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PHOTOMETRY OF HIGH-AMPLITUDE DELTA SCUTI STARS

WILS, PATRICK¹; PANAGIOTOPOULOS, KOSTAS^{2,3}; VAN WASSENHOVE, JEROEN¹; AYIOMAMITIS, ANTHONY^{2,4}; NIEUWENHOUT, FRANS⁵; ROBERTSON, C.W.⁶; VANLEENHOVE, MAARTEN¹; HAMBSCH, FRANZ-JOSEF^{1,7}; HAUTECLER, HUBERT¹; PICKARD, ROGER D.⁸; BAILLIEN, ANTOINE¹; STAEELS, BART^{1,9}; KLEIDIS, STELIOS^{2,10}; LAMPENS, PATRICIA¹¹; VAN CAUTEREN, PAUL^{1,11}

¹ Vereniging Voor Sterrenkunde, Belgium; e-mail: patrickwils@yahoo.com

² Helliniki Astronomiki Enosi, Greece

³ Pouda Observatory, Diakopto, Greece

⁴ Perseus Observatory, Athens, Greece

⁵ Werkgroep Veranderlijke Sterren, The Netherlands

⁶ SETEC Observatory, Goddard, Kansas, USA

⁷ Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. Germany

⁸ British Astronomical Association, UK

⁹ Center for Backyard Astrophysics Flanders

¹⁰ Zagori Observatory, Epirus, Greece

¹¹ Koninklijke Sterrenwacht van België (ROB), Brussel, Belgium

In this paper we report 432 further times of maxima for 64 High-Amplitude Delta Scuti Stars (HADS), following the reports of Wils et al. (2009, 2010, 2011). The majority of the data were obtained during 2011.

The observers and their instruments are listed in Table 1. The times of maxima obtained are given as an Appendix in Table 4. When the same maximum was observed in more than one filter, the table shows the average value of the times obtained in each band individually. The method used to calculate the times of maximum is described in Wils et al. (2009).

Elements for the previously unknown HADS GSC 3004-0870 (magnitude range 13.2-13.8V, J2000 position: 10^h21^m35^s.33 +40°31'41"2) are given in Table 2, together with elements for a number of other stars that have been observed in detail the past year, or for which the existing ephemeris deviates substantially from our recent observations. To get a better precision, use was made of data from the ASAS (Pojmański, 2002), NSVS (Woźniak et al., 2004) and SuperWASP surveys (Butters et al., 2010).

The star GSC 1924-1134 (= NSVS 7293918) discovered by Hoffman, Harrison and McNamara (2009) was found to be a double-mode HADS from observations by FN. It is pulsating in the fundamental and first overtone modes, with a period ratio of 0.7737, typical of other stars of the class and period (Poretti et al., 2005). The independent frequencies, and their amplitudes and phases, determined using Period04 (Lenz & Breger, 2005) are given in Table 3. The linear combinations $f_0 + f_1$ and $2f_0 + f_1$ of these independent frequencies were detected as well.

Table 1: List of instruments used for the observations.

Code	Observer(s)	Telescope	Observatory	CCD
AA	AA	Refractor 16 cm	Perseus Observatory	SBIG ST-10XME
AA30	AA	Refractor 30 cm	Perseus Observatory	SBIG ST-10XME
AB	AB	Refractor 10 cm	Carpe Noctem Observatory	SBIG ST-9E
BHO	PL+PVC	Newton 25 cm	Beersel Hills Observatory	SBIG ST-10XME
FN	FN	Catadioptric 40 cm	Alkmaar, Nederland	SBIG ST-7XME
FN25	FN	Catadioptric 25 cm	Alkmaar, Nederland	SBIG ST402XME
HHU	HH	Catadioptric 20 cm	Roosbeek Lake Observatory	SBIG ST-7XME
HMB4	FJH	Catadioptric 35 cm	Mol, Belgium	SBIG ST-8
HMB8	FJH	Ritchey-Chrétien 20 cm	Mol, Belgium	SBIG ST-8XME
HMBC	FJH	Catadioptric 28 cm	Mol, Belgium	SBIG ST-10XME
HMBH	FJH	Hypergraph 40 cm	Mol, Belgium	SBIG STL-11000XM
KP	KP	Modified Cassegrain 26 cm	Pouda Observatory	SBIG ST-10XME
MAV	MV	Newton 25 cm	Leest Observatory	SBIG ST-10XME
RP	RDP	Catadioptric 36 cm	Shobdon, UK	Starlight XPress SXV-H9
SBL	BS	Cassegrain 28 + 23.5 cm	Alan Guth Observatory	Starlight XPress MX-716
SK	SK	Catadioptric 30 cm	Zagori Observatory	SBIG ST-7XMEI
SO30	CWR	Catadioptric 30 cm	SETEC Observatory	SBIG ST-8XME
SO40	CWR	Catadioptric 40 cm	SETEC Observatory	SBIG ST-8XME
VWS	JVW	Refractor 15.2 cm	Hooglede, Belgium	SBIG ST-7XME

