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Three RRC Variable Stars with Multiple Frequencies

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#	Name	Other	Coord (J2000)	Type	Max	Min	System	Period	Epoch (JD)	type	Sp	Comment	L.Curve	Find.Chart	Data
1		GSC 2493-00118	09 18 16.99, +31 58 48.7	RRC	13.83	14.26	CV	(see Comments)	(see Comments)	max		Comm. 1	1.PNG	chart1.PNG	CSS_data_1.txt 1SWASP_data_1.txt
2		GSC 2010-00224	14 10 22.29, +25 44 32.9	RRC	13.83	14.30	CV	(see Comments)	(see Comments)	max		Comm. 2	2.PNG	chart2.PNG	CSS_data_2.txt 1SWASP_data_2.txt
3		USNO-A2.0 0900-20281750	22 58 09.31, +00 52 16.7	RRC	15.51	16.10	CV	(see Comments)	(see Comments)	max		Comm. 3	3.PNG	chart3.PNG	CSS_data_3.txt

Comments:

1. The variability of GSC 2493-00118 was discovered by Kinman et al. (2012). The variable was classified as an RRC star with the light elements: Max = JD 2450503.429 + 0.403114 x E. This period is wrong (one-day alias of P_1, see the Table).

According to data from Catalina Surveys and SuperWASP, it is actually an RRC star with a nonradial pulsation co-existing with the first-overtone mode.

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	3.48360	0.119 (1SWASP), 0.110 (CSS)	0.287059	2454700.597
f_2	3.54616	0.103 (1SWASP), 0.088 (CSS)	0.281995	2454700.652

This variable strongly resembles TYC 6556 00609 1 (Antipin and Jurcsik 2005) by its amplitude and light curve of the secondary oscillation. The period ratio is $P_2 / P_1 = 0.9824$. J – K = 0.198 (2MASS).

2. The variability of GSC 2010-00224 was discovered by Wils (2010; BPS BS 15623-004) from 1SWASP data. The variable was classified as an RRC star with the light elements: Max = HJD 2454216.42 + 0.34471 x E. I analyzed all available observations of GSC 2010-00224 from the Catalina Surveys and SuperWASP online public archives. It is actually a multiperiodic RR Lyrae variable star. Besides clearly expressed first-overtone radial pulsations, it shows at least two non-radial modes.

RR Lyrae variables with equidistant triplets of frequencies (two non-radial frequencies around the first-overtone mode) have been known for some time in the LMC (Alcock et al. 2000); in our Galaxy, such stars are NSV 07340 = TYC 3060 01159 1 (Antipin et al. 2010) and the variable TYC 3877 02198 1 studied by us earlier (Khruslov 2010).

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	2.901048	0.137 (CSS), 0.150 (SWASP)	0.344703	2454700.710
f_2	2.881421	0.057 (CSS), 0.080 (SWASP)	0.347051	2454700.610
f_3	2.920706	0.049 (CSS), 0.060 (SWASP)	0.342383	2454700.590

The frequencies are equidistant: $f_3 - f_1 = 0.019658$; $f_1 - f_2 = 0.019627$. J – K = 0.108 (2MASS).

3. The variability of USNO-A2.0 0900-20281750 was discovered by Sesar et al. (2010; Id. 747380). The variable was classified as an RRC star with the light elements: Max = HJD 2452577.181 + 0.394196 x E. This period

is wrong (it is a one-day alias of the P_1, see the Table). According to data from Catalina Surveys and from Sesar et al. (2010), it is actually an RRC star with a nonradial pulsation co-existing with the first-overtone mode.

Mode	Frequency, c/d	Semi-amplitude, mag	Period, days	Epoch, JD
f_1	3.536826	0.183 (CSS), 0.176 (r)	0.282741	2454700.502
f_2	3.45877	0.065 (CSS), 0.051 (r)	0.289120	2454700.723

$P_1 / P_2 = 0.9779$. J – K = 0.203 (2MASS).

Remarks:

I present a new investigation of three known RR Lyrae (RRC type) variable stars. I analyzed all available observations of these stars from the Catalina Surveys (Drake et al. 2009) and SuperWASP (Butters et al. 2010) online public archives and from the literature using the period-search software developed by Dr. V.P. Goranskij for Windows environment.

For each star, my analysis permitted to detect nonradial pulsations co-existing with the first-overtone mode. 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 from the 2MASS catalog.

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