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PHOTOMETRY OF HIGH-AMPLITUDE DELTA SCUTI STARS IN 2012

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This paper is the fifth in a series reporting on photometry of High-Amplitude Delta Scuti (HADS) Stars (see Wils et al., 2012 for references to the earlier papers). This report presents details on 385 times of maximum for 79 HADS, obtained during 2012. A description of the method used to calculate the times of maximum is given in the first paper of the series (Wils et al., 2009).

The code used for the observers and the instruments are given in Table 1. In Table 2 we list the star name (Col. 1), the epoch (Col. 2), the uncertainty of the epoch (Col. 3), the observer's code (Col. 4) and the filter used (Col. 5). When a maxima was observed in more than one filter by the same observer, the table shows the average value of the times obtained in each filter individually (note that there may be a significant delay between the maximum times when observed in different filters).

For some stars the times of maximum were deviating considerably from their ephemeris, mostly because of insufficient precision in the original determination of the period. For these stars new elements are given in Table 3. To obtain the highest possible precision, data from the ASAS (Pojmański, 2002), NSVS (Woźniak et al., 2004) and SuperWASP surveys (Butters et al., 2010) were used in conjunction with our own data.

Two stars observed by FJH, GSC 8740-0359 (= ASAS J172915-5939.9) and GSC 9049-0905 (= ASAS J162330-6720.7) were found to be multiperiodic pulsators. Details about the independent frequencies f_0, probably the fundamental radial mode, and f_1, likely a non-radial mode, are given in Table 4. The frequencies, amplitudes and phases, and their

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
ABC	AB	Catadioptric 35 cm	Carpe Noctem Observatory	SBIG ST-9E
AC	AC	Refractor 10 cm	Zonalunar Observatory	ATIK 383L+
FN	FN	Catadioptric 40 cm	Alkmaar, Nederland	SBIG ST-7XME
GW	GW	Newton 20 cm	Farm Tivoli, Namibia	SBIG ST-7
HH11	HH	Catadioptric 28 cm	Roosbeek Lake Observatory	SBIG ST7ME
HH8	HH	Catadioptric 20 cm	Roosbeek Lake Observatory	SBIG ST-7
HMB4	FJH	Catadioptric 35 cm	Mol, Belgium	SBIG ST-8
HMBC	FJH	Catadioptric 28 cm	Mol, Belgium	SBIG ST-10XME
HMBK	FJH	Catadioptric 28 cm	Astrokolkhoz, New Mexico	SBIG ST-8
HMBN	FJH	Catadioptric 28 cm	Farm Hakos, Namibia	SBIG ST-8XME
HO18	PL+PVC	Refractor 18 cm	R.O.B.-Humain	SBIG ST-10XME, STL6303
HO40	PL+PVC	Newton 40 cm	R.O.B.-Humain	SBIG ST-10XME
IS	IS	Catadioptric 25 cm	ABT Metius	SBIG ST402XME
KP	KP	Modified Cassegrain 26 cm	Pouda Observatory	SBIG ST-10XME
MAV	MV	Maksutov 26 cm	Leest Observatory	SBIG ST-10XME
MAVN	MV	Newton 35 cm	Leest Observatory	QSI583 WSG
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
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

