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PHOTOMETRY OF HIGH-AMPLITUDE DELTA SCUTI STARS IN 2014

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This paper continues the series of reports on photometry of High-Amplitude Delta Scuti (HADS) stars (see Wils et al., 2014 for the previous paper). It presents details on 409 times of maximum for 70 HADS, most of them obtained during 2014. In the first paper of the series (Wils et al., 2009), the method used to calculate the times of maximum is described.

We list the observed maxima in Table 1 with the star name (Col. 1), the epoch of the observed maximum (Col. 2), the uncertainty of the epoch (Col. 3), the observer/instrument code (Col. 4) and the filter used for the observations (Col. 5). The index to the observer/instrument code is given in Table 2. It lists the observer's initials, the location and the instruments used.

The period of KZ Lac has been found to vary rather erratically. An $O-C$ plot with respect to a linear ephemeris based on all our data (from this and previous papers in the series) is given in Fig. 1. The elements themselves are given in Table 3. It is possible that the period of KZ Lac shows cyclical changes on a timescale of about 10 years. However, for the moment the timespan of our observations is too short to confirm this.

Changes in the period of GSC 0191-1282 (= ASAS J073758+0552.3) have been detected as well. In the $O-C$ plot given in Fig. 2 our data are supplemented with maxima calculated from yearly phase plots of ASAS (Pojmański, 2002) and NSVS (Woźniak et al., 2004) data. This shows shorter term period changes in addition to a longer term

Table 1: Observed times of maximum (Epoch = HJD − 2400000).

Star	Epoch	Error	Obs.	Filter	Star	Epoch	Error	Obs.	Filter
GP And	56904.3841	0.0010	HMB	V	LW Dra	56814.4654	0.0020	IS	C
	56949.3125	0.0004	HO40	V		56904.3821	0.0007	VWS	V
	56949.3913	0.0004	HO40	V		56962.3946	0.0009	VWS	V
	56949.4698	0.0005	HO40	V	DY Her	56741.5839	0.0006	HMB	V
	56949.5485	0.0004	HO40	V		56750.5022	0.0023	HMB	V
V460 And	56742.3147	0.0004	HMB	V		56750.6505	0.0007	HMB	V
	56912.4453	0.0004	MAV	V		56796.5782	0.0021	HMB	V
	56912.5204	0.0004	MAV	V	V1086 Her	56745.5587	0.0013	HMB	V
	56962.3075	0.0004	AB	C		56767.6298	0.0016	HMB	V
	56962.3832	0.0008	AB	C		56781.6039	0.0013	HMB	V
	57000.4732	0.0005	RP	V	V1116 Her	56113.4295	0.0012	GCJ	C
	57006.3208	0.0004	AB	C		56113.5235	0.0017	GCJ	C
