OPEN EUROPEAN JOURNAL ON VARIABLE STARS
January 2013 http://var.astro.cz/oejv ISSN nnnn-nnnn

GSC 02626-00896: an RR Lyrae star with a ceasing Blazhko effect and three new variables in the field.

Rainer Gröbel [1, 2]

1) DE- 90542 Eckental, Germany rainer.groebel@web.de
2) Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV)
Munsterdamm 90, D-12169 Berlin, Germany

BAV Mitteilungen Nr. 230

Abstract: By analysis of Superwasp data, Srdoc and Bernhard (2012) have shown recently that GSC 02626-00896 (18:09:30.34 + 32:45:13.52) is an RRc type variable showing indications of Blazhko effect. A night by night reanalysis of the data shows that in fact a 26 d secondary period is present in the 2004 observations. However, no trace of this can be found in the 2007 and 2008 data. CCD observations of the star on 19 nights in 2012 yielded a strictly repeating light curve with a broad maximum similar to those derived from the second and third SWASP data group. A slightly revised ephemeris Max.(HJD) = 2456069.3919(43) + 0.32272138(60) d x E could be derived.

The CCD observations also revealed three short period eclipsing variables in the field of GSC 02626-00896. The 15.16 R mag. GSC2.3 star N25F001920 (18:09:24.282 +32:44:51.72) shows 0.15 and 0.1 mag. shallow eclipses with the ephemeris Max.(HJD) = 2456064.5155(13) + 0.389228(18) d x E. The 15.39 R mag. GSC 2.3 N25D013720 (18:09:41.141 +32:33:46.99) is a W UMa type star with the ephemeris Min.(HJD) = 2456072.4354(4) + 0.393563(7) d x E and 0.45 mag. amplitude. The 16.13 R mag. GSC 2.3 N25D015132 (18:09:01.767 +32:36:53.59) is also a W UMa type star with the ephemeris Min.(HJD) = 2456072.4909(2) + 0.287800(3) d x E with an amplitude of 0.75 and 0.5 mag respectively.

Simbad objects: GSC1 02626-00896 GSC2.3 N25F001920 GSC2.3 N25D013720 GSC2.3 N25D015132

1) GSC 02626-00896 (18:09:30.34 + 32:45:13.52), 2MASS 18093032+3245136, 1SWASP J180930.33 +324513.8, USNO-B1.0 1227-0378420:

The variability of the star was discovered by G.Srdoc and K. Bernhard (Srdoc and Bernhard, 2012) by analysis of SuperWASP data (Butters et al., 2010). It was classified as an RRc star with the ephemeris:

$$\text{HJD (Max.)} = 2453160.713(3) + 0.3227214(2) \times E \qquad (1)$$

From the variability of the light curve (LC), it was presumed that Blazhko effect is present. For the present analysis SWASP data was reanalysed and the star was included in the observation program.

SWASP data analysis:

The SWASP database gives 16946 measurements for this star. They are grouped into three dense observation periods lasting from April 29 to October 01 2004, from July 15 to August 23 2007 and from April 18 to August 09 2008 (fig.1).

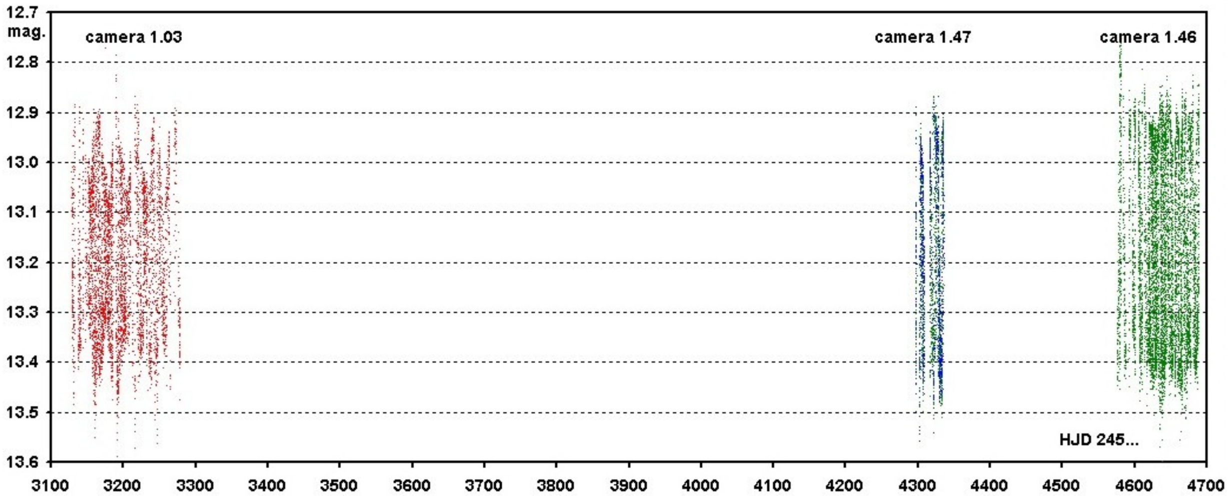

Figure 1: The presently available SWASP data on GSC 02626-00896.

The data was first sorted by the camera identification number (ID). Only the TAMFlux 2 magnitudes were used for they are corrected for the differing sensitivity of the involved cameras. Furthermore, data with a TAMFlux 2 error exceeding +/- 0.1 mag. was discarded. The data was displayed night by night and the eventually present maxima or minima in the LC were isolated and redisplayed at closer scale. A sixth order polynomial was used to determine the time of extrema, but only if the extrema were sufficiently covered. In most cases, the error in time determination was estimated to be +/-0.001 d.

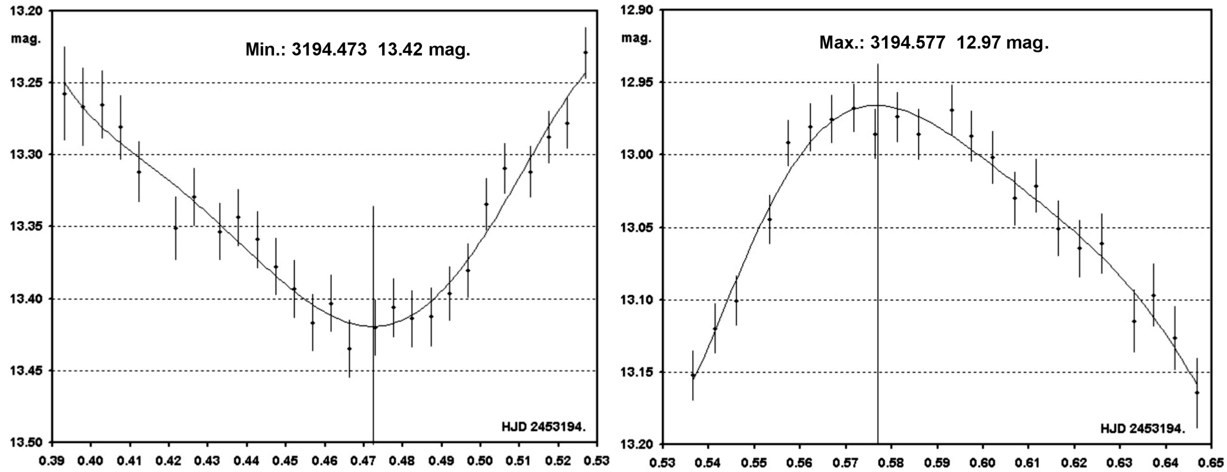

Figure 2: The minimum and maximum determination in the SWASP LC for the 7.7.2004 observations.