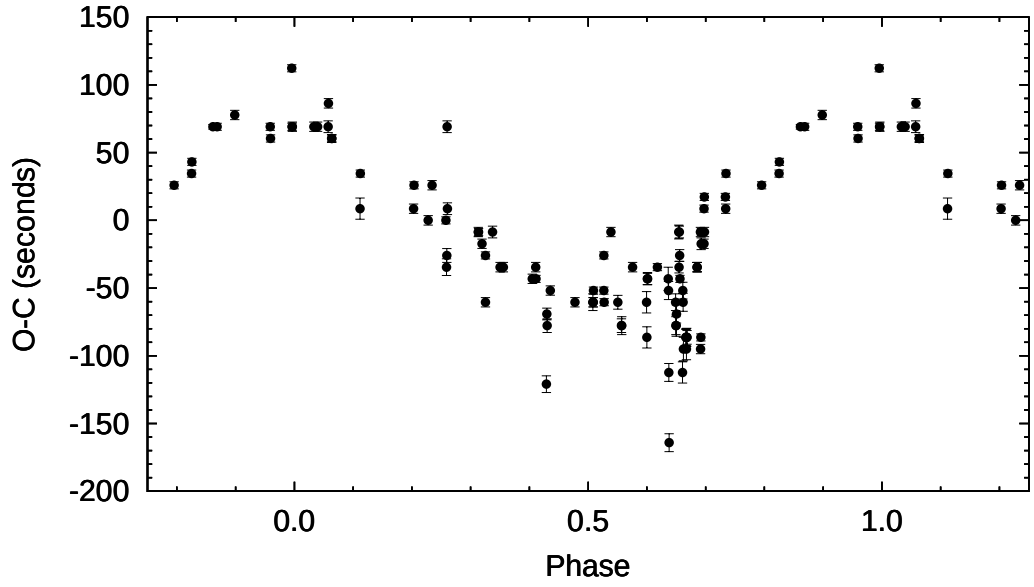

Figure 1. Phase plot of the $O-C$ values of GSC 4556-1113 with respect to a binary orbit with a period of 164 days (phase zero corresponds to JD 2455572).

uncertainties were determined using Period04 (Lenz & Breger, 2005). The uncertainties were derived using Monte Carlo simulations. A number of linear combinations of the independent frequencies could be detected as well in both stars. The data for GSC 8740-0359 and GSC 9049-0905 are available from the IBVS website. GSC 3043-0463 was also found to be a multiperiodic variable, but there are not enough data to accurately determine additional frequencies at this moment.

The cyclical period change of GSC 4556-1113 first reported in Wils et al. (2012) is confirmed, with two more binary cycles observed. A plot of the $O - C$ data calculated from a linear ephemeris and phased with the probable binary period of 164 ± 3 days is given in Fig. 1. There are no indications at this moment that the orbit deviates from a circle.