V524 And	56862.5369	0.0005	MAVR	V		56113.5257	0.0012	PNQ	C
	56908.3657	0.0015	HMB	V		56742.4880	0.0015	HMB	V
	56908.4594	0.0014	HMB	V		56742.5841	0.0018	HMB	V
	56935.4850	0.0006	RP	V		56749.5894	0.0013	HMB	V
	56935.5798	0.0006	RP	V		56791.5334	0.0022	HMB	V
	56935.6742	0.0004	RP	V	V1209 Her	56745.4912	0.0003	HMB	V
V544 And	56928.3646	0.0010	AB	C		56745.5424	0.0003	HMB	V
	56928.4713	0.0005	AB	C		56745.5935	0.0002	HMB	V
	57004.2907	0.0006	RP	V		56745.6450	0.0004	HMB	V
	57004.3983	0.0008	RP	V		56763.5477	0.0003	HMB	V
CY Aqr	56928.3955	0.0003	HO18	V		56763.5989	0.0002	HMB	V
	56928.4565	0.0004	HO18	V		56782.5271	0.0004	HMB	V
YZ Boo	56691.6967	0.0006	IS	C		56782.5783	0.0003	HMB	V
	56722.5072	0.0014	HO18	V	KZ Lac	56165.4640	0.0008	KTU	V
	56726.6710	0.0006	IS	C		56176.5318	0.0007	KTU	V
V336 Boo	56728.5098	0.0018	IS	C		56180.2909	0.0010	KTU	V
	56728.6237	0.0008	IS	C		56794.5734	0.0018	MAVR	V
V367 Cam	56721.4044	0.0041	RP	V		56856.4944	0.0019	MAV	V
	57006.3038	0.0013	MAV	V		56903.3793	0.0022	MAV	V
V376 Cam	56676.3804	0.0005	IS	C		56909.3305	0.0043	MAV	V
	56700.6559	0.0005	IS	C		56909.4330	0.0040	MAV	V
	56724.6506	0.0006	IS	C		56910.4773	0.0025	RP	V
	56743.4534	0.0006	IS	C		56910.5829	0.0026	RP	V
	56764.3602	0.0006	VWS	V		56913.4018	0.0012	HMB	V
	56764.5009	0.0003	VWS	V		56962.3738	0.0011	HMB	V
	56796.4940	0.0008	IS	C	EH Lib	56729.6669	0.0004	IS	C
	56928.3953	0.0005	MAV	V		56796.5080	0.0006	HO18	V
	56928.5357	0.0005	MAV	V	SZ Lyn	56728.3898	0.0009	HMB	V
	56940.3226	0.0006	MAV	V		56728.5104	0.0009	HMB	V
	57005.4316	0.0003	ALI	V		56728.6302	0.0009	HMB	V
	57011.3249	0.0004	ALI	V		56745.3849	0.0011	HMB	V
AD CMi	56699.5445	0.0013	HMBC	V		56757.4377	0.0008	HMB	V
	56699.6682	0.0014	HMBC	V		56763.3443	0.0008	HMB	V
V792 Cep	56869.4133	0.0009	MAVR	V		56763.4651	0.0008	HMB	V
	56869.5469	0.0011	MAVR	V	V593 Lyr	56823.3922	0.0010	MAV	V
	56944.2573	0.0016	MAV	V		56823.4937	0.0008	MAV	V
	56944.3905	0.0007	MAV	V	V1162 Ori	56654.6679	0.0022	SO30	V
XX Cyg	56890.5010	0.0011	RP	V		56654.7476	0.0032	SO30	V
V2455 Cyg	56862.4019	0.0004	MAV	V		56654.8262	0.0022	SO30	V
	56862.4960	0.0003	MAV	V		56654.9084	0.0034	SO30	V
	56862.5901	0.0003	MAV	V		56691.2572	0.0041	HO40	V
	56863.4380	0.0010	MAV	V		56691.3347	0.0027	HO40	V
	56863.5324	0.0005	MAV	V		56691.4166	0.0039	HO40	V
LW Dra	56781.3840	0.0012	VWS	V		56711.3220	0.0026	HO40	V
	56781.5024	0.0007	VWS	V		56711.4027	0.0037	HO40	V