The first SWASP data group:

In fig. 3 the 2004 observations are shown at greater scale. A rhythmic variation of the amplitude of the variable between 0.3 to 0.6 mag. can be seen whose period was estimated to be somewhat shorter than 30 d. This was a first indication of a pronounced and relatively rapid Blazhko effect.

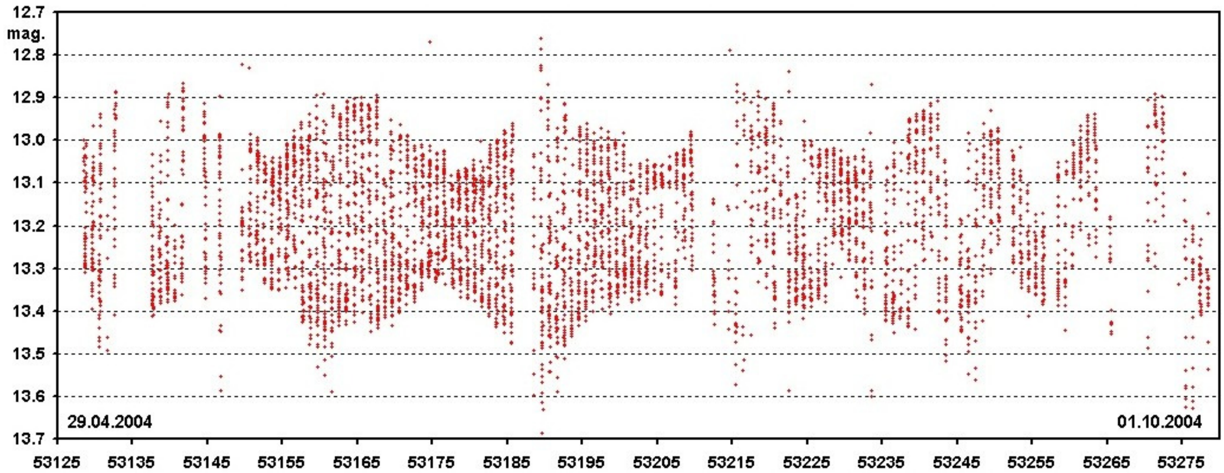

Figure 3: The first observation period, spanning around five months.

From data of this observation period, the times and magnitudes of 64 maxima (max.) and 59 minima (min.) (Table 1) could be determined. In the (O-C) diagram (fig. 4), the max. timing varies between one hour later and half an hour earlier against the calculations with a mean period of 0.3227 d. An approximate secondary period of 26 d was derived and could be followed over five cycles. It seems that the min. doesn´t follow the cycle. This may be due to variations in the steepness of the rising branch of the LC. An investigation will require LCs with both extrema in one night, but this is only rarely found in SWASP data.
In contrast, the magnitude variations diagram of the extrema (fig. 5) shows that if the max. are bright, the min. are faint and vice versa. This alternation follows the Blazhko cycle and explains the above noticed strong variations in the amplitude of the LC.

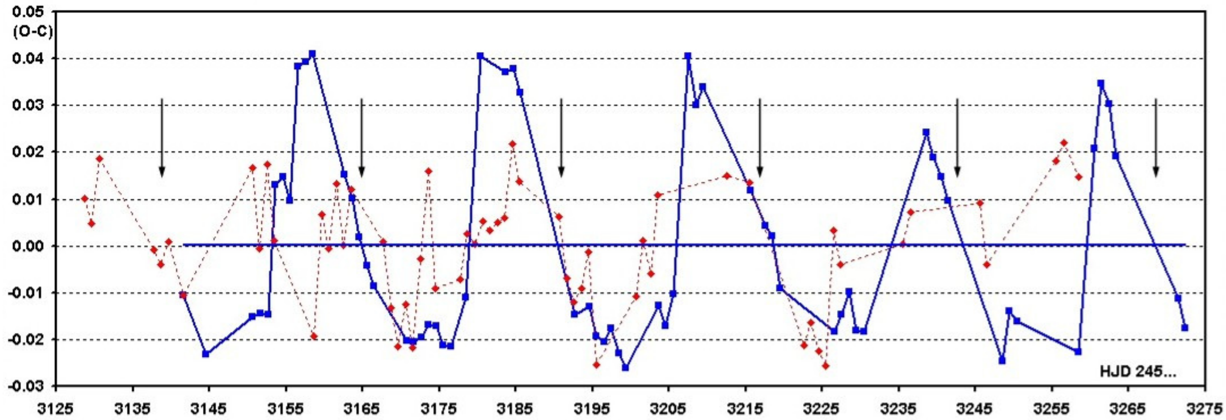

Figure 4: The deviations in time of the max. (blue) and min. (red) against the mean period.
The 26d Blazhlo period is marked with arrows.

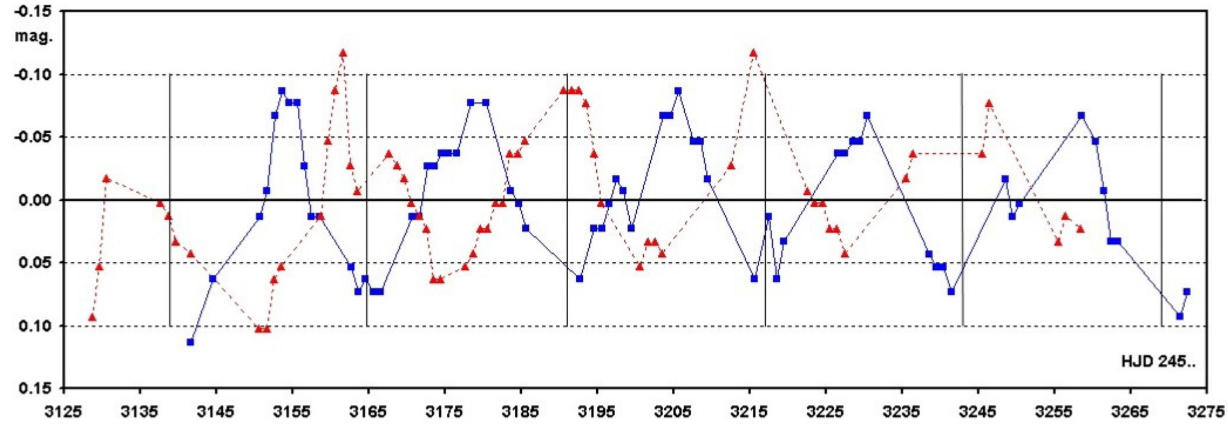

Figure 5: The magnitude variations of the max. (blue) and min. (red) against their respective mean magnitude.

