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New Variable Stars on Digitized Moscow Collection Plates. The Field of 66 Ophiuchi

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Abstract—In the course of a program to digitize the astronomical plates of the Sternberg Astronomical Institute's plate stacks, we are developing algorithms for searching for new variable stars and studying them using digitized photographic plates. We have discovered and studied 480 new variable stars in a $10° \times 10°$ field of view centered on 66 Ophiuchi. The digitized plate negatives used are from the 40-cm astrograph, and are 30×30 cm in size. These stars include three new Cepheids of the Galaxy's spherical component, 157 eclipsing binaries, 11 high-amplitude δ Scuti stars (HADSs), 144 RR Lyrae stars, 110 irregular variables (109 LB and one white star), and 55 semi-regular red variables. New important information has been obtained for 43 known variables, which we have classified and derived or improved their light elements; an erroneous identification of the Mira V404 Oph has been corrected. We have also identified more than 50 suspect brightness variables; a program of CCD observations of these suspected variables has been initiated. Our discoveries of new variable stars were performed in a star field with a large number of known variables, detected earlier photographically or using CCD techniques. The discovery of hundreds of new variables in a well-studied region of sky demonstrates that archive photographs possess a large information potential that has remained unrealized.

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1. INTRODUCTION

The era of astronomical photography using glass photographic plates and films began in the late 19th century and continued during almost the whole 20th century. A number of observatories worldwide have accumulated hundreds of thousands of direct and spectroscopic photographs of the starry sky. Maintaining such collections and distributing information from them turns out to be a fairly difficult task. After the transition to modern CCD imaging techniques, efficient algorithms for extracting data and analyzing information from panoramic sky images were developed. These are applicable, in a somewhat modified form, to old photographic images, provided that they are digitized, which also guarantees safe archive keeping and simple data transfer. The importance of the information kept in photographic archives is widely recognized [1]. Many observatories of the world have started projects on digitizing their plate stacks.

Regular photographic observations at the Moscow Observatory began in 1895, after the first experiments performed in 1883 by A.A. Belopolskii, still with colloid emulsions. The archive of direct and spectroscopic sky photographs kept at the Sternberg Astronomical Institute (SAI) currently contains more than 60 000 photographs taken with various telescopes in Moscow and other observatories of Russia and the USSR for studies of variable stars and for other fields of astrophysics and astrometry.

The most important part of the Moscow plate collection are direct sky photographs acquired in 1948–1996 with a 40-cm astrograph. This instrument was ordered by Cuno Hoffmeister for Sonneberg Observatory (Germany) and first installed there in 1938. 1658 direct sky photographs from this telescope taken in 1938–1945 are kept in the Sonneberg plate archive (the GA series of the Sonneberg collection). In 1945, the telescope was taken to the USSR as part of war reparation. It was initially installed in Simeiz (Crimea), then brought to Kuchino near Moscow. In

1958, the astrograph became the first instrument of the Crimean Station of the SAI (Nauchny, Crimea, Ukraine). The total number of plates taken with the 40-cm astrograph after 1948 is about 22 500 (the A series of the Moscow collection).

The size of the 40-cm astrograph plates is 30 × 30 cm, corresponding to a $10° \times 10°$ field of view. The quality of the stellar images is quite satisfactory near the plate center, but becomes considerably worse towards the edges (primarily due to the coma aberration). The typical exposure time for variable-star studies was 45 minutes, and the limiting magnitude of good-quality plates is about $17.5^m B$. The instrument was mainly used to photograph program sky fields, and rich series (up to ∼500) of plates were accumulated for some of these fields. If an object of interest can be found in several overlapping fields, sometimes as many as 1000 brightness estimates can be obtained. Most plates were initially of excellent quality, which has not been lost in storage.

We started digitizing the Moscow collection of astronomical photographs in 2004 using two Creo EverSmart Supreme II scanners.

Current scanning of plate stacks of other observatories is mainly aimed at securing information storage and providing easier access to the data. The SAI program of digitizing its plate stacks simultaneously includes the development of algorithms for variable-star searches and studies using digitized plates. Pilot projects resulted in the discovery of 38 new variable stars from scans of relatively small parts of the plates [2–5]. Numbers of the Moscow Digital Variable (MDV) series were later introduced [6] for variable stars discovered in our program, with numbers in [6] beginning with MDV 39. The correspondence of the first variables discovered in our program to the MDV serial numbers was not published earlier. Table 1 presents the list of variable objects MDV 1–38.

2. SCANNING AND PHOTOMETRY IN THE FIELD OF 66 OPHIUCHI

The scanning of plates from the Moscow stacks is not organized in order of their numbers within the A series, but separately for each program field area. The first area to be completely digitized was the field centered on 66 Ophiuchi.

66 Oph ($18^h00.3^m$, $+4°22'$, J2000.0) was the center of 254 plates taken in 1976–1995. In our plate-collection digitizing program, we scan all plates with a resolution of 2540 dpi (dots per inch), or $1.2''$ per pixel. Each pixel contains 14 bits of information per color channel. Color images produced by the scanner were saved in TIFF (RGB) format using the scanner software operating in the Mac OS X environment and then transformed to FITS format. When searching for variable stars, we used only the green channel of each image, selected empirically.

To overcome problems related to non-uniform image quality and background density, air-mass differences across a large-area field, possible inhomogeneity of the photographic emulsion coating, etc., we subdivided the $10° \times 10°$ field into 144 partially overlapping, approximately square subfields and reduced each of these separately. We used the VaST software package [1] [7]. The results obtained for each subfield were put together during the final reduction stages.

The VaST package uses the well-known SExtractor code for star detection and aperture photometry [8]. We carried out aperture photometry using a round diaphragm. The SExtractor parameters and the aperture diameter were selected to optimize photometry of stars with B magnitudes 13.5^m–16.5^m. This magnitude range was preferred because, among other reasons, brighter variable stars in the program field have mostly already been discovered in the ASAS-3 CCD survey of the southern sky [9] and the ROTSE-I/NSVS CCD survey of the northern sky [10], which overlap in the equiatorial region of the sky, where the 66 Oph field is just situated.

The VaST code matches stars detected on a plate to stars detected on a reference plate selected from the best photographs of the series. All the measured magnitudes were converted to the instrumental magnitude system of the reference plate. In the final stage, the magnitudes were converted to the B-magnitude scale of the USNO-A2.0 catalog [11]. The resulting light curves show that the characteristic rms uncertainties of our photometry are 0.03^m–0.1^m for stars with B magnitudes 13.5^m–16.5^m.

Recently, we began to use the Astrometry.net internet service[2] [12, 13] to obtain astrometric solutions of our reference images and to write corresponding World Coordinate System keys into the image headers. The higher accuracy of the astrometric solution enabled us to implement the large-scale automated identification of detected stars with the USNO-A2.0 catalog, thereby increasing the accuracy of the photometric calibration thanks to the increased number of stars with known magnitudes.

Our current algorithms for photographic photometry from the digitized plates bear some similarities to those applied in the Digital Access to a Sky Century Harvard (DASCH) project (in particular, the use of the SExtractor software and Astrometry.net facility) [14]. The main differences of our technique are the use of aperture photometry and photometry

[1] http://saistud.sai.msu.ru/vast

[2] http://astrometry.net/

Table 1. Variable stars of the MDV series discovered in the pilot projects

MDV	α (J2000)	δ (J2000)	Type	Reference	MDV	α (J2000)	δ (J2000)	Type	Reference
1	$16^h10^m47.74^s$	+33°03′37.4″	GAL	[2]	20	$21^h24^m16.40^s$	+36°35′48.1″	EA	[4]
2	13 14 34.49	+20 30 25.2	RRAB	[3]	21	21 25 00.61	+36 03 28.3	EW	[4]
3	13 15 04.47	+19 42 53.2	RRC	[3]	22	21 26 41.17	+35 46 40.0	LB	[4]
4	13 15 19.72	+19 30 24.3	RRAB	[3]	23	21 26 42.12	+35 59 51.2	LB	[4]
5	13 15 55.17	+21 25 21.6	GAL	[3]	24	21 21 03.34	+36 26 12.8	EW	[4]
6	13 18 12.50	+17 22 02.5	RRAB	[3]	25	21 21 09.39	+36 41 35.9	CEP:	[4]
7	13 18 41.92	+17 45 24.5	RRAB	[3]	26	21 21 32.77	+36 49 30.8	RRAB	[4]
8	13 20 32.74	+19 09 22.7	RRC	[3]	27	21 25 02.37	+36 19 55.6	EW	[4]
9	13 21 18.43	+18 08 22.3	SXPHE	[3]	28	21 25 09.85	+36 12 04.4	IN:	[4]
10	13 22 00.08	+18 27 09.1	RRAB	[3]	29	21 26 10.20	+36 59 47.1	EW	[4]
11	13 24 12.75	+17 02 18.1	EW	[3]	30	21 28 06.19	+36 54 15.5	RS	[4]
12	13 24 48.58	+17 41 10.4	EW	[3]	31	21 28 45.61	+37 04 34.0	EW	[4]
13	13 26 46.20	+21 00 57.8	GAL:	[3]	32	21 21 27.80	+37 08 11.5	LB	[5]
14	13 28 10.41	+19 38 16.6	LB	[3]	33	21 23 03.32	+37 03 08.4	EA	[5]
15	13 29 09.34	+18 00 17.5	RRAB	[3]	34	21 23 18.21	+35 41 10.6	EW	[5]
16	13 32 04.62	+18 31 03.3	RRAB	[3]	35	21 23 37.87	+37 05 27.6	EA	[5]
17	20 56 40.51	+41 18 27.8	RRAB	[4]	36	21 24 20.55	+37 08 44.2	EA	[5]
18	21 23 11.19	+35 52 09.4	RRAB	[4]	37	21 24 26.78	+36 51 02.3	EW	[5]
19	21 23 42.69	+35 44 22.9	EW	[4]	38	21 27 43.71	+35 40 25.7	EW	[5]

in a large field subdivided into smaller sub-fields, each reduced separately, as opposed to obtaining a position-dependent solution for the entire plate. Both our approach and that of the DASCH project have their positive and negative features; we are planning to perform a comparative analysis in our further studies.

3. SEARCH FOR VARIABLE STARS

Preliminary results of our search for variable stars in the northern half of the 66 Oph field were published by Kolesnikova et al. [6]; that paper also contains a detailed description of the methods used for our semi-automated search for variable stars. Our search is arranged in several steps: deriving a relation between the rms deviation of the instrumental magnitude from that on the reference plate and the stellar brightness; identifying stars demonstrating deviations larger than is expected from this relation; and selecting those that reveal reliable periodic or aperiodic brightness variations. The last step is an unautomated visual inspection of the light curves and final selection of variable and suspected variable stars. We checked if the stars in our list of detected variables were new by comparing the list to the databases of the General Catalogue of Variable Stars and the International Variable-Star Registry, VSX,[3] supported by the American Association of Variable-Star Observers.

