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Five new variable stars in the field of the old nova RS Car

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Abstract: Five new eclipsing binary stars (2MASS J11080308-6145589, 2MASS J11080447-6143290, 2MASS J11080559-6147079, 2MASS J11083782-6146288 and 2MASS J11085087-6143349) have been identified in the field of the 1895 nova RS Car. The phase plots indicate that all five stars are eclipsing binary stars of the EA subtype.

The primary aim of this feasibility study was to devise a rapid system to identify previously uncatalogued eclipsing binary type variable stars. Candidate variable stars in the publicly available data of the Optical Gravitational Lensing Experiment (OGLE) project (Udalski et al., 1997) were identified by data mining the OGLE-II I-band DIA photometry galactic disk database for entries in the chosen field that matched the following criteria: a minimum of 200 detections, a mean I-band magnitude between 8 and 17 and a standard deviation of I-band magnitude between 0.02 and 0.4. The OGLE database contained over 10^{10} measurements of more than 40 million objects in the OGLE-II fields so it was important to use a range of selection criteria that would facilitate the identification of eclipsing binary stars without requiring human scrutiny of very large numbers of light curves.

It was not the intention at this stage to publish details of every uncatalogued variable star discovered in the OGLE database and for this reason results for just five discoveries are presented from a small region of Carina.

The identification and classification of eclipsing binary stars required time-resolved photometry and examination of the resultant light curve. The OGLE photometry was examined using the SQL interface (Szymański, 2005) available from the OGLE website (http://ogledb.astrouw.edu.pl/~ogle/photdb/phot_query.html). Identifying candidate variable stars was an eight stage process.

Option "Select OGLE target:" – select Galactic Disk
Option "Select parameters database:" – select OGLE-II I-band DIA photometry
From range of parameters – select and use "Right Ascension (J2000)" with values 11 07 06 to 11 09 06
From range of parameters – select and use "Declination (J2000)" with values –61 41 08 to –62 11 08
From range of parameters – select and use "Mean I-magnitude" with values 8 to 17
From range of parameters – select and use "Standard deviation of I-magnitude" with values 0.02 to 0.4
From range of parameters – select and use "No. of detections on subtracted image" with values 200 to 1000
Select "Sexag. RA/Dec output"

It was then possible to examine the light curve for each star by clicking on the relevant StarID in the table of results generated via the SQL interface.

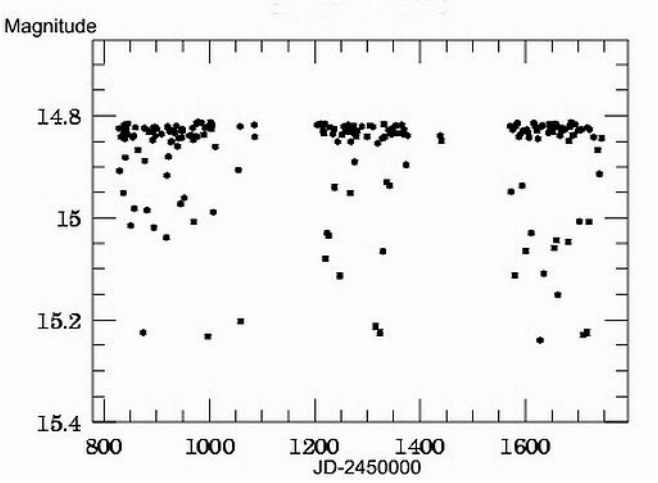

Figure 1. The characteristic light curve of a type EA eclipsing binary star

A total of 44169 candidate variable stars were identified before the application of the selection criteria described above.

Stage of analysis	Candidate variable stars
Initial positional download with no other constraints applied	44169
Removal of stars too faint for reliable photometry	3045
Removal of stars with too few data points for period determination	781
Removal of stars unlikely to show significant variation	72
Remaining light curves examined and those not showing characteristics of a type EA eclipsing binary and those where no reliable period could be determined were eliminated	5

The period, amplitude, type and epoch of each of the new discoveries was determined using the software package Peranso 2.31 (Vanmunster, 2008).

In the case of this survey every entry was subject to a clerical and then to an astronomical check. The clerical check was used to ensure that the associated data files were complete and free from error and the astronomical check was to ensure that the star was a type EA eclipsing binary star based on the OGLE data and that at the time that the International Variable Star Index or VSX (http://www.aavso.org/vsx/) was checked – January 2009 – that the variability of each new entry had not previously been reported.

