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Photometric investigation of the dwarf nova Pegasi 2010 – a new WZ Sge-type object

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Abstract. We present our $UBVR_CI_C$ CCD photometry of a new dwarf nova OT J213806.6+261957 in Pegasus, discovered during its superoutburst on May 6, 2010 and classified as a WZ Sge-type star. In the term May 15 – November 27, 2010, we obtained more than 10 000 CCD observations of the nova. Two-colour diagrams together with the superoutburst evolutionary tracks of the nova are presented. The analysis of our data revealed the presence of ordinary superhumps with the mean period of $0.^d055106$ and late superhumps with the period of $0.^d05490$. We calculated the orbital period of the dwarf nova Pegasi 2010 to be $0.^d0542 \pm 0.005$ and estimated the mass of the red dwarf component in the binary as $0.09 \pm 0.01\ M_\odot$. The period change of superhumps of the dwarf nova Pegasi 2010 is in agreement with other WZ Sge-type stars. The evolution of superhumps profiles is discussed. The superoutburst of the dwarf nova Pegasi 2010 finished at the end of September 2010. In October and November 2010 night-to-night brightness variations as well as a flickering on a time scale of minutes were detected.

Key words: dwarf novae – photometry, superoutburst, superhumps

1. Introduction

Dwarf Novae (DNe) are a subclass of cataclysmic variable stars – semidetached binaries consisting of a red dwarf, transferring matter to a white dwarf. Variability of DNe is caused by the orbital motion of the components and quasi-periodic outbursts, resulting from instabilities in an accretion disk surrounding a white dwarf. According to the form and duration of the outburst, DNe are divided into several types, named after their typical object. In general, outbursts last a few days (in U Gem-type and SS Cyg-type stars) but some DNe (SU UMa-type stars) show less frequent superoutbursts, lasting for several weeks. Superoutbursts have a distinguished peculiarity: a hump-shaped modulation that appears shortly after maximum and maintains until the beginning of a quiescence stage. The humps show longer periods in comparison with orbital ones, and evolve during the brightness decline.

The WZ Sge-type DNe are a subgroup of SU UMa stars with a long (several years or even decades) recurrence time of superoutbursts. The superhumps of WZ Sge-type stars evolve from "early superhumps" with a double-humped profile near the brightness maximum and the period extremely close to the orbital one, through "ordinary superhumps" with a single-humped profile and the period of a few percent longer than the orbital one, to "late superhumps" that appear several days after the rapid decline from the plateau of a superoutburst and may continue for several hundred cycles after the end of the superoutburst.

The early superhumps are a unique feature of WZ Sge-type stars. Osaki and Meyer (2002) suggested that a double peaked profile of early superhumps is manifestation of the tidal 2:1 resonance in accretion disks of binary systems with extremely low mass ratios. Early superhumps can be explained by a two-armed spiral pattern of tidal dissipation generated by the 2:1 resonance, first proposed by Lin and Papaloizou (1979). The ordinary superhumps, with a single-humped profile, can be explained by the thermal tidal instability model of an accretion disk (Osaki, 1989; Whitehurst, 1988). The presence of the tidal 3:1 resonance in the disk (with the radius smaller than the 2:1 resonance radius) results in the formation of an eccentric outer ring undergoing apsidal precession with a period considerably longer than the orbital one. The beating of the orbital and precessional periods cause periodic variations, identified as superhumps. This model is supported by numerical simulations (Kaigorodov et al., 2006; Smith et al., 2007). The late superhumps are proposed to originate in the precessing eccentric disk near the tidal truncation. The eccentric disk slowly expands during the decline of the superoutburst and finally reaches the tidal truncation, where the period is stabilized (Kato et al., 2008).

Dwarf nova Pegasi 2010 (DNP2010 = J2138+26) was discovered as a bright optical transient by Yi (Yamaoka, 2010a) and independently by Kaneko (Nakano, 2010). The first measurements were presented by Itagaki (2010) and Camilleri (2010). Yi detected the object of ~ 10.8 mag on two images taken on May 6.77 with a Canon 5D digital camera and confirmed it on May 7.76, when it reached 8.4 mag. The confirmation image suggests that the brightened object is positionally coincident with the GSC star 2197:886. Its catalogued position in GSC version 2.3 is R.A. $= 21^h38^m06^s.571$, Decl. $= +26°19'57.''33$ (equinox 2000.0), with photographic red and blue magnitudes $F = 13.88$ and $j = 14.57$, respectively. Yamaoka (2010b) noted that the Digitized Sky Survey image of GSC 2197:886 is elongated toward the north-south, indicating that the object is a double/multiple star. There is a bright X-ray source (1RXS J213807.1+261958) near this position. Henden (2010) found that Palomar Observatory Sky Survey (POSS) plates show a close pair of objects at the location of the outbursted

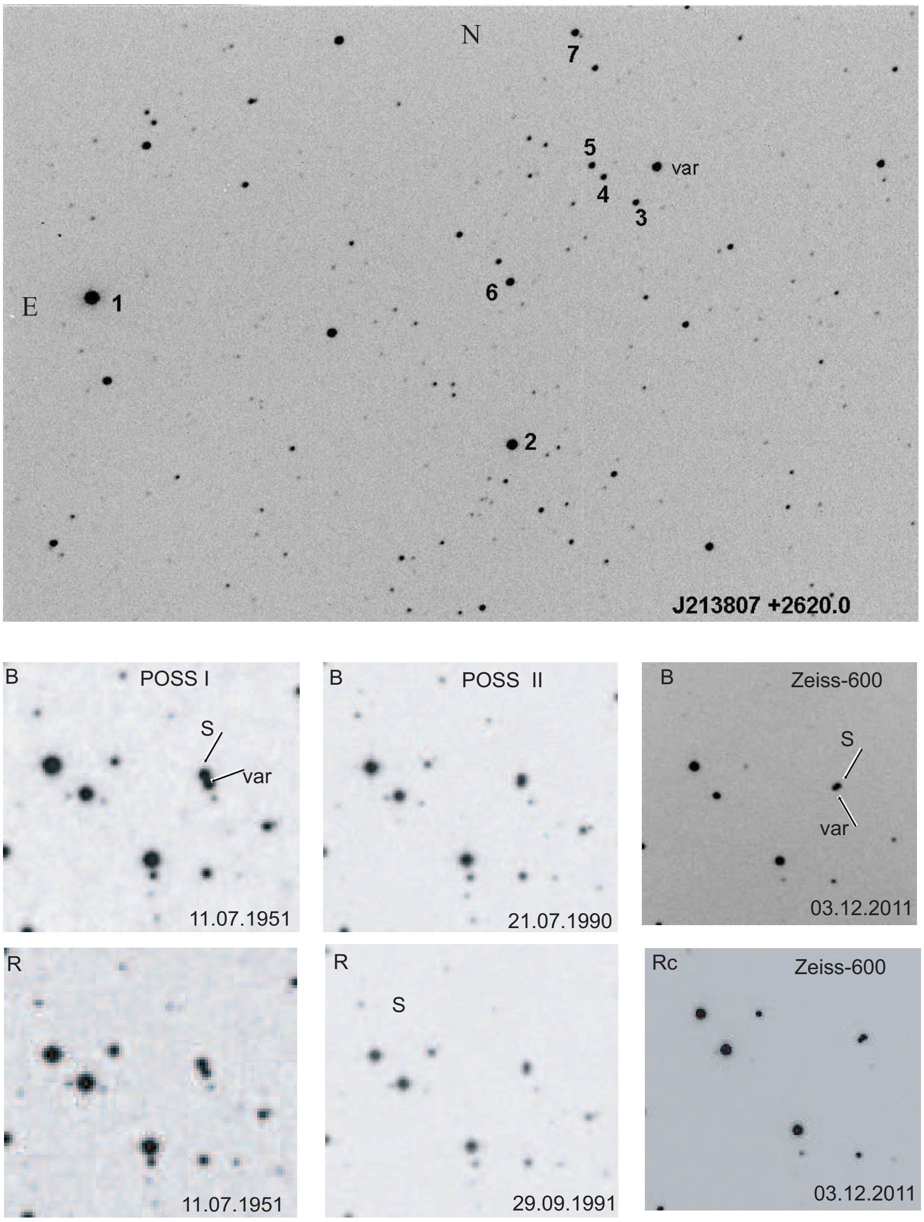


Figure 1. Positions of the DNP2010 (var) and comparison stars. The size of the CCD frame is 15x20 arcminutes (top). Position of the star GSC 2197:886 ("S") and DNP2010 in POSS plates and our CCD image (bottom).

variable: one is essentially stationary, while the other has a relatively high proper motion. On the POSS-I plates, the southwest component of the $3''$–separated double is obviously blue, while on the POSS-II plates, it has moved east-northeast by about $3''$and is now about $1''$southeast of the stationary north-east component. The moving object is the outbursting object – a cataclysmic variable with an amplitude of about 6 mag.

The dates of expositions of the POSS-I and POSS-II plates were July 11, 1951 and July 21, 1990, respectively. We obtained a CCD image, where both objects were well resolved using the 0.6m telescope at the Crimean Laboratory of the Sternberg Astronomical Institute on December 3, 2011. We measured the position of the DNP2010 relatively to GSC 2197:886 in a POSS-I plate and our CCD image, taken 60.4 years later (see Fig. 1, bottom.) Due to the fact that the proper motion of GSC 2197:886 is given in the Catalog of positions and proper motions (Roeser et al., 2010) as 14.2 mas/year in α and 36.7 mas/yr in δ, it is easy to estimate the proper motion of the DNP2010 as $\sim$ 60 mas/year in α and $\sim$ 50 mas/yr in δ.

Table 1. The magnitudes and positions of the comparison stars "1 - 7" shown in Fig. 1. The star "8" lies outside the CCD field. Magnitudes of the stars "1, 3, 4, 5, 6, 7, 8" were found relatively to the star "2"."S" is a close optical component of the DNP2010. Its magnitudes were found out during our observations.

star	Name USNO Other name	U	B	V	R_C	I_C	α_{2000} δ_{2000}
1	A2.0 1125-18630159 BD +25 4581	10.61	9.80	8.83	8.20	7.72	$21^h\ 39^m 03.^s 467$ $26^\circ\ 17'\ 57.''92$
2	B1.0 1162-0553070 BD +25 4580	10.70	10.62	10.03	9.65	9.31	$21^h\ 38^m 23.^s 052$ $26^\circ\ 14'\ 02.''432$
3	A2.0 1125-18612647 GSC 2197-01038	14.30	13.94	13.12	12.68	12.28	$21^h\ 38^m 08.^s 981$ $26^\circ\ 19'\ 09.''52$
4	A2.0 1125-18613561 GSC 2197-01006	15.96	14.92	13.37	12.30	11.08	$21^h\ 38^m 11.^s 914$ $26^\circ\ 19'\ 48.''44$
5	A2.0 1125-18614015 GSC 2197-00842	13.31	13.37	12.94	12.63	12.35	$21^h\ 38^m 13.^s 107$ $26^\circ\ 20'\ 05.''18$
6	A2.0 1125-18616815 GSC 2197-00808	12.64	12.51	11.84	11.47	11.10	$21^h\ 38^m 21.^s 982$ $26^\circ\ 17'\ 37.''77$
7	B1.0 1163-0561305 GSC 2197-00946	14.82	14.40	13.43	12.82	12.26	$21^h\ 38^m 13.^s 737$ $26^\circ\ 38'\ 03.''01$
8	A2.0 1125-18600891 GSC 2196-01869	12.35	11.29	10.10	9.52	8.90	$21^h\ 37^m 31.^s 998$ $26^\circ\ 21'\ 50.''82$
S	A2.0 1125-18611877 GSC 2197-00886	15.69	15.72	15.23	14.76	14.30	$21^h\ 38^m 06.^s 471$ $26^\circ\ 19'\ 57.''33$

Arai (2010) reported that the optical spectrogram (resolution 500) of the variable, obtained using the 1.3m ARAKI telescope at the Koyama Astronomical Observatory on May 8.66 showed a blue continuum and a weak Hα emission line (EW about 4 Å), suggesting that the object would be classified as a dwarf nova. Graham et al. (2010) reported that a spectrum (range λ3900–7030 Å, resolution 3 Å) of this variable, obtained on May 8.47 UT with the 1.82m Plaskett Telescope at the Dominion Astrophysical Observatory, B.C., Canada, showed strong Hα and Hβ in emission (FWHM 800 km s^{-1}), as well as He II (λ4686 Å) and a broad emission feature centered at λ4650 Å. All members of the Balmer series exhibit shell-like profiles with both red and blue absorption components. The dwarf nova nature and its WZ Sge classification was proposed by Tovmassian et al. (2010) from the 2.5 hours spectrophotometry of the object obtained with the 2.1m UNAM telescope in Mexico.

Gänsicke (2010) reported that the object was detected in the GALEX All-Sky Survey in quiescence (JD 2453956) at $m(fuv)$=16.15±0.03, $F(fuv)$ = 1257.58±33.16 μJy. The flat ultraviolet spectrum of DNP2010 observed by GALEX is compatible with a white dwarf temperature of $\sim$ 15000 K. Assuming a 0.6 $M_\odot$ white dwarf mass, the GALEX fluxes imply a distance of 70 pc. It appears that the object is a WZ Sge-type star.

Hudec (2010) found on the Sonneberg Observatory Archival Sky Patrol Plates another superoutburst of the object, peaked on November 30, 1942 at B = 9.8±0.5 mag. He estimated the duration of this event to be between 12 and 46 days and superoutbursts' recurrence time about 67 years. The detection of another superoutburst confirms that the DNP2010 is a WZ Sge-type object. The database search of outbursts in Plate archive of the Sternberg Astronomical Institute gave a negative result.

The light curve and $O - C$ diagram of DNP2010 were presented by Kato et al. (2010). They also determined the period of early superhumps of DNP2010 as $0.^{d}05450$.

2. Photometry of the superoutburst

Early $UBVR_CI_C$ CCD observations of the DNP2010, presented in this paper, were taken in the Terskol Observatory (in Caucasus) with both the 0.6m telescope Zeiss-600 equipped by the PixelVision Vienna camera (1024x1024 array and pixel size 24 μm) and MEADE 0.35m telescope (STL-1001 camera). Further observations were obtained with the SBIG ST10-XME camera mounted in the Newton focus of the 0.5m (f/5) reflector at the Stará Lesná AISAS observatory and with the Apogee-47p and VersArray 1300 cameras mounted in the Cassegrain focus of the 0.6m (f/12.5) and 1.25m (f/18) telescopes at the Crimean Laboratory of the Sternberg Astronomical Institute.

Positions of the variable and comparison stars 1–7 are given in Fig. 1 and Table 1. The comparison star "8" is located outside the 15x20 arcminutes field.

We determined the magnitude of the comparison star "2" using the photometric sequence published by Henden & Munari (2006) for the object PU Vul. We determined the magnitudes of the comparison stars "1, 3, 4, 5, 6, 7" and "8" relatively to the star "2". They are shown in Table 1 together with the magnitudes of the close optical component "S" of the DNP2010.

The data reduction was made using MAXIM DL4 package. The bias, dark and flat-field reduction was performed before aperture photometry. The close optical component "S" was measured together with the DNP2010.

Due to the different equipments used for our observations, it was necessary to reduce them into one system using linear shifts. As the mutual agreement of the Crimean and Stará Lesná data was good, they did not need correction. We rectified the Terskol data in accordance with $V = V_T - 0.045$, $B = B_T - 0.09$ and $R_C = R_{C,T} + 0.14$, where index "T" means "Terskol". All Terskol observations were taken in the early decline from the maximum. The comparison of the Terskol data with the Stará Lesná data taken at the same nights showed that the linear shift of the data is sufficient and the colour term is not needed. The colour indices changes were negligible as seen in Fig. 8 of the section 3.

The light curves of the DNP2010 in the $UBVR_C$ passbands are shown in Fig. 2. We accepted its discovery date May 6, 2010 (JD 2455323) as the date of the outburst. The days after outburst (AO) in our paper are calculated from this date. The DNP2010 reached a brightness maximum $V \sim 8.4$ mag on May 7, 2010. Due to the fact that our observations of DNP2010 started 9 days AO, we added the data from VSNET before May 18, 2010 from VSNET to complete the shape of the superoutburst light curve.

The list of our observations of DNP2010 is given in Table 2. It includes JD, the average $UBVR_CI_C$ magnitudes during the night, the number of CCD frames and the combination of the telescope and CCD-camera denoted by marks "a, m, s, p, v".

All our $UBV(RI)_C$ Crimea and Stará Lesná CCD observations of the DNP2010 during its superouburst, decline and in quiescence are displayed in Appendix as follows: U in Table 4, B in Table 5, V in Table 6, R_C in Table 7 and I_C in Table 8. Because of strong influence of the close companion to the brightness of the DNP2010, which increased from the R_C to I_C passband, we omitted the I_C data after JD 2455358, when the brightness of the system in the I_C passband decreased to 15 mag. The Terskol CCD observations of the DNP2010 are displayed on-line at http://www.astro.sk/caosp/Eedition/FullTexts/vol42no1/pp39-79.dat/.

The brightness of the DNP2010 declined by 2 magnitudes 13 days after maximum. The object returned to its quiescence stage ($V \sim 16.0$ mag) at the end of September 2010, 140 days AO (see Fig. 2). Nevertheless, night to night brightness variations with the amplitude of 0.2–0.4 mag remained. Usually, both B and V light curves were similar with the amplitude of variations two times larger in the B passband than in the V one. But we have found the case, when the depression in the B passband, which started on JD 2455513 (190

Table 2. The mean $UBVR_cI_c$-magnitudes of DNP2010 obtained at Terskol (“p”: Zeiss-600, PixelVision and “m”: MEADE, STL-1001), Stará Lesná (“s”: 0.5m, SBIG ST10-XME) and Crimea (“a”: Zeiss-600, Apogee-47p and “v”: ZTE-1.25m, VersArray 1300). “N” is the number of frames, JD = JD*+2455000.

