 2 and 3, respectively.

The variability of the stars was suspected from visual inspection of the DSS colored maps using [SIMBAD](#) web interface. The stars displaying either unusually blue or extremely red color on the combined POSS-II blue+red plates were suspected to be variable. Then we checked in the [VSX](#) if the objects were already known as variable stars. We inspected the Catalina Real-Time Transient Survey (Drake et al., 2009), Zwicky Transient Facility Data Release 19 (Masci et al., 2019), Pan-STARRS1 Data Release 2 (Flewelling et al., 2020) and ATLAS Forced Photometry server (Heinze et al., 2018) to find light curves of the candidates, if available. The photometric time series from those surveys were then combined using [the script](#) written by D.N. and analysed with [the period search software](#) by K. Sokolovsky. The light elements were determined using Heliocentric Julian Days (HJD) of observations. Pan-STARRS1 data for the objects will be provided upon request, the data from other surveys are given in the table. Note that abbreviations zg, zr and zi are for ZTF g-, r- and i-bands, and ac and ao are for ATLAS cyan and orange bands respectively. We provide the finder charts with the variables being near the minimal brightness.

Stars' designations in table are from USNO-B1.0 catalogue (Monet et al., 2003). The coordinates of the stars were drawn from the Gaia DR3 catalogue (Gaia Collaboration, 2023).

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References:

- Drake, A. J., Djorgovski, S. G., Mahabal, A., et al., 2009, *Astrophys. J.*, 696, No. 1, 870
Flewelling, H. A., Magnier, E. A., Chambers, K. C. et al., 2020, *Astrophys. J. Supp. Ser.*, 251, 7
Gaia Collaboration, Vallenari, A., Brown, A. G. A., et al., 2023, *Astron. Astrophys.*, 674, A1
Heinze, A. N., Tonry, J. L., Denneau, L., et al., 2018, *Astron. J.*, 156, id. 241
Masci, F. J., Laher, R. R., Rusholme, B., 2019, *Publ. Astron. Soc. Pacific*, 131, 018003
Monet, D. G., Levine, S. E., Canzian, B., et al., 2003, *Astron. J.*, 125, 984
Skrutskie, M. F., Cutri, R. M., Stiening, R., et al., 2006, *Astron. J.*, 131, 1163