Table 1: Observed times of maximum (continued).

Star	Epoch	Error	Obs.	Filter	Star	Epoch	Error	Obs.	Filter
V1162 Ori	56712.3458	0.0031	HO40	V	GSC 0321-0314	56795.3857	0.0005	HO40	C
	56722.3396	0.0032	HO40	V	GSC 0429-2098	56764.6231	0.0018	HMB	V
	56722.4183	0.0032	HO40	V	GSC 0612-0771	56913.5020	0.0005	HMB	V
	56723.3606	0.0032	HO40	V		56913.5650	0.0005	HMB	V
	56725.3302	0.0035	HO40	V		56952.4911	0.0008	RP	V
	56728.3185	0.0031	HO40	V	GSC 0628-0348	56973.3852	0.0009	LP11	V
	56728.3995	0.0044	HO40	V	GSC 0753-1489	56701.6175	0.0013	HMBC	V
	56729.3422	0.0041	HO40	V		56701.7104	0.0007	HMBC	V
	56729.4187	0.0045	HO40	V		57004.4994	0.0008	RP	V
	56730.2841	0.0042	HO40	V		57004.5923	0.0007	RP	V
	56730.3644	0.0030	HO40	V		57004.6858	0.0007	RP	V
	56949.5817	0.0022	HO40	V	GSC 0933-0651	56733.5775	0.0015	HMB	V
	56973.4976	0.0032	LP11	V		56794.4527	0.0018	HMB	V
	56973.5797	0.0033	LP11	V		56794.5579	0.0013	HMB	V
	56973.6567	0.0028	LP11	V	GSC 1061-1651	56548.4931	0.0020	PNQ	V
	56973.7370	0.0030	LP11	V	GSC 1220-1131	56912.6238	0.0027	HMB	V
DY Peg	56900.4755	0.0011	RP	V		56962.4869	0.0008	HMB	V
	56900.5479	0.0004	RP	V		56962.5678	0.0009	HMB	V
	56900.6210	0.0003	RP	V		56962.6485	0.0011	HMB	V
	57002.3529	0.0004	ALI	V	GSC 1306-0466	56722.3077	0.0006	FN	C
V536 Peg	56875.4535	0.0004	AB	C		56722.3946	0.0006	FN	C
	56912.3949	0.0005	HMB	V		56968.4248	0.0016	MAV	V
	56912.4592	0.0005	HMB	V	GSC 1442-1358	56711.5844	0.0010	FN	C
	56940.2929	0.0005	HMB	V		56721.6023	0.0020	RP	V
	56940.3581	0.0004	HMB	V		56729.3217	0.0013	HMB	V
DW Psc	56913.4989	0.0007	HMB	V		56729.4030	0.0009	HMB	V
	56913.5574	0.0006	HMB	V		56729.4838	0.0015	HMB	V
	56917.4953	0.0005	HO40	C	GSC 1716-1598	56264.3726	0.0014	PNQ	C
	56917.5546	0.0003	HO40	C		56904.4033	0.0014	AB	C
	56928.5296	0.0004	HO40	C	GSC 1750-1237	56917.4539	0.0012	AB	C
GW UMa	56702.4418	0.0009	MAV	V	GSC 2043-1201	56742.5398	0.0016	HMB	V
	56728.4505	0.0009	HMB	V		56742.6174	0.0014	HMB	V
	56767.4635	0.0009	HMB	V		56795.4565	0.0015	HMB	V
	56791.4399	0.0007	HMB	V		56795.5341	0.0021	HMB	V
YZ UMi	56711.5120	0.0011	IS	C	GSC 2080-0986	56746.5173	0.0007	HMB	V
	56711.6087	0.0008	IS	C		56792.5441	0.0006	HMB	V
	56722.3320	0.0005	VWS	V	GSC 2194-2001	56911.5199	0.0018	RP	V
	56722.4285	0.0004	VWS	V		56912.4405	0.0019	HMB	V
	56746.3884	0.0010	VWS	V	GSC 2290-1195	56912.4217	0.0013	AB	C
	56757.4025	0.0005	VWS	V		56958.2891	0.0050	MAV	V
	56797.4956	0.0015	IS	C		56958.3677	0.0031	MAV	V
	56810.4416	0.0011	IS	C		57011.2478	0.0012	ALI	V
	56810.5391	0.0020	IS	C	GSC 2496-0118	56711.3423	0.0006	FN	C
	56958.3536	0.0009	IS	C		56711.4100	0.0004	FN	C
	56958.4501	0.0005	IS	C		56730.3118	0.0014	HMB	V
	56958.5465	0.0005	IS	C		56730.3799	0.0016	HMB	V
	56961.4450	0.0006	VWS	V		56730.4477	0.0017	HMB	V
GSC 0191-1282	56660.4026	0.0004	AB	C		56746.3684	0.0007	HMB	V
	56660.4501	0.0003	AB	C		56746.4362	0.0007	HMB	V
	56660.4976	0.0003	AB	C		56757.3437	0.0023	HMB	V
	56660.5447	0.0006	AB	C		56757.4118	0.0024	HMB	V
	56700.5666	0.0005	HMBC	V		56757.4790	0.0017	HMB	V
	56700.6139	0.0005	HMBC	V		56764.3904	0.0017	HMB	V
	56700.6613	0.0007	HMBC	V		56764.4579	0.0013	HMB	V
	56700.7089	0.0004	HMBC	V	GSC 2566-1398	56690.6609	0.0009	IS	C
GSC 0321-0314	56738.6587	0.0005	IS	C		56690.7511	0.0006	IS	C
	56767.5300	0.0009	IS	C		56726.5812	0.0007	IS	C

Table 1: Observed times of maximum (continued).