In total, we discovered 480 new variable stars in the field of 66 Oph (MDV 39—MDV 518), of which 274 (MDV 39–MDV 312) were found in the northern part of the field [6]. About 30 stars in the northern half-field were suspected brightness variables; four of these were confirmed by CCD observations [15] and designated MDV 313–MDV 316. The name MDV 317 was given to an RRAB variable discovered during an additional analysis of our results for the northern part of the field. The variable stars MDV 318–MDV 518 were revealed in the southern half-field. Complete information on the variable stars we detected is collected in Table 2.[4] The table con-

[3] http://www.aavso.org/vsx/

[4] Table 2 is published in an abbreviated form. The complete version of the table is published electronically at the site of the Strasbourg Center of Astronomical Data http://cdsarc.u-strasbg.fr/viz-bin/Cat; it is also available at the GCVS site.

Table 2. New variable stars*

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
39	$17^h40^m07.83^s$	+04°24′28.0″	LB	16.0	16.6				1
40	17 40 29.79	+06 55 42.1	RRAB	15.6	16.35		44847.280	0.759705	
41	17 40 35.50	+06 17 00.4	RRAB	14.65	15.3		42902.512	0.734964	
42	17 41 18.87	+03 49 25.6	SR:	15.1	15.6				1, 2
43	17 42 13.95	+05 42 45.2	EB	15.6	16.0	15.85	44491.256	0.528001	3
44	17 42 21.25	+04 18 42.2	SR	14.8	15.15				1, 4
45	17 42 44.86	+04 46 37.4	EW	15.4	15.75	15.7	43282.452	0.381209	
46	17 43 04.48	+06 54 44.4	RRAB	15.7	16.35		43285.493	0.404791	
47	17 43 52.96	+06 36 02.3	EW	15.7	16.2	16.2	42957.469	0.383012	
48	17 45 13.67	+05 03 15.6	LB	15.7	16.8				1
49	17 45 18.14	+08 14 20.9	RRAB	14.8	16.0		42922.490	0.612771	
50	17 45 49.57	+05 13 49.9	LB	14.05	14.45				5
51	17 45 57.40	+05 02 45.6	RRAB	15.6	16.2		44072.391	0.676667	
52	17 46 15.35	+06 14 14.5	SR	15.4	16.1			58.5:	1, 6
53	17 47 23.26	+06 10 26.7	EW	15.2	15.8	15.7	42876.527	0.353475	
54	17 47 55.07	+08 15 58.3	EW	14.9	15.4	15.35	44027.451	0.315782	
55	17 48 09.07	+05 08 33.3	RRAB	16.1	17.0		43283.447	0.641829	
56	17 48 09.74	+06 09 09.8	EW	15.75	16.3	16.25	44025.432	0.254585	
57	17 48 23.11	+06 37 29.5	SR:	14.9	15.25			48:	1, 7
58	17 48 29.26	+05 29 16.8	EA	16.0	16.5		46344.23	0.98930	8
59	17 48 34.33	+06 30 25.4	EB	14.55	15.0	14.8	45941.312	0.473063	
60	17 48 34.57	+08 09 40.9	RRC	15.8	16.2		42933.452	0.310296	
61	17 48 40.02	+08 29 06.0	RRAB	14.8	16.0		42892.539	0.640799	
62	17 48 50.05	+05 59 20.3	LB	15.4	16.0				1
63	17 49 11.11	+08 24 26.2	RRC:	14.7	15.2		43253.517	0.443354	9
64	17 49 11.11	+06 03 53.0	RRAB	15.6	16.4		42933.452	0.614422	
65	17 49 37.25	+06 51 44.2	SR:	15.15	15.6			54.9:	1
66	17 49 46.77	+05 30 56.5	RRAB	14.15	14.5		42872.494	0.721473	
67	17 49 51.67	+07 16 41.1	EW	15.9	16.2	16.2	42876.562	0.378639	
68	17 50 46.76	+06 07 57.8	RRC	15.4	16.0		43702.392	0.392512	
69	17 50 50.76	+07 51 10.8	SR	15.8	16.2			47:	1, 10
70	17 50 56.82	+06 21 19.7	LB	15.0	15.7				5
71	17 51 23.46	+08 25 02.5	RRAB:	15.25	15.7		42954.322	0.392501	
72	17 51 34.63	+07 40 30.7	RRC	14.95	15.5		44043.431	0.322902	
73	17 51 37.90	+08 44 01.5	HADS	15.3	15.9		43198.598	0.0999541	11
74	17 51 45.02	+03 47 54.8	LB	15.5	16.1				
75	17 51 48.78	+09 26 33.6	RRAB	14.2	15.6		43700.317	0.487961	
76	17 51 54.83	+05 26 14.8	LB	15.1	16.1				1
77	17 51 59.69	+03 56 22.6	RRC	15.1	15.7		44087.407	0.318240	
78	17 52 02.92	+08 49 51.6	EW	15.0	15.6	15.5	43190.597	0.412666	
79	17 52 05.13	+04 33 22.1	EA	15.0	15.6		49949.335	1.68149	8
80	17 52 24.09	+04 31 57.8	L	14.0	14.5				12
81	17 52 24.75	+09 16 16.1	RRC	15.4	15.85		44087.407	0.292674	9
82	17 52 31.50	+05 01 18.0	RRC	16.0	16.4		42871.515	0.336160	
83	17 52 37.26	+07 20 49.9	EW	15.45	15.9	15.9	42894.525	0.355982	
84	17 52 40.57	+08 28 06.2	EW	15.7	16.05	16.0	44077.360	0.429948	
85	17 52 53.84	+04 24 34.4	RRC	15.9	16.2		42875.563	0.256808	
86	17 53 04.03	+06 14 32.0	SR:	15.8	16.45			143:	1
87	17 53 04.77	+06 13 45.7	RRAB	16.1	16.6		42876.562	0.584480	
88	17 53 08.46	+04 32 04.2	RRC	15.7	16.2		43289.393	0.284575	
89	17 53 22.29	+04 00 01.1	EW	14.4	14.95	14.9	44012.480	0.677689	3
90	17 53 32.34	+06 08 34.7	EW	14.2	14.65	14.6	46973.322	0.299660	

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
91	$17^h53^m44.10^s$	$+07°00'52.6''$	LB	15.2	16.0				1
92	17 53 50.57	+07 13 27.1	RRC	15.5	15.95		46934.425	0.312434	
93	17 53 52.77	+06 11 25.7	LB:	15.0	15.45				1, 13
94	17 54 23.42	+08 13 13.0	RRAB	15.2	16.1		44491.256	0.492470	
95	17 54 23.45	+06 21 45.3	RRAB	15.4	16.25		42922.490	0.603587	
96	17 54 24.07	+05 05 44.6	CWB:	15.1	15.6		46979.46	4.22851	14
97	17 54 34.54	+04 31 43.4	RRAB	15.7	16.7		46618.465	0.555057	
98	17 55 12.15	+08 30 49.7	RRC	15.9	16.4		42894.525	0.274916	
99	17 55 14.25	+07 55 00.6	EB	14.95	15.25	15.1	43426.226	0.580428	
100	17 55 22.79	+04 00 23.2	RRC	14.25	14.8		46972.316	0.312420	
101	17 55 34.54	+07 19 33.0	EW	15.3	15.9	15.85	44397.415	0.545532	15
102	17 55 36.01	+09 04 14.8	RRAB	15.4	16.3		43253.517	0.761835	
103	17 55 44.14	+05 59 29.5	RRAB:	15.9	16.2		45941.312	0.945095	
104	17 55 50.95	+08 11 09.9	EW	15.75	16.1	16.0	42963.332	0.542425	
105	17 55 59.58	+04 02 28.8	SR	15.7	16.4			145	1
106	17 56 05.81	+08 11 35.3	CWA:	15.4	15.8		42894.53	16.56	
107	17 56 17.88	+06 22 43.0	HADS	14.65	15.3		43249.548	0.107927	
108	17 56 41.05	+05 53 58.0	LB	14.7	15.3				1
109	17 56 50.87	+08 08 02.0	RRC	15.7	16.05		44397.415	0.350064	
110	17 56 56.53	+04 19 08.5	LB	14.6	15.1				1
111	17 57 01.57	+06 15 24.6	LB	15.85	16.3				1
112	17 57 32.53	+05 19 20.2	RRC:	15.5	16.2		43427.283	0.332701	
113	17 57 42.66	+04 23 59.1	RRAB	15.8	16.6		44789.394	0.464905	
114	17 57 44.84	+07 32 52.6	RRC:	16.15	16.4		42963.332	0.284003	
115	17 57 46.82	+05 55 29.1	EW	14.9	15.6	15.5	46972.320	0.547264	3
116	17 57 58.89	+04 09 47.6	EB	15.9	16.5	16.1	43034.230	0.913185	
117	17 58 01.29	+05 49 26.7	EB	13.65	14.4	13.8	42957.338	0.425898	
118	17 58 05.41	+09 02 33.3	RRAB	15.1	16.2		43938.578	0.777133	
119	17 58 07.94	+08 22 59.0	RRAB	15.3	16.0		43189.593	0.633042	
120	17 58 09.44	+08 05 09.5	RRAB	15.6	16.5		44455.302	0.477403	
121	17 58 21.36	+06 35 08.4	LB	15.9	16.5				5
122	17 58 22.55	+05 53 15.2	EB	14.4	14.9	14.65	44494.247	0.323388	
123	17 58 28.58	+06 10 01.1	LB	15.7	16.3				1
124	17 58 34.10	+06 02 56.6	LB:	15.0	15.9				1, 16
125	17 58 34.73	+05 01 06.0	LB	15.4	16.5				1
126	17 58 40.05	+04 54 16.7	EB	15.45	15.9	15.7	42871.520	0.649782	
127	17 58 48.46	+07 16 42.6	EA	15.3	15.9		42872.52	1.55847	
128	17 58 59.30	+04 20 03.2	RRC	15.6	16.2		42922.490	0.318133	9
129	17 59 11.58	+09 01 53.0	EA	15.0	16.0		43272.41	6.3593	
130	17 59 12.18	+07 52 05.4	LB	14.3	14.7				17
131	17 59 15.95	+05 13 13.7	RRC	16.0	16.5		46977.463	0.386846	
132	17 59 19.71	+07 51 04.9	RRAB	15.0	16.0		43284.449	0.599402	
133	17 59 22.50	+05 07 33.1	EB	15.55	16.0	15.8	42989.295	0.404381	
134	17 59 29.36	+04 32 33.2	LB	15.2	15.65				1
135	17 59 29.41	+08 45 41.8	EA	14.8	15.4	15.0	46977.46	1.20425	
136	17 59 39.81	+04 59 51.3	SR	13.7	14.2			66.5:	1, 18
137	17 59 47.76	+09 22 41.9	RRC	15.3	15.9		43289.393	0.285936	9
138	17 59 48.51	+08 10 48.3	EW	13.7	14.2	14.15	45203.305	0.345281	
139	18 00 00.75	+07 26 22.0	LB	14.6	15.0				1
140	18 00 03.71	+04 41 21.4	RRAB	15.4	16.3		42872.523	0.684805	
141	18 00 07.82	+04 30 27.0	SR:	14.8	15.3			31:	1
142	18 00 12.49	+06 26 26.1	EW	15.0	15.4	15.35	44847.280	0.448969	