Max. JD hel.	Epoch	(O-C)	Min. JD hel.	Epoch	(O-C)
2453141.650	-9072	-0.014	2453141.540	-9057	-0.008
2453144.542	-9063	-0.026	2453150.603	-9029	0.019
2453150.682	-9044	-0.018	2453151.554	-9026	0.002
2453151.651	-9041	-0.017	2453152.540	-9023	0.019
2453152.619	-9038	-0.017	2453153.492	-9020	0.003
2453153.615	-9035	0.011	2453158.635	-9004	-0.017
2453154.585	-9032	0.013	2453159.629	-9001	0.009
2453155.548	-9029	0.007	2453160.590	-8998	0.001
2453156.545	-9026	0.036	2453161.572	-8995	0.015
2453157.514	-9023	0.037	2453162.527	-8992	0.002
2453158.484	-9020	0.039	2453163.507	-8989	0.014
2453162.654	-9007	0.014	2453167.691	-8976	0.003
2453163.617	-9004	0.008	2453168.645	-8973	-0.012
2453164.577	-9001	0.000	2453169.605	-8970	-0.020
2453165.539	-8998	-0.006	2453170.582	-8967	-0.011
2453166.503	-8995	-0.010	2453171.541	-8964	-0.020
2453170.687	-8982	-0.021	2453172.528	-8961	-0.001
2453171.655	-8979	-0.022	2453173.515	-8958	0.018
2453172.624	-8976	-0.021	2453174.458	-8955	-0.008
2453173.595	-8973	-0.018	2453177.687	-8945	-0.006

Table 1: The SWASP max. and min. over the first Blazhko period. The (O-C) were calculated with ephemeris (2) and (3) respectively. The timings of all extrema are given in appendix 1.

Another way to illustrate the behaviour of the Blazhko cycle is shown in fig. 6. Starting from right counterclockwise, the max. are progressively getting brighter and coming in earlier until they reach their greatest advance in time at a mean magnitude around 13 mag.. Then they get fainter with increasing retardation in time. In Le Borgne et al., 2010, a great diversity of cycle shapes is shown. This seems to be specific for a given Blazhko RR Lyrae star.

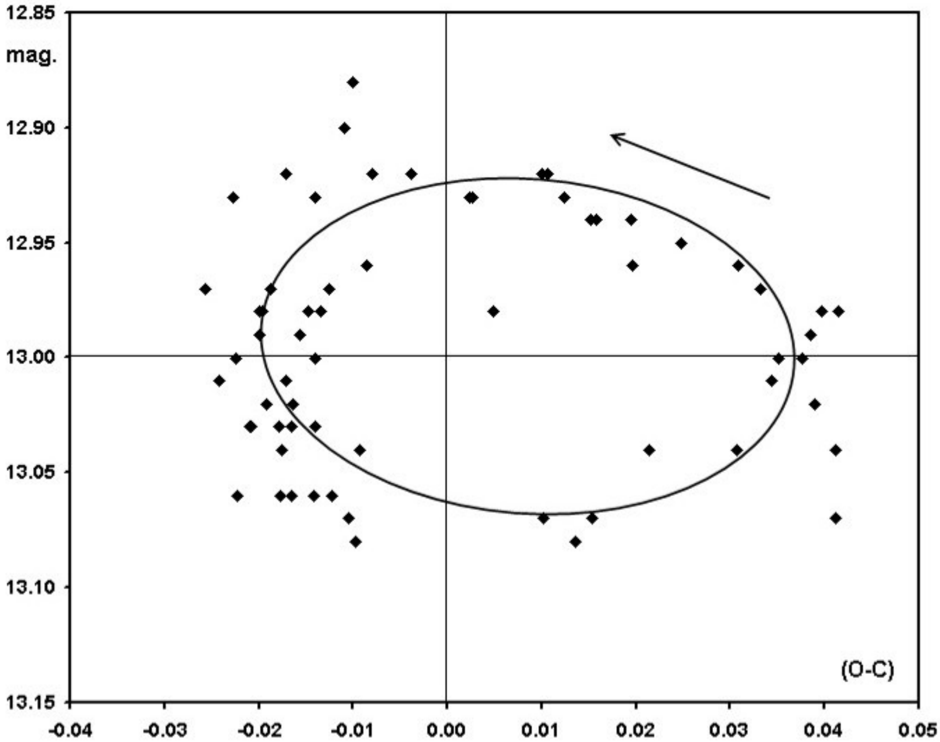

Figure 6: In 2004 the max. followed a 26 d cycle counterclockwise.

The second and third SWASP data group:

The secondary period seems to be characteristic for a given Blazhko RR Lyrae star. Cycles fom a few to several hundred days are known with a clustering between 20 and 40 d. Thus it was surprising to find no trace of a secondary period during the processing of the second data group (Fig. 7, middle). The overall luminosity increased about 0.3 mag. and the star seems to pulsate with its mean period displaying only slight variations in the shape of the LC, at the limit of the data scatter. Somewhere between late 2004 and mid 2007 a major change in the pulsation mode must have taken place.

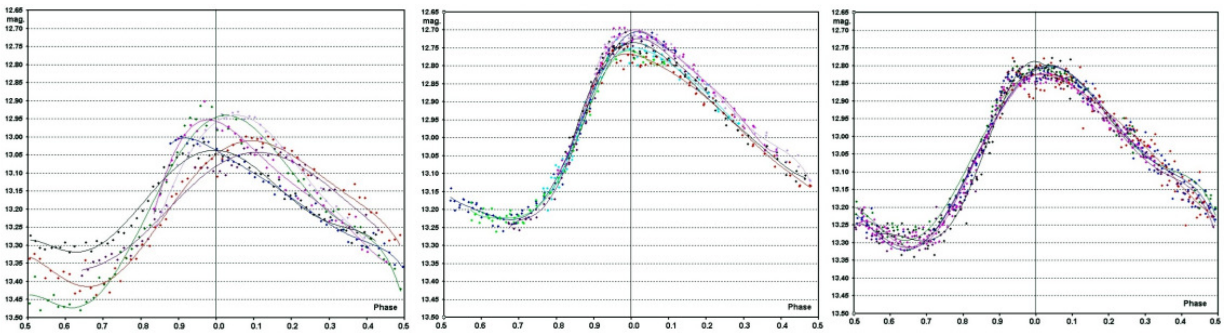

Figure 7: A sample of LCs from the three SWASP observation periods.

In the third data group the overall luminosity decreases by about 0.1 mag., but the LC shows a similar shape with only slight variations. The 2012 observations (Fig. 9) show an analogous shape and amplitude of the LC with rounded max. and only slight variations in their height. There seems to be no variation of the mean period; all max. fit well in the (O-C) diagram in fig. 10 on the base of ephemeris (2).

It will be interesting to investigate when and how the transition has taken place, but observations of this formerly unknown variable are probably not available. A search for data from other robotic telescopes yielded only a data set from the CSDR2 (The Catalina Sky Survey). The observations span from April 18 2005 to June 04 2006, eight months after the first SWASP serie. The few measurements at least demonstrate that the LC also shows great variations in amplitude; therefore the Blazhko cycle may still be present at that time.

