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40 previously unreported variable stars in the OGLE-II database

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Abstract:
Details of 40 previously unreported variable stars in the OGLE-II database are reported. The phase plots indicate that 34 are eclipsing binary stars of the EA subtype, 4 are eclipsing binary stars of the EB subtype, 1 is an eclipsing binary star of the EW subtype and 1 is a pulsating variable star of the RV Tauri type. The stars in question are (2MASS unless indicated):

J11054998-6131521 J11063560-6140119 J11065121-6114072
J11070397-6126450 J11071145-6131226 J11084175-6057302
J11084257-6128404 J11084840-6140069 J11092679-6049285
J11093077-6043018 J11104169-6108597 J11104326-6040081
J13572196-6319063 J13575494-6305467 J13592679-6250239
J16121245-5427297 J16144301-5358564 J16144884-5402452
J16145635-5336269 J16151239-5357318 J16155992-5408329
J16161980-5359411 J16162999-5355564 J16163593-5336381
J16165892-5328577 J16172241-5412386 J16180533-5350579
J16240706-5231050 J16240831-5203176 J16245716-5157579
J16254555-5202176 J16403400-4457564 J16405322-4428228
J16412665-4423320 J16425405-4416152 J16435193-4428101
J17003058-4435568 J17004594-4410145 J17010630-4407438
UCAC3 092-285054

Methodology:
Nicholson (2009) described how candidate variable stars could be extracted from the publicly available data of the Optical Gravitational Lensing Experiment (OGLE) project (Udalski et al., 1997) via the SQL interface (Szymański, 2005) available from the OGLE website:

http://ogledb.astrouw.edu.pl/~ogle/photdb/phot_query.html

The period, amplitude, type and epoch of each of the new discoveries was determined using the software package Peranso 2.31 (Vanmunster, 2008). Every discovery 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 at the time that the International Variable Star Index or VSX (http://www.aavso.org/vsx/) was checked – late October 2009 – that detailed information on the variability of each new entry had not previously been reported by another observer.

Identifying candidate variable stars was a six 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 “Mean I-magnitude” with values 12 to 16
From range of parameters – select and use “No. of good points” with values 100 to 1000

From range of parameters – select and use “Percentage of good points” with values 80 to 100
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.

Results and objects of particular interest:

Table 1. Summary of the forty new variable stars

			Epoch (See note)	Period	
#	2MASS Identifier	Coordinates (J2000)	(HJD)	(Days)	Type
1	J11054998-6131521	11 05 50.10 -61 31 51.8	2451310.541	9.46270(1)	EA
2	J11063560-6140119	11 06 35.75 -61 40 11.7	2450551.713	2.09839(4)	EA
3	J11065121-6114072	11 06 51.33 -61 14 06.9	2451706.470	3.58238(6)	EA
4	J11070397-6126450	11 07 04.10 -61 26 44.5	2451372.470	3.45378(5)	EA
5	J11071145-6131226	11 07 11.59 -61 31 22.2	2450574.554	9.19440(6)	EA
6	J11084175-6057302	11 08 41.87 -60 57 30.1	2450507.892	8.33688(7)	EA
7	J11084257-6128404	11 08 42.72 -61 28 39.9	2451311.509	3.11413(3)	EA
8	J11084840-6140069	11 08 48.55 -61 40 06.7	2450518.837	10.51791(6)	EA
9	J11092679-6049285	11 09 26.93 -60 49 28.2	2450924.638	25.27990(2)	RVA
10	J11093077-6043018	11 09 30.90 -60 43 01.5	2450535.717	1.78237(1)	EA
11	J11104169-6108597	11 10 41.81 -61 08 59.5	2450978.494	5.80116(7)	EA
12	J11104326-6040081	11 10 43.37 -60 40 07.4	2450647.500	6.24253(3)	EA
13	J13572196-6319063	13 57 22.05 -63 19 05.6	2451621.712	2.29008(9)	EA
14	J13575494-6305467	13 57 55.06 -63 05 46.1	2451204.816	1.76845(4)	EA
15	J13592679-6250239	13 59 26.91 -62 50 23.1	2450945.552	1.83991(6)	EA
16	J16121245-5427297	16 12 12.43 -54 27 30.3	2451002.550	1.25033(8)	EA
17	J16144301-5358564	16 14 42.96 -53 58 57.3	2451720.658	3.31014(2)	EA
18	J16144884-5402452	16 14 48.91 -54 02 45.7	2451058.620	1.19760(8)	EA
19	J16145635-5336269	16 14 56.27 -53 36 28.0	2451577.831	3.75960(2)	EA
20	J16151239-5357318	16 15 12.61 -53 57 34.9	2451299.633	0.54755(7)	EW
21	J16155992-5408329	16 15 59.89 -54 08 33.5	2451003.659	1.62934(5)	EA
22	J16161980-5359411	16 16 19.74 -53 59 41.8	2451280.674	1.67715(9)	EA
23	J16162999-5355564	16 16 29.91 -53 55 57.2	2451304.728	2.91124(3)	EA
24	J16163593-5336381	16 16 35.83 -53 36 39.2	2450920.741	1.17701(3)	EA
25	J16165892-5328577	16 16 58.82 -53 28 58.8	2451005.530	1.59084(5)	EA
26	J16172241-5412386	16 17 22.37 -54 12 39.4	2450947.657	1.09088(6)	EA
27	J16180533-5350579	16 18 05.28 -53 50 58.4	2451718.555	1.53315(4)	EA
28	J16240706-5231050	16 24 06.93 -52 31 05.2	2451698.552	2.90577(6)	EA
29	J16240831-5203176	16 24 08.23 -52 03 17.9	2451607.766	1.20479(2)	EA
30	J16245716-5157579	16 24 57.10 -51 57 58.1	2451331.747	1.62836(2)	EA
31	J16254555-5202176	16 25 45.50 -52 02 18.1	2450874.844	1.66841(6)	EB
32	J16403400-4457564	16 40 34.03 -44 57 56.4	2451624.747	2.68177(3)	EB
33	J16405322-4428228	16 40 53.25 -44 28 22.8	2451701.526	3.68919(0)	EA
34	J16412665-4423320	16 41 26.69 -44 23 32.0	2451008.521	0.95635(2)	EA
35	J16425405-4416152	16 42 54.09 -44 16 15.3	2451703.531	1.86442(1)	EB
36	J16435193-4428101	16 43 51.98 -44 28 10.1	2450933.713	1.37604(5)	EB
37	J17003058-4435568	17 00 30.59 -44 35 56.6	2451630.789	2.85025(6)	EA
38	J17004594-4410145	17 00 45.98 -44 10 15.0	2450936.672	3.43507(9)	EA
39	J17010630-4407438	17 01 06.31 -44 07 43.8	2451593.813	2.61185(3)	EA
40	UCAC3 092-285054	17 02 39.43 -44 18 22.1	2451658.889	1.6378(6)	EA

Note - 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.

Table 2. More details of the forty new variable stars

	Max magnitude	Min I magnitude	Min II magnitude	Duration type EA	Duration Type EA	OGLE data
#	OGLE I-band	OGLE I-band	OGLE I-band	Min I (d)	Min II (d)	
1	14.64	15.10	15.09	0.44	0.44	Link
2	15.70	16.07	15.82	0.13	0.13	Link
3	15.42	15.73	15.63	0.30	0.30	Link
4	14.77	15.03	14.84	0.26	-	Link
5	15.04	15.29	15.29	0.62	0.62	Link
6	15.30	15.81	15.63	0.08	0.08	Link
7	15.55	15.85	15.80	0.27	0.27	Link
8	14.27	14.71	14.61	0.40	0.40	Link
9	15.85	16.05	16.00	-	-	Link
10	15.03	15.26	15.20	0.25	0.25	Link
11	14.44	14.94	14.66	0.38	0.38	Link
12	15.65	16.13	15.99	0.35	0.35	Link
13	15.21	15.56	15.43	0.15	0.15	Link
14	15.86	16.16	16.15	0.14	0.14	Link
15	15.81	16.22	16.00	0.18	0.18	Link
16	15.76	16.10	15.96	0.10	0.10	Link
17	15.56	15.93	15.89	0.20	0.20	Link
18	15.62	15.90	15.72	0.13	0.13	Link
19	14.66	14.94	14.92	0.27	0.27	Link
20	15.26	15.49	15.41	-	-	Link
21	15.25	15.51	15.49	0.16	0.16	Link
22	15.21	15.47	15.47	0.16	0.16	Link
23	14.74	14.98	14.97	0.21	0.21	Link
24	15.09	15.36	15.27	0.13	0.13	Link
25	15.71	15.96	15.95	0.23	0.23	Link
26	14.50	14.76	14.58	0.12	0.12	Link
27	14.02	14.25	14.25	0.24	0.24	Link
28	15.19	15.42	15.30	0.29	0.29	Link
29	15.56	15.85	15.68	0.11	0.11	Link
30	15.87	16.30	16.11	0.19	0.19	Link
31	14.55	14.76	14.76	-	-	Link
32	15.14	15.40	15.30	-	-	Link
33	14.62	15.00	14.80	0.31	0.31	Link
34	15.84	16.11	16.06	0.15	0.15	Link
35	15.31	15.52	15.52	-	-	Link
36	14.68	14.90	14.81	-	-	Link
37	15.09	15.35	15.32	0.12	0.12	Link
38	15.47	15.80	15.57	0.28	0.28	Link
39	15.12	15.44	15.22	0.23	0.23	Link
40	15.33	15.54	15.47	0.17	0.17	Link

Scatter in the observations plus the low sampling density of the OGLE survey means that it is impossible to determine the duration of the primary and secondary eclipses to a high degree of accuracy.

Star #1 is an eccentric eclipsing binary of subtype EA with a secondary eclipse at a phase of 0.605 +/- 0.005.

Star #4 is clearly an eclipsing binary but the phase diagram is quite unlike others generated during this study. It is possible that one of the components is itself variable, perhaps it is a pulsating star.

Star #6 is an eccentric eclipsing binary of subtype EA with a secondary eclipse at a phase of 0.445 +/- 0.005

Star #8 is an eccentric eclipsing binary of subtype EA with a secondary eclipse at a phase of 0.370 +/- 0.005. The primary and secondary eclipses appear to have very different durations but the precise durations are hard to determine due to scatter and insufficient sampling density.