JD*	U	N	B	N	V	N	R_c	N	I_c	N	Obs.
332	–		9.87	173	9.93	897	10.11	192	–		p,m
334	–		–		10.34	525	–	–	–		p
336	–		–		10.57	535	–	–	–		p
337	–		10.46	220	10.65	220	10.67	220	–		m
338	10.05	2	10.62	178	10.78	319	10.81	174	12.00	2	m,s
340	10.46	3	10.97	2	11.10	319	11.08	5	12.24	3	m,s
341	–		11.04	139	11.15	137	11.16	137	12.27	4	m
342	10.49	3	10.98	227	11.12	431	11.10	226	–		m,s
343	–		10.99	177	11.12	178	11.13	176	–		m
345	–		11.00	55	11.15	55	11.15	60	–		m
346	10.74	2	11.21	2	11.35	94	11.35	3	12.49	2	s
347	–		12.07	157	12.21	159	12.15	158	–		m
348	–		13.69	268	13.62	266	13.37	274	–		m
350	–		14.41	3	14.30	77	14.00	3	14.43	3	s
353	13.49	3	14.75	2	14.59	53	14.32	2	14.65	2	s
354	13.79	2	14.86	2	14.82	170	14.34	3	14.68	2	s
357	13.85	3	15.13	2	14.87	36	14.73	1	14.89	2	s
358	14.14	4	15.24	3	14.97	85	14.84	2	15.00	2	s
380	14.38	2	15.68	1	15.73	30	15.65	1	–		s
381	14.71	1	15.81	3	15.83	55	15.78	3	–		s
382	–		–		15.92	21	–		–		s
383	–		–		15.95	51	–		–		s
385	–		15.76	2	16.02	40	15.84	2	–		s
387	14.93	3	15.94	7	16.06	59	15.87	11	–		s
388	14.51	2	15.74	35	15.83	49	15.68	3	–		s
389	14.97	3	15.76	26	15.88	33	15.88	2	–		s
390	14.78	2	15.73	25	15.91	32	16.04	2	–		s
391	–		15.75	18	15.85	12	15.67	1	–		s
399	14.82	4	15.81	82	15.89	27	16.07	3	–		s
434	–		15.97	8	16.00	26	15.83	16	–		s
438	–		16.13	7	16.18	8	–		–		s
454	–		16.07	15	16.04	14	15.91	4	–		a
455	15.03	2	15.93	13	16.08	14	15.83	4	–		a
459	15.14	3	16.41	14	16.23	22	16.10	3	–		a
463	15.40	2	16.39	14	16.27	25	16.19	3	–		a
464	–		16.30	21	16.31	38	–		–		a
468	15.37	3	16.39	22	16.30	20	16.20	4	–		a

Table 2. (continued)

JD*	U	N	B	N	V	N	R_c	N	I_c	N	Obs.
482	–		16.26	27	16.28	34	16.23	2	–		s
483	–		16.37	31	16.27	37	16.29	2	–		s
484	–		16.25	19	16.29	48	16.17	3	–		s
491	–		–		16.27	21	–		–		s
497	–		16.42	18	–		16.42	2	–		s
509	–		16.50	66	16.54	56	–		–		v
511	–		16.39	87	16.25	75	–		–		v
513	14.90	54	16.58	59	16.40	5	15.99	1	–		v
514	15.15	74	16.72	73	16.31	2	16.24	2	–		v
515	–		16.09	8	16.21	9	16.11	6	–		s
521	–		16.35	5	16.31	6	16.32	7	–		s
655	–		16.49	3	16.13	1	16.07	3	–		s
657	–		16.45	2	16.01	1	15.98	1	–		s
662	–		16.27	5	16.05	1	16.05	1	–		s

days after the outburst) and continued also the next night, was replaced by an increase of brightness in the V passband. The amplitude of the brightness variations increased with decreasing wavelength and reached 0.5 mag in the U passband and 0.4 mag in the B passband. Such behavior could be explained by non-stationary processes in the hot accretion disk, radiating mostly in the UV region.

2.1. Evolution of superhumps and periodograms

There were systematic investigation of period variations of superhumps in a number of papers about the values of period derivatives $Pdot = \dot{P}/P$ in SU UMa- and WZ Sge-type systems (Kato et al., 2009, 2010, 2012). The authors found that $O-C$ diagrams for many of them consist of an "A", a "B" and a "C" stage. As the duration of the stage "A" is short, the observational data from this early stage of a superoutburst are very often missing. The longer stages "B" and "C" are studied better. During the stage "B" the superhump period is usually stabilizied with positive $Pdot$ and superhump period larger than the orbital one. During the "C" stage the superhump period becomes shorter. The transition between the stage "B" and "C" is abrupt.

The short term variations of the V light curves in different stages of superoutburst, after the declining trend removal, are depicted in Fig. 3. The evolution of the single-humped profile in the stage "B" through very dissected hump profiles in the stage "C" up to the variations of brightness in the last stage of superoutburst and quiescence are shown in four plots for each stage.

After careful removal of the superoutburst declining trend from our BVR_C light curves, we combined them together to find out more precisely the periods of

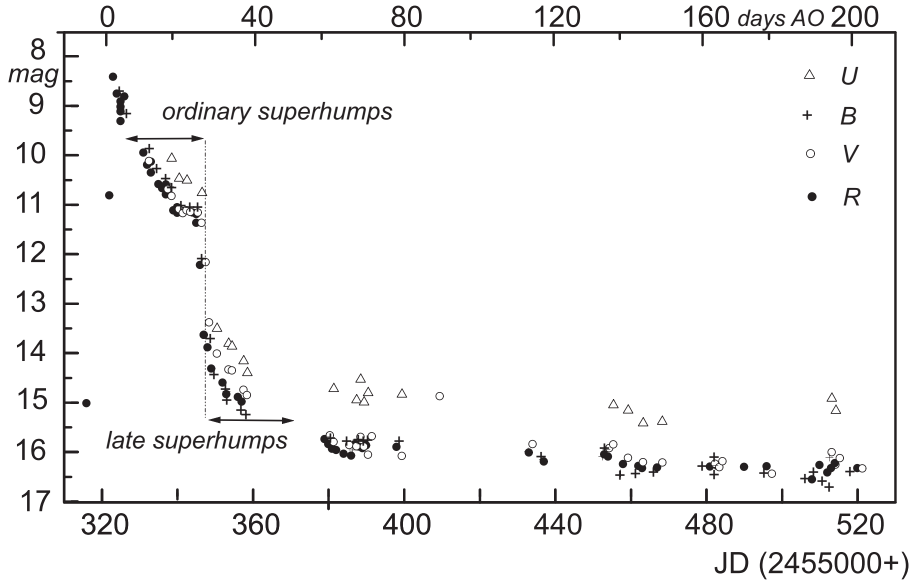


Figure 2. The $UBVR_C$ light curves of the DNP2010. The number of days after the outburst are marked on the top axis. The beginning and end of the superhumps' stages are designated by arrows.

superhumps using the method of Fourier analysis. The periodograms of different segments of time series are shown in Fig. 4. Due to the fact that our observations started 9 days AO, they did not cover the stage A ("early superhumps"). As seen in Fig. 4, we determined periods of ordinary superhumps in a stage "B", approximate location of the "period break" (transition to "late superhumps") and periods of late superhumps in a stage "C". In the last stage of superoutburst and quiescence we did not find any clear periodicities in segments 57–76 days AO and 186–192 days AO. A very imprecise period of $0.^d05268$ appeared on the periodogram in segment 111–145 days AO. We found a period of $0.^d05435$ in segment 159–174 days AO.

Because the amplitudes of superhumps depend on the passband only slightly, we present their summarized phase light curves in the B, V, R_C passbands in Fig. 5. The observational data are marked by grey points, and the average light curves – by black ones. The folded light curves of DNP2010 were phased with the periods of $0.^d0.5493$ (9–15 d AO), $0.^d0.5512$ (17–20 d), $0.^d05486$ (24–25 d), $0.^d05485$ (27–35 d), $0.^d0566$ (111–145 d) and $0.^d05435$ (159–174 d) in accordance with the values of periods given in Fig. 4. We took the initial epoch of the superhump maximum $HJD_{max} = 2455332.4152$.

Table 3. The superhumps maxima and their $O-C$ residuals. E is the number of the cycle. JD=JD*+2 455 000.

E	JD*	$O-C$	error	E	JD*	$O-C$	error
1	332.467	-0.0033	0.001	273	347.469	0.0099	0.004
2	332.523	-0.0024	0.001	274	347.519	0.0048	0.004
38	334.499	-0.0102	0.001	289	348.349	0.0082	0.001
75	336.528	-0.0202	0.001	290	348.394	-0.0019	0.001
92	337.466	-0.0190	0.001	292	348.509	0.0028	0.001
93	337.520	-0.0201	0.001	327	350.433	-0.0019	0.003
110	338.458	-0.0189	0.002	329	350.541	-0.0041	0.003
111	338.511	-0.0210	0.001	384	353.553	-0.0229	0.003
146	340.445	-0.0157	0.010	399	354.386	-0.0165	0.001
164	340.460	+0.0074	0.013	400	354.439	-0.0186	0.001
165	341.510	0.0023	0.013	401	354.495	-0.0177	0.005
182	342.445	0.0005	0.010	402	354.551	-0.0168	0.006
183	342.503	0.0034	0.012	456	357.518	-0.0255	0.005
184	342.550	-0.0047	0.010	473	358.445	-0.0353	0.008
200	343.442	0.0056	0.006	474	358.499	-0.0364	0.005
201	343.487	-0.0045	0.006	475	358.553	-0.0375	0.005
237	345.488	0.0127	0.020				

Below we describe some features of the nightly and phased light curves from Figs. 3 – 5.

Days 9–15 AO.
Ordinary superhumps with the amplitude of about 0.1 mag in V were present. The mean period was $0.^{d}05493$. Flickering was hardly visible in scattered data, but in the last two nights considerable flashes were observed. The light curves exhibited a sharp maximum, but their minimum evolves from broad to narrow. The phased light curve has a saw-edged form, typical for "ordinary" superhumps.

Days 17–20 AO.
Ordinary superhumps remained, but their shape changed and amplitude decreased. The mean period was $0.^{d}05512$. Comparing with the previous interval, superhumps looked like being turned upside-down. The sharp maximum became broad, and the minimum, on the contrary, narrow. Flickering became more evident, and its amplitude sometimes reached 0.1 mag. As seen from Fig. 2, the V light curve exhibited the plateau before the end of the stage "B" and transition to the stage "C".

Days 24–25 AO.
The V light curve exhibited dramatic decay after transition to the stage "C". The amplitude of short-term brightness variations increased twice and reached 0.5 mag in day 25 AO. As seen from Fig. 3, the humps were spoiled by small flares. Nevertheless, the mean period of $0.^{d}05486$ was well-determined and in

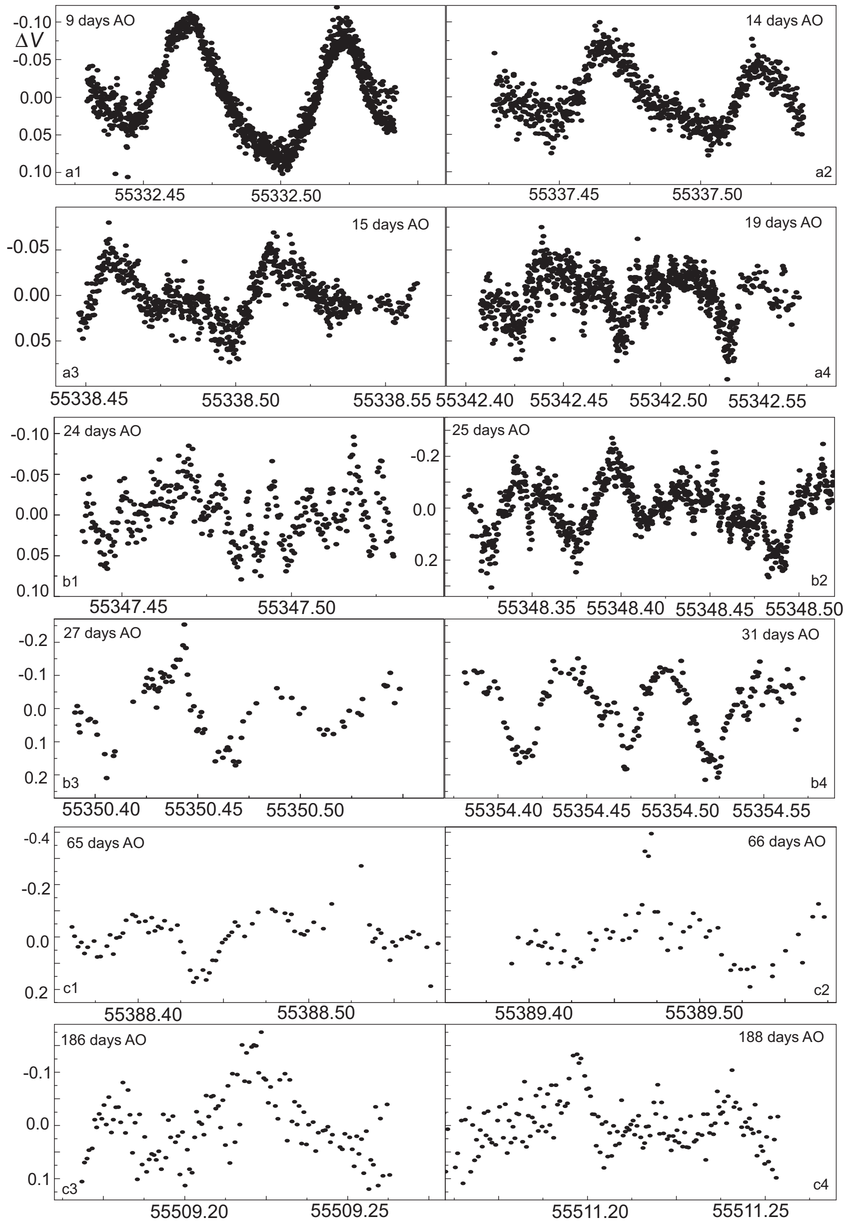


Figure 3. The nightly V light curves of DNP2010 during the superoutburst after the declining trend removal and in quiescence relatively to the mean night value of the magnitude. The days after outburst (AO) are marked. The ordinary superhumps of stage "B" are shown in plots a1–a4, late superhumps of stage "C" in plots b1–b4 and variations of brightness in the last stage of the superoutburst and quiescence in plots c1–c4.

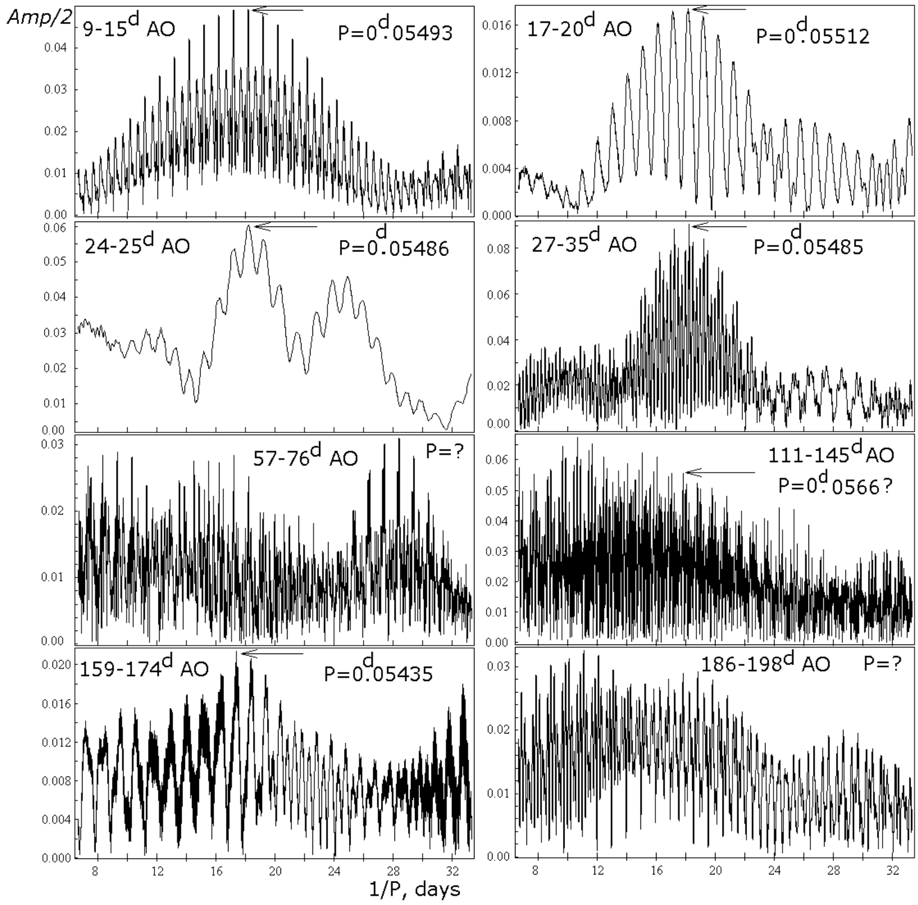


Figure 4. The periodograms of different segments of time series. The best period in each time segment is marked by an arrow.

the average, summed light curve a single-humped profile is visible (Fig. 5).

Days 27–35 AO.

The V light curve exhibited moderate fading. The amplitude of short-term variations was unstable, varying from 0.1 to 0.4 mag. In general, once in a cycle a noticeable (about 0.2 mag) flash or dip appeared. The mean period of $0.^d05485$ was close enough to the previous one.

Days 57–76 AO.

The nights were combined in one interval, because no evident superhumps were determined. The determination of their period failed.

