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Chromospherically active stars in the ROTSE-1 database: Paper 6. Variables 126 - 149

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Abstract: Another 24 new chromospherically active stars are presented, which were found in the ROTSE-1 database:
GSC 02268-00394, GSC 01224-00894, GSC 00648-00579, GSC 02865-01987, GSC 01851-01202, GSC 00124-00551, GSC 00150-01109, GSC 01339-00572, GSC 02968-01511, GSC 03005-00885, GSC 01083-00698, GSC 03941-00354, GSC 04450-00134, GSC 05163-01764, GSC 01095-00848, GSC 04459-00659, USNO A2.0 1275-14029063, GSC 04247-00903, GSC 01656-01276, GSC 02197-01430, GSC 02227-01294, GSC 04480-00965, GSC 01159-00245, GSC 02237-01574.
For one of these stars (GSC 00124-00551), further observations were made using a TeleView 509/5.0 telescope with a CCD camera SIGMA1603 and IR-cutting filter in Velden, Germany.

During a programme of optical identification of X-ray sources from the ROSAT All-Sky Bright Source Catalogue (Voges et al., 1999) and from the ROSAT All-Sky Survey Faint Source Catalog (Voges et al., 2000) in the ROTSE1 database (http://skydot.lanl.gov/ , Wozniak et al., 2004) another 24 new chromospherically active stars have been found. For further details of the programme see Bernhard et al. (2010).

The criteria for including a star in this list of chromospherically active stars after an analysis of the available data with Period 04 (Lenz and Breger, 2005) were:

i) the X-ray identification: Only those variable NSVS objects were chosen, which were within the error ellipse of the ROSAT All-Sky Bright Source Catalogue or of the ROSAT All-Sky Faint Source Catalogue. Therefore it is very likely that the X-ray identifications of the variables stars given in this paper are correct and types of variables like Cepheids or semiregular variables can be ruled out because of their low X-ray emission (see the more detailed discussion in Bernhard and Lloyd, 2008).

ii) an investigation of the respectively star fields with ALADIN (http://aladin.u-strasbg.fr/aladin.gml) to check, if there are nearby open star clusters or known young stellar objects to rule out young stellar objects (T Tauri stars), which usually can be found in associations.

iii) period, amplitude and shape of the light curve are consistent with the definition of RS CVn and BY Dra stars in the GCVS (http://www.sai.msu.su/groups/cluster/gcvs/gcvs/iii/vartype.txt), for a detailed description and sample light curves of the various types of chromospherically active stars see Berdyugina (2005). Due to the shapes of the light curves other types of chromospherically active and X-ray emitting objects like W UMa variables and Algol stars can be ruled out.

iv) appropriate 2MASS J-K (Skrutskie et al. 2006, Table 8 in Gonzalez-Solares et al., 2008) and B-V (Høg et al., 2000) colour indices if available.

Further information like the ratios of X-ray to optical flux f_X / f_opt (Voges et al., 1999), proper motions and the relation of the maximum amplitude vs. periods of main sequence stars given in Messina et al., 2003 were also used to guide the classification of these objects.

The resulting list of variables contains with a very high likelihood chromospherically active stars of the types RS CVn or BY Dra, which have spectral types of F-K (these are mostly RS CVn systems, and a small number of FK Comae stars) and K-M (BY Dra variables).

The light variability of RS CVn and BY Dra variables is caused by axial rotation of a star with a variable degree of non-uniformity of the surface brightness (spots). Some of these variables may also be eclipsing systems. Secular variations of the light curves, which are typical for many RS CVn and BY Dra variables (see the detailed light curves below) can be explained by the existence of a long-period stellar activity cycle similar to the 11-year solar activity cycle, during which the number and total area of spots on the star's surface vary.

The ROTSE-I telescope was operated without any filters so the quantum efficiency of the used CCD camera AP-10 camera makes the effective band most comparable to the Johnson R band (range in Table 1). The ranges are derived from the time span of the NSVS observations, due to secular variations (activity cycles) the full ranges could be somewhat larger. The values of the column "var" denote the extent of secular variations: "0" for no secular variation, "1" for weak secular variation, "2" for strong secular variation of amplitude and/or mean magnitude. The epochs are given for the minima as HJD-2450000, ASAS-3 V-data (http://www.astrouw.edu.pl/asas/?page=main) are used for the period analysis and the following figures when available (Pojmanski, 2002). Figures in brackets denote errors (sigma) in units of the last decimal.

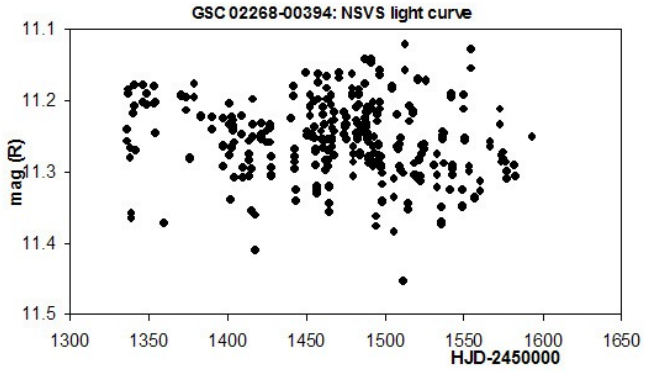
Table 1: Positions, identifications and photometric data for the new chromospherically active stars

