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V1224 Cas: An EL CVn-type Eclipsing Binary Consisting of a Helium White Dwarf Precursor and a Delta Scuti Pulsator

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Abstract

We report the discovery of a new eclipsing EL CVn-type binary, consisting of a δ Sct-type pulsator and a thermally bloated low-mass pre-He white dwarf (WD). Spectroscopy and time-series *BV* photometry of V1224 Cas were carried out. The spectroscopy reveals a spectral type of A3 for the star. Light curve modeling indicates that V1224 Cas is a short-period detached system containing a possible low-mass WD with an effective temperature of about 9516 K. Based on the effective temperature and the surface gravity of the A-type primary star from the spectroscopic results, the absolute parameters of the components were estimated as: $M_P = 2.16 \pm 0.22 M_\odot$, $R_P = 3.54 \pm 0.12 R_\odot$, $L_P = 55.9 \pm 6.9 L_\odot$, $M_S = 0.19 \pm 0.02 M_\odot$, $R_S = 0.97 \pm 0.04 R_\odot$, and $L_S = 6.9 \pm 0.6 L_\odot$. We therefore introduce V1224 Cas as a new EL CVn-type binary candidate. The light curves in both filters all show multi-periodic pulsations, superimposed on binary effects. We performed a preliminary frequency analysis of the light residuals after removing the synthetic eclipsing curve from the original observational data. The results suggest that the rapid light variations among the light curves could be attributed to the δ Sct-type primary component. We therefore conclude that V1224 Cas is very likely a WD+δ Sct binary.

Key words: binaries: eclipsing – stars: individual (V1224 Cas) – stars: variables: delta Scuti

Supporting material: data behind figure

1. Introduction

Low-mass white dwarf stars (WDs; $M \lesssim 0.45 M_\odot$), which likely harbor an He core, are generally thought to be the product of strong mass-loss episodes during the red giant branch phase of low-mass stars in interactive binary systems before the occurrence of He-flash (Marsh et al. 1995; Althaus et al. 2013; Istrate et al. 2016; Chen et al. 2017). When the mass transfer ends, the donor star still has a thick hydrogen envelope surrounding the helium core. The helium white dwarf precursor (pre-He-WD) then evolves to higher effective temperature at nearly constant luminosity through an active hydrogen burning shell. Recently, dozens of pre-He-WDs were found in EL CVn-type binaries (Maxted et al. 2014b; van Roestel et al. 2018), which consist of an A/F type main sequence star and a pre-He-WD ($M \sim 0.15$–$0.33 M_\odot$). Maxted et al. (2014b) discovered 17 EL CVn systems using the Super Wide Angle Search for Planets (SWASP) photometric database (Pollacco et al. 2006) and chose the brightest one, EL CVn, as the prototype of this class of eclipsing binaries. A total of 13 such samples were discovered in the *Kepler* survey. They are KOI 74, KOI 81 (Rowe et al. 2010; van Kerkwijk et al. 2010), KIC 10657664 (Carter et al. 2011), KOI 1224 (Bressan et al. 2012), KIC 9164561, KIC 10727668 (Rappaport et al. 2015), KIC 4169521, KOI-3818, KIC 2851474, KIC 9285587 (Faigler et al. 2015), KIC 8262223 (Guo et al. 2017), KIC 10989032, and KIC 8087799 (Zhang et al. 2017). By applying machine learning techniques, van Roestel et al. (2018) discovered 36 eclipsing EL CVn binaries using data from the Palomar Transient Factory.

Among the observed EL CVn-type binaries, several of them have been shown to pulsate. Multi-periodic pulsations had been detected on three very-low-mass pre-He-WDs in the EL CVn-type systems: WASP 0247-25 (Maxted et al. 2013), WASP 1628 + 10 (Maxted et al. 2014a), and KIC 9164561 (Zhang et al. 2016). Not only the pre-He-WD companion, but also the dwarfs, can also show pulsations. Five pulsating EL CVn-type binaries were reported (Maxted et al. 2014a; Faigler et al. 2015; Guo et al. 2017; Zhang et al. 2017), each consisting of a pre-He-WD and a δ Scuti-type pulsator. The δ Scuti stars are pulsating main sequence or less-evolved stars with masses in the range 1.5–2.5 $M_\odot$, situated in the extensive part of the Cepheid instability strip toward low luminosities (Breger 2000). Both radial and nonradial oscillations, driven by the κ mechanism, occur in δ Scuti stars with typical periods in the range 12 minutes to 8 hours (Aerts et al. 2010). To date, about 200 δ Scuti stars have been discovered in eclipsing binaries (Liakos & Niarchos 2017). Those with short orbital periods, such as oscillating eclipsing systems of Algol type (oEA stars; Mkrtichian et al. 2004), very probably undergo mass-transfer episodes resembling the EL CVn-type systems. Some of them may eventually evolve into exotic system containing a δ Sct-type pulsator plus a low-mass pre-He-WD companion. Such systems that have both binary properties and asteroseismology are interesting objects for exploring the stellar interiors and evolution.