Star	Epoch	Error	Obs.	Filter	Star	Epoch	Error	Obs.	Filter
GSC 2696-1396	56912.5217	0.0008	RP	V	GSC 3428-1497	56745.5290	0.0017	HO18	B
GSC 2843-1999	56938.3431	0.0011	MAV	V		56745.6051	0.0008	HO18	B
	56938.4053	0.0013	MAV	V		56746.3520	0.0008	HO18	B
	56940.3297	0.0017	MAVR	V		56746.4266	0.0018	HO18	B
	56940.3920	0.0014	MAVR	V		56746.5008	0.0008	HO18	B
	56942.3788	0.0010	AB	C		56746.5746	0.0030	HO18	B
GSC 2861-0970	56742.3120	0.0007	HMB	V		56750.3916	0.0024	HMB	V
	56949.3102	0.0004	MAV	V		56763.4149	0.0038	HMB	V
	56949.4200	0.0004	MAV	V		56763.4886	0.0022	HMB	V
	56949.5301	0.0004	MAV	V		56792.3841	0.0017	HMB	V
	56962.5226	0.0004	HMB	V		56792.4589	0.0019	HMB	V
	56962.6327	0.0004	HMB	V	GSC 3489-0868	56730.5108	0.0004	HMB	V
	56991.2601	0.0006	MAV	V		56730.5976	0.0006	HMB	V
	56991.3702	0.0006	MAV	V		56730.6841	0.0003	HMB	V
	56999.4081	0.0006	RP	V		56793.5048	0.0006	HMB	V
GSC 2977-0238	56014.3723	0.0008	PNQ	C		56793.5918	0.0005	HMB	V
	56014.4482	0.0004	PNQ	C	GSC 3755-0845	56669.4499	0.0010	RP	V
	56711.2900	0.0003	MAV	V		56669.5258	0.0017	RP	V
	56711.3658	0.0004	MAV	V		56968.3618	0.0008	MAVR	V
	56711.4417	0.0005	MAV	V		56968.4379	0.0011	MAVR	V
	56713.3402	0.0003	MAV	V		56997.4324	0.0015	RP	V
	56713.4160	0.0004	MAV	V		56997.5077	0.0012	RP	V
	56726.3240	0.0006	FN	C		56997.5845	0.0013	RP	V
	56726.3996	0.0003	FN	C		56997.6602	0.0013	RP	V
	56726.4755	0.0002	FN	C		57020.2595	0.0025	MAV	V
	56749.3325	0.0003	HMB	V	GSC 3810-1553	56690.4583	0.0004	MAV	V
	56749.4084	0.0004	HMB	V		56690.5290	0.0003	MAV	V
	56764.4434	0.0004	HMB	V		56696.3276	0.0005	MAV	V
	56972.6527	0.0008	LP11	V		56696.3982	0.0005	MAV	V
GSC 3004-0870	56691.3675	0.0014	MAV	V		56767.3926	0.0004	HMB	V
	56691.4494	0.0012	MAV	V		56767.4631	0.0004	HMB	V
	56691.5316	0.0012	MAV	V		56781.3934	0.0005	HMB	V
	56725.3813	0.0007	FN	C	GSC 3832-0152	56690.5568	0.0008	IS	V
	56725.4634	0.0006	FN	C		56725.4496	0.0004	RP	V
	56725.5455	0.0007	FN	C		56725.5409	0.0010	RP	V
	56725.6273	0.0008	FN	C		56725.6320	0.0004	IS	C
GSC 3031-0307	56709.6583	0.0020	RP	V		56725.6322	0.0006	RP	V
	56722.3449	0.0041	MAV	V		56725.7235	0.0013	RP	V
	56722.4445	0.0033	MAV	V		56764.5438	0.0005	IS	C
	56722.5418	0.0013	HO18	C	GSC 3863-0740	56726.3690	0.0013	MAV	V
GSC 3097-0583	56787.4183	0.0005	MAV	V		56746.3373	0.0019	MAV	V
	56794.4191	0.0008	MAV	V		56746.5352	0.0015	MAV	V
	56794.5032	0.0007	MAV	V		56795.5572	0.0056	RP	V
	56794.5875	0.0006	MAV	V	GSC 3934-1904	56797.3957	0.0008	MAV	V
	56796.5271	0.0004	HO40	C		56797.5052	0.0004	MAV	V
	56824.4448	0.0006	MAV	V	GSC 4163-0984	56693.3806	0.0004	MAV	V
	56824.5289	0.0005	MAV	V		56693.4602	0.0003	MAV	V
GSC 3428-1497	56728.3166	0.0025	HMB	V		56730.3346	0.0011	MAV	V
	56728.3898	0.0020	HMB	V		56747.4214	0.0005	RP	V
	56728.4664	0.0029	HMB	V		56747.5009	0.0003	RP	V
	56728.5417	0.0025	HMB	V		56747.5802	0.0003	RP	V
	56728.6139	0.0028	HMB	V	GSC 4417-0394	56713.5831	0.0007	IS	C
	56730.3350	0.0010	HO18	V		56713.7146	0.0006	IS	C
	56730.4088	0.0008	HO18	V		56727.3372	0.0016	MAV	V
	56730.4842	0.0009	HO18	V		56728.3947	0.0012	MAV	V
	56730.5581	0.0013	HO18	V		56729.3207	0.0010	MAV	V
	56745.4558	0.0012	HO18	V		56729.4527	0.0009	MAV	V