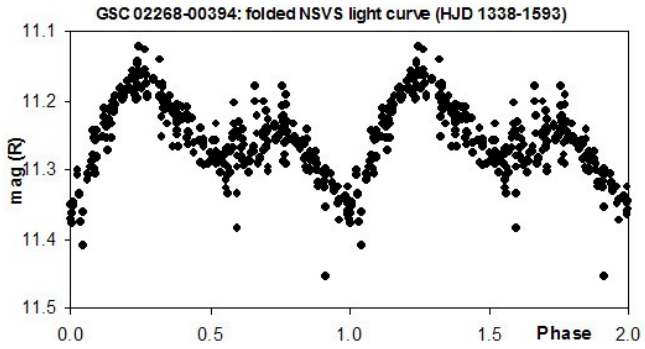
No.	GSC	RA (2000)	Dec	1RXS	Range(NSVS)	Epoch(Min)	Per.(d)	var	NSVS ID
126	02268-00394	00 17 00.97	+33 57 23.2	J001658.9+335733	11.15-11.35	1338.90(2)	2.6227(4)	0	6328138
127	01224-00894	02 55 21.05	+15 39 23.2	J025521.3+153951	11.00-11.30	1466.6(4)	33.998(4)	1	9285542
128	00648-00579	03 08 25.98	+08 05 02.9	J030825.5+080528	13.10-13.45	1491.69(6)	6.647(3)	1	9310420
129	02865-01987	03 20 43.89	+39 23 48.8	J032043.5+392348	11.80-12.00	1515.6(1)	12.28(2)	0	4154174
130	01851-01202	05 20 59.63	+24 46 05.2	J052059.3+244603	12.20-12.45	1554.68(4)	4.4028(4)	1	6912950
131	00124-00551	05 45 17.70	+05 33 18.3	J054517.9+053348	12.00-12.25	1519.721(5)	0.55208(3)	2	12360584
132	00150-01109	06 31 02.15	+03 27 29.8	J063102.8+032726	11.35-11.50	1496.9(1)	18.29(5)	1	12493507
133	01339-00572	06 49 05.07	+19 59 53.4	J064907.0+195957	11.40-11.60	3295.8(1)	12.069(5)	2	9804990
134	02968-01511	07 58 45.24	+42 11 20.8	J075846.1+421151	12.20-12.45	1602.65(6)	6.110(2)	1	4730111
135	03005-00885	10 34 17.94	+41 01 04.6	J103419.7+410120	12.20-12.55	1295.68(6)	6.370(1)	0	4914505
136	01083-00698	19 57 53.02	+14 20 18.2	J195753.8+142034	10.95-11.15	3504.8(2)	27.573(5)	2	11335584
137	03941-00354	20 15 16.63	+56 10 05.6	J201518.9+560922	11.50-11.80	1353.777(4)	0.39675(1)	1	3224112
138	04450-00134	20 16 08.54	+70 53 56.3	J201609.9+705406	11.45-11.70	1404.6(1)	11.236(8)	1	1328748
139	05163-01764	20 23 35.17	-01 45 04.3	J202333.7-014502	10.75-10.90	2441.7(2)	26.08(8)	2	14210197
140	01095-00848	20 28 23.92	+11 31 11.0	J202823.9+113115	09.80-10.05	2784.834(5)	0.51034(7)	2	11384300
141	04459-00659	20 29 39.37	+73 54 34.4	J202935.2+735425	10.45-10.75	1413.66(3)	3.5722(3)	0	1337434
142	----------	20 38 06.23	+39 46 00.5	J203806.8+394554	12.45-12.70	1340.7(1)	19.59(5)	1	5747643
143	04247-00903	20 57 30.15	+60 03 08.9	J205731.0+600316	10.95-11.15	1509.61(8)	8.24(1)	1	3308712
144	01656-01276	21 03 23.26	+19 30 55.8	J210324.7+193026	11.05-11.25	1397.7(1)	10.377(7)	1	11598855
145	02197-01430	21 41 16.75	+26 58 58.1	J214116.5+265900	09.20-09.40	4371.5(3)	36.8(2)	2	8776790
146	02227-01294	22 34 34.25	+27 07 46.0	J223432.2+270745	12.00-12.25	1353.7(1)	13.48(1)	1	8945309
147	04480-00965	22 36 15.95	+70 32 04.2	J223613.9+703206	10.40-10.65	1401.9(1)	15.38(1)	1	159689
148	01159-00245	22 50 24.02	+14 31 42.8	J225024.9+143141	10.25-10.55	4296.8(1)	18.11(1)	2	11826310
149	02237-01574	23 21 53.08	+23 16 56.3	J232153.8+231703	10.75-10.90	2871.7(2)	19.09(1)	2	8989195

Light curves, folded light curves (with the period given above) and comments:

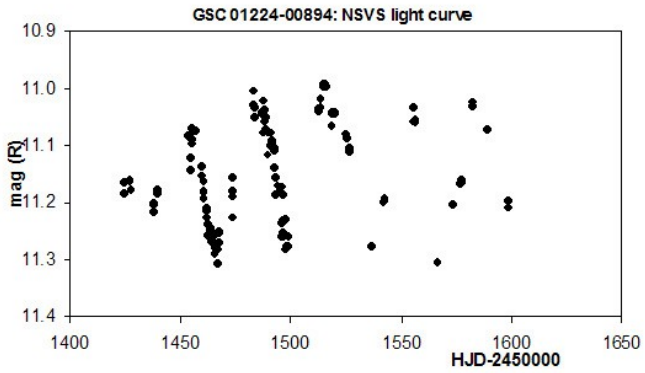
Some of the following stars showed a clear variation of the shape of the light curves.
Therefore the folded light curves are given for a distinct time period of time (described in figure as HJD 245 ....-....).

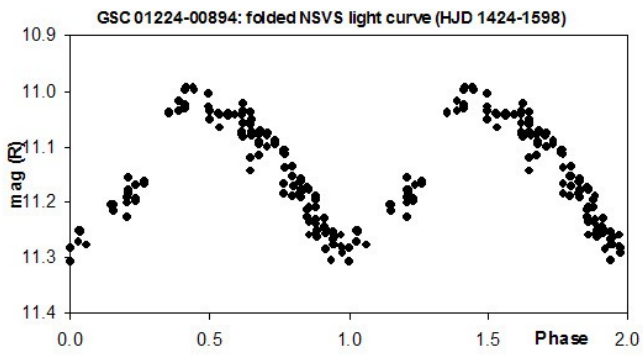
No. 126: GSC 02268-00394
Period: 2.6227(4) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=6328138&mask=32004
2MASS J-K: 0.748
Johnson B-V=1.160 (derived from Tycho-2)
Proper motion: pmRA: -20.14 mas/yr, pmDE: -14.30 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2=0.46
Likely RS CVn variable



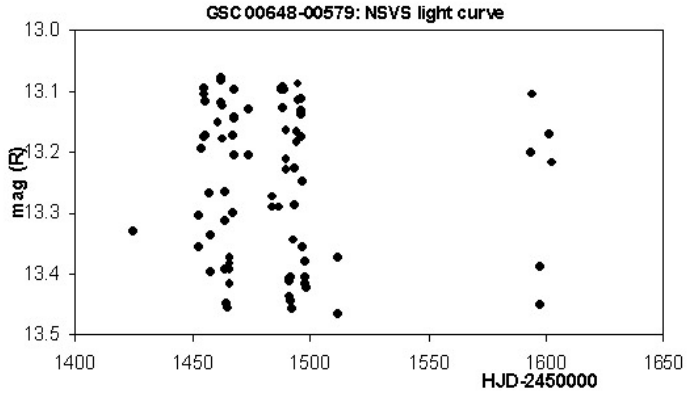


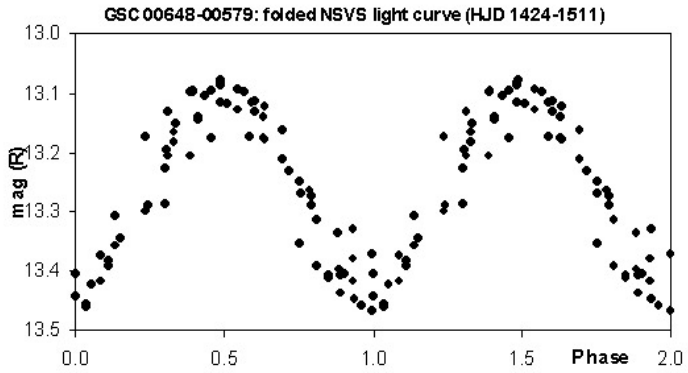
No. 127: GSC 01224-00894
Period: 33.998(4) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=9285542&mask=32004
2MASS J-K: 0.843
Johnson B-V=1.004 (derived from Tycho-2)
Proper motion: pmRA: 6.28 mas/yr, pmDE: -5.62 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.88, HR2=0.41
Known variable: type EA (Pojmanski, 2002)
Likely RS CVn variable



