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New Variable Stars at the Borderline of Ophiuchus and Serpens

V. Solovyov[#1], A. Samokhvalov[#2], T. Kryachko[#3], B. Satovskiy[#3]

#1. Kazan Federal University, Kazan, Russia;
#2. Surgut, Russia;
#3. Astrotel Observatory, Karachay-Cherkessia, Russia

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(E-mail for contact: solo.vya@gmail.com, sav@surgut.ru, bredfild@mail.ru, bs25@mail.ru)

#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1		USNO-A2.0 0900-12927997	18 28 30.02, +02 51 56.1	RRAB	16.53	17.76	*	0.40878	2455769.437	Max		Comm. 1	01_PC-R.png	01_chart.jpg	01_data.txt
2		USNO-A2.0 0900-12932590	18 28 35.74, +02 59 26.9	SR:	14.88	15.10	*	23.8	2456186.7	Max		Comm. 2	02_PC-R.png	02_chart.jpg	02_data.txt
3		USNO-A2.0 0900-12933840	18 28 37.30, +03 18 04.9	RRC	15.61	16.00	*	0.32260	2456200.2274	Max		Comm. 3	03_PC-R.png	03_chart.jpg	03_data.txt
4		USNO-A2.0 0900-12941846	18 28 47.46, +03 05 25.9	EW	15.82	16.28	*	0.385182	2455344.3523	Min		Comm. 4	04_PC-R.png	04_chart.jpg	04_data.txt
5		USNO-A2.0 0900-12947082	18 28 53.80, +02 48 48.5	SR:	13.60	13.77	*	28.3	2455038.2	Max		Comm. 5	05_PC-R.png	05_chart.jpg	05_data.txt
6		USNO-A2.0 0900-12947371	18 28 54.23, +03 31 05.5	LB	13.29	14.40	*			other		Comm. 6	06_PC-R.png	06_chart.jpg	06_data.txt
7		USNO-A2.0 0900-12952481	18 29 00.80, +03 12 52.5	SR:	14.58	14.86	*	41	2456199.5	Max		Comm. 7	07_PC-R.png	07_chart.jpg	07_data.txt
8		2MASS 18290128+0319587	18 29 01.29, +03 19 58.8	EA	16.05	17.80	*	2.19848	2455019.269	Min			08_PC-R.png	08_chart.jpg	08_data.txt
9		2MASS 18290864+0254162	18 29 08.65, +02 54 16.3	EA	14.90	15.19	*	1.9619	2455038.521	Min		Comm. 9	09_PC-R.png	09_chart.jpg	09_data.txt
10		USNO-A2.0 0900-12961860	18 29 12.73, +03 13 40.8	SR:	13.76	14.78	*	101:	2455803	Max		Comm. 10	10_PC-R.png	10_chart.jpg	10_data.txt
11		USNO-A2.0 0900-12961808	18 29 12.73, +03 37 07.4	SR:	13.60	13.88	*	30.6	2455773	Max		Comm. 11	11_PC-R.png	11_chart.jpg	11_data.txt
12		USNO-A2.0 0900-12962061	18 29 13.04, +03 05 01.9	EW	13.79	13.97	*	0.306429	2455344.3580	Min		Comm. 12	12_PC-R.png	12_chart.jpg	12_data.txt
13		USNO-A2.0 0900-12965054	18 29 16.68, +03 26 55.8	SR:	13.72	14.12	*	48.7	2455773	Max		Comm. 13	13_PC-R.png	13_chart.jpg	13_data.txt
14		USNO-A2.0 0900-12966247	18 29 18.06, +03 40 56.5	LB	14.19	14.63	*			other		Comm. 14	14_PC-R.png	14_chart.jpg	14_data.txt
15		USNO-A2.0 0900-12976816	18 29 30.66, +03 24 29.7	SR:	14.28	15.12	*	113	2455778	Max		Comm. 15	15_PC-R.png	15_chart.jpg	15_data.txt
16		USNO-A2.0 0900-12977755	18 29 31.82, +03 28 53.1	SR:	15.80	16.44	*	41.7:	2456242	Max		Comm. 16	16_PC-R.png	16_chart.jpg	16_data.txt
17		USNO-A2.0 0900-12979209	18 29 33.67, +03 30 49.1	SR:	12.77	12.87	*	37.4	2456203	Max		Comm. 17	17_PC-R.png	17_chart.jpg	17_data.txt
18		USNO-A2.0 0900-12982072	18 29 37.32, +03 27 52.0	SR:	14.49	15.45	*	124:	2455757	Max		Comm. 18	18_PC-R.png	18_chart.jpg	18_data.txt
19		2MASS 18293993+0251548	18 29 39.94, +02 51 54.8	SR:	13.46	14.51	*	74:	2455741	Max		Comm. 19	19_PC-R.png	19_chart.jpg	19_data.txt
20		USNO-A2.0 0900-12984926	18 29 40.89, +03 24 34.6	RRAB	15.08	16.06	*	0.564245	2455772.4814	Max		Comm. 20	20_PC-R.png	20_chart.jpg	20_data.txt