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Table 2: Observed times of maximum (Epoch = HJD − 2400000).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
GP And	55940.2845	0.0030	RP	V	LW Dra	55968.6079	0.0009	IS	V
	55940.3638	0.0010	RP	V		55968.7264	0.0007	IS	V
	55942.2505	0.0001	HH8	C		56010.5525	0.0011	IS	V
	56176.4112	0.0007	HO40	V		56012.5602	0.0009	IS	V
	56241.2453	0.0002	KP	BV		56100.3492	0.0008	AA30	C
	56241.3240	0.0003	KP	BV		56100.4673	0.0005	AA30	C
	56241.4026	0.0002	KP	BV	DY Her	56117.3341	0.0011	AA30	C
	56241.4814	0.0003	KP	BV	V1086 Her	56108.3661	0.0013	AA30	C
	56241.5600	0.0004	KP	BV		56108.4964	0.0008	AA30	C
	56263.1978	0.0003	AA	C	V1116 Her	56081.4256	0.0007	AA30	C
	56263.2764	0.0003	AA	C	KZ Lac	56132.4682	0.0018	MAV	V
	56263.3550	0.0003	AA	C		56174.4433	0.0015	HO40	C
V460 And	56176.5845	0.0004	RP	V		56197.3096	0.0011	AA	C
	56176.6597	0.0007	RP	V		56197.4148	0.0010	AA	C
	56254.2645	0.0010	ABC	C		56197.5197	0.0013	AA	C
V524 And	56131.4553	0.0006	MAVN	V	SZ Lyn	56001.3182	0.0004	HH8	C
	56131.5491	0.0015	MAVN	V	V593 Lyr	56073.3973	0.0005	MAV	C
	56202.2294	0.0008	AA	C		56073.4998	0.0005	MAV	C
	56202.3236	0.0006	AA	C	V1162 Ori	55942.3267	0.0030	HO18	V
	56202.4180	0.0005	AA	C		55942.4066	0.0017	HO18	V
	56202.5127	0.0006	AA	C		55942.4854	0.0033	HO18	V
V544 And	56228.3511	0.0007	MAV	V		55943.3507	0.0027	HO18	V
	56235.3026	0.0014	ABC	C		55943.4276	0.0024	HO18	V
CY Aqr	56134.4084	0.0005	MAV	V		55944.3715	0.0021	HO18	V
	56134.4694	0.0003	MAV	V		55944.4519	0.0032	HO18	V
	56168.5285	0.0003	IS	V		55958.3796	0.0028	HO18	V
	56168.5896	0.0004	IS	V	DY Peg	56133.4374	0.0008	MAVN	V
	56233.3507	0.0007	ABC	C		56175.5164	0.0003	RP	V
YZ Boo	56033.4210	0.0006	SBL	V		56175.5891	0.0007	RP	V
	56033.5250	0.0005	SBL	V		56198.2694	0.0003	AA	C
	56033.6290	0.0007	SBL	V		56198.3420	0.0004	AA	C
	56034.4624	0.0006	HMB4	V		56198.4153	0.0004	AA	C
	56034.5659	0.0009	HMB4	V		56198.4880	0.0004	AA	C
	56074.4331	0.0005	SBL	V		56223.3549	0.0007	SBL	V
	56074.5372	0.0007	SBL	V		56223.4277	0.0006	SBL	V
V336 Boo	56090.3333	0.0005	AA30	C		56223.5011	0.0006	SBL	V
	56090.4461	0.0003	AA30	C		56266.3809	0.0003	AC	C
V367 Cam	55967.3883	0.0024	FN	V		56266.4536	0.0005	AC	C
V376 Cam	55943.4782	0.0007	IS	V	DW Psc	56179.5212	0.0002	HO40	C
	55943.6184	0.0007	IS	V		56179.5813	0.0002	HO40	C
	55943.7589	0.0004	IS	V		56180.4763	0.0002	HO40	C
	55968.3155	0.0005	VWS	V		56180.5355	0.0002	HO40	C
	55968.4558	0.0002	VWS	V		56222.3496	0.0004	HO40	C
AD CMi	55968.4618	0.0009	FN	V		56223.3036	0.0006	HO40	C
V1040 Cas	56179.3031	0.0012	AA	C		56223.3632	0.0004	HO40	C
	56179.3763	0.0009	AA	C		56223.4235	0.0004	HO40	C
	56179.4498	0.0008	AA	C		56245.1949	0.0004	AA	C
	56179.5229	0.0006	AA	C		56245.2550	0.0004	AA	C
V792 Cep	56131.5161	0.0012	MAV	V		56245.3146	0.0002	AA	C
XX Cyg	56132.5579	0.0002	IS	V		56245.3738	0.0002	AA	C
	56236.2693	0.0002	KP	V		56245.4338	0.0003	AA	C
	56236.4041	0.0003	KP	V		56269.2924	0.0010	AC	C
	56240.3152	0.0002	KP	BV		56269.3519	0.0009	AC	C
	56240.4500	0.0001	KP	BV		56269.4119	0.0006	AC	C
V2455 Cyg	56107.3405	0.0005	AA30	B		56269.4715	0.0007	AC	C
	56107.4348	0.0005	AA30	B		56269.5307	0.0011	AC	C
	56107.5286	0.0005	AA30	B		56270.5463	0.0003	HMBK	r