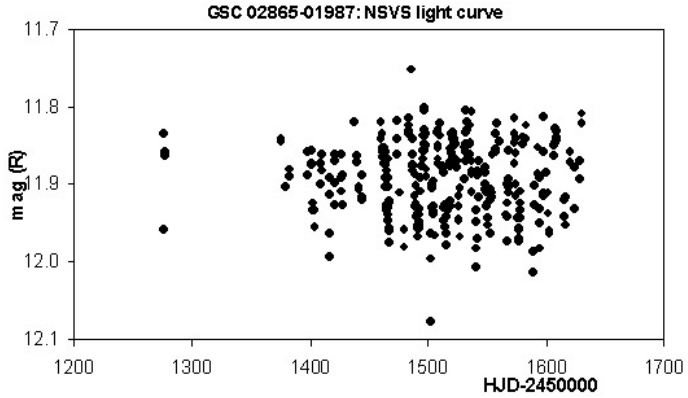


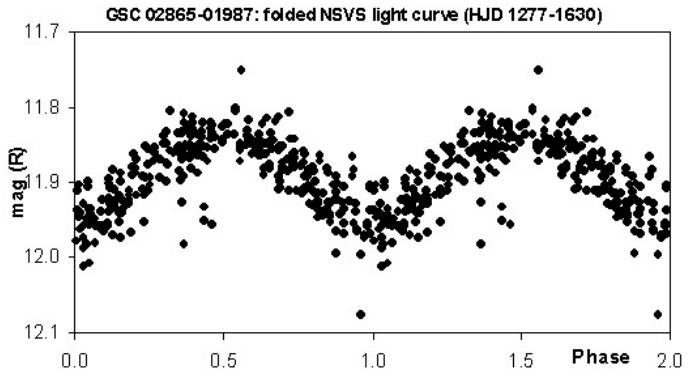
No. 128: GSC 00648-00579
Period: 6.647(3) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=9310420&mask=32004
2MASS J-K: 0.884
Proper motion: pmRA: -16.25 mas/yr, pmDE: -11.80 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2=1.00
Known variable: type Cep (http://hal.physast.uga.edu/~jss/nsvs/)
Probably a BY Dra variable



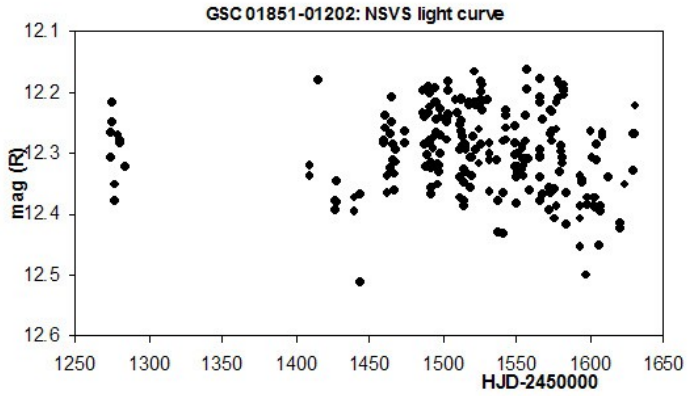


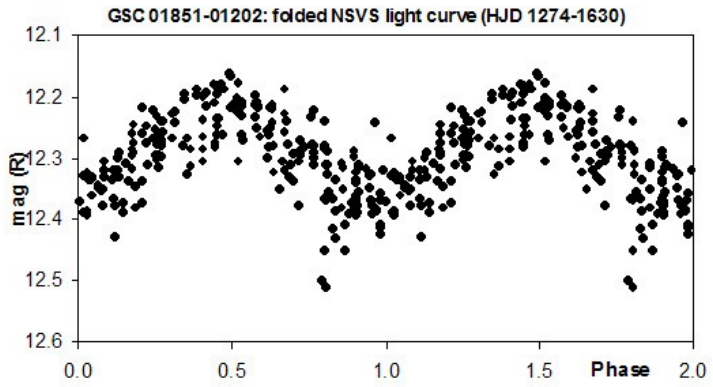
No. 129: GSC 02865-01987
Period: 12.28(2) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=4154174&mask=32004
2MASS J-K: 0.790
Proper motion: pmRA: 1.66 mas/yr, pmDE: -9.45 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2= 0.92
Likely RS CVn variable



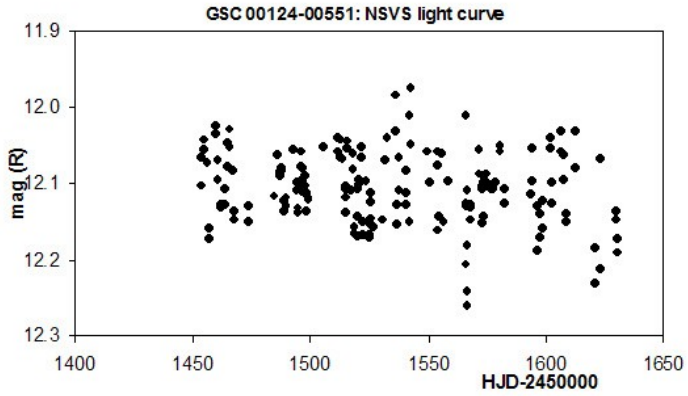


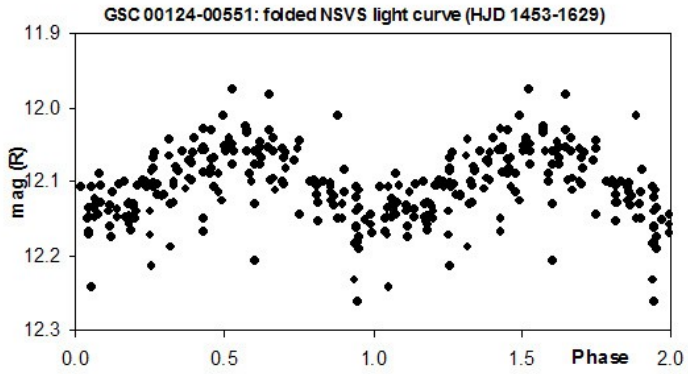
No. 130: GSC 01851-01202
Period: 4.4028(4) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=6912950&mask=32004
2MASS J-K: 0.880
Proper motion: pmRA:1.14 mas/yr, pmDE: -12.72 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 1.00, HR2=0.88
Probably a BY Dra variable



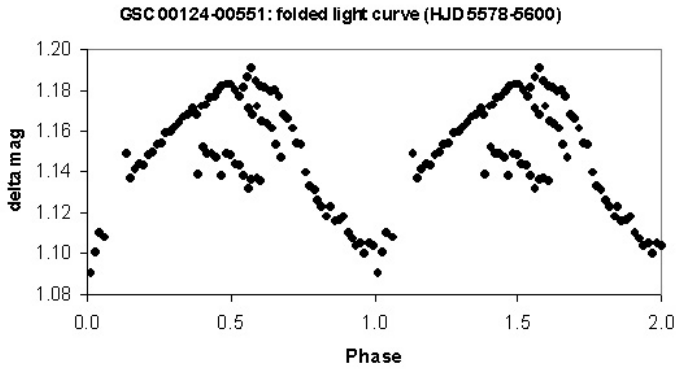


No. 131: GSC 00124-00551
Period: 0.55208(3) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=12360584&mask=32004
2MASS J-K: 0.541
Proper motion: pmRA: -5.95 mas/yr, pmDE: -1.96 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2=0.91
Likely RS CVn variable