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
143	$18^h00^m32.68^s$	$+06°50'24.0''$	LB	15.1	15.5				1
144	18 00 37.01	+08 55 07.7	RRAB	14.4	14.8		42874.530	0.66754	
145	18 00 37.83	+05 06 00.7	EA	15.5	16.4	15.9	44847.28	2.10038	
146	18 00 56.85	+09 21 29.9	LB	15.5	16.2				1
147	18 00 59.38	+07 21 22.4	RRC:	16.25	16.5		45228.243	0.330633	
148	18 01 00.83	+04 07 51.8	EW	15.3	16.1	15.9	44850.280	0.324859	
149	18 01 05.60	+06 21 14.1	RRAB	14.4	15.3		43249.546	0.581607	
150	18 02 03.93	+07 08 06.6	EW	15.65	15.9	15.9	46619.406	0.332680	19
151	18 02 11.42	+07 26 42.7	LB	14.5	15.0				1
152	18 02 12.50	+06 48 14.4	SR:	15.2	15.9			92:	1, 20
153	18 02 13.54	+06 52 59.5	EB	15.6	16.1	15.95	42925.456	0.464174	
154	18 02 14.03	+08 12 18.4	EW	16.0	16.5	16.4	43685.342	0.414680	
155	18 02 23.14	+08 01 39.6	RRAB	14.0	14.9		43036.237	0.679221	
156	18 02 29.47	+07 12 47.6	RRAB	14.8	16.2		42963.505	0.509009	
157	18 02 36.98	+05 32 12.0	RRAB	14.6	15.5		42922.490	0.537830	21
158	18 02 41.85	+04 33 02.0	EW	13.8	14.15	14.15	45171.387	0.381728	
159	18 02 49.98	+08 43 57.7	EW	15.1	15.6	15.6	46596.478	0.392278	
160	18 02 54.90	+06 34 10.1	EW	14.05	14.6	14.6	43277.523	0.376706	
161	18 02 57.07	+06 02 09.7	EB	15.8	16.1	15.95	43692.392	0.392170	
162	18 02 59.80	+07 22 02.3	LB	15.0	15.5				1
163	18 03 05.98	+05 03 01.3	SR	13.9	14.3			63.5:	1, 22
164	18 03 07.17	+04 20 41.4	LB	15.4	15.8				5
165	18 03 10.52	+03 57 14.6	EW	14.2	14.65	14.65	43046.268	0.307384	
166	18 03 24.13	+05 16 56.1	LB	15.2	15.8				
167	18 03 24.67	+06 40 58.6	LB	14.7	15.1				1
168	18 03 51.48	+08 05 36.6	EB	15.6	16.2	16.05	44732.521	0.399152	
169	18 04 04.70	+03 54 19.7	LB	14.6	15.15				1
170	18 04 16.53	+08 23 39.1	LB	14.6	15.15				1
171	18 04 22.43	+08 12 34.0	SR	14.9	15.7			74	1, 23
172	18 04 34.12	+04 43 20.6	EW	15.15	15.6	15.5	43198.600	0.335051	24
173	18 04 39.62	+07 31 03.3	RRAB	15.1	16.1		42891.529	0.589471	
174	18 04 43.43	+05 53 27.3	RRAB	15.2	16.1		42926.500	0.658642	
175	18 04 51.24	+08 03 57.8	RRC	15.2	15.8		43420.247	0.276090	
176	18 04 58.48	+03 46 03.9	EB	13.9	14.3	14.15	43332.356	0.749889	
177	18 05 00.41	+06 22 51.1	LB	15.5	16.05				1
178	18 05 27.92	+07 16 51.1	LB	14.3	15.1				1
179	18 05 29.88	+06 07 53.3	EB	15.15	15.8	15.3	43272.375	1.018765	
180	18 05 35.60	+08 35 00.0	RRAB	15.0	16.3		42951.355	0.531888	
181	18 05 39.42	+05 10 11.8	HADS	15.7	16.1		43418.213	0.131870	21
182	18 05 42.75	+05 20 18.1	EB	14.25	15.0	14.5	42891.529	0.502317	25
183	18 05 49.45	+07 55 12.8	SR:	15.2	16.1			70:	1
184	18 05 54.43	+07 13 48.2	RRAB	15.9	16.8		42874.564	0.617842	
185	18 06 05.81	+05 54 54.4	RRAB	14.8	15.2		42957.403	0.657303	
186	18 06 12.13	+05 06 37.8	RRAB:	15.5	16.2		42868.507	0.923155	
187	18 06 15.28	+07 06 35.1	RRC	16.0	16.7		43417.212	0.332192	26
188	18 06 18.63	+08 55 20.5	EB	14.9	15.4	15.1	43199.585	0.740361	
189	18 06 30.80	+08 22 06.0	EB	15.8	16.25	16.1	42957.470	0.379855	
190	18 06 31.82	+03 59 52.8	SR:	15.5	16.1			47:	1
191	18 06 32.78	+04 29 32.2	RRAB	14.8	15.8		42925.392	0.670269	
192	18 06 36.54	+05 00 43.6	RRAB	15.8	16.7		42868.539	0.496878	
193	18 06 38.35	+08 02 52.2	EA	15.3	16.2	15.5	45232.24	1.51209	
194	18 06 46.37	+08 50 11.6	SR	15.3	16.4			254	1

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
195	$18^h06^m51.41^s$	+05°09′30.2″	EW	15.0	15.6	15.55	46653.414	0.478173	
196	18 06 56.18	+06 27 48.4	RRC	14.3	14.8		46617.342	0.322833	
197	18 07 05.65	+06 05 14.9	LB	14.4	14.9				5
198	18 07 12.73	+04 58 10.3	EW	15.9	16.45	16.4	44491.256	0.298816	
199	18 07 16.39	+05 16 52.2	LB	14.7	15.15				1
200	18 07 21.54	+05 32 13.3	SR	15.8	16.5			78.3:	1, 27
201	18 07 36.93	+07 26 35.9	RRAB	15.9	16.7		42875.531	0.588969	
202	18 07 41.28	+06 45 28.6	SR:	15.3	16.4			145:	1, 28
203	18 07 49.65	+05 27 51.6	EA	13.7	14.3	13.75	44455.302	0.711615	
204	18 07 56.04	+04 56 46.7	EW	13.85	14.1	14.05	44025.432	0.519085	
205	18 07 59.01	+04 45 55.6	LB	14.85	15.4				1
206	18 08 01.92	+05 23 57.2	LB	14.9	15.5				1
207	18 08 03.10	+06 14 14.3	SR	15.3	16.5			131	1, 29
208	18 08 10.12	+05 40 58.3	RRC:	15.4	16.0		46972.316	0.312194	
209	18 08 11.17	+03 52 53.6	RRAB	14.3	15.2		44489.274	0.675244	
210	18 08 14.53	+04 47 59.9	HADS	14.7	15.35		43253.519	0.1002330	
211	18 08 24.30	+06 28 14.0	LB:	14.2	14.9				1, 27
212	18 08 24.31	+05 26 18.7	LB	15.4	16.2				1
213	18 08 30.82	+05 39 11.8	RRAB	15.35	16.0		43282.487	0.749949	
214	18 08 44.55	+05 57 55.0	SR	15.4	15.9			180:	1
215	18 08 55.97	+05 12 35.7	SR:	14.55	15.3			51.7:	1
216	18 08 56.18	+05 57 10.1	EW	14.2	14.5	14.5	42930.401	0.421105	
217	18 09 04.43	+07 55 37.8	RRC:	13.85	14.2		46973.455	0.436515	
218	18 09 09.12	+05 04 23.6	EB	15.7	16.2	16.05	42892.539	0.97154	
219	18 09 09.16	+03 47 52.1	LB	15.0	15.8				1
220	18 09 09.93	+07 28 09.8	SR	14.9	16.0			65.7	1
221	18 09 13.54	+05 50 41.1	RRC	15.85	16.3		42868.539	0.339997	
222	18 09 23.78	+06 51 47.7	LB	15.0	15.9				1
223	18 09 26.16	+05 35 58.9	EW	13.9	14.1	14.1	46979.464	0.393194	
224	18 09 27.62	+04 28 50.7	HADS	15.4	15.9		42927.415	0.0610848	
225	18 09 48.60	+06 00 37.6	SR	15.1	15.9			59	1, 30
226	18 09 51.09	+05 03 47.2	EB	15.5	16.0	15.8	46971.317	0.621532	
227	18 09 53.94	+04 16 08.6	EA	13.6	14.1		42922.49	1.94171	
228	18 09 59.29	+04 44 29.1	RRAB	14.9	15.6		42872.523	0.607108	
229	18 10 07.79	+07 58 22.7	LB	14.9	15.4				1
230	18 10 17.44	+08 11 27.1	EW	14.1	14.6	14.6	46979.390	0.449795	
231	18 10 20.07	+06 02 08.0	EB	14.6	15.2	15.0	42927.410	0.654786	
232	18 10 24.56	+05 27 16.3	EB	15.15	15.8	15.5	42870.546	0.396235	
233	18 10 29.54	+04 22 49.3	RRC	14.4	14.7		43284.483	0.236166	9
234	18 10 55.71	+06 20 08.7	EB	14.7	15.45	15.1	43694.395	0.901138	
235	18 10 59.00	+05 07 48.6	LB	15.1	16.0				1
236	18 11 05.34	+07 54 03.6	EW	14.0	14.3	14.3	42890.512	0.410104	
237	18 11 12.67	+05 26 17.1	EW	15.0	15.5	15.4	45203.305	0.492401	
238	18 11 20.03	+07 16 11.9	EW	14.9	15.25	15.2	42891.529	0.585531	3
239	18 11 22.94	+03 43 39.2	RRAB	14.8	15.4		42901.520	0.565079	
240	18 11 25.22	+08 41 15.5	RRAB	14.9	15.9		42902.512	0.498133	
241	18 11 51.49	+03 50 02.6	EW	15.5	16.1	16.1	46344.236	0.443803	
242	18 12 07.63	+06 03 44.7	LB	14.8	15.7				1
243	18 12 09.75	+05 18 40.1	SR	15.0	15.7			42.4	
244	18 12 14.39	+09 06 17.7	SR:	14.3	15.3				1, 31
245	18 12 21.45	+05 26 55.7	SR:	13.8	14.2				1, 32
246	18 12 29.32	+05 10 05.6	LB	15.6	16.4				1