Star #11 has a noisy phase diagram that strongly suggests that at least one component of the binary pair is intrinsically variable.

Star #31, 32, 35 and 36 are all type EB eclipsing binaries. With no clear onset of the eclipse it is difficult to determine minima durations.

A number of stars show ellipticity effects. This can be seen in the phase diagrams where the magnitude is not constant between eclipses. The effect is particularly well seen in star #24 where it reaches a value of 0.04 magnitudes.

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. The quoted value within the article is based on the analysis of variance statistic. This method, selected via the user interface screen within the software, was chosen because it improves peak detection sensitivity and damps alias periods.

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

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

Nicholson M., 2009, Five new variable stars in the field of the old nova RS Car, (2009OEJV..102....1N)

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. 2008, Peranso period analysis software, http://www.peranso.com

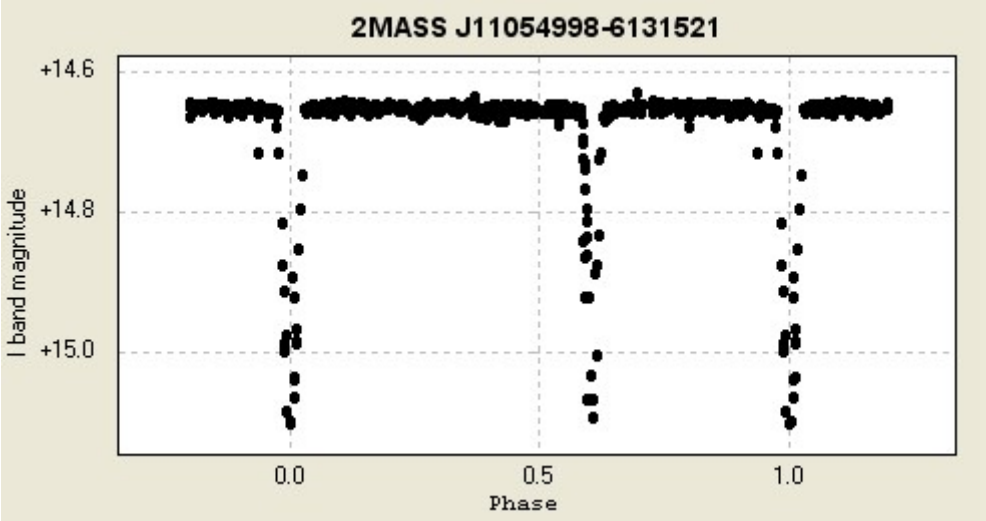


Figure 1 – Star #1 (2MASS J11054998-6131521)

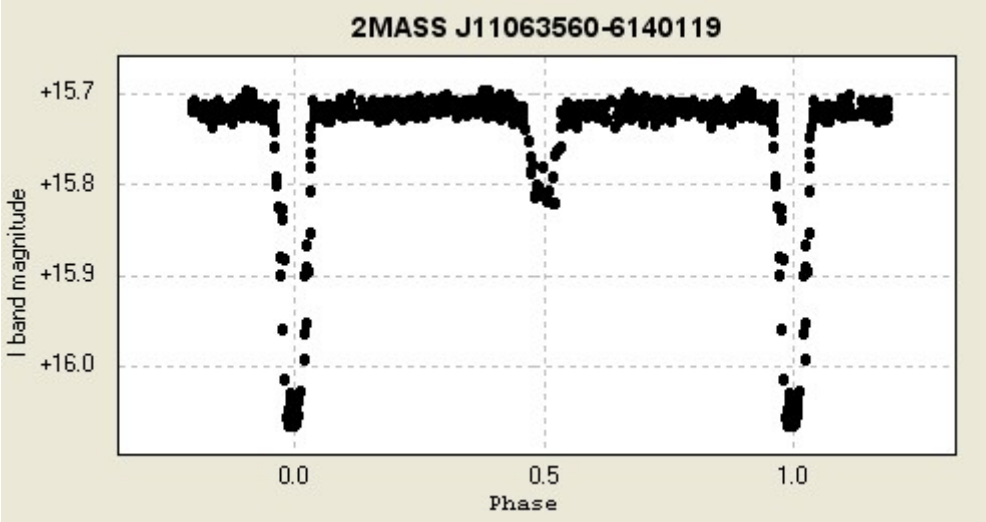


Figure 2 – Star #2 (2MASS J11063560-6140119)

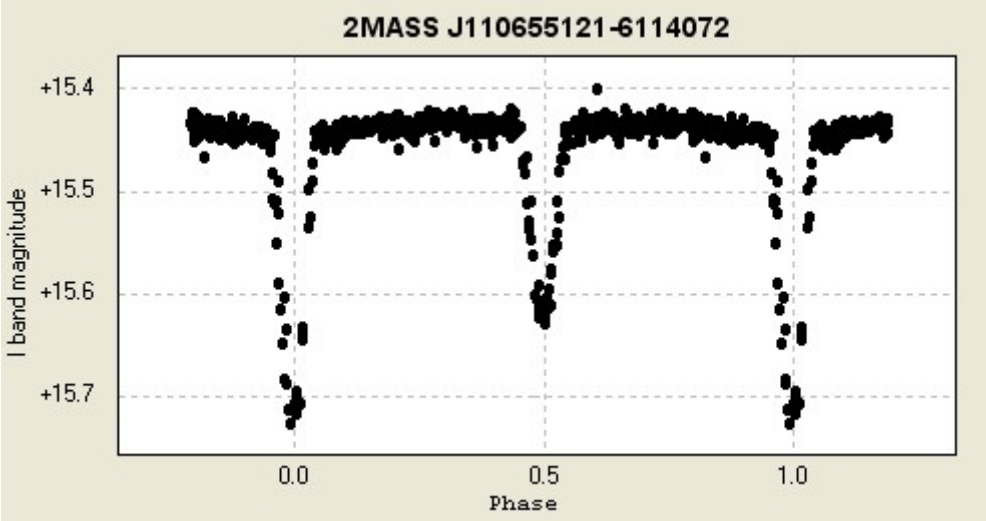


Figure 3 – Star #3 (2MASS J11065121-6114072)

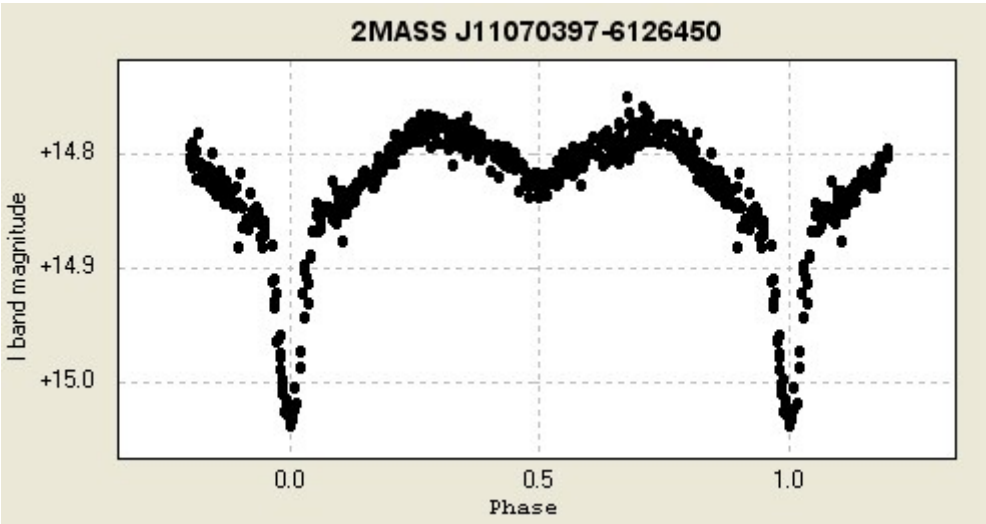


Figure 4 – Star #4 (2MASS J11070397-6126450)

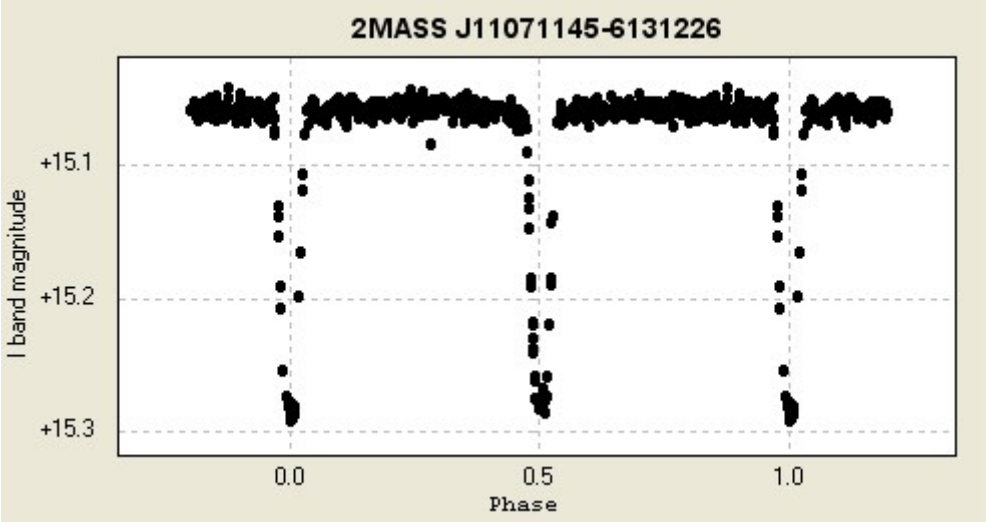


Figure 5 – Star #5 (2MASS J11071145-6131226)

