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Photometric Studies of the Eclipsing Binary DS Psc† ⋆

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Abstract New multi-color photometry and spectroscopic observation were made on the eclipsing binary DS Psc from 2009 to 2014, leading to the light curves in the B, V, and R bands with a complete phase coverage. Forty-one new times of light minimum are determined, and the spectral type of the binary system is firstly deduced. The O-C method is applied to obtain a new orbital period and the epoch formula, in combination with the times of light minimum in literature. The light curves are fitted to derive the photometric solution of the binary system firstly by using the Wilson-Devinney code. The result shows that DS Psc is an over-contact binary system with the spectral type of G7V, the orbital inclination of 66.6°, and the mass ratio of 2.506. Since the less-massive component has a higher surface temperature than the more-massive one, DS Psc should belong to the W subtype of W UMa binary stars.

Key words binaries: close—binaries: eclipsing—stars: individual: DS Psc

1. INTRODUCTION

Since it was discovered in 1940, DS Psc (NSV 00361, GSC 00015-00112, HV 6379) was recognized as a RR Lyr variable[1]. Until in 1997, by through the time-series of photometric observations on it at the B and V wavebands with a two-meter diameter telescope, Vidal-Sainz et al.[2] found that it is a W UMa type over-contact eclipsing binary, and gave the

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epoch formula for its light-minimum times as follows:

$$Min.I = \text{HJD}2450376.43495 + 0.342487 \times E\,. \quad (1)$$

In this formula E is the cycle number, HJD2450376.43495 is the initial epoch, and 0.342487 is the orbital period in units of day. And the German BAW variable research group has collected 9 observed minimum times since 1998, and given the epoch formula to be

$$Min.I = \text{HJD}2452500.2244 + 0.34249179 \times E\,. \quad (2)$$

In order to analyze further the orbital period of DS Psc, and to obtain the preliminary photometric solution of its orbit, from 2009 to 2014 we made the 5 year CCD photometric observation toward this star, obtained the B, V, and R three-color light curves, measured multiple light-minimum times, in addition, we photographed also its low-resolution spectrum.

2. OBSERVATIONS

2.1 Photometric Observations

From 2009 to 2014, the photometric observations of totally 15 nights were made, in which at 13 nights the 60 cm telescope (XL) at the Xinglong station of the National Astronomical observatories was used, its focal ratio at the prime focus is F/4.23, the CCD is PI 1024, the pixel resolution is 1.056"/pixel, and the effective field of view is $18' \times 18'$. At one night, the 85 cm telescope at the Xinglong station was used, its prime-focus focal ratio is F/3.27, the CCD is PI MicroMAX:1024BFT, the pixel resolution is $1''$/pixel, and the effective field of view is $17.1' \times 17.1'$. At another one night, the 60 cm telescope of Yunnan Observatory (YN) was used, its Cassegrain focal ratio is F/12.5, the CCD is Andor/s DW 436 with 2018×2018 pixels, the pixel resolution is $0.37''$/pixel, and the effective field of view is $12.67' \times 12.67'$. For the above observations, the Johnson B, V, R, and I four wavebands were used. The observational times and the frame numbers at the every waveband are listed in Table 1. The names, coordinates, and magnitudes of the target star, comparison star, and calibration star are given in Table 2.

2.2 Photometric Data Processing

The IRAF software was used for data processing and aperture photometry, an identical group of apertures were selected for the observed data at the four wavebands, and the optimal aperture was obtained according to the criterion that the dispersion of the light curve of the magnitude difference between the calibration star and the comparison star is minimum. Taking the differential magnitude between the target star and the comparison star as the ordinate, the heliocentric Julian date as the abscissa, Fig.1 shows the B, V, and R three-color light curves at four nights with higher photometric accuracies (5th, 25th, 27th, and 28th October 2010), and the related data are given in Appendix.

Table 1 Data of the photometric observations on DS Psc from 2009 to 2014

Telescope	Date	Frame number			
		B	V	R	I
XL 60 cm	2009-10-12		169		
	2010-10-05	191	191	191	
	2010-10-06	157	157	157	
	2010-10-25	161	159	158	
	2010-10-27	173	172	172	
	2010-10-28	169	169	169	
	2010-10-29	173	174	180	
	2011-11-19		100	99	
	2012-10-27		279	279	
	2012-10-29		152	152	
	2013-10-25		483	483	
	2013-11-22		59	59	
	2013-11-23		60	60	
XL 85 cm	2014-01-21			116	116
YN 60 cm	2010-01-25			39	

Table 2 Information about the target, comparison, and calibration stars

Target	Name	R.A.(J2000)	DEC(J2000)	m_V/mag	m_B/mag
Variable	DS Psc	$00^h58^m51.960^s$	$+03°03'\ 57.86''$	11.77	12.33
Comparison	GSC00015-00231	$00^h59^m11.739^s$	$+03°02'\ 07.17''$	11.5	
Check star	GSC00015-00388	$00^h59^m11.731^s$	$+02°58'\ 47.02''$	11.79	

2.3 Spectroscopic Observation

On 18th November 2008 the spectroscopic observation of DS Psc was made by using the Xinglong 2.16 m telescope and its OMR low-dispersion spectrograph (the grating with the dispersion of 50 Å/mm). The central wavelength of the spectrum is 610 nm, and the wavelength range is 550∼670 nm. By using the IRAF software we obtained the spectrum of DS Psc as shown in Fig.2. We used the Pickles[4] spectral flux database to compare it with the spectrum of DS Psc, and the spectral type of DS Psc was preliminarily identified as G7V, namely the two component stars are the main-sequence stars with temperatures of 5100∼5300 K.

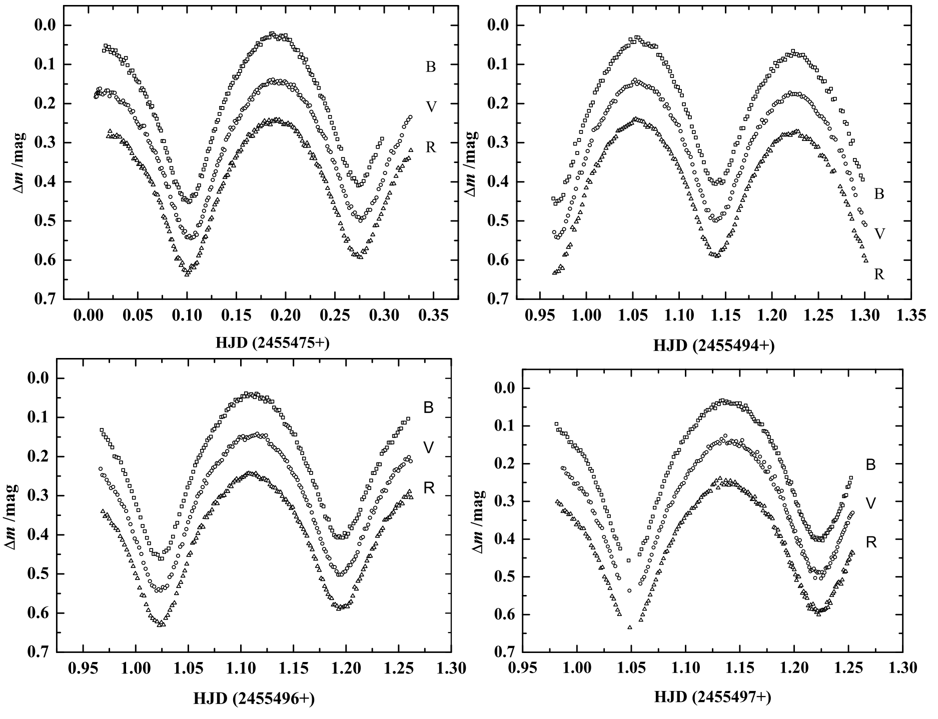

Fig. 1 Light curves of DS Psc

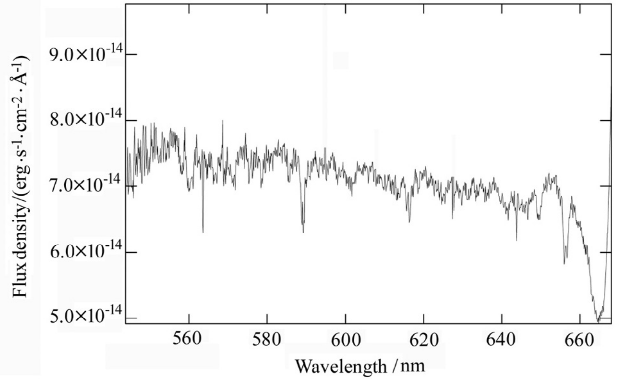

Fig. 2 The low-dispersion spectrum of Ds Psc obtained with the Xinglong 2.16 m telescope

3. PERIOD ANALYSIS

In order to analyze the variation of orbital period of DS Psc, we made fitting on all the minimum values observed by us, and obtained the times of light minimum shown in Table 3. Combined with the data of light-minimum times published in literature (see Table 4), we obtained a new epoch formula for the times of light minimum, fitted by the least square method:

$$Min.I. = \text{HJD}2455499.0795(3) + 0.34249167(7) \times E\,. \tag{3}$$

This result is consistent with the light period 0.34249179 d[3] of DS Psc obtained by the German BAW group from fitting the 9 light-minimum times observed before 2011. But we have increased the data of 41 minimum times observed from 2009 to 2014, thus the accuracy of the period is further improved.