Some of the objects observed earlier turned out to be multiperiodic variables: V337 Ori (observations from MV, RDP and FN), GSC 1621-1643 (FJH), GSC 2847-0586 (FJH, KP and MV), GSC 3490-0814 = V1139 Her (KP, AA and MV) and GSC 4464-0924 (JVW and HH). The frequencies detected in these stars are also listed in Table 3. In all of these stars also the combination frequency $f_0 + f_1$ was detected. In V337 Ori the modes $2f_0 + f_1$ and $f_1 - f_0$ were detected as well. In GSC 2847-0586, a possible third independent frequency may have been detected at 6.373 c/d, but with a signal-to-noise ratio of 4.0 it is barely significant. For GSC 4464-0924 the influence of the secondary frequency on the time of maximum is negligible, so that its observed maxima are also included in Table 4. A sample light curve of V1139 Her is given in Fig. 1.

The period of GSC 4556-1113 seems to vary cyclically. Especially during the recent data when the star was followed closely by JVW, the $O - C$ varied with a period of 164 ± 3 days and an amplitude of 68 ± 6 seconds. The recent $O - C$ data, covering almost three of these cycles are given in Fig. 2. If the origin of this cyclical variation is the light-travel time effect caused by an unknown companion in a circular orbit, some further details can be calculated from the $O - C$ of the maxima or from the full light curve data as shown by Shibahashi & Kurtz (2012). Both methods give equivalent results. It follows that the projected radius $asini$ of the orbit of the pulsating star equals 0.137(5) AU, its projected orbital velocity $9.1 (\pm 0.4)$ km/s. Finally the mass function $f(m_1, m_2, \sin i) = 0.0126(13)M_\odot$, suggesting the companion is a red dwarf. Companions of HADS have been suggested before from $O - C$ data, but in many cases these are invalidated by further observations. Only in the case of SZ Lyn (Moffett et al., 1988) the presence of a companion is established without any doubt, as almost 16 cycles of the 1180 day orbital period have now been observed. Further observations are required to make sure the companion of GSC 4556-1113 is real as well.

GSC 4431-1487, one of the comparison stars used (for LW Dra), was found to be variable by one of us (JVW). It turns out to be a W UMa type variable with a period of 0.2548 days. The photometry for this object, together with those from Table 3, are

available from the IBVS website. GSC 1320-119 near V337 Ori is likely a new eclipsing variable with rare eclipses. It was found to have faded by about 0.4 magnitudes on JD 2455623 by one of us (MV).

