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New Variable Stars on Digitized Moscow Collection Plates. Field 66 Ophiuchi (Northern Half)

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ABSTRACT

We initiated digitization of the Moscow collection of astronomical plates using flatbed scanners. Techniques of photographic photometry of the digital images were applied, enabling an effective search for new variable stars. Our search for new variables among 140 000 stars in the $10^\circ \times 5^\circ$ northern half of the field centered at 66 Oph, photographed with the Sternberg Institute's 40-cm astrograph in 1976–1995, gave 274 new discoveries, among them: 2 probable Population II Cepheids, 81 eclipsing variables, 5 high-amplitude δ Sct stars (HADSs), 82 RR Lyr stars, 62 red irregular variables and 41 red semiregular stars, 1 slow irregular variable not red in color. Ephemerides were determined for periodic variable stars. We detected about 30 variability suspects for follow-up CCD observations, confirmed 11 stars from the New Catalog of Suspected Variable Stars, and derived new ephemerides for 2 stars already contained in the General Catalog of Variable Stars.

Key words: *Stars: variables: general – Surveys*

1. Introduction

Regular photographic observations of the sky for variable-star studies started in Moscow in 1895. Since then, several different telescopes were used to take direct sky plates for astrometry and for astrophysics. The Moscow plate archive now contains more than 60 000 direct photographs and objective-prism plates taken in Moscow, at other sites in Russia, and at the Sternberg Institute's observatory in Crimea, Ukraine.

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 Prof. C. Hoffmeister for Sonneberg Observatory (Germany) and first installed there in 1938. 1658 plates from this telescope, taken in 1938–1945, are kept in Sonneberg (the GA series of the Sonneberg plate collection). In 1945, the telescope was taken to the Soviet Union as a part of the World War II reparations. It was initially installed in Simeiz (Crimea), then brought to Kuchino near Moscow, and in 1958 became the first instrument of the Crimean Laboratory of the Sternberg Institute in Nauchny, Crimea. The total number of plates taken with the 40-cm astrograph after 1948 is about 22 500. A single attempt of direct comparison between Sonneberg and Crimean plates of the 40-cm astrograph at a blink comparator was undertaken in 1980s (Samus 1983).

The field of view of the 40-cm astrograph is $10^\circ \times 10^\circ$, on 30×30 cm plates (the focal length is 1600 mm). The typical exposure time for the variable-star fields was 45 minutes. The limiting magnitude of good-quality plates is about 17.5 (B). The instrument was mainly used for variable-star studies, including search for new variables. For some fields, rich series of plates exist (up to ≈ 500 plates). For variable stars that can be found in several fields, sometimes as many as 1000 photographic plates are available. The list of fields, with numbers of plates obtained, can be found in Internet (*http://cataclysm.sai.msu.ru/www/plates/40.dat*). Plates are kept in good conditions, most plates, initially of excellent quality, are still perfect.

The Moscow plate collection, like other major astronomical plate collections of the world, has been actively used for scientific research for decades. It still contains a large amount of significant information never used by researchers, as indicated by discoveries of interesting events missed at the time of observation, like the discovery of Nova Aql 1985 (V1680 Aql) made 17 years later (Antipin *et al.* 2002).

Guaranteed conservation of the vast amounts of information contained in the plate collection and its use by means of modern methods of image processing require digitization of plate archives. This work commenced in Moscow, in 2004, after the purchase of two Creo EverSmart Supreme II scanners. The initial digitization plans, along with a more detailed description of the Moscow plate archive from different instruments, were presented in Samus *et al.* (2006).

Most plates from the 40-cm astrograph were taken for variable-star studies. It was natural to search for new variable stars using digital images obtained in the process of scanning the Moscow collection plates. In our first experiments, we discovered 38 new variable objects (mostly variable stars, but also extragalactic objects) on test partial scans (several square degrees) of star fields photographed with the astrograph (Sokolovsky 2006, Manannikov *et al.* 2006, Kolesnikova *et al.* 2007a,b). We introduced preliminary designations for variable stars discovered in this program with the prefix MDV (Moscow Digital Variable).

There were several other attempts to search for variable objects on digitized photographic plates. Among them are: a search for QSOs on the base of optical variability and zero proper motion criteria (Scholz *et al.* 1997, Brunzendorf and Meusinger 2001), a search for long-term variability using Sonneberg archival patrol plates (Vogt *et al.* 2004), a search for novae in M31 using Tautenburg Schmidt plates (Henze *et al.* 2008).

In this paper, we announce the discovery and study of 274 new MDVs in the northern half of the field 66 Oph of the 40-cm astrograph.

2. Scanning and Reductions

The field 66 Oph ($18^{h}00\overset{m}{.}3$, $+4^{\circ}22'$, J2000.0) was photographed with the 40-cm astrograph in 1976–1995, a total of 254 plates were acquired.

All these plates were scanned with a resolution of 2540 dpi ($1\overset{''}{.}2$ per pixel), providing 14 bit per pixel per color. Color images produced by the scanner were saved in the TIFF (RGB) format using the scanner software operating in the Mac OS X environment. In our further reductions, we made use only of the green channel of each image, selected empirically. The files were then moved to a Linux server equipped with a 5 TB RAID array for storage and subsequent analysis. The images were converted to the FITS format using custom-written software*. In this paper, we present our analysis of the northern half of the field ($10^{\circ}\times5^{\circ}$) containing about 140 000 stars within our detection limits (see below).

The response to a point source of a given brightness on a large-scale photographic plate is a subject to strong spatial variations. Obvious reasons for that include abberations in the optics of the astrograph (coma, vignetting, etc.), inhomogeneity in photographic emulsion coating, and differences in airmass for stars in different parts of a plate. All these factors are expected to be relatively weak functions of coordinates on a plate. To overcome these complexities, the $10^{\circ}\times5^{\circ}$ field was subdivided into 72 nearly-square subfields. The influence of systematic factors is assumed to be the same for all stars in a given subfield. Each subfield was analyzed separately using VAST† software (Sokolovsky and Lebedev 2005), the results were combined at the final stage.

For star detection and aperture photometry, VAST uses the well-known SEXTRACTOR code (Bertin and Arnouts 1996). All objects identified by SEXTRACTOR as blended or non-point sources were excluded from further consideration because such sources produce many false detections in a variability search. Aperture photometry was performed with a circular aperture. The aperture diameter was automatically selected for each image to compensate for seeing variations. This method was preferred against the variable elliptical aperture photometry (parameter MAG_AUTO) enabled by default in SEXTRACTOR, because the addition of extra

**ftp://scan.sai.msu.ru/pub/software/tiff2fits*
†http://saistud.sai.msu.ru/vast

degrees of freedom (the aperture shape and size determined for each star separately) deteriorates the quality of measurements of faint stars. THE SEXTRACTOR parameters and the aperture diameter were selected to optimize measurements of stars in the 13.5–16.5 mag in (*B*) range. This magnitude range was preferred because brighter variable stars in this particular field have mostly been already discovered in the ASAS-3 (Pojmański 2002) and ROTSE-I/NSVS (Woźniak *et al.* 2004) CCD surveys, both covering the near-equatorial field of our plates.

The VAST code automatically matches stars detected on an image by SEXTRACTOR with stars detected on the reference image using the technique of the search for similar triangles. One of the best photographs was chosen as a reference image. Magnitudes of stars were measured by SEXTRACTOR in an instrumental scale with respect of the background level of the current image. All measured magnitudes were converted to the instrumental system of the reference image by approximating the relation between magnitudes on the current and reference images with a parabolic function. All stars matched on the images were used to establish this relation. Visual inspection confirms that this approximation works well in the required range of magnitudes.

The resulting light curves are characterized by an *rms* error of 0.05–0.15 mag for stars in the 13.5–16.5 mag range.

3. The Method of the Search for Variability and Its Limitations

A light curve of a variable star is, obviously, characterized by a larger scatter of magnitude measurements compared to non-variable stars measured on the same series of images. However, the precision of magnitude measurements for a particular star is a function not only of its brightness but of many different factors, like the presence of close companions and image defects. That is why a variability search based solely on magnitude scatter as a function of a star's magnitude is inefficient, at least for noisy photographic data, and will result either in dramatic incompleteness or in a very large number of false "positive" detections. To deal with the problem, we extensively use time information contained in our data, as described below.

The search for variability in a sample of light curves was conducted in several steps. First, the relation *rms* deviation – instrumental magnitude was constructed for each subfield. Stars with *rms* deviations in excess of the average for their magnitudes were selected using a soft criterion. The second step was to study time series for each selected star for periodicities using a number of complementary algorithms:

– Our own version of the Phase Dispersion Minimization algorithm, developed by one of the authors (D.M.K.).
– An Analysis of Variance (ANOVA, Schwarzenberg-Czerny 1989, 1996) technique. We made use of the C code from DEBIL package (Devor 2005) implementing this algorithm.

– Box Least Squares algorithm (Kovács *et al.* 2002) originally developed for search for transiting extrasolar planets. This algorithm has proven to be useful in identifying Algol-type variables among photographic light curves.