In order to analyze the variation of orbital period of DS Psc, by using Eq.(3), we calculated the corresponding O-C value and the cycle number E for all the observed light-minimum times, and listed respectively in Table 3 and Table 4.

Table 3 New light-minimum times of DS Psc obtained by this paper

Minimum (HJD2450000+)	Error/d	Filter	E	O-C/d
5117.1966	±0.00005	V	-1115	-0.0047
5475.10056	±0.00015	B	-70	-0.0045
5475.10253	±0.00007	V	-70	-0.0026
5475.10106	±0.00015	R	-70	-0.004
5475.27432	±0.00013	B	-69.5	-0.002
5475.27643	±0.00018	V	-69.5	0.0001
5475.27442	±0.00016	R	-69.5	-0.0019
5476.12815	±0.00014	B	-67	-0.0044
5476.12845	±0.00015	V	-67	-0.0041
5476.1284	±0.00001	R	-67	-0.0042
5476.30114	±0.00015	V	-66.5	-0.0027
5476.301	±0.00003	R	-66.5	-0.0028
5495.14078	±0.00013	B	-11.5	0
5495.14072	±0.00013	V	-11.5	-0.0001
5495.14084	±0.00018	R	-11.5	0
5497.02263	±0.00007	B	-6	-0.0019
5497.02273	±0.00012	V	-6	-0.0018
5497.02281	±0.00005	R	-6	-0.0017
5497.19596	±0.00012	B	-5.5	0.0002

Table 3 Continued

Minimum (HJD2450000+)	Error/d	Filter	E	O-C/d
5497.19562	±0.00017	V	-5.5	-0.0002
5497.19585	±0.00017	R	-5.5	0.0001
5498.22324	±0.00014	B	-2.5	-0.0001
5498.22303	±0.00018	V	-2.5	-0.0003
5498.22312	±0.00021	R	-2.5	-0.0002
5499.07763	±0.00008	B	0	-0.0019
5499.07792	±0.00009	V	0	-0.0016
5499.07784	±0.00007	R	0	-0.0017
5885.06911	±0.00007	V	1127	0.0015
5885.06908	±0.00006	R	1127	0.0015
6228.07119	±0.00014	V	2128.5	-0.0018
6228.07207	±0.00006	R	2128.5	-0.0009
6230.12666	±0.00008	V	2134.5	-0.0013
6230.12688	±0.00016	R	2134.5	-0.0011
6591.11808	±0.00010	V	3188.5	0.0039
6591.11806	±0.00017	R	3188.5	0.0039
6619.02791	±0.00008	V	3270	0.0006
6619.02797	±0.00006	R	3270	0.0007
6620.05573	±0.00012	V	3273	0.0010
6620.05555	±0.00016	R	3273	0.0009
6678.97102	±0.00010	R	3445	0.0077
6678.97109	±0.00008	I	3445	0.0078

Using the data listed in Table 3 and Table 4, we made the O-C diagram of DS Psc as shown in Fig.3. From this O-C diagram we can find that since the minimum value was observed in 1997, basically, its period has had no large variations. To determine whether its period has a long-term or long-period variation, we have to continue the observation of light-minimum times.

4. ORBIT SOLUTION OF PHOTOMETRIC DATA

With the data obtained by the Xinglong 60 cm telescope on 5th, 25th, 27th, and 28th October 2010, as well as the 2007 version of the Wilson-Dovinney (W-D)[12] binary orbit solution code, we made the orbit solution. Fig.4 gives the observed 3-color light curves and the theoretical light curves obtained from the W-D calculations. The derived mass ratio (M_2/M_1) is 2.506 (M_1/M_2 is 0.399), this means that during the main minimum (the phase is equal to zero), the companion star corresponding to a larger mass shelters the companion star with a smaller mass, and the small-mass component has a higher temperature, namely DS Psc is an over-contact binary system of W subtype. Correspondingly, let the companion 1 be the less-massive companion star, and let the companion 2 be the more-massive companion star. According to our spectroscopic observation, the spectral type of DS Psc is identified to be about G7V, namely its temperature is in the range of 5100∼5300 K. Hence, in the photometric solution, it was assumed at first that the temperature of companion 2 is 5100 K, and according to this temperature the binary's logarithmic thermal limb-darkening coefficient (X, Y) and the monochromatic limb-darkening coefficient (x, y) were obtained[13]. The thermal albedo was fixed to be $A_1 = A_2 = 0.5$[14], the gravitational constant was fixed to be $g_1 = g_2 = 0.32$[15], and these coefficients suit the convective envelope of this binary.

Table 4 The light-minimum times given by other literature

Minimum (HJD2450000+)	Filter	E	O-C/d	Ref.
744.4414	C	-13882.5	0.0025	[5]
1140.3614	Ir	-12726.5	0.0021	[6]
1495.3511	Ir	-11690	-0.0008	[6]
1840.4126	Ir	-10682.5	0.0004	[6]
4761.699	V	-2153	0.0041	[7]
4761.8685	V	-2152.5	0.0023	[7]
4823.0048	V	-1974	0.0039	[8]
5170.6345	C	-959	0.0045	[9]
5527.6821	V	83.5	0.0045	[10]
5895.6851	V	1158	0.0002	[11]

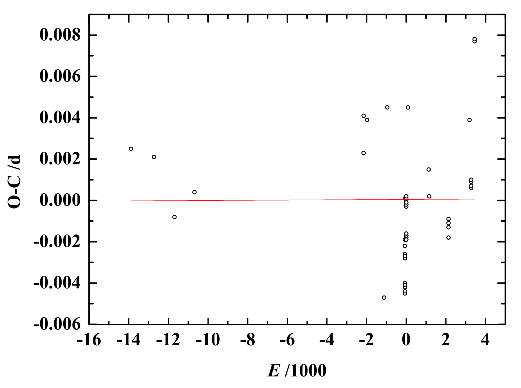

Fig. 3 The O-C diagram of DS Psc

The parameters to be adjusted by using the W-D program were the orbital inclination i, the temperature T_1 of companion 1, the 3-color luminosity $(L_1(B), L_1(V), L_1(R))$ of companion 1, the surface potentials Ω_1 and Ω_2 of both companions, and the radii r_1 and r_2 of both companions in units of solar radius, because the shapes of two companions are no longer spherical, hence in Table 5 we use "pole" to indicate the direction perpendicular to the binary's orbital plane, "side" the direction along the orbital plane and perpendicular to the line of sight, and "back" the direction along the orbital plane and parallel to the line of sight.

Input the above parameters, the theoretical light curves calculated with the W-D program could not fit very well the two observed asymmetrical light curves with different maximum values, namely exists the O'Connell effect. As the two companions of DS Psc are all the rapidly rotating sun-like stars, some activities including the cool spots should exist on their photospheric surfaces. So the asymmetric light curves can be explained by the cool spots existed on the surface of a companion star. Mullan[16] suggested that in the W subtype over-contact binary system, the cool spots are more likely exist on the surface of the companion with a larger mass, hence we put a cool spot on the more massive companion 2. At first we set the weights of the measurements in the phase range 0.7∼0.9 to be 0, and under the assumption of no spot, we made fitting first on a part of light curve which contains the first light minimum only, then we set the weights of all measured data to be 1, and made fitting by using the model with a spot added[17]. Finally, we obtained the four parameters of the spot: longitude, latitude, photospheric temperature in the spot region, and spot radius, as well as the best-fit solution of this binary system as listed in Table 5.