In this work, we introduce V1224 Cas as a new EL CVn-type binary candidate containing a δ Sct-type pulsator. V1224 Cas (=UCAC4 733-108496, $\alpha_{J2000} = 23^h57^m38\overset{s}{.}59$, $\delta_{J2000} = +56°35'57\overset{''}{.}80$) is located in the field of the open cluster NGC 7789. The light variability of V1224 Cas was first noticed by Mochejska & Kaluzny (1999). Based on their sparse data, the authors classified this star as an EA-type eclipsing binary with an orbital period of 2.1077 days. Until now, the pulsating characteristics of V1224 Cas have not been reported.

As a contribution to the ongoing project to search for and study variable stars in the 50BiN open cluster survey (Wang et al. 2015b), we have performed time-series charge-coupled device (CCD) photometry of the open cluster NGC 7789.

Table 1
Log of Time-series Photometric Observations for NGC 7789

Date	Start Date (HJD 2457250+)	Length (hr)	Exposure Time (B, V) (in seconds)	Number of Frames (B, V)
2015 Aug 24	9.116	6.5	140, 70	137, 315
2015 Aug 29	14.116	2.7	100, 50	52, 154
2015 Aug 31	16.065	6.6	140, 70	125, 282
2015 Sep 04	20.265	3.1	140, 70	57, 150
2015 Sep 11	27.128	4.1	140, 70	87, 139
2015 Sep 13	29.049	8.5	140, 70	184, 411
2015 Sep 14	30.048	8.4	140, 70	180, 401
2015 Sep 16	32.135	6.3	140, 70	128, 300
2015 Sep 18	34.152	6.0	140, 70	123, 260
2015 Sep 30	46.043	7.3	140, 70	93, 360
2015 Oct 01	47.027	8.0	140, 70	164, 359
2015 Oct 03	49.018	7.7	140, 70	172, 369
2015 Oct 04	50.015	4.5	140, 70	88, 198
2015 Oct 06	52.014	8.2	140, 70	187, 385
2015 Oct 07	53.152	4.8	140, 70	115, 229
2015 Oct 08	54.026	7.7	140, 70	178, 370
2015 Oct 09	55.015	7.6	140, 70	168, 351
2015 Oct 10	56.112	5.4	140, 70	122, 260
2015 Oct 12	58.076	6.2	140, 70	147, 300
2015 Oct 13	59.005	7.8	140, 70	181, 376
2015 Oct 14	60.001	7.8	140, 70	180, 380

V1224 Cas was detected in the program field. With intensive observational data and careful analysis, we found that the star could very likely be the sixth EL CVn-type binary consisting of a low-mass pre-He-WD and a δ Scuti-type pulsator. We report the discovery in this paper.

2. Observations and Data Reduction

The photometric observations were made with the 50-centimeter binocular telescope at the Qinghai Station of Purple Mountain Observatory (Deng et al. 2013; Tian et al. 2016). This telescope, as the prototype of the 50 cm Binocular Network (50BiN), has two parallel camera systems. Each of them has a 2k $\times$ 2k Andor CCD camera and a set of standard Johnson/Cousins *UBVRI* filters. The pixel scale is about 0.59 arcsec/pixel and the field of view is $\sim$20 $\times$ 20 arcmin^2. Two filters, B and V, fixed on the two tubes, respectively, were applied to simultaneous two-color photometry. V1224 Cas was monitored on 21 nights (a total of $\sim$135.2 hr) from 2015 August 24 to October 14. An overview of the time-series photometric observations is given in Table 1.

The photometric reductions were performed by using an automated reduction pipeline (Wang et al. 2015b). It includes bias subtraction, flat-field correction, astrometric calibration, and photometry extraction. As we did not make observations of standard stars, the instrumental magnitudes of stars were standardized using 45 secondary standard stars in NGC 7789. Their standard magnitudes B and V were taken from Stetson Standard Star Catalog[3] (Stetson 2000). A detailed procedure was described in our earlier work (Wang et al. 2015b).