21		USNO-A2.0 0900-13004335	18 30 06.19, +03 27 22.5	SR:	13.80	13.94	*	18.37	2455023	Max		Comm. 21	21_PC-R.png	21_chart.jpg	21_data.txt
22		USNO-A2.0 0900-13006814	18 30 09.56, +03 25 45.2	SR:	14.69	14.84	*	18.9	2455770	Max		Comm. 22	22_PC-R.png	22_chart.jpg	22_data.txt
23		USNO-A2.0 0900-13010036	18 30 13.95, +03 10 49.7	SR:	14.24	14.44	*	22.28	2455734.6	Max		Comm. 23	23_PC-R.png	23_chart.jpg	23_data.txt
24		USNO-A2.0 0900-13012157	18 30 16.85, +03 12 10.7	SR:	14.08	14.30	*	20.6:	2456219	Max		Comm. 24	24_PC-R.png	24_chart.jpg	24_data.txt
25		USNO-A2.0 0900-13018489	18 30 25.63, +03 40 56.4	LB	14.67	15.85	*			other		Comm. 25	25_PC-R.png	25_chart.jpg	25_data.txt
26		USNO-A2.0 0900-13019383	18 30 26.79, +02 50 17.1	SR:	12.64	12.82	*	20.38	2456185	Max		Comm. 26	26_PC-R.png	26_chart.jpg	26_data.txt
27		USNO-A2.0 0900-13022138	18 30 30.37, +03 31 47.8	SR:	15.26	15.82	*	100:	2455100	Max		Comm. 27	27_PC-R.png	27_chart.jpg	27_data.txt
28		USNO-A2.0 0900-13033000	18 30 45.07, +03 37 50.1	SR:	15.03	15.48	*	42.6:	2455048	Max		Comm. 28	28_PC-R.png	28_chart.jpg	28_data.txt
29		USNO-A2.0 0900-13033890	18 30 46.40, +03 14 57.3	RRAB	14.83	16.24	*	0.439717	2456173.3065	Max		Comm. 29	29_PC-R.png	29_chart.jpg	29_data.txt
30		USNO-A2.0 0900-13034971	18 30 47.83, +03 41 00.9	M	14.85	18.50	*	231	2455134	Max		Comm. 30	30_PC-R.png	30_chart.jpg	30_data.txt
31		USNO-A2.0 0900-13047629	18 31 05.70, +03 09 43.2	BY:	14.69	14.83	*	6.2550	2455023.19	Max		Comm. 31	31_PC-R.png	31_chart.jpg	31_data.txt
32		USNO-A2.0 0900-13059807	18 31 24.24, +02 52 58.5	SR:	14.11	14.38	*	21.8	2456193.4	Max		Comm. 32	32_PC-R.png	32_chart.jpg	32_data.txt
33		USNO-A2.0 0900-13063626	18 31 30.44, +03 12 55.6	SR:	14.75	15.37	*	42.8:	2456178.9	Max		Comm. 33	33_PC-R.png	33_chart.jpg	33_data.txt
34		USNO-A2.0 0900-13071884	18 31 42.91, +02 59 58.0	SR:	12.87	13.20	*	38.7:	2456207.	Max		Comm. 34	34_PC-R.png	34_chart.jpg	34_data.txt
35		USNO-A2.0 0900-13076486	18 31 49.92, +03 22 46.1	SR:	13.17	13.70	*	181	2455109	Max		Comm. 35	35_PC-R.png	35_chart.jpg	35_data.txt
36		USNO-A2.0 0900-13077017	18 31 50.72, +03 32 45.8	EB	14.32	14.63	*	0.654299	2456174.3115	Min		Comm. 36	36_PC-R.png	36_chart.jpg	36_data.txt
37		USNO-A2.0 0900-13079606	18 31 54.63, +03 28 50.3	SR:	15.34	16.16	*	69.6:	2455071	Max		Comm. 37	37_PC-R.png	37_chart.jpg	37_data.txt