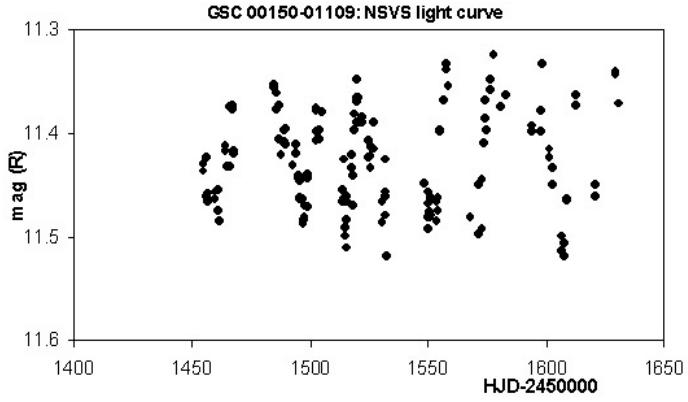


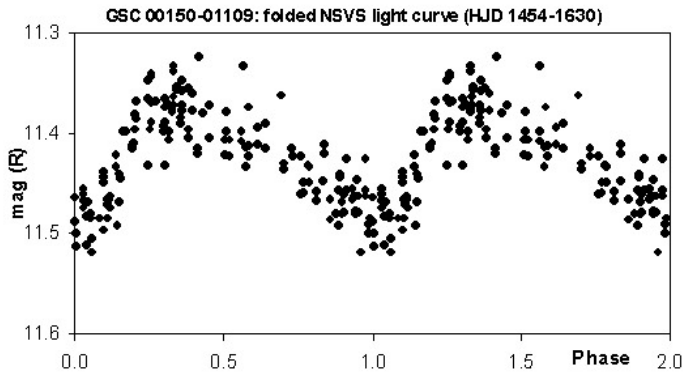
Because of the large scatter of the NSVS data own observations (P.F.) were made in three nights between JD 2455578 and 2455600 to study the variation of the variable more in detail. Therefore a TeleView 509/5.0 telescope with a CCD-camera SIGMA1603 was used in combination with a IR cutting filter. The comparison star was GSC 124 583, the check star was GSC 124 1171.



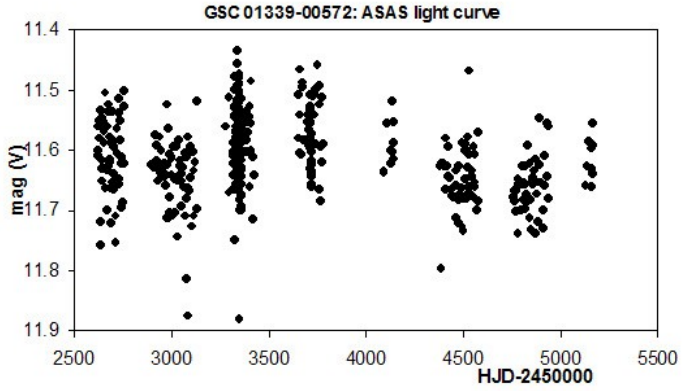
These observations confirmed the ephemeris derived from the NSVS data and showed, that a large part of the scatter of the folded NSVS light curve is likely due to secular variations of the light curve.

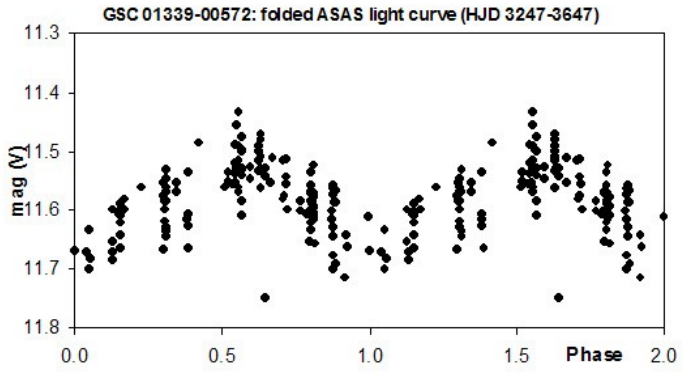
No. 132: GSC 00150-01109
Period: 18.29(5) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=12493507&mask=32004
2MASS J-K: 0.752
Johnson B-V=0.968 (derived from Tycho-2)
Proper motion: pmRA: -1.42 mas/yr, pmDE: -14.70 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2= -0.70
Known variable: type L (Benko and Csubry, 2007)
Likely RS CVn variable



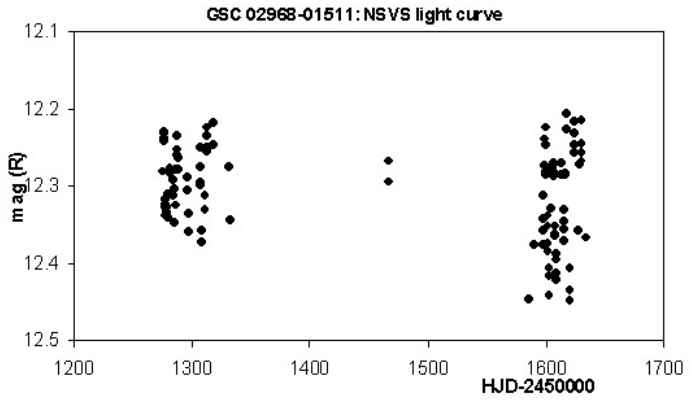


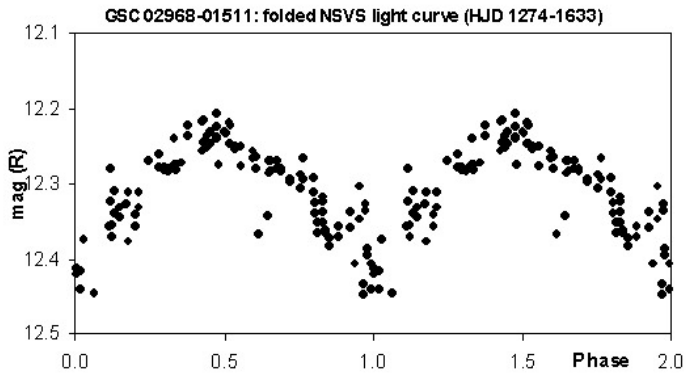
No. 133: GSC 01339-00572
Period: 12.069(5) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=9804990&mask=32004
2MASS J-K: 0.719
Johnson B-V=0.986 (derived from Tycho-2)
Proper motion: pmRA: -5.22 mas/yr, pmDE: -7.77 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.58, HR2=-0.24
Likely RS CVn variable



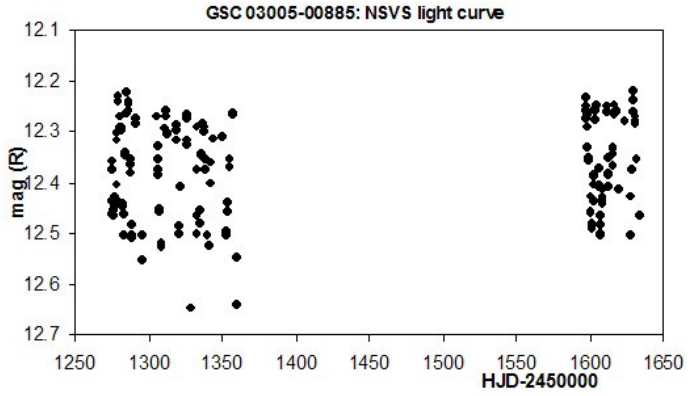


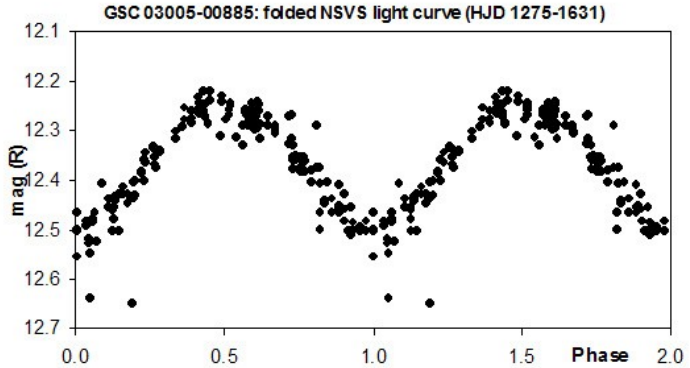
No. 134: GSC 02968-01511
Period: 6.110(2) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=4730111&mask=32004
2MASS J-K: 0.649
Proper motion: pmRA: 5.44 mas/yr, pmDE: -5.69 mas/yr (Roeser et al., 2008)
Likely RS CVn variable



