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MINIMA AND MAXIMA TIMINGS OF SEVERAL VARIABLE STARS

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Abstract: We present 228 times of minima of 33 eclipsing binaries and nine maxima timings of two pulsating stars. The majority of the objects are newly discovered variables and they were observed as by product. The observations were employed five different telescopes with diameters from 20cm up to 2.3m and six cameras in three different observatories located in Greece.

1 Introduction

Precise timings of eclipses of binary systems as well as the maxima timings of pulsating stars are quite useful for the determination of the orbital periods of the systems and the pulsation periods of the oscillating stars, respectively. Especially, light elements of newly discovered periodic variables will allow for further monitoring of these systems/stars and, after the publication of their light curves, hence their classification, can be considered as very essential information for future studies.

2 Observations, data reduction, and calculation methods

All the variables presented in this study, except for EG Cas and IK Vir, have been recently discovered/classified (i.e. during the last decade) and all of them were observed as by product, since they are located within the field-of-view (FoV) of other objects of interest (mostly Planetary Nebulae), which were the prime aims of the respective observations. The observations cover a time span between November 2009 and August 2020. Various telescopes and cameras were used and they are briefly described in the following paragraphs.

The first approximately three years (i.e. up to August 2012), the three telescopes of the University of Athens Observatory[1] were used. These telescopes (40cm, 25cm and 20cm) are located at the Department of Physics (alt∼250 m), University of Athens campus, Zografos, Athens, Greece, and were operated with two different CCD cameras. The first camera was the SBIG ST-10XME (KAF-3200ME chip, pixel size 6.8 μm and a total of 2184×1472 pixels) and the second was the SBIG ST8-XMEI (KAF-1603ME chip, pixel size 9 μm and a total of 1530×1020 pixels). Both cameras were equipped with the Bessell $UBVRI$ filters.

In 2014, the observations were obtained using the 2.3m Aristarchos telescope of Helmos Observatory[2], located at Mt. Helmos (alt∼2340 m), Achaia, Greece. The camera

[1] http://observatory.phys.uoa.gr
[2] http://helmos.astro.noa.gr

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Princeton Instruments VersArray 1024B (SITeAB chip, pixel size 24 μm and a total of 1024×1024 pixels) and the Bessel $UBVRI$ filter set were employed for the observations.

After July 2017, the observations were made at the Kryoneri Observatory[3] (IAU MPC code: L10), located at Mt. Kyllini (alt∼930 m), Corinthia, Greece using the 1.2m telescope and two different cameras setup. The first setup concerned the simultaneous use of two identical Andor Zyla 5.5 sCMOS cameras (Front Illuminated Scientific CMOS chip, pixel size 6.48 μm and a total of 2560×2160 pixels), which each of them is permanently equipped with one photometric filter. The one camera uses the Johnson-Cousins R_c and the other one the I_c photometric filters. Details about this setup can be found in Xilouris et al. (2018) and Liakos et al. (2020). The second setup included the Apogee CG47 CCD camera (e2V CCD47-10 chip, pixel size 13 μm and a total of 1024×1024 pixels), which is equipped with one filter (usually the R) from the Bessell $UBVRI$ photometric filter set.

All the above instrument setups are briefly given in Tab. 1 along with their resulting FoVs. The abbreviations for the telescopes and the cameras (Ti and Ci, respectively, with i an increasing number) are used in Section 3 for denoting the equipment setup used for each observed variable.

The differential aperture photometry method was applied for the data analysis using the *C-MUNIPACK* software package (*Muniwin* v.1.1.26; Hroch, 1998) and in some cases the *AIP4WIN* software (Berry & Burnell, 2000). The software *Minima* v.2.3 (Nelson, 2020) that applies the Kwee & van Woerden (1956) method and the parabolic fitting on the data was used for calculating the minima/maxima timings of the variables. Particularly, in cases with enough and symmetric data points around the eclipse, the Kwee & van Woerden (1956) method was preferred. In cases with missing parts of the light curve near the eclipses, the parabolic fitting was used. There were a few cases in which both methods were used, mostly to check the efficiency of each fitting method. For each observed light minimum or maximum, 2-3 calculations for the central timing using different data points sample were made. The time of minimum/maximum was assumed to be the average of these timings. In cases of multi colour photometry of an object, the aforementioned method was applied for the eclipse/maximum light curve of each band, and the final timing was the average of all the individual calculations. In cases for which both the Kwee & van Woerden (1956) method and parabolic fitting were used, again, the average of the individual timings per filter and per method was assigned as the final calculated minimum/maximum timing. The error of the latter value for simplicity was assumed to be the average of the individual error values.