The listed algorithms provide means to judge on the statistical significance of detected periodicities. The period significance cut-offs for candidate selection were chosen for each algorithm using a number of previously found variable stars.

Along with the periodicity search approach, we used the variability detection algorithm proposed by Welch and Stetson (1993) to search for slow (compared to typical time sampling of our photographic light curves) non-periodic brightness variations which are often found for post-AGB and AGB stars and for active galactic nuclei. This technique was used mostly as a complementary one but not as a main candidate-selection method. Surprisingly, we found that slow irregular variables could often be detected by spurious periodicities found by period-search techniques even if the light variations are non-periodic. These false periods are usually found around integer multiples of 1 day and they correspond to beat frequencies between the typical light-curve sampling frequency and the characteristic frequency of real light variations. In such cases, visual inspection of a light curve readily reveals the true character of variability.

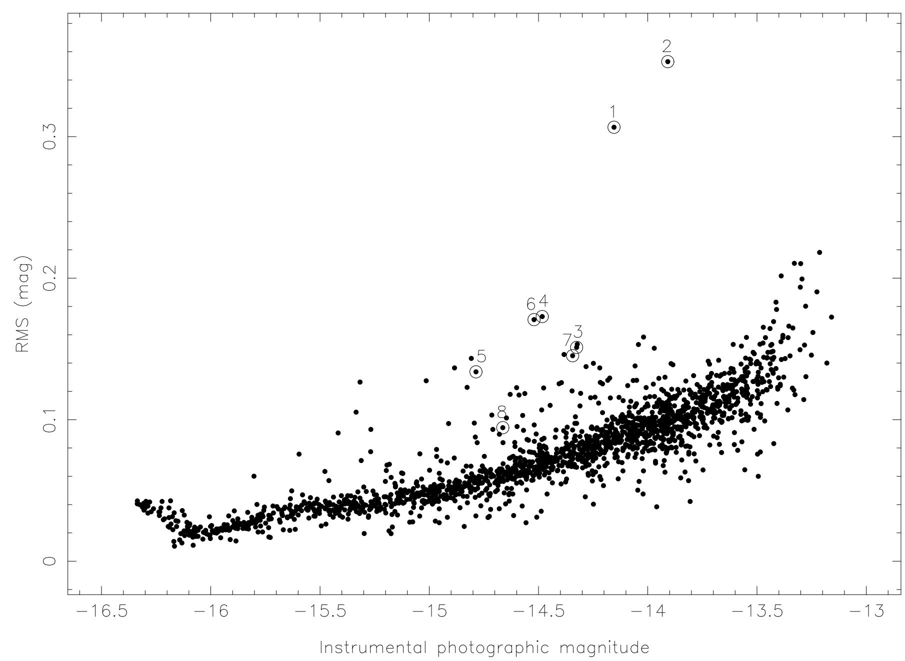

Fig. 1. The results of the search for variable stars in one of the 72 subfields in the northern half of the 66 Oph field. Circled are the eight detected objects: No. 1 is V1077 Oph, No. 2, V2328 Oph, No. 3, MDV 92, No. 4, MDV 91, No. 5, MDV 72, No. 6, V940 Oph, No. 7, MDV 83, No. 8 is one of suspected variables for our future CCD studies.

Fig. 1 shows the results of our variable-star search in a small subfield that gave 8 detections of variable stars (some of them known).

Magnitudes of all detected variable stars were then converted to the *B* scale using a number of USNO-A2.0 stars (Monet *et al.* 1998). The relation between the instrumental magnitudes and the USNO-A2.0 *B* magnitudes for each subfield was, again, approximated by a parabolic function. This step was performed after the selection of variable-star candidates since possible errors on this stage could introduce additional noise into light curves. A sample calibration diagram for a subfield is displayed in Fig. 2.

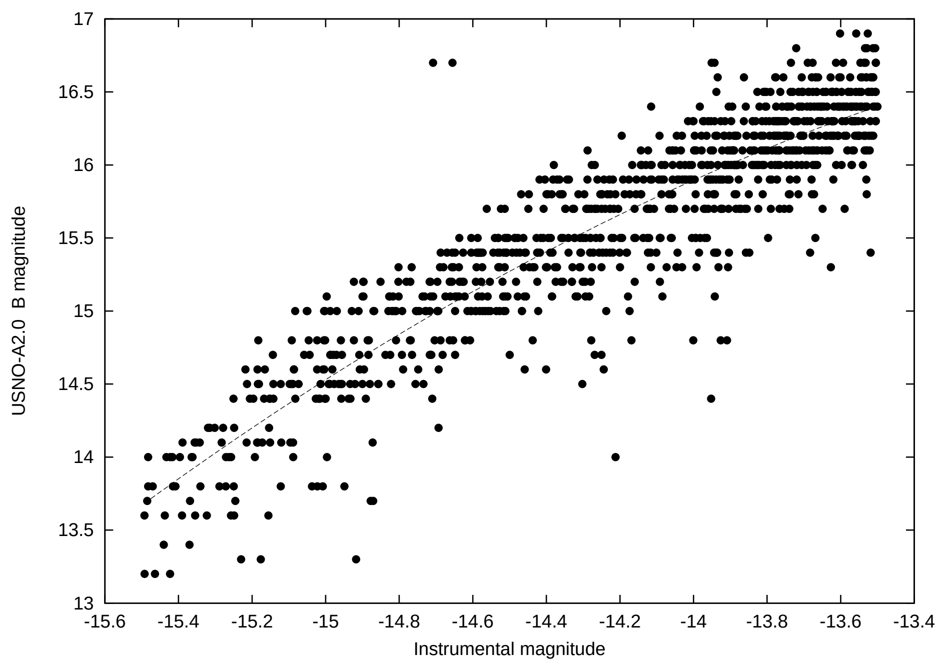

Fig. 2. A sample calibration curve for one of subfields. The dashed curve is the adopted magnitude calibration.

Having selected the candidates, we then studied their brightness variations using the WINEFK software written by Dr. V.P. Goranskij and kindly made available to us. This software permits to view light curves, to look for periodicities using several well-known algorithms (Deeming, Lafler–Kinman, etc.), to search for second periodicities. Our final decision if an automatically selected candidate was a real variable star was made only after a visual inspection of its light curve.

The described variability search technique has a number of limitations. First, it is not particularly sensitive to irregular light variations on time scales shorter than the light curve sampling time. Objects showing this type of variability can be detected solely on the base of large magnitude *rms* deviations if a careful inspection of images does not reveal any reason why this particular star was measured with a much worse precision than other stars. Without an aid of the period search technique, this results in a much worse detection probability for such variations. No such objects were found in the field described in this paper. However, T Tau variables found during a special search in the field of V451 Tau show exactly this behavior. The results of the variability search in the V451 Tau field will be discussed elsewhere.

The second limitation results from the properties of the VAST software. This software constructs light curves only for those stars detected on the reference image for which the total number of detections exceeds 30. This approach effectively avoids many false star detections (because of plate flaws, dust, and large grains of the emulsion) but remains sensitive even to the faintest stars visible on the plates. However, this makes us completely insensitive to any transient phenomena (Novae, dwarf nova outbursts, etc.) that can be present on the plates.

4. Results

As expected, we detected rather many known variable stars. They were analyzed along with the new variables (see below), but this paper deals with only those of them for which our results significantly correct or append published information.

We have discovered a total of 274 new variable stars (MDV 39 – MDV 312). They are presented in Table 1. Among these stars, there are 2 probable Population II Cepheids, 81 eclipsing variables, 5 high-amplitude δ Sct stars (HADSs), 82 RR Lyr stars, 62 red irregular variables and 41 red semiregular stars, 1 slow irregular variable not red in color (MDV 80).

Our phased photographic light curves of the new periodic variable stars (with the exception of some of the red semiregular variables) can be found at the web site of our team (*http://www.sai.msu.su/gcvs/digit/mdv/*). Fig. 3 shows, as an example, the first eight phased light curves. Fig. 4 is the light curve of MDV 80. The observations of all the new variable stars are also available at our web site (*http://www.sai.msu.su/gcvs/digit/mdv/data/*).

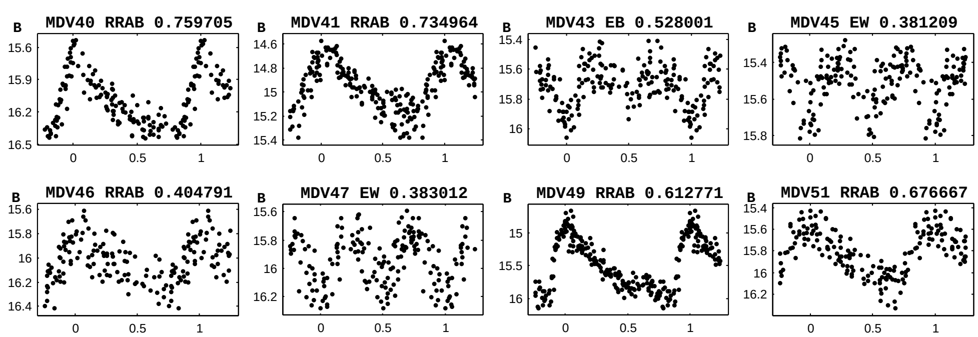

Fig. 3. Sample phased light curves for the new regular variable stars. Only the first 8 light curves are shown.

