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Times of Minima of Selected Eclipsing Binaries Obtained with the IST40 Telescope

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Abstract
We present 71 times of minima of 20 eclipsing binaries obtained from Istanbul University Observatory between 2021-2023.

Key words: binaries: eclipsing – methods: observational – techniques: photometric

1 Introduction

In the framework of monitoring variable stars from Istanbul University Observatory, we obtained several minima times of various eclipsing binaries.

Target systems were selected based on their brightness ($m_V<15$) and pulsation period ($P<1$ day). Targets were selected from the General Catalogue of Variable Stars (GCVS) (Samus' et al. 2017) and the All-sky Automated Survey for Supernovae (ASAS-SN) (Jayasinghe et al. 2018). Target systems were selected based on their brightness and orbital period. As the transparency of the sky at the Beyazit Campus is very variable, we focus mainly on short period binaries displaying W UMa (EW) and Algol-type (EA) light variations in order to obtain their entire light curves or only minima profiles for the measurements of light minima of a given eclipsing binary in a single night of observation.

The variable star monitoring program is conducted as a training for the undergraduate students of the Astronomy and Space Sciences Department of Istanbul University. The program is performed mainly by the 3rd and 4th year students with an increasing interest from the junior and MSc students as well. Observations were severely disrupted during the COVID-19 epidemic, but the situation has been improving steadily since September 2022.

2 Observations and Data Reduction

All observations presented in this study were carried out with the 0.4m Schmidt-Cassegrain telescope (aka. IST40) of the Istanbul University Observatory. The telescope is located in the university campus at Beyazit, Istanbul (N 41.01167°, E 28.96528°, altitude 65 m).

Observations were performed with a thermoelectrically cooled CCD consisting a KAF-8300 chip which has 3358×2536 pixels. Pixel size of 5.4μ yields 0.27″/pixel resolution at the focal plane and this resolution allows to capture 16×12 arcminutes field of view.

All frames were bias, dark and flat-field corrected in a standard manner. Several bias and dark frames were combined in order to create a master calibration frame. Flat-fielding was done with sky flats obtained at dusk. Calibration images were obtained in each observing night. The log of observations is given in Table 1.

Instrumental magnitudes were determined with aperture photometry using *Muniwin* software of the `C-Munipack` package (Hroch 2014). Photometry procedures of the *C-Munipack* package are based on the well-known DAOPHOT (Stetson 1987) package.

Minimum times of eclipsing binaries were computed with the help of Peranso software (Paunzen & Vanmunster 2016) which uses Kwee and van Woerden method (Kwee & van Woerden 1956). This method requires a homogeneous temporal coverage of the minimum light. Thus, we use the data halfway from the eclipse center at each side. In result, we omit eclipses when the descending or the ascending portion of the light curve is not complete. In this way, we ensure the precision of the minima times given in Table 2. All times in the table were converted into Heliocentric Julian Date (HJD).

3 Results

Table 2 lists the minima times that we obtain in this study. Date (UT), minimum time and its uncertainty, filter used in the acquisition of the light curve (V and R are standard Johnson filters), and the type of the minimum are given in the table as well as the star name. Min. I refers the deeper minimum, while the Min. II is when the fainter star is eclipsed. Some stars were observed extensively and has many times of minimum.

