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NEW ECLIPSING BINARY TIMES OF MINIMA IN THE NORTHERN SKY MEASURED DURING THE YEAR 2020

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Abstract: We present 167 times of minima of 69 eclipsing binaries in the Northern Sky determined from differential, partly multicolor photometry, during the year 2020.

1 Introduction

In 2020, during 203 observation nights, 393 objects were observed, 357 of these are eclipsing binaries. We registered 167 times of minima of 69 eclipsing binary systems in the Northern Sky during the year 2020. All observations were done with a CCD detector, using Johnson-Cousins filter set *BVRcIc* and filter *Clear*.

2 Observation

The private observatory SMO (South-Moravian-Observatory[1]) is located near Brno, Czech Republic (N 49.28171°, E 16.45352°, altitude 243 m). The main instrument is a 0.3 m (12“) f/4 Newtonian telescope with a CCD camera G2-1600 from Moravian Instruments Inc.[2] , chip Kodak KAF1602[3] (1536x1024 px, size 9 µm) with a field of view (FOV) of 58.6´x 39.1´ and Johnson-Cousins *BVRcIc* filters. The angular resolution is 2.29´´/px.
The private observatory TRO (Toscana-Remote-Observatory) is located near Orciatico, Tuscany, Italy (N 43.42888°, E 10.71722°, altitude 434 m). Its main instrument is a 0.3 m (12“) f/3.85 Newtonian telescope with a CCD camera G2-1600 from Moravian Instruments Inc., chip Kodak KAF1602 (1536x1024 px, size 9 µm) with a FOV of 41.8´x 27.8´ and Johnson-Cousins *UBVRcIc* filters. The angular resolution is 1.71´´/px.
Imaging and photometric data processing has been done with SIPS[4] .

[1] http://south-moravian-observatory.jimdo.com/
[2] http://www.gxccd.com/
[3] https://www.datasheets360.com/part/detail/kaf-1603me/7148940108719137862/
[4] Scientific-Imaging-Data-Processing-Software by Moravian Instruments

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3 Data analysis

The data were calibrated with bias, dark frames and flat fields. The differential aperture photometry was performed on the calibrated image sets using the SIPS-Photometry-Tool. During this process SIPS performs also the astronometry for each image of the data set and registers all main paramters of the stars using the astronomical catalogues UCAC-4[5] or USNO-B1.0[6] catalogue unless the star were not included in the UCAC-4 catalogue.
The comparison (CMP) and check (CHK) stars for the differential photometry were selected according to their (B-V) and (J-K) color indices that can be compared with the indices of the variable star, as well as comparable magnitudes based on the UCAC-4 catalog data.
The minima estimations were performed with SILICUPS[7,8,9] .

4 Results

Table 1: Times of Minima

VAR	CONST	VAR-TYPE[10]	HJD	ERROR	MIN-TYPE	FILTER
AH Cas	Cas	EA/SD	2459127.488786	0.000237	P	V
AH Cas	Cas	EA/SD	2459127.488802	0.000238	P	R
ASASSN-V J003242.76+412307.0	Aur	EW	2459160.372413	0.007813	S	V
ASASSN-V J003242.76+412307.0	Aur	EW	2459160.374019	0.002334	S	R
ASASSN-V J013410.10+711512.1	And	EW	2459127.399096	0.000892	P	V
ASASSN-V J013410.10+711512.1	And	EW	2459127.399693	0.000795	P	R
ASASSN-V J014802.06+553251.7	Cas	EA	2459163.405522	0.003036	P	R
ASASSN-V J014802.06+553251.7	Cas	EA	2459175.421416	0.026797	S	R
ASASSN-V J014802.06+553251.7	Cas	EA	2459175.422647	0.004364	S	V
ASASSN-V J014802.06+553251.7	Cas	EA	2459175.422828	0.007503	S	C
ASASSN-V J060633_11+281722.2	Cas	EA	2458855.410678	0.000661	S	C
ASASSN-V J180737.64+693804.1	Cas	SR	2459061.523209	0.002537	P	V
ASASsn101135ab Aur	Aur	EA	2459175.456888	0.002757	P	C
ASASsn101135ab Aur	Dra	EA	2459176.389516	0.001824	S	C
AW Cam	Cam	EB	2458861.337914	0.004890	P	C
BK Peg	Peg	EA/D	2459177.401642	0.000614	P	V
CSS_J003227.2+411407	And	EW	2459160.308247	0.005284	S	V
CSS_J003227.2+411407	And	EW	2459160.446513	0.006351	P	R
CSS_J003227.2+411407	And	EW	2459160.461503	0.010131	NA	V
CSS_J065209+380857	Aur	EA	2459175.461313	0.001208	P	C
CSS_J065249.1+381317	Aur	EW	2459175.560712	0.000898	P	C
CSS_J066350.8+382226	Aur	EW	2459175.429109	0.001809	NA	C
CSS_J066350.8+382226	Aur	EW	2459175.623364	0.012396	NA	C
CSS_J066350.8+382226	Aur	EW	2459175.623364	0.012396	NA	C