T a b l e 1

New Moscow Digital Variables

MDV	Coord. (J2000)	GSC / USNO-A2.0	type	max-min-min II	epoch JD24...	period	rem.
39	$17^h40^m07^s.83$ $+4^\circ24'28''.0$	A2 0900-10266740	LB	16.0-16.6			1
40	$17^h40^m29^s.79$ $+6^\circ55'42''.1$	A2 0900-10281306	RRAB	15.6-16.35	max 44847.280	0.759705	
41	$17^h40^m35^s.50$ $+6^\circ17'00''.4$	A2 0900-10285157	RRAB	14.65-15.3	max 42902.512	0.734964	
42	$17^h41^m18^s.87$ $+3^\circ49'25''.6$	GSC 00423-01670	SR:	15.1-15.6			1, 2
43	$17^h42^m13^s.95$ $+5^\circ42'45''.2$	A2 0900-10351850	EB	15.6-16.0-15.85	min 44491.256	0.528001	3
44	$17^h42^m21^s.25$ $+4^\circ18'42''.2$	GSC 00423-00845	SRB	14.8-15.15			1, 4
45	$17^h42^m44^s.86$ $+4^\circ46'37''.4$	A2 0900-10372558	EW	15.4-15.75-15.7	min 43282.452	0.381209	
46	$17^h43^m04^s.48$ $+6^\circ54'44''.4$	A2 0900-10385352	RRAB	15.7-16.35	max 43285.493	0.404791	
47	$17^h43^m52^s.96$ $+6^\circ36'02''.3$	A2 0900-10416750	EW	15.7-16.2-16.2	min 42957.469	0.383012	
48	$17^h45^m13^s.67$ $+5^\circ03'15''.6$	GSC 00424-00974	LB	15.7-16.8			1
49	$17^h45^m18^s.14$ $+8^\circ14'20''.9$	A2 0975-09664523	RRAB	14.8-16.0	max 42922.490	0.612771	
50	$17^h45^m49^s.57$ $+5^\circ13'49''.9$	GSC 00424-00684	LB	14.05-14.45			5
51	$17^h45^m57^s.40$ $+5^\circ02'45''.6$	A2 0900-10497630	RRAB	15.6-16.2	max 44072.391	0.676667	
52	$17^h46^m15^s.35$ $+6^\circ14'14''.5$	A2 0900-10509345	SRB	15.4-16.1		58.5:	1, 6
53	$17^h47^m23^s.26$ $+6^\circ10'26''.7$	GSC 00428-00825	EW	15.2-15.8-15.7	min 42876.527	0.353475	
54	$17^h47^m55^s.07$ $+8^\circ15'58''.3$	A2 0975-09739370	EW	14.9-15.4-15.35	min 44027.451	0.315782	
55	$17^h48^m09^s.07$ $+5^\circ08'33''.3$	A2 0900-10583670	RRAB	16.1-17.0	max 43283.447	0.641829	
56	$17^h48^m09^s.74$ $+6^\circ09'09''.8$	A2 0900-10584141	EW	15.75-16.3-16.25	min 44025.432	0.254585	
57	$17^h48^m23^s.11$ $+6^\circ37'29''.5$	GSC 00428-01925	SR:	14.9-15.25		48:	1, 7
58	$17^h48^m29^s.26$ $+5^\circ29'16''.8$	A2 0900-10597576	EA	16.0-16.5	min 46344.23	0.98930	8
59	$17^h48^m34^s.33$ $+6^\circ30'25''.4$	GSC 00428-00148	EB	14.55-15.0-14.8	min 45941.312	0.473063	
60	$17^h48^m34^s.57$ $+8^\circ09'40''.9$	A2 0975-09759232	RRC	15.8-16.2	max 42933.452	0.310296	
61	$17^h48^m40^s.02$ $+8^\circ29'06''.0$	A2 0975-09761937	RRAB	14.8-16.0	max 42892.539	0.640799	
62	$17^h48^m50^s.05$ $+5^\circ59'20''.3$	A2 0900-10611848	LB	15.4-16.0			1
63	$17^h49^m11^s.11$ $+8^\circ24'26''.2$	A2 0975-09777699	RRC:	14.7-15.2	max 43253.517	0.443354	9
64	$17^h49^m11^s.11$ $+6^\circ03'53''.0$	A2 0900-10627092	RRAB	15.6-16.4	max 42933.452	0.614422	
65	$17^h49^m37^s.25$ $+6^\circ51'44''.2$	GSC 00428-00414	SRB:	15.15-15.6		54.9:	1
66	$17^h49^m46^s.77$ $+5^\circ30'56''.5$	A2 0900-10653069	RRAB	14.15-14.5	max 42872.494	0.721473	
67	$17^h49^m51^s.67$ $+7^\circ16'41''.1$	A2 0900-10656595	EW	15.9-16.2-16.2	min 42876.562	0.378639	
68	$17^h50^m46^s.76$ $+6^\circ07'57''.8$	A2 0900-10697991	RRC	15.4-16.0	max 43702.392	0.392512	
69	$17^h50^m50^s.76$ $+7^\circ51'10''.8$	A2 0975-09829154	SRB	15.8-16.2		47:	1, 10
70	$17^h50^m56^s.82$ $+6^\circ21'19''.7$	GSC 00428-01901	LB	15.0-15.7			5
71	$17^h51^m23^s.46$ $+8^\circ25'02''.5$	GSC 00994-01460	RRAB:	15.25-15.7	max 42954.322	0.392501	
72	$17^h51^m34^s.63$ $+7^\circ40'30''.7$	A2 0975-09851918	RRC	14.95-15.5	max 44043.431	0.322902	
73	$17^h51^m37^s.90$ $+8^\circ44'01''.5$	A2 0975-09853705	HADS	15.3-15.9	max 43198.598	0.0999541	11
74	$17^h51^m45^s.02$ $+3^\circ47'54''.8$	A2 0900-10744203	LB	15.5-16.1			
75	$17^h51^m48^s.78$ $+9^\circ26'33''.6$	A2 0975-09859679	RRAB	14.2-15.6	max 43700.317	0.487961	
76	$17^h51^m54^s.83$ $+5^\circ26'14''.8$	GSC 00424-00123	LB	15.1-16.1			1
77	$17^h51^m59^s.69$ $+3^\circ56'22''.6$	A2 0900-10756126	RRC	15.1-15.7	max 44087.407	0.318240	
78	$17^h52^m02^s.92$ $+8^\circ49'51''.6$	A2 0975-09867207	EW	15.0-15.6-15.5	min 43190.597	0.412666	
79	$17^h52^m05^s.13$ $+4^\circ33'22''.1$	A2 0900-10760510	EA	15.0-15.6	min 49949.335	1.68149	8
80	$17^h52^m24^s.09$ $+4^\circ31'57''.8$	GSC 00424-01416	L	14.0-14.5			12
81	$17^h52^m24^s.75$ $+9^\circ16'16''.1$	A2 0975-09878755	RRC	15.4-15.85	max 44087.407	0.292674	9
82	$17^h52^m31^s.50$ $+5^\circ01'18''.0$	A2 0900-10781877	RRC	16.0-16.4	max 42871.515	0.336160	
83	$17^h52^m37^s.26$ $+7^\circ20'49''.9$	A2 0900-10786611	EW	15.45-15.9-15.9	min 42894.525	0.355982	
84	$17^h52^m40^s.57$ $+8^\circ28'06''.2$	A2 0975-09887194	EW	15.7-16.05-16.0	min 44077.360	0.429948	
85	$17^h52^m53^s.84$ $+4^\circ24'34''.4$	A2 0900-10800230	RRC	15.9-16.2	max 42875.563	0.256808	
86	$17^h53^m04^s.03$ $+6^\circ14'32''.0$	A2 0900-10808592	SR:	15.8-16.45		143:	1
87	$17^h53^m04^s.77$ $+6^\circ13'45''.7$	A2 0900-10763277	RRAB	16.1-16.6	max 42876.562	0.584480	
88	$17^h53^m08^s.46$ $+4^\circ32'04''.2$	A2 0900-10812302	RRC	15.7-16.2	max 43289.393	0.284575	
89	$17^h53^m22^s.29$ $+4^\circ00'01''.1$	A2 0900-10823986	EW	14.4-14.95-14.9	min 44012.480	0.677689	
90	$17^h53^m32^s.34$ $+6^\circ08'34''.7$	GSC 00429-02191	EW	14.2-14.65-14.6	min 46973.322	0.299660	
91	$17^h53^m44^s.10$ $+7^\circ00'52''.6$	GSC 00429-02060	LB	15.2-16.0			1
92	$17^h53^m50^s.57$ $+7^\circ13'27''.1$	A2 0900-10847301	RRC	15.5-15.95	max 46934.425	0.312434	
93	$17^h53^m52^s.77$ $+6^\circ11'25''.7$	GSC 00429-01936	LB:	15.0-15.45			1, 13
94	$17^h54^m23^s.42$ $+8^\circ13'13''.0$	A2 0975-09945912	RRAB	15.2-16.1	max 44491.256	0.492470	
95	$17^h54^m23^s.45$ $+6^\circ21'45''.3$	A2 0900-10874520	RRAB	15.4-16.25	max 42922.490	0.603587	
96	$17^h54^m24^s.07$ $+5^\circ05'44''.6$	GSC 00425-01277	CWB:	15.1-15.6	max 46979.46	4.22851	14
97	$17^h54^m34^s.54$ $+4^\circ31'43''.4$	A2 0900-10884039	RRAB	15.7-16.7	max 46618.465	0.555057	
98	$17^h55^m12^s.15$ $+8^\circ30'49''.7$	A2 0975-09978626	RRC	15.9-16.4	max 42894.525	0.274916	
99	$17^h55^m14^s.25$ $+7^\circ55'00''.6$	A2 0975-09980031	EB	14.95-15.25-15.1	min 43426.226	0.580428	
100	$17^h55^m22^s.79$ $+4^\circ00'23''.2$	A2 0900-10928663	RRC	14.25-14.8	max 46972.316	0.312420	
101	$17^h55^m34^s.54$ $+7^\circ19'33''.0$	A2 0900-10939727	EW	15.3-15.9-15.85	min 44397.415	0.545532	15
102	$17^h55^m36^s.01$ $+9^\circ04'14''.8$	A2 0975-09994108	RRAB	15.4-16.3	max 43253.517	0.761835	
103	$17^h55^m44^s.14$ $+5^\circ59'29''.5$	A2 0900-10948278	RRAB:	15.9-16.2	max 45941.312	0.945095	
104	$17^h55^m50^s.95$ $+8^\circ11'09''.9$	A2 0975-10003602	EW	15.75-16.1-16.0	min 42963.332	0.542425	
105	$17^h55^m59^s.58$ $+4^\circ02'28''.8$	A2 0900-10962191	SR	15.7-16.4		145	1
106	$17^h56^m05^s.81$ $+8^\circ11'35''.3$	A2 0975-10012892	CWA:	15.4-15.8	max 42894.53	16.56	