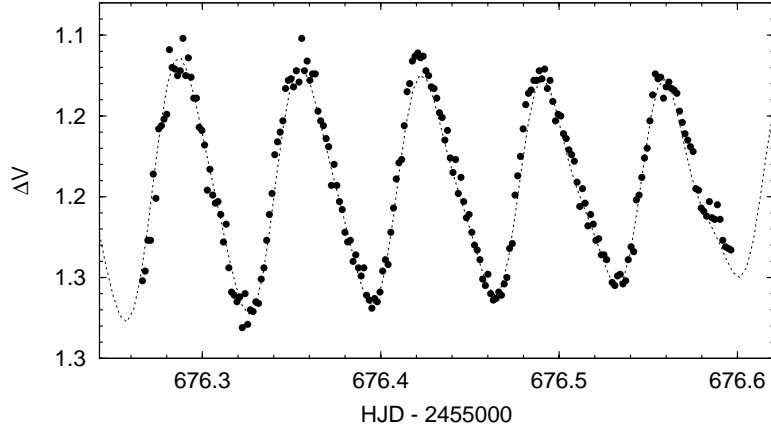


Figure 1. One night of data of V1139 Her plotted with the model light curve with all detected frequencies.

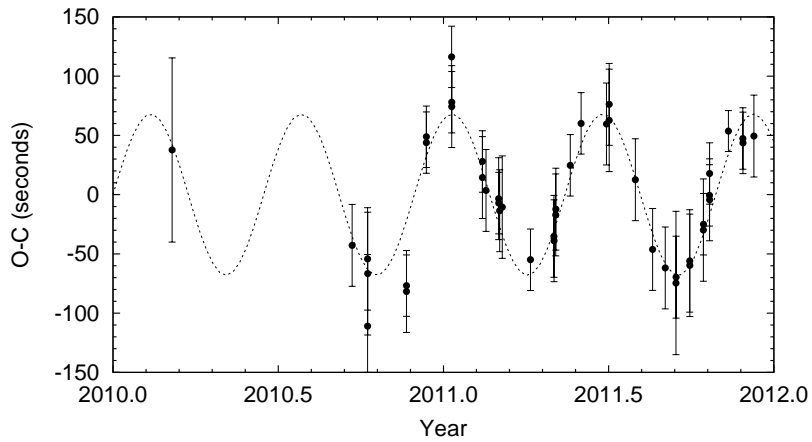


Figure 2. $O - C$ graph of GSC 4556-1113 with respect to a linear ephemeris. A proposed cyclical model with a period of 164 days and an amplitude of 68 seconds is added as a dotted line.

Table 2: Updated elements of known HADS. Uncertainties are given in units of the last decimal.

Star	Max (HJD)	Period (d)
V376 Cam	2454823.4142(1)	0.14032368(2)
GSC 2290-1195	2454410.548(3)	0.0779984(3)
GSC 3004-0870	2455601.4482(4)	0.08215879(2)
GSC 3428-1497	2455571.5826(3)	0.07484470(3)

Table 3: Independent frequencies detected in multiperiodic HADS. Uncertainties are given in units of the last decimal. The phase is given with respect to HJD = 0. Observations were obtained with a V filter.

Star		Frequency c/d	Semi-Amplitude Mag.	Phase
V1139 Her	f_0	14.57979(4)	0.0761(5)	0.497(1)
	f_1	13.7999(2)	0.0195(5)	0.993(4)
V337 Ori	f_0	4.968695(3)	0.182(2)	0.803(1)
	f_1	6.72403(3)	0.022(2)	0.383(9)
GSC 1621-1643	f_0	8.72095(8)	0.135(1)	0.235(1)
	f_1	12.1152(4)	0.022(1)	0.763(9)
GSC 1924-1134	f_0	11.29473(4)	0.1914(6)	0.0797(5)
	f_1	14.5982(5)	0.0169(7)	0.062(6)
GSC 2847-0586	f_0	7.077126(2)	0.1136(4)	0.0948(6)
	f_1	6.95255(1)	0.0171(4)	0.339(4)
GSC 4464-0924	f_0	12.402261(5)	0.1807(5)	0.0441(4)
	f_1	18.54333(7)	0.0113(5)	0.801(7)

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Appendix:

