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MASS RATIO DETERMINATION OF BINARY SYSTEMS BD+14°5016, GSC 2757-769 AND GSC 3472-641†

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We present radial velocity studies performed for three contact binary stars recently discovered by the Semi-Automatic Variability Search[1] sky survey described detailed in Niedzielski et al. (2003). The gathered spectroscopic observations allowed us to determine radial velocity amplitudes and hence mass ratio of component stars. The observations were collected at the David Dunlap Observatory (DDO), University of Toronto, with the 1.9 m telescope and the Cassegrain spectrograph giving a dispersion of 10.8 Å mm^{-1}, corresponding to about 0.16 Å pixel^{-1} or about 9 km s^{-1} pixel^{-1}. The spectra were centered at 5184 Å with a spectrum coverage of 310 Å. The exposure time of 20 min was used for all spectra. For reduction standard IRAF[2] procedures were employed. The velocity determinations were done with broadening function algorithm (Rucinski 1999) against a sharp-line standard star used as a template.

BD+14°5016 was discovered as a variable of W UMa type by Maciejewski et al. (2002). It is a $9\overset{\mathrm{m}}{.}5$ magnitude star of F2 spectral type, with an amplitude of slightly smaller than 0.5 mag and with a period of 15 hours. A preliminary spectroscopic and photometric solution of this eclipsing binary was presented in Maciejewski et al. (2003a). The obtained model based on mass ratio determined from only three spectra indicates that BD+14°5016 is an A-type W UMa system in a large degree of overcontact of about 54 percent. The O'Connell effect suggests that there is a hot spot located on the surface of the more massive component.

GSC 2757-769 was announced as an eclipsing binary by Maciejewski et al. (2003b). It reaches $10\overset{\mathrm{m}}{.}5$ and varies in brightness with an amplitude of $0\overset{\mathrm{m}}{.}24$ and with a period of 10 hours.

Variability of GSC 3472-641 was shown in Maciejewski et al. (2003c). It is a $11\overset{\mathrm{m}}{.}0$ magnitude W UMa system with a period of almost 8 hours and an amplitude of $0\overset{\mathrm{m}}{.}5$.

The radial velocity measurements for all stars of interest are listed in Table 1. For every spectrum the Heliocentric Julian Date of the exposure, phase and radial velocity determinations with the deviations from the circular solution as errors are given. The

† Based on data obtained at the David Dunlap Observatory, University of Toronto.

[1] For further information on SAVS see http://www.astri.uni.torun.pl/~gm/SAVS/.

[2] IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

phase was calculated according to photometric ephemeris given in Maciejewski et al. (2002), Maciejewski et al. (2003b) and Maciejewski and Karska (2004) for BD+14°5016, GSC 2757-769 and GSC 3472-641, respectively. Radial velocities were transformed to the solar system barycenter. As a templates the stars HD 16895, HD 222368 and HD 19373 were used for BD+14°5016, GSC 2757-769 and GSC 3472-641, respectively.

Table 1. Radial velocities measurements in km s^{-1}

HJD-2450000	Phase	V_1	ΔV_1	V_2	ΔV_2
BD+14°5016.....					
2865.650087	0.7839	86.5	10.9	−190.3	16.1
2865.777699	0.9843	36.8	9.2	...	...
2871.884731	0.5731	26.5	19.8	...	...
2871.898922	0.5954	44.2	8.7	...	...
2872.834641	0.0646	−11.5	12.0	...	...
2874.676122	0.9560	57.2	20.1	−55.2	13.5
2874.692396	0.9815	40.8	12.3	...	...
2874.709168	0.0079	16.3	3.0	...	...
2874.828479	0.1952	−19.8	9.4	252.1	9.7
2874.844533	0.2204	−17.0	14.5	275.9	23.9
2874.861039	0.2463	−32.7	0.2	268.1	12.1
2875.762517	0.6618	53.4	15.2	−164.3	12.3
2879.723759	0.8814	64.0	4.8	−122.8	13.5
GSC 2757-769.....					
2880.659330	0.1990	43.9	2.8	−246.8	25.4
2880.675013	0.2364	50.9	1.6	−224.6	7.5
2880.690465	0.2733	50.4	1.5	−263.8	33.2
2880.706311	0.3111	42.8	2.7	−234.0	17.6
2880.722237	0.3491	34.0	5.3	...	...
2880.738430	0.3877	33.0	2.5	−90.8	61.7
2880.754889	0.4269	24.6	5.2	−74.2	31.3
2880.770607	0.4644	−2.9	10.4	...	...
2882.590643	0.8062	−63.3	8.2	257.6	47.6
2882.606847	0.8448	−52.4	3.3	145.3	39.3
2882.622380	0.8819	−43.1	2.2	...	...
2882.638005	0.9192	−32.2	1.5	63.2	43.3
2882.653735	0.9567	−1.3	17.6	...	...
2882.669766	0.9949	15.7	21.9	...	...
2882.688586	0.0398	12.9	4.0	...	...
GSC 3472-641.....					
2872.613955	0.2396	−184.1	17.3	129.5	5.3
2872.623503	0.2696	−185.3	15.0	131.0	3.0
2872.637554	0.3137	−199.2	13.5	133.8	9.0
2877.544484	0.7121	165.1	39.9	−110.1	12.3
2877.560722	0.7630	225.1	14.8	−117.4	8.2
2877.577099	0.8144	224.9	30.6	−124.1	8.5
2877.593777	0.8667	172.0	14.2	−96.6	4.1
2878.554534	0.8817	159.4	15.3	−99.3	15.4
2878.570830	0.9328	53.5	35.5	...	...
2888.545421	0.2340	−210.8	9.9	133.6	0.8

