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MINIMA OF ECLIPSING BINARIES, VARIABILITY OF V840 HER AND NSV5740, NEW EPHEMERIDES FOR V997 CYG, V1037, V1098, V1100 HER

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The accompanying list contains 97 times of minima for 49 eclipsing binary stars (including the cataclysmic DO Leo) calculated from CCD observations made by participants in the SSV-UAI Eclipsing Binaries Program. All the observatories are located in Italy; one is managed by the Physics Department of the University of Siena, while the others are privately operated.

The observations were reduced following standard procedures (see next section) and the light curves were analyzed using the Kwee−van Woerden algorithm (Kwee & van Woerden, 1956) to determine the times of minimum. All the times of minimum listed in this paper are heliocentric.

We note most of the observed stars are neglected objects.

Observatory and telescope:
University of Siena Astron. Observatory: 32-cm Maksutov–Cassegrain (MC32)
Skylive Remote Telescopes: 30-cm Schmidt–Cassegrain (S30)
Other private astronomical stations:
30-cm Schmidt–Cassegrain (SC30)
25-cm Newton (NW25)
25-cm Schmidt–Cassegrain (SC25)
20-cm Newton (NW20)
20-cm Schmidt–Cassegrain (SC20)
11-cm Newton (NW11)

Detector:	Meade DSI Pro II Monochromatic CCD camera (DSI)
	QSI 516wsg
	SBIG ST-7 CCD Camera (ST7)
	SBIG ST-8XME CCD Camera (ST8)
	SBIG ST-9 CCD Camera (ST9)
	SBIG ST-10XME CCD camera (ST10)
	Sony ICX429ALL based CCD camera (CCD-UAI)

Method of data reduction:

Frame calibration (dark subtraction and flat field correction) and photometric analysis (differential photometry on each image) were performed using MaxImDL or Mira Pro software packages.

Method of minimum determination:

The times of minima, expressed as heliocentric Julian days (see the attached Table), were computed adopting the KW method (Kwee & van Woerden, 1956) using AVE (Barberá, 1996). This algorithm also provides an error estimate, that is the formal internal error of the KW method, so which can be considered as a lower limit of the actual uncertainty on times of minimum. Together with that error, we provide an alternative estimate error according to the Arlot's (modified) method (Arlot *et al.*, 2009) by adopting the formula $\sigma_{ToM} = \frac{1}{\sqrt{2}}\frac{\sigma_m}{\Delta m}\Delta t$, where σ_m is the error in magnitude and Δm is the magnitude drop during a time range Δt delimiting the part of the light curve where the speed of decrease in magnitude is the highest. The $\frac{1}{\sqrt{2}}$ factor takes into account that 2 branches (descending and ascending) contribute to the time of minimum estimation.

The types of minimum quoted in the Table were deduced according the ephemerides provided by Kreiner's (2004) web site (`http://www.as.up.krakow.pl/ephem`), by B.R.N.O. – *O−C Gateway* web site (`http://var.astro.cz/ocgate`) or by our updated elements (see below). Only in the latter case we are sure that the primary minimum (conventionally at zero phase) is the deeper.