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
247	$18^h12^m31.61^s$	$+05°21'09.6''$	EW	15.7	16.25	16.2	44839.273	0.360409	33
248	18 12 37.32	+03 49 33.2	LB	15.4	16.4				1
249	18 12 37.92	+07 18 23.1	RRAB	15.1	16.2		46591.462	0.647362	
250	18 12 40.09	+04 45 30.6	LB	15.0	15.6				1
251	18 12 59.75	+04 20 35.3	LB	15.2	16.3				1
252	18 13 00.21	+06 52 27.4	EB	14.8	15.4	15.2	42930.401	0.451938	
253	18 13 01.88	+03 40 41.8	LB	15.7	16.3				1
254	18 13 06.78	+08 15 49.4	LB	14.7	15.5				1
255	18 13 08.61	+05 25 22.3	SR:	15.1	16.2			182	1, 34
256	18 13 13.90	+06 16 54.9	SR	14.1	14.7			58:	1, 35
257	18 13 21.93	+04 20 39.6	RRAB	14.55	15.4		44815.380	0.538190	
258	18 13 27.91	+06 23 12.4	SR:	15.3	16.0			415:	1
259	18 13 37.28	+06 53 38.4	LB	14.6	15.3				1
260	18 13 44.99	+06 32 19.9	RRAB	15.8	16.3		42957.469	0.629529	
261	18 13 54.90	+04 42 37.9	EW	14.6	15.4	15.3	42872.523	0.353219	
262	18 13 56.50	+06 22 44.3	LB	15.5	16.0				1, 36
263	18 13 58.69	+08 55 44.0	EB	15.1	16.0	15.3	46978.31	1.084030	
264	18 14 07.60	+09 01 41.7	SR:	15.1	16.3			81:	1, 37
265	18 14 12.34	+05 07 30.4	LB	14.4	15.1				1
266	18 14 22.84	+05 31 30.7	RRAB	14.9	16.5		42902.512	0.444778	
267	18 14 22.88	+06 09 56.4	RRAB	15.7	16.4		44489.274	0.756962	
268	18 14 24.38	+07 12 52.2	SR	14.9	15.8			69.8:	1
269	18 15 04.17	+07 55 41.5	RRAB	15.0	15.9		44113.304	0.486940	
270	18 15 11.71	+06 47 02.6	RRAB	13.6	14.1		43199.585	0.614567	
271	18 15 13.53	+09 06 07.8	LB	14.8	15.3				1
272	18 15 14.48	+07 29 35.4	LB	15.3	16.4				1
273	18 15 20.96	+05 39 10.4	SR	15.4	16.1			85:	5
274	18 15 28.15	+06 47 52.9	EW	15.8	16.3	16.25	44397.415	0.363117	
275	18 15 31.44	+06 19 20.1	LB	14.8	15.6				1
276	18 15 38.82	+06 29 58.9	SR	14.6	15.2			61:	1
277	18 15 47.01	+05 38 34.6	RRC	15.8	16.2		46653.414	0.284193	38
278	18 15 47.87	+06 18 41.2	EB:	14.8	15.15	15.05	46591.46	1.54528	39
279	18 15 48.94	+07 08 33.4	RRAB	15.5	16.4		44107.290	0.566656	40
280	18 16 11.22	+07 21 48.1	LB	15.5	16.2				1
281	18 16 18.43	+06 16 10.6	SR	14.1	15.0			80	1, 41
282	18 16 27.14	+06 42 55.5	SR:	15.2	15.8			86:	
283	18 16 35.19	+05 34 35.0	SR	15.6	16.5			252:	1
284	18 16 40.10	+06 37 12.3	SR	15.2	16.2			73:	
285	18 16 45.22	+07 57 50.1	RRC	14.8	15.5		43254.534	0.281676	9
286	18 16 46.19	+08 18 49.5	LB	13.7	14.2				
287	18 16 50.09	+05 41 14.0	LB	14.9	15.5				1
288	18 17 00.69	+04 29 24.7	LB	14.4	14.9				1
289	18 17 11.39	+06 18 13.2	RRAB	14.6	15.15		42872.523	0.820628	
290	18 17 20.57	+06 08 43.7	EW	15.4	16.0	15.9	46623.455	0.325430	
291	18 17 22.37	+05 26 14.0	LB	15.3	16.2				1
292	18 17 30.45	+08 14 47.1	EA	14.3	14.8	14.45	43420.250	0.845830	
293	18 17 32.09	+08 14 16.5	RRAB	15.2	16.2		43197.623	0.521403	
294	18 17 37.92	+04 58 12.4	EW	15.1	15.7	15.6	44131.297	0.423964	
295	18 18 00.35	+05 18 06.2	EA	15.3	16.3:	16.0:	43198.60	3.05819	42
296	18 18 31.41	+04 15 21.9	SR:	15.1	16.1				1, 43
297	18 18 56.33	+04 40 05.5	SR	14.4	16.0			148	1
298	18 18 57.01	+06 37 53.5	LB	14.35	14.8				5

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
299	$18^h19^m17.22^s$	$+04°57'27.5''$	RRAB	15.1	16.0		43272.409	0.534392	
300	18 19 18.43	+06 34 41.3	EW	15.0	15.3	15.3	43422.199	0.457672	
301	18 19 20.32	+04 39 48.0	EW	15.1	15.8	15.7	44732.521	0.376235	
302	18 19 21.17	+05 17 20.1	SR:	15.1	15.9				1, 28
303	18 19 21.38	+06 22 45.3	EB	15.35	15.9	15.6	43277.523	0.938567	
304	18 19 28.92	+05 37 54.0	RRAB	15.4	16.3		46973.455	0.762271	
305	18 19 34.90	+06 12 10.2	SR:	15.15	15.6			88.3:	
306	18 19 52.67	+04 16 36.6	LB	14.3	14.9				1
307	18 20 00.86	+08 25 09.5	EW:	15.3	15.9	15.9	44839.273	0.527540	3
308	18 20 04.10	+04 11 34.4	EW	14.9	15.5	15.4	43422.199	0.465738	
309	18 20 15.58	+08 03 36.4	LB	14.5	15.3				1
310	18 20 19.35	+06 20 05.9	LB	15.5	16.1				1
311	18 20 30.08	+03 48 02.5	HADS	15.2	15.8		43243.438	0.097296	44
312	18 20 55.11	+04 44 46.0	EW	15.1	15.7	15.65	46646.401	0.463428	
313	17 52 28.67	+07 01 01.4	EA	15.00	15.40		54674.32	0.6813197	45
314	17 54 37.74	+07 10 45.6	EW:	15.95	16.45		54671.437	0.366764:	45
315	17 58 54.93	+09 27 45.6	EB	15.52	15.95		55023.36	0.702891	45
316	18 03 58.96	+06 21 30.6	EW	15.70	16.35	16.3	54666.32	0.3555338	45
317	18 03 51.37	+05 48 22.2	RRAB	15.6	17.3		43198.569	0.532064	
318	17 40 13.60	+04 53 04.5	RRAB	15.6	16.5		43938.548	0.671230	
319	17 40 13.70	+01 32 52.2	RRC:	15.8	16.4		43420.247	0.344659	46
320	17 41 28.95	+03 23 43.7	RRC	15.3	16.05		43420.247	0.378602	
321	17 41 38.05	+03 46 56.0	EW	15.7	16.25	16.2	43285.455	0.495834	47
322	17 41 49.84	+02 50 11.3	SR:	15.2	16.0				1, 48
323	17 41 51.99	+00 14 57.0	LB	15.6	16.4				49
324	17 42 27.32	+03 38 33.6	LB	15.7	16.4				1
325	17 42 42.58	+03 00 33.0	LB	13.65	13.95				1
326	17 43 10.22	+03 29 35.3	SR	15.0	15.65			52:	1, 50
327	17 43 48.31	+02 38 24.4	RRAB	15.8	16.6		44087.407	0.539312	
328	17 44 19.18	+03 25 23.3	EW	14.4	14.8	14.8	43195.586	0.646000	3
329	17 44 19.48	+02 24 29.8	RRC	15.9	16.35		43284.483	0.369382	
330	17 44 32.92	+01 34 14.3	EW	15.9	16.5	16.4	42933.452	0.635434	3
331	17 44 39.55	+02 44 18.4	LB	14.15	14.7				1
332	17 45 00.38	+01 27 40.8	EB	15.25	15.8	15.55	44107.290	0.580536	
333	17 45 25.69	+02 16 45.9	HADS	15.1	15.85		44021.438	0.126262	
334	17 45 38.13	+01 15 32.8	RRAB	15.0	15.85		42957.499	0.485891	21, 51, 52
335	17 45 40.46	+01 01 59.0	RRC	15.75	16.15		44072.391	0.201283	
336	17 48 41.52	−00 24 27.0	EW	15.7	16.3:	16.15	42957.370	0.436202	21, 52, 53
337	17 48 58.30	+02 02 14.0	EW	14.45	14.7	14.65	43424.216	0.308510	54
338	17 49 06.54	+01 42 20.1	LB	15.5	16.2				1
339	17 49 50.68	−00 11 01.2	RRC	15.45	16.0		42876.531	0.259207	
340	17 49 52.59	+03 30 03.0	RRC	14.85	15.45		43663.409	0.327488	
341	17 50 00.30	+04 38 17.5	RRAB	15.8	16.8		44077.359	0.579490	
342	17 50 02.07	+01 34 34.8	RRAB	15.9	16.55		43700.317	0.634138	
343	17 50 26.86	+02 19 22.3	LB	14.85	15.4				1
344	17 50 43.07	+01 00 25.8	EW	15.45	15.8	15.8	45137.428	0.504256	
345	17 50 45.52	+01 23 52.1	RRAB	15.5	16.15		43426.226	0.785642	
346	17 50 51.48	+02 51 49.0	EW	15.7	16.15	16.05	43272.409	0.294480	
347	17 50 53.09	+03 36 11.7	EB	14.75	15.3	14.95	42957.403	0.548711	
348	17 50 57.92	−00 16 52.7	LB	15.3	15.75				55
349	17 51 16.24	+00 10 28.4	LB	15.4	15.9				56
350	17 51 21.04	+02 54 40.4	RRAB	14.2	15.3		42922.490	0.529969	