Table 2: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
DW Psc	56270.6053	0.0004	HMBK	r	GSC 1306-0466	55929.3910	0.0012	AB	C
	56270.6652	0.0003	HMBK	r	GSC 1442-1358	56008.2908	0.0008	KP	V
	56270.7253	0.0004	HMBK	r		56008.3729	0.0006	KP	V
V1307 Sco	56093.5035	0.0004	HMBN	V		56008.4548	0.0006	KP	V
	56093.6204	0.0004	HMBN	V		56008.5368	0.0004	KP	V
CW Ser	56074.4583	0.0024	IS	V		56008.6189	0.0010	KP	V
GW UMa	55968.3014	0.0009	MAV	C	GSC 1594-2234	56077.4436	0.0014	MAVN	V
	55991.4664	0.0018	RP	V	GSC 1716-1598	56208.2505	0.0008	AA	C
	56001.4223	0.0006	MAV	C		56208.3496	0.0009	AA	C
	56005.2831	0.0006	KP	V		56208.4478	0.0009	AA	C
	56005.4860	0.0007	KP	V	GSC 1750-1237	56199.2812	0.0009	AA	C
	56010.3633	0.0008	KP	V		56199.3678	0.0007	AA	C
	56010.5660	0.0008	KP	V		56199.4547	0.0007	AA	C
	56040.6387	0.0006	SO30	V		56199.5416	0.0007	AA	C
	56041.6549	0.0006	SO30	V	GSC 2080-0986	56077.4385	0.0008	MAV	V
	56041.8589	0.0010	SO30	V		56077.5381	0.0009	MAV	V
	56052.8300	0.0011	SO30	V		56089.3425	0.0006	AA30	C
YZ UMi	55958.4266	0.0005	VWS	V		56089.4414	0.0004	AA30	C
	55959.2956	0.0008	VWS	V	GSC 2108-1564	56076.4677	0.0016	MAVN	V
	56002.3849	0.0004	VWS	V		56088.3411	0.0009	AA30	C
	56015.3304	0.0005	VWS	V		56088.4384	0.0005	AA30	C
	56047.5015	0.0010	HMBC	V	GSC 2290-1195	56206.2250	0.0015	AA	C
	56092.3302	0.0005	AA30	C		56206.3056	0.0019	AA	C
	56092.4265	0.0004	AA30	C		56206.3839	0.0014	AA	C
	56158.5086	0.0005	VWS	V		56206.4597	0.0013	AA	C
GSC 0191-1282	55943.3531	0.0004	HH8	C		56206.5377	0.0014	AA	C
	55943.4002	0.0002	HH8	C		56229.3140	0.0026	ABC	C
	56010.3062	0.0006	HH8	C	GSC 2566-1398	56019.3238	0.0006	SBL	V
	56010.3534	0.0007	HH8	C		56019.4134	0.0005	SBL	V
	56012.3450	0.0003	HH8	C		56019.5040	0.0011	SBL	V
	56014.3355	0.0005	HO18	V		56019.5957	0.0009	SBL	V
	56015.3325	0.0004	HH8	C	GSC 2696-1396	56105.3342	0.0020	AA30	C
	56015.3800	0.0004	HH8	C		56105.4369	0.0005	AA30	C
	56015.4274	0.0005	HH8	C		56254.2788	0.0006	HH11	C
GSC 0321-0314	56009.4265	0.0011	HO18	V	GSC 2843-1999	55967.3751	0.0019	IS	V
	56009.5042	0.0005	HO18	V		55967.4369	0.0021	IS	V
GSC 0429-2098	56076.4702	0.0017	MAV	C		56243.3216	0.0010	AB	C
GSC 0513-0624	56172.3269	0.0005	AA	C	GSC 2861-0970	55944.3783	0.0003	FN	V
	56172.3992	0.0004	AA	C		56211.2730	0.0010	MAV	V
GSC 0612-0771	55943.3064	0.0014	AB	C		56211.3836	0.0005	MAV	V
	55943.3661	0.0013	AB	C		56211.4936	0.0005	MAV	V
	55943.4315	0.0010	AB	C		56257.2985	0.0019	ABC	C
	56200.2794	0.0009	AA	C	GSC 2977-0238	55941.4762	0.0005	HO18	V
	56200.3416	0.0007	AA	C		55942.5388	0.0028	RP	V
	56200.4047	0.0007	AA	C		56002.3746	0.0002	HH8	C
	56200.4671	0.0004	AA	C		56003.3618	0.0005	KP	BV
	56200.5296	0.0004	AA	C		56003.4376	0.0007	KP	BV
GSC 0753-1489	55958.4130	0.0033	AB	C		56003.5135	0.0008	KP	BV
GSC 0933-0651	56074.4930	0.0009	FN	V		56228.5047	0.0005	MAV	V
GSC 1076-0158	56145.2935	0.0007	AA30	C		56228.5805	0.0005	MAV	V
	56145.3805	0.0006	AA30	C	GSC 3031-0307	56008.4150	0.0012	MAV	C
	56145.4676	0.0005	AA30	C	GSC 3043-0463	56014.4659	0.0029	HO18	V
GSC 1158-0921	56133.4262	0.0006	MAV	V		56015.5055	0.0020	HO18	V
	56133.4908	0.0006	MAV	V	GSC 3074-0114	56077.5105	0.0004	IS	V
	56133.5554	0.0006	MAV	V		56077.5617	0.0004	IS	V
	56223.3858	0.0004	ABC	C	GSC 3428-1497	55943.3385	0.0007	MAV	V
GSC 1220-1131	55943.2519	0.0012	HH8	C		55943.4139	0.0008	MAV	V

