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Discovery of four W UMa type eclipsing binaries in the field of open cluster ASCC 5 *

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Abstract We carried out time-series photometric observations in the $R_{\rm c}$-band of the young, poorly studied open cluster ASCC 5 during November and December, 2012, to search for magnetically active stars, and discovered four eclipsing binary stars in this field. In order to characterize these four newly discovered binaries, we derived their orbital periods by their times of light minimum, estimated their effective temperatures based on their $(J-H)$ colors and analyzed their light curves using the Wilson-Devinney light curve modeling technique. Our analyses reveal that all of them are contact binaries with short orbital periods of less than 0.5 d, with spectral types from late-F to mid-K. Among them, one is a typical A subtype contact binary with a mass ratio around 0.5 and a period of 0.44 d, and one is an H subtype contact binary with a high mass ratio around 0.9 and a short period of about 0.27 d. The other two systems show low amplitudes of light variation ($A_{R_{\rm c}} \leq 0.11^{\rm m}$); their actual photometric mass ratios could not be determined by the light curve modelings, probably due to their attributes of being partially eclipsing stars. A preliminary analysis for these two systems indicates that both of them are likely to be W subtype contact binaries with low orbital inclinations. In addition, both of these two low amplitude variables show asymmetric distorted light curves (e.g., O'Connell effect of $\Delta R_{\rm c} \simeq 0.02^{\rm m}$) during the observing runs, suggesting the presence of starspots on these two systems. More interestingly, the one showing a large case of the O'Connell effect presented a remarkable variation in the shape of the light curve on a time scale of one day, indicating that this star is in a very active state. Therefore, these two stars need spectroscopic observations to precisely determine their parameters, as well as further photometric observations to understand the properties of their magnetic activity, e.g., the evolution of starspots.

Key words: stars:binaries: close — stars:binaries: eclipsing — stars: spots

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1 INTRODUCTION

ASCC 5 is a very young, poorly studied open cluster with an age of about 11 Myr, lying at a distance of 1500 pc in the direction of the constellation Cassiopeia ($\alpha_{2000} = 00$:57:58, $\delta_{2000} = +55$:50:24, $l = 123.85°$, $b = -7.02°$) (Kharchenko et al. 2005; Wu et al. 2009). It was first detected by Kharchenko et al. (2005) using three criteria (spatial-kinematical-photometric criteria) together based on the All-Sky Compiled Catalogue of 2.5 Million Stars with proper motions in the Hipparcos system and Johnson B, V magnitudes, spectral types and radial velocities (ASCC-2.5, Kharchenko 2001; Kharchenko et al. 2004).

In November and December, 2012, we obtained the first photometric observations that formed a time series for the $R_{\rm c}$-band of the open cluster ASCC 5 with the purpose of searching for variable stars with magnetic activity. In the field of this open cluster, we discovered four W UMa type eclipsing binary stars, namely, 2MASS J00570305+5541588, 2MASS J00572555+5546091, 2MASS J00580602+5541451 and 2MASS J00583140+5539042 (hereafter 2MJ5703, 2MJ5725, 2MJ5806 and 2MJ5831 respectively), whose basic information is listed in Table 1. In this paper, in order to characterize these four newly discovered binaries, we derived their orbital periods by using times of light minimum, and analyzed their light curves with the Wilson-Devinney modeling code (Wilson & Devinney 1971; Wilson 1979, 1990, 1994).

Table 1 Basic Data on Four Newly Discovered Eclipsing Binaries in the Field of ASCC 5

Name	R.A. (J2000) (h: m: s)	Dec. (J2000) (d: m: s)	$A_{R_{\rm c}}$ (mag)	Period (d)	J (mag)	H (mag)	K_s (mag)	$T_{\rm eff}$ (K)
2MJ5703	00:57:03.054	+55:41:58.85	0.18	0.44035	12.432	12.165	12.066	6022(186)
2MJ5725	00:57:25.551	+55:46:09.15	0.07	0.30243	12.759	12.299	12.157	5178(202)
2MJ5806	00:58:06.025	+55:41:45.13	0.30	0.27423	13.867	13.273	13.197	4593(181)
2MJ5831	00:58:31.406	+55:39:04.23	0.11	0.27300	13.151	12.665	12.594	5065(236)

Notes: $A_{R_{\rm c}}$ denotes the difference between light maximum and minimum in the data set for the $R_{\rm c}$-band we obtained in 2012. The magnitudes of J, H and K_s are from the 2MASS All-Sky Catalog of Point Sources (Cutri et al. 2003), and the temperatures ($T_{\rm eff}$) are derived from the colors given by ($J-H$). The corresponding errors propagated from uncertainties in the J and H magnitudes, see the text for details.