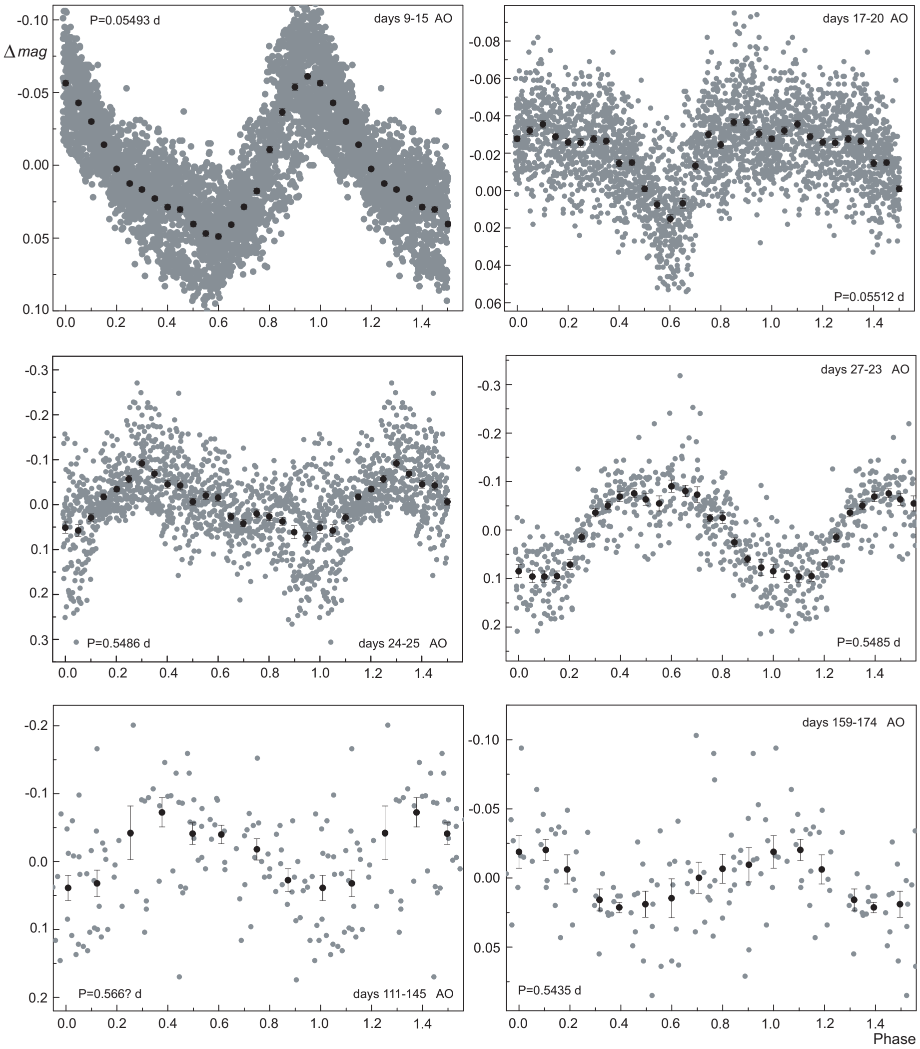


Figure 5. The phase diagrams of ordinary and late superhumps and brightness variations in a late decline and quiescence, found from the summarized nightly light curves in the B, V, R_C passbands.

Days after 111 AO.
We attempted to find out the mean period in different time intervals. Results are shown in Fig. 4. Unfortunately, the spectral window of the data is rather poor. Short datasets and large gaps between the observations cause severe aliasing. Therefore, identification of the best periods is ambiguous. We also convolved curves with a late superhumps' period, trying to find its echo in the quiescence state, but no reliable outcome was obtained. As seen in Fig. 3, the nightly light curves became irregular with considerable flickering, dips and flashes. The amplitude of variability changed from 0.1 to 0.5 mag.

Due to the observational gaps and high flickerings, it is a challenging problem to indicate the end of the stage "B" and the exact beginning of the stage "C" in some DNe (see Kato et al. 2009, 2010, 2012). Nevertheless, for DNP2010 we can say for sure that ordinary superhumps, well detected in day 20 AO, were not present in day 23 AO. According to Kato (2010), the DNP2010 had not yet entered to the stage "C" of superhump evolution in day 22 AO, but was close to the transition. Therefore, the transition from the "B" stage to the "C" stage occurred between the days 22 and 23 AO.

The two intervals cover the stage "C" of superhumps' evolution: days 24–25 AO and 27–35 AO. The period of late superhumps $P_{sh} = 0.^{d}05486$ was almost stable as opposed to the superhumps' amplitude. During the transition from the stage "B" to "C" a superhump period decreased by 0.4 %, which is a typical value for such objects (Kato et al., 2009, 2010, 2012).

The periods of "ordinary" superhumps were presented in a list of WZ Sge-type systems (Chochol et al. 2010). The authors found a mean value of superhump period excess $\epsilon = P_{sh}/P_{orb} - 1 = 0.019 \pm 0.03$. Using this relation we calculated the orbital period of DNP2010 – $0.^{d}0542 \pm 0.005$. We estimated the mass of the secondary red dwarf component using the empirical formula (see Warner, 1995)

$$M_2 = 0.065 P_{orb}^{5/4}(h),$$

as $0.09 \pm 0.01\ M_{\odot}$.

3. Colour-magnitude and two-colour diagrams

Tracks of DNP2010 during the superoutburst from day 9 AO to day 68 AO are plotted in $(V, B-V)$ and $(V, B-R)$ colour–magnitude diagrams (Fig. 6). Data points are marked with the number of days AO. The type of superhumps and behavior of the V passband data in different time intervals are indicated, too. In days 14–27 AO, the courses of the $B-V$ and $V-R$ indices are almost identical, but in day 9 AO and after day 30 AO, the courses of both indices are different. In general, the star becomes redder at the decline and bluer at a transition to quiescence. In the paper of Pavlenko et al. (2008) the tracks of some SU UMa-stars and postnovae in $(V, B-R)$ diagrams show similar behaviour.

The tracks of the object in the two-colour $(U-B, B-V)$, $(B-V, V-R_C)$ and $(V-R_C, R_C-I_C)$ diagrams are shown in Figs. 7 – 9. The position of the field stars, used as comparison stars, are marked, too. The small distance of the object 70 pc (Gänsicke, 2010) and moderately high galactic latitude +30° allow to neglect the effect of interstellar reddening.

As seen in Fig. 7, the investigated object was located below the blackbody sequence and close to the main sequence in days 15–23 AO. This feature can be explained by a relatively thick accretion disk, so the energy distribution in the spectrum is more similar to the star than to the diluted gas. After rapid fading of brightness in days 23–27 AO, the significant UV excess appeared, typical for a majority of cataclysmic variables. The object moved to the position above the blackbody sequence. At that time a transition from "ordinary" to "late" superhumps occurred. In days 30–35 AO its colour temperature varied between 10 000–15 000 K. Then either UV excess or colour temperature gradually increased and a position of DNP2010 corresponded to the values 16 000–24 000 K. The maximum of colour temperature was reached in day 64 AO. Then the temperature decreases to 16 000 K in day 132 AO. The behaviour of DNP2010 during its outburst was similar to the prototype WZ Sge. Godon et al. (2004) and Long et al. (2004) investigated the temperature changes of the white dwarf in WZ Sge during the superoutburst in 2001. The white dwarf, which had a temperature 14 500 K prior to the outburst was heated to 28 200 K by the outburst in day 50 AO. 17 months AO the WD had cooled to 15 900 K. For earlier investigated dwarf novae during their outbusts the use of two-colour $(U-B, B-V)$ diagrams led to the determinations of their colour temperatures: 12 000 K for V466 And (Chochol et al., 2010), 15 000 K for OT J023839.1 +255648 (Chochol et al., 2009) and about 22 000 K for the dwarf nova in Leo: ID CSS100217:104411+211307 (Drake et al. 2009, Shugarov et al., 2012).

Figs. 8 –9 show the tracks of the DNP2010 in the $(B-V, V-R_C)$ and $(V-R_C, R_C-I_C)$ diagrams. The colour indices of a black body, calculated by Dodin (2011), are depicted by a solid line. As seen in Fig. 8, the object was below the main sequence in day 9 AO (near the beginning of ordinary superhumps). This can be the result of a peculiar spectral energy distribution. Its colour temperature reached 18 000 K, which is typical for dwarf novae during their outbursts. Till day 24 AO, the colour temperature of the DNP2010 varied from 16 000 K to 18 000 K, but in day 25 AO, it suddenly dropped and reached 9 000 K. Simultaneously, a dramatic decrease of brightness started. Apparently, the characteristics of the accretion disk changed.

As seen in Fig. 9, the position of DNP2010 was above the black body and main sequence and near A0–A5 stars ($\sim$ 10 000 K). After the fast decline stage (27–30 d AO) the colour temperature dropped by several thousand degrees, but the blue excess increased. The $(B-V, V-R_C)$ and $(V-R_C, R_C-I_C)$ diagrams were plotted only for the first 35 and 30 days AO, respectively. Thereafter, the observations were distorted by a close companion.

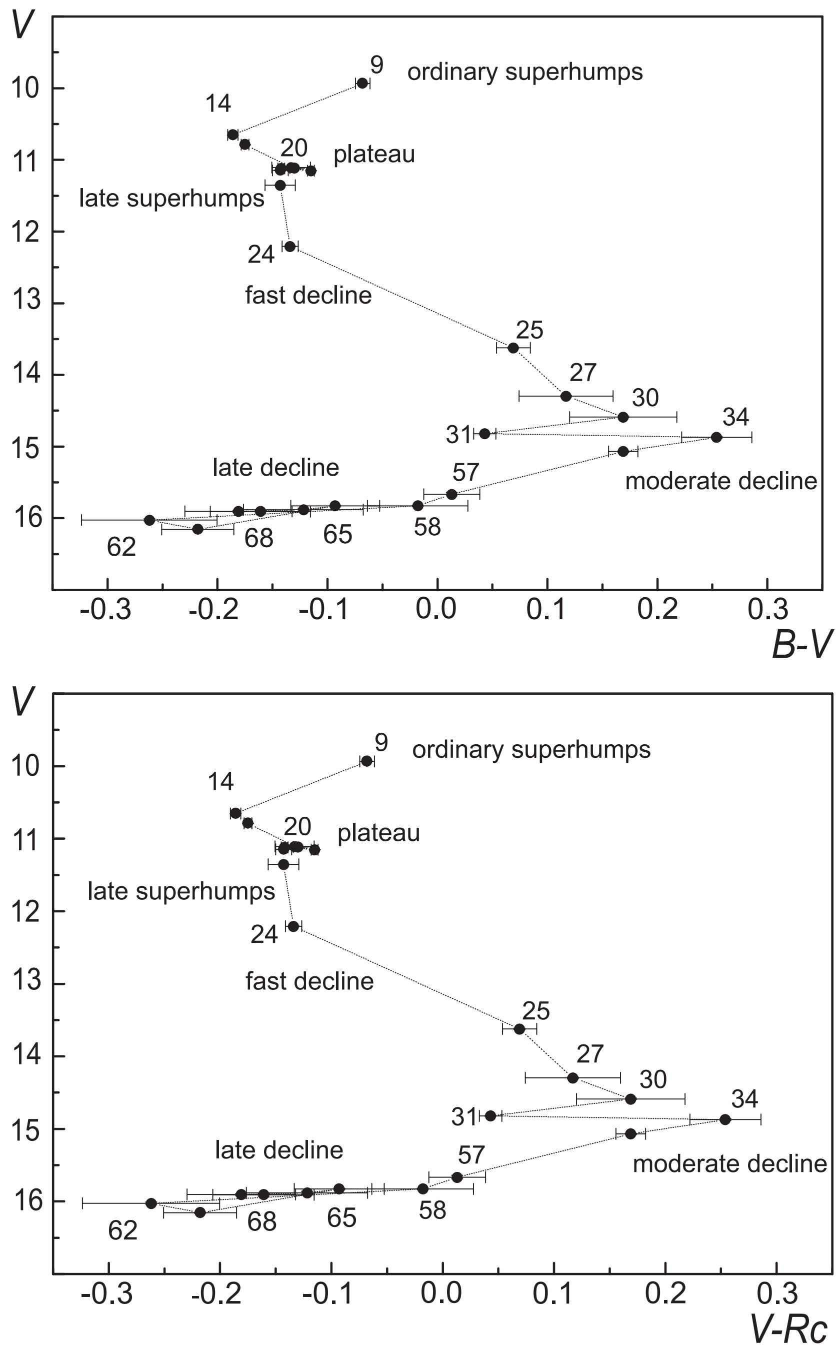
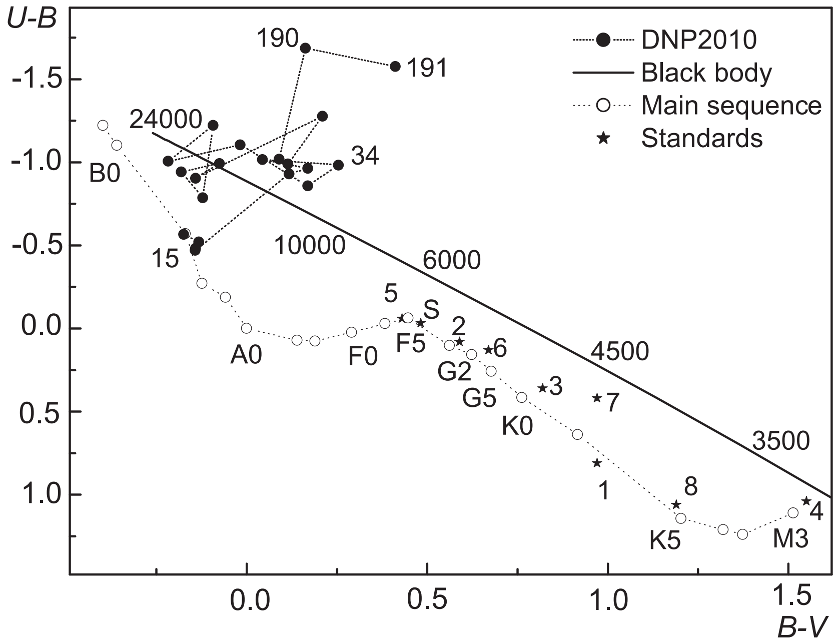


Figure 6. The colour-magnitude $(V, B-V)$ and $(V, V-R_C)$ diagrams. The days after outburst (AO) are marked.



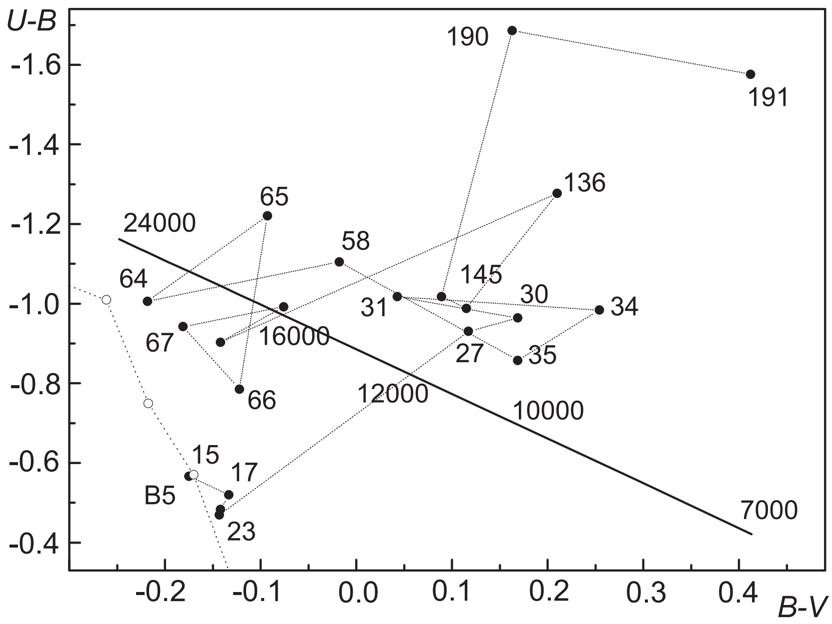


Figure 7. The two-colour $(U-B, B-V)$ diagram and its detail. The blackbody and main sequences are plotted with the solid and dot lines. Filled circles and evolutionary track correspond to the DNP2010, asterisks to the comparison stars.

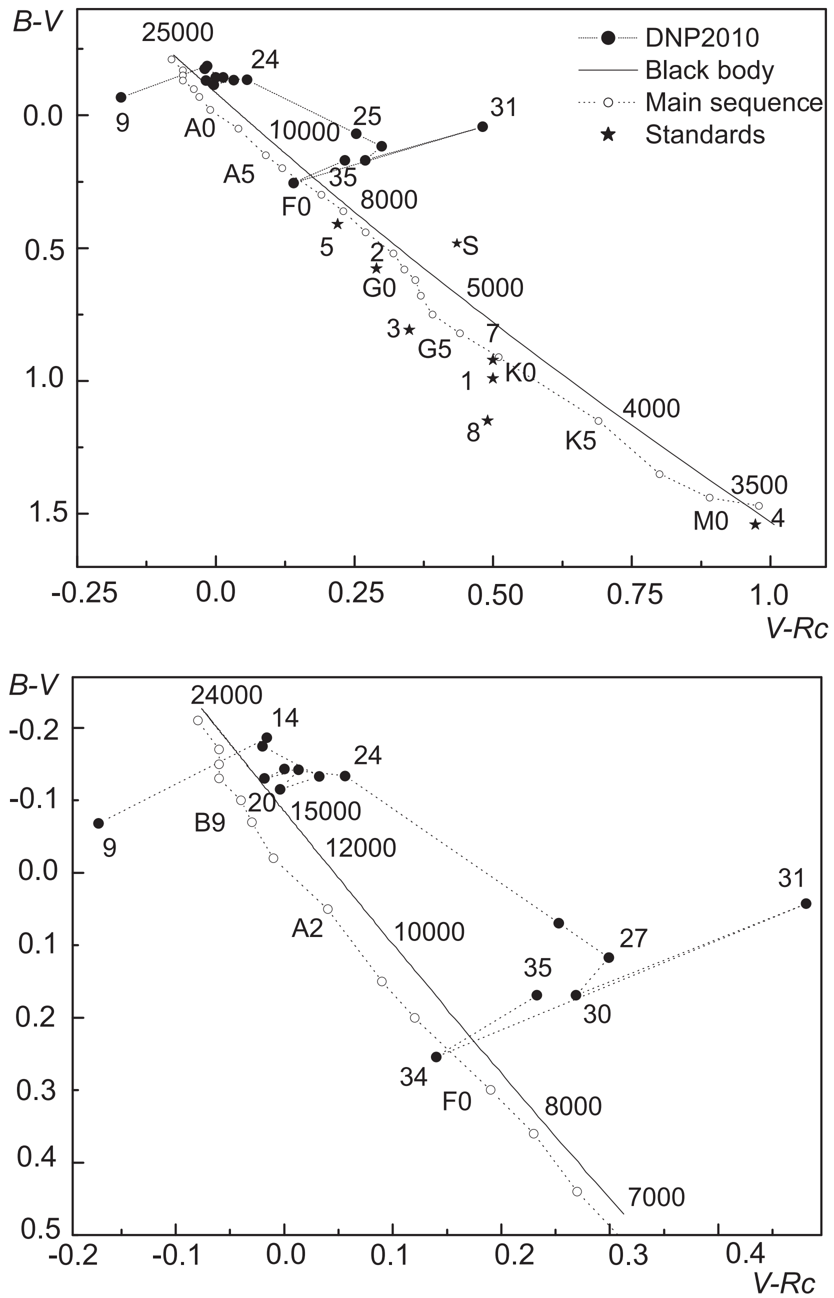


Figure 8. The two-colour $(B-V, V-R_C)$ diagram and its detail. The signs and symbols are the same as in Fig. 7.