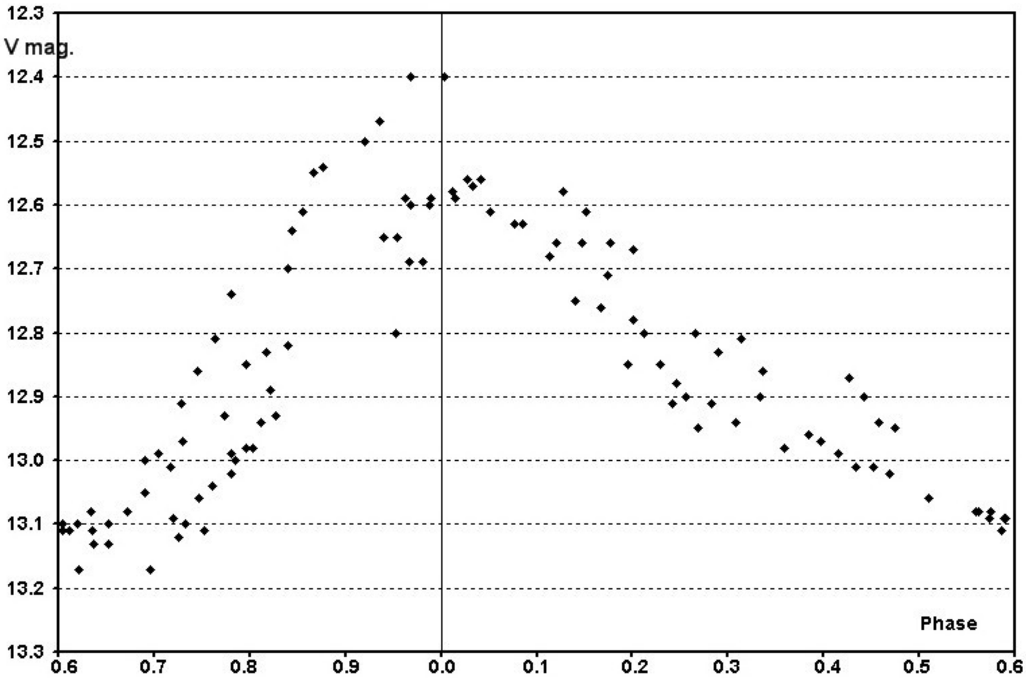

Figure 8: The measurements of the CRTS robotic telescope reduced with ephemeris (2).

By comparing the LCs in fig. 7, a problem of the SWASP data appears. In the measurements different cameras with unequal sensitive CCD chips are involved. The uncorrected Flux2 magnitudes show variations up to +/- 0.2 mag. from one camera to another at the same observation time. To align the cameras on a common magnitude scale, the SWASP group developed a correction program (Collier Cameron et al., 2006). Beside the raw data, a corrected TAMFlux 2 value and the corresponding TAMFlux2 error is given. Inspection of the data shows that the magnitude values are now much closer, but the authors warned that their solution may not be infaillible.
A simple way to control the validity of the correction is to take some of the comparison stars used in the 2012 measurements (Fig. 11) and check the constancy of their magnitude values from one camera to another. The mean magnitudes for the involved cameras fit well with only differences of a few millimags. and standard deviations about +/- 0.02 mag. (Table 2). The deviation of check star 1 with camera 1.03 could not be explained. The 2012 measurements showed no variations against the other reference stars exceeding the scatter.

star	Camera ID	1.03		1.46 I		1.46 II		1.47	
GSC1	SWASP	Tmag.	+/-	Tmag.	+/-	Tmag.	+/-	Tmag.	+/-
2626 0267	Comp.	12.841	0.018	12.840	0.014	12.841	0.019	12.839	0.018
2626 1106	Chk 1	13.100	0.028	13.139	0.019	13.141	0.025	13.139	0.025
2626 0226	Chk 2	12.498	0.015	12.497	0.012	12.498	0.014	12.496	0.014
2626 0643	Chk 3	11.535	0.018	11.534	0.012	11.535	0.014	11.533	0.015
2626 1155	Chk 4	11.662	0.024	11.660	0.020	11.662	0.022	11.658	0.022

Table 2: Comparison stars magnitudes for different cameras.

The 2012 measurements:

The measurements were performed with a 10” SCT in a semi-automated mode and a SBIG ST8XME camera with 94s exposition time in the 2x2 binning mode without filter to increase the S/N ratio. The observation period lasted from May 22 to July 29 2012 under mostly good sky conditions. 19 series yielding a total of 2641 measurements could be won. The reductions were performed with the Muniwin (Motl, D., 2012) reduction program. Depending on weather conditions, a 3.8, 5 or 7 pixel radius diaphragm corresponding to a 6, 7.5 or 10.5" aperture radius was used. Twilight sky-flat images were used for flatfield corrections.

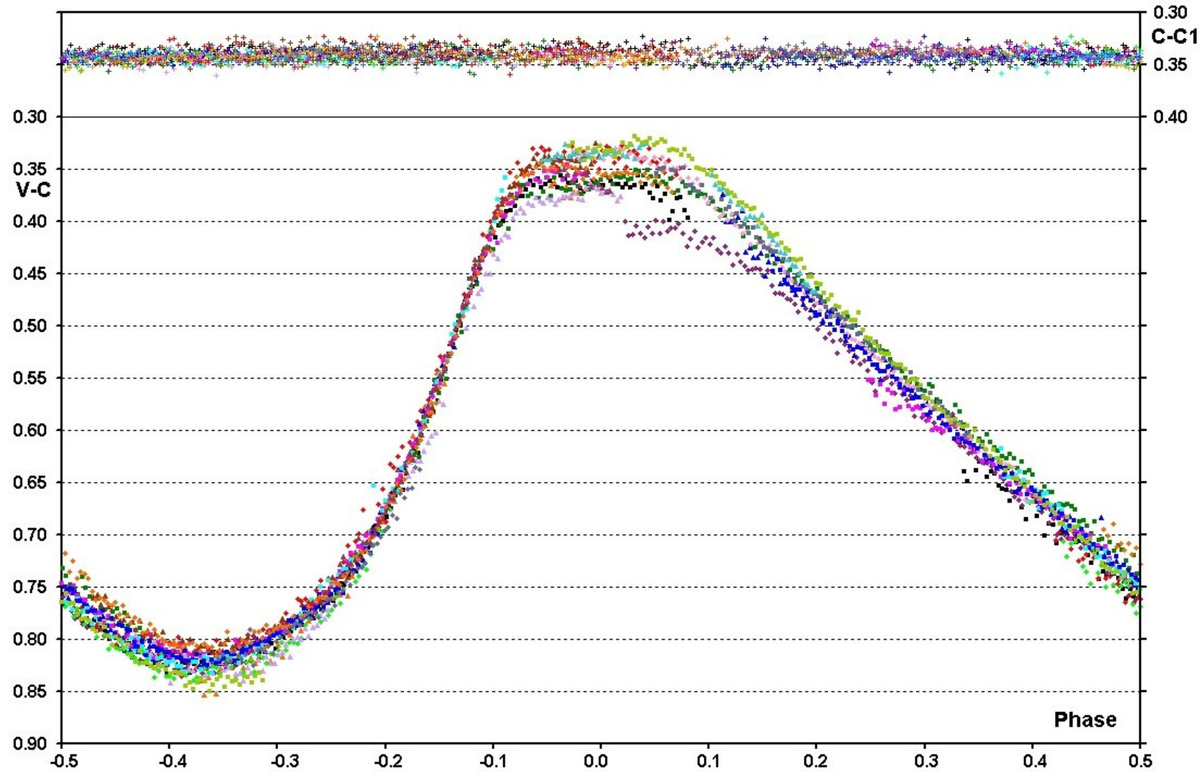

Figure 9: The 2012 measurements reduced with ephemeris (2).