Times of minima:					
Star name	Time of min. HJD 2400000+	Error	Type	Filter	Rem.
V1490 Aql	55755.3731	0.0015[a] 0.0001[b]	I	*R*	Marino/NW25/ST7
EM Boo	55662.4656	0.0010 0.0009	II	*V*	Martinengo/SC20/QSI-516wsg
GG Boo	55694.3652	0.0009 0.0004	I	*r*	Ruocco/SC25/ST7
GI Boo	55671.4805	0.0021 0.0011	II	*V*	Banfi/SC25/ST7
EG Cep	55751.3698	0.0002 0.0001	I	*c*	Arena/NW20/DSI
V338 Cep	55436.3741	0.0005 0.0002	I	*I*	Marino/NW20/ST7
V383 Cep	55434.3814	0.0014 0.0002	II	*I*	Marino/NW20/ST7
AM CrB	55693.4176	0.0004 0.0003	I	*r*	Ruocco/SC25/ST7
CX CVn	55655.4633	0.0012 0.0003	I	*V*	Banfi/SC25/ST7
DU CVn	55658.3619	0.0011 0.0007	I	*r*	Ruocco/SC25/ST7
DU CVn	55658.5164	0.0005 0.0004	II	*r*	Ruocco/SC25/ST7
DU CVn	55661.4319	0.0007 0.0008	I	*r*	Ruocco/SC25/ST7
WZ Cyg	55412.3457	0.0005 0.0001	II	*R*	Romeo, Marino/SC20/ST7
V997 Cyg	55459.3667	0.0014 0.0003	II	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55460.5135	0.0006 0.0017	I	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55462.3445	0.0007 0.0003	I	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55463.4917	0.0012 0.0010	II	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55469.4474	0.0004 0.0002	II	*c*	Zambelli/SC25/ST8
V997 Cyg	55469.4481	0.0017 0.0006	II	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55472.4243:	0.0020 0.0015	I	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55476.3207	0.0022 0.0006	II	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55478.3836	0.0011 0.0002	I	*R*610	Corfini/NW20/CCD-UAI
V997 Cyg	55479.2994	0.0004 0.0002	I	*R*610	Corfini/NW20/CCD-UAI
V1905 Cyg	55739.4298	0.0002 0.0001	I	*V*	Martinengo/SC20/QSI 516wsg
V2197 Cyg	55754.3883	0.0001 0.0001	I	*V*	Banfi, Aceti, Pesenti/SC25/ST7
V2278 Cyg	55710.4459	0.0009 0.0004	I	*V*	Marino/NW20/ST7
V2478 Cyg	55740.4118	0.0006 0.0002	II	*V*	Martinengo/SC20/QSI 516wsg
V2480 Cyg	55754.5378	0.0010 0.0001	I	*V*	Banfi/SC25/ST7
EF Dra	55754.5431	0.0009 0.0003	II	*c*	Arena/NW20/DSI
GM Dra	55755.3665	0.0009 0.0001	I	*c*	Arena/NW20/DSI
GM Dra	55755.5379	0.0009 0.0001	II	*c*	Arena/NW20/DSI
HL Dra	55644.5838	0.0019 0.0003	I	*V*	Banfi/SC25/ST7
HL Dra	55645.5304	0.0026 0.0002	I	*V*	Banfi/SC25/ST7
HL Dra	55706.4376	0.0064 0.0010	II	*V*	Martinengo/SC20/QSI 516wsg
MY Dra	55655.4064	0.0004 0.0002	I	*V*	Papini/SC25/ST9
BC Her	55726.4459	0.0007 0.0003	I	*V*	Banfi/SC25/ST7
V923 Her	55661.5027	0.0060 0.0002	I	*V*	Marino/NW20/ST7
V1037 Her	55696.5741	0.0003 0.0002	I	*r*	Ruocco/SC25/ST7
V1037 Her	55700.5123	0.0004 0.0003	I	*r*	Ruocco/SC25/ST7
V1037 Her	55700.5120	0.0004 0.0001	I	*V*	Marchini/MC32/ST7
V1037 Her	55702.4821	0.0014 0.0004	II	*V*	Banfi/SC25/ST7
V1037 Her	55719.4146	0.0012 0.0002	I	*V*	Banfi/SC25/ST7
V1037 Her	55750.5258	0.0020 0.0025	II	*V*	Banfi/SC25/ST7
V1072 Her	55670.4421	0.0012 0.0007	I	*V*	Banfi/SC25/ST7
V1072 Her	55698.3723	0.0011 0.0011	II	*c*	Zambelli/SC25/ST8
V1072 Her	55710.4276	0.0003 0.0001	I	*V*	Martinengo/SC20/QSI 516wsg
V1072 Her	55738.3594	0.0013 0.0007	II	*c*	Ruocco/SC25/ST7
V1098 Her	55417.3951	0.0007 0.0003	II	*V*	Corfini/NW20/CCD-UAI
V1098 Her	55454.3815	0.0007 0.0002	II	*R*610	Corfini/NW20/CCD-UAI
V1098 Her	55641.6130	0.0004 0.0001	I	*V*	Papini/SC25/ST9
V1098 Her	55644.6084	0.0004 0.0002	II	*V*	Papini/SC25/ST9
V1098 Her	55645.4866	0.0010 0.0006	I	*V*	Papini/SC25/ST9