[5] arXiv:1212.6182 [astro-ph.IM]
[6] http://www.nofs.navy.mil/data/FchPix/
[7] Simply Light Curve Processing System is part of the SIPS bundle
[8] Fitting based on ‚cmpfit' code by S. Moshier and C. Markwardt (based on NINPACK-1 Last Square Fitting Library by B. Garbow, K. Hilstrom, J. More)
[9] Light curve phenomenological model based on Mikulasek (2015)
[10] Type of the variables according to the VSX (The International Variable Star Index)

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CSS_J066350.8+382226	Aur	EW	2459175.623364	0.012396	NA	C
CSS_J171143.8+425004	Her	EW	2458987.492638	0.000638	P	R
CzeV1227	Lac	EW	2459108.507638	0.007352	P	V
CzeV1227	Lac	EW	2459108.509212	0.011412	P	R
CzeV1640	Aur	EB	2458857.469770	0.005766	S	C
CzeV1640	Aur	EB	2458857.472059	0.007908	S	C
CzeV1640	Aur	EB	2458861.359933	0.008712	S	C
CzeV1640	Aur	EB	2458895.443231	0.000962	P	C
CzeV1731	Dra	EA	2459023.413498	0.001779	P	R
CzeV1731	Dra	EA	2459023.426090	0.001667	P	B
CzeV1905	Aur	EB	2458857.442553	0.000952	P	C
CzeV1905	Aur	EB	2458861.384172	0.001583	P	C
CzeV1905	Aur	EB	2458895.317817	0.002211	S	C
CzeV1905	Aur	EB	2458902.321475	0.002103	S	C
CzeV1925	Aur	EB	2458895.364834	0.002747	S	C
CzeV1942	Aur	EB	2458857.548612	0.017565	P	C
CzeV1942	Aur	EB	2458861.332716	0.001487	S	C
CzeV1994	Aur	EB	2458857.256666	0.009884	NA	C
CzeV488	Cep	EB	2459111.415122	0.001363	NA	V
CzeV488	Cep	EB	2459111.418915	0.001182	NA	R
CzeV488	Cep	EB	2459111.587825	0.001247	NA	R
CzeV488	Cep	EB	2459111.589563	0.004680	NA	V
CzeV488	Cep	EB	2459111.415122	0.001363	NA	V
CzeV488	Cep	EB	2459111.418915	0.001182	NA	R
CzeV490	Cep	EW	2459111.405975	0.001898	NA	R
CzeV490	Cep	EW	2459111.405975	0.001898	P	R
CzeV490	Cep	EW	2459111.416420	0.004332	NA	V
CzeV490	Cep	EW	2459111.416420	0.004332	P	V
CzeV492	Cep	EA	2459111.496434	0.009824	S	V
CzeV492	Cep	EA	2459111.516014	0.007714	S	R
EF Dra	Dra	EW/KW	2459061.521893	0.000730	S	V
EM Lac	Lac	EW/KW	2459088.444697	0.000460	P	V
EM Lac	Lac	EW/KW	2459088.445856	0.000566	P	R
EO Lac	Lac	EA/SD	2459088.444700	0.000399	P	V
EO Lac	Lac	EA/SD	2459088.445858	0.000418	P	R
EQ UMa	UMa	EW	2458886.677739	0.010078	P	C
EX Dra	Dra	UG+E	2459097.397330	0.003506	S	C
EX Dra	Dra	UG+E	2459097.494360	0.000778	P	C
EY Cas	Cas	EW/KW	2459115.359488	0.001559	S	R
EY Cas	Cas	EW/KW	2459115.360015	0.001401	S	V
EY Cas	Cas	EW/KW	2459115.597870	0.006024	P	V
EY Cas	Cas	EW/KW	2459115.601248	0.006315	P	R
FG Gem	Gem	EW	2459197.489608	0.001478	P	V
GW Cep	Cep	EW/KW	2459098.339790	0.001850	S	B
GW Cep	Cep	EW/KW	2459098.348271	0.001494	S	V
GW Cep	Cep	EW/KW	2459098.497535	0.004668	P	V
GW Cep	Cep	EW/KW	2459098.500627	0.001996	P	R
GW Cep	Cep	EW/KW	2459098.501757	0.003279	P	B
GW Cep	Cep	EW/KW	2459141.380975	0.000489	NA	R
GW Cep	Cep	EW/KW	2459141.381781	0.000459	NA	V