Table 1

Continued

MDV	Coord. (J2000)		GSC / USNO-A2.0	type	max-min-min II	epoch JD24...		period	rem.
107	$17^h56^m17^s.88$	$+6^\circ22'43''.0$	A2 0900-10977879	HADS	14.65-15.3	max	43249.548	0.107927	
108	$17^h56^m41^s.05$	$+5^\circ53'58''.0$	GSC 00429-00460	LB	14.7-15.3				1
109	$17^h56^m50^s.87$	$+8^\circ08'02''.0$	A2 0975-10041649	RRC	15.7-16.05	max	44397.415	0.350064	
110	$17^h56^m56^s.53$	$+4^\circ19'08''.5$	GSC 00425-00661	LB	14.6-15.1				1
111	$17^h57^m01^s.57$	$+6^\circ15'24''.6$	A2 0900-11015717	LB	15.85-16.3				1
112	$17^h57^m32^s.53$	$+5^\circ19'20''.2$	A2 0900-11043387	RRC:	15.5-16.2	max	43427.283	0.332701	
113	$17^h57^m42^s.66$	$+4^\circ23'59''.1$	A2 0900-11052443	RRAB	15.8-16.6	max	44789.394	0.464905	
114	$17^h57^m44^s.84$	$+7^\circ32'52''.6$	A2 0975-10077478	RRC:	16.15-16.4	max	42963.332	0.284003	
115	$17^h57^m46^s.82$	$+5^\circ55'29''.1$	A2 0900-11056158	EW	14.9-15.6-15.5	min	46972.320	0.547264	3
116	$17^h57^m58^s.89$	$+4^\circ09'47''.6$	A2 0900-11066904	EB	15.9-16.5-16.1	min	43034.230	0.913185	
117	$17^h58^m01^s.29$	$+5^\circ49'26''.7$	GSC 00429-01622	EB	13.65-14.4-13.8	min	42957.338	0.425898	
118	$17^h58^m05^s.41$	$+9^\circ02'33''.3$	A2 0975-10091473	RRAB	15.1-16.2	max	43938.578	0.777133	
119	$17^h58^m07^s.94$	$+8^\circ22'59''.0$	A2 0975-10093169	RRAB	15.3-16.0	max	43189.593	0.633042	
120	$17^h58^m09^s.44$	$+8^\circ05'09''.5$	A2 0975-10094181	RRAB	15.6-16.5	max	44455.302	0.477403	
121	$17^h58^m21^s.36$	$+6^\circ35'08''.4$	A2 0900-11087520	LB	15.9-16.5				5
122	$17^h58^m22^s.55$	$+5^\circ53'15''.2$	GSC 00429-00150	EB	14.4-14.9-14.65	min	44494.247	0.323388	
123	$17^h58^m28^s.58$	$+6^\circ10'01''.1$	A2 0900-11094464	LB	15.7-16.3				1
124	$17^h58^m34^s.10$	$+6^\circ02'56''.6$	GSC 00429-00842	LB:	15.0-15.9				1, 16
125	$17^h58^m34^s.73$	$+5^\circ01'06''.0$	GSC 00425-00007	LB	15.4-16.5				1
126	$17^h58^m40^s.05$	$+4^\circ54'16''.7$	A2 0900-11105212	EB	15.45-15.9-15.7	min	42871.520	0.649782	
127	$17^h58^m48^s.46$	$+7^\circ16'42''.6$	A2 0900-11113082	EA	15.3-15.9	min	42872.52	1.55847	
128	$17^h58^m59^s.30$	$+4^\circ20'03''.2$	A2 0900-11123180	RRC	15.6-16.2	max	42922.490	0.318133	9
129	$17^h59^m11^s.58$	$+9^\circ01'53''.0$	A2 0975-10136593	EA	15.0-16.0	min	43272.41	6.3593	
130	$17^h59^m12^s.18$	$+7^\circ52'05''.4$	GSC 01007-01100	LB	14.3-14.7				17
131	$17^h59^m15^s.95$	$+5^\circ13'13''.7$	A2 0900-11138974	RRC	16.0-16.5	max	46977.463	0.386846	
132	$17^h59^m19^s.71$	$+7^\circ51'04''.9$	A2 0975-10142159	RRAB	15.0-16.0	max	43284.449	0.599402	
133	$17^h59^m22^s.50$	$+5^\circ07'33''.1$	A2 0900-11145400	EB	15.55-16.0-15.8	min	42989.295	0.404381	
134	$17^h59^m29^s.36$	$+4^\circ32'33''.2$	GSC 00425-01015	LB	15.2-15.65				1
135	$17^h59^m29^s.41$	$+8^\circ45'41''.8$	A2 0975-10148658	EA	14.8-15.4-15.0	min	46977.46	1.20425	
136	$17^h59^m39^s.81$	$+4^\circ59'51''.3$	GSC 00425-00040	SRB	13.7-14.2			66.5:	1, 18
137	$17^h59^m47^s.76$	$+9^\circ22'41''.9$	A2 0975-10161161	RRC	15.3-15.9	max	43289.393	0.285936	9
138	$17^h59^m48^s.51$	$+8^\circ10'48''.3$	GSC 01007-01237	EW	13.7-14.2-14.15	min	45203.305	0.345281	
139	$18^h00^m00^s.75$	$+7^\circ26'22''.0$	GSC 00442-00127	LB	14.6-15.0				1
140	$18^h00^m03^s.71$	$+4^\circ41'21''.4$	A2 0900-11185755	RRAB	15.4-16.3	max	42872.523	0.684805	
141	$18^h00^m07^s.82$	$+4^\circ30'27''.0$	A2 0900-11189631	SR:	14.8-15.3			31:	1
142	$18^h00^m12^s.49$	$+6^\circ26'26''.1$	A2 0900-11194031	EW	15.0-15.4-15.35	min	44847.280	0.448969	
143	$18^h00^m32^s.68$	$+6^\circ50'24''.0$	GSC 00442-01610	LB	15.1-15.5				1
144	$18^h00^m37^s.01$	$+8^\circ55'07''.7$	GSC 01008-00060	RRAB	14.4-14.8	max	42874.530	0.66754	
145	$18^h00^m37^s.83$	$+5^\circ06'00''.7$	A2 0900-11218671	EA	15.5-16.4-15.9	min	44847.28	2.10038	
146	$18^h00^m56^s.85$	$+9^\circ21'29''.9$	A2 0975-10208777	LB	15.5-16.2				1
147	$18^h00^m59^s.38$	$+7^\circ21'22''.4$	A2 0900-11240189	RRC:	16.25-16.5	max	45228.243	0.330633	
148	$18^h01^m00^s.83$	$+4^\circ07'51''.8$	A2 0900-11241662	EW	15.3-16.1-15.9	min	44850.280	0.324859	
149	$18^h01^m05^s.60$	$+6^\circ21'14''.1$	A2 0900-11246429	RRAB	14.4-15.3	max	43249.546	0.581607	
150	$18^h02^m03^s.93$	$+7^\circ08'06''.6$	A2 0900-11304795	EW	15.65-15.9-15.9	min	46619.406	0.332680	19
151	$18^h02^m11^s.42$	$+7^\circ26'42''.7$	GSC 00442-00055	LB	14.5-15.0				1
152	$18^h02^m12^s.50$	$+6^\circ48'14''.4$	A2 0900-11313535	SRB:	15.2-15.9			92:	1, 20
153	$18^h02^m13^s.54$	$+6^\circ52'59''.5$	A2 0900-11314540	EB	15.6-16.1-15.95	min	42925.456	0.464174	
154	$18^h02^m14^s.03$	$+8^\circ12'18''.4$	A2 0975-10263405	EW	16.0-16.5-16.4	min	43685.342	0.414680	
155	$18^h02^m23^s.14$	$+8^\circ01'39''.6$	A2 0975-10270079	RRAB	14.0-14.9	max	43036.237	0.679221	
156	$18^h02^m29^s.47$	$+7^\circ12'47''.6$	A2 0900-11330921	RRAB	14.8-16.2	max	42963.505	0.509009	
157	$18^h02^m36^s.98$	$+5^\circ32'12''.0$	A2 0900-11338540	RRAB	14.6-15.5	max	42922.490	0.537830	21
158	$18^h02^m41^s.85$	$+4^\circ33'02''.0$	GSC 00438-02006	EW	13.8-14.15-14.15	min	45171.387	0.381728	
159	$18^h02^m49^s.98$	$+8^\circ43'57''.7$	A2 0975-10289889	EW	15.1-15.6-15.6	min	46596.478	0.392278	
160	$18^h02^m54^s.90$	$+6^\circ34'10''.1$	A2 0900-11357287	EW	14.05-14.6-14.6	min	43277.523	0.376706	
161	$18^h02^m57^s.07$	$+6^\circ02'09''.7$	A2 0900-11359572	EB	15.8-16.1-15.95	min	43692.392	0.392170	
162	$18^h02^m59^s.80$	$+7^\circ22'02''.3$	GSC 00442-00400	LB	15.0-15.5				1
163	$18^h03^m05^s.98$	$+5^\circ03'01''.3$	GSC 00438-01095	SRB	13.9-14.3			63.5:	1, 22
164	$18^h03^m07^s.17$	$+4^\circ20'41''.4$	A2 0900-11369966	LB	15.4-15.8				5
165	$18^h03^m10^s.52$	$+3^\circ57'14''.6$	A2 0900-11373534	EW	14.2-14.65-14.65	min	43046.268	0.307384	
166	$18^h03^m24^s.13$	$+5^\circ16'56''.1$	GSC 00438-01591	LB	15.2-15.8				
167	$18^h03^m24^s.67$	$+6^\circ40'58''.6$	GSC 00442-01740	LB	14.7-15.1				1
168	$18^h03^m51^s.48$	$+8^\circ05'36''.6$	A2 0975-10335151	EB	15.6-16.2-16.05	min	44732.521	0.399152	
169	$18^h04^m04^s.70$	$+3^\circ54'19''.7$	GSC 00438-00764	LB	14.6-15.15				1
170	$18^h04^m16^s.53$	$+8^\circ23'39''.1$	GSC 01008-01224	LB	14.6-15.15				1
171	$18^h04^m22^s.43$	$+8^\circ12'34''.0$	GSC 01008-01677	SRB	14.9-15.7			74	1, 23
172	$18^h04^m34^s.12$	$+4^\circ43'20''.6$	A2 0900-11460939	EW	15.15-15.6-15.5	min	43198.600	0.335051	24
173	$18^h04^m39^s.62$	$+7^\circ31'03''.3$	A2 0975-10371582	RRAB	15.1-16.1	max	42891.529	0.589471	
174	$18^h04^m43^s.43$	$+5^\circ53'27''.3$	A2 0900-11470688	RRAB	15.2-16.1	max	42926.500	0.658642	
175	$18^h04^m51^s.24$	$+8^\circ03'57''.8$	A2 0975-10380595	RRC	15.2-15.8	max	43420.247	0.276090	