Table 4: Observed times of maximum (Epoch = HJD - 2400000).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
GP And	55834.3764	0.0001	KP	BV	YZ Boo	55669.6213	0.0009	SBL	V
	55836.5010	0.0003	FN	V		55674.8256	0.0005	SO40	V
	55836.5797	0.0003	FN	V		55689.7107	0.0004	SO40	V
	55855.4635	0.0009	HMB4	V		55689.8148	0.0004	SO40	V
	55856.4078	0.0010	HMB4	V		55705.3246	0.0013	AA30	C
	55877.3372	0.0013	HMB4	V		55705.4286	0.0019	AA30	C
	55877.4153	0.0015	HMB4	V		55707.4067	0.0004	AA30	C
	55904.2470	0.0004	KP	V		55707.5102	0.0004	AA30	C
	55904.3257	0.0004	KP	V		55718.6480	0.0006	SO40	V
	55904.4042	0.0005	KP	V		55718.7523	0.0005	SO40	V
V460 And	55590.3099	0.0008	FN	V	55718.8562	0.0005	SO40	V	
	55590.3844	0.0007	FN	V	55750.7084	0.0005	SO40	V	
	55590.4591	0.0003	FN	V	55750.8125	0.0008	SO40	V	
	55856.2666	0.0004	HHU	C	BL Cam	55893.4535	0.0004	AA30	C
	55856.3408	0.0002	HHU	C		55893.4924	0.0003	AA30	C
	55889.6329	0.0005	SO40	V		55893.5318	0.0003	AA30	C
	55889.7076	0.0007	SO40	V		55893.5710	0.0004	AA30	C
	55889.7826	0.0003	SO40	V	V367 Cam	55625.3385	0.0004	HMB4	VI
	55889.8579	0.0004	SO40	V		55626.4331	0.0008	HMB4	VI
	55889.9325	0.0006	SO40	V		55627.2837	0.0008	HMB4	V
	55890.0072	0.0005	SO40	V		55627.4063	0.0010	HMB4	V
	55893.6067	0.0004	SO40	V		55628.3786	0.0015	HMB4	V
	55893.6820	0.0004	SO40	V		55629.3516	0.0009	HMB4	V
	55893.7568	0.0005	SO40	V	55631.2980	0.0005	SK	BR	
	55893.8316	0.0007	SO40	V	55861.3568	0.0009	MAV	V	
	55893.9067	0.0006	SO40	V	55861.4784	0.0012	MAV	V	
	55893.9823	0.0006	SO40	V	V376 Cam	55599.2639	0.0004	KP	V
	55894.5813	0.0006	SO40	V		55599.4041	0.0004	KP	V
	55894.6564	0.0003	SO40	V		55599.5444	0.0002	KP	V
	55894.7316	0.0003	SO40	V		55643.3253	0.0007	VWS	V
55894.8064	0.0005	SO40	V	55643.4658		0.0003	VWS	V	
55894.8812	0.0004	SO40	V	55646.2723		0.0004	KP	V	
55894.9565	0.0005	SO40	V	55646.4127		0.0004	KP	V	
55897.2054	0.0005	AA30	C	55649.3594		0.0004	VWS	V	
55897.2808	0.0004	AA30	C	55715.4520		0.0003	VWS	V	
55897.3556	0.0003	AA30	C	55848.3387		0.0006	MAV	V	
V524 And	55834.5624	0.0007	FN	V	55857.3194	0.0003	VWS	V	
	55834.6567	0.0006	FN	V	AD CMi	55623.3957	0.0011	HHU	C
	55838.2473	0.0009	KP	V		V792 Cep	55839.3461	0.0009	KP
	55838.3417	0.0007	KP	V	55839.4790		0.0005	KP	V
	55838.4362	0.0004	KP	V	55839.6125	0.0005	KP	V	
	55875.2877	0.0004	HHU	C	XX Cyg	55729.4472	0.0006	HHU	C
	55905.3365	0.0006	KP	V		55751.6988	0.0002	SO40	V
	55905.4308	0.0008	KP	V		55751.8337	0.0003	SO40	V
	55905.5250	0.0010	KP	V		55799.7108	0.0002	SO40	V
	V544 And	55851.2895	0.0004	HHU	C	55804.7008	0.0002	SO40	V
55870.2183		0.0006	KP	V	55804.8357	0.0002	SO40	V	
55870.3251		0.0004	KP	V	55809.6908	0.0002	SO40	V	
55870.4321		0.0004	KP	V	55809.8257	0.0002	SO40	V	
CY Aqr	55870.5389	0.0005	KP	V	55866.3353	0.0006	HHU	C	
	55833.3662	0.0004	HHU	C	V2455 Cyg	55820.3878	0.0011	HHU	C
	55848.3207	0.0004	KP	V		55855.3385	0.0004	HHU	C
YZ Boo	55905.2695	0.0001	HHU	C	LW Dra	55676.4152	0.0006	VWS	V
	55604.4597	0.0004	KP	B		55706.4260	0.0008	VWS	V
	55604.5637	0.0003	KP	B		55799.6521	0.0013	SO30	V
	55604.6675	0.0002	KP	B		55824.3433	0.0007	VWS	V
	55669.4122	0.0015	SBL	V		55829.4235	0.0007	VWS	V
55669.5166	0.0012	SBL	V	55832.3773	0.0007	VWS	V		