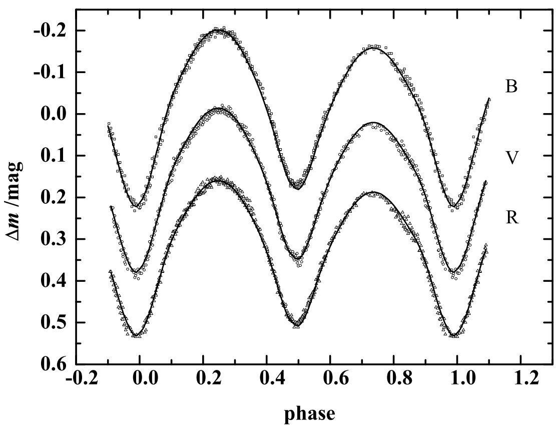

Fig. 4 The observed light curves of DS Psc in the B, V, and R bands (data points), and their fitted results with the W-D code (solid lines)

Table 5 The orbital and physical parameters of DS Psc

Parameter	Best-fit value	Formal error
$i/(^\circ)$	66.6	±0.07
$q = m_2/m_1$	2.506	±0.003
T_1/K	5300	±20
T_2/K	5100	±20
$g_1 = g_2$	0.32a	
$A_1 = A_2$	0.50a	
Ω_1=Ω_2	5.8742	±0.0002
$X_1 = X_2$(bolo)	0.646a	
$Y_1 = Y_2$(bolo)	0.180a	
$x_1 = x_2$(B)	0.849a	
$x_1 = x_2$(V)	0.787a	
$x_1 = x_2$(R)	0.698a	
$y_1 = y_2$(B)	0.052a	
$y_1 = y_2$(V)	0.170a	
$y_1 = y_2$(R)	0.210a	
$L_1/(L_1 + L_2)$ (B)	0.345	±0.001
$L_1/(L_1 + L_2)$ (V)	0.335	±0.001
$L_1/(L_1 + L_2)$ (R)	0.326	±0.001
r_1(pole)/$R_\odot$	0.2887	±0.0003
r_1(side)/$R_\odot$	0.3019	±0.0003
r_1(back)/$R_\odot$	0.3393	±0.0005
r_2(pole)/$R_\odot$	0.4392	±0.0003
r_2(side)/$R_\odot$	0.4703	±0.0003
r_2(back)/$R_\odot$	0.4994	±0.0004
Spot latitude/$(^\circ)$	121.5	±0.3
Spot longitude/$(^\circ)$	297.9	±0.3
Spot radius/$(^\circ)$	91.6	±0.1
Tspot/T_2	0.989	±0.003
Σ(O-C)^2	0.0419	

Note: a is an assumed value

5. RESULT ANALYSIS

In this paper, with the data of our photometric and spectroscopic observations, in combination with the data in literature, we have obtained a new period and epoch formula of DS Psc. The obtained period is P =0.34249167±0.00000007 d, close to the values obtained by

Vidal-Sainz[2] and the German BAW group[3], but ours is more accurate.

From the O-C diagram given by this paper, it is found that in the recent ten and more years, the period has no significant variations. The light curves of DS Psc exhibit asymmetry, the W-D calculations indicate that cool spots may exist on the surface of companion 2, and this implies the existence of magnetic activity. But the period of DS Psc has not obviously changed in recent years. Liao et al.[18] studied 53 EW over-contact binary systems, and suggested that for an EW type binary system, magnetic activity is not the unique reason to cause the variation of its revolution period, the rather stable period of DS Psc seems to be a support to the opinion of Liao et al. Whether the revolution period of DS Psc has a long-period variation, it needs to continue the successive observations of light-minimum times, in order for more detailed analysis of orbital period variation and the study of evolution of DS Psc.

With the W-D orbit solution code we have obtained for the first time the preliminary photometric orbit solution of DS Psc, and some of its physical parameters: the orbital inclination 66.6°, the primary's temperature T_1 =5300 K, the secondary's temperature T_2 =5100 K, and the mass ratio M_2/M_1 =2.506 (M_1/M_2 =0.399), the less-massive companion 1 has a higher temperature, hence DS Psc is identified as a W subtype over-contact binary system, and there is a cool spot on the surface of companion 2.

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Appendix: Corresponding data in Fig.1

HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag
75.0157	0.0648	75.1881	0.0247	95.0688	0.0529	96.9819	0.2018	97.1835	0.3611	98.1185	0.5111
75.0175	0.0519	75.1896	0.0292	95.071	0.0553	96.984	0.2035	97.1852	0.3813	98.1202	0.5073
75.0192	0.0611	75.1911	0.029	95.0731	0.052	96.9861	0.2147	97.1869	0.3894	98.122	0.5071
75.0209	0.0553	75.1926	0.0354	95.0752	0.055	96.9881	0.2346	97.1886	0.4007	98.1237	0.5011
75.0226	0.0682	75.194	0.0321	95.0774	0.0754	96.9902	0.2446	97.1902	0.4046	98.1255	0.4932
75.0243	0.0629	75.1955	0.0264	95.0795	0.0761	96.9922	0.2609	97.1919	0.407	98.1272	0.503
75.026	0.0719	75.197	0.0289	95.0816	0.0847	96.9943	0.2752	97.1936	0.4034	98.1289	0.4893
75.0277	0.0643	75.1985	0.0359	95.0838	0.0982	96.9964	0.2884	97.1953	0.4069	98.1307	0.4924
75.0294	0.0764	75.2	0.0254	95.0859	0.0947	96.9984	0.3055	97.1969	0.4075	98.1324	0.4829
75.0311	0.0791	75.2015	0.0358	95.088	0.1068	97.0005	0.3224	97.1986	0.3956	98.1341	0.4816
75.0328	0.0874	75.203	0.0378	95.0902	0.1175	97.0025	0.3372	97.2003	0.405	98.1359	0.4896
75.0345	0.0982	75.2046	0.037	95.0923	0.1297	97.0046	0.3554	97.202	0.3973	98.1376	0.4846
75.0362	0.0885	75.2062	0.048	95.0944	0.1445	97.0066	0.3774	97.2037	0.3788	98.139	0.4883
75.038	0.0835	75.2078	0.0551	95.0966	0.1563	97.0087	0.391	97.2053	0.3834	98.1404	0.4871
75.0397	0.102	75.2094	0.0619	95.0987	0.1579	97.0108	0.4078	97.207	0.3707	98.1417	0.4913
75.0414	0.1213	75.211	0.0634	95.1008	0.1676	97.0128	0.4217	97.2087	0.3649	98.1431	0.491
75.0431	0.1158	75.2126	0.0635	95.103	0.1789	97.0149	0.4388	97.2104	0.3579	98.1445	0.4904
75.0448	0.1156	75.2142	0.0808	95.1051	0.2019	97.0169	0.449	97.2121	0.3481	98.1459	0.4914
75.0465	0.129	75.2158	0.0744	95.1072	0.2156	97.019	0.4484	97.2137	0.3363	98.1473	0.4899
75.0482	0.1386	75.2174	0.0835	95.1094	0.2255	97.021	0.4512	97.2154	0.3091	98.1487	0.4975
75.0499	0.1433	75.219	0.0952	95.1115	0.2353	97.0231	0.4611	97.2171	0.3039	98.1501	0.4898
75.0515	0.146	75.2206	0.0874	95.1137	0.2585	97.0252	0.4606	97.2188	0.292	98.1515	0.4998
75.053	0.1661	75.2223	0.1066	95.1158	0.2731	97.0272	0.4438	97.2205	0.2764	98.1528	0.5075
75.0545	0.1609	75.2239	0.1148	95.1179	0.2869	97.0293	0.4401	97.2221	0.2804	98.1541	0.5046
75.056	0.1652	75.2255	0.1243	95.1201	0.3076	97.0313	0.4348	97.2238	0.2613	98.1554	0.4958
75.0574	0.1745	75.2271	0.1273	95.1222	0.3213	97.0334	0.4199	97.2255	0.2422	98.1567	0.5041
75.0589	0.1826	75.2287	0.1401	95.1243	0.3319	97.0355	0.4048	97.2272	0.2424	98.1579	0.5121
75.0604	0.2005	75.2303	0.1479	95.1265	0.35	97.0375	0.3796	97.2289	0.2313	98.1592	0.5126
75.0619	0.1968	75.2319	0.1488	95.1286	0.3713	97.0396	0.3693	97.2305	0.2194	98.1604	0.5188
75.0634	0.2095	75.2335	0.16	95.1307	0.3784	97.0417	0.3477	97.2322	0.2201	98.1617	0.5258
75.0648	0.2065	75.2351	0.18	95.1329	0.3929	97.0437	0.3272	97.2339	0.1928	98.1629	0.5316
75.0663	0.2285	75.2368	0.1829	95.135	0.3962	97.0456	0.3129	97.2356	0.1859	98.1642	0.5377
75.0678	0.2315	75.2384	0.1871	95.1371	0.404	97.0474	0.2964	97.2373	0.1827	98.1655	0.5377
75.0693	0.239	75.24	0.1997	95.1393	0.4051	97.0493	0.279	97.239	0.1771	98.1667	0.5373
75.0707	0.2537	75.2416	0.2113	95.1414	0.3996	97.0511	0.2674	97.2406	0.1645	98.168	0.544
75.0722	0.2638	75.2432	0.2173	95.1436	0.3946	97.0529	0.2552	97.2423	0.1645	98.1692	0.5458
75.0737	0.2693	75.2449	0.2341	95.1457	0.403	97.0548	0.2387	97.244	0.1638	98.1705	0.5455
75.0752	0.2956	75.2468	0.249	95.1478	0.3991	97.0564	0.2224	97.2457	0.1474	98.1717	0.5631
75.0767	0.296	75.2487	0.2628	95.15	0.3782	97.0581	0.2132	97.2474	0.1468	98.173	0.5637
75.0781	0.3137	75.2506	0.2774	95.1521	0.3715	97.0598	0.2028	97.249	0.1386	98.1743	0.5655
75.0796	0.325	75.2525	0.291	95.1543	0.3566	97.0614	0.1966	97.2507	0.1293	98.1755	0.5707
75.0811	0.3409	75.2544	0.3104	95.1564	0.3455	97.0631	0.1853	97.2524	0.128	98.1768	0.5796
75.0826	0.3458	75.2563	0.3157	95.1585	0.3234	97.0648	0.1776	97.2541	0.1136	98.178	0.5915