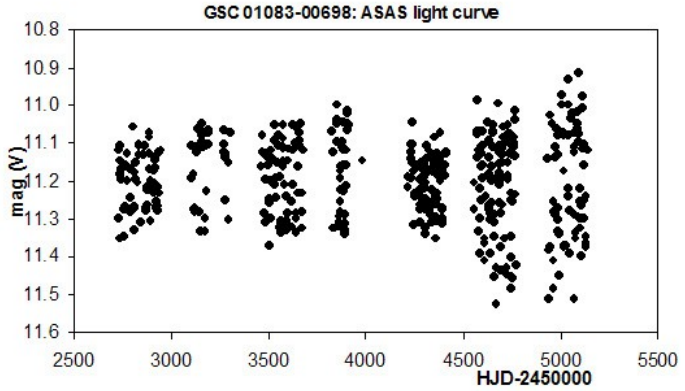


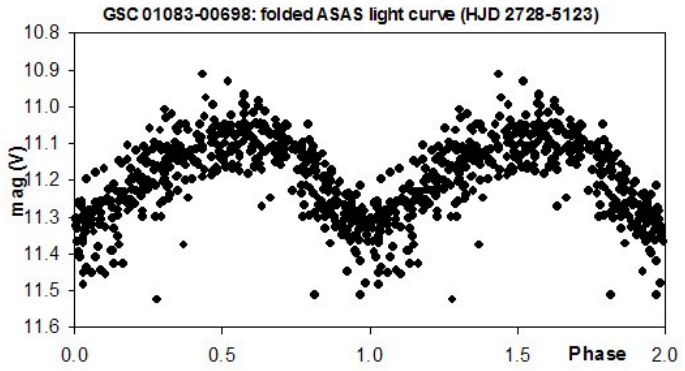
No. 135: GSC 03005-00885
Period: 6.370(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=4914505&mask=32004
2MASS J-K: 0.680
Proper motion: pmRA: -0.42 mas/yr, pmDE: -8.17 mas/yr (Roeser et al., 2008)
ROSAT: HR1= -0.02, HR2= -0.18,
Known variable: type EB (http://hal.physast.uga.edu/~jss/nsvs/)
Likely RS CVn variable



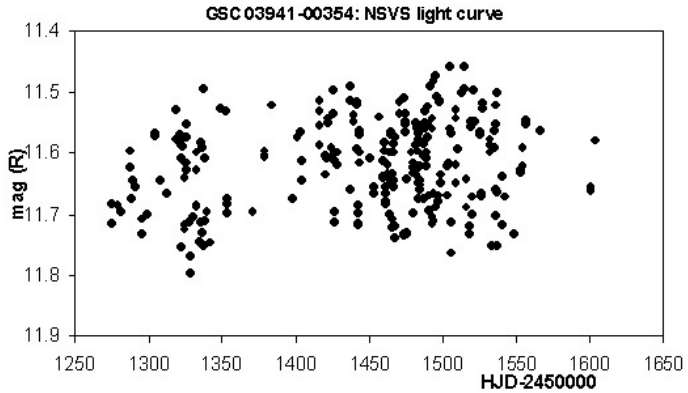


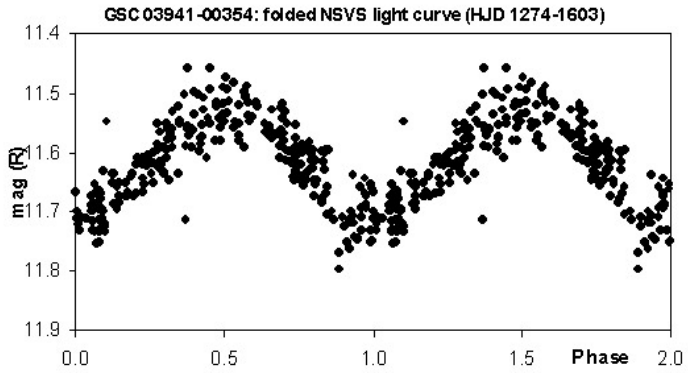
No. 136: GSC 01083-00698
Period: 27.573(5) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=11335584&mask=32004
2MASS J-K: 0.749
Johnson B-V=1.155 (derived from Tycho-2)
Proper motion: pmRA: 9.95 mas/yr, pmDE: -17.14 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.61, HR2=0.31, fxfopt=-2.51
Likely RS CVn variable



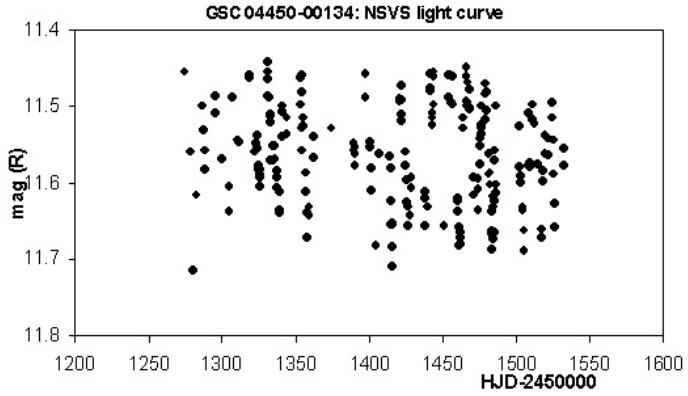


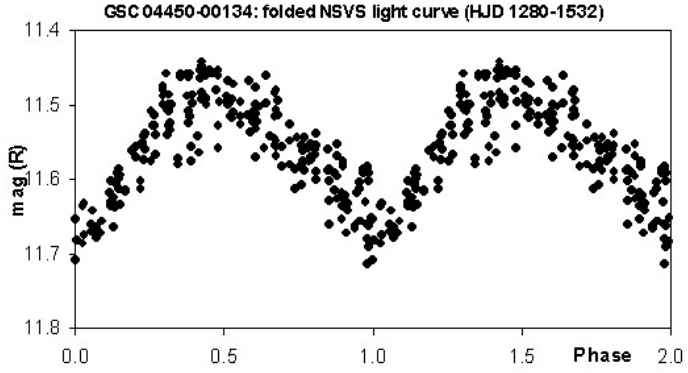
No. 137: GSC 03941-00354
Period: 0.39675(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=3224112&mask=32004
2MASS J-K: 0.192
Johnson B-V=0.365 (derived from Tycho-2)
Proper motion: pmRA : -2.58 mas/yr, pmDE: -7.04 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.92, HR2= 0.66, fxfopt=-2.18
Known variable: type RR (http://hal.physast.uga.edu/~jss/nsvs/)
Likely RS CVn variable