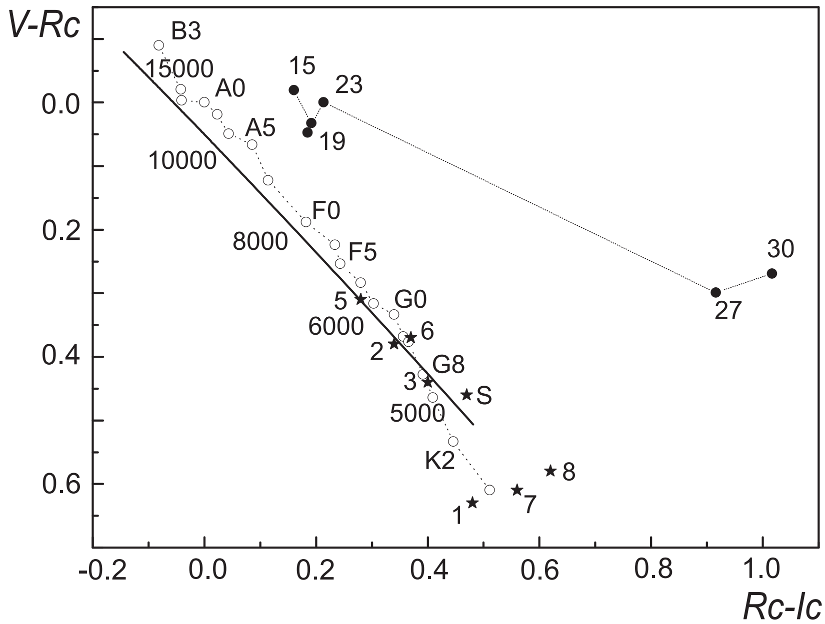


Figure 9. The two-colour $(V - R_C, R_C - I_C)$ diagram. The signs and symbols are the same as in Fig. 7.

The colour temperatures found from the $(B-V, V-R_C)$ and $(V-R_C, R_C-I_C)$ diagrams were considerably lower than those derived from the $(U-B, B-V)$ diagram due to the fact that in the IR region dominates the continuum from cooler parts of the accretion disk. The presence of strong emission lines near the Balmer jump and in the blue region of the spectrum can also have an influence on the determination of the colour temperature. One should bear in mind that the DNP2010 has an extremely close optical component "S", most probably a main sequence F6 – G9 type star (see Figs. 7 – 9), that distorts visible magnitudes and colours. We corrected the magnitude of a variable in our calculations, removing the influence of this component. However, due to the difficulties in determination of its exact magnitude, some systematic errors, up to a few tenths of magnitude, could remain. So the colour temperature, determined from colour indices, can slightly differ from the true value.

4. $O - C$ diagrams

We used the $O - C$ analysis for finding the superhump period variations. The dependence of superhump amplitude, the $O-C$ values and V magnitude differences as a function of number of superhumps' periods are plotted in Fig. 10. We took the mean period of $0.^{d}055106$ and the initial epoch $HJD = 2455332.4152$ for calculations of the $O - C$ values and obtained $Pdot = +6.2 \cdot 10^{-5}$ from a parabolic fit. The V magnitude differences were calculated relatively to the value of V at maximum. The $O-C$ diagram suggests day 22 AO as the last day of the "B" stage. According to Kato et al. (2010), the "ordinary" superhumps apperead in day 7 AO. So, the duration of the "B" stage lasted about 15 days. The times of superhumps' maxima and the $O-C$ residuals are given in Table 3.

As seen in Fig. 10, the superhump amplitude reached its maximum during the sharp decrease of the V magnitude, after the beginning of the phase "C". The range of superhumps' amplitudes of the DNP2010 is about 0.3 mag, in agreement with other WZ Sge-type systems, with the range of superhumps up to 0.5 mag (Kato et al., 2009, 2010, 2012).

The linear approximation of the $O - C$ values for the phase "C" gave a period of $0.^{d}05490$, close to the results obtained by the method of Fourier analysis. Kato et al. (2010) presented the $O - C$ diagram for DNP2010 till 82 days AO. Our $O - C$ diagram, which covers only 36 days AO, is very similar. Our observations after the day 57 AO do not support the existence of any superhumps and the light curve and periodograms (Figs. 3 and 4) support this fact, leaving the doubts about a strict periodicity of late superhumps found by Kato et al. (2010). Our observations after day 57 show that the flickering amplitude became appreciably larger than any smooth variations of the light curves.

The $O - C$ diagram of DNP2010 looks like other diagrams of superoubursts of SU UMa- and WZ Sge-stars (see Kato et al., 2009, 2010, 2012): a positive $Pdot$ on the stage "B" (the increase of the superhump period) and relatively stable and shorter period during the stage "C".

5. Summary

We estimated the duration of the stage "B" of the DNP2010 to ≈ 15 days and found out the approximate time of transition between "B" and "C" stage as 22–23 day AO. We determined the mean period of ordinary superhumps as $0.^{d}055106$ and superhump period increase: $Pdot = \dot{P}/P = +6.2 \cdot 10^{-5}$ in the stage "B". We determined the period of late superhumps $0.^{d}05490$ in the stage "C". We calculated the orbital period of the DNP2010 to be $0.^{d}0542 \pm 0.005$ and estimated the mass of the red dwarf component in the binary as $0.09 \pm 0.01\ M_{\odot}$.

The evolution of the superhump shape and the superhump period and behaviour of DNP2010 at the two-colour and colour-magnitude diagrams were investigated. We showed that the colour temperature of the hot component during the superoutburst increased from 10 000 to 24 000 K. Thereafter, the hot component started to cool down and its colour temperature declined to 16 000 K in day 132 AO.

We registered strong UV-excess in quiescence (190 days AO) and connected this fact to processes in the central parts of the accretion disk. The flickering

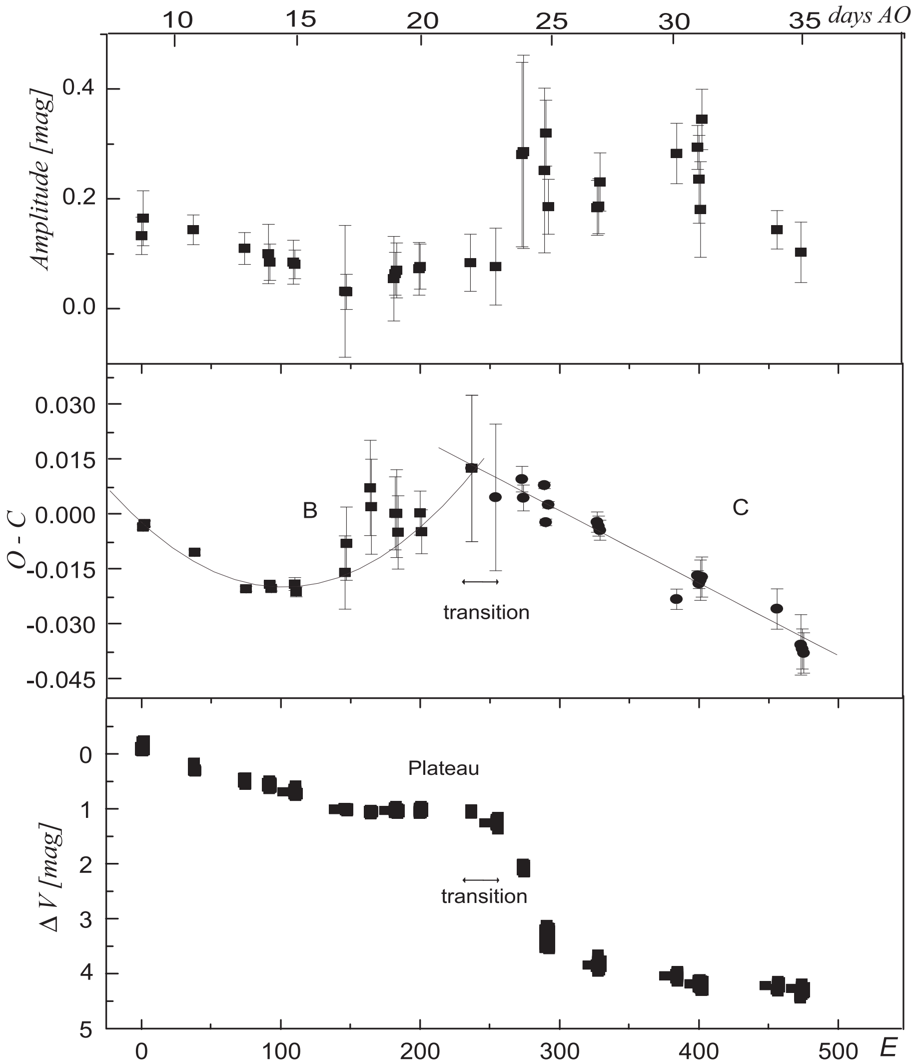


Figure 10. The dependence of superhumps' amplitude, the $O - C$ values and the V magnitude differences as a function of a number of superhump periods. The superhump stages "B","C" and the moment of transition between them are marked.

with a variable amplitude during the decline and in quiescence was observed. We can conclude that the behaviour of dwarf nova Pegasi 2010 is consistent with the behaviour of other WZ Sge-type stars.

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A. $UBVR_CI_C$ observations

Table 4. U magnitudes of DNP2010. The symbols after magnitudes are explained in Table 2. JD_{hel} =JD* + 2 455 000.

JD*	U	JD*	U	JD*	U	JD*	U
338.4829	10.06 s	459.2628	15.05 a	513.2272	14.98 v	514.1880	15.06 v
338.4844	10.06 s	459.2690	15.17 a	513.2296	15.05 v	514.1902	15.05 v
340.4411	10.49 s	459.2749	15.11 a	513.2345	14.97 v	514.1941	14.96 v
340.4427	10.43 s	463.2810	15.45 a	513.2370	14.94 v	514.1964	15.04 v
340.4444	10.46 s	463.2870	15.40 a	513.2394	14.92 v	514.1987	15.01 v
342.4948	10.51 s	468.3434	15.33 a	513.2419	14.87 v	514.2010	15.05 v
342.4967	10.47 s	468.3492	15.32 a	513.2443	14.93 v	514.2032	15.04 v
342.4987	10.49 s	468.3549	15.35 a	513.2468	14.87 v	514.2055	15.07 v
346.4807	10.73 s	513.1424	14.86 v	513.2493	14.86 v	514.2077	15.05 v
346.4824	10.74 s	513.1462	14.75 v	513.2517	14.86 v	514.2100	15.11 v
350.3987	13.56 s	513.1487	14.73 v	513.2542	14.79 v	514.2123	15.08 v
350.4893	13.42 s	513.1511	14.76 v	513.2566	14.78 v	514.2145	15.09 v
350.4918	13.46 s	513.1536	14.82 v	513.2591	14.72 v	514.2168	15.15 v
353.5278	13.81 s	513.1560	14.79 v	513.2615	14.79 v	514.2191	15.14 v
353.5292	13.76 s	513.1585	14.82 v	513.2648	14.83 v	514.2213	15.20 v
354.4361	13.90 s	513.1609	14.76 v	513.2721	14.92 v	514.2236	15.19 v
354.4381	13.86 s	513.1634	14.74 v	513.2746	14.97 v	514.2259	15.13 v
354.4401	13.96 s	513.1658	14.80 v	513.2819	14.86 v	514.2281	15.12 v
357.4907	14.18 s	513.1683	14.93 v	513.2844	14.87 v	514.2304	15.14 v
357.4929	14.13 s	513.1707	14.92 v	513.2868	14.86 v	514.2326	15.17 v
357.4970	13.99 s	513.1732	14.91 v	513.2917	14.96 v	514.2349	15.21 v
357.4985	14.10 s	513.1783	14.82 v	514.1424	15.06 v	514.2372	15.19 v
358.4769	14.34 s	513.1807	14.82 v	514.1447	15.12 v	514.2394	15.18 v
358.4790	14.47 s	513.1832	14.73 v	514.1470	15.19 v	514.2417	15.18 v
381.4040	14.70 s	513.1856	14.73 v	514.1492	15.19 v	514.2440	15.23 v
387.4368	14.97 s	513.1881	14.79 v	514.1515	15.27 v	514.2462	15.24 v
387.4382	14.94 s	513.1905	14.87 v	514.1538	15.22 v	514.2485	15.22 v
387.4397	14.91 s	513.1930	14.98 v	514.1561	15.12 v	514.2508	15.15 v
388.4692	14.59 s	513.1954	14.93 v	514.1583	15.08 v	514.2530	15.16 v
388.4707	14.48 s	513.1979	14.85 v	514.1606	15.03 v	514.2553	15.19 v
389.3832	15.03 s	513.2003	14.90 v	514.1629	15.08 v	514.2576	15.23 v
389.3850	14.90 s	513.2028	14.87 v	514.1652	15.02 v	514.2598	15.22 v
389.3887	14.97 s	513.2052	14.86 v	514.1674	15.06 v	514.2621	15.23 v
390.4863	14.77 s	513.2077	14.84 v	514.1697	15.06 v	514.2643	15.18 v
390.4999	14.72 s	513.2100	14.95 v	514.1720	15.10 v	514.2666	15.20 v
399.3846	14.73 s	513.2125	14.95 v	514.1743	15.09 v	514.2689	15.11 v
399.3857	14.96 s	513.2149	14.96 v	514.1766	15.13 v	514.2711	15.07 v
399.3868	14.74 s	513.2174	14.91 v	514.1788	15.13 v	514.2734	15.05 v
399.3879	14.81 s	513.2198	14.93 v	514.1811	15.14 v	514.2758	15.09 v
455.3911	14.64 a	513.2223	14.91 v	514.1834	15.13 v	514.2780	15.10 v
455.4020	15.46 a	513.2247	14.94 v	514.1857	15.12 v	514.2803	15.12 v

Table 4. Continued.

JD*	U	JD*	U	JD*	U	JD*	U
514.2826	15.20 v	514.2917	15.36 v	514.3008	15.23 v	514.3452	15.10 v
514.2849	15.25 v	514.2940	15.31 v	514.3031	15.11 v		
514.2872	15.29 v	514.2963	15.29 v	514.3054	15.12 v		
514.2894	15.37 v	514.2986	15.29 v	514.3077	15.15 v		

Table 5. B magnitudes of DNP2010. The symbols after magnitude are explained in Table 2. JD_{hel}=JD* + 2 455 000.

JD*	B	JD*	B	JD*	B	JD*	B
338.4788	10.66 s	388.3649	15.79 s	388.5492	15.77 s	390.3969	15.83 s
338.4830	10.58 s	388.3686	15.82 s	388.5595	15.75 s	390.4044	15.90 s
338.4845	10.64 s	388.3761	15.84 s	389.3899	15.99 s	390.4194	15.87 s
340.4412	10.96 s	388.3836	15.74 s	389.3937	15.86 s	390.4344	15.84 s
340.4429	10.99 s	388.3874	15.75 s	389.4011	15.87 s	390.4419	15.83 s
342.4951	10.97 s	388.3911	15.73 s	389.4056	15.88 s	390.4457	15.90 s
342.4971	10.99 s	388.3986	15.65 s	389.4077	15.88 s	390.4532	15.98 s
342.4990	10.98 s	388.4061	15.73 s	389.4114	15.96 s	390.4644	15.87 s
350.3956	14.47 s	388.4099	15.72 s	389.4189	15.94 s	390.4757	15.86 s
350.4904	14.38 s	388.4136	15.71 s	389.4264	15.95 s	390.4870	15.72 s
350.4929	14.36 s	388.4249	15.77 s	389.4302	15.92 s	390.4970	15.71 s
353.5247	14.71 s	388.4324	15.96 s	389.4377	15.85 s	390.5051	15.65 s
353.5265	14.79 s	388.4399	15.95 s	389.4456	15.74 s	390.5166	15.70 s
354.4376	14.86 s	388.4437	15.86 s	389.4493	15.75 s	390.5278	15.63 s
354.4395	14.86 s	388.4474	15.82 s	389.4568	15.66 s	390.5353	15.45 s
357.4924	15.10 s	388.4512	15.76 s	389.4643	15.64 s	390.5391	15.44 s
357.4945	15.06 s	388.4549	15.73 s	389.4681	15.36 s	390.5428	15.46 s
358.4721	15.24 s	388.4587	15.70 s	389.4718	15.28 s	390.5466	15.52 s
358.4744	15.24 s	388.4705	15.64 s	389.4756	15.62 s	390.5541	15.56 s
358.4768	15.23 s	388.4786	15.62 s	389.4831	15.66 s	390.5655	15.47 s
380.3742	15.68 s	388.4861	15.64 s	389.4906	15.68 s	391.4955	15.79 s
381.3933	15.74 s	388.4899	15.65 s	389.4943	15.66 s	391.4998	15.78 s
381.3975	15.86 s	388.4974	15.74 s	389.5058	15.66 s	391.5036	15.66 s
381.4018	15.84 s	388.5086	15.71 s	389.5108	15.64 s	391.5073	15.56 s
385.5136	15.72 s	388.5166	15.21 s	389.5183	15.82 s	391.5111	15.55 s
385.5187	15.81 s	388.5184	15.35 s	389.5296	15.88 s	391.5148	15.76 s
387.3731	16.02 s	388.5233	15.47 s	389.5427	15.81 s	391.5186	15.81 s
387.3790	15.96 s	388.5254	15.47 s	389.5602	15.72 s	391.5223	15.85 s
387.3908	15.98 s	388.5288	15.28 s	390.3470	15.70 s	391.5261	15.87 s
387.4086	15.86 s	388.5322	15.38 s	390.3631	15.75 s	391.5298	15.83 s
387.4204	15.87 s	388.5356	15.69 s	390.3706	15.77 s	391.5336	15.84 s
387.4263	15.98 s	388.5390	15.76 s	390.3781	15.80 s	391.5373	15.81 s
387.4322	16.02 s	388.5424	15.73 s	390.3894	15.77 s	391.5411	15.76 s

Table 5. Continued.

