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Seven Double-Mode RR Lyrae Variables

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#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1		USNO-A2.0 0900-06705094	10 30 08.33, +03 36 08.4	RR(B)	15.12	15.70	CV	(see Comments)	(see Comments)	max		Comm. 1	1.PNG	chart1.PNG	CSS_data_1.txt
2		USNO-A2.0 0900-06907148	11 21 05.14, +03 30 56.0	RR(B)	16.64	17.45	CV	(see Comments)	(see Comments)	max		Comm. 2	2.PNG	chart2.PNG	CSS_data_2.txt
3		GSC 0293-01052	12 49 28.95, +03 22 41.6	RR(B)	14.68	15.26	CV	(see Comments)	(see Comments)	max		Comm. 3	3.PNG	chart3.PNG	CSS_data_3.txt
4		GSC 0310-00922	13 31 16.06, +03 34 07.4	RR(B)	13.68	14.46	CV	(see Comments)	(see Comments)	max		Comm. 4	4.PNG	chart4.PNG	CSS_data_4.txt
5		GSC 0321-00872	14 20 22.40, +03 06 51.9	RR(B)	14.29	14.94	CV	(see Comments)	(see Comments)	max		Comm. 5	5.PNG	chart5.PNG	CSS_data_5.txt
6		USNO-A2.0 0900-08468794	16 11 04.26, +03 28 52.9	RR(B)	16.58	17.29	CV	(see Comments)	(see Comments)	max		Comm. 6	6.PNG	chart6.PNG	CSS_data_6.txt
7	V2220 Sgr	GSC 7959-01725	20 00 22.55, -44 31 01.7	RR(B)	15.3	16.8	SWASP	(see Comments)	(see Comments)	max		Comm. 7	7.PNG	chart7.PNG	1SWASP_data_7.txt

Comments:

1. The variability of USNO-A2.0 0900-06705094 was discovered by Kraus et al. (2007, MG1 646352), log P = 0.153. The AAVSO Variable Star Index (VSX; www.aavso.org/vsx/) suggests type RRC, without light elements. According to 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	2.301936	0.155	0.434417	2454800.820
f_0	1.720318	0.053	0.581288	2454801.000
$f_1 + f_0$	4.022186	0.022	0.248621	2454800.608
$f_1 - f_0$	0.581649	0.021	1.71925	2454801.90

$P_1/P_0 = 0.7473$. J – K = 0.362 (2MASS).

2. The variability of USNO-A2.0 0900-06907148 was discovered by Kraus et al. (2007, MG1 666086), log P = 0.65. The AAVSO Variable Star Index suggests type RRC, without light elements. According to 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	2.781804	0.151	0.359479	2454800.634
f_0	2.069973	0.105	0.483098	2454800.541

$f_1 + f_0$	4.85178	0.049	0.206110	2454800.574

$P_1/P_0 = 0.7441$. J – K = 0.203 (2MASS).

3. The variability of GSC 0293-01052 was discovered by Kraus et al. (2007, MG1 698628), log P = 0.3. The AAVSO Variable Star Index suggests type RRAB, without light elements. According to 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	2.558644	0.163	0.390832	2454800.880
f_0	1.906836	0.095	0.524429	2454800.650

$P_1/P_0 = 0.7453$. J – K = 0.265 (2MASS).

4. The variability of GSC 0310-00922 was discovered by Kraus et al. (2007, MG1 716004), log P = 2.474. The AAVSO Variable Star Index suggests type RRAB, without light elements. According to 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	2.953372	0.149	0.338596	2454800.060
f_0	2.193093	0.142	0.455977	2454800.145
$f_1 + f_0$	5.14655	0.047	0.194305	2454800.070
$f_1 - f_0$	0.760375	0.038	1.31514	2454801.05

$P_1/P_0 = 0.7426$. J – K = 0.255 (2MASS).

5. The variability of GSC 0321-00872 was discovered by Kraus et al. (2007, MG1 738552), log P = 2.874. The AAVSO Variable Star Index suggests type RRAB, without light elements. According to 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	2.653780	0.150	0.376821	2454800.570
f_0	1.976957	0.089	0.505828	2454800.750
$f_1 + f_0$	4.630744	0.032	0.215948	2454800.627
$f_1 - f_0$	0.676773	0.027	1.47760	2454801.40

$P_1/P_0 = 0.7450$. J – K = 0.132 (2MASS).

6. The variability of USNO-A2.0 0900-08468794 was discovered by Kraus et al. (2007, MG1 816948), log P = 2.449. The AAVSO Variable Star Index suggests type RRC, without light elements. According to 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	2.803500	0.177	0.356697	2454800.751
f_0	2.087055	0.065	0.479144	2454800.609

$P_1/P_0 = 0.7444$.

7. The variability of V2220 Sgr was discovered by Hoffmeister (1963). The variable is listed in the GCVS as an RR star without light elements. According to data from SuperWASP, 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	2.51345	0.341	0.39786	2454300.879
f_0	1.87434	0.184	0.53352	2454300.810
$f_1 + f_0$	4.38781	0.087	0.227904	2454300.825
$f_1 - f_0$	0.63902	0.080	1.5649	2454301.06

$P_1/P_0 = 0.7457$. J – K = 0.184 (2MASS). When plotting the phased light curves for the identified frequencies, f_1 and f_0, I 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).

Remarks:

I present a new investigation of seven known RR Lyrae variable stars. I analyzed all observations available for these stars in the Catalina Surveys (Drake et al. 2009) 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, I 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). When reducing the SuperWASP observations, I rejected nights with large scatter of data points, probably due to weather or instrumental errors.

The tabulated coordinates of the variables were drawn either from the 2MASS catalog or from the GCVS (Samus et al. 2007–2012).

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