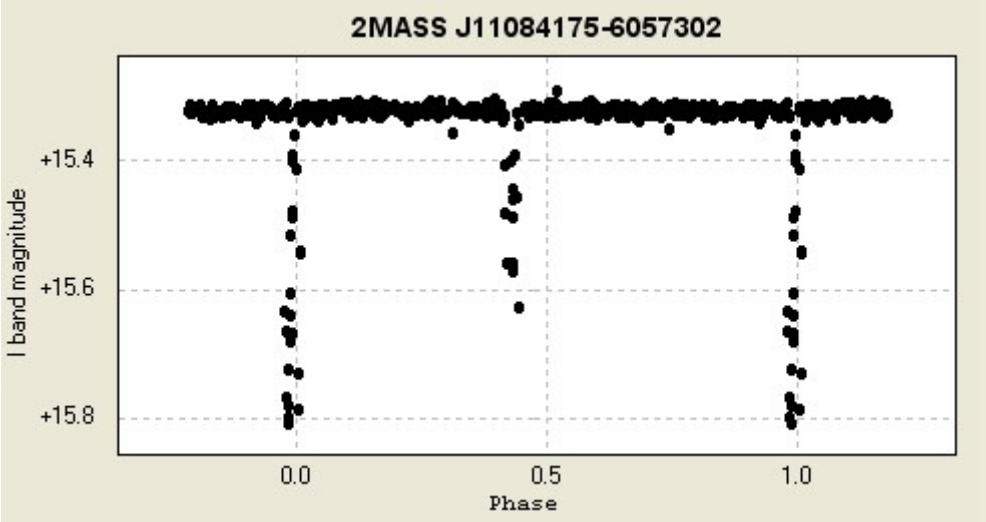


Figure 6 – Star #6 (2MASS J11084175-6057302)

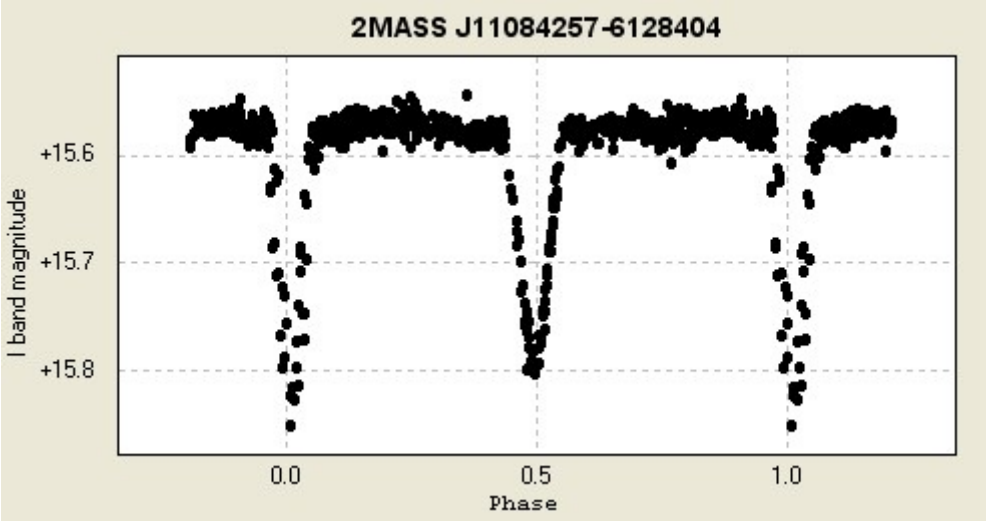


Figure 7 – Star #7 (2MASS J11084257-6128404)

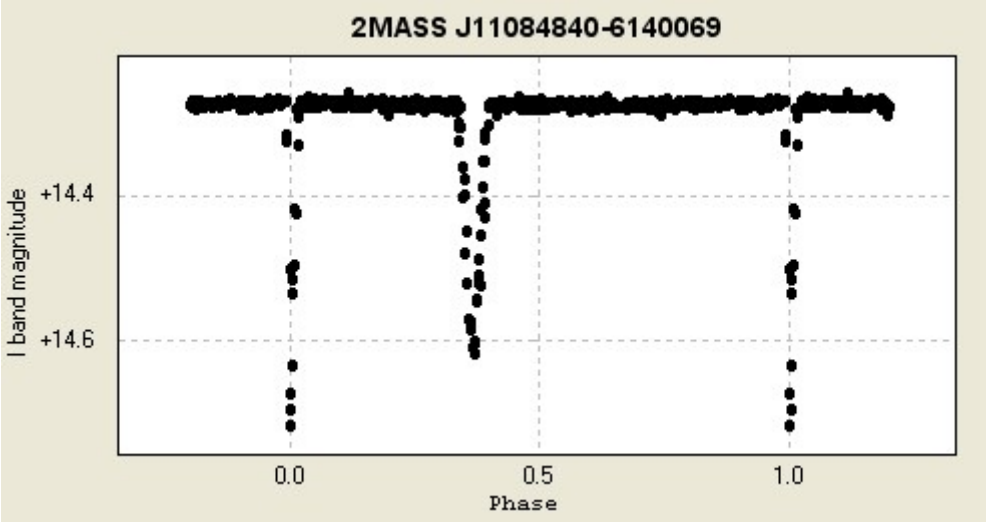
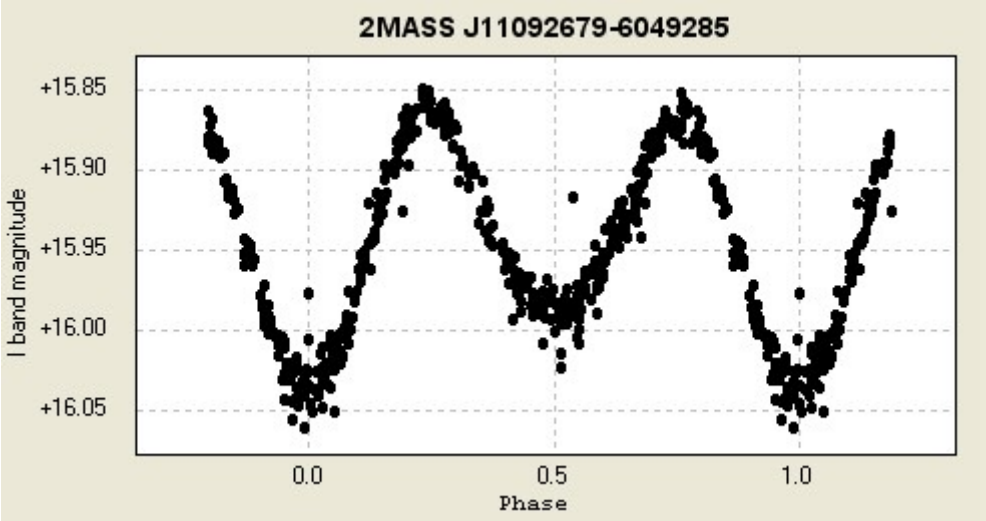


Figure 8 – Star #8 (2MASS J11084840-6140069)



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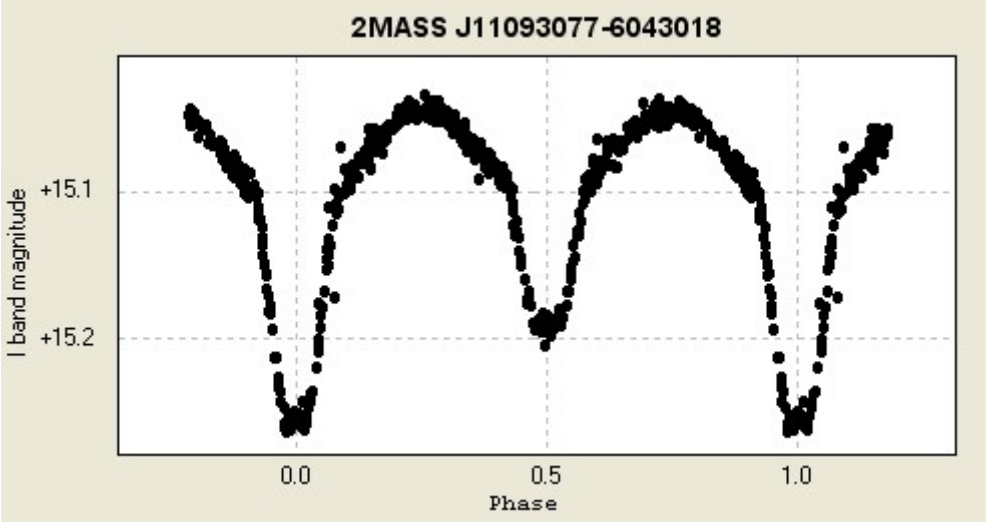


Figure 10 – Star #10 (2MASS J11093077-6043018)

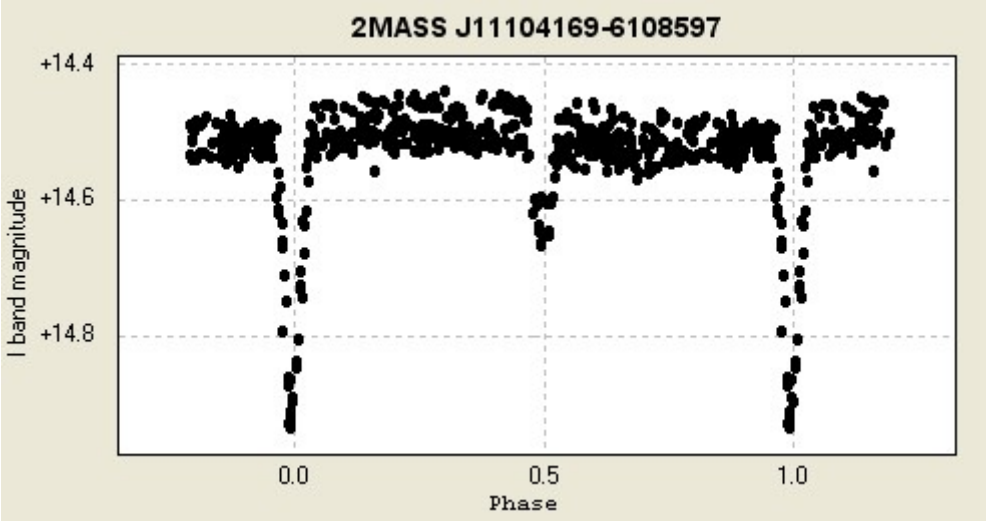
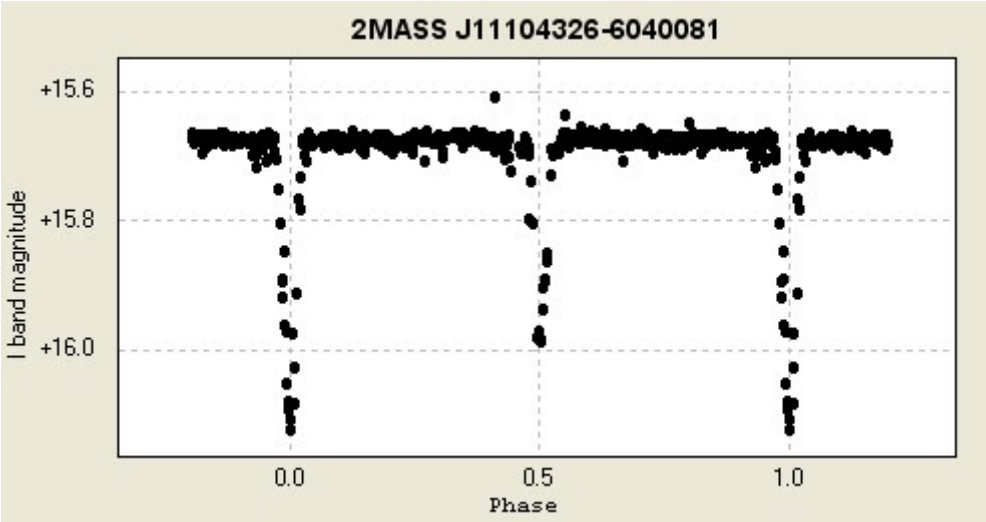