2 OBSERVATIONS AND DATA REDUCTION

Photometric observations in the field of ASCC 5 were performed during two observing runs. On 2012 November 9, 12 and 13, the observations were carried out on the 85 cm telescope at Xinglong station of the National Astronomical Observatories, Chinese Academy of Sciences, using a 512×512 pixel CCD camera with a standard Johnson-Cousins-Bessell $R_{\rm c}$ filter (Zhou et al. 2009); on 2012 December 2, 3 and 4, the observations were performed using the 1.0 m Cassegrain reflecting telescope equipped with a 2048×2048 CCD camera at Yunnan Observatory, Chinese Academy of Sciences, with the $R_{\rm c}$ filter.

Initial data reduction of all raw CCD frames consisted of bias and flat-field corrections, as well as the removal of cosmic ray events, which were performed with the IRAF package in the standard way. The instrumental magnitudes of stars in each image were obtained using the point spread function fitting method with the IRAF/DAOPHOT package (Stetson 1987) because of the crowding of stars in the field of ASCC 5.

The variations in the instrumental magnitude from image to image were calibrated by ensemble relative photometry using a method called photometric calibration (Hidas et al. 2005). We refer readers to the work of Hidas et al. (2005) for more details. At first, we selected a subset of bright stars as reference stars, whose magnitude residuals Δm from their individual nightly mean values

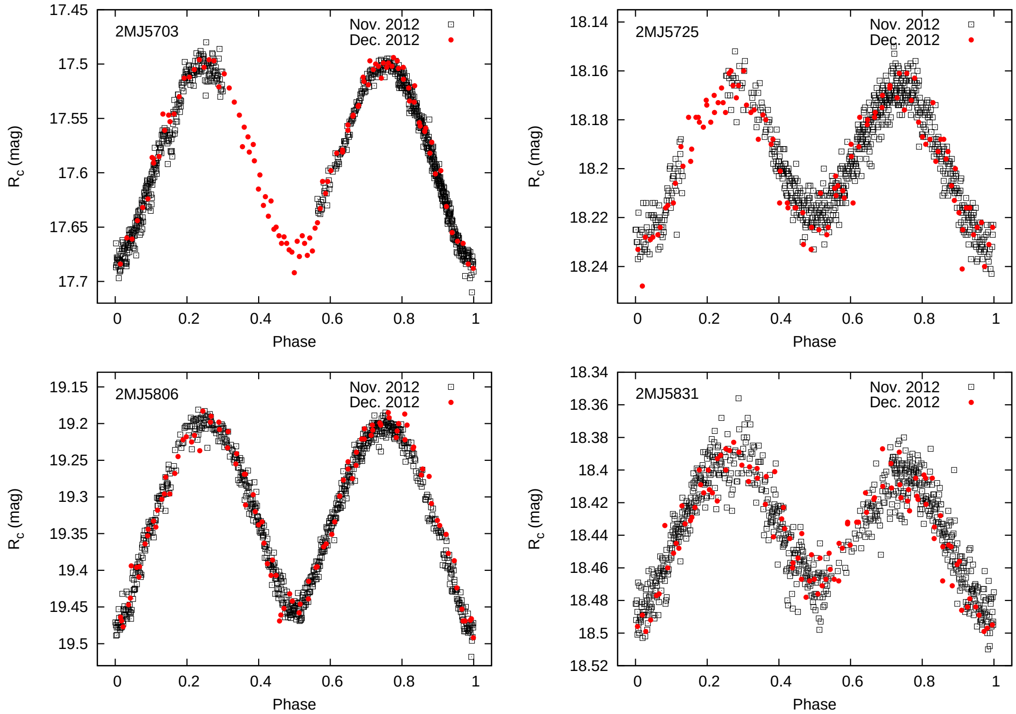

Fig. 1 Light curves of four newly discovered eclipsing binaries in the field of ASCC 5, folded with the adopted ephemeris. Note that the x-axes represent the phase and the y-axes are calibrated R_c-band magnitudes, which have an arbitrary zero point.

were calculated, then we fitted Δm for each reference star in each image by a position-dependent function of the form

$$\Delta m = a + bx + cy\,, \tag{1}$$

where x and y are the pixel coordinates of the star on the CCD frame, and a, b and c are constants for each image. Slightly different from Hidas et al. (2005), here we simply considered the first-order term in coordinates, rather than higher order terms. In the iterative fitting, we removed the reference stars with large rms residuals (e.g., variables or badly measured stars), then we adopted a subset of bright and 'constant' reference stars and repeated the fitting. Finally, the instrumental magnitude for each star in each image was subtracted by the resulting Δm from the fittings. The resulting R_c-band light curves of four newly discovered binaries are displayed in Figure 1. The typical rms of calibrated R_c-band magnitudes of stars in the field of ASCC 5 was about $0.015^{\rm m}$, as presented in Figure 2, where we show the results of the R_c-band data set obtained on the observing night 2012 November 9.