The LC in fig. 9 shows an overall constant shape with only some slight variations in the height of the max. Three max. and six min. could be determined and with the SWASP extrema, the ephemeris

$$\text{HJD (Max.)} = 2456069.3919(43) + 0.32272138(60) * E \qquad (2)$$

was derived. The deviations of the min. times were calculated with the ephemeris

$$\text{HJD (Min.)} = 2456064.4372(16) + 0.32272156(24) * E \qquad (3)$$

The timings of all extrema yielded the (O-C) diagram in fig.10 and are tabulated in appendix 1.

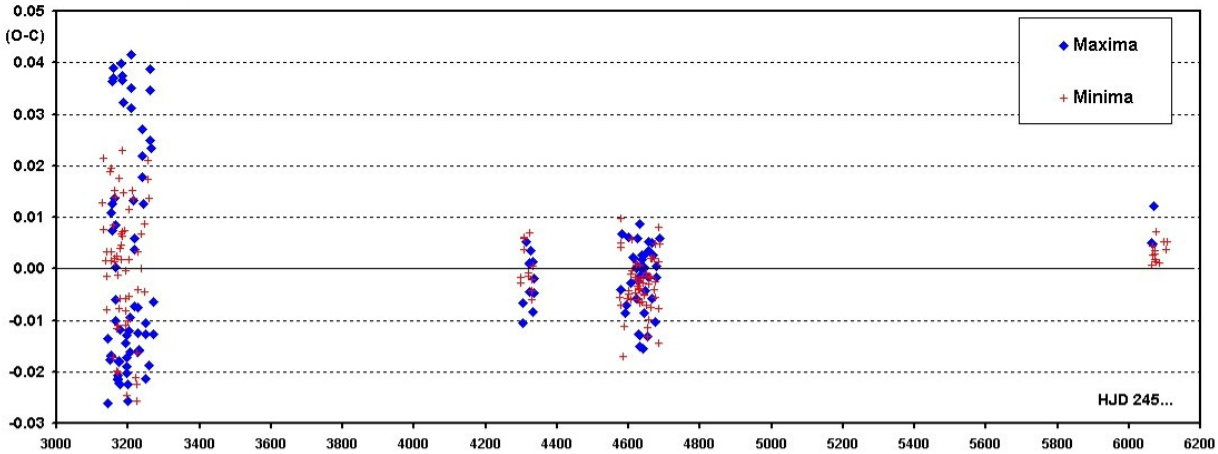

Figure 10: (O-C) diagram with the SWASP and the 2012 extrema.

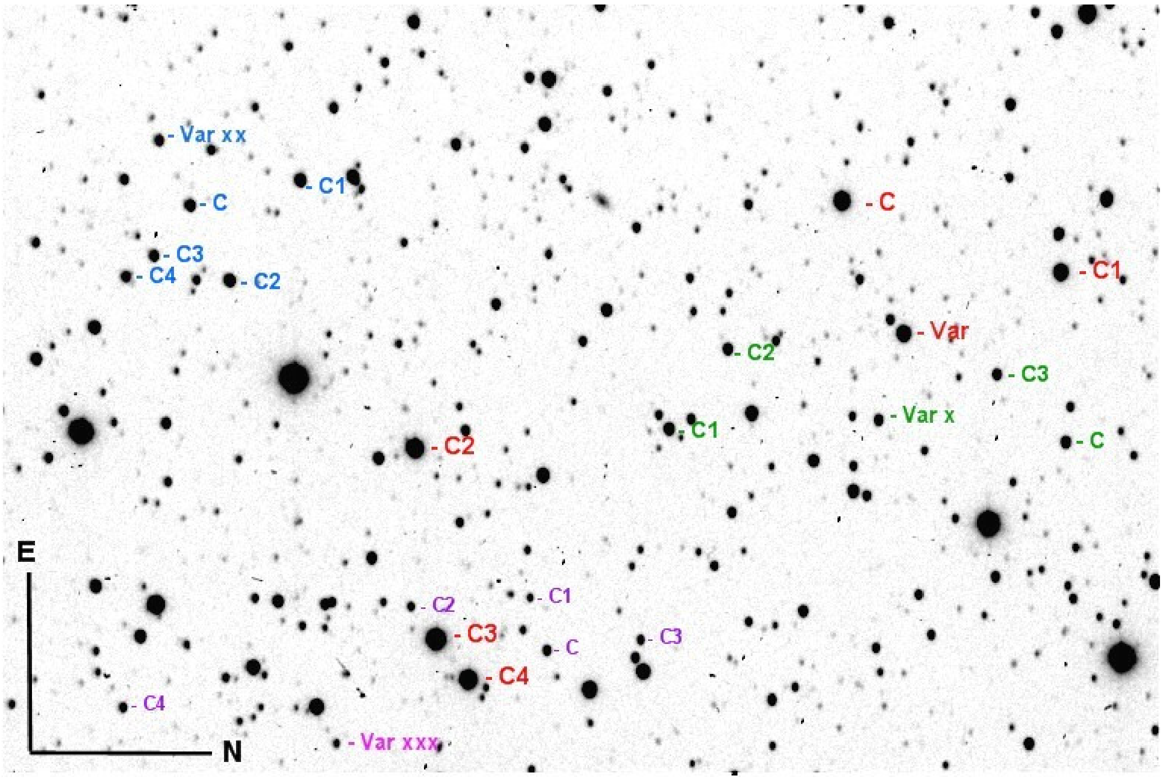

Fig. 11: The 20´ x 13´ field of the camera with the RR lyrae star Var, the variables Vx, Vxx, Vxxx and their comparison stars.

2) Var. X (18:09:24.282 +32:44:51.72), GSC2.3 N25F001920, 2MASS 18092430+3244515:

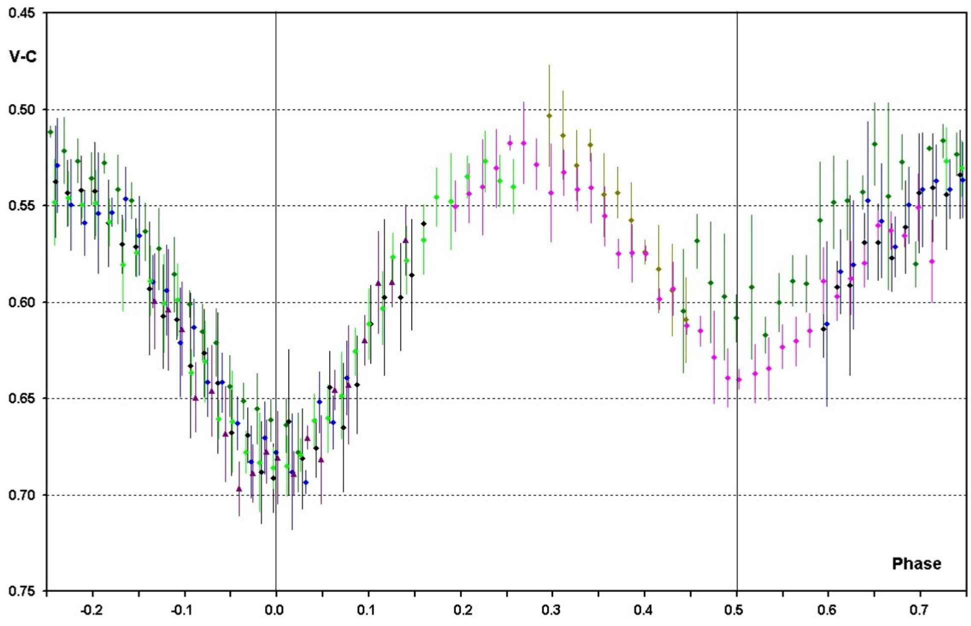

Figure 12: The light curve of the star GSC2.3 N25F001920.