JD*	B	JD*	B	JD*	B	JD*	B
391.5448	15.77 s	399.5568	15.78 s	455.4577	16.13 a	464.3837	16.29 a
391.5486	15.65 s	399.5643	15.70 s	455.4602	16.16 a	464.3886	16.30 a
391.5523	15.66 s	399.5680	15.66 s	455.4627	16.15 a	464.4012	16.34 a
391.5561	15.90 s	399.5718	15.71 s	459.2657	16.24 a	464.4062	16.33 a
391.5598	16.02 s	399.5755	15.77 s	459.2719	16.29 a	464.4112	16.28 a
399.3968	16.04 s	434.4135	15.93 s	459.2778	16.46 a	464.4162	16.34 a
399.4012	15.94 s	434.4315	15.92 s	459.2829	16.40 a	464.4187	16.43 a
399.4049	15.88 s	434.4414	15.91 s	459.2858	16.39 a	468.3461	16.39 a
399.4087	15.84 s	434.4667	16.03 s	459.2886	16.44 a	468.3518	16.50 a
399.4124	15.85 s	434.4824	15.97 s	459.2915	16.46 a	468.3575	16.49 a
399.4162	15.92 s	434.5034	15.92 s	459.2972	16.40 a	468.3633	16.41 a
399.4199	15.84 s	434.5201	15.99 s	459.3029	16.39 a	468.3688	16.33 a
399.4237	15.85 s	434.5351	16.13 s	459.3119	16.49 a	468.3712	16.32 a
399.4274	15.81 s	438.3838	16.21 s	459.3148	16.45 a	468.3737	16.25 a
399.4312	15.80 s	438.3933	16.23 s	459.3204	16.47 a	468.3762	16.23 a
399.4349	15.76 s	438.4063	16.30 s	459.3262	16.37 a	468.3787	16.18 a
399.4387	15.74 s	438.4138	16.26 s	459.3348	16.55 a	468.3812	16.21 a
399.4424	15.98 s	438.4176	16.21 s	463.2838	16.22 a	468.3837	16.17 a
399.4462	16.01 s	438.4213	16.14 s	463.3004	16.29 a	468.3887	16.30 a
399.4499	15.90 s	438.4288	16.12 s	463.3156	16.29 a	468.3962	16.33 a
399.4537	15.95 s	454.3451	16.14 a	463.3255	16.34 a	468.4016	16.41 a
399.4574	15.79 s	454.3529	16.15 a	463.3305	16.29 a	468.4040	16.39 a
399.4612	15.81 s	454.3614	16.08 a	463.3384	16.35 a	468.4065	16.44 a
399.4649	15.89 s	454.3664	15.92 a	463.3409	16.45 a	468.4090	16.44 a
399.4687	15.91 s	454.3689	15.90 a	463.3434	16.48 a	468.4115	16.59 a
399.4742	15.90 s	454.3714	15.91 a	463.3459	16.50 a	468.4140	16.54 a
399.4780	15.88 s	454.3739	15.90 a	463.3509	16.58 a	468.4165	16.56 a
399.4817	15.93 s	454.3764	16.03 a	463.3559	16.59 a	468.4190	16.52 a
399.4892	15.99 s	454.3839	16.09 a	463.3584	16.56 a	468.4215	16.38 a
399.4967	15.94 s	454.3971	16.12 a	463.3609	16.57 a	482.2456	16.30 s
399.5005	15.85 s	454.4021	16.00 a	463.3639	16.42 a	482.2497	16.29 s
399.5042	15.85 s	454.4046	16.04 a	464.3156	16.18 a	482.2538	16.28 s
399.5080	15.79 s	454.4071	16.00 a	464.3230	16.19 a	482.2579	16.30 s
399.5118	15.80 s	454.4096	15.98 a	464.3255	16.23 a	482.2661	16.28 s
399.5155	15.88 s	454.4121	16.05 a	464.3280	16.23 a	482.2784	16.31 s
399.5193	16.02 s	455.3935	15.92 a	464.3330	16.24 a	482.2866	16.33 s
399.5230	16.03 s	455.4005	16.01 a	464.3379	16.24 a	482.2907	16.37 s
399.5268	16.06 s	455.4092	15.78 a	464.3404	16.23 a	482.2948	16.28 s
399.5305	16.02 s	455.4171	15.74 a	464.3479	16.22 a	482.2989	16.29 s
399.5343	16.01 s	455.4246	15.87 a	464.3529	16.21 a	482.3030	16.30 s
399.5380	15.87 s	455.4321	15.89 a	464.3554	16.22 a	482.3071	16.28 s
399.5418	15.92 s	455.4371	16.00 a	464.3612	16.39 a	482.3112	16.24 s
399.5455	15.90 s	455.4396	15.96 a	464.3662	16.39 a	482.3153	16.26 s
399.5493	15.88 s	455.4451	15.98 a	464.3712	16.44 a	482.3194	16.23 s
399.5530	15.86 s	455.4526	16.21 a	464.3787	16.53 a	482.3295	16.29 s

Table 5. Continued.

JD*	*B*	JD*	*B*	JD*	*B*	JD*	*B*
482.3378	16.24 s	484.3594	16.31 s	509.1826	16.41 v	509.2492	16.52 v
482.3460	16.32 s	484.3669	16.35 s	509.1840	16.57 v	509.2506	16.53 v
482.3542	16.17 s	484.3781	16.30 s	509.1855	16.64 v	509.2521	16.61 v
482.3583	16.24 s	484.3856	16.28 s	509.1869	16.60 v	509.2535	16.57 v
482.3624	16.14 s	484.3894	16.33 s	509.1884	16.62 v	509.2550	16.63 v
482.3706	16.18 s	484.3969	16.37 s	509.1899	16.57 v	509.2564	16.67 v
482.3788	16.27 s	484.4044	16.42 s	509.1913	16.59 v	509.2579	16.60 v
482.3829	16.28 s	484.4081	16.43 s	509.1928	16.62 v	509.2594	16.66 v
482.3870	16.27 s	484.4119	16.43 s	509.1942	16.58 v	509.2609	16.63 v
482.3911	16.32 s	484.4156	16.21 s	509.1957	16.53 v	509.2629	16.63 v
482.3952	16.37 s	484.4194	16.22 s	509.1972	16.54 v	511.1585	16.43 v
483.2453	16.42 s	484.4231	16.30 s	509.1986	16.63 v	511.1596	16.39 v
483.2479	16.41 s	484.4269	16.42 s	509.2001	16.66 v	511.1607	16.42 v
483.2538	16.39 s	484.4306	16.40 s	509.2015	16.62 v	511.1634	16.47 v
483.2575	16.38 s	484.4381	16.36 s	509.2030	16.53 v	511.1645	16.39 v
483.2613	16.42 s	484.4419	16.31 s	509.2045	16.49 v	511.1656	16.38 v
483.2650	16.39 s	497.2439	16.38 s	509.2059	16.52 v	511.1667	16.35 v
483.2725	16.35 s	497.2551	16.37 s	509.2074	16.47 v	511.1677	16.39 v
483.2838	16.34 s	497.2664	16.42 s	509.2089	16.42 v	511.1688	16.42 v
483.2875	16.30 s	497.2776	16.43 s	509.2103	16.45 v	511.1699	16.39 v
483.2913	16.24 s	497.2852	16.39 s	509.2118	16.43 v	511.1710	16.35 v
483.3011	16.31 s	497.2889	16.36 s	509.2132	16.39 v	511.1720	16.34 v
483.3086	16.37 s	497.2927	16.35 s	509.2147	16.36 v	511.1731	16.41 v
483.3124	16.39 s	497.2964	16.46 s	509.2162	16.37 v	511.1742	16.42 v
483.3161	16.39 s	497.3002	16.47 s	509.2176	16.29 v	511.1752	16.32 v
483.3236	16.39 s	497.3039	16.43 s	509.2191	16.31 v	511.1763	16.39 v
483.3311	16.40 s	497.3077	16.36 s	509.2205	16.30 v	511.1774	16.43 v
483.3368	16.39 s	497.3114	16.36 s	509.2220	16.29 v	511.1785	16.40 v
483.3424	16.38 s	497.3189	16.43 s	509.2235	16.26 v	511.1796	16.39 v
483.3461	16.36 s	497.3302	16.50 s	509.2249	16.38 v	511.1807	16.33 v
483.3499	16.35 s	497.3414	16.43 s	509.2264	16.40 v	511.1818	16.39 v
483.3536	16.33 s	497.3527	16.48 s	509.2279	16.45 v	511.1829	16.41 v
483.3574	16.36 s	497.3602	16.43 s	509.2293	16.38 v	511.1840	16.38 v
483.3649	16.42 s	497.3715	16.40 s	509.2308	16.36 v	511.1850	16.34 v
483.3746	16.40 s	509.1685	16.65 v	509.2322	16.38 v	511.1861	16.36 v
483.3784	16.37 s	509.1692	16.60 v	509.2337	16.43 v	511.1872	16.35 v
483.3821	16.41 s	509.1700	16.59 v	509.2351	16.45 v	511.1883	16.36 v
483.3859	16.41 s	509.1707	16.56 v	509.2366	16.46 v	511.1894	16.34 v
483.3934	16.49 s	509.1723	16.48 v	509.2381	16.50 v	511.1905	16.37 v
483.4046	16.33 s	509.1738	16.47 v	509.2395	16.49 v	511.1916	16.29 v
483.4159	16.42 s	509.1753	16.44 v	509.2410	16.52 v	511.1927	16.31 v
483.4234	16.43 s	509.1767	16.42 v	509.2425	16.51 v	511.1938	16.29 v
484.3381	16.25 s	509.1782	16.48 v	509.2439	16.50 v	511.1948	16.22 v
484.3481	16.32 s	509.1796	16.45 v	509.2454	16.52 v	511.1959	16.17 v
484.3556	16.30 s	509.1811	16.39 v	509.2477	16.56 v	511.1970	16.16 v

Table 5. Continued.

JD*	B	JD*	B	JD*	B	JD*	B
511.1981	16.17 v	511.2472	16.46 v	513.2396	16.65 v	514.1988	16.66 v
511.1992	16.22 v	511.2482	16.54 v	513.2420	16.72 v	514.2011	16.68 v
511.2003	16.25 v	511.2493	16.59 v	513.2445	16.71 v	514.2034	16.69 v
511.2014	16.31 v	511.2504	16.56 v	513.2469	16.61 v	514.2056	16.66 v
511.2025	16.40 v	511.2515	16.52 v	513.2494	16.54 v	514.2079	16.62 v
511.2036	16.41 v	511.2525	16.59 v	513.2518	16.50 v	514.2102	16.57 v
511.2046	16.46 v	511.2536	16.53 v	513.2543	16.63 v	514.2124	16.58 v
511.2057	16.43 v	513.1411	16.70 v	513.2567	16.61 v	514.2147	16.73 v
511.2068	16.43 v	513.1454	16.50 v	513.2592	16.58 v	514.2169	16.80 v
511.2079	16.40 v	513.1488	16.53 v	513.2616	16.51 v	514.2192	16.82 v
511.2090	16.40 v	513.1513	16.51 v	513.2641	16.52 v	514.2215	16.79 v
511.2101	16.38 v	513.1537	16.53 v	513.2673	16.57 v	514.2237	16.85 v
511.2112	16.36 v	513.1562	16.46 v	513.2722	16.61 v	514.2260	16.79 v
511.2123	16.36 v	513.1586	16.59 v	513.2747	16.45 v	514.2283	16.69 v
511.2134	16.39 v	513.1611	16.47 v	513.2771	16.67 v	514.2305	16.73 v
511.2144	16.34 v	513.1635	16.54 v	513.2820	16.42 v	514.2328	16.78 v
511.2155	16.43 v	513.1660	16.52 v	513.2845	16.36 v	514.2350	16.80 v
511.2166	16.37 v	513.1684	16.56 v	513.2869	16.51 v	514.2373	16.81 v
511.2177	16.40 v	513.1709	16.60 v	513.2894	16.75 v	514.2396	16.85 v
511.2193	16.35 v	513.1733	16.64 v	513.2918	16.46 v	514.2418	16.83 v
511.2204	16.40 v	513.1758	16.50 v	513.2943	16.44 v	514.2441	16.90 v
511.2214	16.41 v	513.1771	16.56 v	514.1399	16.76 v	514.2464	16.87 v
511.2225	16.42 v	513.1808	16.57 v	514.1448	16.72 v	514.2486	16.84 v
511.2236	16.46 v	513.1833	16.52 v	514.1471	16.71 v	514.2509	16.76 v
511.2246	16.43 v	513.1858	16.41 v	514.1494	16.73 v	514.2532	16.71 v
511.2257	16.44 v	513.1882	16.54 v	514.1516	16.77 v	514.2554	16.70 v
511.2268	16.46 v	513.1907	16.53 v	514.1539	16.69 v	514.2577	16.75 v
511.2279	16.46 v	513.1931	16.50 v	514.1562	16.66 v	514.2599	16.78 v
511.2289	16.39 v	513.1956	16.60 v	514.1585	16.69 v	514.2622	16.78 v
511.2300	16.46 v	513.1980	16.59 v	514.1607	16.60 v	514.2645	16.74 v
511.2311	16.44 v	513.2005	16.57 v	514.1630	16.64 v	514.2667	16.78 v
511.2321	16.45 v	513.2029	16.63 v	514.1653	16.68 v	514.2690	16.67 v
511.2332	16.52 v	513.2054	16.57 v	514.1676	16.69 v	514.2713	16.67 v
511.2343	16.46 v	513.2078	16.57 v	514.1699	16.63 v	514.2735	16.61 v
511.2354	16.46 v	513.2126	16.66 v	514.1721	16.66 v	514.2759	16.62 v
511.2364	16.36 v	513.2151	16.70 v	514.1744	16.59 v	514.2782	16.59 v
511.2375	16.42 v	513.2175	16.59 v	514.1767	16.61 v	514.2804	16.67 v
511.2386	16.40 v	513.2200	16.60 v	514.1790	16.63 v	514.2827	16.71 v
511.2397	16.39 v	513.2224	16.65 v	514.1813	16.67 v	514.2850	16.80 v
511.2407	16.33 v	513.2249	16.63 v	514.1835	16.74 v	514.2873	16.83 v
511.2418	16.42 v	513.2273	16.63 v	514.1858	16.68 v	514.2896	16.81 v
511.2429	16.44 v	513.2298	16.65 v	514.1881	16.66 v	514.2918	16.82 v
511.2439	16.52 v	513.2322	16.69 v	514.1904	16.70 v	514.2941	16.80 v
511.2450	16.50 v	513.2347	16.67 v	514.1927	16.65 v	514.2964	16.82 v
511.2461	16.51 v	513.2371	16.67 v	514.1965	16.64 v	514.2987	16.80 v

Table 5. Continued.

JD*	B	JD*	B	JD*	B	JD*	B
514.3010	16.74 v	515.2855	16.15 s	515.3376	16.08 s	521.3068	16.27 s
514.3032	16.72 v	515.2907	16.09 s	515.3480	15.99 s	521.3226	16.34 s
514.3055	16.62 v	515.3011	16.20 s	521.2585	16.54 s	655.6220	16.49 s
514.3476	16.83 v	515.3115	16.23 s	521.2742	16.36 s	657.6230	16.45 s
515.2750	16.17 s	515.3219	16.11 s	521.2904	16.28 s	662.6187	16.27 s

Table 6. V magnitudes of DNP2010. The symbols after magnitudes are explained in Table 2. JD_{hel}=JD* + 2 455 000.

