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Seven Double-Mode RR Lyrae Variables

S. Huemmerich[#1,2], A. V. Khruslov[#3]

#1. Bundesdeutsche Arbeitsgemeinschaft fuer Veraenderliche Sterne e.V. (BAV), Berlin, Germany;
#2. Braubach, Germany;
#3. Institute of Astronomy, Russian Academy of Sciences, Moscow, Russia.

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(E-mail for contact: ernham@rz-online.de , khruslov@bk.ru)

#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1		GSC 0839-00170	10 43 06.16, +09 03 40.4	RR(B)	13.39	14.07	CV	(see Comments)	(see Comments)	max		Comm. 1	1.PNG	chart1.PNG	CSS_MLS_data_1.txt ASAS 104306+0903.7 NSVS 10303225
2		USNO-A2.0 0900-06813517	10 57 31.42, +04 57 03.7	RR(B)	13.39	14.05	CV	(see Comments)	(see Comments)	max		Comm. 2	2.PNG	chart2.PNG	CSS_MLS_data_2.txt ASAS 105731+0457.0 NSVS 13082928
3		USNO-A2.0 0750-08069398	13 13 42.53, -10 13 55.8	RR(B)	16.42	17.37	CV	(see Comments)	(see Comments)	max		Comm. 3	3.PNG	chart3.PNG	CSS_MLS_data_3.txt
4	V1360 Cen	GSC 7304-00119	14 39 29.75, -33 51 27.2	RR(B)	13.08	13.75	CV	(see Comments)	(see Comments)	max		Comm. 4	4.PNG	chart4.PNG	SSS_data_4.txt 1SWASP_data_4.txt ASAS 143930-3351.4
5		GSC 0925-00503	15 07 40.60, +12 41 42.9	RR(B)	13.26	13.83	CV	(see Comments)	(see Comments)	max		Comm. 5	5.PNG	chart5.PNG	CSS_data_5.txt ASAS 150741+1241.6 NSVS 10564788
6		USNO-A2.0 0675-14795162	15 51 56.61, -18 03 19.2	RR(B)	16.20	17.12	CV	(see Comments)	(see Comments)	max		Comm. 6	6.PNG	chart6.PNG	CSS_MLS_SSS_data_6.txt
7		USNO-A2.0 0975-20240597	21 19 27.06, +11 05 56.7	RR(B)	15.65	16.25	CV	(see Comments)	(see Comments)	max		Comm. 7	7.PNG	chart7.PNG	CSS_data_7.txt

Comments:

1. According to VSX, variability of GSC 0839-00170 was reported in 2013 by Alexandr Ditkovsky (VS-COMPAS project), based on ROTSE-I/NSVS data. VSX suggests type RRC with Blazhko effect, the listed light elements are: HJD(max) = 2453362.802 + 0.417517×E. Based on the data from ROTSE-I/NSVS, ASAS-3 and Catalina Surveys, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	2.395101	0.150 (CV, CSS, MLS), 0.172 (V, ASAS), 0.097 (R, NSVS)	0.417519	2455000.747
f_0	1.785472	0.080 (CV, CSS, MLS), 0.081 (V, ASAS), 0.061 (R, NSVS)	0.560076	2455000.521
$f_1 + f_0$	4.180515	0.040 (CV, CSS, MLS)	0.239205	2455000.638
$f_1 - f_0$	0.609611	0.021 (CV, CSS, MLS)	1.64039	2455001.24

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7455$. J–K = 0.234 (2MASS), B–V = 0.344 (APASS). Combined brightness of two stars, GSC 0839-00170 (= var) and GSC 0839-00205, was measured in NSVS, the amplitudes are somewhat underestimated.

2. Variability of USNO-A2.0 0900-06813517 was discovered by Alexandr Ditkovsky from VS-COMPAS project in 2012, based on ROTSE-I/NSVS data. The AAVSO Variable Star Index suggests type RRC with Blazhko effect, the listed light elements are: HJD(max) = 2452732.721 + 0.348758×E. Based on data from Catalina Surveys, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, CV mag	Period, days	Epoch, JD
	2.867342	0.169	0.348755	2455000.680

f_1				
f_0	2.130992	0.092	0.469265	2455000.701
$f_1 + f_0$	4.998276	0.037	0.200069	2455000.673

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7432$. J–K = 0.238 (2MASS), B–V = 0.265 (APASS). The ROTSE data with photometric correction flags were kept for the analysis.

3. The variability of USNO-A2.0 0750-08069398 was reported by Keller et al. (2008; Id. 109253.24). The variable was classified as an RR: star without light elements. Based on Catalina Surveys data, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, CV mag	Period, days	Epoch, JD
f_1	2.866159	0.144	0.348899	2454800.775
f_0	2.130456	0.121	0.469383	2454800.730

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7433$. J–H = 0.280 (2MASS).