The instrumental magnitudes of time-series BV frames were calibrated with an ensemble normalization technique (Gilliland & Brown 1988). Following the same procedure used in Wang et al. (2015b), about 45 isolated standard stars were picked out for the calibration. Using the following normalization equations, the instrumental magnitudes (b, v) were transformed to the magnitudes (B, V) on the standard Johnson system.

$$B = b + a_1 + a_2(B - V) + a_3X + a_4Y, \quad (1)$$

$$V = v + c_1 + c_2(B - V) + c_3X + c_4Y, \quad (2)$$

where X and Y are the star positions on a CCD frame. The coefficients for each CCD frame a_1/c_1, a_2/c_2, a_3/c_3 and a_4/c_4 were calculated by the least-squares method with the 45 standard stars.

In order to make a better classification for the star, additional spectroscopic observations at low resolution were taken on 2017 September 15 with the Beijing Faint Object Spectrograph and Camera (BFOSC) attached to the 2.16 m telescope at Xinglong Station of the National Astronomical Observatories, Chinese Academy of Sciences (Fan et al. 2016). A low-resolution grism with a slit width of 1$''$.8 (G6 + filter of 385LP) was used during the observations. The spectra covers the wavelength range from 3300 to 5450 Å with a nominal resolving power of $\sim$2020. The unprocessed frames were reduced following the standard CCD

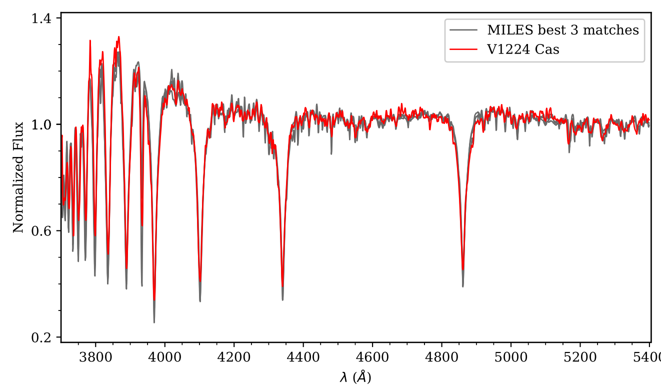

Figure 1. Normalized spectrum of V1224 Cas (red line) matching with three MILES standard spectra (gray line), whose average effective temperature and surface gravity are 8395.0 $\pm$ 422 K and 3.9 $\pm$ 0.24 dex, respectively.

[3] http://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/en/community/STETSON/standards/