Figure 11 – Star #11 (2MASS J11104169-6108597)



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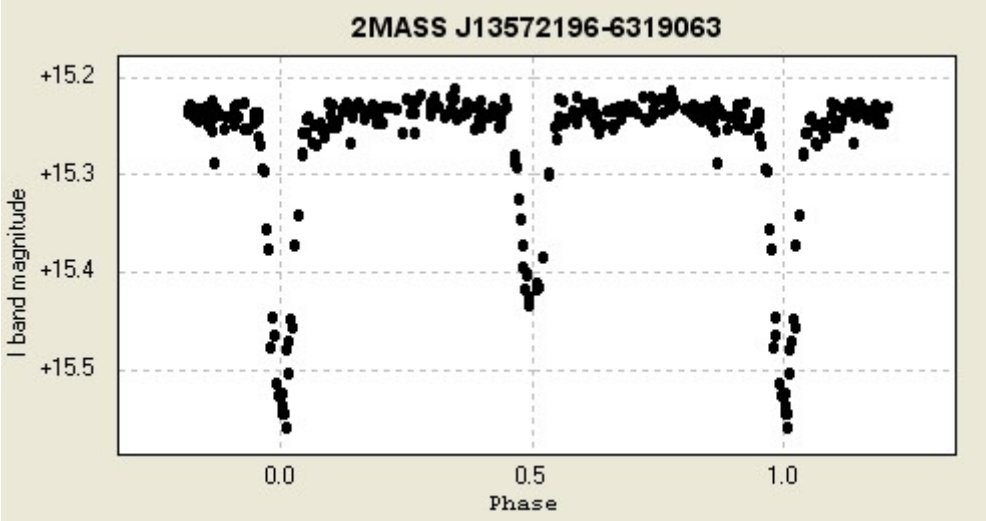
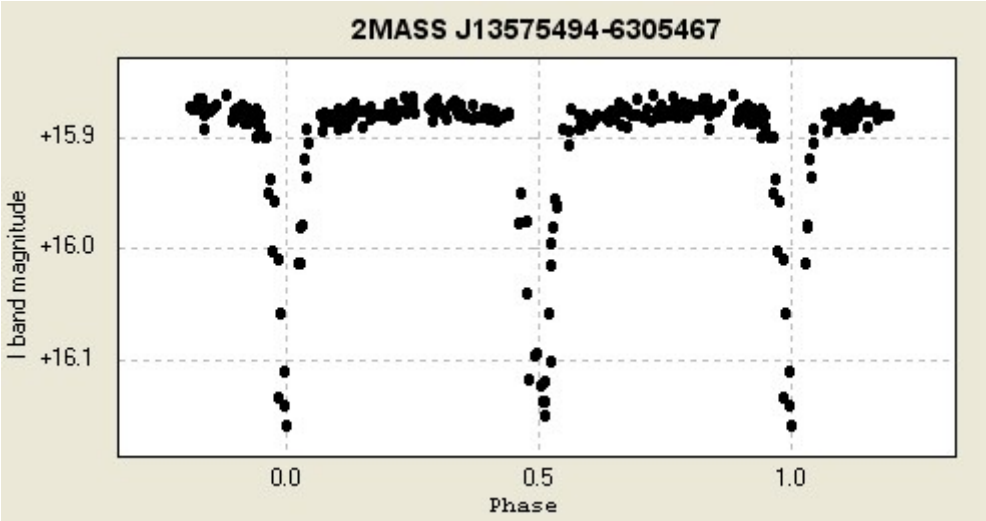


Figure 13 – Star #13 (2MASS J13572196-6319063)



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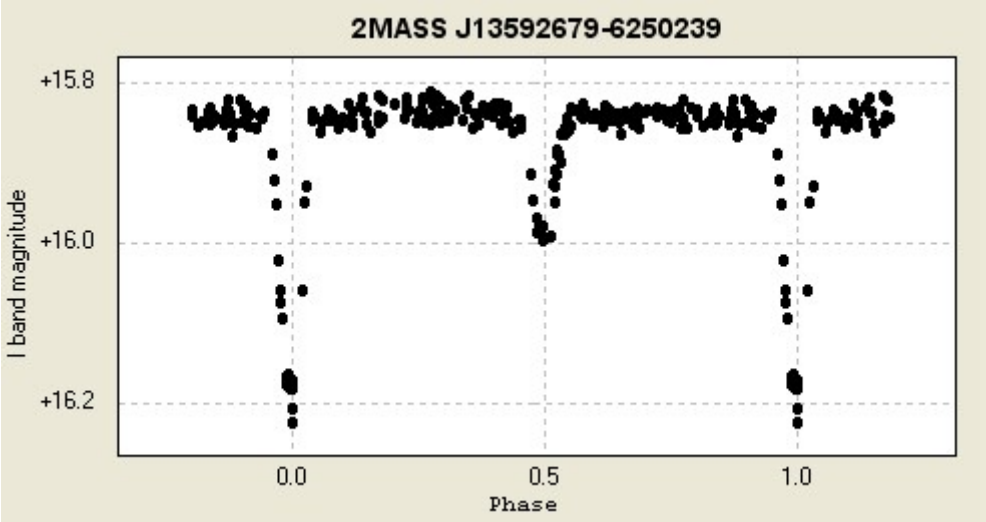


Figure 15 – Star #15 (2MASS J13592679-6250239)

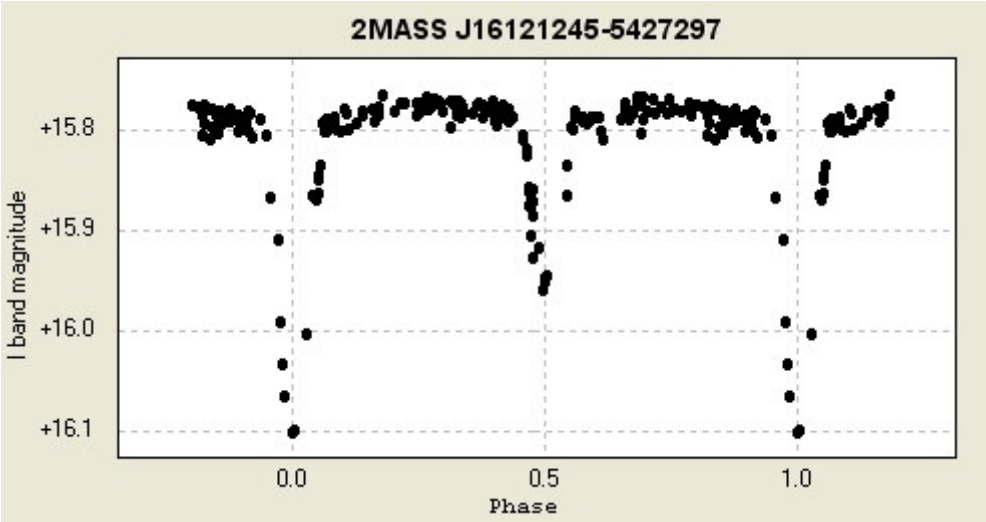


Figure 16 – Star #16 (2MASS J16121245-5427297)