Table 1: Observed times of maximum (continued). The catalogue name USNO-A2.0 is abbreviates as U.

Star	Epoch	Error	Obs.	Filter	Star	Epoch	Error	Obs.	Filter
GSC 4417-0394	56753.3889	0.0012	MAV	V	GSC 4552-1498	56741.4090	0.0005	MAV	V
	56753.5207	0.0009	MAV	V		56741.4652	0.0003	MAV	V
GSC 4464-0924	56782.4017	0.0009	ALI	C		56749.6123	0.0002	IS	C
	56880.4504	0.0013	VWS	V		56749.6684	0.0002	IS	C
	56901.4138	0.0012	ALI	C		56757.4261	0.0002	ALI	C
	56912.3804	0.0007	VWS	V		56903.4282	0.0004	ALI	V
	56912.3807	0.0012	MAV	V		56958.6246	0.0003	IS	C
	56912.4602	0.0024	VWS	V		56958.6810	0.0002	IS	C
	56912.5419	0.0007	VWS	V		56968.2804	0.0005	ALI	V
	56961.3213	0.0019	ALI	C		56968.3362	0.0007	ALI	V
	56972.2888	0.0009	ALI	V	GSC 4556-1113	56669.3004	0.0003	VWS	V
	56972.2888	0.0008	VWS	V		56690.3685	0.0005	VWS	V
	56972.3699	0.0015	VWS	V		56690.4551	0.0003	VWS	V
	56972.4498	0.0009	VWS	V		56711.3497	0.0003	VWS	V
	56991.3166	0.0005	VWS	V		56711.4364	0.0003	VWS	V
	56991.3995	0.0008	VWS	V		56723.3514	0.0005	MAV	V
	56991.4776	0.0005	VWS	V		56723.4378	0.0004	MAV	V
	57011.3961	0.0010	VWS	V		56729.3952	0.0004	VWS	V
GSC 4500-0083	56628.4467	0.0024	PNQ	V		56794.4105	0.0003	VWS	V
	56628.5329	0.0023	PNQ	V		56794.4970	0.0004	VWS	V
	56733.3359	0.0017	VWS	V		56811.5069	0.0015	IS	C
	56853.5373	0.0025	MAV	V		56913.3918	0.0004	VWS	V
	56855.4940	0.0030	MAV	V		56958.2897	0.0004	VWS	V
	56886.3727	0.0019	MAVR	V		56958.3760	0.0004	VWS	V
	56913.3384	0.0018	MAV	V	GSC 4923-0693	56723.4130	0.0009	AB	C
	56913.4239	0.0024	MAV	V		56723.4795	0.0004	AB	C
	56913.5087	0.0022	MAV	V		56741.3804	0.0006	AB	C
GSC 4552-1498	56692.6857	0.0005	IS	V		57007.7773	0.0005	HMBC	V
	56692.7419	0.0007	IS	V	GSC 5018-1085	56736.6365	0.0009	IS	C
	56725.3351	0.0004	MAV	V		56736.7059	0.0006	IS	C
	56725.3909	0.0006	MAV	V	U 1425-04240809	56990.4183	0.0017	AB	C
	56725.4465	0.0005	MAV	V		57023.2611	0.0011	AB	C
	56741.3534	0.0004	MAV	V		57023.3182	0.0010	AB	C