JD*	V	JD*	V	JD*	V	JD*	V
338.4773	10.80 s	338.5069	10.79 s	338.5254	10.80 s	338.5365	10.81 s
338.4782	10.78 s	338.5072	10.78 s	338.5257	10.79 s	338.5368	10.80 s
338.4793	10.80 s	338.5075	10.77 s	338.5259	10.79 s	338.5370	10.81 s
338.4799	10.83 s	338.5078	10.76 s	338.5262	10.80 s	338.5373	10.81 s
338.4821	10.76 s	338.5081	10.79 s	338.5266	10.80 s	338.5376	10.80 s
338.4849	10.79 s	338.5086	10.75 s	338.5268	10.79 s	338.5379	10.82 s
338.4857	10.79 s	338.5092	10.77 s	338.5271	10.79 s	338.5382	10.81 s
338.4862	10.81 s	338.5095	10.75 s	338.5274	10.80 s	338.5388	10.81 s
338.4865	10.81 s	338.5098	10.75 s	338.5280	10.79 s	338.5394	10.81 s
338.4868	10.81 s	338.5101	10.69 s	338.5286	10.78 s	338.5397	10.81 s
338.4873	10.83 s	338.5107	10.68 s	338.5289	10.79 s	338.5400	10.81 s
338.4879	10.83 s	338.5110	10.65 s	338.5292	10.80 s	338.5403	10.81 s
338.4882	10.81 s	338.5112	10.74 s	338.5298	10.79 s	338.5406	10.82 s
338.4885	10.78 s	338.5115	10.73 s	338.5303	10.81 s	338.5409	10.82 s
338.4888	10.79 s	338.5118	10.74 s	338.5306	10.81 s	338.5412	10.81 s
338.4891	10.78 s	338.5121	10.74 s	338.5309	10.81 s	338.5414	10.81 s
338.4897	10.80 s	338.5127	10.72 s	338.5312	10.82 s	338.5449	10.80 s
338.4905	10.79 s	338.5133	10.75 s	338.5315	10.80 s	338.5466	10.82 s
338.4947	10.84 s	338.5136	10.75 s	338.5318	10.80 s	338.5475	10.81 s
338.4953	10.86 s	338.5139	10.76 s	338.5321	10.80 s	338.5479	10.81 s
338.4970	10.79 s	338.5142	10.78 s	338.5324	10.81 s	338.5483	10.81 s
338.4973	10.85 s	338.5180	10.73 s	338.5327	10.80 s	338.5487	10.81 s
338.4979	10.86 s	338.5211	10.79 s	338.5330	10.82 s	338.5491	10.81 s
338.4994	10.84 s	338.5219	10.79 s	338.5335	10.80 s	338.5495	10.81 s
338.5025	10.84 s	338.5227	10.77 s	338.5341	10.82 s	338.5499	10.81 s
338.5030	10.80 s	338.5233	10.78 s	338.5344	10.79 s	338.5503	10.82 s
338.5036	10.82 s	338.5236	10.79 s	338.5347	10.80 s	338.5507	10.80 s
338.5041	10.81 s	338.5239	10.78 s	338.5350	10.81 s	338.5511	10.81 s
338.5046	10.80 s	338.5242	10.77 s	338.5353	10.79 s	338.5515	10.81 s
338.5051	10.78 s	338.5245	10.79 s	338.5356	10.81 s	338.5519	10.82 s
338.5057	10.76 s	338.5248	10.79 s	338.5359	10.80 s	338.5523	10.82 s
338.5063	10.78 s	338.5251	10.79 s	338.5362	10.81 s	338.5527	10.83 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
338.5531	10.84 s	340.4668	11.11 s	340.5020	11.08 s	340.5231	11.09 s
338.5536	10.83 s	340.4680	11.12 s	340.5028	11.08 s	340.5239	11.10 s
338.5540	10.82 s	340.4696	11.12 s	340.5032	11.07 s	340.5247	11.09 s
338.5544	10.81 s	340.4704	11.12 s	340.5037	11.09 s	340.5251	11.08 s
338.5548	10.82 s	340.4709	11.12 s	340.5041	11.10 s	340.5255	11.10 s
338.5552	10.83 s	340.4713	11.11 s	340.5045	11.09 s	340.5260	11.10 s
338.5556	10.81 s	340.4721	11.12 s	340.5049	11.10 s	340.5264	11.11 s
338.5560	10.82 s	340.4733	11.11 s	340.5057	11.09 s	340.5272	11.11 s
338.5564	10.82 s	340.4745	11.11 s	340.5065	11.09 s	340.5284	11.11 s
338.5568	10.83 s	340.4753	11.10 s	340.5069	11.09 s	340.5296	11.13 s
338.5572	10.82 s	340.4757	11.09 s	340.5073	11.11 s	340.5308	11.11 s
338.5576	10.81 s	340.4765	11.09 s	340.5077	11.10 s	340.5320	11.08 s
338.5580	10.81 s	340.4777	11.11 s	340.5081	11.11 s	340.5332	11.10 s
338.5585	10.80 s	340.4786	11.11 s	340.5089	11.10 s	340.5340	11.10 s
338.5589	10.80 s	340.4794	11.10 s	340.5097	11.12 s	340.5349	11.11 s
338.5593	10.80 s	340.4798	11.11 s	340.5101	11.10 s	340.5357	11.10 s
338.5597	10.79 s	340.4802	11.11 s	340.5106	11.11 s	340.5361	11.11 s
338.5605	10.79 s	340.4810	11.12 s	340.5110	11.10 s	340.5369	11.10 s
340.4382	11.08 s	340.4818	11.11 s	340.5114	11.10 s	340.5381	11.11 s
340.4399	11.08 s	340.4822	11.12 s	340.5118	11.11 s	340.5389	11.12 s
340.4417	11.09 s	340.4826	11.11 s	340.5122	11.12 s	340.5393	11.11 s
340.4447	11.09 s	340.4830	11.12 s	340.5126	11.11 s	340.5397	11.12 s
340.4472	11.08 s	340.4838	11.11 s	340.5130	11.09 s	340.5405	11.13 s
340.4494	11.09 s	340.4850	11.12 s	340.5134	11.10 s	340.5418	11.12 s
340.4506	11.07 s	340.4858	11.13 s	340.5138	11.10 s	340.5430	11.13 s
340.4514	11.08 s	340.4862	11.12 s	340.5142	11.11 s	340.5438	11.13 s
340.4518	11.08 s	340.4871	11.11 s	340.5146	11.12 s	340.5442	11.12 s
340.4526	11.09 s	340.4883	11.12 s	340.5150	11.11 s	340.5446	11.12 s
340.4538	11.08 s	340.4895	11.12 s	340.5154	11.10 s	340.5454	11.12 s
340.4546	11.09 s	340.4903	11.12 s	340.5158	11.12 s	340.5462	11.12 s
340.4554	11.08 s	340.4907	11.11 s	340.5162	11.10 s	340.5466	11.12 s
340.4567	11.10 s	340.4911	11.12 s	340.5166	11.11 s	340.5470	11.12 s
340.4575	11.09 s	340.4915	11.11 s	340.5170	11.10 s	340.5474	11.13 s
340.4579	11.09 s	340.4919	11.11 s	340.5174	11.11 s	340.5482	11.12 s
340.4587	11.10 s	340.4923	11.10 s	340.5178	11.11 s	340.5486	11.10 s
340.4599	11.10 s	340.4931	11.10 s	340.5183	11.12 s	340.5494	11.10 s
340.4611	11.11 s	340.4939	11.10 s	340.5187	11.11 s	340.5507	11.10 s
340.4619	11.11 s	340.4944	11.11 s	340.5191	11.10 s	340.5519	11.14 s
340.4623	11.10 s	340.4952	11.09 s	340.5195	11.10 s	340.5527	11.15 s
340.4631	11.10 s	340.4964	11.10 s	340.5199	11.10 s	340.5543	11.08 s
340.4640	11.10 s	340.4976	11.11 s	340.5203	11.11 s	340.5555	11.12 s
340.4644	11.11 s	340.4988	11.11 s	340.5211	11.10 s	340.5567	11.10 s
340.4652	11.12 s	340.4996	11.10 s	340.5219	11.10 s	340.5584	11.09 s
340.4660	11.11 s	340.5004	11.10 s	340.5223	11.10 s	340.5602	11.07 s
340.4664	11.11 s	340.5012	11.09 s	340.5227	11.10 s	340.5616	11.12 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
342.4189	11.11 s	342.4709	11.11 s	342.5016	11.11 s	342.5251	11.12 s
342.4247	11.14 s	342.4717	11.13 s	342.5020	11.12 s	342.5255	11.12 s
342.4251	11.14 s	342.4721	11.11 s	342.5025	11.10 s	342.5259	11.13 s
342.4259	11.18 s	342.4725	11.13 s	342.5029	11.12 s	342.5263	11.11 s
342.4278	11.18 s	342.4729	11.12 s	342.5033	11.12 s	342.5271	11.11 s
342.4296	11.15 s	342.4733	11.12 s	342.5038	11.11 s	342.5279	11.12 s
342.4340	11.09 s	342.4737	11.12 s	342.5042	11.10 s	342.5283	11.13 s
342.4348	11.11 s	342.4745	11.14 s	342.5046	11.09 s	342.5291	11.14 s
342.4352	11.06 s	342.4753	11.14 s	342.5050	11.10 s	342.5299	11.15 s
342.4352	11.08 s	342.4762	11.14 s	342.5054	11.08 s	342.5303	11.15 s
342.4356	11.06 s	342.4770	11.16 s	342.5058	11.10 s	342.5307	11.13 s
342.4364	11.07 s	342.4774	11.16 s	342.5067	11.11 s	342.5316	11.14 s
342.4377	11.10 s	342.4778	11.17 s	342.5075	11.10 s	342.5324	11.14 s
342.4385	11.06 s	342.4782	11.16 s	342.5079	11.10 s	342.5328	11.17 s
342.4389	11.03 s	342.4790	11.17 s	342.5083	11.11 s	342.5332	11.17 s
342.4393	11.08 s	342.4798	11.15 s	342.5087	11.11 s	342.5340	11.17 s
342.4413	11.06 s	342.4802	11.17 s	342.5091	11.10 s	342.5348	11.18 s
342.4433	11.12 s	342.4806	11.17 s	342.5095	11.11 s	342.5352	11.17 s
342.4445	11.16 s	342.4810	11.13 s	342.5100	11.11 s	342.5356	11.16 s
342.4447	11.11 s	342.4814	11.17 s	342.5108	11.11 s	342.5360	11.17 s
342.4458	11.06 s	342.4818	11.18 s	342.5116	11.11 s	342.5364	11.16 s
342.4486	11.07 s	342.4826	11.15 s	342.5120	11.12 s	342.5368	11.16 s
342.4498	11.12 s	342.4839	11.12 s	342.5124	11.11 s	342.5376	11.16 s
342.4526	11.11 s	342.4847	11.15 s	342.5132	11.10 s	342.5384	11.16 s
342.4551	11.08 s	342.4851	11.17 s	342.5145	11.10 s	342.5389	11.16 s
342.4559	11.13 s	342.4855	11.12 s	342.5157	11.10 s	342.5393	11.15 s
342.4563	11.10 s	342.4859	11.12 s	342.5165	11.08 s	342.5397	11.14 s
342.4567	11.11 s	342.4863	11.12 s	342.5169	11.09 s	342.5401	11.14 s
342.4571	11.13 s	342.4871	11.11 s	342.5174	11.09 s	342.5405	11.12 s
342.4575	11.10 s	342.4879	11.11 s	342.5178	11.09 s	342.5409	11.12 s
342.4579	11.09 s	342.4887	11.11 s	342.5182	11.11 s	342.5413	11.10 s
342.4583	11.11 s	342.4896	11.13 s	342.5186	11.10 s	342.5421	11.11 s
342.4587	11.11 s	342.4900	11.13 s	342.5190	11.12 s	342.5429	11.12 s
342.4595	11.15 s	342.4904	11.14 s	342.5194	11.10 s	342.5433	11.12 s
342.4607	11.14 s	342.4908	11.15 s	342.5198	11.12 s	342.5437	11.12 s
342.4624	11.11 s	342.4912	11.15 s	342.5202	11.12 s	342.5441	11.12 s
342.4640	11.11 s	342.4920	11.14 s	342.5206	11.12 s	342.5445	11.11 s
342.4652	11.12 s	342.4928	11.12 s	342.5210	11.12 s	342.5449	11.11 s
342.4660	11.13 s	342.4932	11.10 s	342.5214	11.10 s	342.5453	11.11 s
342.4664	11.10 s	342.4936	11.10 s	342.5218	11.11 s	342.5457	11.11 s
342.4672	11.09 s	342.4955	11.10 s	342.5222	11.10 s	342.5461	11.12 s
342.4685	11.12 s	342.4974	11.08 s	342.5226	11.10 s	342.5470	11.12 s
342.4693	11.10 s	342.5000	11.11 s	342.5235	11.12 s	342.5478	11.12 s
342.4697	11.10 s	342.5008	11.10 s	342.5243	11.12 s	342.5482	11.10 s
342.4701	11.12 s	342.5012	11.10 s	342.5247	11.11 s	342.5486	11.11 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
342.5490	11.11 s	346.4069	11.35 s	346.4341	11.39 s	350.3918	14.32 s
342.5498	11.09 s	346.4073	11.35 s	346.4347	11.39 s	350.3924	14.35 s
342.5506	11.10 s	346.4077	11.35 s	346.4353	11.39 s	350.3930	14.28 s
342.5510	11.12 s	346.4082	11.35 s	346.4359	11.39 s	350.3965	14.31 s
342.5514	11.12 s	346.4086	11.33 s	346.4365	11.40 s	350.3976	14.30 s
342.5522	11.12 s	346.4090	11.31 s	346.4370	11.39 s	350.3999	14.31 s
342.5530	11.11 s	346.4094	11.34 s	346.4376	11.37 s	350.4009	14.35 s
342.5538	11.10 s	346.4098	11.32 s	346.4382	11.38 s	350.4045	14.41 s
342.5546	11.12 s	346.4102	11.33 s	346.4388	11.40 s	350.4057	14.48 s
342.5555	11.12 s	346.4106	11.33 s	346.4394	11.40 s	350.4088	14.42 s
342.5563	11.14 s	346.4110	11.34 s	346.4399	11.40 s	350.4096	14.40 s
342.5567	11.14 s	346.4114	11.32 s	346.4405	11.38 s	350.4186	14.25 s
342.5571	11.14 s	346.4118	11.35 s	346.4411	11.40 s	350.4239	14.22 s
342.5575	11.14 s	346.4122	11.34 s	346.4417	11.40 s	350.4246	14.20 s
342.5579	11.14 s	346.4126	11.34 s	346.4422	11.38 s	350.4254	14.18 s
342.5583	11.14 s	346.4130	11.35 s	346.4428	11.39 s	350.4262	14.21 s
342.5587	11.13 s	346.4134	11.35 s	346.4434	11.42 s	350.4269	14.16 s
342.5591	11.14 s	346.4138	11.37 s	346.4440	11.40 s	350.4277	14.19 s
342.5595	11.12 s	346.4146	11.31 s	346.4451	11.30 s	350.4284	14.20 s
342.5599	11.13 s	346.4159	11.34 s	346.4469	11.49 s	350.4292	14.22 s
342.5603	11.14 s	346.4167	11.27 s	346.4486	11.30 s	350.4299	14.27 s
342.5607	11.15 s	346.4171	11.38 s	346.4503	11.33 s	350.4307	14.22 s
342.5615	11.14 s	346.4175	11.35 s	346.4521	11.24 s	350.4314	14.21 s
342.5623	11.11 s	346.4179	11.40 s	346.4544	11.38 s	350.4322	14.17 s
342.5628	11.10 s	346.4187	11.31 s	346.4561	11.32 s	350.4329	14.18 s
342.5632	11.10 s	346.4195	11.31 s	346.4579	11.39 s	350.4337	14.17 s
342.5636	11.10 s	346.4199	11.32 s	346.4596	11.40 s	350.4344	14.19 s
342.5640	11.12 s	346.4207	11.28 s	346.4613	11.28 s	350.4359	14.18 s
342.5644	11.14 s	346.4215	11.38 s	346.4723	11.27 s	350.4374	14.19 s
342.5648	11.15 s	346.4219	11.36 s	346.4735	11.25 s	350.4382	14.15 s
342.5652	11.15 s	346.4228	11.29 s	346.4741	11.33 s	350.4389	14.15 s
342.5660	11.14 s	346.4243	11.34 s	346.4747	11.33 s	350.4397	14.13 s
342.5668	11.14 s	346.4255	11.33 s	346.4753	11.30 s	350.4412	14.13 s
342.5672	11.16 s	346.4260	11.36 s	346.4758	11.38 s	350.4427	14.08 s
342.5676	11.14 s	346.4266	11.39 s	346.4764	11.27 s	350.4435	14.02 s
342.5684	11.13 s	346.4272	11.35 s	346.4770	11.29 s	350.4442	14.09 s
342.5696	11.13 s	346.4278	11.40 s	346.4776	11.33 s	350.4450	14.17 s
342.5709	11.13 s	346.4284	11.36 s	346.4781	11.31 s	350.4457	14.23 s
346.4030	11.37 s	346.4289	11.33 s	346.4787	11.33 s	350.4465	14.28 s
346.4036	11.40 s	346.4295	11.33 s	346.4793	11.33 s	350.4480	14.27 s
346.4047	11.36 s	346.4307	11.36 s	346.4799	11.32 s	350.4495	14.34 s
346.4053	11.34 s	346.4318	11.37 s	346.4815	11.30 s	350.4502	14.34 s
346.4057	11.36 s	346.4324	11.38 s	346.4833	11.34 s	350.4510	14.30 s
346.4061	11.35 s	346.4330	11.37 s	350.3902	14.29 s	350.4517	14.29 s
346.4065	11.36 s	346.4336	11.38 s	350.3912	14.27 s	350.4525	14.35 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
350.4532	14.34 s	353.5291	14.67 s	354.3813	14.69 s	354.4485	14.70 s
350.4585	14.43 s	353.5306	14.66 s	354.3822	14.72 s	354.4500	14.77 s
350.4600	14.41 s	353.5312	14.64 s	354.3866	14.68 s	354.4515	14.76 s
350.4623	14.42 s	353.5318	14.65 s	354.3883	14.69 s	354.4523	14.77 s
350.4638	14.40 s	353.5324	14.67 s	354.3907	14.69 s	354.4538	14.79 s
350.4645	14.39 s	353.5330	14.67 s	354.3924	14.75 s	354.4553	14.79 s
350.4653	14.40 s	353.5335	14.64 s	354.3936	14.76 s	354.4561	14.81 s
350.4660	14.36 s	353.5347	14.65 s	354.3941	14.75 s	354.4568	14.81 s
350.4675	14.43 s	353.5364	14.59 s	354.3953	14.74 s	354.4576	14.85 s
350.4683	14.45 s	353.5376	14.61 s	354.3980	14.72 s	354.4583	14.88 s
350.4698	14.44 s	353.5382	14.63 s	354.3997	14.74 s	354.4591	14.85 s
350.4713	14.36 s	353.5388	14.63 s	354.4015	14.77 s	354.4598	14.85 s
350.4720	14.31 s	353.5393	14.62 s	354.4032	14.85 s	354.4606	14.84 s
350.4751	14.29 s	353.5399	14.64 s	354.4047	14.86 s	354.4618	14.82 s
350.4784	14.26 s	353.5405	14.68 s	354.4061	14.89 s	354.4636	14.84 s
350.4886	14.22 s	353.5411	14.70 s	354.4073	14.90 s	354.4656	14.81 s
350.4908	14.24 s	353.5417	14.77 s	354.4084	14.93 s	354.4673	14.84 s
350.4957	14.24 s	353.5428	14.72 s	354.4096	14.93 s	354.4688	14.88 s
350.4995	14.29 s	353.5440	14.75 s	354.4102	14.95 s	354.4696	14.91 s
350.5017	14.28 s	353.5445	14.64 s	354.4107	14.92 s	354.4703	14.94 s
350.5093	14.34 s	353.5451	14.58 s	354.4119	14.97 s	354.4711	15.01 s
350.5115	14.36 s	353.5457	14.58 s	354.4136	14.94 s	354.4719	15.01 s
350.5130	14.34 s	353.5469	14.59 s	354.4154	14.96 s	354.4726	15.01 s
350.5160	14.35 s	353.5486	14.58 s	354.4165	14.94 s	354.4734	14.95 s
350.5205	14.32 s	353.5498	14.51 s	354.4177	14.94 s	354.4749	14.95 s
350.5213	14.33 s	353.5503	14.44 s	354.4194	14.95 s	354.4764	14.93 s
350.5239	14.28 s	353.5509	14.44 s	354.4209	14.92 s	354.4771	14.90 s
350.5281	14.29 s	353.5515	14.47 s	354.4223	14.87 s	354.4779	14.83 s
350.5296	14.30 s	353.5521	14.49 s	354.4240	14.80 s	354.4786	14.89 s
350.5303	14.25 s	353.5526	14.48 s	354.4252	14.79 s	354.4794	14.91 s
350.5409	14.21 s	353.5532	14.46 s	354.4258	14.76 s	354.4801	14.86 s
350.5416	14.21 s	353.5538	14.44 s	354.4269	14.77 s	354.4809	14.85 s
350.5424	14.21 s	353.5544	14.46 s	354.4281	14.78 s	354.4816	14.77 s
350.5439	14.17 s	353.5550	14.47 s	354.4287	14.78 s	354.4824	14.77 s
350.5461	14.26 s	353.5561	14.47 s	354.4298	14.73 s	354.4831	14.79 s
350.5484	14.22 s	353.5579	14.52 s	354.4310	14.67 s	354.4839	14.79 s
353.5190	14.59 s	353.5596	14.60 s	354.4321	14.70 s	354.4846	14.78 s
353.5196	14.59 s	353.5613	14.59 s	354.4353	14.71 s	354.4854	14.77 s
353.5202	14.60 s	353.5631	14.57 s	354.4401	14.71 s	354.4861	14.79 s
353.5208	14.59 s	353.5648	14.56 s	354.4423	14.70 s	354.4869	14.75 s
353.5214	14.53 s	353.5660	14.49 s	354.4434	14.73 s	354.4877	14.74 s
353.5219	14.52 s	353.5673	14.50 s	354.4452	14.67 s	354.4884	14.75 s
353.5225	14.56 s	353.5690	14.51 s	354.4463	14.75 s	354.4892	14.73 s
353.5231	14.64 s	353.5713	14.60 s	354.4469	14.74 s	354.4899	14.74 s
353.5252	14.66 s	353.5731	14.57 s	354.4478	14.71 s	354.4914	14.71 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
354.4929	14.73 s	354.5298	14.87 s	357.4931	15.08 s	358.4158	15.22 s
354.4944	14.72 s	354.5305	14.88 s	357.4952	14.94 s	358.4180	15.21 s
354.4959	14.72 s	354.5313	14.87 s	357.4952	14.94 s	358.4202	15.25 s
354.4974	14.73 s	354.5320	14.86 s	357.5011	14.87 s	358.4224	15.20 s
354.4989	14.75 s	354.5335	14.84 s	357.5034	14.82 s	358.4235	15.17 s
354.4997	14.75 s	354.5350	14.84 s	357.5056	14.84 s	358.4246	15.16 s
354.5004	14.75 s	354.5358	14.79 s	357.5079	14.91 s	358.4268	15.02 s
354.5012	14.77 s	354.5366	14.80 s	357.5101	14.86 s	358.4301	15.06 s
354.5019	14.79 s	354.5373	14.80 s	357.5124	14.84 s	358.4334	15.03 s
354.5027	14.77 s	354.5381	14.84 s	357.5146	14.76 s	358.4367	14.99 s
354.5035	14.70 s	354.5388	14.88 s	357.5169	14.72 s	358.4400	14.94 s
354.5042	14.73 s	354.5396	14.85 s	357.5192	14.78 s	358.4433	14.91 s
354.5050	14.79 s	354.5403	14.88 s	357.5214	14.82 s	358.4466	14.88 s
354.5057	14.83 s	354.5411	14.89 s	357.5237	14.78 s	358.4488	14.80 s
354.5065	14.80 s	354.5418	14.87 s	357.5259	14.82 s	358.4532	14.87 s
354.5072	14.82 s	354.5426	14.82 s	357.5282	14.90 s	358.4565	15.03 s
354.5080	14.82 s	354.5433	14.80 s	357.5304	14.89 s	358.4598	15.05 s
354.5087	14.89 s	354.5441	14.76 s	357.5327	14.85 s	358.4631	15.08 s
354.5095	14.87 s	354.5448	14.80 s	357.5350	14.80 s	358.4664	15.11 s
354.5102	14.88 s	354.5456	14.75 s	357.5372	14.93 s	358.4697	15.16 s
354.5110	14.87 s	354.5463	14.76 s	357.5395	14.90 s	358.4728	15.16 s
354.5117	14.89 s	354.5471	14.75 s	357.5417	14.96 s	358.4752	15.15 s
354.5125	14.91 s	354.5478	14.72 s	357.5440	14.94 s	358.4789	15.15 s
354.5132	14.96 s	354.5493	14.85 s	357.5462	14.93 s	358.4816	15.13 s
354.5140	14.95 s	354.5516	14.81 s	357.5485	14.87 s	358.4827	15.13 s
354.5147	14.95 s	354.5524	14.81 s	357.5508	14.85 s	358.4838	15.14 s
354.5155	14.97 s	354.5531	14.79 s	357.5530	14.76 s	358.4849	15.10 s
354.5162	15.00 s	354.5539	14.77 s	357.5553	14.88 s	358.4860	15.08 s
354.5170	15.06 s	354.5554	14.81 s	357.5575	14.88 s	358.4871	15.06 s
354.5177	14.98 s	354.5569	14.81 s	357.5598	14.76 s	358.4882	15.01 s
354.5185	15.00 s	354.5584	14.83 s	357.5620	14.86 s	358.4904	15.00 s
354.5192	15.01 s	354.5599	14.84 s	357.5643	14.89 s	358.4937	14.95 s
354.5200	14.99 s	354.5606	14.79 s	357.5666	14.83 s	358.4970	15.00 s
354.5208	15.00 s	354.5621	14.80 s	358.4000	15.13 s	358.4992	15.02 s
354.5215	15.00 s	354.5636	14.74 s	358.4014	15.21 s	358.5003	15.01 s
354.5223	15.00 s	354.5644	14.79 s	358.4032	15.26 s	358.5025	14.95 s
354.5230	15.03 s	354.5652	14.80 s	358.4048	15.24 s	358.5047	14.99 s
354.5238	15.06 s	354.5666	14.82 s	358.4059	15.27 s	358.5058	15.00 s
354.5245	15.04 s	354.5682	14.93 s	358.4070	15.28 s	358.5069	14.98 s
354.5253	15.02 s	354.5697	14.90 s	358.4081	15.24 s	358.5080	15.00 s
354.5260	15.00 s	354.5719	14.77 s	358.4092	15.27 s	358.5091	15.01 s
354.5268	14.94 s	357.4810	14.98 s	358.4103	15.29 s	358.5102	15.05 s
354.5275	14.91 s	357.4837	15.01 s	358.4114	15.31 s	358.5113	15.05 s
354.5283	14.92 s	357.4860	14.97 s	358.4125	15.32 s	358.5124	15.03 s
354.5290	14.89 s	357.4892	15.03 s	358.4136	15.28 s	358.5135	15.03 s