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
351	$17^h51^m39.00^s$	$+04°32'07.6''$	RRC	13.7	13.95		42891.529	0.256396	
352	17 51 56.98	+01 30 50.5	LB	14.65	15.1				1
353	17 52 18.41	+01 03 06.6	RRC	15.4	15.85		42954.322	0.319239	
354	17 52 28.53	+02 52 47.5	EA	14.5	14.9	14.7:	44782.327	0.842454	57
355	17 52 36.67	+00 41 23.0	EW	15.3	15.9	15.85	44087.407	0.658055	3
356	17 52 44.91	+03 33 39.6	LB	14.5	15.4				1
357	17 52 53.80	+02 15 56.1	EW	15.05	15.4	15.35	43198.600	0.520631	
358	17 53 07.39	+03 13 38.8	EB	14.75	15.1	15.05	44105.283	0.572390	
359	17 53 43.37	+01 52 35.6	RRAB	15.6	16.7		43285.493	0.575125	
360	17 53 44.15	+02 37 42.1	RRC	15.3	15.75		43261.495	0.276794	46
361	17 53 50.82	−00 28 46.0	LB	15.0	15.7				1
362	17 53 51.82	+00 28 39.3	LB	14.35	14.7				1
363	17 54 01.86	+01 03 18.5	EW	14.45	14.75	14.75	44397.415	0.325450	
364	17 54 07.02	+02 04 02.5	EW	15.3	15.85	15.85	43287.426	0.771217	3
365	17 54 08.42	+00 59 49.1	EA	14.0	14.45		44839.273	1.31207	
366	17 54 20.53	+04 52 02.9	LB	15.0	15.5				1
367	17 54 24.89	+03 08 53.3	RRC	13.85	14.45		42874.564	0.227503	
368	17 54 29.29	+02 03 14.7	RRC	15.45	16.05		42871.482	0.287754	
369	17 54 58.62	+02 59 20.1	LB	15.3	15.9				1
370	17 55 04.33	+02 25 49.9	EW	15.1	15.75	15.65	43279.448	0.374993	
371	17 55 09.14	+03 16 21.8	EW:	15.15	15.55	15.55	42875.531	0.352211:	58
372	17 55 45.75	+03 39 56.5	RRAB	15.7	16.25		43672.362	0.546988	21, 59
373	17 56 19.68	−00 13 56.1	SR	14.4	14.8			58.2:	17, 60
374	17 56 27.85	+02 21 19.6	LB	15.3	16.1				56
375	17 56 50.83	+01 45 57.6	EW	15.55	16.1	16.0	42874.564	0.400830	61
376	17 56 54.05	+02 18 13.3	EA	14.35	14.8	14.7	44113.304	3.54487	62
377	17 56 54.21	+03 37 52.8	RRC	15.85	16.25		43199.617	0.323399	
378	17 57 00.18	+03 56 41.6	EW	13.85	14.25	14.2	43243.437	0.364039	
379	17 57 04.24	+01 57 21.0	SR:	15.2	15.65			58:	56
380	17 57 15.15	+02 19 44.8	RRAB	15.0	16.2		42868.507	0.630509	
381	17 57 20.84	+03 36 04.3	RRAB	14.15	14.9		42934.380	0.613349	
382	17 57 24.00	+02 43 32.5	SR:	16.0	16.55			61:	1
383	17 57 26.64	+01 03 16.7	RRC	15.4	16.0		43287.426	0.348779	
384	17 57 40.53	+04 50 51.4	EB	14.1	14.6	14.25	42954.498	0.623307	
385	17 57 42.32	+04 39 07.9	EW	15.7	16.1	16.1	42954.322	0.456255	63
386	17 57 43.63	+01 48 11.8	EB	14.3	14.8	14.5	42930.509	0.611578	
387	17 57 44.63	+02 30 43.6	SR	14.6	15.05			51.5:	1, 64
388	17 57 49.71	−00 16 59.6	HADS	15.0	15.55		42876.564	0.0806262	
389	17 58 03.93	+03 50 23.9	EW	14.8	15.4	15.4	44021.433	0.376975	
390	17 58 07.93	+00 22 03.9	LB	14.8	15.3				5
391	17 58 15.64	+00 50 22.6	EW	15.5	15.95	15.95	43198.600	0.253104	
392	17 58 20.38	+03 01 58.3	RRAB	15.95	16.35		43277.523	0.617933	59, 65
393	17 58 22.68	+02 23 25.4	RRAB:	16.05	16.4		43692.392	0.643645:	46, 66
394	17 58 27.67	+03 32 56.7	RRC	15.6	16.15		42901.520	0.263385	67
395	17 58 33.99	+02 44 08.8	EA	15.6	16.2	16.15	43933.612	1.78982	
396	17 58 50.31	+01 33 36.2	EB	13.9	14.3	14.15	44112.300	0.533503	68
397	17 58 50.46	+01 27 30.9	RRAB	15.45	16.1		42924.501	0.761131	
398	17 58 53.88	+02 05 54.1	EW	15.1	15.7	15.6:	43420.247	0.804050	
399	17 59 37.80	+02 19 56.6	EA	15.1	15.55	15.3:	43395.262	0.764730	
400	18 00 04.74	+03 17 58.8	EB	14.2	14.6	14.4	42925.343	0.727807	
401	18 00 06.61	+02 39 54.1	RRAB	15.0	16.1		42949.328	0.582189	
402	18 00 07.86	+01 58 19.2	RRAB	15.45	16.1		43420.247	0.590710	

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
403	$18^h00^m23.67^s$	$+04°08'24.0''$	SR:	15.15	15.8			277:	17
404	18 00 26.75	+01 23 26.3	EB	15.2	15.55	15.4	43253.517	0.546654	
405	18 00 51.43	+02 40 55.6	EB	15.9	16.45	16.3	43659.468	0.396194	69
406	18 00 57.06	+01 39 57.4	EA	15.3	16.3	15.45	42951.355	0.861964	
407	18 01 06.44	+02 33 48.2	LB	15.6	16.2				56
408	18 01 10.68	+01 50 53.5	RRAB:	15.5	16.05		42901.520	0.728592:	46, 70, 71
409	18 01 33.22	+02 54 39.2	EW	15.65	16.2	16.15	43279.486	0.364697	
410	18 01 33.37	+03 41 16.2	LB	15.3	15.95				1
411	18 01 50.67	+03 26 33.5	LB	15.2	15.8				
412	18 02 01.16	+03 34 57.1	RRC	15.6	16.1		43254.534	0.295172	
413	18 02 10.69	+00 43 27.4	EW	15.9	16.5	16.4	45230.243	0.414215	
414	18 02 13.38	+01 32 26.1	EW	14.9	15.15	15.15	42902.512	0.390995	21, 52, 70, 72
415	18 02 13.81	−00 21 45.0	LB	15.4	15.9				1
416	18 02 25.08	+02 06 22.8	RRAB	15.5	16.3		43346.317	0.642518	
417	18 02 26.17	+01 54 25.4	RRAB	15.3	16.4		43694.395	0.541811	
418	18 02 26.37	+02 47 41.0	EW	15.0	15.5	15.45	43332.356	0.381148	
419	18 02 26.90	+03 24 24.8	RRAB:	14.9	15.5		42868.507	0.686535:	46, 73
420	18 02 29.40	+02 41 24.3	EB:	15.55	16.0	15.95	42954.322	0.712125	74
421	18 02 34.68	+03 23 13.4	LB:	14.8	15.35				1, 16
422	18 02 34.86	+00 36 38.9	LB	14.7	15.0				1, 17
423	18 02 36.57	+02 00 59.1	RRAB	15.4	16.5		43418.214	0.535182	
424	18 02 40.41	+01 55 49.3	EW	16.0	16.4	16.4	42925.343	0.367549	
425	18 02 47.03	+00 00 35.8	RRC	15.35	15.85		42872.523	0.259761	
426	18 03 14.64	+03 25 20.4	EA	14.35	14.85	14.75	42871.482	0.713377	
427	18 03 36.31	+02 57 36.0	EW	13.95	14.3	14.25	43272.409	0.407238	
428	18 03 36.72	+02 18 15.3	RRC	14.8	15.2		42876.499	0.271511	9
429	18 04 04.34	+01 14 26.3	LB	14.45	14.75				75
430	18 04 14.77	+03 38 15.1	EW	13.95	14.5	14.4	42868.572	0.389506	
431	18 04 20.00	+03 08 57.6	LB	15.8	16.6				1
432	18 04 31.14	+03 35 21.1	EW	15.1	15.7	15.65	42989.295	0.441857	
433	18 04 44.07	+03 20 09.4	EW	14.65	15.15	15.1	42927.410	0.423114	
434	18 04 54.72	+02 13 14.1	RRAB	15.35	16.2		44043.431	0.472095	52, 76
435	18 05 07.26	+01 17 30.5	EB	15.25	15.8	15.5	43424.216	0.469976	
436	18 05 09.29	+03 18 35.5	RRAB	15.9	16.7		44106.318	0.742655	40
437	18 05 10.24	+03 01 39.7	RRC	15.1	15.8		43197.623	0.352547	
438	18 05 26.60	+02 13 56.3	EW	14.05	14.35	14.3	44106.318	0.378665	
439	18 05 33.48	+04 45 55.6	EB	15.35	15.7	15.6	42925.425	0.432024	
440	18 05 36.61	+01 40 10.2	LB	15.9	16.45				1
441	18 05 38.04	+02 16 27.5	HADS	15.0	15.5		43261.527	0.0790113	
442	18 05 46.79	+01 54 10.8	EW	15.4	15.8	15.75	43262.512	0.417669	
443	18 05 54.52	+03 31 56.2	RRC	15.1	15.7		43046.268	0.250529	
444	18 05 56.49	+02 55 28.2	EW	15.5	16.1	15.95	43332.356	0.350551	
445	18 06 03.38	+02 43 27.7	SR	15.5	16.4			95:	
446	18 06 05.61	+04 24 37.2	EW	13.4	13.6	13.55	42930.401	0.3574315	68, 70
447	18 06 07.63	+02 53 59.5	LB	14.8	15.2				5
448	18 06 15.10	+01 49 40.9	LB	15.4	15.9				1
449	18 06 32.51	+00 43 55.5	LB	13.9	14.15				1
450	18 06 36.99	+03 38 09.0	EB	14.4	14.9	14.8	43427.283	0.585895	
451	18 06 37.43	+01 48 57.3	LB	15.6	16.2				
452	18 06 43.53	+01 36 52.4	SR:	15.5	16.0				1, 30
453	18 06 50.40	+02 13 47.0	SR:	14.5	15.05			65:	1
454	18 07 06.42	+02 48 03.3	RRC	14.8	15.4		42957.403	0.327441	