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MDV	Coord. (J2000)		GSC / USNO-A2.0	type	max-min-min II	epoch JD24...		period	rem.
176	$18^h04^m58^s.48$	$+3°46'03''.9$	GSC 00438-00473	EB	13.9-14.3-14.15	min	43332.356	0.749889	
177	$18^h05^m00^s.41$	$+6°22'51''.1$	GSC 00442-00933	LB	15.5-16.05				1
178	$18^h05^m27^s.92$	$+7°16'51''.1$	GSC 00442-00860	LB	14.3-15.1				1
179	$18^h05^m29^s.88$	$+6°07'53''.3$	A2 0900-11519382	EB	15.15-15.8-15.3	min	43272.375	1.018765	
180	$18^h05^m35^s.60$	$+8°35'00''.0$	A2 0975-10414913	RRAB	15.0-16.3	max	42951.355	0.531888	
181	$18^h05^m39^s.42$	$+5°10'11''.8$	A2 0900-11529745	HADS	15.7-16.1	max	43418.213	0.131870	21
182	$18^h05^m42^s.75$	$+5°20'18''.1$	GSC 00438-01029	EB	14.25-15.0-14.5	min	42891.529	0.502317	25
183	$18^h05^m49^s.45$	$+7°55'12''.8$	A2 0975-10425490	SRB:	15.2-16.1			70:	1
184	$18^h05^m54^s.43$	$+7°13'48''.2$	A2 0900-11545785	RRAB	15.9-16.8	max	42874.564	0.617842	
185	$18^h06^m05^s.81$	$+5°54'54''.4$	A2 0900-11558043	RRAB	14.8-15.2	max	42957.403	0.657303	
186	$18^h06^m12^s.13$	$+5°06'37''.8$	A2 0900-11565052	RRAB:	15.5-16.2	max	42868.507	0.923155	
187	$18^h06^m15^s.28$	$+7°06'35''.1$	A2 0900-11568523	RRC	16.0-16.7	max	43417.212	0.332192	26
188	$18^h06^m18^s.63$	$+8°55'20''.5$	A2 0975-10449092	EB	14.9-15.4-15.1	min	43199.585	0.740361	
189	$18^h06^m30^s.80$	$+8°22'06''.0$	A2 0975-10458817	EB	15.8-16.25-16.1	min	42957.470	0.379855	
190	$18^h06^m31^s.82$	$+3°59'52''.8$	A2 0900-11586690	SR:	15.5-16.1			47:	1
191	$18^h06^m32^s.78$	$+4°29'32''.2$	A2 0900-11587789	RRAB	14.8-15.8	max	42925.392	0.670269	
192	$18^h06^m36^s.54$	$+5°00'43''.6$	A2 0900-11592041	RRAB	15.8-16.7	max	42868.539	0.496878	
193	$18^h06^m38^s.35$	$+8°02'52''.2$	A2 0975-10464850	EA	15.3-16.2-15.5	min	45232.24	1.51209	
194	$18^h06^m46^s.37$	$+8°50'11''.6$	A2 0975-10471271	SR	15.3-16.4			254	1
195	$18^h06^m51^s.41$	$+5°09'30''.2$	A2 0900-11608642	EW	15.0-15.6-15.55	min	46653.414	0.478173	
196	$18^h06^m56^s.18$	$+6°27'48''.4$	A2 0900-11614215	RRC	14.3-14.8	max	46617.342	0.322833	
197	$18^h07^m05^s.65$	$+6°05'14''.9$	GSC 00442-00871	LB	14.4-14.9				5
198	$18^h07^m12^s.73$	$+4°58'10''.3$	A2 0900-11632505	EW	15.9-16.45-16.4	min	44491.256	0.298816	
199	$18^h07^m16^s.39$	$+5°16'52''.2$	GSC 00438-00265	LB	14.7-15.15				1
200	$18^h07^m21^s.54$	$+5°32'13''.3$	A2 0900-11642030	SRB	15.8-16.5			78.3:	1, 27
201	$18^h07^m36^s.93$	$+7°26'35''.9$	A2 0900-11659025	RRAB	15.9-16.7	max	42875.531	0.588969	
202	$18^h07^m41^s.28$	$+6°45'28''.6$	GSC 00443-00936	SRB:	15.3-16.4			145:	1, 28
203	$18^h07^m49^s.65$	$+5°27'51''.6$	GSC 00439-03982	EA	13.7-14.3-13.75	min	44455.302	0.711615	
204	$18^h07^m56^s.04$	$+4°56'46''.7$	GSC 00439-01998	EW	13.85-14.1-14.05	min	44025.432	0.519085	
205	$18^h07^m59^s.01$	$+4°45'55''.6$	GSC 00439-03124	LB	14.85-15.4				1
206	$18^h08^m01^s.92$	$+5°23'57''.2$	GSC 00439-00910	LB	14.9-15.5				1
207	$18^h08^m03^s.10$	$+6°14'14''.3$	A2 0900-11688498	SRA	15.3-16.5			131	1, 29
208	$18^h08^m10^s.12$	$+5°40'58''.3$	A2 0900-11696307	RRC:	15.4-16.0	max	46972.316	0.312194	
209	$18^h08^m11^s.17$	$+3°52'53''.6$	A2 0900-11697505	RRAB	14.3-15.2	max	44489.274	0.675244	
210	$18^h08^m14^s.53$	$+4°47'59''.9$	A2 0900-11701213	EW	14.6-15.25-15.15	min	42870.481	0.200466	30
211	$18^h08^m24^s.30$	$+6°28'14''.0$	GSC 00443-02136	LB:	14.2-14.9				1, 27
212	$18^h08^m24^s.31$	$+5°26'18''.7$	A2 0900-11711826	LB	15.4-16.2				1
213	$18^h08^m30^s.82$	$+5°39'11''.8$	A2 0900-11718894	RRAB	15.35-16.0	max	43282.487	0.749949	
214	$18^h08^m44^s.55$	$+5°57'55''.0$	GSC 00443-00420	SR	15.4-15.9			180:	1
215	$18^h08^m55^s.97$	$+5°12'35''.7$	GSC 00439-02500	SR:	14.55-15.3			51.7:	1
216	$18^h08^m56^s.18$	$+5°57'10''.1$	A2 0900-11747125	EW	14.2-14.5-14.5	min	42930.401	0.421105	
217	$18^h09^m04^s.43$	$+7°55'37''.8$	GSC 01009-02317	RRC:	13.85-14.2	max	46973.455	0.436515	
218	$18^h09^m09^s.12$	$+5°04'23''.6$	A2 0900-11761590	EB	15.7-16.2-16.05	min	42892.539	0.97154	
219	$18^h09^m09^s.16$	$+3°47'52''.1$	GSC 00439-03557	LB	15.0-15.8				1
220	$18^h09^m09^s.93$	$+7°28'09''.8$	GSC 00443-00094	SRB	14.9-16.0			65.7	1
221	$18^h09^m13^s.54$	$+5°50'41''.1$	A2 0900-11766734	RRC	15.85-16.3	max	42868.539	0.339997	
222	$18^h09^m23^s.78$	$+6°51'47''.7$	GSC 00443-00758	LB	15.0-15.9				1
223	$18^h09^m26^s.16$	$+5°35'58''.9$	GSC 00439-00043	EW	13.9-14.1-14.1	min	46979.464	0.393194	
224	$18^h09^m27^s.62$	$+4°28'50''.7$	A2 0900-11782663	HADS	15.4-15.9	max	42927.415	0.0610848	
225	$18^h09^m48^s.60$	$+6°00'37''.6$	GSC 00443-00459	SRB	15.1-15.9			59	1, 31
226	$18^h09^m51^s.09$	$+5°03'47''.2$	A2 0900-11808436	EB	15.5-16.0-15.8	min	46971.317	0.621532	
227	$18^h09^m53^s.94$	$+4°16'08''.6$	GSC 00439-00357	EA	13.6-14.1	min	42922.49	1.94171	
228	$18^h09^m59^s.29$	$+4°44'29''.1$	A2 0900-11817531	RRAB	14.9-15.6	max	42872.523	0.607108	
229	$18^h10^m07^s.79$	$+7°58'22''.7$	GSC 01009-02199	LB	14.9-15.4				1
230	$18^h10^m17^s.44$	$+8°11'27''.1$	GSC 01009-01807	EW	14.1-14.6-14.6	min	46979.390	0.449795	
231	$18^h10^m20^s.07$	$+6°02'08''.0$	A2 0900-11840595	EB	14.6-15.2-15.0	min	42927.410	0.654786	
232	$18^h10^m24^s.56$	$+5°27'16''.3$	A2 0900-11845655	EB	15.15-15.8-15.5	min	42870.546	0.396235	
233	$18^h10^m29^s.54$	$+4°22'49''.3$	GSC 00439-03369	RRC	14.4-14.7	max	43284.483	0.236166	9
234	$18^h10^m55^s.71$	$+6°20'08''.7$	A2 0900-11878794	EB	14.7-15.45-15.1	min	43694.395	0.901138	
235	$18^h10^m59^s.00$	$+5°07'48''.6$	GSC 00439-01424	LB	15.1-16.0				1
236	$18^h11^m05^s.34$	$+7°54'03''.6$	GSC 01009-02424	EW	14.0-14.3-14.3	min	42890.512	0.410104	
237	$18^h11^m12^s.67$	$+5°26'17''.1$	A2 0900-11896688	EW	15.0-15.5-15.4	min	45203.305	0.492401	
238	$18^h11^m20^s.03$	$+7°16'11''.9$	A2 0900-11904490	EW	14.9-15.25-15.2	min	42891.529	0.585531	3
239	$18^h11^m22^s.94$	$+3°43'39''.2$	GSC 00435-00252	RRAB	14.8-15.4	max	42901.520	0.565079	
240	$18^h11^m25^s.22$	$+8°41'15''.5$	A2 0975-10706743	RRAB	14.9-15.9	max	42902.512	0.498133	
241	$18^h11^m51^s.49$	$+3°50'02''.6$	A2 0900-11938410	EW	15.5-16.1-16.1	min	46344.236	0.443803	
242	$18^h12^m07^s.63$	$+6°03'44''.7$	GSC 00443-01265	LB	14.8-15.7				1
243	$18^h12^m09^s.75$	$+5°18'40''.1$	GSC 00439-00431	SR	15.0-15.7			42.4	