3 Results

The results regarding the minima and maxima timings calculations of the observed variables are given in Tables 2 and 8, respectively. The columns of Tab. 2 include: i) The name of the eclipsing binary from the catalogue used for its announcement (for the newly discovered cases), ii) the type of the minimum (Min. I is the primary and Min. II the secondary minima, respectively), iii) the Heliocentric Julian Date (HJD) of the minimum

[3] http://kryoneri.astro.noa.gr

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Table 1: Instrument setups used for the observations.

Observatory	Telescope	Camera	FoV
University of Athens	T1: Cassegrain 40cm (f/8)	C1: SBIG ST-10XME	$16' \times 10'$
	T2: Newtonian 25cm (f/4.7)	C2: SBIG ST8-XMEI	$40' \times 26'$
	T3: Newtonian 20cm (f/5)		$45' \times 32'$
Kryoneri	T4: Prime focus 1.2m (f/2.8)	C3: Andor Zyla 5.5 (×2)	$14' \times 17'$
	T4b: Prime focus 1.2m (f/3)	C4: Apogee Aspen CG47	$12.5' \times 12.5'$
Helmos	T5: Richey-Crétien 2.3m (f/8)	C5: Princeton Inst. 1K×1K	$4.8' \times 4.8'$

based on coordinated universal time UTC, iv) the instrumentation setup used for the observations (for details see also Tab. 1), v) the filters used, vi) the light curve type (LC; EW=W UMa type, EA=Algol type, EB=β Lyr type), and vii) a corresponding reference (refers mostly to the discovery of the system). In cases of absence of a complete light curve of a system, the type of the minimum as well as the type of the light curve cannot be yet verified. Therefore, for these cases, the terms *Min.* and *Eclip* are simply used for the type of minimum and the type of the light curve, respectively. In cases of observations without any filters the symbol $''-''$ is used.

The columns of Tab. 8 include the same information as those of Tab. 2, except the (ii) and the (vi) columns, as described above. Particularly, Tab. 8 lists only maxima timings of two pulsating stars, while the type of light curve column includes the RRab and HADS abbreviations that refer to the RR Lyrae (ab) and High-Amplitude Delta Scuti light curve types, respectively.

Linear fittings on the minima/maxima timings of the objects (Tables 2 and 8) were made in order to derive the updated light elements (i.e. ephemeris) of the majority of the newly discovered variables. The epoch time (T_0; i.e. the time of Min. I for the eclipsing binaries and the time of maximum for the pulsating stars) and the period (P; i.e. the orbital period for the eclipsing binaries and the pulsation period for the pulsating stars) for these objects are listed in Tab. 9. In the same table, the maximum and the minimum brightness of each object in a specific band are also listed. Since differential aperture photometry was used for the data reduction, there was not any magnitude estimation of the objects. Therefore, the maximum brightness of each object was assumed to be the one given in stellar catalogues. The reference catalogue for each object contains the magnitude in the band in which the observations were performed, except 2MASS J22262047+5448251 for which no filters were used. The minimum brightness was calculated from the catalogued maximum brightness plus the magnitude difference between maximum and primary minimum for the eclipsing binaries and between maximum and minimum for the pulsating stars as calculated from the differential photometry. For nine eclipsing systems with calculated, but not characterized, minima timings (Tab. 2) or for those with only one or two minima timings available, the light elements cannot be computed, therefore their orbital periods are still unknown.

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Table 2: Minima timings for the observed eclipsing binary systems.