Table 1. Summary of the five new eclipsing binary stars

			Approximate Epoch	Period
#	2MASS Identifier	Coordinates (J2000)	(HJD)	(Days)
1	J11080308-6145589	11 08 03.23 -61 45 58.6	2450518.898	2.01390(4)
2	J11080447-6143290	11 08 04.62 -61 43 28.7	2450828.774	2.88344(2)
3	J11080559-6147079	11 08 05.75 -61 47 07.7	2450552.659	1.76098(7)
4	J11083782-6146288	11 08 37.96 -61 46 28.5	2451628.694	1.82508(8)
5	J11085087-6143349	11 08 51.01- 61 43 34.6	2450633.481	2.62371(9)

	Max magnitude	Min I magnitude	Min II magnitude	Duration	Duration
#	OGLE I-band	OGLE I-band	OGLE I-band	Min I (d)	Min II (d)
1	14.75	15.05	14.95	0.12	0.14
2	15.55	15.95	15.95	0.13	0.13
3	16.45	17.00	16.95	0.23	0.21
4	14.20	15.10	14.35	0.22	0.22
5	15.25	15.50	15.50	0.16	0.16

Remarks:

Stars #2, #3 and #5 may have a true period half that quoted but this would mean that there was no discernible secondary minimum. Is it somewhat unusual that three out of the five new discoveries have primary and secondary eclipses that are so similar. If a much larger sample of stars were examined using the techniques discussed in this paper it would be possible to decide if this were a selection effect or just a random event.

The quoted epoch is only approximate since the light curve and phase diagram were constructed from data points obtained over an extended period rather than by continuously monitoring the stars through a complete cycle. The quoted figure, rounded to 3 decimal places, represents the time of minimum light based on these widespread data points rather than any result obtained by interpolating data from around a single observed minimum.

The software package used – PERANSO – gives slightly different results for the period of these binary stars depending on the analytical technique used and for this reason the quoted period should not be used to more than five decimal places.

Stars #1, #3 and #4 all show ellipticity effects. This can be seen in the phase diagrams where the magnitude is not constant between eclipses. The effect is largest in star #1 where it reaches a value of 0.01 magnitudes.

Acknowledgements:
This research has made use of the SIMBAD and VizieR databases operated at the Centre de Données Astronomiques (Strasbourg) in France and of the International Variable Star Index (AAVSO).

References:

International Variable Star Database, http://www.aavso.org/vsx/

Szymański M., 2005, The Optical Gravitational Lensing Experiment. Internet Access to the OGLE Photometry Data Set: OGLE-II BVI maps and I-band data, (2005AcA....55...43S)

Udalski A., Kubiak M. and Szymański M, 1997, Optical Gravitational Lensing Experiment. OGLE-2 -- the Second Phase of the OGLE Project, (1997AcA....47..319U)

Vanmunster, T. 2007, Peranso period analysis software, http://www.peranso.com

Figure 2. Star #1 (2MASS J11080308-6145589)

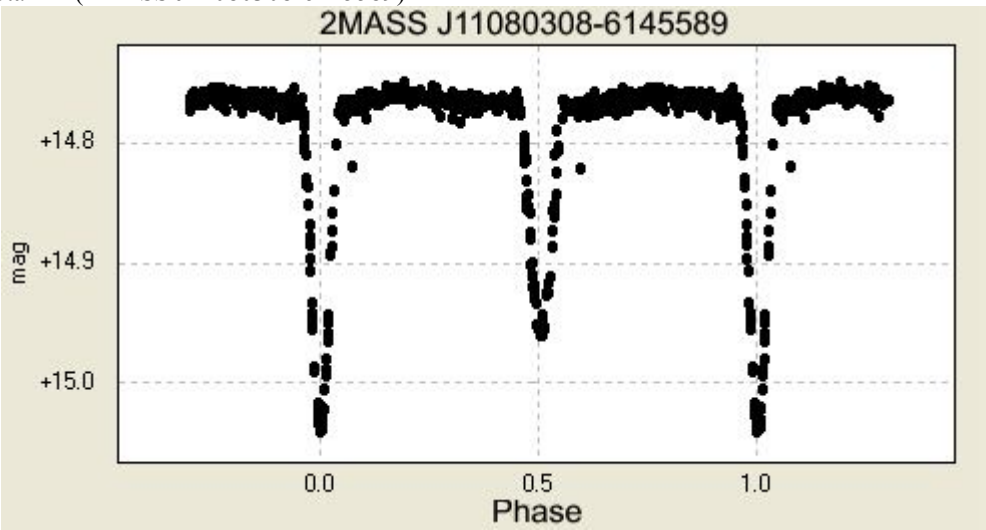

Figure 3. Star #2 (2MASS J11080447-6143290)