Comments:

1. Maxima:

HJD(TT)	±
2455769.437	0.003
2456047.424	0.005
2456049.468	0.003
2456189.2651	0.0008

2. A close pair of two stars: USNO-A2.0 0900-12932590 and 2MASS 18283560+0259315. USNO-A2.0 0900-12932590 varies. Infrared colors J–H = 1.044, H–K = 0.344 and J–K = 1.388 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maximum: HJD(TT) 2456186.7±0.5.

3. A close triplet of stars USNO-A2.0 0900-12933840, 2MASS 18283742+0318015, and a faint star not contained in any catalogues. USNO-A2.0 0900-12933840 varies.
Maximum: HJD(TT) 2456200.2274±0.0009.

4. Primary minima:

HJD(TT)	±

2455344.3523	0.0007
2456173.2661	0.0008
2456183.2770	0.0004
2456200.2275	0.0009

$Min_{II} = 16^{m}.26$.

5. Infrared colors J–H = 0.973, H–K = 0.340 and J–K = 1.313 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

6. Infrared source IRAS 18264+0329. Infrared colors J–H = 1.102, H–K = 0.400 and J–K = 1.502 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and LB classification.

7. Infrared colors J–H = 1.002, H–K = 0.345 and J–K = 1.347 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455747.0	0.9
2456199.5	0.6

9. Period $0^{d}.9810$ is also possible.

10. Infrared colors J–H = 1.026, H–K = 0.503 and J–K = 1.529 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455803	1
2456208	1

11. A close pair of two stars: USNO-A2.0 0900-12961808 and a faint star, not contained in any catalogues. USNO-A2.0 0900-12961808 varies. Infrared colors J–H = 1.036, H–K = 0.374 and J–K = 1.410 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

12. Primary minima:

HJD(TT)	±
2455344.3580	0.0004
2455772.4432	0.0007
2455785.3063	0.0002
2455815.3373	0.0008
2456049.4515	0.0010
2456052.511	0.001
2456173.2469	0.0002

$Min_{II} = 13^{m}.95$.

13. Infrared colors J–H = 1.021, H–K = 0.333 and J–K = 1.354 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maximum: HJD(TT) 2455773±1.

14. Infrared colors J–H = 1.079, H–K = 0.488 and J–K = 1.567 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and LB classification.

15. Infrared colors J–H = 1.071, H–K = 0.431 and J–K = 1.502 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maximum: HJD(TT) 2455778.0±1.5.

16. Infrared colors J–H = 1.094, H–K = 0.383 and J–K = 1.477 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

17. Infrared colors J–H = 0.848, H–K = 0.305 and J–K = 1.153 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maximum: HJD(TT) 2456203±2.

18. Infrared colors J–H = 1.043, H–K = 0.501 and J–K = 1.544 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maximum: HJD(TT) 2455757±1.

19. Infrared colors J–H = 0.933, H–K = 0.337 and J–K = 1.270 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455741	2
2456188	1

20. Maxima:

HJD(TT)	±
2455772.4814	0.0008
2455784.3359	0.0009
2456183.258	0.002
2456218.2414	0.0005

21. A close pair of two stars: USNO-A2.0 0900-13004335 and a faint star, not contained in any catalogues. USNO-A2.0 0900-13004335 varies. Infrared colors J–H = 1.000, H–K = 0.385 and J–K = 1.385 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

22. Infrared colors J–H = 1.066, H–K = 0.281 and J–K = 1.347 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

23. Infrared colors J–H = 1.037, H–K = 0.440 and J–K = 1.477 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455734.6	0.5
2456180.8	0.7

24. A close pair of two stars: USNO-A2.0 0900-13012157 and a faint star, not contained in any catalogues. USNO-A2.0 0900-13012157 varies. Infrared colors J–H = 1.080, H–K = 0.296 and J–K = 1.376 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

25. Infrared colors J–H = 1.131, H–K = 0.455 and J–K = 1.586 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and LB classification.