4. The variability of V1360 Cen was discovered by Hoffmeister (1963). The variable is listed in the GCVS (Samus et al. 2007–2013) as an RR Lyrae star, type RRC, with the light elements: JD(max) = 2452498.53 + 0.344249×E. Based data from 1SWASP, ASAS-3 and Catalina Surveys, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	2.904798	0.164 (CV, SSS), 0.200 (WASP), 0.194 (V, ASAS)	0.344258	2454200.540
f_0	2.159491	0.100 (CV, SSS), 0.132 (WASP), 0.115 (V, ASAS)	0.463072	2454200.806
$f_1 + f_0$	5.06429	0.045 (CV, SSS), 0.055 (WASP), 0.048 (V, ASAS)	0.197461	2454200.623
$f_1 - f_0$	0.745323	0.028 (CV, SSS), 0.031 (WASP)	1.34170	2454200.90
$2f_1 + f_0$	7.96902	0.019 (WASP)	0.125486	2454200.579

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7434$. J–K = 0.200 (2MASS); B–V = 0.355 (APASS). When plotting the phased light curves for the identified frequencies, f_1 and f_0, we also subtracted variations of the mean brightness in the 1SWASP data, probably of instrumental origin (corresponding to the frequency f = 1 in the power spectra). All the observations from the SuperWASP with the error > $0.^m05$ were rejected.

5. Variability of GSC 0925-00503 was discovered by Alexandr Ditkovsky from VS-COMPAS project in 2012, based on ROTSE-I/NSVS data. The AAVSO Variable Star Index suggests type RRC with Blazhko effect, the listed light elements are: HJD(max) = 2454663.561 + 0.41189×E. Based on the data from ROTSE-I/NSVS, ASAS-3 and Catalina Surveys, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	2.427833	0.150 (CV, CSS), 0.208 (V, ASAS), 0.123 (R, NSVS)	0.411890	2455000.885
f_0	1.810391	0.086 (CV, CSS), 0.116 (V, ASAS), 0.056 (R, NSVS)	0.552367	2455000.520
$f_1 + f_0$	4.23824	0.041 (CV, CSS)	0.235947	2455000.702
$f_1 - f_0$	0.617452	0.035 (CV, CSS)	1.61956	2455000.74

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7457$. J–K = 0.214 (2MASS); B–V = 0.217 (APASS). Combined brightness of two stars, GSC 0925-00503=var and GSC 0925-00363, was measured in the NSVS, the tabulated amplitudes are somewhat underestimated.

6. The variability of USNO-A2.0 0675-14795162 was reported by Keller et al. (2008; Id. 111137.2696). The variable was classified as an RR: star without light elements. Based on Catalina Surveys data, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, CV mag	Period, days	Epoch, JD

f_1	2.779415	0.163	0.359788	2454800.660
f_0	2.069806	0.104	0.483137	2454800.795

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7447$. J–K = 0.391 , J–H = 0.388 (2MASS).

7. The variability of USNO-A2.0 0975-20240597 was discovered in 2013 by Igor Baluk, Sergei Dubrovski and Alexander Pobiyaha from Astrobloknot Team, based on CSS data. The light elements were given as: HJD(max) = 2455999.857 + 0.353608×E; the star shows Blazhko effect. Based on data from Catalina Surveys, it is actually a double-mode RR Lyrae star, type RR(B), with the light elements tabulated below.

Mode	Frequency, c/d	Semi-amplitude, CV mag	Period, days	Epoch, JD
f_1	2.827942	0.165	0.353614	2455000.555
f_0	2.104448	0.059	0.475184	2455000.685
$f_1 + f_0$	4.93247	0.039	0.202738	2455000.594

The period ratio of the first-overtone and fundamental modes is $P_1/P_0 = 0.7442$. J–K = 0.288 (2MASS), B–V=0.15 (APASS).

Remarks:

We present a new investigation of seven known RR Lyrae variable stars. We analyzed all observations available for these stars in the Catalina Surveys (Drake et al. 2009), Northern Sky Variability Survey (NSVS , Woźniak et al. 2004),ASAS-3 (Pojmanski 2002) and SuperWASP (Butters et al. 2010) online public archives using the period-search software developed by Dr. V.P. Goranskij for Windows environment. According to these data, the variables are double-mode RR Lyrae variables, pulsating in the first-overtone and fundamental modes.

Their period ratios, P_1 / P_0, are typical of radially pulsating double-mode RR Lyrae stars. Along with the light curves, we present power spectra of the RR Lyrae variables, for the raw data and after subtraction of the first-overtone oscillations. The structure of the power spectra shows that the secondary periods are real.

The SuperWASP observations are available as FITS tables, which were converted into ASCII tables using the OMC2ASCII program as described by Sokolovsky (2007).

The tabulated coordinates of the variables were drawn either from the UCAC4, 2MASS catalogs or from the GCVS (Samus et al. 2007–2013).

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