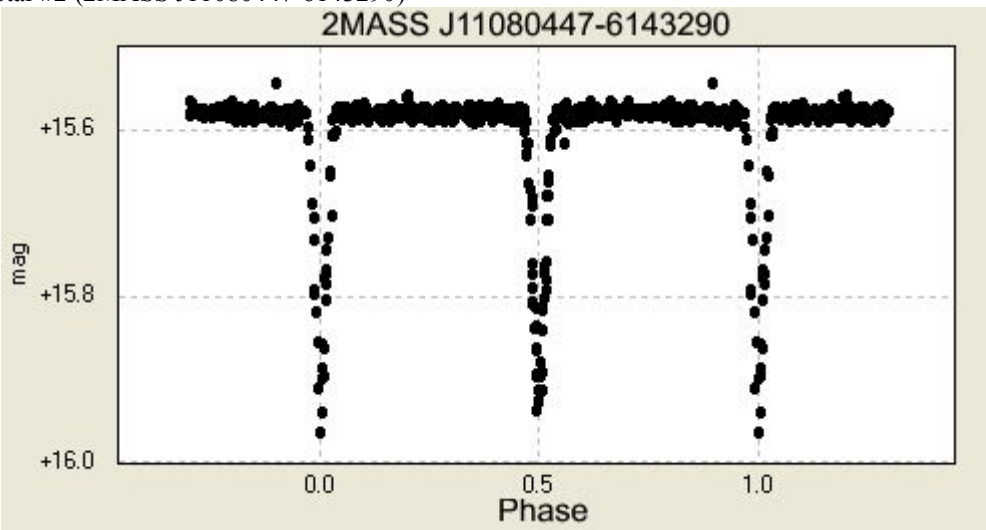

Figure 4. Star #3 (2MASS J11080559-6147079)

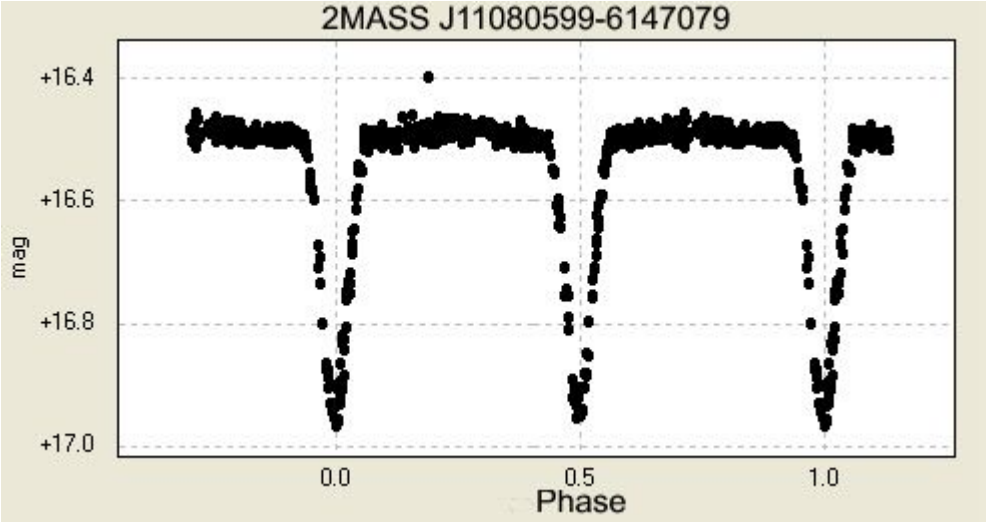

Figure 5. Star #4 (2MASS J11083782-6146288)

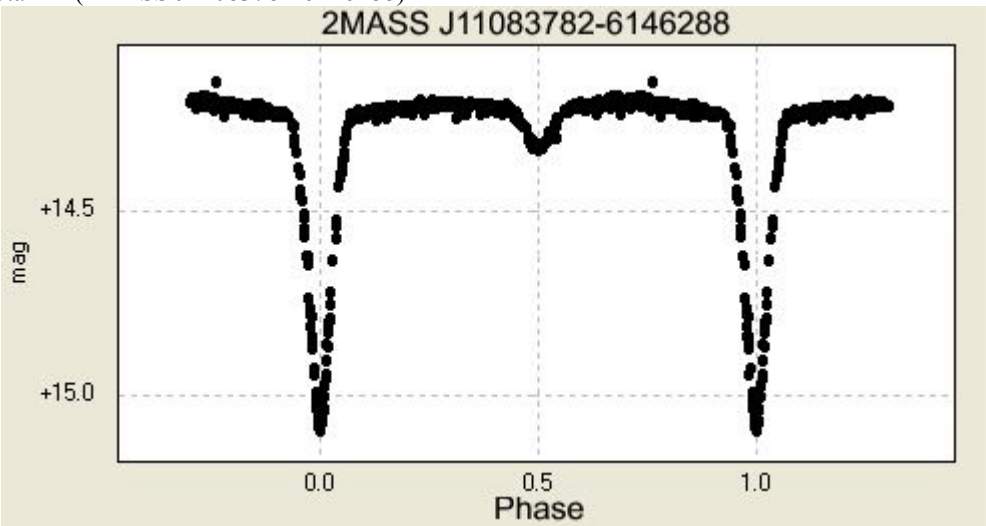

Figure 6. Star #5 (2MASS J11085087-6143349)