3 DATA ANALYSIS

3.1 Orbital Period

For each system, we derived an initial value of the orbital period by means of the Phase Dispersion Minimization method of Stellingwerf (1978). To refine these initial periods, we determined their times of light minimum, which are listed in Table 2. Each minimum time was determined by

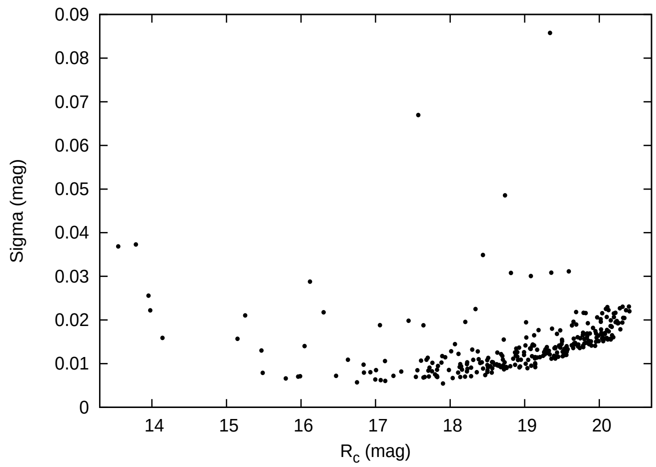

Fig. 2 The rms residuals of calibrated magnitudes of stars in the field of ASCC 5, expressed in R_c-band magnitudes as a function of their nightly mean values in the observing night of 2012 Nov. 9.

Gaussian fitting to the R_c-band data set. Then we calculated the final periods for these systems using these times of minima by means of the linear least-squares method. The resulting period and adopted linear ephemeris for each system are given as follows:

$$\begin{aligned}
&\text{2MJ5703: } \mathrm{Min.I} = \mathrm{HJD}2456241.03033(042) + 0.44035(1)^{\mathrm{d}} \times E,\\
&\text{2MJ5725: } \mathrm{Min.I} = \mathrm{HJD}2456241.12262(103) + 0.30243(2)^{\mathrm{d}} \times E,\\
&\text{2MJ5806: } \mathrm{Min.I} = \mathrm{HJD}2456241.12001(037) + 0.27423(1)^{\mathrm{d}} \times E,\\
&\text{2MJ5831: } \mathrm{Min.I} = \mathrm{HJD}2456241.01585(276) + 0.27300(4)^{\mathrm{d}} \times E.
\end{aligned}$$

Based on the above ephemeris formulae, we folded their light curves in orbital phase (see Fig. 1), and calculated the corresponding $O - C$ values for these four binaries, which are listed in Table 2.

3.2 Light Curve Fitting

We modeled their individual R_c-band light curves with the 2003 version of the Wilson-Devinney modeling code (Wilson & Van Hamme 2004) in order to characterize these four systems. During the procedure of modeling the photometry, the effective temperature of the primary should be specified first, since the light curve only gives constraints on the temperature ratio by using depth of the eclipses, rather than constraints on the absolute temperatures. Therefore, for each binary, we estimated its effective temperature based on color index $(J - H)$ through the following relation obtained by Collier Cameron et al. (2007)

$$T_{\mathrm{eff}} = -4369.5(J - H) + 7188.2, \qquad 4000\,\mathrm{K} < T_{\mathrm{eff}} < 7000\,\mathrm{K}\,, \tag{2}$$

where J and H magnitudes are from the 2MASS All-Sky Catalog of Point Sources (Cutri et al. 2003). The resulting effective temperatures of these four binaries are listed in the last column of Table 1; note that the corresponding errors have propagated from uncertainties in the J and H magnitudes.