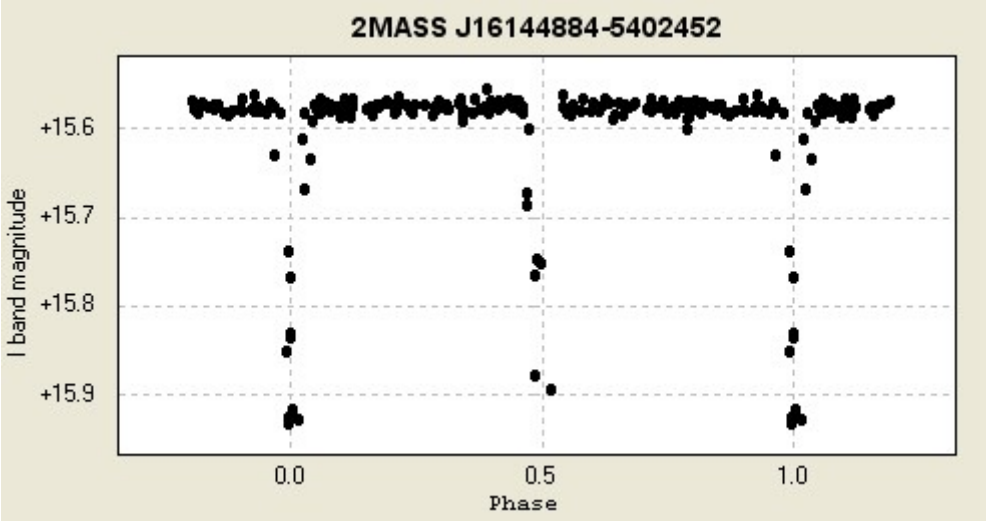
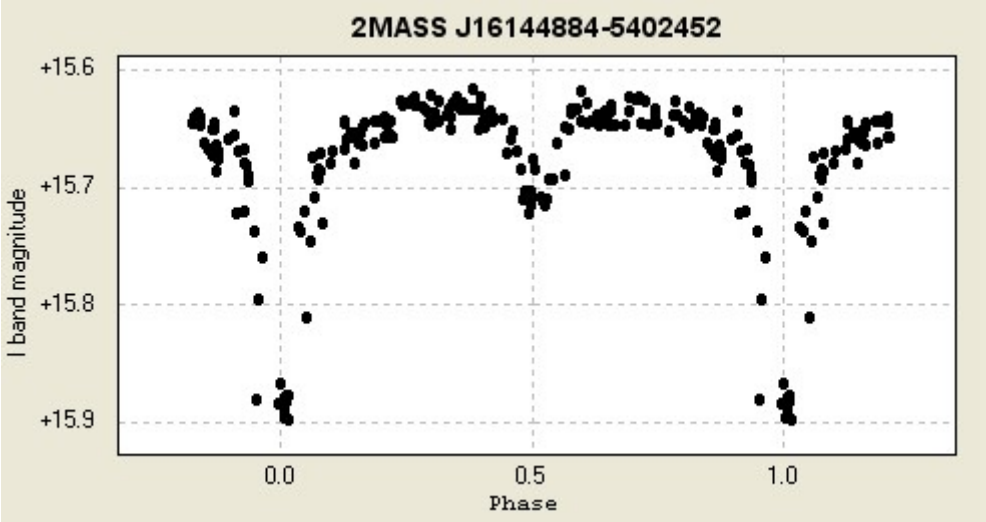


Figure 17 – Star #17 (2MASS J16144301-5358564)



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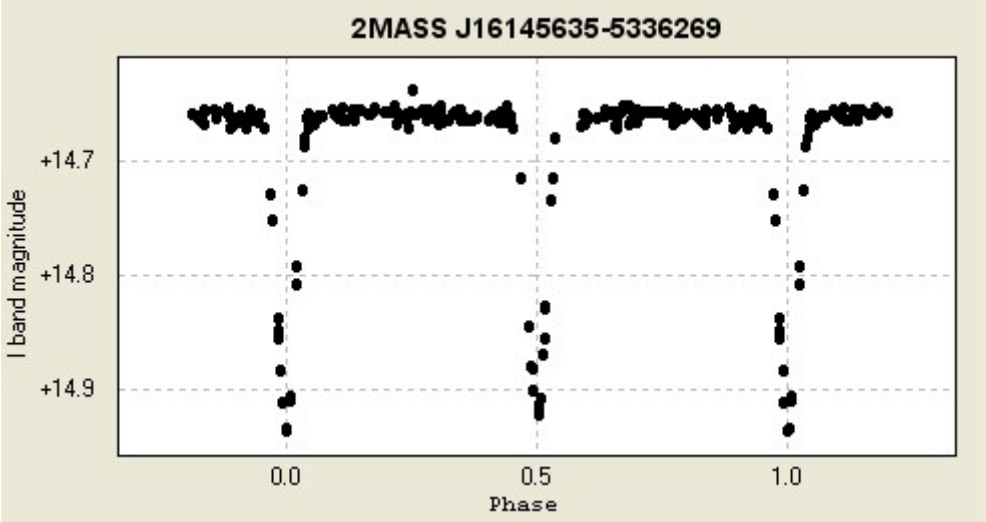

Figure 19 – Star #19 (2MASS J16145635-5336269)

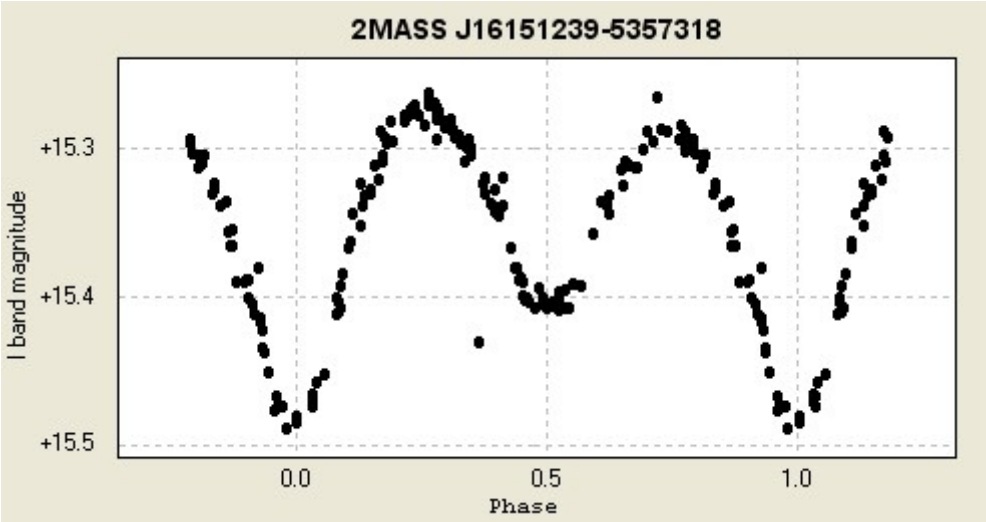

Figure 20 – Star #20 (2MASS J16151239-5357318)

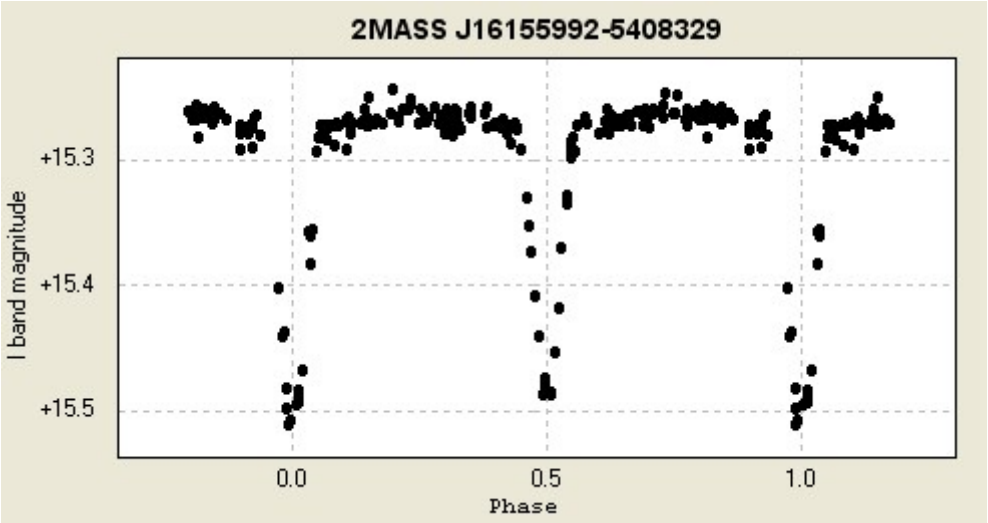

Figure 21 – Star #21 (2MASS J16155992-5408329)

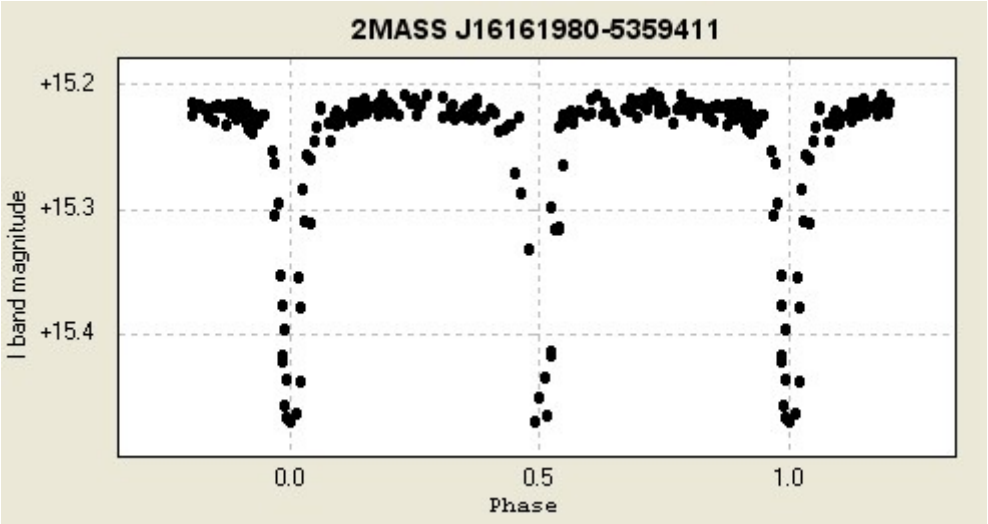

Figure 22 – Star #22 (2MASS J16161980-5359411)

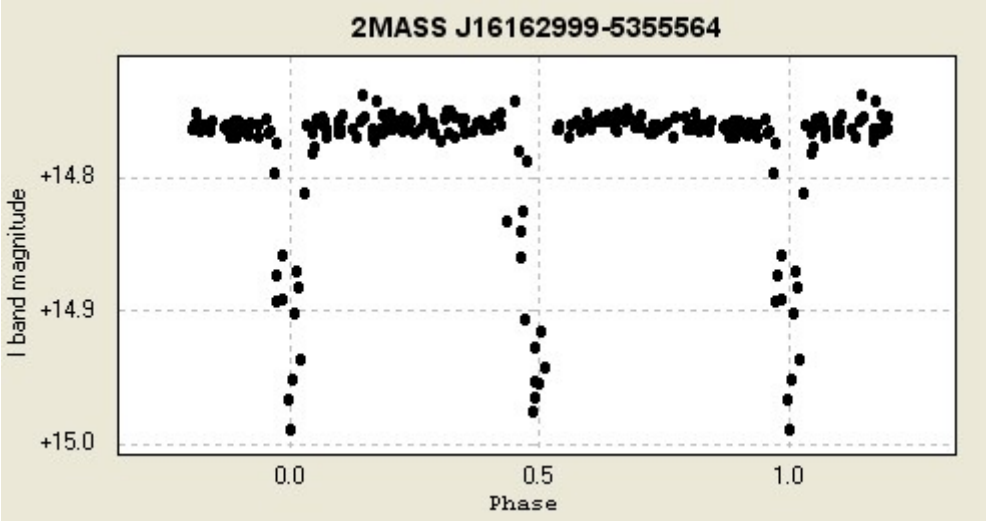

Figure 23 – Star #23 (2MASS J16162999-5355564)