The GSC2.3 lists an R magnitude of 14.9 mag. for this star. The faintness of the star leads to an increased scatter, so that the mean of five consecutive measurements was taken. In the LC (fig. 12), the standard deviation for each point has been indicated. The star is probably a short period eclipsing variable(of W Uma type?) with shallow eclipses of 0.15 mag. amplitude for Min. I and 0.1 mag. for Min. II.
Both seven min. I and min. II (table 3) were derived and led to the ephemeris

$$HJD\ (Min.) = 2456064.5155(13) + 0.389228(18) * E \qquad (4)$$

J.D. Hel.		Epoch	weight	(O-C)	J.D. Hel.	weight	Epoch	weight	(O-C)
2456064.517	Min. I	0.0	10	0.001	2456075.408	Min. I	28.0	10	-0.006
2456065.485	Min.II	2.5	10	-0.004	2456076.394	Min.II	30.5	5	0.007
2456067.435	Min.II	7.5	10	0.000	2456090.404	Min.II	66.5	5	0.005
2456069.379	Min.II	12.5	10	-0.002	2456096.429	Min. I	82.0	10	-0.003
2456071.526	Min. I	18.0	10	0.004	2456102.465	Min.II	97.5	5	0.000
2456072.498	Min.II	20.5	10	0.003	2456110.443	Min. I	118.0	10	-0.001
2456073.467	Min. I	23.0	10	-0.001	2456131.464	Min. I	172.0	10	0.001

Table 3: Minima of the star GSC2.3 N25F001920.

3) Var. XX (18:09:41.141 +32:33:46.99), GSC2.3 N25D013720, 2MASS 18094113+3233468:

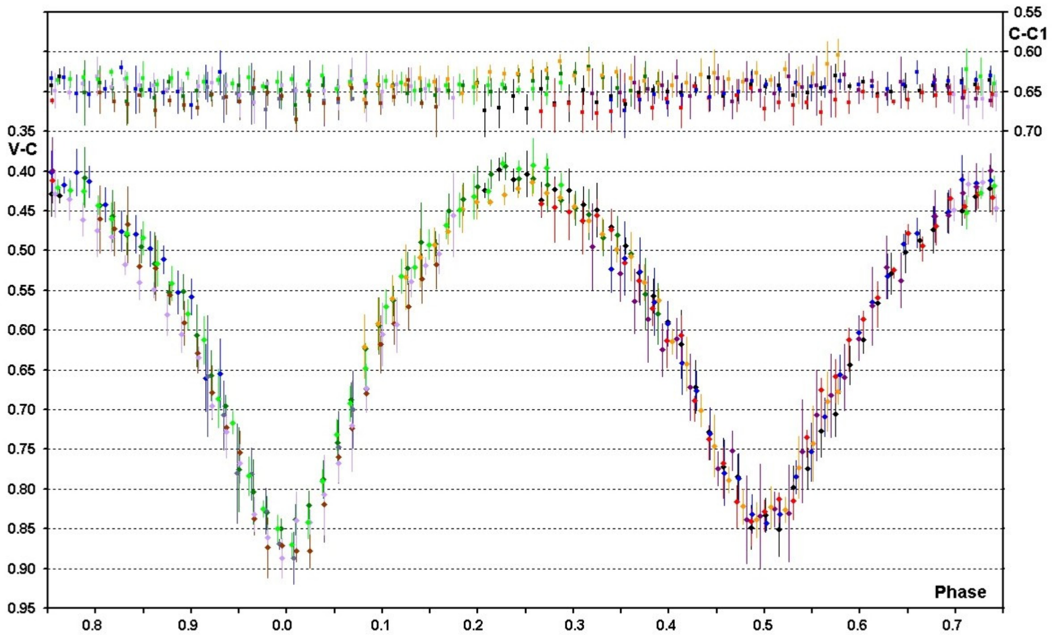

Figure 13: The light curve of the star GSC2.3 N25D013720.

A slightly fainter R magnitude of 15.3 mag. is given for this star. Again, five consecutive points were taken as one measurement. The LC (fig. 13) suggests a classical W Uma system with two eclipses of about 0.45 mag. amplitude. Both five min. I and min. II (table 4) were derived and led to the ephemeris:

HJD (Min.) = 2456072.4354(4) + 0.393563(7) * E (5)

J.D. Hel.		Epoch	(O-C)	J.D. Hel.		Epoch	(O-C)
2456069.4852	Min II	-7.5	0.0015	2456087.3919	Min I	38.0	0.0011
2456071.4500	Min II	-2.5	-0.0015	2456096.4437	Min I	61.0	0.0010
2456072.4349	Min I	0.0	-0.0005	2456102.5421	Min II	76.5	-0.0008
2456073.4194	Min II	2.5	0.0001	2456105.4943	Min I	84.0	-0.0003
2456084.4382	Min II	30.5	-0.0008	2456131.4699	Min I	150.0	0.0001

Table 4: Minima of the star GSC2.3 N25D013720.

4) Var. XXX (18:09:01.767 +32:36:53.59), GSC2.3 N25D015132, 2MASS 18090177+3236533:

An even fainter R magnitude of 16.13 mag. is given for this star, which is at the limit of the equipment. But the LC appears sufficiently well defined to suggest that the star is also a W Uma system, this time with a shorter period and an unequal depht of the min. with 0.75 and 0.5 mag. amplitude. Four min. I and six min. II led to the ephemeris:

HJD (Min.) = 245072.4909(2) + 0.287800(3) * E (6)