Table 6. Continued.

JD*	*V*	JD*	*V*	JD*	*V*	JD*	*V*
358.5146	15.03 s	380.4585	15.45 s	381.4667	15.78 s	382.4845	15.91 s
358.5157	15.04 s	380.4621	15.56 s	381.4696	15.82 s	382.4899	15.92 s
358.5168	15.07 s	380.4639	15.60 s	381.4711	15.82 s	382.4953	15.87 s
358.5179	15.10 s	380.4656	15.64 s	381.4725	15.84 s	382.5007	15.87 s
358.5201	15.05 s	380.4692	15.77 s	381.4740	15.84 s	383.3503	15.84 s
358.5234	14.99 s	380.4746	15.91 s	381.4766	15.83 s	383.3521	15.79 s
358.5256	15.06 s	380.4800	15.85 s	381.4786	15.81 s	383.3539	15.83 s
358.5267	15.08 s	380.4854	15.75 s	381.4815	15.76 s	383.3557	15.88 s
358.5278	15.06 s	380.4908	15.70 s	381.4858	15.71 s	383.3593	15.97 s
358.5289	15.05 s	380.4961	15.78 s	381.4902	15.71 s	383.3647	15.94 s
358.5300	15.09 s	380.4997	15.78 s	381.4930	15.76 s	383.3701	15.99 s
358.5311	15.09 s	380.5015	15.82 s	381.4945	15.76 s	383.3736	16.02 s
358.5322	15.05 s	380.5033	15.87 s	381.4974	15.78 s	383.3754	16.03 s
358.5333	15.10 s	380.5069	15.82 s	381.5017	15.87 s	383.3790	15.98 s
358.5344	15.10 s	380.5123	16.04 s	381.5061	15.84 s	383.3844	16.09 s
358.5355	15.08 s	380.5177	15.99 s	381.5090	15.77 s	383.4011	16.13 s
358.5366	15.08 s	380.5248	15.90 s	381.5119	15.62 s	383.4041	16.06 s
358.5377	15.00 s	381.3617	15.94 s	381.5176	15.80 s	383.4059	15.98 s
358.5388	14.98 s	381.3653	15.92 s	381.5234	15.87 s	383.4095	15.87 s
358.5410	14.96 s	381.3671	15.91 s	381.5278	15.86 s	383.4149	15.86 s
358.5432	14.99 s	381.3726	15.84 s	381.5336	15.70 s	383.4203	15.99 s
358.5454	14.91 s	381.3780	15.81 s	381.5393	15.87 s	383.4239	16.04 s
358.5487	14.95 s	381.3841	15.83 s	381.5437	15.89 s	383.4257	15.99 s
358.5509	14.91 s	381.3877	15.79 s	381.5480	15.89 s	383.4275	16.05 s
358.5520	14.97 s	381.3894	15.80 s	381.5524	15.78 s	383.4293	16.00 s
358.5531	14.95 s	381.3912	15.82 s	381.5582	15.78 s	383.4328	15.96 s
358.5542	14.97 s	381.3948	15.85 s	381.5611	15.84 s	383.4388	15.99 s
358.5564	14.96 s	381.3991	15.86 s	381.5658	15.82 s	383.4450	16.10 s
358.5597	14.94 s	381.4033	15.84 s	382.3746	16.28 s	383.4515	16.10 s
358.5630	15.02 s	381.4088	15.81 s	382.3977	15.77 s	383.4551	16.05 s
358.5663	14.95 s	381.4132	15.81 s	382.3995	15.79 s	383.4569	16.03 s
358.5701	15.09 s	381.4161	15.83 s	382.4013	15.71 s	383.4587	16.05 s
380.3695	15.93 s	381.4175	15.87 s	382.4031	15.75 s	383.4605	16.06 s
380.3722	15.88 s	381.4190	15.86 s	382.4057	15.89 s	383.4623	16.00 s
380.3761	15.79 s	381.4219	15.80 s	382.4479	16.07 s	383.4640	15.99 s
380.3780	15.81 s	381.4262	15.73 s	382.4515	16.09 s	383.4658	15.98 s
380.3813	15.79 s	381.4306	15.76 s	382.4551	16.11 s	383.4676	16.10 s
380.3831	15.75 s	381.4349	15.75 s	382.4587	16.00 s	383.4694	16.10 s
380.3867	15.67 s	381.4392	15.76 s	382.4623	15.98 s	383.4712	16.13 s
380.3921	15.65 s	381.4436	15.76 s	382.4658	15.91 s	383.4730	16.10 s
380.3957	15.59 s	381.4479	15.79 s	382.4694	15.92 s	383.4748	16.14 s
380.4028	15.78 s	381.4523	15.79 s	382.4712	15.79 s	383.4766	16.16 s
380.4333	15.61 s	381.4566	15.72 s	382.4730	15.78 s	383.4784	16.18 s
380.4477	15.58 s	381.4609	15.77 s	382.4755	15.78 s	383.4802	16.17 s
380.4531	15.60 s	381.4638	15.76 s	382.4791	15.76 s	383.4820	16.16 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
383.4838	16.10 s	385.5575	15.97 s	387.4779	16.18 s	388.4306	15.96 s
383.4856	16.06 s	385.5611	16.06 s	387.4794	16.20 s	388.4343	15.99 s
383.4874	16.07 s	385.5629	16.06 s	387.4808	16.19 s	388.4381	15.96 s
383.4892	16.00 s	385.5647	15.91 s	387.4823	16.16 s	388.4418	15.97 s
383.4910	15.98 s	385.5665	15.83 s	387.4852	16.20 s	388.4456	15.93 s
383.4928	16.04 s	385.5683	15.68 s	387.4881	16.20 s	388.4493	15.86 s
383.4946	16.04 s	385.5701	15.82 s	387.4895	16.23 s	388.4531	15.83 s
383.4963	16.14 s	385.5719	16.04 s	387.4909	16.17 s	388.4568	15.78 s
383.4981	16.12 s	385.5737	16.09 s	387.4924	16.15 s	388.4624	15.84 s
383.4999	16.11 s	385.5755	15.87 s	387.4953	16.13 s	388.4670	15.79 s
383.5053	16.05 s	387.3635	16.01 s	387.5024	16.24 s	388.4805	15.74 s
383.5107	16.11 s	387.3653	16.07 s	387.5053	16.24 s	388.4880	15.78 s
385.4654	16.07 s	387.3671	16.13 s	387.5068	16.29 s	388.4918	15.82 s
385.4683	16.08 s	387.3689	16.14 s	387.5082	16.26 s	388.4955	15.83 s
385.4701	16.13 s	387.3707	16.12 s	387.5109	16.10 s	388.4993	15.82 s
385.4729	16.18 s	387.3744	16.11 s	387.5135	16.14 s	388.5030	15.79 s
385.4756	16.18 s	387.3776	16.13 s	387.5182	16.15 s	388.5135	15.72 s
385.4774	16.10 s	387.3803	16.12 s	387.5225	16.19 s	388.5306	15.58 s
385.4792	16.14 s	387.3835	16.07 s	387.5254	16.18 s	388.5374	15.87 s
385.4809	16.06 s	387.3863	16.05 s	387.5283	16.21 s	388.5408	15.82 s
385.4827	16.01 s	387.3895	16.15 s	387.5326	16.21 s	388.5442	15.89 s
385.4845	16.09 s	387.3922	16.23 s	387.5370	16.14 s	388.5476	15.94 s
385.4863	16.10 s	387.3954	16.26 s	387.5399	16.14 s	388.5510	15.89 s
385.4881	16.00 s	387.3981	16.23 s	387.5428	16.02 s	388.5544	15.86 s
385.4917	15.95 s	387.4013	16.24 s	387.5471	16.09 s	388.5578	15.85 s
385.4953	15.97 s	387.4040	16.11 s	387.5514	16.14 s	388.5612	15.83 s
385.4989	16.02 s	387.4072	16.03 s	388.3614	15.78 s	388.5646	15.84 s
385.5025	16.07 s	387.4131	16.09 s	388.3628	15.82 s	388.5692	15.89 s
385.5061	15.98 s	387.4190	16.11 s	388.3668	15.84 s	388.5714	16.04 s
385.5096	16.00 s	387.4217	16.13 s	388.3705	15.86 s	388.5758	15.88 s
385.5114	16.04 s	387.4276	16.18 s	388.3743	15.84 s	389.3996	16.06 s
385.5151	16.10 s	387.4336	16.21 s	388.3780	15.90 s	389.4039	15.99 s
385.5203	16.17 s	387.4369	16.13 s	388.3818	15.86 s	389.4095	16.01 s
385.5252	16.04 s	387.4456	16.13 s	388.3855	15.89 s	389.4133	16.01 s
385.5288	16.04 s	387.4475	16.18 s	388.3893	15.83 s	389.4170	15.95 s
385.5324	16.08 s	387.4504	16.19 s	388.3930	15.76 s	389.4208	15.99 s
385.5360	16.04 s	387.4548	16.20 s	388.3968	15.74 s	389.4283	16.00 s
385.5378	16.08 s	387.4591	16.19 s	388.4005	15.77 s	389.4358	15.87 s
385.5396	16.07 s	387.4620	16.18 s	388.4043	15.77 s	389.4396	15.89 s
385.5414	16.08 s	387.4635	16.18 s	388.4080	15.76 s	389.4474	15.86 s
385.5432	16.04 s	387.4664	16.15 s	388.4118	15.79 s	389.4549	15.85 s
385.5468	16.00 s	387.4692	16.11 s	388.4155	15.77 s	389.4587	15.83 s
385.5503	15.89 s	387.4707	16.09 s	388.4193	15.80 s	389.4624	15.79 s
385.5521	15.98 s	387.4721	16.10 s	388.4230	15.79 s	389.4662	15.69 s
385.5539	16.00 s	387.4750	16.18 s	388.4268	15.89 s	389.4699	15.50 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
389.4737	15.70 s	390.5335	15.82 s	434.4124	16.06 s	454.3752	15.92 a
389.4774	15.80 s	390.5410	15.74 s	434.4229	15.97 s	454.3777	15.91 a
389.4812	15.84 s	390.5523	15.74 s	434.4281	16.07 s	454.3802	15.99 a
389.4887	15.82 s	390.5635	15.78 s	434.4334	15.98 s	454.3827	16.07 a
389.4962	15.68 s	390.5728	15.78 s	434.4386	15.88 s	454.3852	15.99 a
389.5000	15.71 s	391.5017	15.79 s	434.4439	15.91 s	454.3877	16.04 a
389.5037	15.77 s	391.5129	15.82 s	434.4528	15.90 s	454.3908	15.97 a
389.5127	15.84 s	391.5204	15.91 s	434.4580	16.04 s	454.3933	16.02 a
389.5202	15.88 s	391.5242	15.91 s	434.4633	16.02 s	454.3958	16.03 a
389.5240	15.90 s	391.5279	15.91 s	434.4685	16.00 s	454.3983	16.06 a
389.5277	15.90 s	391.5317	16.01 s	434.4738	15.95 s	454.4008	15.97 a
389.5315	15.90 s	391.5355	16.00 s	434.4790	15.89 s	454.4033	15.94 a
389.5427	15.90 s	391.5430	15.90 s	434.4843	16.03 s	454.4058	15.94 a
389.5502	15.86 s	391.5505	15.93 s	434.4895	16.04 s	454.4083	16.02 a
389.5577	15.81 s	391.5542	15.90 s	434.4948	15.97 s	454.4108	15.97 a
389.5663	15.77 s	391.5580	15.93 s	434.5000	15.93 s	454.4134	16.07 a
389.5696	15.73 s	391.5617	15.95 s	434.5053	16.03 s	455.3923	16.09 a
389.5729	15.78 s	399.3941	15.85 s	434.5107	16.07 s	455.3985	16.11 a
390.3451	15.89 s	399.4030	15.93 s	434.5144	16.08 s	455.4023	16.05 a
390.3562	15.90 s	399.4068	15.93 s	434.5182	16.01 s	455.4108	15.92 a
390.3650	15.89 s	399.4105	15.93 s	434.5219	15.96 s	455.4183	15.89 a
390.3688	15.97 s	399.4143	15.95 s	434.5257	15.92 s	455.4233	15.97 a
390.3763	15.92 s	399.4180	15.92 s	434.5295	15.97 s	455.4283	16.02 a
390.3801	15.85 s	399.4256	15.91 s	434.5332	16.00 s	455.4333	16.07 a
390.3876	15.83 s	399.4368	15.84 s	434.5370	15.92 s	455.4439	16.11 a
390.3951	15.90 s	399.4443	15.89 s	434.5407	16.12 s	455.4489	16.30 a
390.3988	15.96 s	399.4518	15.91 s	438.3894	16.19 s	455.4514	16.29 a
390.4026	15.95 s	399.4593	15.84 s	438.3969	16.16 s	455.4564	16.30 a
390.4101	16.03 s	399.4631	15.85 s	438.4007	16.22 s	455.4614	16.33 a
390.4214	16.01 s	399.4724	15.97 s	438.4044	16.21 s	459.2637	16.20 a
390.4326	16.02 s	399.4836	16.00 s	438.4082	16.23 s	459.2699	16.11 a
390.4364	15.98 s	399.4949	16.01 s	438.4157	16.14 s	459.2759	16.16 a
390.4439	15.99 s	399.5024	15.88 s	438.4232	16.12 s	459.2815	16.21 a
390.4551	16.05 s	399.5061	15.86 s	438.4269	16.11 s	459.2844	16.25 a
390.4664	16.04 s	399.5099	15.85 s	454.3438	16.08 a	459.2872	16.23 a
390.4739	16.04 s	399.5174	15.99 s	454.3479	16.08 a	459.2901	16.26 a
390.4776	16.07 s	399.5286	16.01 s	454.3517	16.07 a	459.2958	16.21 a
390.4814	16.01 s	399.5362	15.94 s	454.3544	16.07 a	459.3015	16.27 a
390.4930	15.91 s	399.5399	15.93 s	454.3575	16.09 a	459.3043	16.22 a
390.4984	15.90 s	399.5474	15.93 s	454.3601	15.98 a	459.3076	16.15 a
390.5012	15.95 s	399.5549	15.82 s	454.3626	16.04 a	459.3105	16.17 a
390.5065	15.90 s	399.5587	15.82 s	454.3651	15.99 a	459.3133	16.21 a
390.5130	15.87 s	399.5624	15.86 s	454.3676	15.92 a	459.3162	16.16 a
390.5222	15.81 s	399.5699	15.82 s	454.3701	15.91 a	459.3190	16.27 a
390.5297	15.80 s	399.5801	15.74 s	454.3727	15.85 a	459.3219	16.18 a