Name	Type	HJD	Setup	Filters	LC	Ref.
2MASS J22262047+5448251	Min. II	2457983.3484(1)	T4b+C4	-	EW	1
	Min. I	2457992.5381(2)	T4b+C4	-		
	Min. II	2457993.4954(2)	T4b+C4	-		
	Min. I	2458011.4646(1)	T4b+C4	-		
	Min. I	2458012.5614(16)	T4b+C4	-		
Cas EG	Min. I	2458042.4802(1)	T4+C3	RI	EB	
	Min. I	2458053.4863(1)	T4+C3	RI		
GSC 0445-0903	Min. II	2455727.4499(12)	T1+C1	VRI	EA	2
GSC 2816-2000	Min.	2455887.3980(11)	T1+C1	BVRI	Eclip	2
GSC 3159-1188	Min. I	2456170.4877(13)	T1+C1	VRI	EA	3
GSC 3802-1680	Min. I	2455153.5194(9)	T3+C2	BVI	EA	2
	Min. I	2455604.3707(8)	T2+C2	BVI		
GSC 4320-1033	Min.	2455140.4093(4)	T1+C1	B	EA	2
GSC 4835-1716	Min. I	2455939.3794(40)	T1+C1	BVRI	EW	2
	Min. II	2455940.4445(18)	T1+C1	BVRI		
	Min. II	2455943.4276(15)	T1+C1	BVRI		
	Min. I	2455944.4661(25)	T1+C1	BVRI		
NOMAD1 1609-0153459	Min. I	2456942.5561(6)	T5+C5	VRI	EA	4
UCAC4 737-083435	Min. I	2458013.5734(12)	T4+C3	I	EW	1[a]
	Min. I	2458031.4573(6)	T4+C3	RI		
	Min. I	2458032.3025(8)	T4+C3	I		
	Min. II	2458039.3296(7)	T4+C3	RI		
USNO-A2.0 0900-14578525	Min. II	2458316.4980(12)	T4b+C4	R	EW	5
	Min. I	2458317.5075(21)	T4b+C4	R		
	Min. II	2458318.5104(20)	T4b+C4	R		
	Min. II	2458337.3450(13)	T4b+C4	R		
	Min. I	2458338.3524(9)	T4b+C4	R		
	Min. I	2458346.4197(7)	T4b+C4	R		
	Min. I	2458348.4391(14)	T4b+C4	R		
USNO-A2.0 0975-04711370	Min.	2455537.4735(5)	T1+C1	I	EA	2
USNO-A2.0 0975-15110240	Min. I	2458672.4006(3)	T4+C3	RI	EW	6
	Min. I	2458690.3187(3)	T4+C3	RI		
	Min. II	2458692.3466(2)	T4+C3	RI		
	Min. I	2458702.5272(14)	T4+C3	RI		
	Min. II	2458731.4374(15)	T4+C3	RI		
	Min. II	2458749.3588(5)	T4+C3	RI		
	Min. I	2459014.4675(5)	T4+C3	RI		
	Min. II	2459016.4981(4)	T4+C3	RI		
	Min. II	2459025.4613(7)	T4+C3	RI		
	Min. I	2459027.4943(8)	T4+C3	RI		
	Min. II	2459047.4532(5)	T4+C3	RI		
	Min. I	2459056.4207(4)	T4+C3	R		
	Min. II	2459076.3623(6)	T4+C3	R		

Table 3: Tab 2 cont.