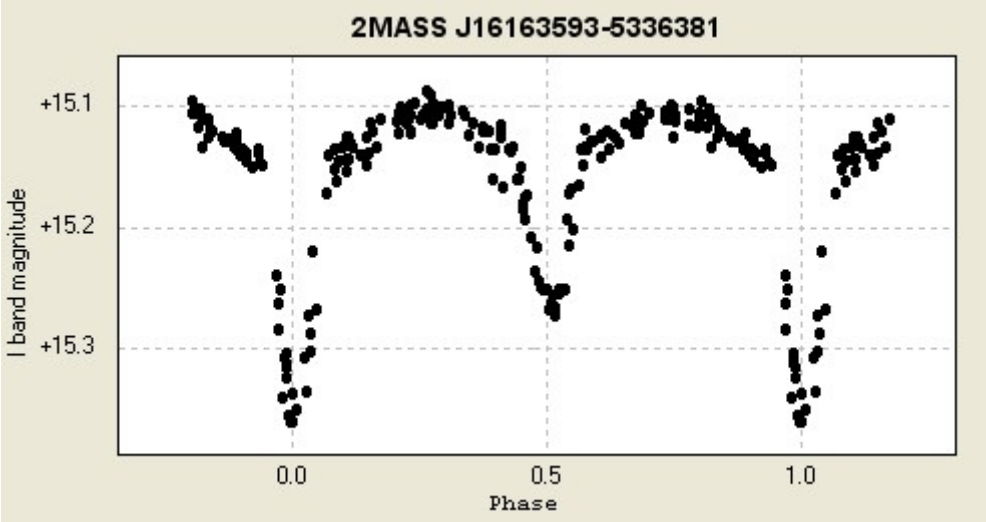

Figure 24 – Star #24 (2MASS J16163593-5336381)

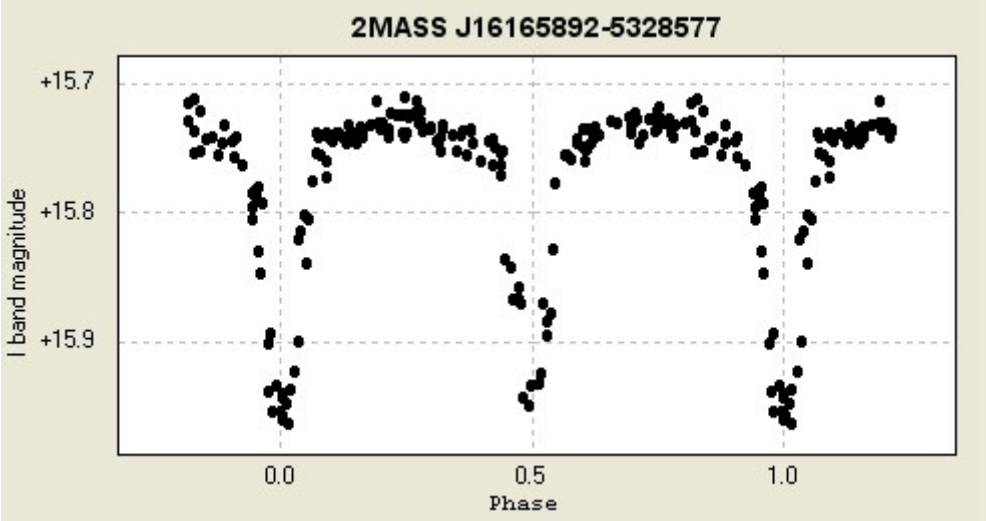

Figure 25 – Star #25 (2MASS J16165892-5328577)

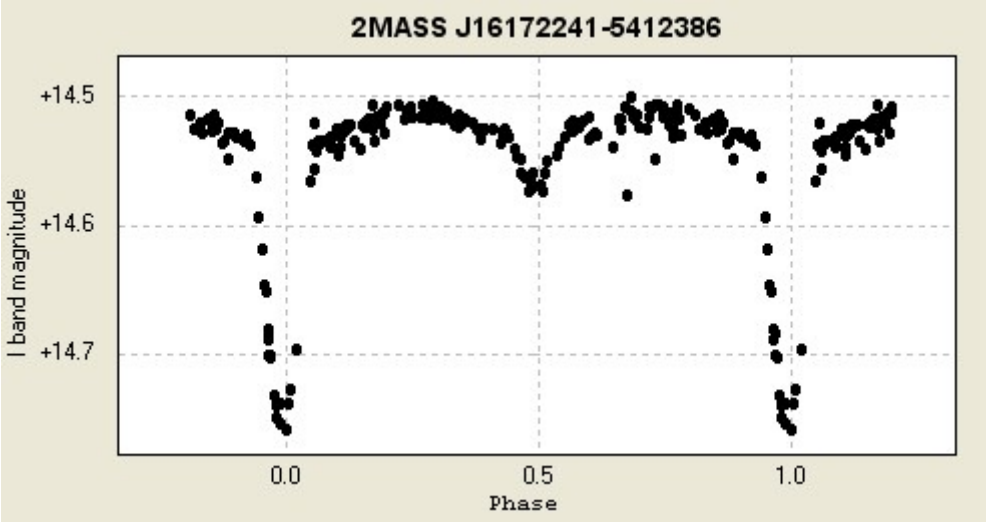

Figure 26 – Star #26 (2MASS J16172241-5412386)

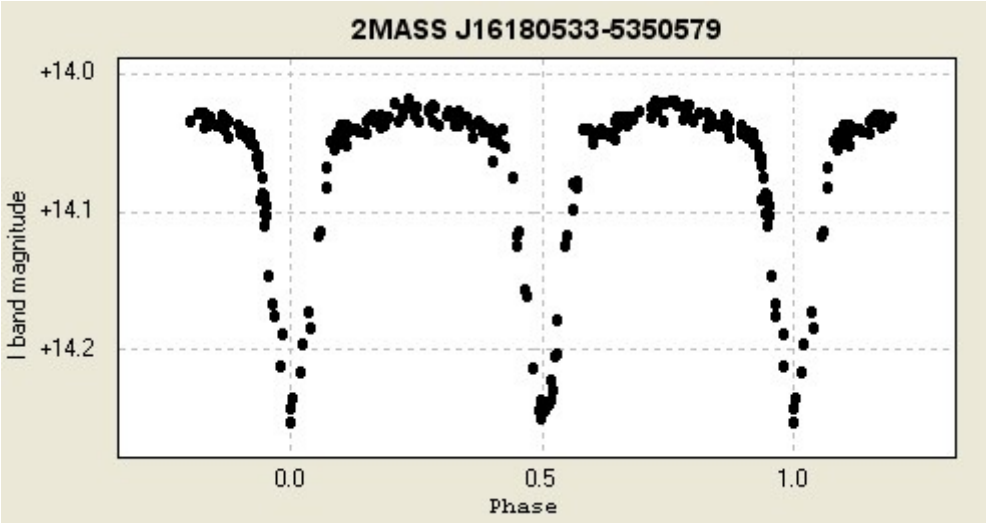

Figure 27 – Star #27 (2MASS J16180533-5350579)

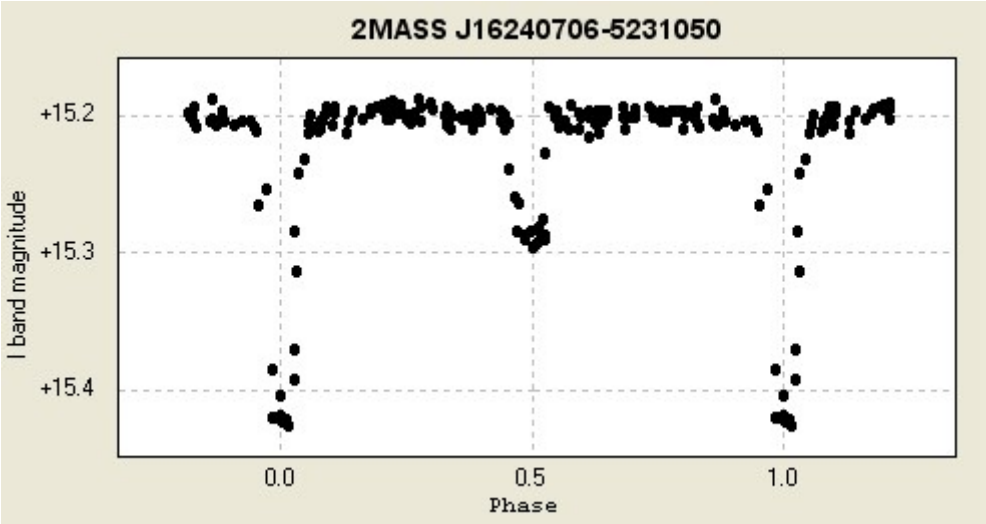

Figure 28 – Star #28 (2MASS J16240706-5231050)