For all of these four binaries, the low effective temperatures, short periods and sinusoidal shapes of light curves resemble aspects of W UMa type binaries, therefore mode 3 (appropriate for contact

Table 2 Times of Light Minima Obtained in 2012 November and December

HJD(2456000+)	E	$O-C$	HJD(2456000+)	E	$O-C$
2MJ5725			2MJ5703		
240.97230(059)	–0.5	0.00089	241.03051(024)	0.0	0.00018
241.12037(055)	0.0	–0.00225	244.99326(023)	9.0	–0.00024
243.99717(039)	9.5	0.00145	264.14943(149)	52.5	0.00064
264.10782(156)	76.0	0.00040	265.02885(101)	54.5	–0.00064
265.01579(112)	79.0	0.00108	266.13043(094)	57.0	0.00006
266.07166(109)	82.5	–0.00156	–	–	–
2MJ5806			2MJ5831		
240.98346(022)	–0.5	0.00057	241.01475(046)	0.0	–0.00110
241.11965(017)	0.0	–0.00036	244.01557(037)	11.0	–0.00327
243.99976(017)	10.5	0.00029	244.97886(062)	14.5	0.00452
244.95886(036)	14.0	–0.00044	264.08534(159)	84.5	0.00107
264.01787(076)	83.5	–0.00074	265.03667(153)	88.0	–0.00309
264.15518(095)	84.0	0.00055	265.18157(135)	88.5	0.00531
265.11564(101)	87.5	0.00009	265.99775(107)	91.5	0.00249
266.07652(074)	91.0	0.00115	266.12583(155)	92.0	–0.00593

Notes: the numbers in parentheses listed in the column labeled HJD are the estimated errors, expressed in terms of corresponding quoted digits, e.g., 240.98346(022) refers to 240.98346 ± 0.00022.

binaries, the components of which are in geometrical contact but not in thermal contact, see Wilson 1979) was chosen to analyze the light curves in this paper. The fixed parameters in the modeling procedure were set as follows: the temperature of primary T_1 was from the value just mentioned above; the bolometric albedos $A_1 = A_2 = 0.5$ (Ruciński 1969), the gravity darkening coefficients $g_1 = g_2 = 0.32$ (Lucy 1967) and the limb darkening coefficients of a non-linear square-root law were interpolated from the tables of Claret (2000). The adjustable parameters were as follows: orbital inclination i, effective temperature of secondary T_2, relative luminosity of the primary L_1 and dimensionless surface potential Ω_1 ($\Omega_1 = \Omega_2$).

Since, at present, there are no spectroscopic mass ratios available for these systems, we fixed the mass ratio $q = m_2/m_1$ (star 1 is the one eclipsed near phase zero) to different values between 0.1-10, and employed a usual q-search method to find the photometric mass ratio. The resulting residual $\sum \omega_i (O-C)_i^2$ (measures the goodness of the fit) is presented as a function of mass ratio for each of these four binaries in Figure 3. Once the mass ratio was determined by this q-search procedure, we then added the term representing mass ratio to the set of adjustable parameters to search for the final solutions by using the DC program.

Several aspects in the modeling procedure should be pointed out here. (1) All data points were used to model light curves with the exception of the case 2MJ5831, whose light curves present remarkable instances of the O'Connell effect (O'Connell 1951), especially in data sets from 2012 Nov. 13 and Dec. 3, therefore only four other data sets were used in the modeling procedure. (2) 2MJ5725 and 2MJ5831 show low amplitudes of light variation, which may result from the presence of a third light in some cases, however, here we did not include such an additional light to model their light curves. (3) As pointed out by Rucinski (2001), generally only two of the three geometrical parameters (inclination, degree of contact and mass ratio) of contact binaries are well constrained by the shapes of their light curve, therefore such a q-search method is very dangerous; even the results on mass ratio are frequently wrong with respect to the values derived from the radial velocity data. Anyway, in this paper, if there was a well expressed minimum of residual $\sum \omega_i (O-C)_i^2$ (e.g., the cases of 2MJ5703 and 2MJ5806, see Fig. 3), we adopted the corresponding mass ratio as the 'real' one and thus obtained other parameters; however, we could not determine an actual mass ratio and thus could not obtain other parameters if there was no unique, clearly evident minimum in the residuals (like the cases of 2MJ5725 and 2MJ5831, as shown in Fig. 3).