Times of minima:					
Star name	Time of min. HJD 2400000+	Error	Type	Filter	Rem.
V1098 Her	55654.4722	0.0009 0.0003	II	V	Banfi/SC25/ST7
V1098 Her	55654.6468	0.0006 0.0002	I	V	Banfi/SC25/ST7
V1098 Her	55669.4424	0.0007 0.0002	I	V	Zambelli/SC25/ST8
V1098 Her	55733.3808	0.0004 0.0002	II	c	Ruocco/SC25/ST7
V1100 Her	55641.5702	0.0005 0.0002	II	V	Zambelli/SC25/ST8
V1100 Her	55646.6008	0.0008 0.0002	I	V	Banfi/SC25/ST7
V1100 Her	55658.5684	0.0016 0.0004	II	V	Banfi/SC25/ST7
V1100 Her	55731.4261	0.0003 0.0003	II	c	Ruocco/SC25/ST7
V1100 Her	55734.3741	0.0003 0.0002	I	c	Ruocco/SC25/ST7
V409 Hya	55652.3572	0.0003 0.0001	I	V	Corfini/NW20/CCD-UAI
XZ Leo	55601.4597	0.0003 0.0001	I	R	Bellia, Bianciardi/S30/ST10
DO Leo	55305.5006	0.0004 0.0001	I	*C.Booster*	Corfini/NW20/CCD-UAI
DO Leo	55308.3147	0.0006 0.0006	I	$R610$	Corfini/NW20/CCD-UAI
HS Leo	55698.3388	0.0002 0.0003	II	c	Corfini/NW20/CCD-UAI
G1965-735	55657.3612	0.0003 0.0003	I	V	Corfini/NW20/CCD-UAI
G1965-735	55660.3982	0.0005 0.0002	I	V	Banfi/SC25/ST7
WZ LMi	55658.3913	0.0008 0.0005	II	V	Corfini/NW20/CCD-UAI
CF Lyn	55632.3946	0.0012 0.0005	I	r	Ruocco/SC25/ST7
CL Lyn	55664.3905	0.0017 0.0020	I	r	Ruocco/SC25/ST7
EH Lyn	55689.4082	0.0014 0.0008	I	V	Corfini/NW20/CCD-UAI
V400 Lyr	55021.4022	0.0004 0.0001	I	c	Corfini/NW11/CCD-UAI
V400 Lyr	55021.5286	0.0009 0.0005	II	c	Corfini/NW11/CCD-UAI
V400 Lyr	55394.5691	0.0003 0.0004	II	$BVRI$	Marino/NW20/ST7
V400 Lyr	55395.4557	0.0005 0.0020	I	$BVRI$	Marino/NW20/ST7
V400 Lyr	55395.5831	0.0062 0.0004	II	$BVRI$	Marino/NW20/ST7
V400 Lyr	55418.3905	0.0004 0.0004	II	$BVRI$	Marino/NW20/ST7
V400 Lyr	55418.5175	0.0002 0.0002	I	$BVRI$	Marino/NW20/ST7
V400 Lyr	55433.4697	0.0008 0.0003	I	$BVRI$	Marino/NW20/ST7
V563 Lyr	55737.3801	0.0005 0.0003	I	V	Marino/NW25/ST7
V2394 Oph	55690.2155:	0.0007 0.0010	I	r	Marino/S30/ST10
V2640 Oph	55710.5011	0.0006 0.0002	I	V	Marino/NW20/ST7
BO Peg	55135.4101	0.0013 0.0003	I	c	Corfini/NW20/CCD-UAI
BO Peg	55147.3105	0.0022 0.0009	II	c	Corfini/NW20/CCD-UAI
WY Sex	55644.5001	0.0007 0.0004	II	V	Corfini/NW20/CCD-UAI
WY Sex	55645.4181	0.0006 0.0002	I	V	Corfini/NW20/CCD-UAI
WY Sex	55651.4923	0.0002 0.0004	II	V	Zambelli/SC25/ST8
XX Sex	55662.4122	0.0008 0.0003	I	V	Corfini/NW20/CCD-UAI
GQ Tau	55305.3461	0.0005 0.0004	I	V	Corfini/NW20/CCD-UAI
HV UMa	55654.2986	0.0043 0.0010	II	r	Ruocco/SC25/ST7
HV UMa	55665.3127	0.0013 0.0012	I	r	Ruocco/SC25/ST7
OQ UMa	55643.4067	0.0004 0.0001	I	V	Corfini/NW20/CCD-UAI
IK Vir	55657.5013	0.0019 0.0003	I	V	Banfi/SC25/ST7
IR Vir	55687.3854	0.0005 0.0001	II	V	Corfini/NW20/CCD-UAI
V384 Vul	55706.5493	0.0011 0.0003	II	V	Banfi/SC25/ST7
V384 Vul	55750.4349	0.0021 0.0004	II	V	Banfi/SC25/ST7
V384 Vul	55759.4315	0.0015 0.0002	I	V	Vincenzi/SC30/ST9