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Table 1. Log of observations. Date is in "year-month-day" format, Add 2459000 to JD Interval, Duration is in hours, VT: Variable Type, Nf: Number of frames, ET: Exposure time in seconds. Observer abbreviations are as follows; YD: Yasin Dalkılıç, CB: Canday Beyaz, MTS: Mustafa Turan Sağlam, EA: Esat Akkaşoğlu, ZT: Zafer Toy, MIE: Melike İlayda Eryılmaz, GO: Görkem Özgül, ANO: Aleyna Nur Öztürk, RM: Rosha Manafzadeh, FIK: Fatma İlayda Keleş, ANA: Asuman Nura Altınöz, SE: Sedanur Ereğli, HE: Hilal Erişti, MG: Mustafa Gümüştaş, MDI: Muhammed Diyaddin İlhan, MC: Meryem Çördük, MMB: Muhammed Baki Bayram, ZCC, Zişan Çağla Çilingir, EC: Elif Çolak, SB: Safahan Başara, EG: Elanur Güler, SO: Serhat Öztürk, YSS: Yağmur S.Seyhan, NY: Nur Yıldırım, MA: Mübin Atmaca, MAY: Mustafa Ahmet Yeşilova, FEG: Fatih Erkam Göktürk, TK: Tuğçe Kocabıyık, SF: Süleyman Fişek, IZK: İrem Zeynep Kelkitli, BG: Baran Günday, BNO: Beyza Nur Okur, FHV: Fatma Hac Mustafa, EED: Elif Ece Devecioğlu, AAC: Anıl Ahmet Çırak, YEC: Yunus Emre Çetinkaya, ENT: Eda Nur Topal, EBU: Ebubekir Şark, ENY: Esmanur Yıldırım, RT: Resul Tancan, ES: Elif Şafak, ATB: Ahmet Talha Bayır, MK: Mustafa Kaptanoğlu, MN: Miray Nar, SS: Sefer Saatçi, MO: Miyasa Özkayıkçı, BE: Burak Erdoğan, YHB: Yaren Hediye Bektaş, MuO: Muhammet Özcan, EY: Esra Yılmaz, RIC: Rabia İrem Çevik, IK: İnanç Kuluç

Date	JD Interval	Duration	Star	VT	Nf	Filter	ET	Observers
2021-11-30	548.449616−548.547454	2.35	LR Cam	EW	120	V	60	ZCC,EAY,YSS,GO
2021-12-01	550.468029−550.568228	2.40	LR Cam	EW	86	V	60	ZCC,EAY,YSS,GO
2021-12-02	551.417528−551.680832	6.32	LR Cam	EW	295	V	60	MG,EG,SS,MC,NY
2021-12-09	558.358749−558.656379	7.14	LR Cam	EW	363	V	60	MC,AAC,SE,SO
2021-12-19	568.240030−568.541870	7.24	LR Cam	EW	343	V	60	MTS,ANA,EC,CB
2021-12-21	570.339459−570.562201	5.35	LR Cam	EW	192	V	60	FEG,ES,GC,IK
2021-12-23	572.204300−572.425931	5.32	LR Cam	EW	272	V	60	MC,MuO,YD,NY
2021-12-24	573.225524−573.283020	1.38	BK Vul	EW	21	V	40	MTS,MIE,ANO,MK
2022-01-31	611.262370−611.395211	3.19	LR Cam	EW	163	V	60	ZT,EED,MN,GO
2022-02-10	621.197595−621.518074	7.69	LR Cam	EW	348	V	60	MTS,RM
2022-02-18	629.286522−629.394061	2.58	LR Cam	EW	140	V	60	MTS,RIC
2022-02-21	632.296062−632.456342	3.85	UU Cam	EW	91	V	80	EA,FIK,RT,GO
2022-06-26	757.432668−757.575086	3.42	V625 And	EW	165	V	60	EA,ESA