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HS And	And	EA	2459160.365735	0.000422	P	R
HS And	And	EA	2459160.365964	0.000286	P	V
HT Cas	Cas	UGSU+E	2459104.336647	0.001445	S	C
HT Cas	Cas	UGSU+E	2459104.404352	0.002245	S	C
HT Cas	Cas	UGSU+E	2459104.472452	0.004194	S	C
IP Peg	Peg	UG+E	2459083.498770	0.000224	P	R
IP Peg	Peg	UG+E	2459083.499148	0.000451	P	V
MNIC V20	Dra	EW	2458956.421430	0.000033	S	C
MNIC V20	Dra	EW	2458963.454338	0.000444	S	C
MW Lac	Lac	EA/DM	2459108.400512	0.004786	P	R
MW Lac	Lac	EA/DM	2459108.400708	0.009699	P	V
NSVS 260293	Cep	EW	2459210.286058	0.002836	NA	V
NSVS 49125 UMi	UMi	E	2459174.562598	0.002610	P	V
NSVS 49125 UMi	UMi	E	2459174.563525	0.001460	P	R
NSVS 49125 UMi	UMi	E	2459174.564196	0.001929	P	I
NSVS 6306374	And	EW	2459111.410700	0.001788	P	C
NSVS 880674	Dra	EA+DSCT	2458924.374809	0.000543	P	C
NSVS 880674	Dra	EA+DSCT	2458924.591006	0.000404	S	C
NU UMa	UMa	EA	2458908.333357	0.000758	P	V
NU UMa	UMa	EA	2458908.334235	0.000610	P	B
NU UMa	UMa	EA	2458908.334263	0.000836	P	I
NU UMa	UMa	EA	2458908.334729	0.000913	P	R
PP Cam	Cam	EA	2459061.359046	0.003129	P	B
PP Cam	Cam	EA	2459061.360231	0.001390	P	R
PP Cam	Cam	EA	2459061.360716	0.002695	P	V
PV Boo	Boo	EW	2458945.465061	0.000326	P	C
PX And	And	NL/VY+E	2459111.410060	0.001585	S	C
PX And	And	NL/VY+E	2459111.500097	0.000376	P	C
QQ UMa	UMa	EW	2458932.386191	0.000461	S	C
QQ UMa	UMa	EW	2458946.551630	0.001475	P	C
ROTSE1 J153139.25+374359.0	CrB	EW	2459002.448681	0.000613	P	R
ROTSE1 J153139.25+374359.0	CrB	EW	2459002.449069	0.001339	P	V
ROTSE1 J161034.46+371538.9	CrB	EW	2458973.395345	0.000967	P	C
ROTSE1 J161034.46+371538.9	CrB	EW	2458973.540866	0.000449	P	C
SERIV 104	Cas	EB	2459139.554418	0.003456	S	R
SERIV 104	Cas	EB	2459139.555708	0.000869	S	V
SERIV 104	Cas	EB	2459159.420394	0.008930	P	V
SERIV 104	Cas	EB	2459174.372956	0.002409	P	R
SERIV 104	Cas	EB	2459174.374016	0.005727	P	V
SERIV 104	Cas	EB	2459174.374928	0.006813	P	C
SERIV 104	Cas	EB	2459175.307414	0.002391	P	C
SERIV 104	Cas	EB	2459175.310446	0.012272	P	V
SERIV 104	Cas	EB	2459175.313033	0.002450	P	R
SERIV 104	Cas	EB	2459175.540966	0.008515	S	V
SERIV 104	Cas	EB	2459175.541383	0.004223	S	C
SERIV 104	Cas	EB	2459175.546928	0.018883	S	R
TSVSC1 TN-N110200230-12-82-2	Dra	exopl	2458965.332631	0.004117	P	V
USNO B1 1382-0235440	UMa	EA/SD	2458926.515328	0.001469	NA	C
USNO-B1.0 1478-0002611	Cas	EW	2459115.424952	0.001137	P	R
USNO-B1.0 1478-0002611	Cas	EW	2459115.427541	0.001133	P	V