Explanation of the remarks in the table:
Rem.: Observer[s]/Telescope/Detector
[a] Arlot's modified method
[b] as given by KW method
: uncertain

Remarks:

V997 Cyg − This variable star was catalogued as RR Lyr type in the catalogues of Sonneberg Obs. (Gessner, 1966), GCVS (Samus *et al.*, 2007-2011) and VSX (`http://www.aavso.org/vsx`), as well as in the Kemper's (1982) spectroscopic program. More recently, the star was recognized to be an eclipsing binary (Akerlof *et al.*, 2000; Devor *et al.*, 2008).
In order to improve the ephemeris of this star, we firstly analyzed our light curves (covering all phases) by using the period searching utilities provided by PERANSO software (Vanmunster, 2007), which lead to the period value $p = 0^d.458219$, consistent with the values given by Akerlof *et al.* (2000) and Devor *et al.* (2008). Subsequently, including also the ROTSE1 time of minima given by Diethelm (2001a), the linear best fit of the O−C vs. the epoch, leaving the initial epoch and period free to vary, led to the following updated ephemeris:

$$T_{min}\ (HJD) = 2455460.5124(\pm 0.0010) + 0^d.4582260(\pm 0.0000003) \times E$$

Figure 1 shows the O−C diagram computed using our new ephemeris. No change of period is evident in the O−C diagram.
V840 Her − The first report we found about a possible short term variability of NSV7814 (=V840 Her) was given in oral communication at a meeting by DeMartino & Predom (1991); nevertheless, Baldwin & Dahm (1993) did not find any variability. Kazarovets & Samus (1995) included the star in the 72^{nd} name-list of variable stars. We observed the star during 24 nights for 52 hours. Only during one nights we found a possible, never confirmed, variation of 0.04 mag.; in the other nights we found the star to be constant within 0.02 mag, allowing us to exclude all possible variability's period $\leq 0^d.9752$ and many greater values.
V1037 Her − For this very neglected star, ROTSE1 (Akerlof *et al.*, 2000) and VSX catalogues report a period of $\sim 1^d.30$ and $\sim 0^d.65$ respectively. Those values are not consistent with our light curves, which lead to the correct value of $\sim 0^d.79$, which also agree with the only two minima found in literature (ROTSE1−Diethelm, 2001b). The linear best fit of the O−C including all available data leads to the following correct ephemeris:

$$T_{min}\ (HJD) = 2455696.57493(\pm 0.00097) + 0^d.7875767(\pm 0.0000003) \times E$$