The radial velocity orbits were solved by least squares fitting of a sinusoid for each component from the form $V(\phi) = \gamma + K_i \sin\phi$, with ϕ being the phase, γ – the velocity of system's barycenter and K_i – the velocity amplitude. The results are shown in Figures 1, 2 and 3. The sine curves and the straight line denote circular-orbit fits and the average radial velocity γ, respectively. The derived orbital elements: the velocity amplitudes K_1 and K_2, average radial velocity γ, mass ratio q, orbit dimensions a, a_1, a_2 and component masses m_1, m_2 are presented in Table 2.

Our results obtained for BD+14°5016 are consistent with those presented in Maciejewski et al. (2003a). The mass ratio occurred to be slightly smaller, however.

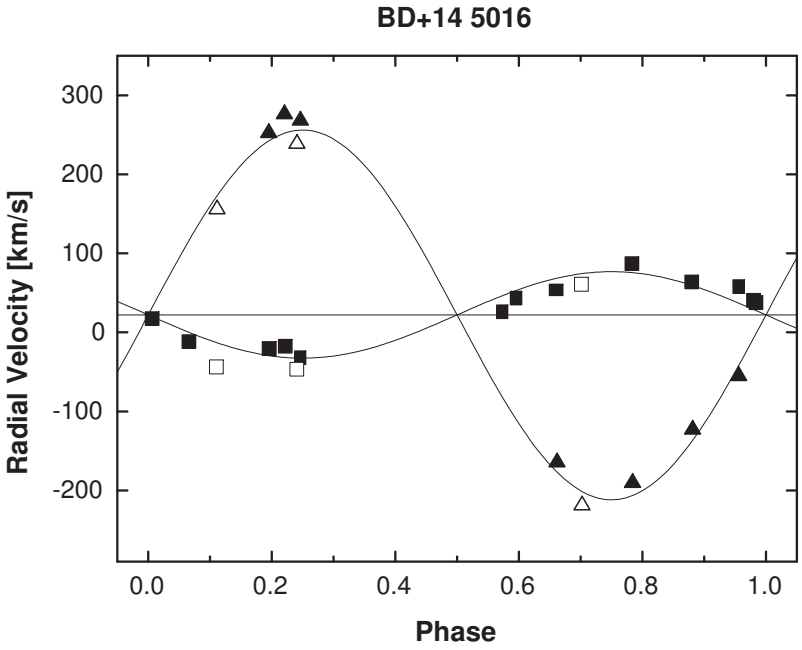

Figure 1. Radial velocities of BD+14°5016 plotted versus orbital phase. Measurements taken from Maciejewski et al. (2003a) are marked with open symbols.