T a b l e 1

Concluded

MDV	Coord. (J2000)	GSC / USNO-A2.0	type	max-min-min II	epoch JD24...		period	rem.
244	$18^{h}12^{m}14^{s}.39$ $+9^{\circ}06'17''.7$	GSC 01009-00236	SR:	14.3-15.3				1, 32
245	$18^{h}12^{m}21^{s}.45$ $+5^{\circ}26'55''.7$	GSC 00439-01334	SR:	13.8-14.2				1, 33
246	$18^{h}12^{m}29^{s}.32$ $+5^{\circ}10'05''.6$	A2 0900-11978953	LB	15.6-16.4				1
247	$18^{h}12^{m}31^{s}.61$ $+5^{\circ}21'09''.6$	A2 0900-11981473	EW	15.7-16.25-16.2	min	44839.273	0.360409	34
248	$18^{h}12^{m}37^{s}.32$ $+3^{\circ}49'33''.2$	A2 0900-11987723	LB	15.4-16.4				1
249	$18^{h}12^{m}37^{s}.92$ $+7^{\circ}18'23''.1$	A2 0900-11988370	RRAB	15.1-16.2	max	46591.462	0.647362	
250	$18^{h}12^{m}40^{s}.09$ $+4^{\circ}45'30''.6$	A2 0900-11990648	LB	15.0-15.6				1
251	$18^{h}12^{m}59^{s}.75$ $+4^{\circ}20'35''.3$	GSC 00439-04024	LB	15.2-16.3				1
252	$18^{h}13^{m}00^{s}.21$ $+6^{\circ}52'27''.4$	A2 0900-12012307	EB	14.8-15.4-15.2	min	42930.401	0.451938	
253	$18^{h}13^{m}01^{s}.88$ $+3^{\circ}40'41''.8$	A2 0900-12014075	LB	15.7-16.3				1
254	$18^{h}13^{m}06^{s}.78$ $+8^{\circ}15'49''.4$	GSC 01009-01148	LB	14.7-15.5				1
255	$18^{h}13^{m}08^{s}.61$ $+5^{\circ}25'22''.3$	A2 0900-12021203	SR:	15.1-16.2			182	1, 35
256	$18^{h}13^{m}13^{s}.90$ $+6^{\circ}16'54''.9$	GSC 00443-02710	SRB	14.1-14.7			58:	1, 36
257	$18^{h}13^{m}21^{s}.93$ $+4^{\circ}20'39''.6$	2M18132192+0420395	RRAB	14.55-15.4	max	44815.380	0.538190	
258	$18^{h}13^{m}27^{s}.91$ $+6^{\circ}23'12''.4$	GSC 00443-02477	SR:	15.3-16.0			415:	1
259	$18^{h}13^{m}37^{s}.28$ $+6^{\circ}53'38''.4$	GSC 00443-01862	LB	14.6-15.3				1
260	$18^{h}13^{m}44^{s}.99$ $+6^{\circ}32'19''.9$	A2 0900-12059839	RRAB	15.8-16.3	max	42957.469	0.629529	
261	$18^{h}13^{m}54^{s}.90$ $+4^{\circ}42'37''.9$	GSC 00439-02896	EW	14.6-15.4-15.3	min	42872.523	0.353219	
262	$18^{h}13^{m}56^{s}.50$ $+6^{\circ}22'44''.3$	GSC 00443-02513	LB	15.5-16.0				1, 37
263	$18^{h}13^{m}58^{s}.69$ $+8^{\circ}55'44''.0$	A2 0975-10845746	EB	15.1-16.0-15.3	min	46978.31	1.084030	
264	$18^{h}14^{m}07^{s}.60$ $+9^{\circ}01'41''.7$	GSC 01009-00647	SR:	15.1-16.3			81:	1, 38
265	$18^{h}14^{m}12^{s}.34$ $+5^{\circ}07'30''.4$	GSC 00439-00952	LB	14.4-15.1				1
266	$18^{h}14^{m}22^{s}.84$ $+5^{\circ}31'30''.7$	A2 0900-12100102	RRAB	14.9-16.5	max	42902.512	0.444778	
267	$18^{h}14^{m}22^{s}.88$ $+6^{\circ}09'56''.4$	A2 0900-12100136	RRAB	15.7-16.4	max	44489.274	0.756962	
268	$18^{h}14^{m}24^{s}.38$ $+7^{\circ}12'52''.2$	GSC 00443-00593	SRB:	14.9-15.8			69.8:	1
269	$18^{h}15^{m}04^{s}.17$ $+7^{\circ}55'41''.5$	A2 0975-10907379	RRAB	15.0-15.9	max	44113.304	0.486940	
270	$18^{h}15^{m}11^{s}.71$ $+6^{\circ}47'02''.6$	GSC 00444-00676	RRAB	13.6-14.1	max	43199.585	0.614567	
271	$18^{h}15^{m}13^{s}.53$ $+9^{\circ}06'07''.8$	GSC 01009-01210	LB	14.8-15.3				1
272	$18^{h}15^{m}14^{s}.48$ $+7^{\circ}29'35''.4$	A2 0900-12156313	LB	15.3-16.4				1
273	$18^{h}15^{m}20^{s}.96$ $+5^{\circ}39'10''.4$	A2 0900-12163463	SRB	15.4-16.1			85:	5
274	$18^{h}15^{m}28^{s}.15$ $+6^{\circ}47'52''.9$	A2 0900-12171052	EW	15.8-16.3-16.25	min	44397.415	0.363117	
275	$18^{h}15^{m}31^{s}.44$ $+6^{\circ}19'20''.1$	GSC 00444-01586	LB	14.8-15.6				1
276	$18^{h}15^{m}38^{s}.82$ $+6^{\circ}29'58''.9$	A2 0900-12182330	SRB	14.6-15.2			61:	1
277	$18^{h}15^{m}47^{s}.01$ $+5^{\circ}38'34''.6$	A2 0900-12191325	RRC	15.8-16.2	max	46653.414	0.284193	39