Table 4: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter	
LW Dra	55833.3230	0.0006	VWS	V	DW Psc	55894.3975	0.0003	KP	C	
	55833.4410	0.0006	VWS	V		55895.2326	0.0004	KP	C	
	55834.3861	0.0009	VWS	V		55895.2921	0.0007	KP	C	
	55836.3946	0.0009	VWS	V		GW UMa	55579.5936	0.0008	KP	V
	55849.3916	0.0009	VWS	V			55580.4056	0.0018	RP	V
55878.4574	0.0009	VWS	V	55580.6099	0.0012		RP	V		
DY Her	55718.7057	0.0006	SO30	V	55604.3831	0.0009	AA	C		
	55718.8540	0.0005	SO30	V	55672.4532	0.0017	RP	V		
	55750.8095	0.0006	SO30	V	QV Vir	55633.4015	0.0018	AA	C	
	55751.7018	0.0008	SO30	V		55633.4680	0.0010	AA	C	
KZ Hya	55751.8501	0.0003	SO30	V		55633.5352	0.0007	AA	C	
	55601.4111	0.0003	AA	C		55633.6029	0.0014	AA	C	
	55601.4705	0.0002	AA	C	GSC 0191-1282	55623.2787	0.0011	HMBC	V	
55601.5298	0.0002	AA	C	55623.3257		0.0005	HMBC	V		
KZ Lac	55833.5293	0.0015	FN	V		55623.3739	0.0008	HMBC	V	
	55833.6334	0.0019	FN	V		55623.4202	0.0007	HMBC	V	
	55849.5041	0.0012	FN	V		55624.4171	0.0003	HMBC	V	
	55849.6087	0.0020	FN	V		55628.3523	0.0005	FN25	V	
	55854.4116	0.0007	KP	V		55628.3991	0.0003	FN25	V	
	55854.5154	0.0010	KP	V		55635.2758	0.0006	AA	C	
	55854.6197	0.0015	KP	V		55635.3226	0.0006	AA	C	
	55869.2386	0.0013	KP	V		55635.3708	0.0007	AA	C	
55869.3433	0.0011	KP	V	GSC 0321-0314	55677.4380	0.0005	HHU	C		
55869.4467	0.0010	KP	V	GSC 0429-2098	55715.4915	0.0008	HHU	C		
EH Lib	55675.4272	0.0002	AA	C	GSC 0612-0771	55849.5056	0.0007	HMB8	V	
	55675.5156	0.0002	AA	C	GSC 0753-1489	55589.4289	0.0004	HHU	C	
SZ Lyn	55583.5449	0.0008	RP	V	55627.3805	0.0005	MAV	V		
	55583.6652	0.0007	RP	V	GSC 1076-0158	55775.4294	0.0007	HHU	C	