USNO-A2.0 0975-15110722	Min. I	2458278.5481(10)	T4+C3	RI	EA	link
	Min. I	2458316.3165(15)	T4b+C4	R		
	Min. I	2458346.3393(4)	T4b+C4	R		
	Min. I	2458614.5865(2)	T4b+C4	R		
	Min. II	2458632.5027(22)	T4b+C4	R		
	Min. II	2458662.5226(16)	T4+C3	RI		
	Min. I	2459015.5057(3)	T4+C3	RI		
	Min. I	2459016.4775(19)	T4+C3	RI		
USNO-A2.0 0975-15174250	Min. II	2458307.4704(27)	T4b+C4	R	EW	7
	Min. II	2458308.4538(10)	T4b+C4	R		
	Min. I	2458316.4725(20)	T4b+C4	R		
	Min. I	2458336.4448(3)	T4b+C4	R		
	Min. I	2458337.4280(8)	T4b+C4	R		
	Min. I	2458338.4171(4)	T4b+C4	R		
	Min. I	2458339.3963(3)	T4b+C4	R		
	Min. II	2458346.4457(6)	T4b+C4	R		
	Min. II	2458348.3960(3)	T4b+C4	R		
	Min. II	2458364.4486(4)	T4b+C4	R		
	Min. I	2458365.2623(6)	T4b+C4	R		
	Min. II	2458365.4251(10)	T4b+C4	R		
	Min. II	2458366.4084(6)	T4b+C4	R		
	Min. II	2458641.4645(16)	T4b+C4	R		
	Min. II	2458661.4344(6)	T4b+C4	R		
	Min. II	2458662.4188(1)	T4+C3	RI		
	Min. II	2458663.4057(8)	T4+C3	RI		
	Min. I	2458671.4252(7)	T4+C3	RI		
	Min. I	2458672.4042(7)	T4+C3	RI		
	Min. II	2458672.5735(61)	T4+C3	RI		
	Min. I	2458690.4111(3)	T4+C3	RI		
	Min. I	2458691.3928(4)	T4+C3	RI		
	Min. II	2458702.3629(16)	T4+C3	RI		
	Min. II	2458720.3747(21)	T4+C3	RI		
	Min. II	2458721.3553(18)	T4+C3	RI		
	Min. II	2458722.3410(28)	T4+C3	RI		
	Min. I	2458731.3389(71)	T4+C3	RI		
	Min. I	2458749.3547(20)	T4+C3	I		
	Min. I	2458750.3387(22)	T4+C3	I		
	Min. I	2458752.3001(8)	T4+C3	I		
	Min. II	2458760.3099(49)	T4+C3	RI		
	Min. II	2458781.2780(39)	T4+C3	I		
	Min. II	2458968.5762(124)	T4+C3	RI		
	Min. II	2459014.4101(4)	T4+C3	I		
	Min. II	2459028.4916(15)	T4+C3	RI		
	Min. II	2459047.4839(24)	T4+C3	RI		

Table 4: Tab 2 cont.

USNO-A2.0 0975-15180095	Min. I	2458307.4219(11)	T4b+C4	R	EW	7
	Min. II	2458308.4908(18)	T4b+C4	R		
	Min. I	2458316.3858(8)	T4b+C4	R		
	Min. II	2458317.4520(26)	T4b+C4	R		
	Min. I	2458318.5205(26)	T4b+C4	R		
	Min. I	2458336.4337(18)	T4b+C4	R		
	Min. II	2458338.3562(25)	T4b+C4	R		
	Min. I	2458339.4160(13)	T4b+C4	R		
	Min. II	2458346.4626(12)	T4b+C4	R		
	Min. I	2458348.3936(8)	T4b+C4	R		
	Min. I	2458366.3150(8)	T4b+C4	R		
	Min. II	2458376.3338(8)	T4b+C4	R		
	Min. I	2458641.5194(45)	T4b+C4	R		
	Min. I	2458662.4237(39)	T4+C3	RI		
	Min. I	2458671.3912(39)	T4+C3	I		
	Min. II	2458672.4457(24)	T4+C3	RI		
	Min. I	2458673.5092(61)	T4+C3	RI		
	Min. II	2458690.3610(38)	T4+C3	RI		
	Min. I	2458691.4320(45)	T4+C3	RI		
	Min. II	2458722.3691(54)	T4+C3	RI		
	Min. II	2458781.2575(57)	T4+C3	I		
	Min. II	2458968.5669(84)	T4+C3	I		
	Min. I	2459014.4385(81)	T4+C3	I		
	Min. II	2459015.5214(135)	T4+C3	I		
	Min. II	2459027.4530(57)	T4+C3	I		
USNO-A2.0 0975-15180948	Min. II	2458249.5811(60)	T4+C3	RI	EW	7
	Min. I	2458258.5214(38)	T4+C3	I		
	Min. II	2458259.5181(23)	T4+C3	I		
	Min. I	2458260.5072(64)	T4+C3	RI		
	Min. I	2458277.5340(80)	T4+C3	I		
	Min. II	2458278.5246(16)	T4+C3	I		
	Min. I	2458307.3330(31)	T4b+C4	R		
	Min. II	2458307.4697(8)	T4b+C4	R		
	Min. I	2458308.4621(15)	T4b+C4	R		
	Min. II	2458317.3983(6)	T4b+C4	R		
	Min. I	2458317.5397(18)	T4b+C4	R		
	Min. II	2458318.5359(5)	T4b+C4	R		
	Min. II	2458338.3986(8)	T4b+C4	R		
	Min. I	2458339.3939(7)	T4b+C4	R		
	Min. II	2458346.3452(6)	T4b+C4	R		
	Min. II	2458347.4748(3)	T4b+C4	R		
	Min. I	2458348.4723(5)	T4b+C4	R		
	Min. I	2458366.3535(10)	T4b+C4	R		
	Min. I	2458661.4424(18)	T4+C3	RI		
	Min. II	2458662.4374(8)	T4+C3	RI		

Table 5: Tab 2 cont.