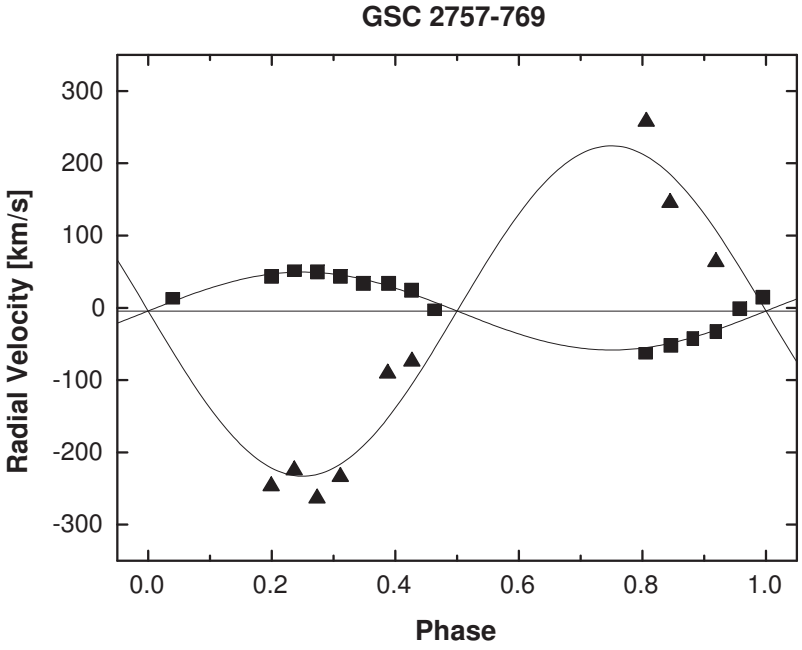

Figure 2. Radial velocities of GSC 2757-769 plotted versus orbital phase.

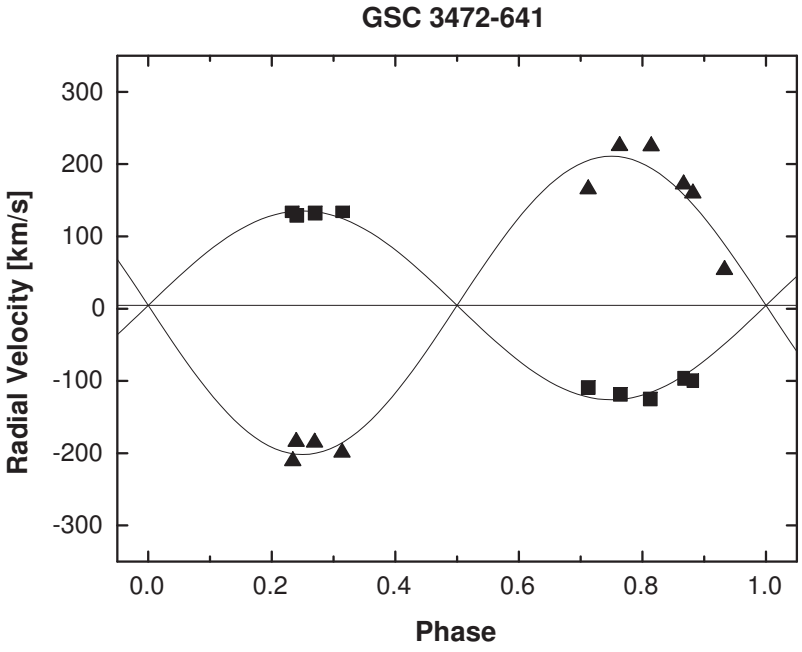

Figure 3. Radial velocities of GSC 3472-641 plotted versus orbital phase.

Table 2. Spectroscopic orbital elements

Element		BD+14°5016	GSC 2757-769	GSC 3472-641
K_1	[km s^{-1}]	54.7 ± 3.8	53.9 ± 2.4	130.7 ± 3.3
K_2	[km s^{-1}]	233.9 ± 5.6	228.6 ± 15.2	206.5 ± 8.2
γ	[km s^{-1}]	22.1 ± 5.9	-4.5 ± 10.9	4.5 ± 6.4
$q = m_2/m_1$		0.234 ± 0.022	0.236 ± 0.061	0.633 ± 0.042
$a \sin i$	[R$_\odot$]	3.63 ± 0.12	2.34 ± 0.14	2.12 ± 0.07
$a_1 \sin i$	[R$_\odot$]	0.69 ± 0.05	0.45 ± 0.02	0.82 ± 0.02
$a_2 \sin i$	[R$_\odot$]	2.94 ± 0.07	1.89 ± 0.12	1.30 ± 0.05
$m_1 \sin^3 i$	[M$_\odot$]	1.29 ± 0.12	0.80 ± 0.15	0.78 ± 0.08
$m_2 \sin^3 i$	[M$_\odot$]	0.30 ± 0.04	0.19 ± 0.03	0.49 ± 0.05

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