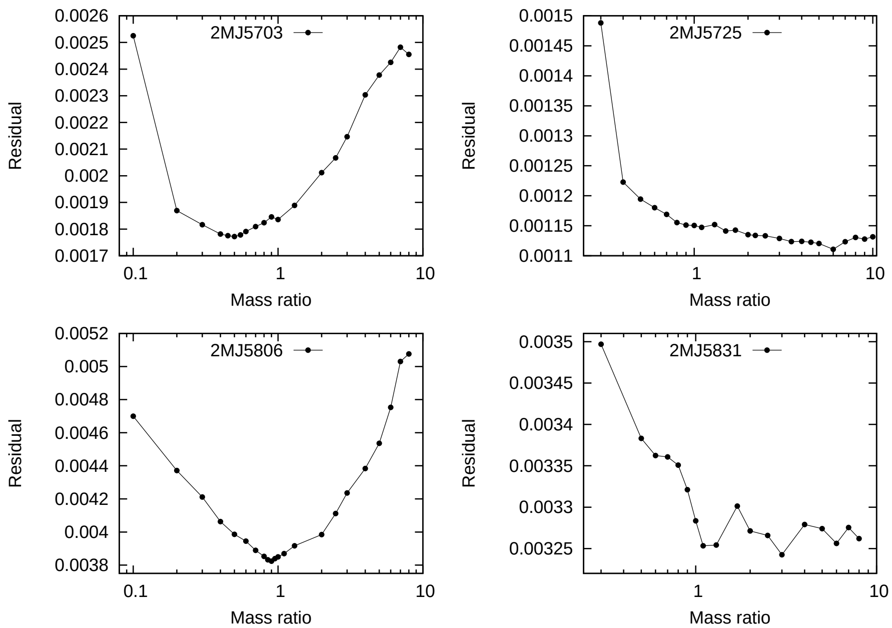

Fig. 3 Residuals of solutions vs. mass ratios for four newly discovered eclipsing binaries. Note that the abscissa of each panel is logarithmic.

4 RESULTS AND DISCUSSION

4.1 2MJ5703

The period of 2MJ5703 is around 0.44 d, and its $(J-H)$ color corresponds to a late F spectral type. The light curves of 2MJ5703 did not exhibit the O'Connell effect during the observing runs, thus we did not include a spot in the modeling procedure. The parameters which were finally adopted are listed in the second column of Table 3, and the theoretical light curves with the observed data points superimposed are displayed in Figure 4. Its photometric solutions show that 2MJ5703 is a typical contact binary, with two components having very different masses ($q \simeq 0.5$) but similar temperatures ($\Delta T_{\rm eff} \simeq 160K$). The hotter primary star of this system has a larger volume (see Table 3), which classifies 2MJ5703 as an A sub-type W UMa binary system (Binnendijk 1965).

4.2 2MJ5725

2MJ5725 is a late G-type W UMa binary star with a short orbital period $P = 0.30243^{\rm d}$. More interestingly, it shows a very low amplitude in its variability ($A_{R_{\rm c}} \simeq 0.07^{\rm m}$). It is common knowledge that the presence of the third star or low orbital inclination can lead to such a small amplitude in the binary's light variation. However, since there is no clue about the presence of a third star in this system at present, we did not include the third light in the fittings. From Figure 3, one can see that the fittings are evidently better if $q > 1.0$, however, the minima of residuals are wide with small differences between different mass ratios. Our experiments suggest that solutions of 2MJ5725 could fit the light curve well over a wide range of mass ratios, which may be due to it being a partially eclipsing star. Therefore, it is impossible to reliably determine its actual parameters from the current light curves alone. This binary star needs radial velocity observations to determine its mass ratio and

Table 3 Photometric Solutions of 2MJ5703 and 2MJ5806

Elements	2MJ5703	2MJ5806
T_1	6022 K	4593 K
A_1=A_2	0.50	0.50
g_1=g_2	0.32	0.32
T_2	5866 ± 53 K	4450 ± 14 K
i	$52.675° \pm 0.324°$	$58.626° \pm 0.197°$
$\Omega_1 = \Omega_2$	2.8260 ± 0.0076	3.5241 ± 0.0080
$q = M_2/M_1$	0.493 ± 0.004	0.893 ± 0.004
$(L_1/(L_1 + L_2))_{R_c}$	0.6757 ± 0.0076	0.5674 ± 0.0055
r_1(pole)	0.4217 ± 0.0015	0.3721 ± 0.0012
r_1(side)	0.4494 ± 0.0019	0.3926 ± 0.0015
r_1(back)	0.4799 ± 0.0027	0.4264 ± 0.0022
r_2(pole)	0.3053 ± 0.0020	0.3533 ± 0.0012
r_2(side)	0.3196 ± 0.0024	0.3717 ± 0.0015
r_2(back)	0.3565 ± 0.0042	0.4066 ± 0.0023
$f(\%)$	12.6	10.1
$\sum \omega_i (O - C)_i^2$	0.001773	0.003828

Notes: T_1, A_1=A_2 and g_1=g_2 were fixed in the modeling runs.