2022-07-19	780.381509−780.424926	1.04	AB And	EW	72	V	35	ANO,MAY,MIE,CB
2022-07-26	787.343494−787.461454	2.83	AB And	EW	326	V	20	ANO,MAY,MIE,CB
2022-08-03	795.281796−795.554189	6.54	V626 Peg	EW	322	R	60	ZT,CB,YD
2022-08-05	797.308328−797.479959	4.12	V1828 Aql	EA	201	V	60	EA,YD,ANO,SE
2022-08-06	798.329899−798.463902	3.22	V1828 Aql	EA	97	V	95	ZT,YD,CB
2022-08-07	799.271607−799.546477	6.60	V1828 Aql	EA	147	R	90	EA,YD,SO,ATB
2022-08-13	805.301502−805.536752	5.65	V2015 Aql	EW	290	V	60	ZT
2022-08-15	807.281622−807.551415	6.48	V595 Vul	EW	633	V	25	ZT
2022-08-16	808.290884−808.490065	4.79	V1828 Aql	EA	265	V	45	FIK,ANA,MTS
2022-08-20	812.272519−812.575351	7.27	V638 Peg	EW	366	V	60	ZT,YD
2022-08-28	820.273135−820.605234	7.97	V638 Peg	EW	415	V	60	EA,EBU
2022-09-07	830.236594−830.386093	3.59	ASAS J212702+1510.8	EW	278	V	30	YD
2022-09-09	832.248744−832.525195	6.63	V576 Peg	EW	458	V	40	YD
2022-09-13	836.326407−836.529288	4.87	V2477 Cyg	EW	641	V	15	SE,ANO,MIE,CB
2022-09-15	838.242839−838.534361	7.00	V477 Peg	EW	344	V	30	YD
2022-09-20	843.344402−843.513696	4.06	PZ Cam	EW	133	V	100	ANA,MIE,CB
2022-09-30	853.245543−853.501914	6.15	PZ Cam	EW	354	V	50	EA,MIE
2022-10-21	874.297752−874.613315	7.57	LR Cam	EW	392	V	30	HE,MG,EC,CB
2022-10-22	875.208686−875.471615	6.31	PZ Cam	EW	326	R	60	EA,MDI
2022-10-25	878.227382−878.465371	5.71	V685 Peg	EW	552	R	30	ZT,BE,ENT,YHB
2022-10-27	880.224093−880.330582	2.56	V685 Peg	EW	225	V	30	SNG,IZK,EY,MTS
2022-10-29	882.217901−882.358567	3.38	PZ Cam	EW	162	V	60	EA,MDI,MA,EBS
2022-11-01	885.235695−885.536295	7.21	V685 Peg	EW	316	V	30	ZT
2022-11-03	889.286315−889.530409	5.86	PZ Cam	EW	261	V	60	EA,EBS,MA,MDI
2023-01-20	965.437217−965.599121	3.89	LR Cam	EW	275	V	20	MG,HE,CB,YEC
2023-02-16	992.228701−992.456266	5.46	PZ Cam	EW	340	V	50	MTS,RM,MBB
2023-02-17	993.252239 − 993.355684	2.48	GW Cnc	EW	115	V	70	FHV,HE,CB
2023-02-20	996.269709 − 996.449181	4.31	IL Cnc	EW	584	V	20	MIE,EED,BG,GO
2023-02-21	997.315289 − 997.557993	5.82	LX Leo	EW	311	R	50	ZT,MO,ENY,BNO
2023-02-22	998.326138 − 998.538202	5.09	IL Cnc	EW	261	V	60	YD,FIK,TK
2023-03-30	1034.292819 − 1034.550251	6.18	AR Boo	EW	310	V	60	MTS,MBB,RM
2023-04-13	1048.298755 − 1048.591227	7.02	RV Cvn	EW	217	V	90	MTS,RM
2023-04-24	1059.319073 − 1059.574609	6.13	RV Cvn	EW	192	V	90	SB
2023-04-29	1064.420311 − 1064.569218	3.57	RV Cvn	EW	125	V	90	SB
2023-05-01	1066.371444 − 1066.527098	3.74	XY Boo	EW	341	V	30	YD,EG,SF