	55587.6425	0.0008	SO30	V		55850.3085	0.0007	FN	V	
	55587.7633	0.0005	SO30	V		55850.3955	0.0010	FN	V	
	55587.8839	0.0006	SO30	V	GSC 1158-0921	55824.3442	0.0006	MAV	V	
	55588.6074	0.0008	SO30	V		55824.4089	0.0007	MAV	V	
	55588.7273	0.0015	SO30	V		55836.4205	0.0004	FN	V	
	55588.8483	0.0007	SO30	V		55849.3368	0.0006	HMB8	V	
	55588.9688	0.0008	SO30	V		55849.4013	0.0006	HMB8	V	
	55629.3475	0.0004	HHU	C		55849.4656	0.0008	HMB8	V	
	V593 Lyr	55703.4063	0.0004	AA30	C	55850.3060	0.0005	HMB8	V	
		55703.5085	0.0003	AA30	C	55850.3701	0.0005	HMB8	V	
		55782.4717	0.0004	RP	V	55850.4344	0.0006	HMB8	V	
		55834.3640	0.0006	AB	C	55853.2765	0.0005	KP	V	
	V1162 Ori	55590.6022	0.0010	SO30	V	55853.3410	0.0005	KP	V	
55590.6793		0.0011	SO30	V	55899.2570	0.0006	AA30	C		
55590.7584		0.0015	SO30	V	GSC 1220-1131	55578.2621	0.0007	HHU	C	
55591.3082		0.0018	BHO	V		55855.4001	0.0012	HHU	C	
DY Peg		55806.3643	0.0004	MAV		V	GSC 1306-0466	55571.4641	0.0004	HHU
	55806.4374	0.0005	MAV	V	55601.4275	0.0021		AB	C	
	55848.4427	0.0004	FN	V	55630.3555	0.0017	FN25	V		
	55848.5157	0.0002	FN	V	GSC 1442-1358	55601.5056	0.0008	HMBC	V	
	55854.2768	0.0003	KP	V		55601.5872	0.0005	HMBC	V	
	55854.3501	0.0002	KP	V		55601.6691	0.0003	HMBC	V	
	55903.2832	0.0012	RP	V		55660.3804	0.0004	HHU	C	
	55903.3564	0.0004	RP	V	55674.3394	0.0007	AA	C		
	55903.4292	0.0002	RP	V	55674.4213	0.0008	AA	C		
	DW Psc	55850.4960	0.0008	FN	V	GSC 1750-1237	55837.5423	0.0006	FN	V
55850.5561		0.0005	FN	V	55877.3779		0.0008	HMB8	V	
55894.2197		0.0006	KP	C	GSC 2043-1201	55688.3253	0.0011	AA	C	
55894.2788		0.0002	KP	C		55688.4027	0.0008	AA	C	
55894.3379		0.0003	KP	C		55688.4805	0.0009	AA	C	