Table 2: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
GSC 3428-1497	55943.4884	0.0006	MAV	V	GSC 4464-0924	56144.2903	0.0008	AA30	C
	56002.2401	0.0003	KP	BV		56144.3693	0.0010	AA30	C
	56002.3156	0.0001	KP	BV		56144.4516	0.0006	AA30	C
	56002.3895	0.0001	KP	BV		56144.5305	0.0008	AA30	C
	56002.4649	0.0003	KP	BV	GSC 4500-0083	56110.4734	0.0017	MAV	V
	56002.5390	0.0001	KP	BV		56110.5602	0.0016	MAV	V
	56002.6135	0.0002	KP	BV		56134.4619	0.0012	MAVN	V
GSC 3489-0868	56075.4428	0.0008	FN	V		56134.5487	0.0014	MAVN	V
	56075.5293	0.0009	FN	V		56135.3980	0.0019	MAVN	V
GSC 3755-0845	55930.2353	0.0011	AA	C		56135.4824	0.0023	MAVN	V
	55930.3108	0.0005	AA	C		56146.2889	0.0017	AA30	C
	55942.2583	0.0011	SBL	V		56146.3731	0.0020	AA30	C
	55942.3342	0.0017	SBL	V		56146.4587	0.0017	AA30	C
	55942.4106	0.0017	SBL	V		56146.5427	0.0014	AA30	C
	55942.4860	0.0016	SBL	V		56223.3583	0.0016	MAV	V
	55942.5623	0.0010	SBL	V		56224.2954	0.0010	HO40	C
	56003.3646	0.0009	HH8	C	GSC 4552-1498	55941.4134	0.0004	MAV	C
	56223.5166	0.0007	MAV	V		55941.4694	0.0003	MAV	C
	56223.5924	0.0004	MAV	V		55941.5249	0.0004	MAV	C
GSC 3810-1553	56009.3647	0.0004	HO18	V		55962.2868	0.0004	MAV	C
	56013.3954	0.0008	RP	V		55962.3425	0.0006	MAV	C
	56245.4709	0.0004	AA	C		55962.3984	0.0005	MAV	C
	56245.5415	0.0004	AA	C		56001.2993	0.0003	KP	V
	56245.6121	0.0002	AA	C		56001.3546	0.0003	KP	V
GSC 3832-0152	55961.4652	0.0009	RP	V		56001.4108	0.0004	KP	V
	55964.2963	0.0004	MAV	C		56001.4665	0.0004	KP	V
	55964.3870	0.0004	MAV	C		56001.5222	0.0004	KP	V
	55964.4787	0.0004	MAV	C		56001.5783	0.0003	KP	V
	56006.3130	0.0006	MAV	C		56001.6338	0.0004	KP	V
	56006.3130	0.0004	KP	V		56002.3033	0.0003	MAV	C
	56006.4042	0.0005	MAV	C		56002.3588	0.0004	MAV	C
	56006.4042	0.0003	KP	V		56002.4150	0.0004	MAV	C
	56006.4955	0.0004	KP	V		56064.4772	0.0005	IS	V
	56006.5869	0.0004	KP	V		56064.5328	0.0005	IS	V
	56040.6578	0.0003	SO40	V		56075.5281	0.0004	IS	V
	56040.7491	0.0004	SO40	V		56075.5831	0.0005	IS	V
	56040.8406	0.0005	SO40	V	GSC 4556-1113	55942.2919	0.0003	VWS	V
	56040.9314	0.0004	SO40	V		55942.4641	0.0007	IS	V
	56041.6623	0.0003	SO40	V		55942.5506	0.0006	IS	V
	56041.7538	0.0003	SO40	V		55942.6380	0.0005	IS	V
	56041.8451	0.0004	SO40	V		55942.7237	0.0005	IS	V
	56041.9365	0.0004	SO40	V		55953.3435	0.0003	VWS	V
	56052.6234	0.0005	SO40	V		55958.3504	0.0003	VWS	V
	56052.7147	0.0004	SO40	V		55966.3811	0.0004	VWS	V
	56082.3098	0.0004	AA30	C		55983.3904	0.0004	VWS	V
	56082.4009	0.0004	AA30	C		55983.4769	0.0003	VWS	V
GSC 3863-0740	55994.4789	0.0014	RP	V		56001.3501	0.0003	VWS	V
GSC 3934-1904	56013.6154	0.0006	IS	V		56007.3080	0.0006	KP	V
	56014.5987	0.0007	IS	V		56007.3941	0.0005	KP	V
	56101.3577	0.0008	AA30	C		56007.4807	0.0005	KP	V
	56101.4666	0.0007	AA30	C		56007.5669	0.0005	KP	V
	56168.4482	0.0013	IS	I		56007.6530	0.0003	KP	V
	56180.3585	0.0007	IS	V		56008.3442	0.0004	VWS	V
	56180.4682	0.0008	IS	V		56013.3521	0.0004	VWS	V
GSC 3986-1266	56174.2778	0.0022	AA	C		56074.3974	0.0003	VWS	V
	56174.4243	0.0023	AA	C		56074.4837	0.0003	VWS	V
GSC 4464-0924	56034.3902	0.0010	VWS	V		56131.3827	0.0004	VWS	V