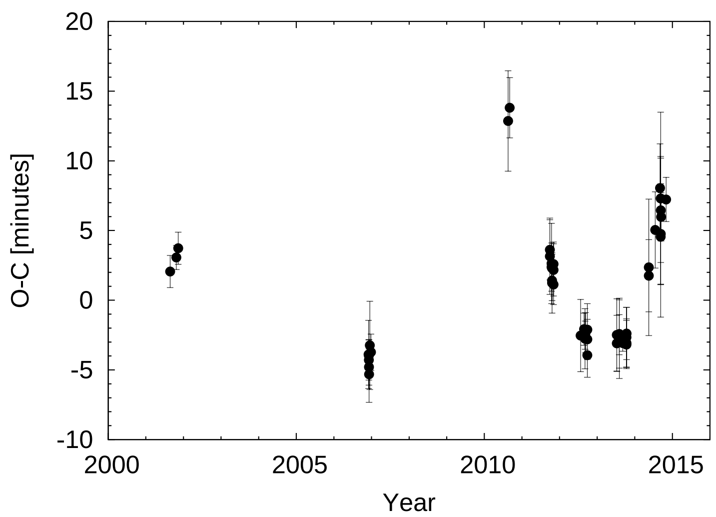

Figure 1. $O - C$ values for the maxima of KZ Lac with respect to the ephemeris of Table 3.

change. Changes in the light curve shape or amplitude have not been detected. The origin of the period changes is unknown at this time.

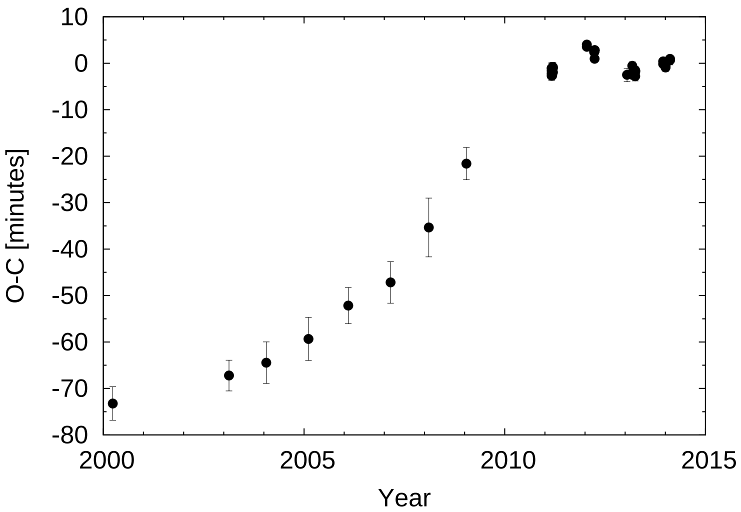

Figure 2. $O - C$ values for the maxima of GSC 0191-1282 with respect to the ephemeris of Table 3.

Of the HADS observed in 2014, two were found to be multiperiodic variables. GSC 3851-0240 was observed by AA, JGC, PL, PVC and RPB and turned out to be a double-mode pulsator with a frequency ratio of 0.774. Such a ratio is indicative of the fundamental to first overtone radial mode pulsation (Stellingwerf, 1979). Modulations in the light curve were already found by Hoffman and Monninger (2011). GSC 2610-0035 (= CSS_J173401.0+320716; discovered by Drake et al., 2014) was observed by JGC and RPB and showed at least one other pulsation frequency, likely a non-radial mode because of the unusual frequency ratio of 0.750. Table 4 lists details about the independent frequencies f_0, the fundamental radial mode, and the secondary frequency f_1 of both stars. The frequencies, amplitudes and phases, and their uncertainties were calculated using Period04 (Lenz & Breger, 2005). The uncertainties were derived using Monte Carlo simulations by Period04. For GSC 2610-0035 data from the Catalina Real-time Transient Survey (Drake et al., 2009) were used. A number of linear combinations of the independent frequencies were also detected in GSC 3851-0240. Our data for these two stars are available as electronic tables from the IBVS website.