	Min. I	2458671.3759(24)	T4+C3	RI		
	Min. II	2458671.5150(17)	T4+C3	RI		
	Min. II	2458672.3698(47)	T4+C3	RI		
	Min. I	2458672.5109(11)	T4+C3	RI		
	Min. II	2458673.5052(23)	T4+C3	RI		
	Min. I	2458690.3835(9)	T4+C3	RI		
	Min. II	2458692.5098(15)	T4+C3	RI		
	Min. II	2458702.4409(7)	T4+C3	RI		
	Min. II	2458720.3246(8)	T4+C3	RI		
	Min. I	2458721.3144(6)	T4+C3	RI		
	Min. II	2458721.4583(3)	T4+C3	RI		
	Min. II	2458722.3045(9)	T4+C3	RI		
	Min. II	2458723.4397(16)	T4+C3	RI		
	Min. II	2458731.3891(3)	T4+C3	RI		
	Min. II	2458749.2610(26)	T4+C3	RI		
	Min. II	2458760.3343(35)	T4+C3	I		
	Min. I	2459014.4213(7)	T4+C3	I		
	Min. I	2459027.4774(4)	T4+C3	I		
	Min. II	2459047.4835(40)	T4+C3	RI		
USNO-A2.0 1125-14844300	Min. II	2459016.3648(12)	T4+C3	I	EW	6
	Min. I	2459016.5136(9)	T4+C3	RI		
	Min. I	2459026.4474(4)	T4+C3	RI		
	Min. II	2459028.4593(4)	T4+C3	RI		
	Min. II	2459047.3879(5)	T4+C3	RI		
USNO-A2.0 1125-16060074	Min. I	2455381.4250(3)	T3+C2	I	EW	8
	Min. I	2455382.4913(20)	T3+C2	I		
	Min. II	2455383.3887(6)	T3+C2	I		
	Min. II	2455384.4668(39)	T3+C2	RI		
	Min. I	2455391.4493(43)	T3+C2	RI		
	Min. II	2455392.3411(28)	T3+C2	RI		
	Min. I	2455392.5218(27)	T3+C2	RI		
	Min. II	2455394.4894(13)	T3+C2	I		
USNO-A2.0 1125-16127402	Min. I	2455381.5160(100)	T3+C2	R	EW	5
	Min. I	2455382.4232(35)	T3+C2	VRI		
	Min. II	2455383.4981(45)	T3+C2	I		
	Min. II	2455384.4241(64)	T3+C2	RI		
	Min. II	2455391.4865(64)	T3+C2	R		
	Min. II	2455392.4159(95)	T3+C2	RI		
	Min. I	2455392.5627(4)	T3+C2	I		
	Min. I	2455394.4099(13)	T3+C2	I		
USNO-A2.0 1275-02644421	Min. I	2458376.4727(11)	T4b+C4	R	EW	5
	Min. II	2458377.5175(5)	T4b+C4	R		
	Min. II	2458395.5051(4)	T4b+C4	R		
USNO-A2.0 1275-18389895	Min. I	2458751.4644(2)	T4+C3	RI	EW	9
	Min. II	2458752.5322(19)	T4+C3	RI		
	Min. II	2458779.3756(30)	T4+C3	RI		

Table 6: Tab 2 cont.