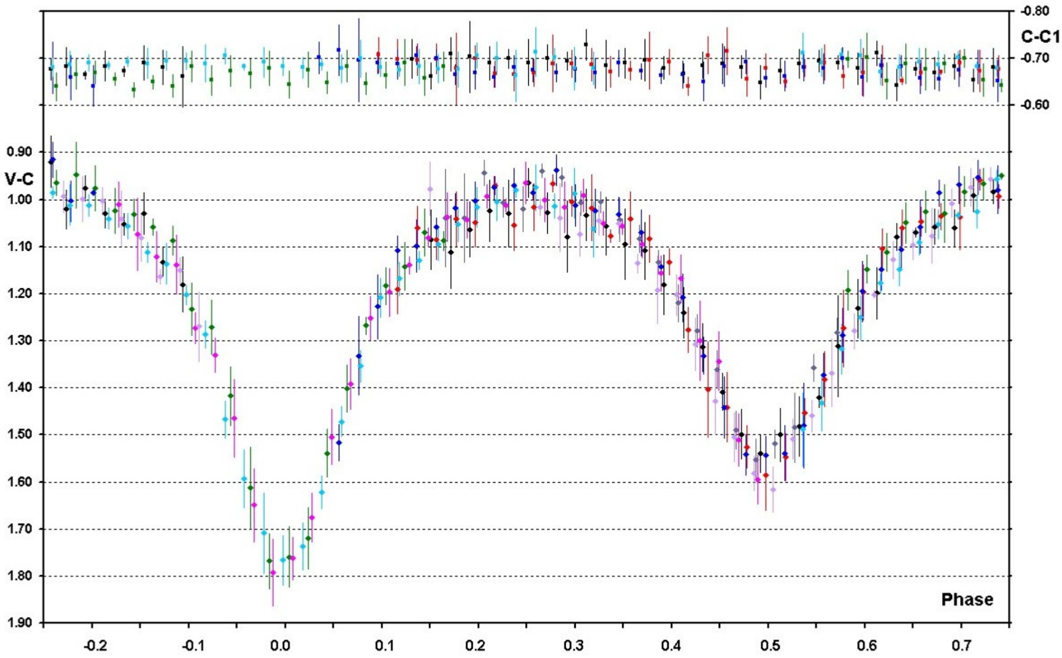

Figure 14: The light curve of the star GSC2.3 N25D015132.

J.D. Hel.		Epoch	(O-C)	J.D. Hel.		Epoch	(O-C)
2456065.4382	Min II	-24.5	-0.0016	2456090.4776	Min II	62.5	-0.0008
2456069.4695	Min II	-10.5	0.0005	2456102.4220	Min I	104.0	-0.0001
2456071.4834	Min II	-3.5	-0.0002	2456105.4442	Min II	114.5	0.0002
2456072.4912	Min I	0.0	0.0003	2456117.3878	Min I	156.0	0.0001
2456073.4988	Min II	3.5	0.0006	2456131.4898	Min I	205.0	-0.0001

Table 5: Minima of the star GSC2.3 N25D015132.

Aknowledgements:

In this research, data from the WASP public archive was used. The WASP consortium comprises of the University of Cambridge, Keele University, University of Leicester, The Open University, The Queen's University Belfast, St. Andrews University and the Isaac Newton Group. It was also made use of the VizieR and Aladin databases operated at the Centre de Données Astronomiques (Strasbourg) in France.
I would like to thank Stefan Hümmerich for improving the manuscript, Klaus Bernhard and Joachim Hübscher for their advices.

References:

Butters et al., 2010, SuperWASP Public archive, http://www.wasp.le.ac.uk/public/lc/index.php

Collier Cameron et al., 2006, A fast hybrid algorithm for exoplanetary transit searches, MNRAS, Volume 373, Issue 2, pp. 799-810, arXiv:astro-ph/0609418

Le Borgne, J.F. et al., 2007, The all–Sky GEOS RR Lyr Survey with the TAROT Telescope, Analysis of the Blazhko Effect, arXiv:astro-ph/1205.6397v1

Motl, D., 2012, http://c-munipack.sourceforge.net/

Srdoc, G., Bernhard, K., 2012, Zwei neue RR Lyrae Sterne aus der SuperWasp Datenbank, BAV Rundbrief 61, 1.

The Catalina Surveys, CSDR2, http://nesssi.cacr.caltech.edu/DataRelease/

Appendices:

Appendix 1: Maxima and minima of the RR Lyrae star GSC 02626-00896.

Appendix 2: The 2012 measurements of the RR Lyrae star GSC 02626-00896.

Maxima of the RR Lyrae star GSC 02626-00896:

Max. HJD	Epoch	weight	(O-C)
2453141.650	-9072	5	-0.014
2453144.542	-9063	5	-0.026
2453150.682	-9044	5	-0.018
2453151.651	-9041	5	-0.017
2453152.619	-9038	5	-0.017
2453153.615	-9035	5	0.011
2453154.585	-9032	5	0.013
2453155.548	-9029	5	0.007
2453156.545	-9026	5	0.036
2453157.514	-9023	5	0.037
2453158.484	-9020	5	0.039
2453162.654	-9007	5	0.014
2453163.617	-9004	5	0.008
2453164.577	-9001	5	0.000
2453165.539	-8998	5	-0.006
2453166.503	-8995	5	-0.010
2453170.687	-8982	5	-0.021
2453171.655	-8979	5	-0.022
2453172.624	-8976	5	-0.021
2453173.595	-8973	5	-0.018
2453174.563	-8970	5	-0.018
2453175.527	-8967	5	-0.022
2453176.495	-8964	5	-0.022
2453178.442	-8958	5	-0.012
2453180.430	-8952	5	0.040
2453183.654	-8942	5	0.037
2453184.623	-8939	5	0.038
2453185.586	-8936	5	0.032
2453192.639	-8914	5	-0.015
2453194.577	-8908	5	-0.013
2453195.539	-8905	5	-0.019
2453196.506	-8902	5	-0.020
2453197.477	-8899	5	-0.017
2453198.440	-8896	5	-0.022
2453199.405	-8893	5	-0.026
2453203.614	-8880	5	-0.012
2453204.578	-8877	5	-0.016
2453205.553	-8874	5	-0.009
2453207.540	-8868	5	0.042
2453208.498	-8865	5	0.031
2453209.470	-8862	5	0.035
2453215.580	-8843	5	0.013
2453217.509	-8837	5	0.006
2453218.475	-8834	5	0.004
2453219.432	-8831	5	-0.007
2453226.523	-8809	5	-0.016
2453227.495	-8806	5	-0.012
2453228.468	-8803	5	-0.008
2453229.428	-8800	5	-0.016
2453230.396	-8797	5	-0.016
2453238.507	-8772	5	0.027
2453239.470	-8769	5	0.022
2453240.434	-8766	5	0.018
2453241.397	-8763	5	0.013
2453248.463	-8741	5	-0.021
2453249.442	-8738	5	-0.010
2453250.408	-8735	5	-0.013
2453258.470	-8710	5	-0.019
2453260.450	-8704	5	0.025
2453261.432	-8701	5	0.039
2453262.396	-8698	5	0.035
2453263.353	-8695	5	0.024
2453271.391	-8670	5	-0.007
2453272.353	-8667	5	-0.013
2454303.450	-5472	5	-0.011
2454304.422	-5469	5	-0.007
2454312.502	-5444	5	0.005
2454321.534	-5416	5	0.001
2454322.502	-5413	5	0.001
2454324.433	-5407	5	-0.004
2454325.409	-5404	5	0.003
2454332.497	-5382	5	-0.008
2454333.475	-5379	5	0.001
2454334.437	-5376	5	-0.005
2454335.408	-5373	5	-0.002
2454579.706	-4616	5	-0.004
2454580.685	-4613	5	0.007
2454591.642	-4579	5	-0.009
2454593.580	-4573	5	-0.007
2454600.693	-4551	5	0.006
2454605.525	-4536	5	-0.003
2454613.598	-4511	5	0.002
2454614.566	-4508	5	0.002
2454621.658	-4486	5	-0.006
2454622.632	-4483	5	0.000
2454623.606	-4480	5	0.006
2454624.566	-4477	5	-0.002
2454625.537	-4474	5	0.001
2454626.503	-4471	5	-0.002
2454627.460	-4468	5	-0.013
2454630.687	-4458	5	-0.013
2454631.653	-4455	5	-0.015
2454632.645	-4452	5	0.009
2454635.541	-4443	5	0.000
2454636.508	-4440	5	-0.001
2454637.479	-4437	5	0.002
2454638.448	-4434	5	0.003
2454641.657	-4424	5	-0.016
2454642.632	-4421	5	-0.009
2454643.609	-4418	5	0.000
2454644.577	-4415	5	0.000
2454645.548	-4412	5	0.003
2454646.509	-4409	5	-0.004
2454652.632	-4390	5	-0.013
2454655.553	-4381	5	0.003
2454656.516	-4378	5	-0.002
2454657.491	-4375	5	0.005
2454665.548	-4350	5	-0.006
2454666.527	-4347	5	0.005
2454668.461	-4341	5	0.003
2454675.548	-4319	5	-0.010
2454676.527	-4316	5	0.001
2454677.493	-4313	5	-0.002
2454688.473	-4279	5	0.006
2456064.556	-15	10	0.005
2456065.524	-12	10	0.005
2456069.404	0	10	0.012