The HADS GSC 4464-0924 was previously already found to have an additional non-radial mode (Wils et al., 2012). Updated frequencies for this star, based on all the data available, are given in Table 4. The amplitude of the secondary frequency in this star is relatively small compared to the amplitude of the radial mode. It is therefore still possible to calculate individual times of maxima for GSC 4464-0924 using our standard procedure. We can see the effect of the beat frequency $f_1 - f_0$ of about 6.14 cycles/day and with semi-amplitude of 1.6 ± 0.4 min on the $O-C$ diagram under the form of a larger than usual scatter in Fig. 3. Subtracting this beat signal from the original data shows a less-scattered $O - C$ diagram in which a period change (of the main period f_0) becomes much more evident (cf. Fig. 4). The observations of GSC 4464-0924 obtained by JVW are also available from the IBVS website.

Table 2: List of instruments used for the observations.

Code	Observer(s)	Telescope	Observatory	CCD
AA	AA	Catadioptric 30 cm	Perseus Observatory	SBIG ST-10XME
AB	AB	Catadioptric 35 cm	Carpe Noctem Observatory	SBIG ST-9E
ALI	FD+LL+SR+SV	Newton 68 cm	Astrolab Iris, Belgium	SBIG STL-6303E
FN	FN	Catadioptric 40 cm	Alkmaar, Nederland	SBIG ST-7XME
GCJ	GCJ	Catadioptric 20 cm	Observatorio Cerro del Viento, Badajoz, Spain	Atik 16HR
HMB	FJH	Catadioptric 28 cm	Mol, Belgium	SBIG ST-8XME
HMBC	FJH	Catadioptric 40 cm	Remote Observatory Atacama Desert, Chile	FLI ML16803
HO18	PL+PVC	Refractor 18 cm	ROB-Humain	SBIG ST-10XME, STL6303
HO40	PL+PVC	Newton 40 cm	ROB-Humain	SBIG ST-10XME
IS	IS	Catadioptric 25 cm	ABT Metius	SBIG ST402XME
KTU	TK	Newton 30 cm	Pieksämäki, Finland	Starlight XPress MX716
LP11	PL+PVC	Refractor 11 cm	Roque de los Muchachos Observatory, La Palma	SBIG ST-10XME
MAV	MV	Maksutov 26 cm	Leest Observatory	SBIG ST-10XME
MAVR	MV	Ritchey-Chrétien 40 cm	Leest Observatory	QSI583
PNQ	PNQ	Catadioptric 28 cm	Observatorio Posadas, Córdoba, Spain	Luna-QHY 9
RP	RDP	Catadioptric 36 cm	Shobdon, UK	Starlight XPress SXV-H9
SO30	CWR	Catadioptric 30 cm	SETEC Observatory	SBIG ST-8iXME
VWS	JVW	Catadioptric 23.5 cm	Hooglede, Belgium	SBIG ST-8XME

Table 3: Current linear elements for HADS that have shown period changes. Uncertainties are given in units of the last decimal. These elements are used to plot the $O-C$ diagrams in Figures 1 to 3.

Star	Max (HJD)	Period (d)
KZ Lac	2454075.5781(6)	0.10441606(3)
GSC 0191-1282	2455635.3714(3)	0.04741785(2)
GSC 4464-0924	2451342.8888(11)	0.08063078(2)

Table 4: Independent frequencies detected in multiperiodic HADS. Uncertainties are given in units of the last decimal. The phase is given with respect to HJD = 0. The period ratio f_1/f_0 is listed in the last column.

Star		Frequency c/d	Semi-Amplitude Mag.	Phase	Period ratio
GSC 3851-0240	f_0	14.718110(2)	0.1385(7)	0.2043(8)	
	f_1	19.01133(2)	0.0122(7)	0.413(9)	0.77418
GSC 2610-0035	f_0	12.206842(5)	0.059(2)	0.720(4)	
	f_1	16.25726(2)	0.012(2)	0.81(2)	0.75085
GSC 4464-0924	f_0	12.4022022(7)	0.1812(6)	0.5436(6)	
	f_1	18.54319(8)	0.0160(6)	0.284(6)	0.66883