Table 4: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
GSC 2043-1201	55688.5584	0.0006	AA	C	GSC 3428-1497	55571.6567	0.0008	HMB8	V
GSC 2080-0986	55834.3094	0.0007	FN	V		55571.7318	0.0009	HMB8	V
	55834.4085	0.0007	FN	V		55625.3220	0.0009	HHU	C
GSC 2108-1564	55739.4349	0.0008	HMB8	V		55673.2974	0.0008	AA	C
	55739.5327	0.0010	HMB8	V		55673.3709	0.0007	AA	C
	55835.3969	0.0012	AB	C		55673.4463	0.0012	AA	C
GSC 2290-1195	55500.4988	0.0012	FN	V		55673.5202	0.0015	AA	C
	55500.5749	0.0009	FN	V		55880.4685	0.0010	MAV	V
	55838.3855	0.0013	HHU	C	GSC 3483-0746	55682.4568	0.0008	RP	V
GSC 2566-1398	55659.4801	0.0008	RP	V		55682.5691	0.0007	RP	V
	55659.5712	0.0006	RP	V	GSC 3489-0868	55713.3338	0.0008	AA30	C
	55714.3586	0.0006	AA30	C		55713.4204	0.0004	AA30	C
	55714.4492	0.0005	AA30	C		55729.3637	0.0005	AA30	C
	55714.5394	0.0005	AA30	C		55729.4504	0.0005	AA30	C
GSC 2696-1396	55829.3994	0.0005	HHU	C		55729.5369	0.0007	AA30	C
	55880.3186	0.0004	FN	V	GSC 3755-0845	55571.2812	0.0011	SBL	V
GSC 2843-1999	55572.3925	0.0028	HMB8	V		55629.3439	0.0007	FN	V
	55578.3535	0.0022	HMB8	V		55834.4275	0.0014	MAV	V
	55829.3389	0.0007	MAV	V		55834.5032	0.0009	MAV	V
	55829.4010	0.0008	MAV	V		55835.4178	0.0015	MAV	V
	55829.4625	0.0007	MAV	V		55835.4938	0.0015	MAV	V
	55856.2877	0.0006	MAV	V		55835.5686	0.0012	MAV	V
	55856.3499	0.0006	MAV	V		55893.2514	0.0007	MAV	V
	55856.4122	0.0005	MAV	V		55893.3274	0.0007	MAV	V
	55856.4741	0.0005	MAV	V		55893.4034	0.0008	MAV	V
	55880.2561	0.0008	MAV	V		55893.4037	0.0015	AB	C
	55880.3184	0.0007	MAV	V		55905.4261	0.0018	RP	V
	55880.3798	0.0007	MAV	V		55905.5040	0.0021	RP	V
	55887.2110	0.0005	AA30	C		55905.5797	0.0019	RP	V
	55887.2729	0.0006	AA30	C		55905.6554	0.0012	RP	V
	55887.3351	0.0007	AA30	C	GSC 3832-0152	55569.4240	0.0004	KP	V
	55887.3972	0.0006	AA30	C		55569.5153	0.0004	KP	V
	55887.4589	0.0004	AA30	C		55569.6065	0.0004	KP	V
GSC 2861-0970	55571.4510	0.0007	HMB8	V		55569.6979	0.0003	KP	V
	55594.3531	0.0005	RP	C		55641.3103	0.0016	HHU	C
	55641.3678	0.0005	FN	V		55641.4015	0.0008	HHU	C
	55859.2661	0.0006	MAV	V		55643.5027	0.0009	RP	V
	55859.3763	0.0007	MAV	V		55655.5595	0.0005	RP	V
	55882.2786	0.0006	MAV	V		55655.6509	0.0006	RP	V
	55882.3884	0.0006	MAV	V		55672.3665	0.0007	HHU	C
GSC 2977-0238	55570.3886	0.0002	KP	V		55672.4576	0.0005	HHU	C
	55570.4645	0.0003	KP	V		55684.4238	0.0004	FN25	V
	55592.4880	0.0013	RP	C		55684.5154	0.0004	FN25	V
	55592.5619	0.0007	RP	C		55684.6067	0.0003	FN25	V
	55592.6379	0.0007	RP	C	GSC 3863-0740	55576.5371	0.0022	KP	C
	55592.7138	0.0010	RP	C		55646.5217	0.0017	RP	V
	55629.3900	0.0004	FN25	V		55649.2944	0.0032	KP	V
	55644.2727	0.0004	KP	V		55676.5745	0.0023	RP	V
	55675.4058	0.0005	FN	V		55866.3658	0.0017	MAV	V
GSC 3004-0870	55601.4481	0.0003	HHU	C	GSC 3934-1904	55729.5173	0.0008	HMBH	C
	55627.4103	0.0006	HHU	C		55836.3808	0.0033	AB	C
	55641.3780	0.0012	AB	C	GSC 4417-0394	55603.5225	0.0008	KP	V
	55683.3606	0.0014	FN	V		55603.6546	0.0007	KP	V
	55683.4428	0.0008	FN	V		55730.3444	0.0008	AA30	C
GSC 3074-0114	55639.4398	0.0007	AA	C		55730.4767	0.0006	AA30	C
	55639.4911	0.0006	AA	C	GSC 4464-0924	55582.2948	0.0005	VWS	V
	55639.5423	0.0009	AA	C		55582.3750	0.0003	VWS	V
GSC 3428-1497	55571.5826	0.0007	HMB8	V		55591.3250	0.0017	VWS	V