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
455	$18^h07^m07.37^s$	+02°10′04.2″	RRC	14.75	15.15		42949.330	0.200406	
456	18 07 13.62	+04 09 00.7	RRAB	15.7	16.6		46973.316	0.511845	
457	18 07 17.19	+01 23 42.0	SR:	15.65	16.2				55, 77
458	18 07 23.06	+02 32 49.5	SR:	15.2	15.9			59.5:	49
459	18 07 30.13	+03 11 06.8	RRC	13.8	14.1		42927.410	0.279441	
460	18 07 50.48	+04 36 38.4	EA	14.5	15.1		42873.568	2.54351	8
461	18 07 50.74	+02 25 20.5	EW	14.1	14.35	14.35	43694.395	0.333834	78
462	18 07 54.59	+02 44 12.6	LB	15.05	15.65				56
463	18 08 00.27	+01 17 31.1	EW	15.45	16.0	16.0	42957.370	0.896409	79
464	18 08 01.09	+01 42 40.0	RRC	15.6	16.2		43254.502	0.222105	46, 80
465	18 08 10.33	+04 29 01.5	RRAB	14.85	15.7		42872.523	0.607109	
466	18 09 04.64	+02 55 11.7	EA	14.2	14.55	14.35	43427.29	1.25868	
467	18 09 13.43	+03 24 47.6	LB	15.6	16.3				1
468	18 09 15.43	+01 51 02.5	LB	15.2	16.0				5
469	18 09 26.68	+03 30 28.0	LB	14.05	14.5				5
470	18 09 27.29	+02 31 40.2	LB	14.8	15.6				1
471	18 09 42.02	+01 53 15.0	EW	15.5	15.9	15.9	42963.505	0.389465	3
472	18 09 46.10	+02 22 33.8	EW	14.9	15.4	15.35	42872.523	0.437150	
473	18 10 11.80	+01 23 29.6	LB	14.8	15.3				5
474	18 10 13.90	+02 10 06.5	RRAB	15.2	16.3		42927.410	0.491299	
475	18 10 16.59	+02 43 51.1	LB	15.05	15.65				56
476	18 10 36.67	+02 29 47.5	LB	14.75	15.3				1
477	18 10 46.84	+01 50 52.4	EW	14.3	14.7	14.7	43394.288	0.494909	
478	18 10 58.81	+02 03 41.5	LB	15.6	16.1				49
479	18 11 09.70	+03 29 08.6	RRAB	15.45	16.4		43190.597	0.598893	
480	18 11 20.63	+02 20 37.9	EB	15.45	15.95	15.7	43757.260	0.506636	
481	18 11 22.79	+01 51 09.9	LB	14.0	14.35				5
482	18 12 01.82	+01 45 42.5	RRC	14.25	14.55		42869.527	0.414704	
483	18 12 26.35	+02 42 16.3	EW	15.4	15.85	15.75	43249.546	0.545411	
484	18 12 27.20	+02 46 49.0	EA	15.25	15.75	15.4:	44489.274	0.639795	
485	18 12 34.08	+03 53 04.4	LB	14.8	15.4				
486	18 12 40.81	+02 00 06.9	EW	15.2	15.6	15.6	42871.482	0.385892	81
487	18 12 48.07	+03 26 41.8	LB	15.45	16.4				1
488	18 12 50.51	+04 23 38.1	EB	15.7	16.5	16.1	44491.256	0.447473	
489	18 12 52.24	+02 55 22.9	RRAB	15.55	16.4		42925.503	0.802186	
490	18 13 16.62	+03 38 17.1	SR:	14.0	14.65			96:	1, 17, 82
491	18 13 19.22	+01 51 16.1	EW	15.6	16.0	16.0	43702.392	0.495578	
492	18 13 20.60	+02 03 10.3	RRAB	15.9	16.55		43272.409	0.473020	
493	18 13 30.87	+03 40 47.4	EW	15.65	16.1	16.1	44021.433	0.256380	54
494	18 13 36.57	+03 28 48.2	RRAB	15.0	16.3		43046.268	0.488209	
495	18 13 48.88	+03 32 20.1	LB	15.0	15.6				
496	18 14 31.83	+03 32 38.1	LB	15.2	16.0				1
497	18 14 53.82	+02 43 09.9	LB	15.5	16.2				1
498	18 15 04.28	+03 20 17.8	EB	13.9	14.4	14.35	43261.495	0.540407	
499	18 15 21.24	+02 27 42.5	SR	15.6	16.2			75.9:	
500	18 15 21.72	+02 37 49.8	RRAB	15.3	16.4		43284.449	0.631287	
501	18 15 25.97	+02 44 38.7	EW	14.6	15.05	15.0	43195.622	0.422450	
502	18 15 31.59	+02 49 17.4	RRAB	15.2	16.5		44025.432	0.444820	
503	18 15 46.26	+03 01 13.9	EA	14.25	14.75		43254.53	1.46489	8
504	18 15 57.08	+04 07 55.5	RRC	15.9	16.6		42925.456	0.324967	70
505	18 16 04.64	+02 37 58.3	RRC	15.65	16.05		42957.338	0.235722	
506	18 16 13.27	−00 03 00.8	EW	14.05	14.55	14.5	42876.562	0.441822	17, 83

Table 2. (Contd.)

MDV	α (J2000)	δ (J2000)	Type	Max	Min	Min II	Epoch (JD 24...)	P, days	Note
507	$18^h16^m20.59^s$	$+03°15'27.2''$	HADS	15.6	16.2		43034.231	0.181854	21, 46, 59
508	18 16 23.15	+04 47 26.3	RRAB	15.05	15.75		43199.617	0.697256	
509	18 16 28.51	+02 06 02.5	LB	14.85	15.25				5
510	18 16 51.76	+03 17 22.9	EB	15.25	16.3:	16.0	42868.572	0.461724	
511	18 17 03.10	+03 31 15.3	LB	15.7	16.5				1
512	18 17 20.27	+02 04 43.9	EB	15.55	15.9	15.75	43249.546	0.456878	
513	18 17 52.10	+01 54 48.4	EB	14.6	15.0	14.95	43659.468	1.10850	
514	18 18 16.28	+02 59 35.5	LB	15.0	15.6				5
515	18 19 10.48	+03 34 44.9	CWB	14.3	14.7		43284.48	1.16303	
516	18 19 24.15	+03 03 11.6	RRC	14.25	14.75		44043.431	0.352922	
517	18 19 47.33	+02 01 03.0	RRC	15.0	15.45		43279.448	0.274601	84
518	18 09 18.66	+02 34 54.2	HADS	14.33	14.61		55022.44	0.0645378	45

Notes. **1**: Varies in the NSVS data. **2**: $P = 55.6^d$ (NSVS data). **3**: RRC type with a period half as long is possible. **4**: $P = 39.7^d$ (NSVS data). **5**: A low-amplitude variable from NSVS data. **6**: $P = 60^d$ (NSVS data). **7**: Possibly $P \sim 50^d$ (NSVS data). **8**: A period twice as long is possible. **9**: EW type with a period twice as long is possible. **10**: $P \sim 51^d$ is possible (NSVS data). **11**: The results were later confirmed with CCD observations. **12**: A white or yellow star, $J - H = 0.529$ (2MASS). **13**: $P \sim 62^d$ is possible (NSVS data). **14**: NSVS data reveal variations with the same period. **15**: One-day aliases of half the period are strong. **16**: $P = 45^d$ (NSVS data). **17**: Variable according to ASAS-3 data, was not included in the catalog of ASAS-3 variable stars. **18**: Not identical to V568 Oph ($17^h59^m44.09^s$, $+4°59'55.6''$, J2000). **19**: One-day period aliases (0.399278^d and 0.285235^d) are also quite possible. **20**: Periods of 83.8^d or 92.5^d are possible (NSVS data). **21**: A double star. **22**: $P \sim 63.5^d$ is possible (NSVS data). **23**: $P = 75^d$ (NSVS data). **24**: A period of 0.286864^d (EW type) is also quite possible. **25**: O'Connell effect. **26**: A one-day alias, $P = 0.49813^d$, is possible. **27**: $P \sim 78^d$ is possible (NSVS data). **28**: $P \sim 150^d$ is possible (NSVS data). **29**: $P \sim 130^d$ is possible (NSVS data). **30**: $P = 58^d$ (NSVS data). **31**: $P = 48^d$ (NSVS data). **32**: $P = 62^d$ (NSVS data). **33**: $P = 0.305252^d$ is also possible. **34**: $P \sim 250^d$ is possible (NSVS data). **35**: $P \sim 60^d$ is possible (NSVS data). **36**: $P \sim 54^d$ is possible (NSVS data). **37**: $P \sim 85^d$ is possible (NSVS data). **38**: A one-day alias, $P = 0.397451^d$, is possible. **39**: RRAB type with a period half as long is possible. **40**: The coordinates are from the USNO-A2.0 catalog. **41**: $P = 81^d$ (NSVS data). **42**: Possibly, the minima are deeper. **43**: $P \sim 82^d$ is possible (NSVS data). **44**: A one-day alias, $P = 0.081429^d$, is possible. **45**: Variations were confirmed with CCD observations. The tabulated variability range is for the V filter. **46**: One-day aliases are strong. **47**: Also possible are the periods 0.397118^d or 0.659863^d (EW type). **48**: $P = 78.5^d$ (NSVS) data. **49**: In the NSVS data, a blend of two stars varying with a small amplitude. **50**: $P = 49.7^d$ (NSVS data). **51**: POSS images suggest that the southwestern component varies. **52**: The tabulated amplitude of the variations is lower than actual. The coordinates are for the star blend from the GSC1.2 catalog. **53**: The northeastern component appears variable in POSS images. **54**: HADS type with a period half as long is possible. **55**: A variable blend in the NSVS data. **56**: A variable blend of two stars in the NSVS data. **57**: EB type is also possible. **58**: HADS type, with a period half as long or with a one-day alias of the half period, is possible. **59**: The tabulated amplitude is lower than actual. The coordinates are for the star blend from the USNO-A2.0 catalog. **60**: $P = 58.3^d$ (ASAS-3 data). **61**: $P = 0.200415^d$ or $P = 0.250820^d$ (RRC type) are also possible. **62**: A period half as long is possible. **63**: $P = 0.371320^d$ (EW type) is also possible. **64**: $P = 51.5^d$ (NSVS data). **65**: A triple or multiple star. **66**: $P = 0.219342^d$ (RRC type) is also possible. **67**: A one-day alias, $P = 0.357913^d$ (RRC type) is possible. **68**: ASAS-3 data confirm our classification and light elements. The star was not included in the ASAS-3 catalog of variable stars. **69** : $P = 0.330540^d$ (EB type) is also possible. **70**: A large scatter of the phased light curve. **71**: $P = 0.842916^d$ (EW type) is possible. **72**: The southeastern component appears variable in the POSS images. **73**: $P = 0.578142^d$ (EW type) is also possible. **74**: $P = 1.10753^d$ (EA or EB type) is also possible. **75**: A small-amplitude variable in ASAS-3 data; was not included in the ASAS-3 catalog of variable stars. **76**: A triple star. **77**: $P = 56.5^d$ (NSVS data for the blend). **78**: $P = 0.285971^d$ (EW type) is also possible. **79**: $P = 0.309472^d$ (RRC type) or $P = 0.618943^d$ (EW type) are also possible. **80**: Periods of 0.285741^d or 0.400063^d (RRC type in both cases), 0.444211^d or 0.571481^d (EW type in both cases) are possible. **81**: $P = 0.323339^d$ (EW type) is also possible. **82**: $P \sim 96^d$ is not excluded (NSVS data). **83**: $P = 0.441831^d$ (ASAS-3 data). **84**: A one-day alias, $P = 0.378940^d$ (RRC type), is also quite possible.