278	$18^{h}15^{m}47^{s}.87$ $+6^{\circ}18'41''.2$	A2 0900-12192227	EB:	14.8-15.15-15.05	min	46591.46	1.54528	40
279	$18^{h}15^{m}48^{s}.94$ $+7^{\circ}08'33''.4$	A2 0900-12193398	RRAB	15.5-16.4	max	44107.290	0.566656	41
280	$18^{h}16^{m}11^{s}.22$ $+7^{\circ}21'48''.1$	A2 0900-12217660	LB	15.5-16.2				1
281	$18^{h}16^{m}18^{s}.43$ $+6^{\circ}16'10''.6$	GSC 00444-02004	SR	14.1-15.0			80	1, 42
282	$18^{h}16^{m}27^{s}.14$ $+6^{\circ}42'55''.5$	GSC 00444-00546	SRB:	15.2-15.8			86:	
283	$18^{h}16^{m}35^{s}.19$ $+5^{\circ}34'35''.0$	A2 0900-12244463	SR	15.6-16.5			252:	1
284	$18^{h}16^{m}40^{s}.10$ $+6^{\circ}37'12''.3$	GSC 00444-00861	SRB	15.2-16.2			73:	
285	$18^{h}16^{m}45^{s}.22$ $+7^{\circ}57'50''.1$	A2 0975-11002638	RRC	14.8-15.5	max	43254.534	0.281676	9
286	$18^{h}16^{m}46^{s}.19$ $+8^{\circ}18'49''.5$	GSC 01010-01418	LB	13.7-14.2				
287	$18^{h}16^{m}50^{s}.09$ $+5^{\circ}41'14''.0$	GSC 00444-00149	LB	14.9-15.5				1
288	$18^{h}17^{m}00^{s}.69$ $+4^{\circ}29'24''.7$	GSC 00440-02278	LB	14.4-14.9				1
289	$18^{h}17^{m}11^{s}.39$ $+6^{\circ}18'13''.2$	GSC 00444-02072	RRAB	14.6-15.15	max	42872.523	0.820628	
290	$18^{h}17^{m}20^{s}.57$ $+6^{\circ}08'43''.7$	A2 0900-12293340	EW	15.4-16.0-15.9	min	46623.455	0.325430	
291	$18^{h}17^{m}22^{s}.37$ $+5^{\circ}26'14''.0$	GSC 00440-00741	LB	15.3-16.2				1
292	$18^{h}17^{m}30^{s}.45$ $+8^{\circ}14'47''.1$	A2 0975-11046328	EA	14.3-14.8-14.45	min	43420.250	0.845830	
293	$18^{h}17^{m}32^{s}.09$ $+8^{\circ}14'16''.5$	A2 0975-11047913	RRAB	15.2-16.2	max	43197.623	0.521403	
294	$18^{h}17^{m}37^{s}.92$ $+4^{\circ}58'12''.4$	A2 0900-12311653	EW	15.1-15.7-15.6	min	44131.297	0.423964	
295	$18^{h}18^{m}00^{s}.35$ $+5^{\circ}18'06''.2$	A2 0900-12334379	EA	15.3-16.3:-16.0:	min	43198.60	3.05819	43
296	$18^{h}18^{m}31^{s}.41$ $+4^{\circ}15'21''.9$	GSC 00440-01122	SR:	15.1-16.1				1, 44
297	$18^{h}18^{m}56^{s}.33$ $+4^{\circ}40'05''.5$	GSC 00440-01831	SR	14.4-16.0			148	1
298	$18^{h}18^{m}57^{s}.01$ $+6^{\circ}37'53''.5$	GSC 00444-01364	LB	14.35-14.8				5
299	$18^{h}19^{m}17^{s}.22$ $+4^{\circ}57'27''.5$	A2 0900-12418606	RRAB	15.1-16.0	max	43272.409	0.534392	
300	$18^{h}19^{m}18^{s}.43$ $+6^{\circ}34'41''.3$	GSC 00444-01143	EW	15.0-15.3-15.3	min	43422.199	0.457672	
301	$18^{h}19^{m}20^{s}.32$ $+4^{\circ}39'48''.0$	A2 0900-12422241	EW	15.1-15.8-15.7	min	44732.521	0.376235	
302	$18^{h}19^{m}21^{s}.17$ $+5^{\circ}17'20''.1$	GSC 00440-00611	SR:	15.1-15.9				1, 28
303	$18^{h}19^{m}21^{s}.38$ $+6^{\circ}22'45''.3$	A2 0900-12423516	EB	15.35-15.9-15.6	min	43277.523	0.938567	
304	$18^{h}19^{m}28^{s}.92$ $+5^{\circ}37'54''.0$	A2 0900-12432214	RRAB	15.4-16.3	max	46973.455	0.762271	
305	$18^{h}19^{m}34^{s}.90$ $+6^{\circ}12'10''.2$	A2 0900-12438878	SR:	15.15-15.6			88.3:	
306	$18^{h}19^{m}52^{s}.67$ $+4^{\circ}16'36''.6$	GSC 00440-02850	LB	14.3-14.9				1
307	$18^{h}20^{m}00^{s}.86$ $+8^{\circ}25'09''.5$	A2 0975-11206579	EW:	15.3-15.9-15.9	min	44839.273	0.527540	3
308	$18^{h}20^{m}04^{s}.10$ $+4^{\circ}11'34''.4$	A2 0900-12469784	EW	14.9-15.5-15.4	min	43422.199	0.465738	
309	$18^{h}20^{m}15^{s}.58$ $+8^{\circ}03'36''.4$	GSC 01010-02424	LB	14.5-15.3				1
310	$18^{h}20^{m}19^{s}.35$ $+6^{\circ}20'05''.9$	A2 0900-12484774	LB	15.5-16.1				1
311	$18^{h}20^{m}30^{s}.08$ $+3^{\circ}48'02''.5$	A2 0900-12494927	HADS	15.2-15.8	max	43243.438	0.097296	45
312	$18^{h}20^{m}55^{s}.11$ $+4^{\circ}44'46''.0$	A2 0900-12518388	EW	15.1-15.7-15.65	min	46646.401	0.463428	