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
459.3247	16.16 a	464.3467	16.31 a	482.2476	16.28 s	484.2555	16.37 s
459.3276	16.12 a	464.3491	16.26 a	482.2517	16.25 s	484.2584	16.33 s
459.3304	16.17 a	464.3516	16.30 a	482.2559	16.20 s	484.2598	16.24 s
459.3333	16.18 a	464.3541	16.40 a	482.2599	16.28 s	484.2613	16.28 s
459.3362	16.24 a	464.3574	16.37 a	482.2640	16.36 s	484.2642	16.29 s
459.3391	16.35 a	464.3600	16.31 a	482.2681	16.32 s	484.2671	16.31 s
463.2818	16.10 a	464.3625	16.34 a	482.2722	16.29 s	484.2685	16.32 s
463.2877	16.14 a	464.3650	16.37 a	482.2763	16.25 s	484.2714	16.28 s
463.2937	16.27 a	464.3675	16.27 a	482.2804	16.38 s	484.2743	16.27 s
463.2972	16.27 a	464.3699	16.33 a	482.2845	16.35 s	484.2758	16.30 s
463.2992	16.27 a	464.3724	16.31 a	482.2886	16.27 s	484.2787	16.31 s
463.3022	16.31 a	464.3749	16.39 a	482.2927	16.21 s	484.2815	16.33 s
463.3052	16.21 a	464.3799	16.41 a	482.2968	16.32 s	484.2830	16.30 s
463.3083	16.27 a	464.3874	16.33 a	482.3009	16.31 s	484.2844	16.32 s
463.3113	16.26 a	464.3974	16.31 a	482.3050	16.24 s	484.2873	16.31 s
463.3174	16.29 a	464.3999	16.30 a	482.3091	16.30 s	484.2917	16.33 s
463.3242	16.20 a	464.4024	16.23 a	482.3132	16.15 s	484.2960	16.28 s
463.3267	16.20 a	464.4049	16.25 a	482.3173	16.18 s	484.3000	16.27 s
463.3292	16.14 a	464.4074	16.20 a	482.3275	16.21 s	484.3032	16.31 s
463.3322	16.17 a	464.4099	16.23 a	482.3358	16.20 s	484.3061	16.36 s
463.3347	16.15 a	464.4125	16.32 a	482.3399	16.29 s	484.3090	16.37 s
463.3372	16.22 a	464.4150	16.28 a	482.3440	16.31 s	484.3119	16.36 s
463.3397	16.31 a	464.4175	16.38 a	482.3481	16.34 s	484.3148	16.29 s
463.3422	16.31 a	464.4200	16.41 a	482.3522	16.20 s	484.3192	16.30 s
463.3447	16.36 a	468.3448	16.24 a	482.3563	16.20 s	484.3235	16.26 s
463.3472	16.35 a	468.3505	16.31 a	482.3604	16.18 s	484.3333	16.36 s
463.3497	16.31 a	468.3563	16.33 a	482.3645	16.25 s	484.3383	16.36 s
463.3521	16.35 a	468.3675	16.25 a	482.3686	16.15 s	484.3420	16.36 s
463.3546	16.34 a	468.3725	16.29 a	482.3727	16.24 s	484.3458	16.31 s
463.3596	16.40 a	468.3750	16.22 a	482.3768	16.26 s	484.3495	16.30 s
463.3651	16.30 a	468.3800	16.21 a	482.3809	16.36 s	484.3570	16.31 s
464.3116	16.26 a	468.3849	16.18 a	482.3850	16.29 s	484.3683	16.27 s
464.3143	16.22 a	468.3874	16.21 a	482.3891	16.33 s	484.3795	16.30 s
464.3168	16.29 a	468.3924	16.27 a	482.3932	16.34 s	484.3908	16.32 s
464.3196	16.25 a	468.3974	16.24 a	482.3973	16.34 s	484.4021	16.32 s
464.3218	16.27 a	468.4003	16.28 a	484.2208	16.21 s	484.4133	16.36 s
464.3242	16.37 a	468.4028	16.35 a	484.2237	16.18 s	484.4246	16.33 s
464.3267	16.34 a	468.4053	16.30 a	484.2251	16.19 s	484.4358	16.32 s
464.3292	16.31 a	468.4078	16.35 a	484.2280	16.31 s	491.2367	16.29 s
464.3317	16.31 a	468.4103	16.40 a	484.2309	16.41 s	491.2421	16.14 s
464.3342	16.27 a	468.4128	16.36 a	484.2338	16.32 s	491.2456	16.13 s
464.3367	16.26 a	468.4153	16.40 a	484.2381	16.32 s	491.2546	16.32 s
464.3392	16.26 a	468.4177	16.40 a	484.2425	16.30 s	491.2654	16.20 s
464.3417	16.26 a	468.4202	16.37 a	484.2468	16.25 s	491.2726	16.20 s
464.3442	16.33 a	468.4228	16.34 a	484.2512	16.28 s	491.2869	16.20 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
491.3414	16.25 s	509.1920	16.62 v	511.1629	16.31 v	511.2209	16.18 v
491.3596	16.36 s	509.1935	16.55 v	511.1651	16.34 v	511.2219	16.21 v
491.3649	16.34 s	509.1950	16.56 v	511.1672	16.32 v	511.2230	16.25 v
491.3685	16.30 s	509.1964	16.55 v	511.1683	16.30 v	511.2241	16.25 v
491.3904	16.34 s	509.1979	16.59 v	511.1694	16.29 v	511.2252	16.24 v
491.4030	16.30 s	509.1994	16.58 v	511.1704	16.27 v	511.2262	16.21 v
491.4120	16.32 s	509.2008	16.61 v	511.1715	16.25 v	511.2273	16.24 v
491.4209	16.31 s	509.2023	16.65 v	511.1726	16.26 v	511.2284	16.27 v
491.4281	16.40 s	509.2037	16.53 v	511.1747	16.22 v	511.2305	16.25 v
491.4371	16.36 s	509.2052	16.55 v	511.1769	16.19 v	511.2327	16.20 v
491.4442	16.24 s	509.2067	16.50 v	511.1780	16.22 v	511.2338	16.20 v
491.4514	16.24 s	509.2081	16.50 v	511.1791	16.23 v	511.2348	16.23 v
491.4622	16.35 s	509.2096	16.52 v	511.1801	16.21 v	511.2359	16.22 v
497.2420	16.25 s	509.2111	16.55 v	511.1812	16.18 v	511.2370	16.19 v
497.2458	16.26 s	509.2125	16.59 v	511.1823	16.15 v	511.2380	16.20 v
497.2533	16.30 s	509.2140	16.62 v	511.1834	16.21 v	511.2391	16.22 v
497.2645	16.25 s	509.2154	16.58 v	511.1845	16.21 v	511.2413	16.19 v
497.2758	16.25 s	509.2169	16.54 v	511.1856	16.17 v	511.2434	16.23 v
497.2833	16.26 s	509.2183	16.46 v	511.1867	16.16 v	511.2445	16.22 v
497.2908	16.34 s	509.2198	16.46 v	511.1878	16.19 v	511.2456	16.21 v
497.3020	16.08 s	509.2213	16.39 v	511.1889	16.17 v	511.2466	16.24 v
497.3133	16.26 s	509.2227	16.44 v	511.1899	16.15 v	511.2477	16.28 v
497.3245	16.30 s	509.2242	16.45 v	511.1910	16.15 v	511.2488	16.26 v
497.3358	16.33 s	509.2257	16.49 v	511.1921	16.18 v	511.2499	16.30 v
497.3471	16.32 s	509.2286	16.52 v	511.1943	16.19 v	511.2509	16.29 v
497.3546	16.35 s	509.2315	16.55 v	511.1976	16.11 v	511.2520	16.31 v
497.3583	16.28 s	509.2330	16.52 v	511.1997	16.16 v	511.2531	16.32 v
497.3621	16.25 s	509.2344	16.52 v	511.2008	16.17 v	513.1421	16.50 v
497.3658	16.23 s	509.2359	16.55 v	511.2019	16.21 v	513.1463	16.31 v
497.3696	16.40 s	509.2373	16.55 v	511.2030	16.21 v	513.1777	16.36 v
497.3771	16.35 s	509.2403	16.56 v	511.2041	16.23 v	513.2102	16.46 v
509.1716	16.64 v	509.2432	16.52 v	511.2052	16.22 v	513.2648	16.28 v
509.1731	16.60 v	509.2447	16.54 v	511.2063	16.24 v	514.1410	16.24 v
509.1745	16.58 v	509.2484	16.55 v	511.2074	16.23 v	514.1410	16.41 v
509.1760	16.59 v	509.2513	16.55 v	511.2085	16.24 v	514.1934	16.31 v
509.1774	16.60 v	509.2528	16.52 v	511.2096	16.18 v	514.1934	16.60 v
509.1789	16.55 v	509.2543	16.52 v	511.2106	16.24 v	515.2717	16.10 s
509.1804	16.58 v	509.2557	16.51 v	511.2117	16.24 v	515.2769	16.12 s
509.1818	16.60 v	509.2572	16.56 v	511.2128	16.22 v	515.2821	16.18 s
509.1833	16.56 v	509.2586	16.46 v	511.2139	16.23 v	515.2873	16.22 s
509.1847	16.58 v	509.2601	16.48 v	511.2150	16.25 v	515.2978	16.29 s
509.1862	16.56 v	509.2622	16.45 v	511.2161	16.26 v	515.3134	16.16 s
509.1877	16.60 v	511.1580	16.29 v	511.2171	16.23 v	515.3290	16.21 s
509.1891	16.64 v	511.1591	16.34 v	511.2187	16.18 v	515.3395	16.13 s
509.1906	16.63 v	511.1602	16.32 v	511.2198	16.15 v	515.3447	16.05 s

Table 6. Continued.

JD*	V	JD*	V	JD*	V	JD*	V
521.2603	16.28 s	521.2869	16.39 s	655.6209	16.13 s		
521.2709	16.29 s	521.3034	16.27 s	657.6199	16.01 s		
521.2761	16.45 s	521.3192	16.13 s	662.6218	16.05 s		

Table 7. R_C magnitudes of DNP2010. The symbols after magnitudes are explained in Table 2. JD_{hel} =JD* + 2 455 000.

JD*	R_C	JD*	R_C	JD*	R_C	JD*	R_C
338.4767	10.83 s	385.5163	15.80 s	434.4592	15.90 s	483.4279	16.27 s
338.4777	10.80 s	385.5212	15.76 s	434.4644	15.87 s	483.4296	16.39 s
338.4853	10.81 s	387.3754	15.97 s	434.4696	15.99 s	484.3324	16.25 s
340.4386	11.08 s	387.3814	15.80 s	434.4749	15.80 s	484.3341	16.17 s
340.4395	11.06 s	387.3873	15.96 s	434.4801	15.78 s	484.3373	16.10 s
340.4451	11.08 s	387.3932	15.92 s	434.4854	15.85 s	497.3823	16.50 s
340.4464	11.08 s	387.3991	16.01 s	434.4906	15.87 s	497.3843	16.35 s
340.4476	11.07 s	387.4050	15.86 s	434.4959	15.90 s	513.1780	15.99 v
342.4227	11.12 s	387.4109	15.86 s	434.5011	15.82 s	514.1416	16.25 v
342.4230	11.14 s	387.4168	15.95 s	434.5064	15.83 s	514.1938	16.40 v
342.4958	11.09 s	387.4227	15.90 s	454.3398	15.98 a	515.2779	16.32 a
342.4978	11.05 s	387.4286	15.99 s	454.3418	15.80 a	515.2936	16.04 a
346.4024	11.37 s	387.4346	15.91 s	454.3466	15.98 a	515.3092	16.09 a
346.4818	11.34 s	388.4631	15.70 s	454.3504	15.95 a	515.3249	16.10 a
346.4836	11.37 s	388.4678	15.59 s	455.3914	15.82 a	515.3405	16.08 a
350.4014	14.04 s	388.5790	15.74 s	455.3976	15.87 a	515.3509	16.06 a
350.4913	13.93 s	389.3977	15.86 s	455.4014	15.81 a	521.2614	16.49 a
350.4938	14.01 s	389.4023	15.87 s	455.4052	15.75 a	521.2772	16.17 a
353.5256	14.29 s	390.5076	15.97 s	459.2628	16.08 a	521.2880	16.68 a
353.5275	14.32 s	390.5087	15.97 s	459.2684	16.09 a	521.2933	16.53 a
354.4334	14.33 s	391.4930	15.67 s	459.2744	16.11 a	521.2986	16.21 a
354.4343	14.36 s	399.3950	16.02 s	463.2804	16.17 a	521.3045	16.19 a
354.5734	14.27 s	399.3978	16.05 s	463.2863	16.22 a	521.3151	16.15 a
357.4897	14.73 s	399.3993	16.13 s	463.2922	16.30 a	655.6163	16.00 s
358.4733	14.83 s	434.4082	15.71 s	468.3484	16.19 a	655.6200	16.00 s
358.4757	14.82 s	434.4187	15.86 s	468.3542	16.19 a	655.6264	16.10 s
380.3708	15.65 s	434.4240	15.77 s	468.3599	16.23 a	657.6165	15.98 s
381.3962	15.81 s	434.4345	15.78 s	468.3657	16.12 a	662.6240	16.48 s
381.4004	15.79 s	434.4450	15.79 s	482.3212	16.19 s		
381.4047	15.78 s	434.4539	15.82 s	482.3227	16.23 s		

Table 8. I_C magnitudes of DNP2010. The symbols after magnitudes are explained in Table 2. JD$_{hel}$ =JD* + 2 455 000.

JD*	I_C	JD*	I_C	JD*	I_C	JD*	I_C
338.4803	11.98 s	342.4238	12.31 s	350.4916	14.39 s	357.4886	14.89 s
338.4811	12.02 s	342.4961	12.28 s	350.4941	14.40 s	357.4901	14.89 s
340.4455	12.24 s	342.4980	12.25 s	353.5260	14.65 s	358.4738	14.95 s
340.4467	12.25 s	346.4821	12.51 s	353.5278	14.64 s	358.4761	14.99 s
340.4480	12.25 s	346.4839	12.47 s	354.4338	14.68 s		
342.4234	12.24 s	350.4017	14.50 s	354.4353	14.66 s		

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