Appendix continued 1

HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag	HJD (2455400+)	Δm_B/ mag
75.0841	0.3648	75.2582	0.3418	95.1607	0.305	97.0664	0.1708	97.2558	0.1134	98.1793	0.5895
75.0856	0.3764	75.2601	0.3517	95.1628	0.3009	97.0681	0.1586	97.2592	0.1032	98.1806	0.6015
75.087	0.401	75.262	0.359	95.1649	0.2859	97.0698	0.1536	97.9811	0.5443	98.1818	0.6092
75.0885	0.3992	75.2638	0.3819	95.1671	0.2631	97.0715	0.1493	97.9826	0.5606	98.1831	0.6072
75.09	0.4067	75.2657	0.3757	95.1692	0.2628	97.0731	0.1332	97.9844	0.5593	98.1843	0.6223
75.0915	0.4144	75.2676	0.3919	95.1714	0.2398	97.0748	0.1296	97.9861	0.569	98.1856	0.6224
75.093	0.4284	75.2695	0.3904	95.1735	0.2329	97.0765	0.1203	97.9878	0.5707	98.1868	0.6393
75.0944	0.4316	75.2714	0.3999	95.1756	0.2141	97.0781	0.1206	97.9896	0.5697	98.1881	0.6447
75.0959	0.4454	75.2733	0.4096	95.1778	0.2034	97.0798	0.1123	97.9913	0.5796	98.1894	0.6561
75.0974	0.4415	75.2752	0.4081	95.1799	0.1881	97.0815	0.0989	97.993	0.5929	98.1906	0.6603
75.0989	0.4456	75.2771	0.4057	95.1821	0.1821	97.0831	0.0978	97.9948	0.5928	98.1919	0.6721
75.1004	0.4482	75.279	0.398	95.1842	0.17	97.0848	0.0956	97.9965	0.6042	98.193	0.6856
75.1019	0.452	75.2809	0.3843	95.1863	0.1591	97.0865	0.0817	97.9982	0.6012	98.194	0.7007
75.1033	0.4485	75.2828	0.3811	95.1885	0.1526	97.0881	0.0784	97.9999	0.6095	98.1951	0.6957
75.1048	0.4362	75.2848	0.363	95.1906	0.1493	97.0898	0.0685	98.0017	0.616	98.1962	0.7038
75.1063	0.433	75.287	0.3484	95.1928	0.1417	97.0915	0.0664	98.0034	0.6141	98.1973	0.6995
75.1078	0.4354	75.2891	0.3384	95.1949	0.1307	97.0931	0.0696	98.0051	0.6248	98.1983	0.7205
75.1093	0.4314	75.2913	0.3315	95.197	0.1285	97.0948	0.0548	98.0069	0.6303	98.1994	0.7246
75.1108	0.4176	75.2934	0.3107	95.1992	0.1116	97.0965	0.0587	98.0086	0.641	98.2005	0.7328
75.1122	0.4092	75.2956	0.3015	95.2013	0.1166	97.0982	0.0541	98.0103	0.6507	98.2016	0.7519
75.1137	0.3833	75.2977	0.29	95.2035	0.0962	97.0998	0.0556	98.0121	0.6635	98.2026	0.7569
75.1152	0.3858	94.9645	0.4429	95.2056	0.1047	97.1015	0.0455	98.0138	0.6691	98.2037	0.7609
75.1167	0.3686	94.9667	0.456	95.2078	0.0917	97.1032	0.0463	98.0155	0.6847	98.2048	0.7763
75.1182	0.3567	94.9688	0.4491	95.2099	0.0903	97.1048	0.0384	98.0173	0.6998	98.2059	0.7844
75.1197	0.3419	94.9709	0.4478	95.212	0.0853	97.1065	0.046	98.019	0.7119	98.2069	0.7863
75.1211	0.3219	94.973	0.4434	95.2142	0.0883	97.1082	0.0419	98.0207	0.7204	98.208	0.797
75.1226	0.3155	94.9752	0.4334	95.2163	0.0749	97.1099	0.0407	98.0225	0.7324	98.2091	0.8052
75.1241	0.2988	94.9773	0.4011	95.2185	0.0759	97.1115	0.0445	98.0242	0.7473	98.2102	0.8084
75.1256	0.2887	94.9794	0.3967	95.2206	0.0779	97.1132	0.048	98.0259	0.7661	98.2113	0.8153
75.1271	0.2698	94.9815	0.3867	95.2227	0.0654	97.1149	0.0392	98.0277	0.7759	98.2123	0.8227
75.1286	0.2653	94.9837	0.3581	95.2249	0.0737	97.1165	0.0424	98.0294	0.7893	98.2134	0.8174
75.1301	0.2468	94.9858	0.3486	95.227	0.0738	97.1182	0.0522	98.0311	0.8079	98.2145	0.8314
75.1315	0.2422	94.9879	0.303	95.2292	0.0778	97.1199	0.0491	98.0329	0.8267	98.2156	0.8363
75.133	0.2265	94.9901	0.3263	95.2313	0.0765	97.1216	0.052	98.0346	0.8429	98.2166	0.8452
75.1345	0.2111	94.9922	0.2931	95.2335	0.0756	97.1232	0.0596	98.0363	0.8485	98.2177	0.8428
75.136	0.2116	94.9943	0.2726	95.2356	0.0825	97.1249	0.0489	98.0381	0.8633	98.2188	0.8474
75.1375	0.1962	94.9964	0.2561	95.2377	0.0895	97.1266	0.0567	98.0398	0.8751	98.2199	0.8514
75.139	0.1896	94.9986	0.243	95.2399	0.0951	97.1283	0.0602	98.0475	0.9064	98.2209	0.8458
75.1404	0.1755	95.0007	0.2308	95.242	0.1031	97.1299	0.0596	98.0577	0.8904	98.222	0.8492
75.1419	0.1743	95.0028	0.2186	95.2442	0.107	97.1316	0.0747	98.0594	0.8766	98.2231	0.8525
75.1434	0.1597	95.0049	0.2046	95.2463	0.108	97.1333	0.08	98.0612	0.8604	98.2242	0.8474
75.1449	0.152	95.0071	0.197	95.2485	0.115	97.1349	0.0825	98.0681	0.804	98.2253	0.8495
75.1464	0.147	95.0092	0.172	95.2506	0.1331	97.1366	0.0809	98.0698	0.79	98.2263	0.8534
75.1479	0.1313	95.0113	0.164	95.2527	0.1353	97.1383	0.093	98.0716	0.7667	98.2274	0.8404
75.1494	0.1354	95.0134	0.1532	95.2549	0.1439	97.14	0.1004	98.0733	0.7529	98.2285	0.843
75.1509	0.1313	95.0156	0.1422	95.257	0.143	97.1416	0.1167	98.0751	0.7436	98.2296	0.8345
75.1524	0.1245	95.0177	0.1416	95.2592	0.1671	97.1433	0.1191	98.0768	0.7299	98.2307	0.8334
75.1538	0.1166	95.0198	0.1219	95.2613	0.17	97.145	0.123	98.0785	0.7106	98.2317	0.8262
75.1553	0.105	95.022	0.118	95.2635	0.1624	97.1467	0.1274	98.0803	0.696	98.2328	0.8231
75.1568	0.1042	95.0241	0.1123	95.2656	0.1896	97.1483	0.138	98.082	0.6814	98.2339	0.8183
75.1583	0.0931	95.0262	0.0988	95.2678	0.1879	97.15	0.1435	98.0837	0.6736	98.235	0.8167
75.1598	0.0914	95.0284	0.0908	95.2742	0.2174	97.1517	0.1438	98.0855	0.6598	98.2361	0.8034
75.1613	0.0868	95.0305	0.0835	95.2763	0.2201	97.1534	0.1638	98.0872	0.649	98.2371	0.8003
75.1628	0.0757	95.0326	0.0822	95.2785	0.2473	97.155	0.1771	98.0889	0.6321	98.2382	0.7984
75.1643	0.0733	95.0348	0.0739	95.2806	0.2521	97.1567	0.1801	98.0907	0.6222	98.2393	0.7923
75.1657	0.0693	95.0369	0.0678	95.2828	0.2774	97.1584	0.1911	98.0924	0.6216	98.2404	0.7844