The O−C diagram obtained with the new ephemeris is shown in Figure 2.
V1098 Her − ROTSE1 catalogue classified the stars as a δ Scuti. In their reclassification, Jin *et al.* (2003) recognized V1098 Her as an eclipsing binary.
Our minima allow us to significantly improve the ephemeris by performing a linear best fit of O−C including, together our data, the only time of minimum publicly available. Figure 3 shows the O−C diagram obtained with our following updated elements:

$$T_{min}\ (HJD) = 2455417.21830(\pm 0.00034) + 0^d.352268564(\pm 0.000000098) \times E$$

V1100 Her − The star is included in the Kreiner's (2004) database. Relevant discrepancies between observed and predicted times of minima led us to examine the O−C diagram, which shows evident period's variation. The following new ephemeris is obtained by computing the linear best fit of all the available data:

$$T_{min}\ (HJD) = 2452500.2778(\pm 0.0036) + 0^d.34693098(\pm 0.00000049) \times E$$

The O−C diagram obtained with the new ephemeris is shown in Figure 4.
NSV5740 − Hübscher, Paschke & Walter (2006), Paschke (2007) and Paschke (2009) report three minima. However, a recent revision of the original images has clarified those were minimum's times of GSC1991-1676 (Paschke, 2011). Actually, Faulkner (1986) had found the star to be constant within 0.02 mag. Our monitoring, performed during 14 hours in 5 nights, confirms the star is constant, within 0.01 mag.

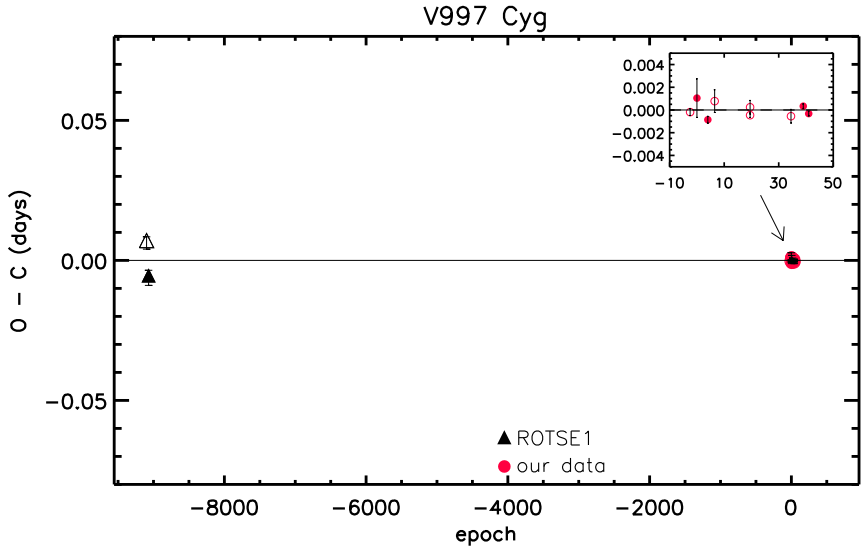

Figure 1. O−C diagram for V997 Cyg. Empty symbols for secondary minima.

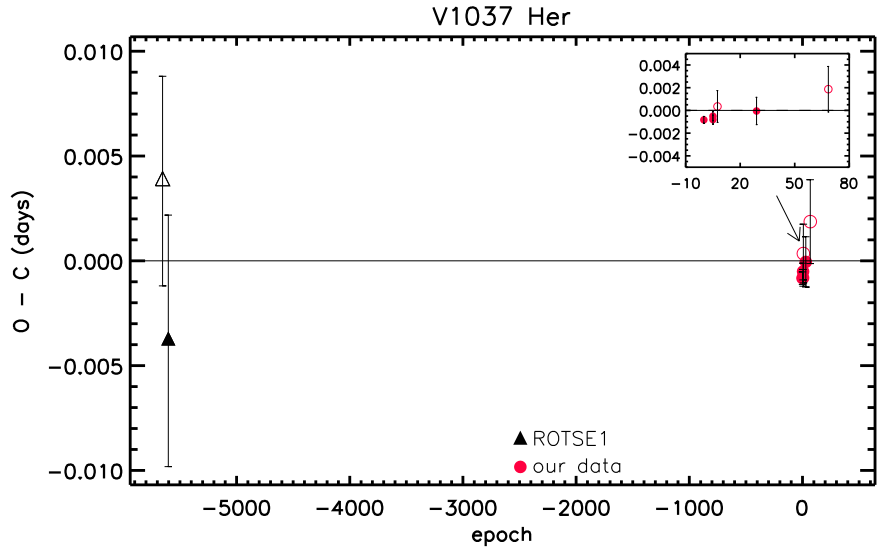

Figure 2. O−C diagram for V1037 Her. Empty symbols for secondary minima.