Table 2. List of minimum times. Table lists UT date, minimum time (T_{min}, HJD 2400000+), uncertainty of the minimum (days), filter of the observation, and the type of the minimum.

Star	UT Date	T_{min}	Uncert.	Filter	Min.Type
AB And	2022-07-19	59780.40396	0.00018	V	Min. I
AB And	2022-07-26	59787.37357	0.00012	V	Min. I
V625 And	2022-06-26	59757.54791	0.00025	V	Min. II
V1828 Aql	2022-08-05	59797.32791	0.00044	V	Min. I
V1828 Aql	2022-08-05	59797.38304	0.00041	V	Min. II
V1828 Aql	2022-08-05	59797.43794	0.00006	V	Min. I
V1828 Aql	2022-08-06	59798.37642	0.00045	V	Min. II
V1828 Aql	2022-08-06	59798.43132	0.00019	V	Min. I
V1828 Aql	2022-08-07	59799.36973	0.00036	R	Min. II
V1828 Aql	2022-08-07	59799.47976	0.00093	R	Min. II
V1828 Aql	2022-08-07	59799.53509	0.00014	R	Min. I
V1828 Aql	2022-08-16	59808.31012	0.00017	V	Min. II
V1828 Aql	2022-08-16	59808.36500	0.00003	V	Min. I
V1828 Aql	2022-08-16	59808.42046	0.00054	V	Min. II
V1828 Aql	2022-08-16	59808.47532	0.00012	V	Min. I
V2015 Aql	2022-08-13	59805.35262	0.00046	V	Min. II
V2015 Aql	2022-08-13	59805.46298	0.00158	V	Min. I
AR Boo	2023-03-30	60034.33381	0.00021	V	Min. II
AR Boo	2023-03-30	60034.50511	0.00047	V	Min. I
XY Boo	2023-05-01	60066.43215	0.00025	V	Min. II
LR Cam	2021-11-30	59548.52187	0.00019	V	Min. II
LR Cam	2021-12-01	59550.47488	0.00010	V	Min. I
LR Cam	2021-12-02	59551.56165	0.00019	V	Min. II
LR Cam	2021-12-09	59558.50768	0.00024	V	Min. II
LR Cam	2021-12-19	59568.27415	0.00027	V	Min. I
LR Cam	2021-12-19	59568.49277	0.00024	V	Min. II
LR Cam	2021-12-21	59570.44443	0.00110	V	Min. I
LR Cam	2021-12-23	59572.39935	0.00032	V	Min. II
LR Cam	2022-02-10	59621.23627	0.00256	V	Min. I
LR Cam	2022-02-10	59621.45626	0.00029	V	Min. II
LR Cam	2022-10-21	59874.34124	0.00019	V	Min. I
LR Cam	2022-10-21	59874.55819	0.00028	V	Min. II
LR Cam	2023-01-20	59965.51207	0.00064	V	Min. I
PZ Cam	2022-09-20	59843.42518	0.00034	V	Min. I
PZ Cam	2022-09-30	59853.28827	0.00059	V	Min. II
PZ Cam	2022-09-30	59853.43078	0.00018	V	Min. I
PZ Cam	2022-10-22	59875.30184	0.00030	R	Min. II
PZ Cam	2022-10-22	59875.44279	0.00064	R	Min. I
PZ Cam	2022-10-29	59882.30408	0.00067	V	Min. I
PZ Cam	2022-11-05	59889.35038	0.00148	V	Min. II
PZ Cam	2022-11-05	59889.49062	0.00030	V	Min. I
PZ Cam	2023-02-16	59992.36945	0.00049	V	Min. I
UU Cam	2022-02-21	59632.31745	0.00041	V	Min. II
GW Cnc	2023-02-17	59993.27910	0.00031	V	Min. I
IL Cnc	2023-02-20	59996.31586	0.00036	V	Min. II
IL Cnc	2023-02-22	59998.45843	0.00013	V	Min. II
RV CVn	2023-04-13	60048.35296	0.00296	V	Min. I
RV CVn	2023-04-13	60048.48744	0.00031	V	Min. II
RV CVn	2023-04-24	60059.40408	0.00047	V	Min. I
RV CVn	2023-04-24	60059.53799	0.00023	V	Min. II
RV CVn	2023-04-29	60064.52494	0.00207	V	Min. I
V2477 Cyg	2022-09-13	59836.36093	0.00006	V	Min. II
V2477 Cyg	2022-09-13	59836.51603	0,00004	V	Min. I
LX Leo	2023-02-21	59997.42967	0.00007	R	Min. I
LX Leo	2023-02-21	59997.54815	0.00012	R	Min. II
V576 Peg	2022-09-09	59832.35110	0.00019	V	Min. II
V576 Peg	2022-09-09	59832.47801	0.00012	V	Min. I
V626 Peg	2022-08-03	59795.28581	0.00020	R	Min. I
V626 Peg	2022-08-03	59795.52621	0.00011	R	Min. I
V638 Peg	2022-08-20	59812.28299	0.00031	V	Min. II
V638 Peg	2022-08-20	59812.42302	0.00011	V	Min. I
V638 Peg	2022-08-20	59812.56489	0.00022	V	Min. II
V638 Peg	2022-08-28	59820.32898	0.00017	V	Min. I
V638 Peg	2022-08-28	59820.47156	0.00031	V	Min. II
V685 Peg	2022-10-25	59878.34091	0.00010	R	Min. II
V685 Peg	2022-10-27	59880.24467	0.00021	V	Min. II
V685 Peg	2022-11-01	59885.36341	0.00049	V	Min. I
V685 Peg	2022-11-01	59885.52214	0.00011	V	Min. II
V595 Vul	2022-08-15	59807.35086	0.00015	V	Min. II
V595 Vul	2022-08-15	59807.48561	0.00060	V	Min. I
<ASAS>	2022-09-07	59830.27910	0.00861	V	Min. I

Table 2 – *continued.* Star name <ASAS> represents "ASAS J212702+1510.8".

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