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UU And	And	EW	2459172.397177	0.000698	P	I
UU And	And	EW	2459172.397262	0.000665	P	R
UU And	And	EW	2459172.397270	0.000409	P	V
UU Cam	Cam	EW	2459061.349927	0.015724	P	R
UU Cam	Cam	EW	2459061.351975	0.017969	P	V
UU Cam	Cam	EW	2459061.354959	0.000650	P	B
UU Cam	Cam	EW	2459062.380073	0.001079	S	B
UU Cam	Cam	EW	2459062.382098	0.006642	S	R
UU Cam	Cam	EW	2459062.382381	0.005276	S	V
V0474 Cam	Cam	EW	2458894.607622	0.000195	S	C
V0474 Cam	Cam	EW	2459185.394677	0.000927	P	R
V0474 Cam	Cam	EW	2459185.396825	0.003242	S	B
V0530 Cam	Cam	EW	2459061.384849	0.003245	P	R
V0567 Dra	Dra	DSCTC	2459061.520004	0.000824	S	V
V0585 Dra	Dra	SRB	2459023.409011	0.004360	P	R
V0698 Cep	Cep	EA	2459111.531538	0.000683	P	V
V0698 Cep	Cep	EA	2459111.531538	0.000683	P	V
V0698 Cep	Cep	EA	2459111.531675	0.000689	P	R
V0698 Cep	Cep	EA	2459111.531675	0.000689	P	R
V0722 Her	Her	Ea	2458987.467827	0.009366	NA	B
V0796 Cep	Cep	EW	2459141.436631	0.004716	P	R
V0796 Cep	Cep	EW	2459141.441716	0.003159	P	V
V0919 Cep	Cep	ZZO	2459159.281890	0.000674	P	V
V0919 Cep	And	ZZO	2459159.282639	0.000894	P	R
V0919 Cep	Cep	ZZO	2459159.281981	0.000863	P	V
V0919 Cep	And	ZZO	2459159.281981	0.000863	P	V
V0919 Cep	Cep	ZZO	2459159.282617	0.000925	P	R
V0919 Cep	Cep	ZZO	2459159.282617	0.000925	P	R
V1260 Tau	Tau	EA	2459177.479691	0.000554	S	V
V1312 Cas	Cas	EA/RS	2459104.365969	0.001177	P	C
V1324 Cas	Cas	EA	2459127.429521	0.000746	P	R
V1324 Cas	Cas	EA	2459127.429943	0.000866	P	V
WISE J013215.0+704856	Cas	EW	2459127.369879	0.001383	P	V
WISE J013215.0+704856	Cas	EW	2459127.372400	0.001311	P	R
WISE J192224.2+564857	Dra	EW/EA	2459023.405997	0.013418	P	R
WISE J192224.2+564857	Dra	EW/EA	2459023.408975	0.016364	P	B
WZ And	And	EB	2459197.391573	0.000791	P	V
ZTF J0146571.07+552932.4	Cas	EW	2459159.552831	0.011216	P	V
ZTF J0146571.07+552932.4	Cas	EW	2459175.327444	0.003717	S	V
ZTF J0146571.07+552932.4	Cas	EW	2459175.347556	0.010355	S	R
ZTF J0146571.07+552932.4	Cas	EW	2459175.361143	0.010120	S	C
ZTF J0146571.07+552932.4	Cas	EW	2459175.508892	0.012220	P	R
ZTF J0146571.07+552932.4	Cas	EW	2459175.512698	0.008350	P	C

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5 Conclusions and Summary

The SIPS photometry tool optionally shows all variables registered in the VSX database within the field of view (FOV). Beside of the project stars of the NYX databases of the Astronomical Institute of Charles University a lot of bycatch stars were measured.

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