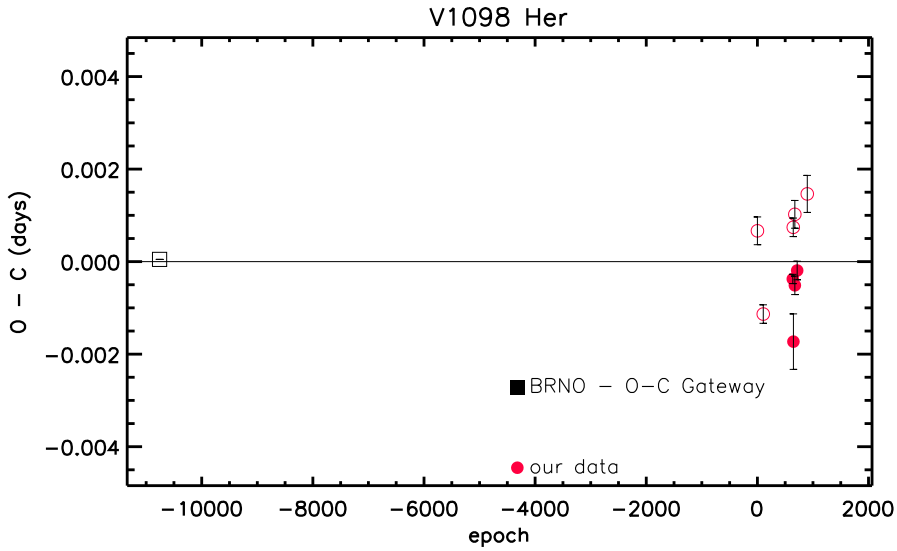

Figure 3. O−C diagram for V1098 Her. Empty symbols for secondary minima.

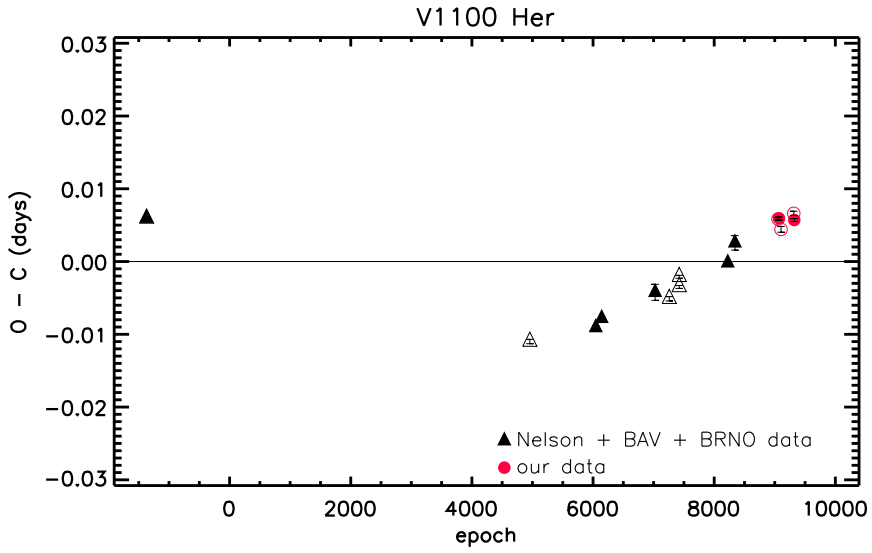

Figure 4. O−C diagram for V1100 Her. Empty symbols for secondary minima.

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