Remarks to Tables 1 and 2.
1. Variable in NSVS data. 2. $P = 55.6$ d (from NSVS data). 3. A twice shorter period and type RRC are possible. 4. $P = 39.7$ d (NSVS data). 5. A small-amplitude variable in NSVS data. 6. $P = 60$ d (NSVS data). 7. $P \approx 50$ d (NSVS data) is possible. 8. A twice longer period is possible. 9. A twice longer period and type EW are possible. 10. $P \approx 51$ d (NSVS data) is possible. 11. A CCD study following this discovery was announced in Antipin *et al.* (2007). 12. A white or yellow star, $J - H = 0.529$ (2MASS). 13. $P \approx 62$ d (NSVS data) is possible. 14. NSVS data show variations with the same period. 15. 1-day aliases of a twice shorter period are strong. 16. $P = 45$ d (NSVS data). 17. Variable in ASAS-3 data, not included into the ASAS-3 catalog of variable stars. 18. Not identical to V568 Oph ($17^h59^m44^s.09$, $+4°59'55''.6$, J2000). 19. 1-day aliases (0.399278 d and 0.285235 d) are also quite possible. 20. The periods 83.8 d or 92.5 d are possible (NSVS data). 21. A double star. 22. $P \approx 63.5$ d (NSVS data) is possible. 23. $P = 75$ d (NSVS data). 24. The period 0.286864 d (type EW) is also quite possible. 25. O'Connell effect. 26. A 1-day alias, $P = 0.49813$ d, is possible. 27. $P \approx 78$ d (NSVS data) is possible. 28. $P \approx 150$ d (NSVS data) is possible. 29. $P \approx 130$ d (NSVS data) is possible. 30. A twice shorter period and type HADS are possible. 31. $P = 58$ d (NSVS data). 32. $P = 48$ d (NSVS data). 33. $P = 62$ d (NSVS data). 34. $P = 0.305252$ d is also possible. 35. $P \approx 250$ d (NSVS data) is possible. 36. $P \approx 60$ d (NSVS data) is possible. 37. $P \approx 54$ d (NSVS data) is possible. 38. $P \approx 85$ d (NSVS data) is possible. 39. A 1-day alias, $P = 0.397451$ d, is possible. 40. A twice shorter period and type RRAB are possible. 41. The coordinates are from the USNO-A2.0 catalog. 42. $P = 81$ d (NSVS data). 43. Possibly, the minima are deeper. 44. $P \approx 82$ d (NSVS data) is possible. 45. A 1-day alias, $P = 0.081429$ d, is possible.

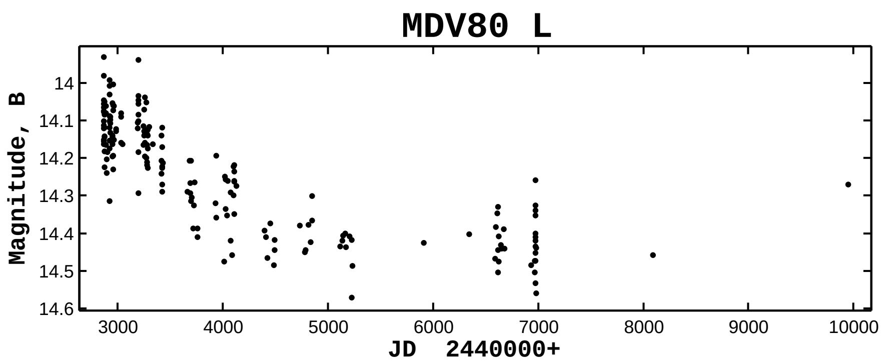

Fig. 4. The light curve of the "white" slow irregular variable star MDV 80.

Most of the new red variable stars we detected also definitely vary in the NSVS observations. It should be especially noted that we did not use the NSVS data to discover new variables in our field but used them only for independent confirmation of our discoveries.

Table 1 does not include some 30 stars we selected as variability suspects. Their amplitudes are too small for reliable judgment from photographic data if they are genuine variable stars. We are planning special follow-up CCD observations to confirm and study these variables.

We were able to confirm variability of 11 stars listed earlier in the NSV catalog. Six of them are periodic variables, for them we present the ephemerides for the first time. The remaining five stars are red irregular variables. We also determined new ephemerides for two GCVS stars: the period we find for the eclipsing star V947 Oph is completely different from that in Götz *et al.* (1957), and we present the first ephemeris for the RR Lyr variable V2087 Oph. The data on the 13 known variables are presented in Table 2. The coordinates given in Tables 1 and 2, unless stated, are from the 2MASS point-source catalog (Cutri *et al.* 2003). The light curves for the eight periodic stars are displayed in Fig. 5.

Table 2

New Data on Known Variables

GCVS/NSV	HV/SON	Coord. (J2000)	type	max-min-min II	epoch JD24...	period	rem.
NSV 9475	HV 11011	$17^{h}40^{m}13^{s}.31$ $+6^{\circ}02'51''.8$	RRAB	15.4-16.4	max 42957.370	0.526203	
NSV 9642	HV 11040	$17^{h}45^{m}26^{s}.26$ $+8^{\circ}22'01''.8$	RRAB	14.6-16.0	max 42870.481	0.467784	
NSV 9704	HV 11046	$17^{h}48^{m}06^{s}.28$ $+8^{\circ}12'54''.2$	RRC	14.1-14.7	max 42934.380	0.320757	
NSV 9721	S 9837	$17^{h}49^{m}03^{s}.37$ $+5^{\circ}06'19''.3$	EW	15.4-16.0-15.9	min 42930.509	0.255458	
NSV 9734	HV 11053	$17^{h}49^{m}30^{s}.19$ $+4^{\circ}18'40''.1$	LB	14.9-15.6			1
NSV 9740	S 9838	$17^{h}49^{m}43^{s}.48$ $+4^{\circ}13'24''.1$	EA	15.1-15.9-15.2:	min 44112.30	1.86895	
NSV 9973	S 9277	$18^{h}00^{m}32^{s}.19$ $+5^{\circ}27'11''.3$	LB	15.2-16.0			1
V947 Oph	S 4199	$18^{h}02^{m}05^{s}.31$ $+5^{\circ}52'45''.5$	EA	14.3-14.8	min 44023.455	0.797747	
NSV 10129	S 9857	$18^{h}03^{m}54^{s}.74$ $+7^{\circ}34'27''.4$	SR:	14.7-15.4		143:	1
NSV 10291	S 9867	$18^{h}09^{m}52^{s}.67$ $+3^{\circ}41'59''.3$	LB	15.2-15.9			1
V2087 Oph	S 9297	$18^{h}11^{m}16^{s}.36$ $+5^{\circ}15'32''.3$	RRAB	15.1-16.3	max 43282.452	0.495589	
NSV 10381	S 9298	$18^{h}13^{m}09^{s}.74$ $+4^{\circ}28'58''.1$	LB	14.0-14.7			1
NSV 10403	S 9872	$18^{h}14^{m}00^{s}.45$ $+3^{\circ}50'35''.0$	LB	14.7-15.1			1

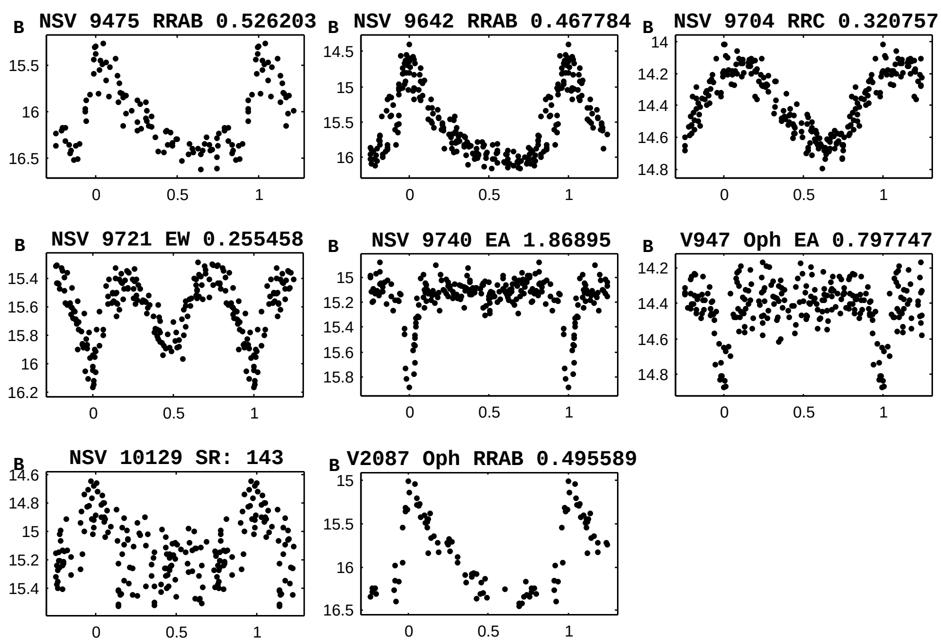

Fig. 5. Phased light curves for the known regular variable stars in the field that were investigated in this study.

5. Conclusions

We have successfully developed necessary techniques to digitize plates of the Moscow collection, search for variable stars using digital images and perform photographic photometry. These techniques will be further improved and repeatedly used in our future research. Its results will be published separately and presented at our web site

www.sai.msu.su/gcvs/digit/digit.html

This study resulted in the discovery and characterization of 274 new variable stars of different types, periodic and aperiodic, fast and slow, in a $10^\circ \times 5^\circ$ field, demonstrating the effectiveness of our approach. Additionally, we found about 30 variability suspects for follow-up CCD studies, confirmed variability of 11 stars from the NSV catalog, and determined ephemerides for 2 GCVS stars. It is worth noting that all these results were achieved for a field rather well-studied for stellar variability.

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