	Min. I	2458790.3255(5)	T4+C3	RI		
	Min. I	2458810.2955(14)	T4+C3	RI		
USNO-A2.0 1350-04394387	Min.	2455885.3577(80)	T1+C1	I	Eclip	2
	Min.	2455892.3528(232)	T1+C1	I		
USNO-A2.0 1425-02035807	Min. I	2458081.4390(6)	T4b+C4	-	EW	7
	Min. II	2458099.3018(4)	T4b+C4	-		
	Min. II	2458100.2502(3)	T4b+C4	-		
	Min. II	2458340.5484(6)	T4b+C4	R		
	Min. II	2458346.5558(5)	T4b+C4	R		
	Min. II	2458364.5760(3)	T4b+C4	R		
	Min. II	2458368.5301(4)	T4b+C4	R		
USNO-A2.0 1425-11417028	Min. I	2458720.3463(24)	T4+C3	RI	EW	7
	Min. II	2458721.3748(14)	T4+C3	RI		
	Min. I	2458722.4045(16)	T4+C3	RI		
USNO-A2.0 1425-11421951	Min. I	2456894.5419(2)	T5+C5	VI	EA	6
	Min. I	2458376.4172(22)	T4b+C4	R		
	Min. I	2458423.2254(67)	T4b+C4	R		
	Min. I	2458722.3770(11)	T4+C3	RI		
USNO-A2.0 1425-11424653	Min. II	2458423.3075(3)	T4b+C4	R	EB	10
	Min. II	2458424.3270(4)	T4b+C4	R		
	Min. II	2458425.3478(17)	T4b+C4	R		
	Min. I	2458435.3076(2)	T4b+C4	R		
	Min. I	2458437.3522(2)	T4b+C4	R		
	Min. I	2458456.2658(1)	T4b+C4	R		
	Min. I	2458692.4210(1)	T4+C3	RI		
	Min. II	2458722.3272(4)	T4+C3	RI		
	Min. I	2458723.5995(5)	T4+C3	RI		
	Min. II	2458731.5252(8)	T4+C3	RI		
USNO-A2.0 1425-11426736	Min. II	2458397.3501(2)	T4b+C4	R	EW	10
	Min. I	2458423.2495(6)	T4b+C4	R		
	Min. I	2458425.2518(14)	T4b+C4	R		
	Min. I	2458435.2905(4)	T4b+C4	R		
	Min. II	2458692.4891(4)	T4+C3	RI		
	Min. I	2458693.5001(8)	T4+C3	RI		
	Min. I	2458720.4024(5)	T4+C3	RI		
	Min. I	2458722.4116(5)	T4+C3	RI		
USNO-A2.0 1425-13104193	Min. I	2458031.3904(38)	T4+C3	RI	EB	1
	Min. I	2458039.2484(18)	T4+C3	RI		
	Min. II	2458039.4479(61)	T4+C3	RI		
USNO-A2.0 1425-15515944	Min. I	2458053.4626(3)	T4+C3	I	EW	5
	Min. II	2458080.2306(56)	T4+C3	I		
	Min. I	2458080.3742(203)	T4+C3	I		
	Min. I	2458081.2763(24)	T4+C3	RI		

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Table 7: Tab 2 cont.

USNO-A2.0 1575-00671270	Min.	2458368.5094(11)	T4b+C4	R	EW	11
USNO-A2.0 1575-00700504	Min.	2458367.5146(20)	T4b+C4	R	EW	11
Vir IK	Min. I	2458906.4702(3)	T4+C3	R	EA	
	Min. II	2458910.4506(3)	T4+C3	R		
	Min. II	2458936.4983(3)	T4+C3	R		
	Min. I	2458956.3997(1)	T4+C3	RI		
	Min. II	2458957.4856(1)	T4+C3	RI		

References: 1-Liakos (2017), 2-Liakos & Niarchos (2011b), 3-Liakos & Niarchos (2011a), 4-Liakos & Nanouris (2014), 5-Liakos (2020a), 6-Liakos (2020b), 7-Liakos (2019), 8-Liakos, Dakanalis & Niarchos (2014), 9-Drake et al. (2014), 10-Chen et al. (2018), 11-Chen et al. (2020), [a]wrongly published as UGPS J221656.43+572125.5, link: https://www.aavso.org/vsx/index.php?view=detail.top&oid=722551

Table 8: Maximum timings for the observed pulsating stars.

Name	HJD	Setup	Filters	LC	Ref.
USNO-A2.0 1125-16097188	2455380.5509(16)	T3+C2	R	RRab	1
	2455384.3616(52)	T3+C2	BVRI		
	2455392.3319(18)	T3+C2	BVRI		
	2455393.3700(95)	T3+C2	VI		
	2455394.4193(46)	T3+C2	BVRI		
	2455396.5077(59)	T3+C2	R		
USNO A2.0 1425-13126187	2458013.4619(16)	T4+C3	RI	HADS	2
	2458031.3461(33)	T4+C3	RI		
	2458039.3807(23)	T4+C3	I		

References: 1-Liakos, Dakanalis & Niarchos (2014), 2-Liakos (2020b)

Table 9: Light elements for the observed objects.