Appendix continued 2

75.1672	0.0643	95.039	0.0604	95.2849	0.3029	97.1601	0.2054	98.0941	0.6136	98.2415	0.7759
75.1687	0.0623	95.0411	0.0574	95.2871	0.2951	97.1617	0.2172	98.0959	0.5939	98.2426	0.769
75.1702	0.0547	95.0433	0.0538	95.2892	0.3442	97.1634	0.2243	98.0976	0.5911	98.2436	0.7568
75.1717	0.0456	95.0454	0.052	95.2914	0.3521	97.1651	0.2346	98.0994	0.5799	98.2458	0.7366
75.1732	0.0493	95.0475	0.0359	95.2935	0.3608	97.1668	0.2417	98.1011	0.5799	98.2469	0.7346
75.1747	0.0496	95.0497	0.0432	95.2957	0.3837	97.1685	0.2619	98.1028	0.5682	98.248	0.7333
75.1762	0.0361	95.0518	0.0425	95.2978	0.3942	97.1701	0.272	98.1046	0.5586	98.249	0.7119
75.1777	0.0351	95.0539	0.0303	96.9678	0.1318	97.1718	0.2787	98.1063	0.5581	98.2501	0.7109
75.1791	0.033	95.0561	0.0311	96.9696	0.1431	97.1735	0.2964	98.1081	0.5517	98.2512	0.7001
75.1806	0.0307	95.0582	0.0382	96.9716	0.151	97.1752	0.3099	98.1098	0.5482	98.2523	0.6873
75.1821	0.0311	95.0603	0.0428	96.9737	0.1577	97.1768	0.324	98.1115	0.535		
75.1836	0.0307	95.0625	0.0495	96.9758	0.1685	97.1785	0.3274	98.1133	0.5294		
75.1851	0.0211	95.0646	0.05	96.9778	0.1766	97.1802	0.3536	98.115	0.5204		
75.1866	0.0202	95.0667	0.047	96.9799	0.1994	97.1818	0.3579	98.1168	0.5221		
HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag
75.0074	0.0833	75.1767	0.0526	95.0334	0.0766	95.2857	0.2942	97.1657	0.2259	98.1053	0.8966
75.008	0.0762	75.1782	0.0525	95.0355	0.0715	95.2878	0.3169	97.1674	0.2429	98.107	0.8918
75.0085	0.082	75.1797	0.0521	95.0376	0.0677	95.29	0.3339	97.1691	0.2619	98.1088	0.8819
75.0091	0.0723	75.1812	0.0508	95.0398	0.0626	95.2943	0.3709	97.1708	0.2707	98.1105	0.8736
75.0096	0.0733	75.1827	0.0424	95.0419	0.0575	95.2964	0.3784	97.1724	0.2828	98.1122	0.8728
75.0101	0.0637	75.1842	0.0404	95.044	0.0566	95.2986	0.4042	97.1741	0.2937	98.114	0.8702
75.0107	0.0732	75.1857	0.0463	95.0462	0.0551	95.3007	0.4099	97.1758	0.3102	98.1157	0.86
75.0112	0.0737	75.1872	0.0386	95.0483	0.0537	96.9666	0.1313	97.1775	0.3224	98.1174	0.8528
75.0117	0.062	75.1887	0.0477	95.0504	0.0445	96.9684	0.1471	97.1792	0.3362	98.1192	0.8494
HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag
75.0123	0.0746	75.1901	0.045	95.0526	0.0392	96.9704	0.1485	97.1808	0.3427	98.1209	0.8348
75.0128	0.0744	75.1916	0.0427	95.0547	0.05	96.9724	0.1594	97.1825	0.3561	98.1227	0.8394
75.0146	0.0765	75.1931	0.0487	95.0568	0.0446	96.9745	0.1686	97.1842	0.3605	98.1244	0.8311
75.0164	0.0731	75.1946	0.0422	95.059	0.0479	96.9765	0.1804	97.1858	0.3766	98.1261	0.8275
75.0181	0.0667	75.1961	0.0479	95.0611	0.0512	96.9786	0.1777	97.1875	0.3818	98.1279	0.8256
75.0198	0.0663	75.1976	0.0485	95.0632	0.0543	96.9806	0.1901	97.1892	0.3826	98.1296	0.8224
75.0215	0.081	75.1991	0.0432	95.0653	0.0586	96.9827	0.1976	97.1909	0.3932	98.1314	0.8265
75.0232	0.0719	75.2006	0.0466	95.0675	0.056	96.9848	0.2113	97.1925	0.4021	98.1331	0.8145
75.0249	0.0721	75.2021	0.0527	95.0696	0.0601	96.9868	0.2213	97.1942	0.4018	98.1348	0.8196
75.0266	0.0726	75.2036	0.0579	95.0717	0.0611	96.9889	0.228	97.1959	0.4015	98.1366	0.8054
75.0283	0.0841	75.2052	0.0515	95.0739	0.0698	96.9909	0.2393	97.1976	0.3959	98.1382	0.8264
75.0301	0.0897	75.2068	0.0652	95.076	0.0693	96.993	0.258	97.1993	0.3938	98.1395	0.824
75.0318	0.0962	75.2084	0.0522	95.0781	0.0764	96.9951	0.2729	97.2009	0.3858	98.1409	0.8244
75.0335	0.0968	75.21	0.0612	95.0803	0.0892	96.9971	0.2915	97.2026	0.3776	98.1423	0.8189
75.0352	0.0925	75.2116	0.0674	95.0824	0.0896	96.9992	0.3094	97.2043	0.3776	98.1437	0.8211
75.0369	0.1008	75.2132	0.0783	95.0845	0.1069	97.0012	0.3188	97.206	0.3684	98.1451	0.8276
75.0386	0.103	75.2148	0.0783	95.0867	0.102	97.0033	0.3326	97.2077	0.3634	98.1465	0.8202
75.0403	0.1042	75.2164	0.0871	95.0888	0.1125	97.0054	0.349	97.2093	0.3548	98.1479	0.8306
75.042	0.1159	75.2181	0.0903	95.0909	0.1299	97.0074	0.3717	97.211	0.3442	98.1493	0.8335
75.0437	0.1225	75.2197	0.0953	95.0931	0.1388	97.0095	0.387	97.2127	0.3233	98.1507	0.8261
75.0454	0.1194	75.2213	0.097	95.0952	0.1437	97.0115	0.4018	97.2144	0.3084	98.1521	0.8176
75.0471	0.1374	75.2229	0.1068	95.0973	0.1521	97.0136	0.4183	97.2161	0.3058	98.1534	0.8321
75.0489	0.1466	75.2245	0.1046	95.0995	0.1555	97.0156	0.4296	97.2177	0.2845	98.1546	0.8382
75.0506	0.1534	75.2261	0.1213	95.1016	0.1703	97.0177	0.4326	97.2194	0.2843	98.1559	0.8408
75.0521	0.1622	75.2277	0.1284	95.1037	0.1921	97.0198	0.4429	97.2211	0.2741	98.1572	0.8412
75.0536	0.1592	75.2293	0.1369	95.1059	0.2056	97.0218	0.439	97.2228	0.2564	98.1584	0.8441
75.055	0.1569	75.2309	0.1455	95.108	0.2193	97.0239	0.4427	97.2245	0.2387	98.1597	0.8473
75.0565	0.1569	75.2325	0.1599	95.1102	0.2263	97.0259	0.4338	97.2261	0.2427	98.161	0.8555