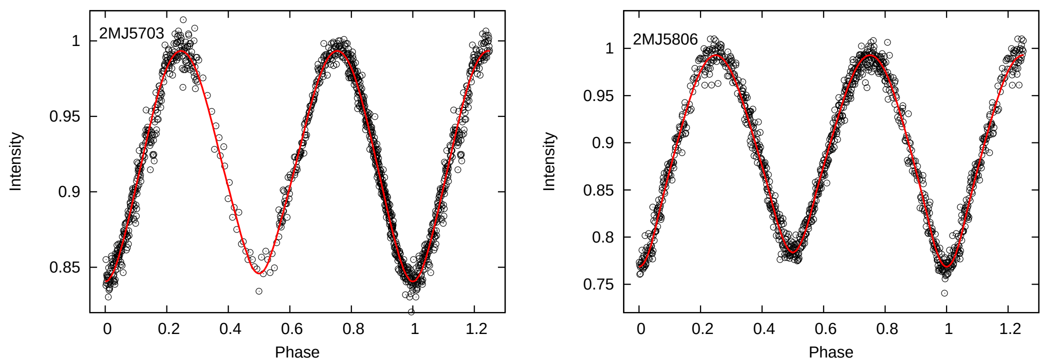

Fig. 4 Plots of the theoretical light curves with observed data superimposed, where the open circles denote the observed data points, and the solid lines refer to the theoretical light curves. Note that the observations are in intensity units.

thus other parameters. A closer inspection shows that there are asymmetric distortions in its light curves, indicating the presence of starspots on this system.

4.3 2MJ5806

The period of 2MJ5806 is around 0.274 d, and its $(J - H)$ color corresponds to a K4 spectral type. The final modeling results are listed in the third column of Table 3, which give a satisfactory fit to the observed data points, as shown in Figure 4. Our analysis shows that it has a high mass ratio of $q \simeq 0.9$, identifying this object as an H-type contact binary (H means high mass ratio), a subgroup of contact binaries with $q > 0.72$ first proposed by Csizmadia & Klagyivik (2004), who found that the energy transfer from the primary to the secondary is not only related to the luminosity ratio but also to the mass ratio; the rate of energy transfer in these H-type contact binaries is found to be less efficient than the one in other contact binaries at a given luminosity ratio. Using the following equation (eq. (3) in the paper by Csizmadia & Klagyivik 2004)

$$\beta = \frac{1 + \alpha\lambda^{5.01}}{1 + \lambda}\,, \tag{3}$$

where $\alpha = (T_1/T_2)^{20.01}$ and $\lambda \equiv L_2/L_1 \simeq q^{0.92}(T_2/T_1)^4$ denotes the luminosity ratio, we derived the transfer parameter $\beta \simeq 0.89$ for this object, which agrees well with the value 0.88 estimated with $\beta = (1 + \lambda)^{-1} + 0.52q^{4.1}$, a formula derived by Csizmadia & Klagyivik (2004) showing that the transfer parameter in subtype H is larger (the rate of energy transfer is less) than those in other subtypes with similar luminosity ratios.

4.4 2MJ5831

2MJ5831 is a late G-type or early K-type W UMa binary star with low amplitude of light variation (about 0.11 mag) and a short orbital period of $P = 0.273^{\rm d}$. Like the case of 2MJ5725, we could not obtain a unique mass ratio and thus other physical parameters for 2MJ5831 based on the current light curves alone, probably due to it being a partially eclipsing star, partly owing to the large distortions and noises in its light curves; therefore a spectroscopic mass ratio derived from radial velocity is needed for this system. Its light curves exhibit cases of the O'Connell effect, a common phenomenon due to magnetic activities on the surface, like many W UMa type contact binaries. Furthermore, there are remarkable variations of light curves on a time scale of one day, e.g., different depths of secondary light minima or different heights of secondary light maxima in different epochs, which suggest this object is in a very active state. In order to better illustrate the rapid variations in the shapes of light curves due to magnetic activities, we plot its individual data sets in different panels, as shown in Figure 5, where we also plot a fitted light curve without accounting for spots, which acts as a reference. From Figure 5, one can see that remarkable instances of the O'Connell effect are present in the data sets from 2012 Nov. 13, Dec. 3 and 4 ($\Delta R_{\rm c} \simeq 0.02$ mag), but this effect disappears in other data sets. In addition, the depth of the second minima in the data set of Dec. 3 is different from those in other data sets. In a word, the growth and decline of manifestations showing the O'Connell effect and the rapid variations in shapes of the light curve strongly suggest the presence of magnetic activities occurring at high levels on the components of 2MJ5831. Thus further photometric observation is needed to better understand the properties of its magnetic activity, such as starspot evolution.