* The complete version of the table is available evectronically at the Strasbourg Center of Astronomical Data http://cdsarc.u-strasbg.fr/viz-bin/Cat and at the GCVS web site.

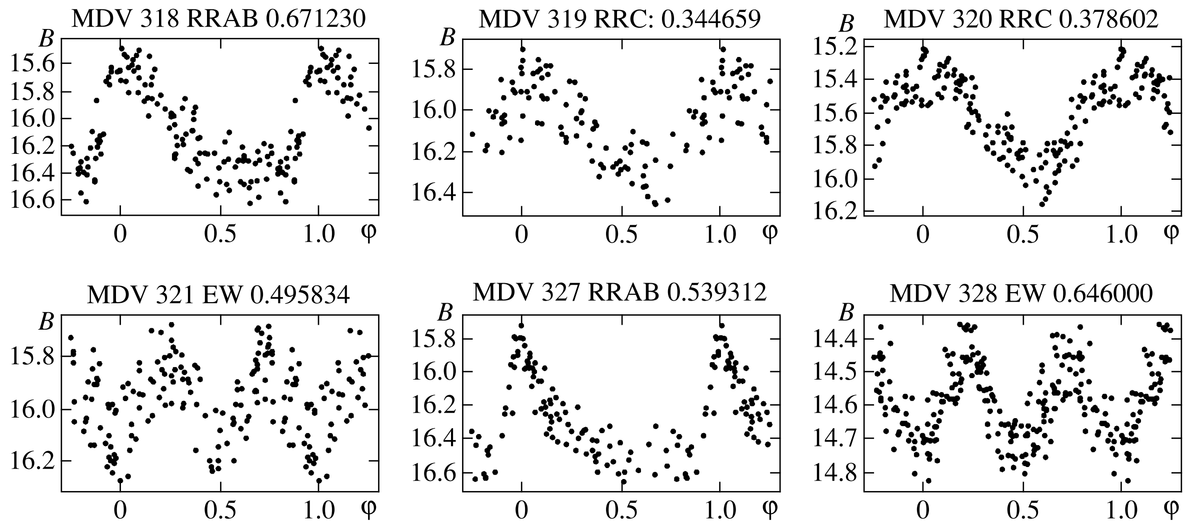

Fig. 1. Examples of phased light curves for new variable stars in the field of 66 Ophiuchi. The periods are in days.

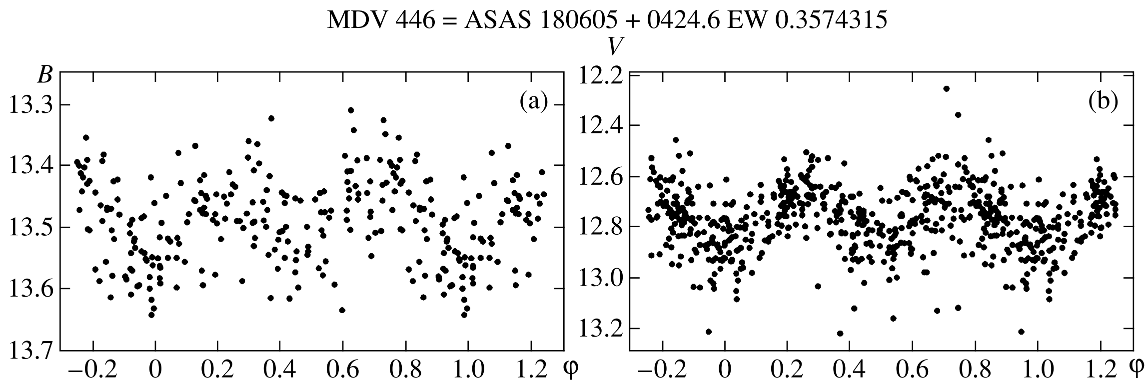

Fig. 2. Phased light curves of MDV 446, an EW eclipsing variable, from (a) our photographic data and (b) CCD observations of the ASAS-3 survey. The period is given in days.

tains the MDV serial numbers, J2000.0 coordinates, identifications with the USNO-A2.0 catalog (only in the electronic version of the table), and variability types and light elements we determined. Epochs of minimum brightness are given for eclipsing stars and epochs of maximum brightness in other cases. Notes accompanying the table present additional information.

Phased light curves for periodic variables (with the exception of several SR stars with uncertain periods) and the results of our automated photographic photometry for all the new variable stars are available at our project web site (http://www.sai.msu.su/gcvs/digit/mdv/). As an example, Fig. 1 displays phased light curves for six new periodic variables from our list.

The variability of most of the red variable stars we detected can be confirmed using observations of the ROTSE-I/NSVS project [10]. Note that we did not use the NSVS [10] or ASAS-3 [9] data to search for variables in the field in question, solely to independently confirm our discoveries. As an example, Fig. 2 shows phased light curves for the star MDV 446, an EW eclipsing variable, from our data and from observations of the ASAS-3 project [9]. This variable was not included in the catalog of ASAS-3 variable stars, but ASAS-3 observations are in excellent agreement with our preliminary classification and light elements for the star.

Our new variables in the field of 66 Oph include three Cepheids (probably Type II Cepheids [16]). We found 157 eclipsing binaries, 11 high-amplitude δ Scuti (HADS) variables, 144 RR Lyrae stars, 110 irregular variable stars (109 LB and one white star), and 55 semi-regular red variables.

In our search for variable stars using digitized photographic plates of the 66 Oph field, we also detected variations of many previously-discovered variable stars. The information we derived for 43 such stars considerably supplements that in catalogs or published papers. Twelve of these stars are objects of the NSV catalog, previously suspected of variability; our study has revealed information sufficient for them to be included in GCVS Name Lists. We are also planning to add to the GCVS 21 stars detected as variables during recent years that remained relatively poorly studied prior to this work. These are mainly equatorial-zone stars from the FASTT project [17]. The 33 stars to be added to the GCVS include seven RR Lyrae variables, six eclipsing binaries, two δ Scuti stars (HADSs), and 18 red semi-regular and irregular variable stars. We significantly improved the information for 10 stars already in the GCVS (corrected their variability types or light elements). For one of these (the Mira V404 Oph), we found that the star was erroneously marked in the discoverer's finding chart [18], leading to incorrect coordinates in the GCVS, and that its published period [19] was approximately half the correct value.

We present our main results for previously-discovered variable stars in Table 3.[5] Epochs of minimum brightness are given for eclipsing stars and RV Tauri variables, and epochs of maximum brightness in other cases. With the exceptions indicated in the notes to the electronic Table 2, the coordinates in Tables 2 and 3 are from the 2MASS Point Source Catalog [20]. Figure 3 displays previously-unpublished light curves of 18 periodic variables from Table 3.

In the southern half of the 66 Oph field, we suspected variability of about 20 stars. We have already initiated CCD observations in order to confirm these variables. The star MDV 518 from Table 2 was initially in the list of suspected variables, but was confirmed using CCD data [21]. The same paper presents refined information for the variables MDV 313–MDV 316; the confirmation of their variability was already reported in [15].

4. SPECIFIC FEATURES OF THE SAMPLE OF NEW VARIABLE STARS

It is of interest to analyze the sample of new variable stars we have discovered in the field of 66 Oph from the point of view of their distributions over type and period, bearing in mind the limited nature of our statistics, as well as possible selection effects. For example, the studied region of the celestial sphere (100 square degrees) is only 0.24% of its total area, and the considerable coma aberration at the corners and edges of our plates makes the effective studied fraction of the sky somewhat smaller.

We first note the absence of certain types of variable stars from our sample, some of which are generally fairly common. For example, we discovered no Mira variables, although Miras are one of the richest GCVS types (about 7500 Mira stars in the 4th GCVS edition and subsequent Name Lists, according to data from the GCVS site, http://www.sai.msu.su/gcvs/gcvs/iii/vartype.txt). This is due to the properties of our variable-star search algorithm. In contrast to searches for variables using CCD frames, the adaptation of the algorithm for photographic plates requires stricter filtering of plate flaws, which are fairly numerous in photographs. The algorithm we are currently using does not enable the efficient detection of variable stars that are absent from the reference plate and remain below the plate limit for many of the images. Mira stars have large variation amplitudes; those that are brighter than 13.5^m at their maximum are mostly already known, while fainter Miras are, as a rule, far below our photometric limit during their minimum brightness.

The same properties of the algorithm are unfavorable for detecting transient events, in particular, dwarf Novae (U Geminorum variables); these are also absent from our sample, though, in fact, the number of stars of this type expected in the field is modest.

It is interesting that our sample contains 11 high-amplitude δ Scuti (HADS) variables, while the total number of this type of stars with amplitudes of at least 0.2^m in the GCVS is only 121. We are not aware of any selection effects that would increase the fraction of such variables in our sample. Obviously, old methods for detecting and studying variable stars using photographic plates were less efficient for detecting such variables than the modern digital techniques, and the actual number of HADS stars is actually much higher than the number of already detected objects.

Finally, we consider the period distribution of our sample's eclipsing variables, presented in Table 4. Each column shows the statistics for one of the major subtypes of eclipsing variable (Algols, β Lyrae stars, and W Ursae Majoris variables); after the fraction of the corresponding period interval in our sample in percent, we indicate the corresponding fraction for the same subtype in the GCVS (in brackets). Applying a Kolmogorov–Smirnov test to the period distributions of eclipsing stars in our program field and the GCVS, we find that the distributions are different for each type of eclipsing variable (at the $p < 1\%$ significance level). Comparing the distributions using the sign test, we conclude that our sample has a considerably higher

[5] Table 3 is published in an abbreviated form. The complete version of the table is published electronically at the site of the Strasbourg Center of Astronomical Data http://cdsarc.u-strasbg.fr/viz-bin/Cat; it is also available at the GCVS site.