Appendix continued 3

75.058	0.1778	75.2342	0.1693	95.1123	0.2366	97.028	0.4358	97.2278	0.2312	98.1622	0.8531
75.0595	0.1792	75.2358	0.17	95.1144	0.2556	97.0301	0.4305	97.2295	0.2154	98.1635	0.8579
75.061	0.1957	75.2374	0.1782	95.1165	0.2757	97.0321	0.4078	97.2312	0.2068	98.1647	0.8676
75.0624	0.2003	75.239	0.1834	95.1187	0.2949	97.0342	0.4017	97.2329	0.2039	98.166	0.849
75.0639	0.2116	75.2406	0.1889	95.1208	0.308	97.0362	0.3828	97.2345	0.1886	98.1672	0.8748
75.0654	0.2193	75.2422	0.2091	95.123	0.3222	97.0383	0.3713	97.2362	0.1858	98.1685	0.8612
75.0669	0.2208	75.2438	0.2196	95.1251	0.3357	97.0404	0.3538	97.2379	0.1873	98.1697	0.8845
75.0684	0.2252	75.2457	0.224	95.1272	0.3525	97.0424	0.3304	97.2396	0.1676	98.171	0.8899
75.0698	0.2397	75.2476	0.2442	95.1294	0.3726	97.0445	0.3242	97.2413	0.1653	98.1723	0.8757
75.0713	0.2467	75.2495	0.2504	95.1315	0.3727	97.0463	0.2992	97.243	0.1542	98.1735	0.9006
75.0728	0.2668	75.2513	0.2659	95.1336	0.3924	97.0481	0.2855	97.2446	0.1482	98.1748	0.9018
75.0743	0.2649	75.2532	0.2821	95.1358	0.3868	97.05	0.2679	97.2463	0.1349	98.176	0.9012
75.0758	0.2773	75.2551	0.2916	95.1379	0.3989	97.0518	0.2546	97.248	0.1325	98.1773	0.889
75.0772	0.2841	75.257	0.3115	95.1401	0.3993	97.0536	0.2394	97.2497	0.1362	98.1786	0.9208
75.0787	0.3046	75.2589	0.3235	95.1422	0.3947	97.0554	0.23	97.2514	0.1272	98.1798	0.917
75.0802	0.3126	75.2608	0.3361	95.1443	0.3922	97.0571	0.2181	97.2531	0.1227	98.1811	0.9352
75.0817	0.313	75.2627	0.3548	95.1465	0.3815	97.0587	0.2017	97.2547	0.12	98.1823	0.9134
75.0832	0.3384	75.2646	0.3669	95.1486	0.3809	97.0604	0.1946	97.2564	0.1069	98.1836	0.9475
75.0846	0.3565	75.2665	0.3629	95.1507	0.3651	97.0621	0.1905	97.2581	0.1076	98.1848	0.9451
75.0861	0.3617	75.2684	0.3828	95.1529	0.3637	97.0637	0.178	97.2598	0.1012	98.1861	0.955
75.0876	0.3665	75.2703	0.3784	95.155	0.343	97.0654	0.1613	97.2615	0.1121	98.1874	0.9684
75.0891	0.3847	75.2722	0.3895	95.1572	0.3273	97.0671	0.1683	97.9868	0.8917	98.1886	0.9519
75.0906	0.3974	75.274	0.3904	95.1593	0.3084	97.0688	0.1472	97.9885	0.8928	98.1899	0.9723
75.092	0.3974	75.2759	0.3995	95.1614	0.2969	97.0704	0.1421	97.9903	0.906	98.1911	0.9901
75.0935	0.4149	75.2778	0.3926	95.1636	0.2851	97.0721	0.1364	97.992	0.9078	98.1923	1.0019
75.095	0.4187	75.2797	0.3906	95.1657	0.2776	97.0738	0.1285	97.9937	0.9156	98.1934	1.0099
75.0965	0.43	75.2816	0.3802	95.1678	0.2634	97.0754	0.1259	97.9954	0.9181	98.1945	1.0238
75.098	0.4261	75.2835	0.3716	95.17	0.2456	97.0771	0.1168	97.9972	0.9329	98.1955	1.021
75.0995	0.4411	75.2857	0.3716	95.1721	0.2316	97.0788	0.1177	97.9989	0.9336	98.1966	1.0304
75.1009	0.4415	75.2878	0.3545	95.1743	0.2138	97.0804	0.1124	98.0006	0.932	98.1977	1.0411
75.1024	0.4384	75.29	0.349	95.1764	0.2023	97.0821	0.1089	98.0024	0.9463	98.1988	1.0485
75.1039	0.444	75.2921	0.3403	95.1785	0.1933	97.0838	0.0938	98.0041	0.9448	98.1998	1.0597
75.1054	0.4423	75.2943	0.3186	95.1807	0.1854	97.0854	0.0951	98.0058	0.9537	98.2009	1.0581
75.1069	0.441	75.2964	0.3077	95.1828	0.1776	97.0871	0.0863	98.0076	0.9612	98.202	1.0766
75.1084	0.4303	75.2986	0.2962	95.185	0.1608	97.0888	0.0746	98.0093	0.962	98.2031	1.0877
75.1098	0.4353	75.3007	0.2776	95.1871	0.1593	97.0904	0.0734	98.011	0.98	98.2042	1.0919
75.1113	0.4113	75.3029	0.256	95.1892	0.142	97.0921	0.0748	98.0128	0.9826	98.2052	1.0829
75.1128	0.4101	75.305	0.243	95.1914	0.1495	97.0938	0.0642	98.0145	1.0049	98.2063	1.0984
75.1143	0.4024	75.3072	0.2214	95.1935	0.1438	97.0955	0.0638	98.0162	1.0117	98.2074	1.1191
75.1158	0.3891	75.3093	0.2257	95.1957	0.1249	97.0971	0.0575	98.018	1.0313	98.2085	1.1123
75.1173	0.3741	75.3115	0.2107	95.1978	0.1207	97.0988	0.0501	98.0197	1.0378	98.2095	1.1228
75.1187	0.3603	75.3136	0.2059	95.1999	0.1177	97.1005	0.0511	98.0214	1.0448	98.2106	1.13
75.1202	0.3475	75.3158	0.1958	95.2021	0.1037	97.1021	0.0478	98.0232	1.0507	98.2117	1.1331
HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag	HJD (2455400+)	Δm_V/ mag
75.1217	0.3406	75.3179	0.1809	95.2042	0.0995	97.1038	0.0574	98.0249	1.0744	98.2128	1.1441
75.1232	0.3198	75.3201	0.1596	95.2064	0.0952	97.1055	0.0504	98.0266	1.086	98.2138	1.1548
75.1247	0.314	75.3222	0.1494	95.2085	0.0961	97.1072	0.0521	98.0284	1.0995	98.2149	1.1654
75.1262	0.295	75.3244	0.1415	95.2107	0.0946	97.1088	0.0493	98.0301	1.1111	98.216	1.1613
75.1276	0.2829	75.3265	0.1341	95.2128	0.0836	97.1105	0.047	98.0318	1.1264	98.2171	1.1617
75.1291	0.2732	94.9653	0.4285	95.2149	0.0793	97.1122	0.0462	98.0336	1.1426	98.2182	1.1582
75.1306	0.2577	94.9674	0.441	95.2171	0.0794	97.1138	0.0451	98.0353	1.1519	98.2192	1.1831
75.1321	0.2464	94.9696	0.4424	95.2192	0.0719	97.1155	0.0414	98.037	1.1744	98.2203	1.1662
75.1336	0.2409	94.9717	0.4356	95.2214	0.076	97.1172	0.0473	98.0388	1.1839	98.2214	1.169
75.1351	0.2304	94.9738	0.4286	95.2235	0.0758	97.1189	0.0496	98.0482	1.2167	98.2225	1.1669
75.1366	0.216	94.9759	0.4212	95.2256	0.0759	97.1205	0.0464	98.0584	1.1979	98.2235	1.1682
75.138	0.2188	94.9781	0.401	95.2278	0.077	97.1222	0.0491	98.0601	1.1873	98.2246	1.1843
75.1395	0.1925	94.9802	0.3865	95.2299	0.0752	97.1239	0.0457	98.0619	1.1805	98.2257	1.1674

Appendix continued 4

75.141	0.1856	94.9823	0.3686	95.2321	0.0824	97.1255	0.0575	98.0636	1.1654	98.2268	1.1768
75.1425	0.1795	94.9844	0.3528	95.2342	0.0815	97.1272	0.0683	98.0653	1.1533	98.2279	1.1685
75.144	0.1616	94.9866	0.3399	95.2364	0.0861	97.1289	0.0681	98.0671	1.1368	98.2289	1.1573
75.1455	0.1661	94.9887	0.3179	95.2385	0.0902	97.1306	0.0748	98.0688	1.1216	98.23	1.1546
75.147	0.1615	94.9908	0.2902	95.2407	0.0957	97.1322	0.078	98.0705	1.1019	98.2311	1.155
75.1485	0.1448	94.9929	0.2767	95.2428	0.1005	97.1339	0.0833	98.0723	1.0894	98.2322	1.1543
75.1499	0.1492	94.9951	0.2764	95.2449	0.1093	97.1356	0.0837	98.074	1.0745	98.2333	1.1437
75.1514	0.1394	94.9972	0.2557	95.2471	0.1187	97.1373	0.0886	98.0757	1.057	98.2343	1.1288
75.1529	0.1386	94.9993	0.2403	95.2492	0.1264	97.1389	0.0952	98.0775	1.0475	98.2354	1.1333
75.1544	0.1304	95.0014	0.2213	95.2514	0.132	97.1406	0.1011	98.0792	1.0352	98.2365	1.118
75.1559	0.1162	95.0036	0.2064	95.2535	0.1329	97.1423	0.1088	98.081	1.0197	98.2376	1.1279
75.1574	0.1123	95.0057	0.195	95.2557	0.1387	97.144	0.1121	98.0827	1.0034	98.2387	1.1127
75.1589	0.1115	95.0078	0.1674	95.2578	0.1479	97.1456	0.1267	98.0844	0.9922	98.2397	1.1013
75.1604	0.1065	95.01	0.1639	95.2599	0.1515	97.1473	0.1315	98.0862	0.9893	98.2408	1.0886
75.1618	0.1022	95.0121	0.1612	95.2621	0.1643	97.149	0.142	98.0879	0.9826	98.2419	1.0838
75.1633	0.0899	95.0142	0.1536	95.2642	0.1857	97.1507	0.1476	98.0896	0.9675	98.243	1.0774
75.1648	0.0851	95.0164	0.1431	95.2664	0.1867	97.1523	0.1523	98.0914	0.9563	98.2495	1.0373
75.1663	0.0897	95.0185	0.1379	95.2685	0.1918	97.154	0.1601	98.0931	0.9501	98.2506	1.0235
75.1678	0.0764	95.0206	0.1248	95.2728	0.2207	97.1557	0.1735	98.0949	0.9414	98.2516	1.0185
75.1693	0.0694	95.0227	0.1171	95.275	0.2199	97.1574	0.1792	98.0966	0.9344	98.2527	1.0134
75.1708	0.0653	95.0249	0.1087	95.2771	0.2349	97.159	0.1915	98.0983	0.9313	98.2538	1.0098
75.1723	0.0727	95.027	0.0981	95.2793	0.2539	97.1607	0.2022	98.1001	0.9176		
75.1738	0.0593	95.0291	0.0928	95.2814	0.2757	97.1624	0.2112	98.1018	0.9078		
75.1752	0.0561	95.0313	0.0944	95.2835	0.2778	97.1641	0.2237	98.1035	0.8984		

HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag
75.0203	0.0844	75.1965	0.0471	95.0596	0.0452	96.9792	0.1764	97.1863	0.3627	98.1196	1.0462
75.022	0.071	75.198	0.0535	95.0617	0.0469	96.9812	0.1837	97.188	0.379	98.1214	1.0427
75.0237	0.0854	75.1995	0.0537	95.0639	0.0553	96.9833	0.1889	97.1897	0.3784	98.1231	1.0432
75.0254	0.0838	75.201	0.0536	95.066	0.0604	96.9854	0.2038	97.1914	0.3819	98.1249	1.0262
75.0271	0.0861	75.2025	0.0501	95.0681	0.0559	96.9874	0.2138	97.193	0.3901	98.1266	1.0238
75.0288	0.0812	75.204	0.0552	95.0702	0.0589	96.9895	0.2257	97.1947	0.3844	98.1283	1.015
75.0305	0.0852	75.2056	0.0544	95.0724	0.0651	96.9915	0.2386	97.1964	0.3861	98.1301	1.034
75.0323	0.0857	75.2072	0.0598	95.0745	0.0657	96.9936	0.2516	97.1981	0.3834	98.1318	1.0088
75.034	0.0987	75.2088	0.0626	95.0766	0.0766	96.9957	0.2666	97.1998	0.3819	98.1336	1.0228
75.0357	0.0953	75.2104	0.0719	95.0788	0.08	96.9977	0.2804	97.2014	0.3836	98.1353	1.0263
75.0374	0.104	75.212	0.0713	95.0809	0.0922	96.9998	0.2992	97.2031	0.3748	98.137	1.0144
75.0391	0.1016	75.2136	0.0789	95.083	0.0979	97.0018	0.3113	97.2048	0.371	98.1385	1.0244
75.0408	0.1098	75.2153	0.0845	95.0852	0.1076	97.0039	0.3356	97.2065	0.3563	98.1399	1.027
75.0425	0.1154	75.2169	0.0958	95.0873	0.1114	97.006	0.3541	97.2082	0.3338	98.1413	1.015
75.0442	0.1275	75.2185	0.1064	95.0894	0.1181	97.008	0.3558	97.2098	0.3388	98.1427	1.023
75.0459	0.1411	75.2201	0.1093	95.0916	0.1287	97.0101	0.3781	97.2115	0.3183	98.1441	1.0259
75.0476	0.1398	75.2217	0.1008	95.0937	0.1414	97.0121	0.3929	97.2132	0.3124	98.1455	1.0189
75.0493	0.1456	75.2233	0.1086	95.0958	0.1429	97.0142	0.4068	97.2149	0.3026	98.1469	1.0267
75.051	0.1556	75.2249	0.1257	95.098	0.1548	97.0162	0.4135	97.2166	0.2891	98.1483	1.0278
75.0525	0.1547	75.2265	0.1399	95.1001	0.165	97.0183	0.4189	97.2182	0.2809	98.1496	1.0335
75.054	0.1648	75.2281	0.131	95.1022	0.1749	97.0204	0.4221	97.2199	0.2667	98.151	1.035
75.0555	0.1609	75.2298	0.1407	95.1044	0.1899	97.0224	0.4317	97.2216	0.2555	98.1524	1.0416
75.0569	0.167	75.2314	0.1548	95.1065	0.2024	97.0245	0.4241	97.2233	0.2544	98.1537	1.0386
75.0584	0.1777	75.233	0.1584	95.1086	0.2132	97.0265	0.4299	97.225	0.2363	98.155	1.0435
75.0599	0.1815	75.2346	0.1619	95.1108	0.2307	97.0286	0.4133	97.2266	0.2328	98.1563	1.0484
75.0614	0.1875	75.2362	0.1768	95.1129	0.2436	97.0307	0.4056	97.2283	0.2229	98.1575	1.0455
75.0629	0.1977	75.2378	0.1846	95.1151	0.2592	97.0327	0.3927	97.23	0.2037	98.1588	1.0515
75.0643	0.2002	75.2394	0.194	95.1172	0.2702	97.0348	0.3809	97.2317	0.1983	98.16	1.055
75.0658	0.2077	75.241	0.1995	95.1193	0.2916	97.0368	0.3742	97.2334	0.1892	98.1613	1.0648
75.0673	0.2288	75.2426	0.2167	95.1215	0.3033	97.0389	0.3499	97.235	0.1835	98.1625	1.0642