In general, short period contact binary systems lie in a well defined region in the color-period diagram (Eggen 1967); the observed systems are found within a broad strip (Kaehler & Fehlberg 1991) defined by

$$1.5 \log T_{\rm eff} - \log P = 5.975 \ldots 6.15\,, \tag{4}$$

where P is the period in days. In order to check such a constraint on contact binaries with these four newly discovered binaries, we plot their color-period diagram in Figure 6, where the strip mentioned above is also displayed, as shown by dashed lines. From Figure 6, one can see that all of them are within this strip, which agrees well with our conclusion that these four systems are contact binary stars.

To analyze the memberships of these four binaries in ASCC 5, we retrieved their proper motions from the USNO-B catalog (Monet et al. 2003) via the VizieR catalogue access tool, as listed in Table 4. By comparing their proper motions with the mean proper motion of ASCC 5, $\mu_\alpha cos\delta = -3.10$ mas yr^{-1} and $\mu_\delta = -2.91$ mas yr^{-1} (Kharchenko et al. 2005), we found that they are more likely to be field stars, rather than member stars. Furthermore, we estimated their individual distances with the help of the Period-Luminosity-Color (PLC) relation for W UMa type binaries. Here, the PLC relation (Eq. (5)), working with infrared colors derived by Eker et al. (2009), was used to derive $M(J)$ and then the distance d (in pc) from $J_0 - M(J) = 5 \log d - 5$, based on the

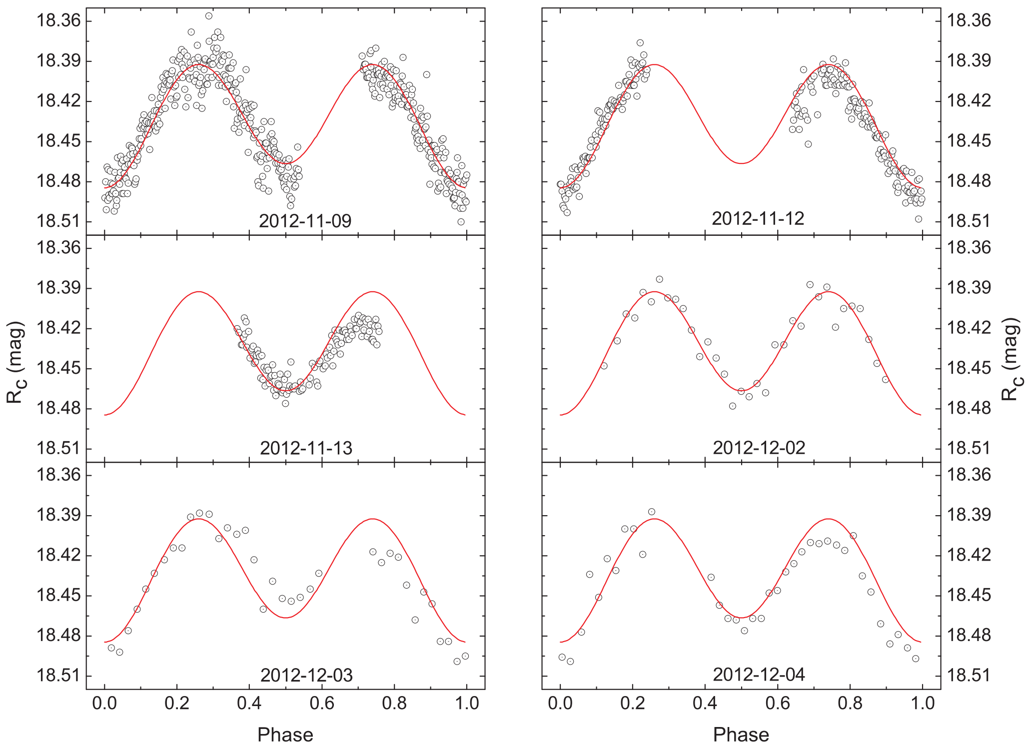

Fig. 5 Individual light curves of 2MJ5831 obtained during different nights. Note that the solid line in each panel refers to an unspotted modeling, being shown here only for reference.