Table 2: Observed times of maximum (continued).

Star	Epoch	Unc.	Obs.	Filter	Star	Epoch	Unc.	Obs.	Filter
GSC 4556-1113	56131.4689	0.0003	VWS	V	GSC 7737-0184	56097.2476	0.0006	HMBN	V
	56150.3782	0.0003	VWS	V		56097.3502	0.0005	HMBN	V
	56150.4642	0.0003	VWS	V	GSC 8459-0201	56089.5293	0.0008	HMBN	V
	56158.4080	0.0004	VWS	V		56089.6403	0.0006	HMBN	V
	56178.3538	0.0003	VWS	V		56156.3815	0.0005	GW	V
	56178.4402	0.0003	VWS	V		56156.4928	0.0004	GW	V
	56211.3376	0.0004	VWS	V	GSC 8729-0957	56096.5257	0.0004	HMBN	V
	56246.3924	0.0003	VWS	V		56096.6394	0.0005	HMBN	V
GSC 4923-0693	56004.2822	0.0009	KP	V	GSC 8814-0245	56092.4559	0.0006	HMBN	V
	56004.3487	0.0006	KP	V		56092.5477	0.0009	HMBN	V
	56004.4153	0.0004	KP	V	GSC 9238-0506	56096.2389	0.0012	HMBN	V
	56004.4820	0.0005	KP	V		56096.3609	0.0009	HMBN	V
	56004.5485	0.0004	KP	V	NSVS 11672463	56178.2632	0.0006	AA	C
	56004.6146	0.0006	KP	V		56178.3703	0.0007	AA	C
GSC 5752-1767	56091.4728	0.0005	HMBN	V		56178.4783	0.0005	AA	C
GSC 6640-0450	56095.3277	0.0004	HMBN	V		56179.3404	0.0006	HO40	C
GSC 7269-0239	56100.2988	0.0007	HMBN	V		56179.4478	0.0004	HO40	C
	56100.4118	0.0007	HMBN	V		56180.4176	0.0008	HO40	C
GSC 7438-1045	56100.5015	0.0003	HMBN	V	NSVS 14243430	56115.3235	0.0008	AA30	C
	56100.5649	0.0003	HMBN	V		56115.4100	0.0005	AA30	C
	56100.6281	0.0002	HMBN	V		56115.4956	0.0004	AA30	C
GSC 7519-0109	56091.6819	0.0005	HMBN	V					

Table 3: Updated elements of known HADS. Uncertainties are given in units of the last decimal.

Star	Max (HJD)	Period (d)
V792 Cep	2455839.3456(3)	0.13341129(6)
V1086 Her	2452451.0716(2)	0.13059901(2)
V593 Lyr	2452084.4969(2)	0.102151174(5)
GSC 0191-1282	2452396.5461(9)	0.047418463(13)
GSC 0612-0771	2451921.7513(5)	0.062783796(8)
GSC 4500-0083	2455108.9778(5)	0.08506724(6)
GSC 8459-0201	2451869.7022(4)	0.111420450(15)

Table 4: Independent frequencies detected in two multiperiodic HADS observed with a V filter. Uncertainties are given in units of the last decimal. The phase is given with respect to HJD = 0.

Star		Frequency c/d	Semi-Amplitude Mag.	Phase
GSC 8740-0359	f_0	9.69946(2)	0.187(1)	0.2636(8)
	f_1	11.4105(2)	0.0169(9)	0.849(9)
GSC 9049-0905	f_0	7.21672(2)	0.213(2)	0.323(1)
	f_1	11.1079(3)	0.019(2)	0.176(12)