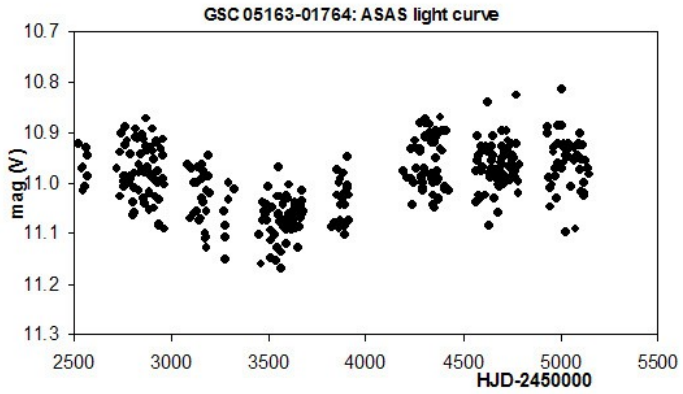


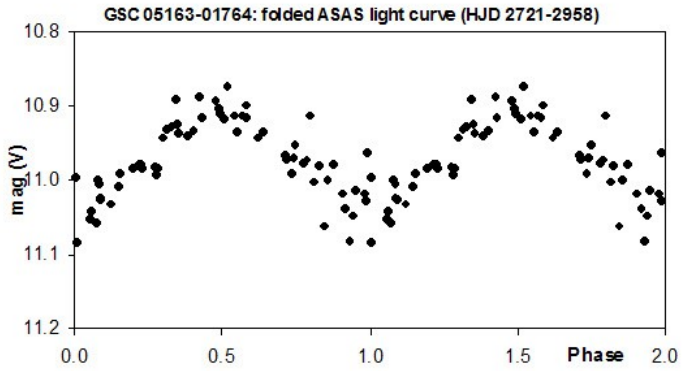
No. 138: GSC 04450-00134
Period: 11.236(8) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=1328748&mask=32004
2MASS J-K: 0.866
Proper motion: pmRA: 5.01 mas/yr, pmDE: 1.41 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.99, HR2=0.18, fxfopt=-2.12
Probably a BY Dra variable



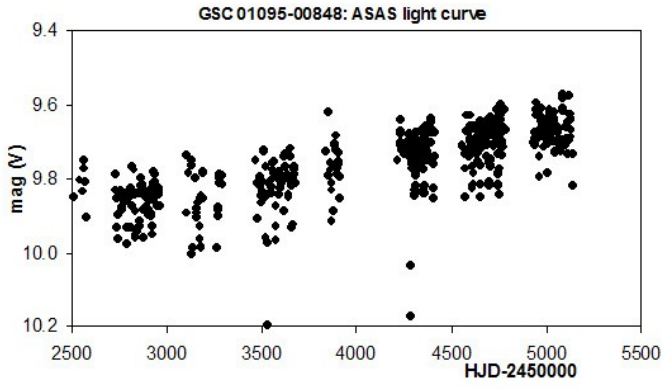


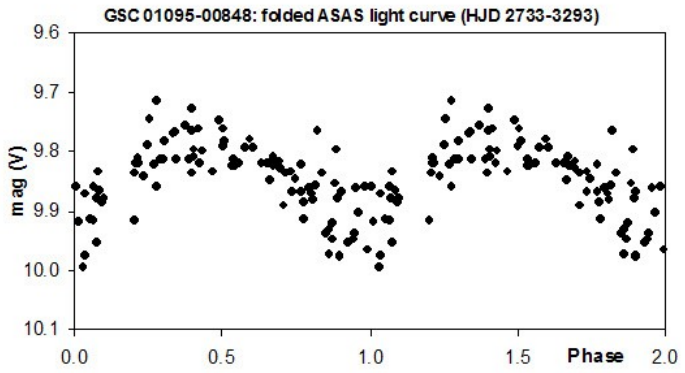
No. 139: GSC 05163-01764
Period: 26.08(8) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=14210197&mask=32004
2MASS J-K: 0.712
Johnson B-V=1.327 (derived from Tycho-2)
Proper motion: pmRA: -20.57 mas/yr, pmDE: -23.19 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.32, HR2=0.40
Known variable: type Misc (Pojmanski, 2002)
Likely RS CVn variable



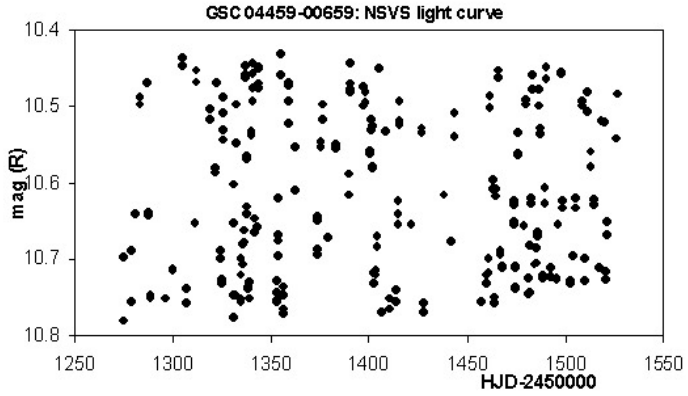


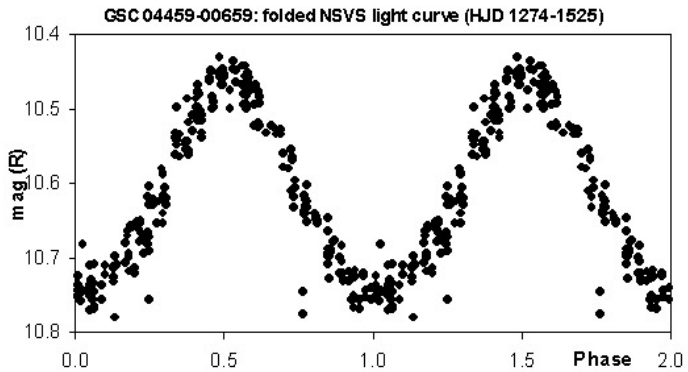
No. 140: GSC 01095-00848
Period: 0.51034(7) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=11384300&mask=32004
2MASS J-K: 0.474
Johnson B-V=0.586 (derived from Tycho-2)
Proper motion: pmRA: 5.85 mas/yr, pmDE: -32.74 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.39, HR2=0.29, fxfopt=-2.74
Known variable: type ESD/EC (Pojmanski, 2002)
Likely RS CVn variable



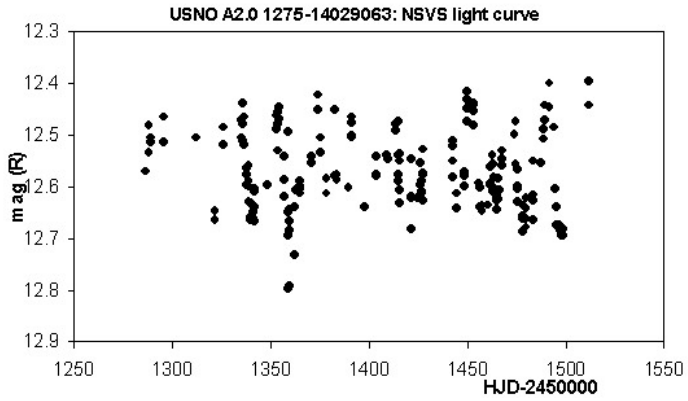


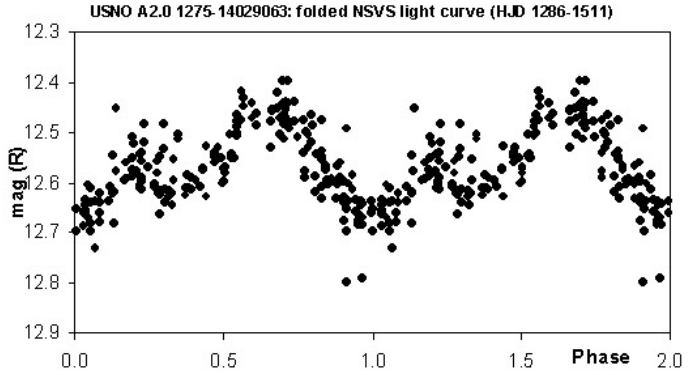
No. 141: GSC 04459-00659
Period: 3.5722(3) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=1337434&mask=32004
2MASS J-K: 0.747
Johnson B-V=1.031 (derived from Tycho-2)
Proper motion: pmRA: 43.87 mas/yr, pmDE: -17.69 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.15, HR2= 0.13, fxfopt=-2.12
Known variable: type Cep (http://hal.physast.uga.edu/~jss/nsvs/)
Likely RS CVn variable