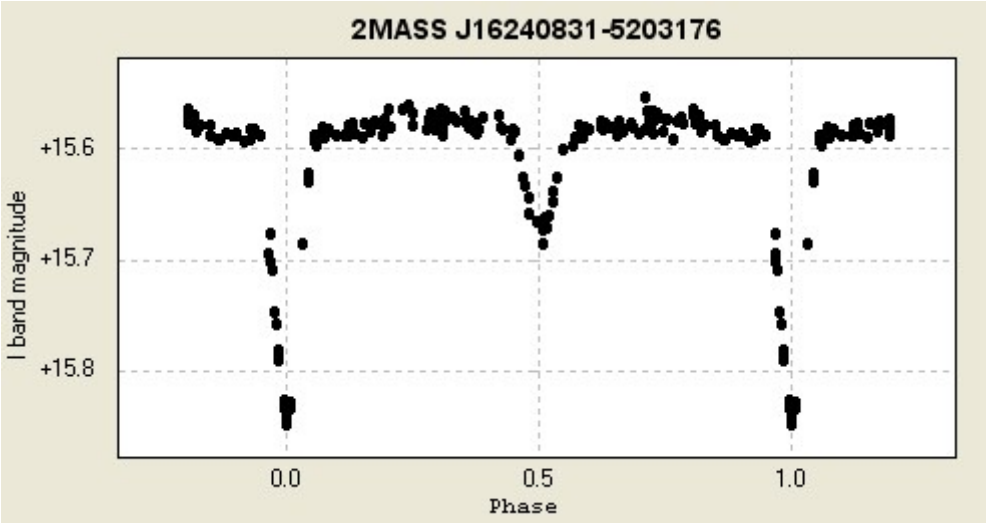

Figure 29 – Star #29 (2MASS J16240831-5203176)

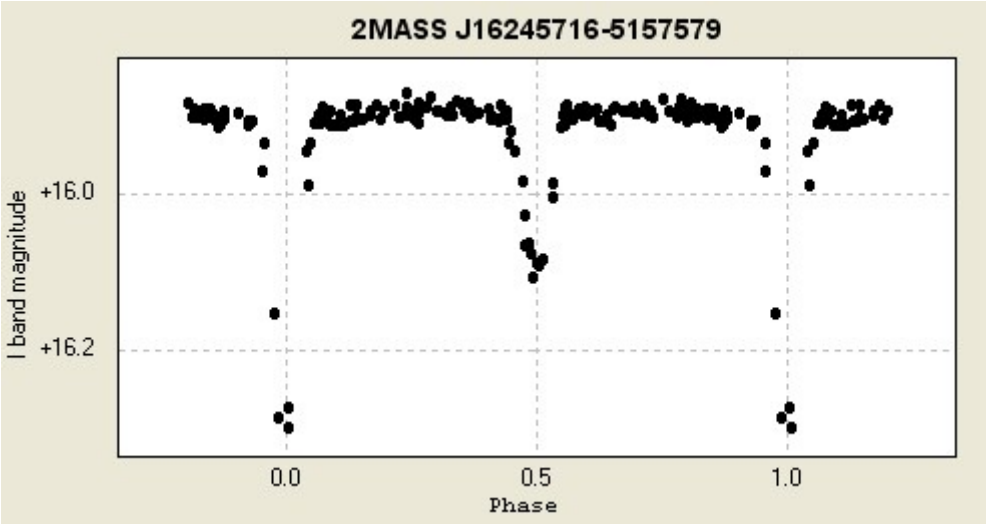

Figure 30 – Star #30 (2MASS J16245716-5157579)

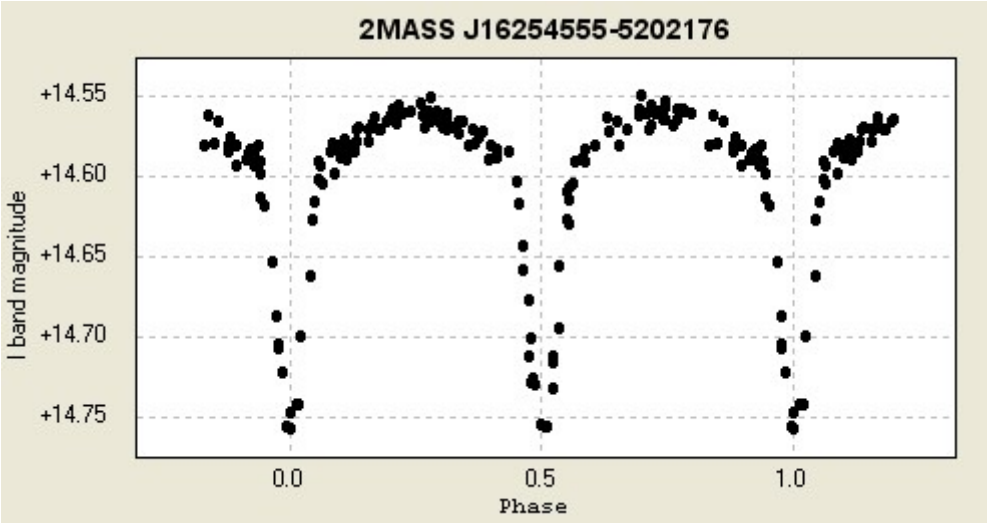

Figure 31 – Star #31 (2MASS J16254555-5202176)

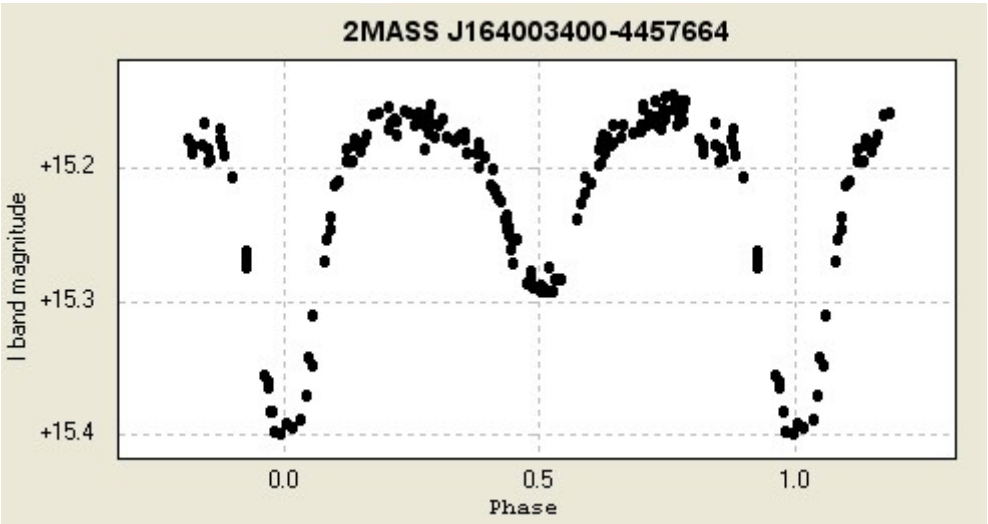

Figure 32 – Star #32 (2MASS J16403400-4457564)

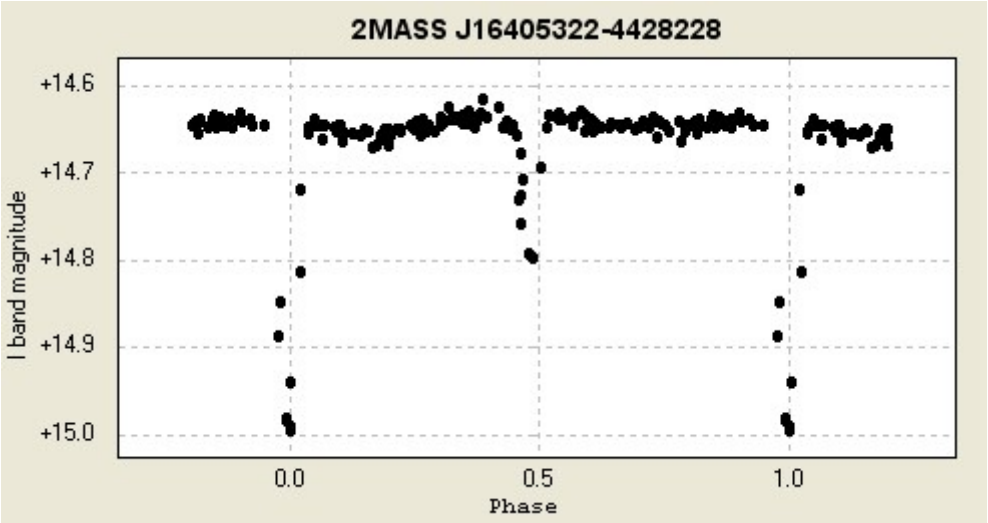

Figure 33 – Star #33 (2MASS J16405322-4428228)

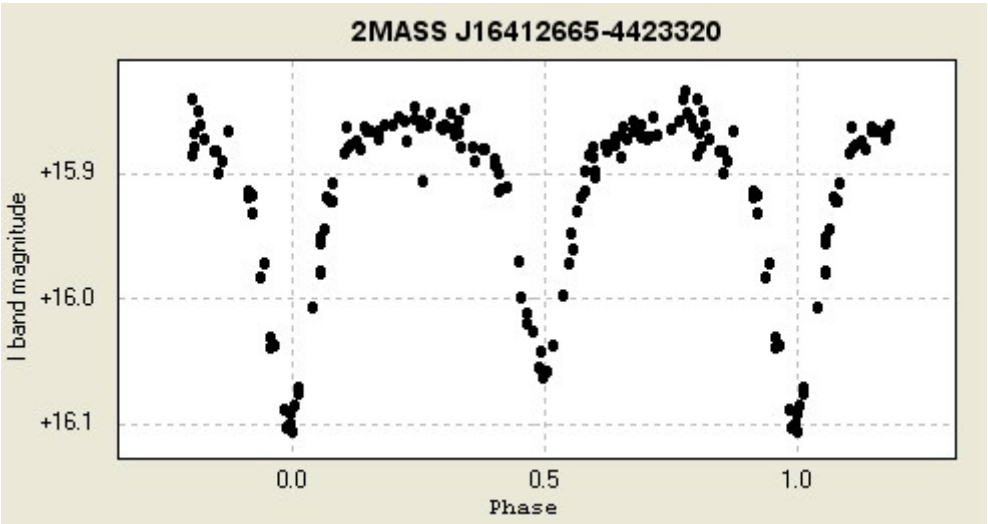

Figure 34 – Star #34 (2MASS J16412665-4423320)