Minima of the RR Lyrae star GSC 02626-00896:

Min. JD hel.	Epoch	weight	(O-C)
2453128.652	-9097	5	0.013
2453129.615	-9094	5	0.008
2453130.597	-9091	5	0.022
2453137.677	-9069	5	0.002
2453138.642	-9066	5	-0.002
2453139.615	-9063	5	0.003
2453141.540	-9057	5	-0.008
2453150.603	-9029	5	0.019
2453151.554	-9026	5	0.002
2453152.540	-9023	5	0.019
2453153.492	-9020	5	0.003
2453158.635	-9004	5	-0.017
2453159.629	-9001	5	0.009
2453160.590	-8998	5	0.001
2453161.572	-8995	5	0.015
2453162.527	-8992	5	0.002
2453163.507	-8989	5	0.014
2453167.691	-8976	5	0.003
2453168.645	-8973	5	-0.012
2453169.605	-8970	5	-0.020
2453170.582	-8967	5	-0.011
2453171.541	-8964	5	-0.020
2453172.528	-8961	5	-0.001
2453173.515	-8958	5	0.018
2453174.458	-8955	5	-0.008
2453177.687	-8945	5	-0.006
2453178.665	-8942	5	0.004
2453179.631	-8939	5	0.002
2453180.604	-8936	5	0.007
2453181.570	-8933	5	0.005
2453182.540	-8930	5	0.006
2453183.509	-8927	5	0.007
2453184.493	-8924	5	0.023
2453185.453	-8921	5	0.015
2453190.609	-8905	5	0.007
2453191.564	-8902	5	-0.006
2453192.527	-8899	5	-0.011
2453193.498	-8896	5	-0.008
2453194.474	-8893	5	0.000
2453195.418	-8890	5	-0.025
2453200.596	-8874	5	-0.010
2453201.576	-8871	5	0.002
2453202.537	-8868	5	-0.005
2453203.522	-8865	5	0.011
2453212.562	-8837	5	0.015
2453215.465	-8828	5	0.014
2453222.530	-8806	5	-0.021
2453223.503	-8803	5	-0.016
2453224.465	-8800	5	-0.022
2453225.430	-8797	5	-0.026
2453226.427	-8794	5	0.003
2453227.388	-8791	5	-0.004
2453235.460	-8766	5	0.000
2453236.435	-8763	5	0.007
2453245.473	-8735	5	0.009
2453246.428	-8732	5	-0.005
2453255.486	-8704	5	0.017
2453256.458	-8701	5	0.021
2453258.387	-8695	5	0.014
2454297.535	-5475	5	-0.002
2454298.502	-5472	5	-0.003
2454306.579	-5447	5	0.006
2454307.547	-5444	5	0.006
2454308.513	-5441	5	0.004
2454318.512	-5410	5	-0.002
2454320.449	-5404	5	-0.001
2454321.425	-5401	5	0.007
2454328.512	-5379	5	-0.006
2454329.484	-5376	5	-0.002
2454330.450	-5373	5	-0.004
2454331.423	-5370	5	0.001
2454575.717	-4613	5	-0.006
2454576.695	-4610	5	0.004
2454577.664	-4607	5	0.005
2454578.620	-4604	5	-0.007
2454579.605	-4601	5	0.010
2454585.710	-4582	5	-0.017
2454586.684	-4579	5	-0.011
2454597.662	-4545	5	-0.006
2454598.631	-4542	5	-0.005
2454600.568	-4536	5	-0.004
2454606.698	-4517	5	-0.006
2454607.671	-4514	5	-0.001
2454608.646	-4511	5	0.006
2454609.608	-4508	5	0.000
2454618.643	-4480	5	-0.002
2454619.608	-4477	5	-0.005
2454620.582	-4474	5	0.001
2454621.547	-4471	5	-0.002
2454622.518	-4468	5	0.001
2454623.482	-4465	5	-0.003
2454627.677	-4452	5	-0.004
2454628.643	-4449	5	-0.006
2454629.613	-4446	5	-0.004
2454630.586	-4443	5	0.001
2454631.551	-4440	5	-0.002
2454632.515	-4437	5	-0.007
2454638.647	-4418	5	-0.006
2454639.620	-4415	5	-0.002
2454640.587	-4412	5	-0.003
2454641.556	-4409	5	-0.002
2454642.521	-4406	5	-0.005
2454643.489	-4403	5	-0.005
2454649.625	-4384	5	-0.001
2454650.587	-4381	5	-0.007
2454651.549	-4378	5	-0.013
2454652.519	-4375	5	-0.011
2454655.425	-4366	5	-0.010
2454656.400	-4363	5	-0.003
2454660.597	-4350	5	-0.001
2454661.559	-4347	5	-0.008
2454662.533	-4344	5	-0.002
2454663.505	-4341	5	0.002
2454664.473	-4338	5	0.002
2454671.573	-4316	5	0.002
2454672.535	-4313	5	-0.004
2454673.512	-4310	5	0.005
2454674.473	-4307	5	-0.002
2454675.438	-4304	5	-0.006
2454682.529	-4282	5	-0.014
2454683.513	-4279	5	0.001
2454684.472	-4276	5	-0.008
2454685.456	-4273	5	0.008
2454686.421	-4270	5	0.005
2456064.438	0	10	0.001
2456065.408	3	10	0.003
2456067.346	9	10	0.004
2456071.540	22	10	0.003
2456072.507	25	10	0.002
2456073.477	28	10	0.004
2456075.411	34	10	0.001
2456076.385	37	10	0.007
2456084.447	62	10	0.001
2456096.392	99	10	0.005
2456102.522	118	10	0.004
2456105.428	127	10	0.005