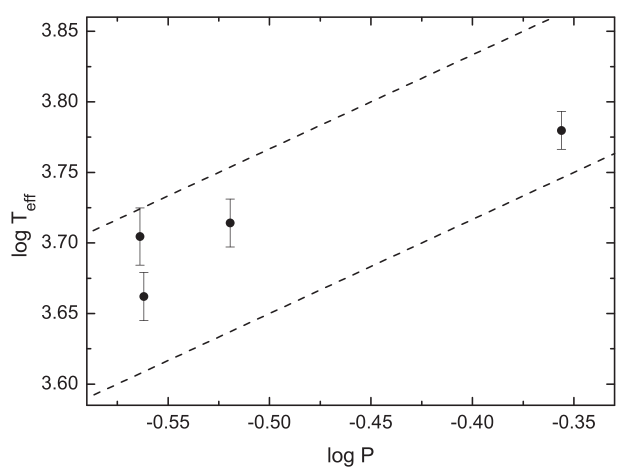

Fig. 6 The periods vs. effective temperatures of four newly discovered binaries. Note that the error bars refer to the temperature errors (the last column of Table 1), and the *dashed* lines denote the relation between period and temperature described by Kaehler & Fehlberg (1991).

Table 4 The Proper Motions and Distances of Four Newly Discovered Binaries

Name	μ_α (mas yr^{-1})	$\mu_\alpha \cos\delta$ (mas yr^{-1})	μ_δ (mas yr^{-1})	d (pc)	d (pc)
2MJ5703	-12 ± 2	-6.76 ± 1.23	0 ± 1	1013.2	936.9
2MJ5725	-14 ± 4	-7.88 ± 2.25	4 ± 4	636.6	588.6
2MJ5806	4 ± 1	2.25 ± 0.56	-4 ± 4	830.8	768.2
2MJ5831	0 ± 0	0.00 ± 0.00	0 ± 0	724.1	669.5

Notes: the error in each $\mu_\alpha \cos\delta$ was propagated from the uncertainty in μ_α; the distances in the fifth column were derived from $E(B-V) = 0.25$, while the values of the last column were from $E(B-V) = 0.0$.

colors from 2MASS data.

$$M(J) = -3.17 \log P + 3.84(J-H)_0 + 1.81(H-K_s)_0 + 0.24\,. \tag{5}$$

Since we did not know the actual reddenings of their infrared colors due to interstellar absorption, here we assumed that all of them are members of ASCC 5 and hence suffered from the reddening $E(B-V) = 0.25$, a value derived by Kharchenko et al. (2005) for ASCC 5. After de-reddening of the infrared bands using the following relations (Eqs. (6)–(8)) given by Fiorucci & Munari (2003),

$$J_0 = J - 0.887E(B-V)\,, \tag{6}$$

$$(J-H)_0 = (J-H) - 0.322E(B-V)\,, \tag{7}$$

$$(H-K_s)_0 = (H-K_s) - 0.183E(B-V)\,, \tag{8}$$

we obtained the resulting distances, which are listed in the fifth column of Table 4. For comparison, we also calculated the distances based on $E(B-V) = 0.0$ (e.g., they were assumed to be field stars with very little extinctions), which are listed in the last column of Table 4. The big discrepancies between these resulting values and the distance of ASCC 5 (1500 pc) indicates that they are not members of this open cluster; all of them are more likely to be foreground stars within 1000 pc.

5 SUMMARY

In this paper we present photometric data for four newly discovered close eclipsing binaries in the field of very young open cluster ASCC 5, as well as their basic parameters based on light curve analysis. The main results we derived for them are as follows:

– 2MJ5703 is a typical A-type contact binary (mass ratio $q \simeq 0.5$, the degree of contact $f \simeq 0.13$) with a late F spectral type, having an orbital period of 0.44 d.
– 2MJ5725 is more likely to be a W-type contact binary with a very low amplitude of light variation of about 0.07 mag, though we did not obtain its exact mass ratio or other parameters based on its photometric light curves alone. It has an orbital period of about 0.302 d. There are asymmetric distortions in its light curves, suggesting the presence of starspots on the components.
– 2MJ5806 is an H sub-type contact binary system with a high mass ratio around 0.9 and a small degree of contact about 0.1, and it has a short orbital period of about 0.274 d.
– 2MJ5831 is probably a W subtype contact binary with a low amplitude of light variation around $0.11^{\rm m}$ and a short orbital period of 0.273 d. We could not obtain a unique mass ratio or other parameters based on its current light curves alone, probably due to it being a partially eclipsing star. The presence of remarkable manifestations of the O'Connell effect and rapid variations of light curves indicates strong magnetic activities on the components of this binary system.

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