Appendix continued 5

75.0688	0.232	75.2443	0.2308	95.1236	0.3202	97.041	0.3321	97.2367	0.1624	98.1638	1.0578
75.0703	0.2336	75.2462	0.2387	95.1257	0.3419	97.043	0.3215	97.2384	0.1609	98.165	1.0723
HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag
75.0717	0.2478	75.2481	0.2525	95.1279	0.3471	97.045	0.3054	97.2401	0.1566	98.1663	1.0777
75.0732	0.2535	75.2499	0.2674	95.13	0.3589	97.0468	0.2921	97.2418	0.1552	98.1676	1.0773
75.0747	0.2666	75.2518	0.2778	95.1321	0.3678	97.0487	0.2747	97.2435	0.1461	98.1688	1.077
75.0762	0.2887	75.2537	0.2856	95.1343	0.384	97.0505	0.2523	97.2451	0.1419	98.1701	1.0814
75.0777	0.2923	75.2556	0.3067	95.1364	0.3864	97.0523	0.2467	97.2468	0.1325	98.1713	1.0946
75.0791	0.3052	75.2575	0.3208	95.1386	0.3869	97.0541	0.2211	97.2485	0.1229	98.1726	1.0826
75.0806	0.3147	75.2594	0.3384	95.1407	0.3907	97.0559	0.2182	97.2502	0.126	98.1738	1.1019
75.0821	0.3275	75.2613	0.3519	95.1428	0.3876	97.0576	0.2087	97.2519	0.117	98.1751	1.1058
75.0836	0.3478	75.2632	0.3466	95.145	0.3753	97.0592	0.1962	97.2536	0.1206	98.1764	1.1046
75.0851	0.3481	75.2651	0.3694	95.1471	0.3733	97.0609	0.1815	97.2552	0.1038	98.1776	1.1115
75.0865	0.3648	75.267	0.3735	95.1492	0.3677	97.0626	0.1767	97.2569	0.104	98.1789	1.1118
75.088	0.3742	75.2689	0.386	95.1514	0.3565	97.0642	0.1805	97.2586	0.098	98.1801	1.1158
75.0895	0.3972	75.2708	0.3871	95.1535	0.3381	97.0659	0.1557	97.2603	0.0895	98.1814	1.1386
75.091	0.3939	75.2726	0.3855	95.1557	0.3336	97.0676	0.1558	97.262	0.1052	98.1827	1.1407
75.0925	0.397	75.2745	0.3923	95.1578	0.3247	97.0692	0.1459	97.9821	1.0706	98.1839	1.1569
75.0939	0.4136	75.2764	0.3936	95.1599	0.3098	97.0709	0.146	97.9838	1.0761	98.1852	1.1457
75.0954	0.4075	75.2783	0.3773	95.1621	0.2929	97.0726	0.1361	97.9855	1.0791	98.1864	1.1632
75.0969	0.4246	75.2802	0.3805	95.1642	0.273	97.0742	0.1205	97.9872	1.0965	98.1877	1.1627
75.0984	0.4266	75.2821	0.3709	95.1664	0.2624	97.0759	0.1163	97.989	1.0938	98.189	1.1773
75.0999	0.438	75.2841	0.3531	95.1685	0.2472	97.0776	0.1203	97.9907	1.0984	98.1902	1.1834
75.1014	0.4321	75.2862	0.3505	95.1706	0.2355	97.0793	0.1045	97.9924	1.1047	98.1915	1.1797
75.1028	0.4264	75.2884	0.3352	95.1728	0.2191	97.0809	0.1011	97.9942	1.1032	98.1925	1.2006
75.1043	0.4154	75.2905	0.312	95.1749	0.2115	97.0826	0.1008	97.9959	1.117	98.1936	1.2069
75.1058	0.4169	75.2927	0.3114	95.1771	0.1977	97.0843	0.0993	97.9976	1.1173	98.1947	1.2134
75.1073	0.4195	75.2948	0.2953	95.1792	0.1864	97.0859	0.089	97.9994	1.1317	98.1958	1.232
75.1088	0.4098	75.297	0.2831	95.1813	0.1827	97.0876	0.089	98.0011	1.1264	98.1969	1.2422
75.1103	0.4071	75.2991	0.2685	95.1835	0.168	97.0893	0.0752	98.0028	1.1383	98.1979	1.2344
75.1117	0.3892	75.3013	0.2537	95.1856	0.1599	97.0909	0.0766	98.0046	1.1421	98.199	1.245
75.1132	0.3821	75.3034	0.241	95.1878	0.1496	97.0926	0.0666	98.0063	1.1418	98.2001	1.2511
75.1147	0.37	75.3056	0.2287	95.1899	0.1471	97.0943	0.0622	98.008	1.1562	98.2012	1.2646
75.1162	0.353	75.3077	0.2057	95.192	0.1354	97.0959	0.0571	98.0098	1.1639	98.2022	1.2794
75.1177	0.3424	75.3099	0.2049	95.1942	0.1303	97.0976	0.0621	98.0115	1.1691	98.2033	1.2692
75.1192	0.3401	75.312	0.1857	95.1963	0.1178	97.0993	0.0574	98.0132	1.187	98.2044	1.2701
75.1206	0.323	75.3142	0.1649	95.1985	0.1208	97.101	0.0537	98.015	1.1934	98.2055	1.2956
75.1221	0.3177	75.3163	0.171	95.2006	0.1062	97.1026	0.052	98.0167	1.2083	98.2065	1.2926
75.1236	0.2964	75.3185	0.1602	95.2027	0.0983	97.1043	0.0483	98.0184	1.2149	98.2076	1.3135
75.1251	0.2918	75.3206	0.1453	95.2049	0.096	97.106	0.044	98.0202	1.2261	98.2087	1.3089
75.1266	0.2718	75.3228	0.1438	95.207	0.0923	97.1076	0.0425	98.0219	1.2471	98.2098	1.3236
75.1281	0.2589	75.3249	0.14	95.2092	0.0881	97.1093	0.0443	98.0236	1.2446	98.2108	1.3142
75.1296	0.2518	75.3271	0.1197	95.2113	0.0802	97.111	0.0454	98.0253	1.2701	98.2119	1.3268
75.131	0.246	94.9659	0.4334	95.2134	0.0806	97.1127	0.0469	98.0271	1.2783	98.213	1.3468
75.1325	0.2262	94.9681	0.4295	95.2156	0.0801	97.1143	0.0432	98.0288	1.2871	98.2141	1.355
75.134	0.2183	94.9702	0.429	95.2177	0.0782	97.116	0.0497	98.0305	1.3009	98.2152	1.3446
75.1355	0.2122	94.9723	0.4167	95.2199	0.0808	97.1177	0.0531	98.0323	1.3213	98.2162	1.3558
75.137	0.2044	94.9744	0.4213	95.222	0.0759	97.1193	0.0587	98.034	1.3289	98.2173	1.3424
75.1385	0.1888	94.9766	0.387	95.2242	0.0743	97.121	0.0563	98.0357	1.3446	98.2184	1.3573
75.14	0.1842	94.9787	0.3848	95.2263	0.0713	97.1227	0.0567	98.0375	1.358	98.2195	1.3551
75.1414	0.1829	94.9808	0.3674	95.2284	0.0718	97.1244	0.0608	98.0392	1.3698	98.2206	1.3644
75.1429	0.1693	94.9829	0.3612	95.2306	0.083	97.126	0.062	98.0487	1.4049	98.2216	1.3603
75.1444	0.1533	94.9851	0.3168	95.2327	0.0834	97.1277	0.0719	98.0589	1.385	98.2227	1.3707
75.1459	0.1514	94.9872	0.3231	95.2349	0.0916	97.1294	0.0762	98.0606	1.3706	98.2238	1.3607
75.1474	0.1595	94.9893	0.3024	95.237	0.0854	97.1311	0.0794	98.0623	1.3559	98.2249	1.3598
75.1489	0.139	94.9915	0.2935	95.2391	0.0914	97.1327	0.0801	98.0641	1.3417	98.2259	1.3584

Appendix continued 6

75.1504	0.1337	94.9936	0.2786	95.2413	0.0917	97.1344	0.0893	98.0658	1.3338	98.227	1.359
75.1519	0.1227	94.9957	0.2586	95.2434	0.1001	97.1361	0.0906	98.0675	1.3179	98.2281	1.3565
75.1533	0.1229	94.9978	0.2355	95.2456	0.1043	97.1378	0.0913	98.0693	1.3032	98.2292	1.3538
75.1548	0.1184	95	0.2154	95.2477	0.1116	97.1394	0.1017	98.071	1.2916	98.2303	1.3379
75.1563	0.1064	95.0021	0.1962	95.2499	0.1107	97.1411	0.1115	98.0727	1.2779	98.2313	1.3511
75.1578	0.0992	95.0042	0.2009	95.252	0.1335	97.1428	0.1096	98.0745	1.2598	98.2324	1.3341
75.1593	0.0995	95.0063	0.1784	95.2542	0.1329	97.1444	0.1177	98.0762	1.2552	98.2335	1.3401
75.1608	0.0933	95.0085	0.1726	95.2563	0.1358	97.1461	0.1225	98.0779	1.234	98.2346	1.3193
75.1623	0.0791	95.0106	0.156	95.2584	0.1434	97.1478	0.1324	98.0797	1.2214	98.2357	1.314
75.1638	0.08	95.0127	0.1591	95.2606	0.1573	97.1495	0.1295	98.0814	1.2051	98.2367	1.3094
75.1652	0.0839	95.0148	0.1453	95.2649	0.1745	97.1512	0.1443	98.0831	1.202	98.2378	1.2965
75.1667	0.0831	95.017	0.1367	95.267	0.1721	97.1528	0.1541	98.0849	1.1881	98.2389	1.2975
75.1682	0.0678	95.0191	0.127	95.2735	0.2124	97.1545	0.1649	98.0866	1.1807	98.24	1.2866
75.1697	0.0724	95.0212	0.1141	95.2756	0.2253	97.1562	0.1682	98.0884	1.172	98.2411	1.284
75.1712	0.0654	95.0234	0.1049	95.2777	0.2327	97.1579	0.1785	98.0901	1.1558	98.2421	1.2867
75.1727	0.056	95.0255	0.1005	95.2799	0.2507	97.1595	0.1863	98.0918	1.1449	98.2432	1.2894
75.1742	0.0592	95.0276	0.0975	95.282	0.2595	97.1612	0.1955	98.0936	1.1367	98.2443	1.2781
75.1757	0.056	95.0298	0.0898	95.2842	0.2831	97.1629	0.2033	98.0953	1.1277	98.2454	1.252
HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag	HJD (2455400+)	Δm_R/ mag
75.1772	0.0498	95.0319	0.0846	95.2863	0.2952	97.1646	0.2223	98.097	1.1253	98.2465	1.2573
75.1786	0.0445	95.034	0.07	95.2885	0.3252	97.1662	0.2278	98.0988	1.1149	98.2475	1.2558
75.1801	0.0526	95.0362	0.0681	95.2906	0.3386	97.1679	0.2379	98.1005	1.1061	98.2486	1.2353
75.1816	0.0488	95.0383	0.0654	95.2928	0.346	97.1696	0.2558	98.1023	1.1016	98.2497	1.2266
75.1831	0.0426	95.0404	0.0616	95.2949	0.352	97.1713	0.2622	98.104	1.1009	98.2508	1.2234
75.1846	0.0541	95.0425	0.0593	95.2971	0.3661	97.1729	0.2808	98.1057	1.0884	98.2519	1.2124
75.1861	0.0447	95.0447	0.0553	95.2992	0.3893	97.1746	0.2909	98.1075	1.0875	98.253	1.2046
75.1876	0.046	95.0468	0.0529	95.3014	0.4022	97.1763	0.3114	98.1092	1.0829	98.2541	1.2072
75.1891	0.0419	95.0489	0.0504	96.9689	0.1405	97.178	0.3143	98.111	1.0727		
75.1906	0.041	95.0511	0.0417	96.971	0.1531	97.1796	0.3316	98.1127	1.0695		
75.1921	0.0454	95.0532	0.0392	96.973	0.1493	97.1813	0.341	98.1144	1.0593		
75.1935	0.0413	95.0553	0.0423	96.9751	0.1593	97.183	0.3521	98.1162	1.0534		
75.195	0.0479	95.0575	0.0438	96.9771	0.1713	97.1847	0.3594	98.1179	1.0505		