Table 4: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter	
GSC 4464-0924	55661.3921	0.0009	VWS	V	GSC 4556-1113	55684.4712	0.0004	VWS	V	
	55661.4740	0.0006	VWS	V		55686.3710	0.0004	VWS	V	
	55661.5532	0.0010	VWS	V		55686.4574	0.0004	VWS	V	
	55670.3415	0.0006	VWS	V		55702.4313	0.0003	VWS	V	
	55670.4239	0.0007	VWS	V		55714.4334	0.0003	VWS	V	
	55670.5034	0.0010	VWS	V		55742.4949	0.0004	VWS	V	
	55670.5855	0.0009	VWS	V		55745.4306	0.0005	VWS	V	
	55716.4635	0.0004	VWS	V		55745.5171	0.0004	VWS	V	
	55836.3616	0.0006	HHU	C		55774.4413	0.0004	VWS	V	
	55866.2748	0.0004	VWS	V		55793.4361	0.0004	VWS	V	
	55866.3554	0.0012	VWS	V		55807.4235	0.0004	VWS	V	
	55906.2670	0.0015	VWS	V		55819.3387	0.0007	VWS	V	
	55906.3483	0.0005	VWS	V		55819.4251	0.0004	VWS	V	
	GSC 4500-0083	55601.3466	0.0017	HHU		C	55834.5353	0.0005	VWS	V
		55818.3532	0.0018	MAV		V	55834.6216	0.0005	VWS	V
55818.4399		0.0016	MAV	V	55849.5593	0.0005	VWS	V		
55836.3027		0.0019	KP	V	55849.6457	0.0003	VWS	V		
55836.3869		0.0010	KP	V	55856.2944	0.0003	VWS	V		
GSC 4552-1498	55580.4278	0.0002	KP	C	55856.3807	0.0004	VWS	V		
	55580.4838	0.0003	KP	C	55856.4673	0.0003	VWS	V		
	55580.5394	0.0002	KP	C	55877.2764	0.0002	VWS	V		
	55580.5952	0.0003	KP	C	55893.2498	0.0003	VWS	V		
	55580.6512	0.0003	KP	C	55893.3361	0.0003	VWS	V		
	55640.3689	0.0003	HHU	C	55905.4242	0.0004	VWS	V		
	55640.3693	0.0003	FN	V	GSC 4638-0455	55605.4094	0.0005	KP	V	
	55640.4251	0.0003	FN	V		55605.5059	0.0005	KP	V	
	55646.2850	0.0003	AA	C		55605.6026	0.0004	KP	V	
	55646.3407	0.0004	AA	C		55625.4078	0.0005	VWS	V	
55646.3967	0.0003	AA	C	55660.3807		0.0005	VWS	V		
55646.4523	0.0003	AA	C	GSC 4923-0693	55655.3007	0.0009	AA	C		
55683.3999	0.0003	FN25	V		55655.3663	0.0009	AA	C		
GSC 4556-1113	55571.2772	0.0003	VWS		V	55655.4332	0.0009	AA	C	
	55571.3631	0.0003	VWS	V	55661.4215	0.0007	AB	C		
	55571.4494	0.0004	VWS	V	55663.4194	0.0006	RP	V		
	55605.2952	0.0004	VWS	V	55663.4854	0.0008	RP	V		
	55605.3817	0.0003	VWS	V	GSC 5018-1085	55676.3172	0.0008	AA	C	
	55609.3532	0.0004	VWS	V		55676.3857	0.0004	AA	C	
	55623.3407	0.0004	VWS	V		55676.4546	0.0004	AA	C	
	55623.4270	0.0003	VWS	V		55676.5236	0.0004	AA	C	
	55624.3767	0.0004	VWS	V		NSVS 11672463	55832.3697	0.0006	HHU	C
	55658.3954	0.0003	VWS	V	55866.3021		0.0008	FN	V	
55684.3849	0.0004	VWS	V	NSVS 14243430	55832.3942	0.0024	FN	V		