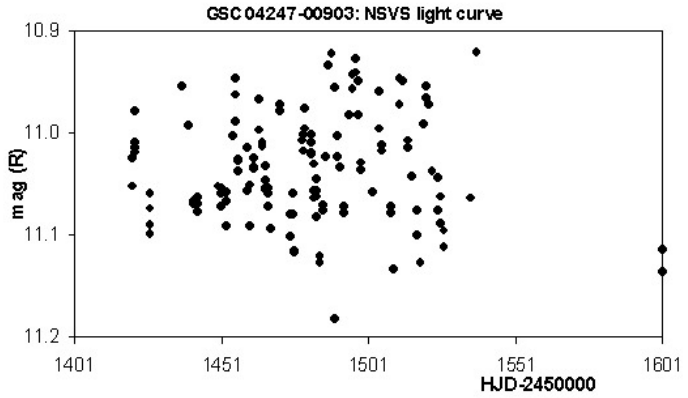


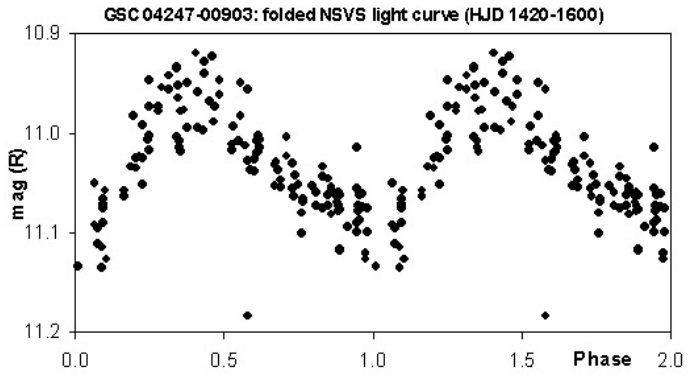
No. 142: USNO A2.0 1275-14029063
Period: 19.59(5) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=5747643&mask=32004
2MASS J-K: 0.691
ROSAT: HR1=0.75, HR2= 0.01
Likely RS CVn variable



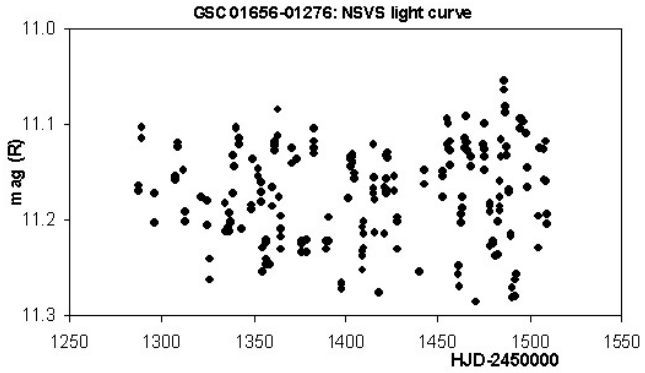


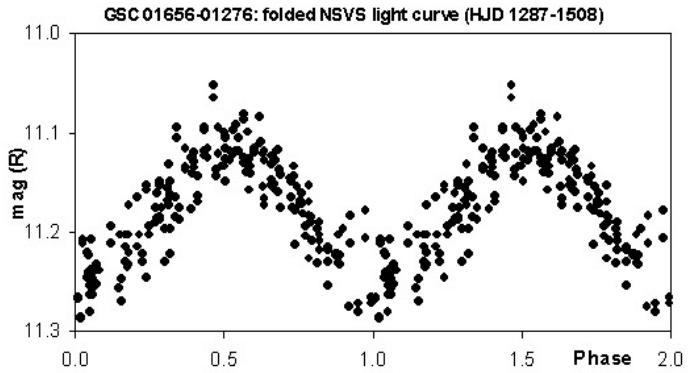
No. 143: GSC 04247-00903
Period: 8.24(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=3308712&mask=32004
2MASS J-K: 0.652
Johnson B-V=0.972 (derived from Tycho-2)
Proper motion: pmRA: 21.29 mas/yr, pmDE: 1.12 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.71, HR2= 0.00, fxfopt=-2.58
Likely RS CVn variable



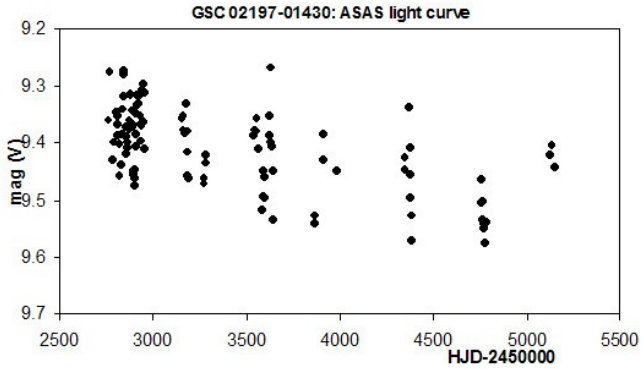


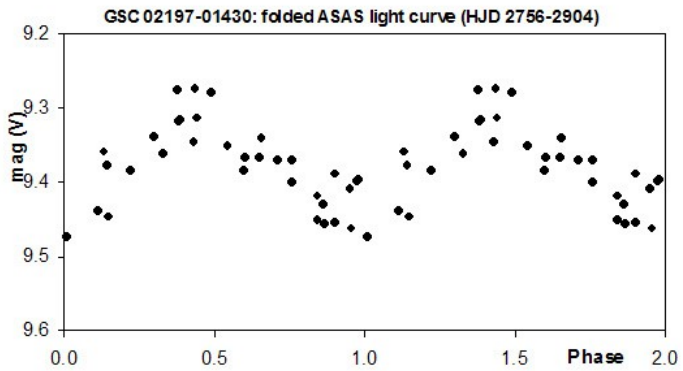
No. 144: GSC 01656-01276
Period: 10.377(7) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=11598855&mask=32004
2MASS J-K: 0.771
Johnson B-V=0.781 (derived from Tycho-2)
Proper motion: pmRA: 12.05 mas/yr, pmDE: -14.26 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.62, HR2=0.48, fxfopt=-2.40
Known variable: type DCEP-FU (Pojmanski, 2002)
Likely RS CVn variable



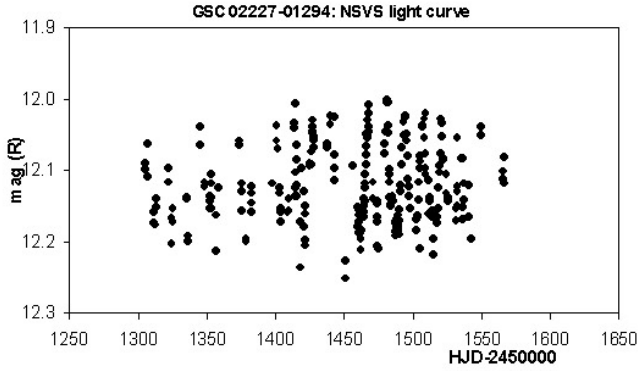


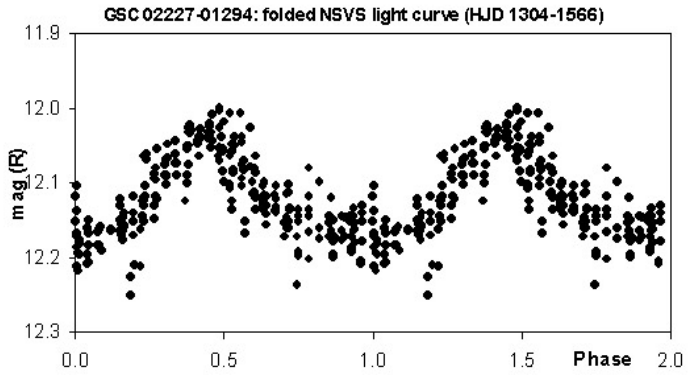
No. 145: GSC 02197-01430
Period: 36.8(2) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=8776790&mask=32004
2MASS J-K: 0.683
Johnson B-V=1.041 (derived from Tycho-2)
Proper motion: pmRA: 2.91 mas/yr, pmDE: 0.14 mas/yr (Roeser et al., 2008)
ROSAT: HR1=0.88, HR2=0.29, fxfopt=-2.90
Known variable: type Misc (Pojmanski, 2002)
Likely RS CVn variable