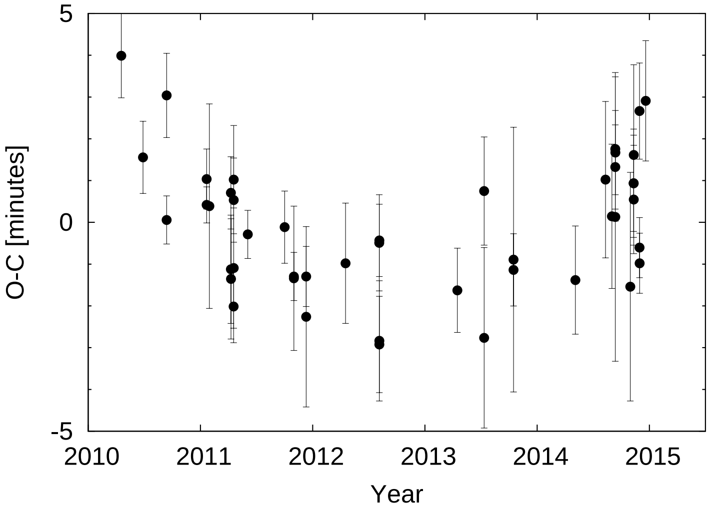

Figure 3. $O - C$ values for the maxima of GSC 4464-0924 with respect to the ephemeris in Table 3.

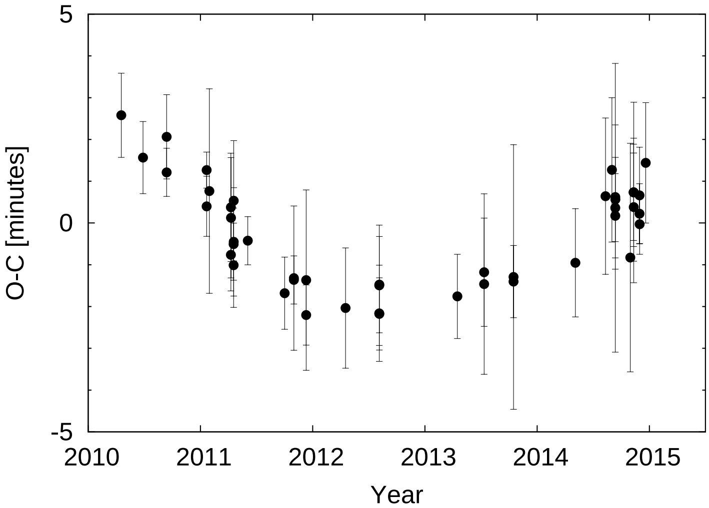

Figure 4. The same data as in Fig. 3, but in this case a sine wave with a frequency equal to the beat frequency and a semi-amplitude of 1.6 minutes has first been subtracted from the data.

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References:

Drake A.J., Djorgovski S.G., Mahabal A., et al., 2009, *ApJ*, **696**, 870

Drake A.J., Graham M.J., Djorgovski S.G., et al., 2014, *ApJS*, **213**, 9

Hoffman D.I., Monninger G., 2011, *IBVS*, **5999**

Lenz P., Breger M., 2005, *CoAst*, **146**, 53

Pojmański G., 2002, *AcA*, **52**, 397

Stellingwerf, R.F., 1979, *ApJ*, **227**, 935

Wils P., Kleidis S., Hambsch F.-J., Vidal-Sáinz J., Vanleenhove M., Lampens P., Van Cauteren P., Robertson C.W., Staels B., Pickard R.D., Rozakis I., Dufoer S., Groenendaels R., Gómez-Forrellad J.M., García-Melendo E., Hautecler H., Van der Looy J., 2009, *IBVS*, **5878**

Wils P., Panagiotopoulos K., Van Wassenhove J., Ayiomamitis A., Nieuwenhout F., Robertson C.W., Vanleenhove M., Hambsch F.-J., Hautecler H., Pickard R.D., Baillien A., Staels B., Kleidis S., Lampens P., Van Cauteren P., 2012, *IBVS*, **6015**

Wils P., Ayiomamitis A., Robertson C.W., Hambsch F.-J., Vanleenhove M., Nieuwenhout F., van de Stadt I., Baillien A., Lampens P., Van Cauteren P., Van Wassenhove J., Pickard R.D., Kleidis S., Staels B., 2014, *IBVS*, **6122**

Woźniak P.R., Vestrand W.T., Akerlof C.W., et al., 2004, *AJ*, **127**, 2436