Name	T_0 [HJD-2400000]	P [d]	Max [mag]	Min [mag]	Band
Eclipsing binaries					
2MASS J22262047+5448251	57992.5372(6)	0.27431(1)	14.30[1]	15.00[a]	R
GSC 0445-0903	-	-	12.32[2]	12.42[b]	V
GSC 2816-2000	-	-	13.30[1]	13.36	R
GSC 3159-1188	-	-	13.36[3]	13.75	V
GSC 3802-1680	55604.3707(8)	3.44161(9)	11.60[4]	11.74	V
GSC 4320-1033	-	-	9.70[1]	9.95	B
GSC 4835-1716	55939.383(9)	0.4245(1)	13.66[3]	13.86	V
NOMAD1 1609-0153459	-	-	18.00[1]	18.73	R
UCAC4 737-083435[c]	58031.452(2)	0.42572(7)	15.96[5]	16.22	R
USNO-A2.0 0900-14578525	58317.506(1)	0.67246(4)	14.50[1]	14.77	R
USNO-A2.0 0975-04711370	-	-	13.80[6]	13.94	I
USNO-A2.0 0975-15110240	58672.399(2)	0.81436(1)	12.60[1]	12.81	R
USNO-A2.0 0975-15110722	58278.5491(7)	0.96841(1)	14.70[1]	15.97	R
USNO-A2.0 0975-15174250	58336.445(1)	0.32744(1)	16.70[1]	17.04	R
USNO-A2.0 0975-15180095	58307.424(2)	0.42668(1)	17.60[1]	17.83	R
USNO-A2.0 0975-15180948	58317.5425(6)	0.28375(1)	17.60[1]	18.12	R
USNO-A2.0 1125-14844300	59016.517(2)	0.31026(4)	15.10[1]	15.28	R
USNO-A2.0 1125-16060074	55391.447(1)	0.35806(7)	14.90[1]	15.74	R
USNO-A2.0 1125-16127402	55392.565(3)	0.3072(1)	14.80[1]	15.05	R
USNO-A2.0 1275-02644421	58376.471(2)	0.29975(6)	15.60[1]	15.70	R
USNO-A2.0 1275-18389895	58751.462(2)	0.42944(5)	16.40[1]	16.95	R
USNO-A2.0 1350-04394387	-	-	14.32[6]	14.78	I
USNO-A2.0 1425-02035807	58081.4381(5)	0.31618(1)	16.50[1]	16.77	R
USNO-A2.0 1425-11417028	58720.3461(5)	0.4116(1)	17.90[1]	18.54	R
USNO-A2.0 1425-11421951	58376.410(4)	0.73143(1)	15.90[1]	16.33	R
USNO-A2.0 1425-11424653	58435.313(2)	0.51115(1)	14.10[1]	14.54	R
USNO-A2.0 1425-11426736	58693.497(2)	0.40156(1)	15.80[1]	16.11	R
USNO-A2.0 1425-13104193	58039.245(4)	0.4134(3)	16.80[1]	17.27	R
USNO-A2.0 1425-15515944	58081.275(2)	0.29906(4)	17.50[1]	18.03	R
USNO-A2.0 1575-00671270	-	-	14.70[1]	15.30	R
USNO-A2.0 1575-00700504	-	-	18.40[1]	18.96	R
Pulsating stars					
USNO-A2.0 1125-16097188	55392.337(3)	0.3468(2)	13.10	13.76	R
USNO A2.0 1425-13126187	58013.462(2)	0.15157(2)	16.30	16.53	R

[a]rough estimation, [b]probably this is the value of the secondary minimum [c]wrongly published as UGPS J221656.43+572125.5 in Liakos (2017), [1]The USNO-A2.0 Catalogue (Monet et al., 1998), [2]The Tycho-2 catalogue of the 2.5 million brightest stars (Høg et al., 2000), [3]UCAC4 Catalogue (Zacharias et al., 2012), [4]The TYCHO Input Catalogue (Egret et al., 1992), [5]IPHAS DR2 Source Catalogue (Barentsen et al., 2014), [6]The USNO-B Catalog (Monet et al., 2003)

Sensing of the National Observatory of Athens. This work has made use of the VSX database.

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