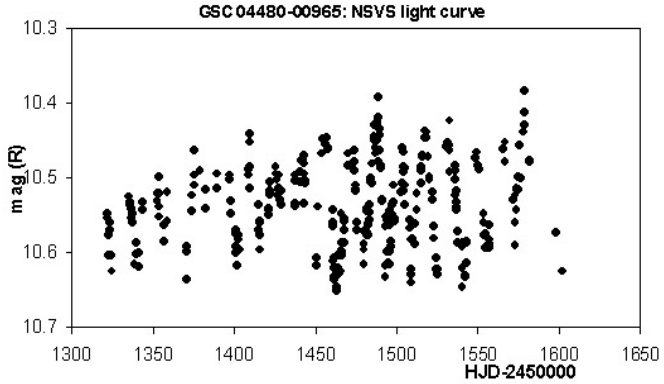


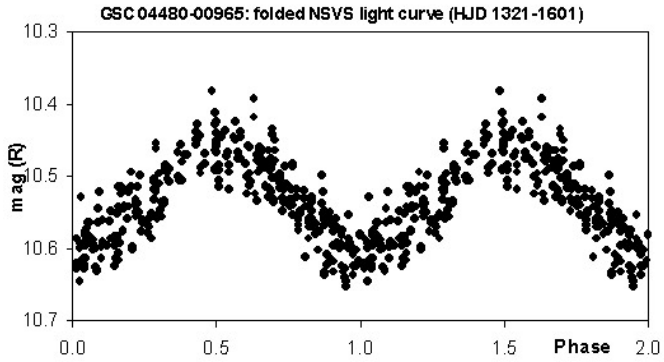
No. 146: GSC 02227-01294
Period: 13.48(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=8945309&mask=32004
2MASS J-K: 0.644
Johnson B-V=0.538 (derived from Tycho-2)
Proper motion: pmRA: -9.80 mas/yr, pmDE: -0.73 mas/yr (Roeser et al., 2008)
ROSAT: HR1=1.00, HR2=1.00
Likely RS CVn variable



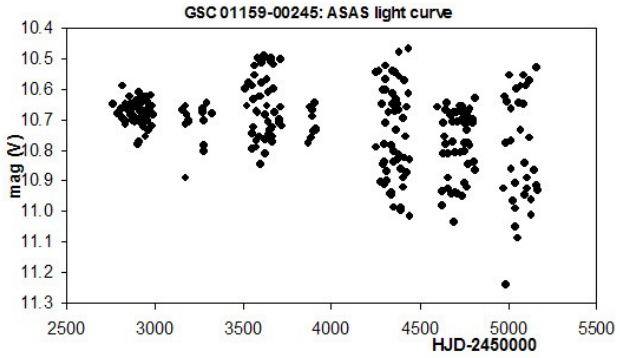


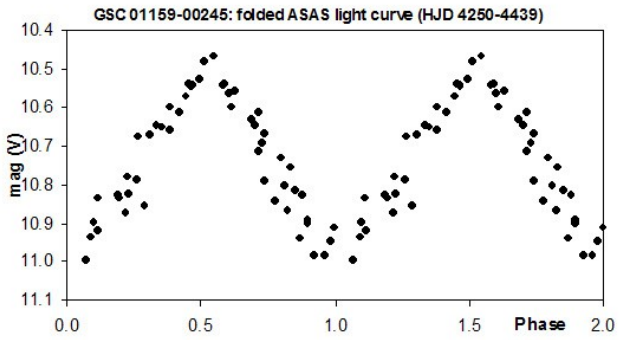
No. 147: GSC 04480-00965
Period: 15.38(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=159689&mask=32004
2MASS J-K: 0.722
Johnson B-V=0.932 (derived from Tycho-2)
Proper motion: pmRA: 21.52 mas/yr, pmDE: 23.35 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.70, HR2=0.11, fxfopt=-2.40
Likely RS CVn variable



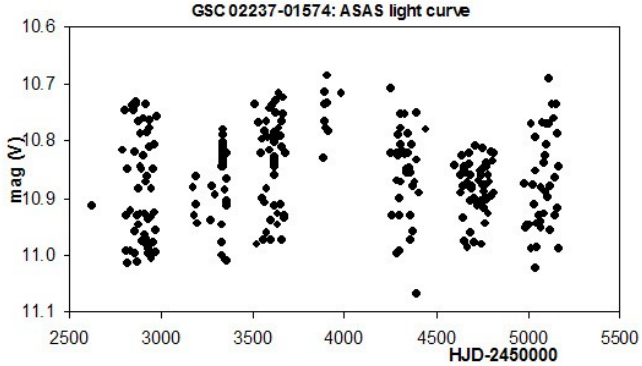


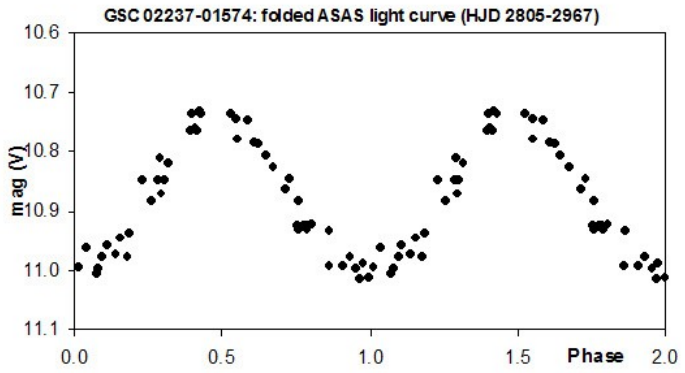
No. 148: GSC 01159-00245
Period: 18.11(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=11826310&mask=32004
2MASS J-K: 0.707
Johnson B-V=1.122 (derived from Tycho-2)
Proper motion: pmRA: -12.16 mas/yr, pmDE: -47.92 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.69, HR2= 0.25, fxfopt=-2.46
Spectral type: K1e (Skiff, 2010)
Known variable: type LPV (http://hal.physast.uga.edu/~jss/nsvs/)
Likely RS CVn variable





No. 149: GSC 02237-01574
Period: 19.09(1) d
NSVS data: http://skydot.lanl.gov/nsvs/star.php?num=8989195&mask=32004
2MASS J-K: 0.687
Johnson B-V=0.710 (derived from Tycho-2)
Proper motion: pmRA: 15.54 mas/yr, pmDE: 1.91 mas/yr (Roeser et al., 2008)
ROSAT: HR1= 0.87, HR2= 0.54, fxfopt=-2.73
Spectral type: K5e (Skiff, 2010)
Known variable: type MISC (Pojmanski, 2002)
Likely RS CVn variable





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