26. A close triplet of stars USNO-A2.0 0900-13019383 and two faint stars, not contained in any catalogues. USNO-A2.0 0900-13019383 varies. Infrared colors J–H = 1.101, H–K = 0.429 and J–K = 1.530 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455736	1
2456185	1

27. A close triplet of stars USNO-A2.0 0900-13022138, NOMAD1 0935-0383912 and NOMAD1 0935-0383907. USNO-A2.0 0900-13022138 varies. Infrared colors J–H = 1.160, H–K = 0.462 and J–K = 1.622 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

28. Infrared colors J–H = 1.103, H–K = 0.382 and J–K = 1.485 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

29. Blazhko effect with a period of $53^{d}.4$.
Maxima:

HJD(TT)	±
2455344.4166	0.0006
2455432.366	0.001
2456173.3065	0.0004
2456195.2942	0.0008

30. USNO-A2.0-0900-13034971 is located near the position of a known variable star, NSVS 13891310, discovered by Benko and Csubry (2007) using NSVS data. The angular resolution of the ROTSE-I instrument is insufficient for a decision which star varies. Using our telescope, we confidently identified the variable star and determined its variability parameters. Infrared colors J–H = 1.059, H–K = 0.524 and J–K = 1.583 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and Mira classification.

31. Infrared colors J–H = 0.772, H–K = 0.295 and J–K = 1.067 (2MASS) are consistent with the K-M spectral type (Bessell and Brett 1988) and BY: classification.

32. Infrared colors J–H = 0.778, H–K = 0.245 and J–K = 1.023 (2MASS) are consistent with the K-M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455733.9	0.7
2455781.6	0.7
2456193.4	0.3

33. Infrared colors J–H = 1.122, H–K = 0.482 and J–K = 1.604 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.
Maxima:

HJD(TT)	±
2455747.9	0.8

2456178.9	0.6

34. Infrared colors J–H = 1.105, H–K = 0.459 and J–K = 1.564 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

35. Infrared colors J–H = 1.125, H–K = 0.424 and J–K = 1.549 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

36. Primary minima:

HJD(TT)	±
2456174.3115	0.0006
2456195.2510	0.0006

$Min_{II} = 14^{m}.48$.

37. Infrared colors J–H = 1.202, H–K = 0.438 and J–K = 1.640 (2MASS) are consistent with the M spectral type (Bessell and Brett 1988) and SR: classification.

Remarks:

During observations of a field at the borderline of Ophiuchus and Serpens, we discovered 37 new variable stars. Our observations were carried out at the Astrotel-Caucasus observatory, located at the Astronomical station of the Kazan Federal university, using the 300-mm Ritchey-Chretien telescope, equipped with an unfiltered Apogee Alta U9000 CCD camera. A total of 1327 images with 5-minute exposures were obtained on JD 2455018–2456218. For basic reductions for dark current, flat fields, bias and for removing cosmic-ray hits we used IRAF routines. For search and photometry of new variable stars, we applied VaST software by Sokolovsky and Lebedev (2005). The comparison star was USNO-A2.0 0900-13006962 = USNO-B1.0 0936-0378151, $\alpha = 18^{h}30^{m}09^{s}.78$, $\delta = +03°36' 55''.1$ (J2000, 2MASS), $R_1 = 13^{m}.73$, $R_2 = 13^{m}.72$ (USNO-B1.0). Unfiltered magnitudes were calibrated using the comparison star, assuming $R_{comp} = 13^{m}.725$. The coordinates of the variable stars in the table were drawn from the 2MASS catalogue (Skrutskie et al. 2006). For search for periods and epochs of extrema we use Peranso software.

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References:

Benko, J.M., Csubry, Z., 2007, Acta Astron., 57, 73
Bessell, M.S., Brett, J.M., 1988, Publ. Astron. Soc. Pacific, 100, 1134
Skrutskie, M.F., Cutri, R.M., Stiening, R., et al., 2006, Astron. J., 131, 1163
Sokolovsky, K., Lebedev, A., 2005, in 12th Young Scientists' Conference on Astronomy and Space Physics, Kyiv, Ukraine, April 19–23, 2005, eds.: Simon, A., Golovin, A., p.79