Table 3. Improved information for known variable stars*

GCVS/NSV	Name	α (J2000)	δ (J2000)	Type	Epoch (JD 24...)	P, days	Note
NSV 9475	HV 11011	$17^h40^m13.31^s$	$+6°02'51.8''$	RRAB	42957.370	0.526203	
	FASTT 932	17 44 20.67	+0 19 31.6	RRAB	42957.469	0.536412	
NSV 9613	FASTT 933	17 44 22.96	+0 08 22.6	RRAB	42989.432	0.574755	
NSV 9642	HV 11040	17 45 26.26	+8 22 01.8	RRAB	42870.481	0.467784	
	FASTT 937	17 46 25.75	+0 15 23.9	LB			1
	FASTT 939	17 47 19.34	+0 13 54.4	EW	43700.317	0.329988	
NSV 9704	HV 11046	17 48 06.28	+8 12 54.2	RRC	42934.380	0.320757	
NSV 9721	S 9837	17 49 03.37	+5 06 19.3	EW	42930.509	0.255458	
V378 Oph		17 49 04.81	+5 00 31.5	RVA	42989.3	70.47	
NSV 9734	HV 11053	17 49 30.19	+4 18 40.1	LB			1
NSV 9740	S 9838	17 49 43.48	+4 13 24.1	EA	44112.30	1.86895	
	FASTT 1017	17 51 45.87	"—0 10 58.5	HADS	44410.365	0.1077343	
V1078 Oph	S 9263	17 53 37.12	+4 25 53.3	RV:	42872.5	96.6	2
	FASTT 890	17 53 57.64	+0 58 53.5	RRAB	43418.214	0.565534	
V1079 Oph	S 9845	17 54 03.53	+3 19 59.2	RRAB	44050.409	0.498261	
	FASTT 902	17 54 05.10	+0 34 04.4	SR:			1, 3
V942 Oph	S 4190	17 54 38.51	+2 45 33.9	RRAB	43261.524	0.845957	
	FASTT 835	17 55 10.63	+1 20 48.3	LB			
	FASTT 849	17 59 36.90	+1 07 53.0	SR		73	1, 4
	FASTT 953	17 59 46.43	+0 03 48.3	EW	43254.502	0.371283	
NSV 9973	S 9277	18 00 32.19	+5 27 11.3	LB			1
	Mis V0572	18 01 46.62	+8 18 34.8	EA	43694.395	4.83277	
V947 Oph	S 4199	18 02 05.31	+5 52 45.5	EA	44023.455	0.797747	
	FASTT 863	18 02 27.24	+1 03 17.0	LB			1
	FASTT 996	18 03 16.70	"—0 06 43.1	SR:		48.5:	1, 5, 6
	FASTT 867	18 03 35.16	+1 28 45.1	RRC	43349.371	0.355679	
	FASTT 868	18 03 48.13	+1 02 43.6	LB			1, 5
NSV 10129	S 9857	18 03 54.74	+7 34 27.4	SR:		143:	1
	FASTT 1001	18 04 39.02	"—0 23 37.0	SR		59	1, 7
V2035 Oph	S 10359	18 04 54.89	+2 59 51.1	SR:			1, 8
	FASTT 874	18 05 25.88	+1 27 16.7	EB	44050.409	0.620950	
	FASTT 1003	18 05 26.13	"—0 21 03.3	LB			1
	FASTT 1077	18 06 04.42	"—0 32 05.2	SR:		61:	1, 9
	FASTT 914	18 06 39.88	+0 36 47.0	LB			1
	FASTT 925	18 08 54.52	+0 22 36.6	HADS:	43190.594	0.188118	10
NSV 10291	S 9867	18 09 52.67	+3 41 59.3	LB			1
	FASTT 975	18 10 41.03	+0 10 56.5	LB			1
V2087 Oph	S 9297	18 11 16.36	+5 15 32.3	RRAB	43282.452	0.495589	
NSV 10381	S 9298	18 13 09.74	+4 28 58.1	LB			1
NSV 10403	S 9872	18 14 00.45	+3 50 35.0	LB			1
V404 Oph		18 14 14.19	+2 32 53.3	M	42870.5	202.5	
V964 Oph	S 4219	18 15 56.47	+3 50 58.7	RRAB	43284.483	0.509331	
V878 Oph	S 4221	18 16 39.83	+0 22 27.2	RRAB	43417.212	0.633576	

Notes. **1**: Variable in the NSVS data. **2**: Type SR is possible. Variable in the NSVS and ASAS-3 data. $P = 97^d$ (NSVS data), $P = 96.8^d$ (ASAS-3 data). **3**: $P \sim 143^d$ is possible (NSVS data). **4**: $P = 67^d$ (NSVS data). **5**: Variable in the ASAS-3 data, not included in the ASAS-3 catalog of variable stars. **6**: $P \sim 47^d$ is possible (ASAS-3 data). **7**: $P = 60^d$ (NSVS data). **8**: $P \sim 50^d$ is possible (NSVS data). **9**: $P \sim 68^d$ is possible (NSVS data). **10**: One-day aliases are strong. $P = 0.301831^d$ (RRC type) is also possible.

* The table in its complete form is available electronically at the site of the Strasbourg Center of Astronomical Data http://cdsarc.u-strasbg.fr/viz-bin/Cat and at the GCVS web site.

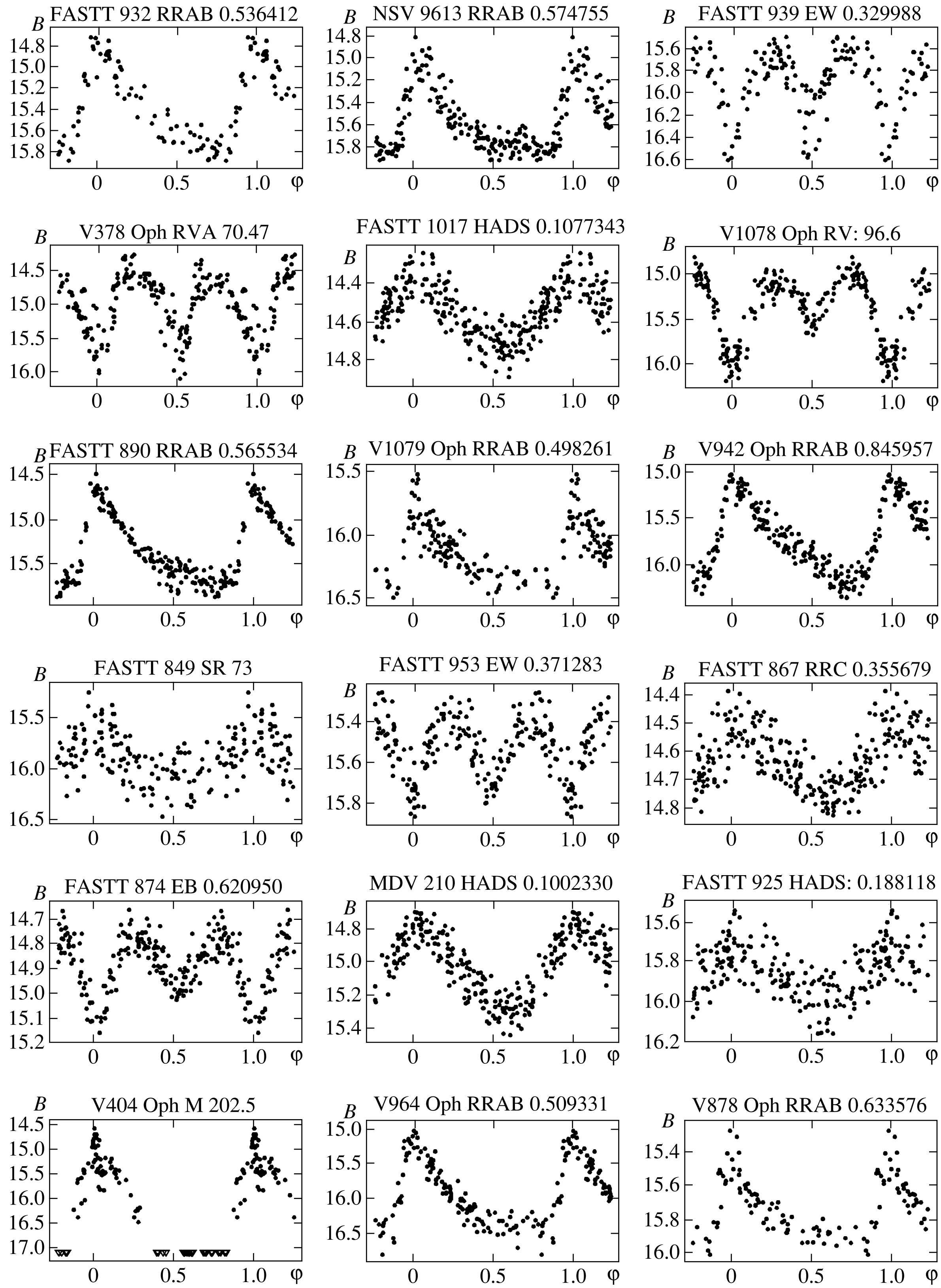

Fig. 3. Phased light curves for 18 previously-known variable stars studied using our automated photographic photometry. The periods are in days.

Table 4. Period distribution for the new eclipsing variable stars (the corresponding GCVS fraction is in brackets)

P, days	EA		EB		EW	
	N	Fraction	N	Fraction	N	Fraction
0.2–0.4			6	13% (1.7%)	45	50% (47.8%)
0.4–0.6			21	47% (15.4%)	37	42% (30.9%)
0.6–0.8	5	22% (3.7%)	10	22% (17.8%)	5	6% (14.0%)
0.8–1.0	4	17% (5.0%)	4	9% (13.4%)	2	2% (5.5%)
>1.0	14	61% (89.2%)	4	9% (51.7%)		

fraction of short-period Algols and β Lyrae eclipsing stars, while the difference of the characteristic periods in our sample and the GCVS is statistically insignificant for the W Ursae Majoris stars. For the Algols, the fraction of long-period stars in our sample could be too low due to selection effects: rare fadings of eclipsing stars with narrow minima could be rejected by our variability-search algorithms, interpreted as resulting from possible plate flaws. This explanation is not applicable to the two other subtypes and, as in the previous case, we tend to believe that the differences are due to shortcomings of the traditional techniques for searching for variable stars.

5. CONCLUSIONS

Let us summarize the main results of our study.

1. We have started our program of digitizing the SAI plate stacks of astronomical photographs. We have developed algorithms for searching for and studying new variable stars using digitized plates. Special attention to searches for variable stars carried out in parallel to the scanning process is a characteristic feature of our plate-collection digitizing program.

2. We have discovered and studied 480 new variable stars in a $10° \times 10°$ field of the digitized 30×30 cm plates of the 40-cm astrograph centered on 66 Ophiuchi. These stars include three new Cepheids of the spherical galactic component, 157 eclipsing binaries, 11 high-amplitude δ Scuti (HADS) stars, 144 RR Lyrae stars, 110 irregular variables (109 LB and one white star), and 55 semi-regular red variables. We have also significantly improved the parameters for 43 known variables in the same field. Brightness variations are suspected for more than 50 stars; we have initiated a program of CCD observations of these suspected variables.

3. We have considered the statistical properties of our sample of new variable stars, mainly associated with the properties of the analyzed material and the search algorithm used. The actual frequency of HADS variables may be much higher than their fraction in existing catalogs.

4. Our discoveries of new variables were performed in a sky field rich in known variables stars, detected earlier photographically or using CCD methods. Our discovery of hundreds of new variables in a well-studied region of sky demonstrates that archive photographs possess a large information potential that has remained unrealized thus far.

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