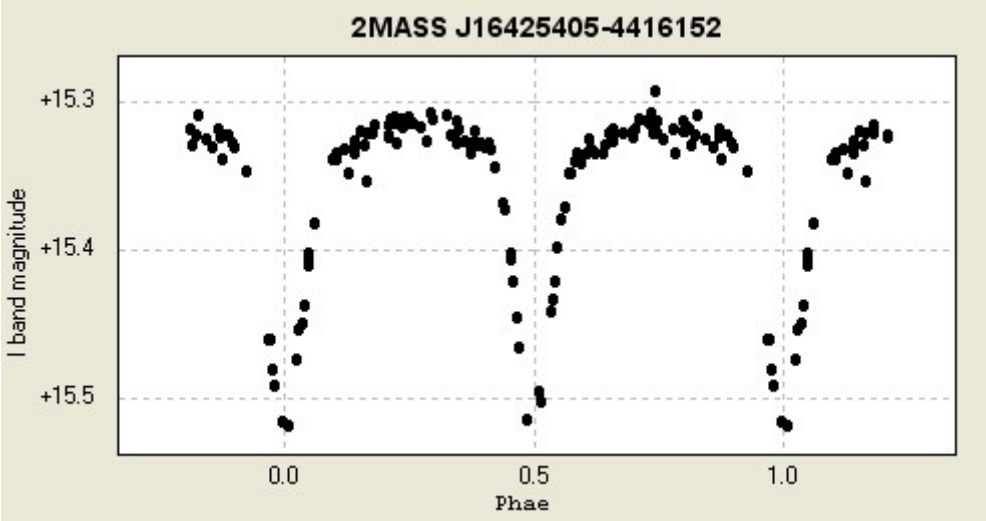

Figure 35 – Star #35 (2MASS J16425405-4416152)

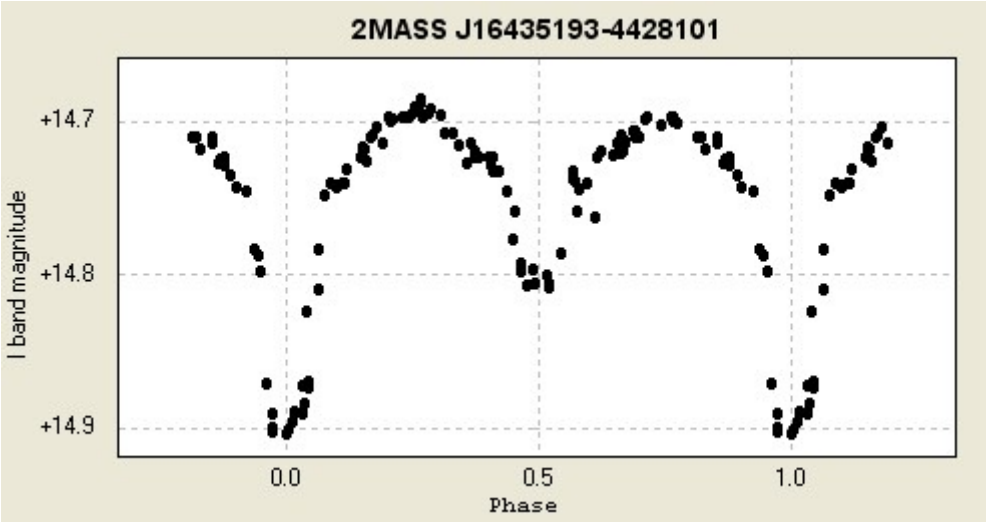

Figure 36 – Star #36 (2MASS J16435193-4428101)

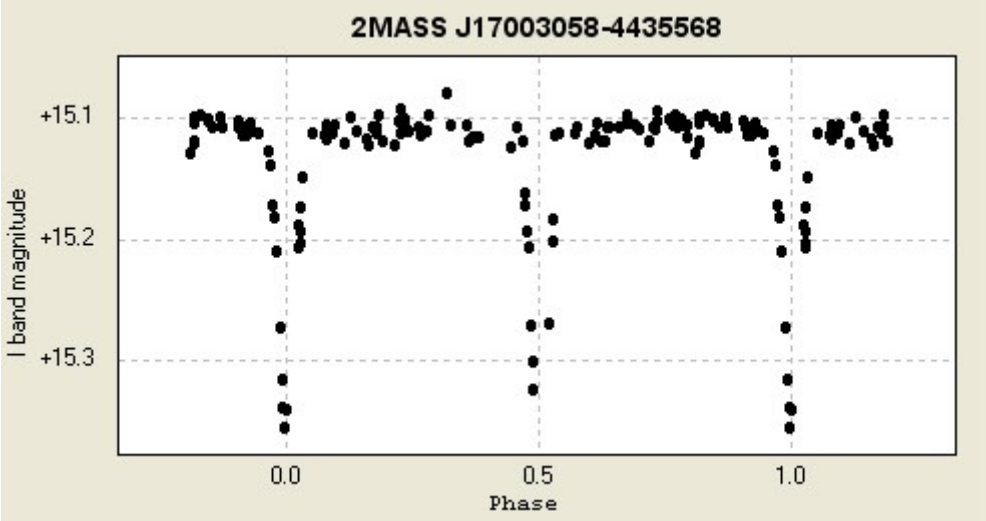

Figure 37 – Star #37 (2MASS J17003058-4435568)

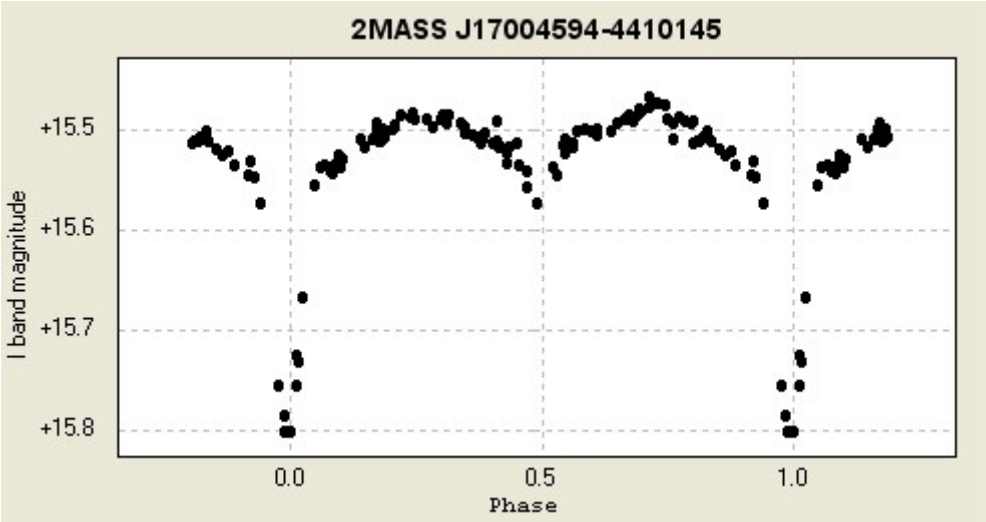

Figure 38 – Star #38 (2MASS J17004594-4410145)

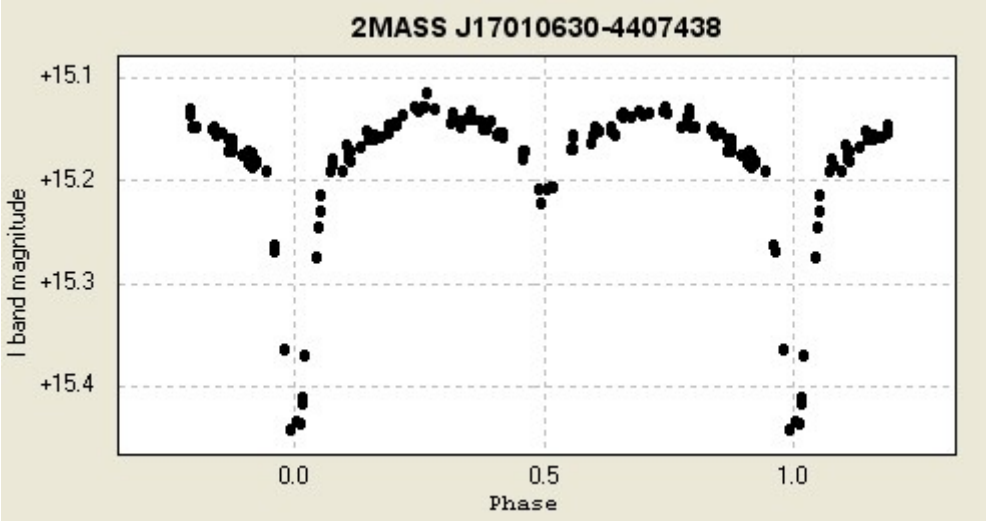

Figure 39 – Star #39 (2MASS J17010630-4407438)

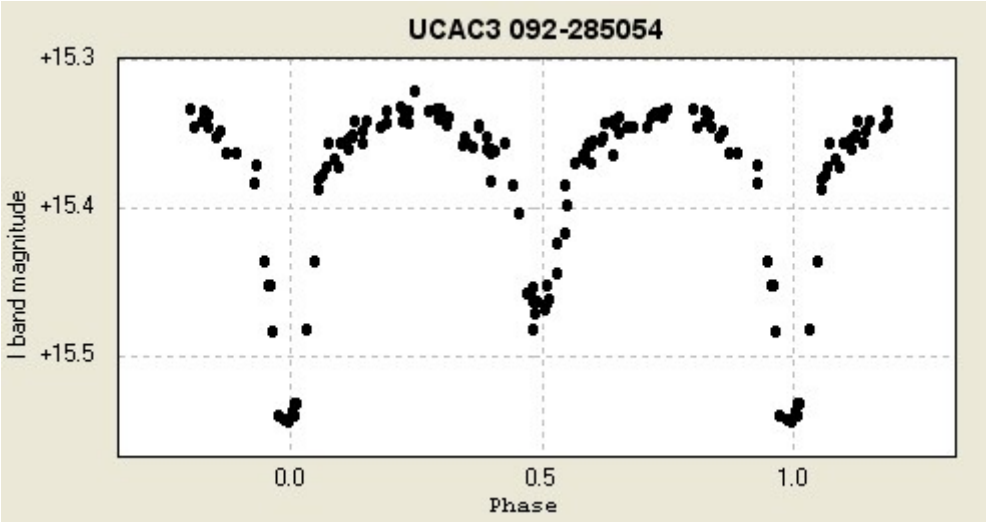

Figure 40 – Star #40 (UCAC3 092-285054)