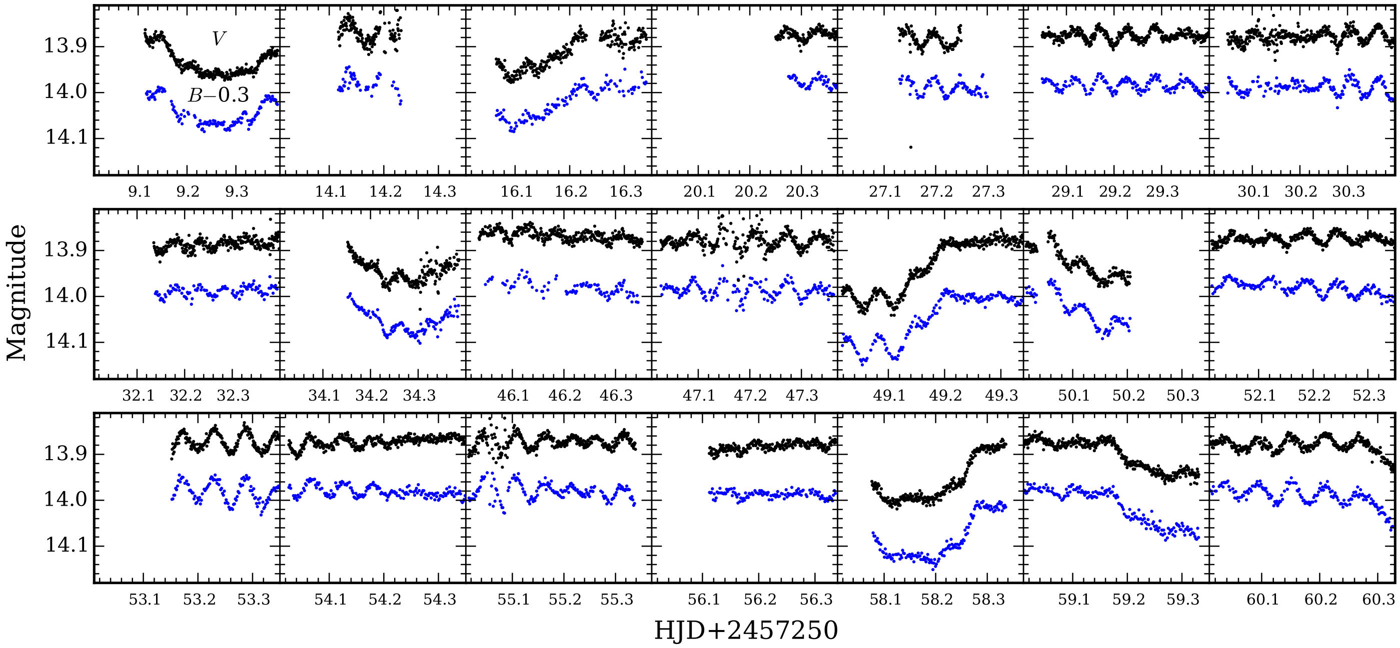

Figure 2. Original real-time B- and V-band light curves of V1224 Cas. The B-band points have been shifted by −0.3 mag in order to show light curve features more clearly. The data used to create this figure are available.

procedure in the IRAF package (Tody 1986, 1993). The CCD reductions include mainly bias subtraction and flat-field correction. Wavelength calibration was carried out using the Fe/Ar lamp. In Figure 1, we plot the normalized spectrum of V1224 Cas and the best three matches with the MILES standard spectra (Sánchez-Blázquez et al. 2006). It presents a typical feature of A-type stars. The best match of the spectrum of the system was found with that of an A3V standard star. The average effective temperature $T_{\rm eff}$ and surface gravity log g of the best three matches are 8395.0 ± 422 K and 3.9 ± 0.24 dex, respectively.

3. Light Curve Modeling and System Parameters

The original real-time B- and V-band light curves of V1224 Cas are displayed in Figure 2. A total of seven eclipse-like events were recorded in this observational season. In addition to the eclipse-like light variations, the light curves can also be seen to show short-term pulsations, with cycle length and amplitude that are characteristic of δ Scuti-like oscillations. As there are not enough minimum light times available, we employed the phased dispersion minimization (PDM) method (Stellingwerf 1978) to look for the orbital period of the binary system. The orbital period of V1224 Cas was calculated to be 2.27537 ± 0.00001 days, apparently longer than the result (2.1077 days) given by Mochejska & Kaluzny (1999). The phases of all of the measurements were computed with the reference epoch ($T_0 = 2457308.17$ days) and the newly derived orbital period. The phase-folded light curves are shown in the upper panel of Figure 3. The light curves of V1224 Cas all present a flat-bottomed primary eclipse and a slightly shallower secondary eclipse, similar to the EL CVn-type binaries (Maxted et al. 2014b; van Roestel et al. 2018). The depths of the two eclipses are estimated to be about 0.135 and 0.102 mag, respectively. These characteristics indicate that V1224 Cas may be a new EL CVn-type system with multi-periodic pulsations.

To test the above hypothesis and further clarify the pulsating properties of this binary system, our two-color light curves were simultaneously analyzed by applying the 2013 version of the Wilson–Devinney (W-D) binary code (Wilson & Devinney 1971; Wilson 1979, 1990, 2012). The light curve synthesis was carried out in a similar way to that for the eclipsing binaries KIC 9164561 (Zhang et al. 2016), HH UMa (Wang et al. 2015a), and V410 Aur (Luo et al. 2017). We designated the luminous primary component as star 2 and its surface temperature is fixed at $T_2 = 8395$ K from the former spectroscopic result. The corresponding bolometric limb-darkening coefficients (X_1, X_2, Y_1, Y_2) and monochromatic ones (x_1, x_2, y_1, y_2) were interpolated using the values from van Hamme (1993)'s tables with a logarithmic law. As V1224 Cas is an A-type star whose envelopes are probably in radiative equilibrium, we therefore adopted the theoretical values of the gravity-darkening exponents ($g_1 = g_2 = 1.0$, Lucy 1967) and the bolometric albedos ($A_1 = A_2 = 1.0$, Ruciński 1969). The

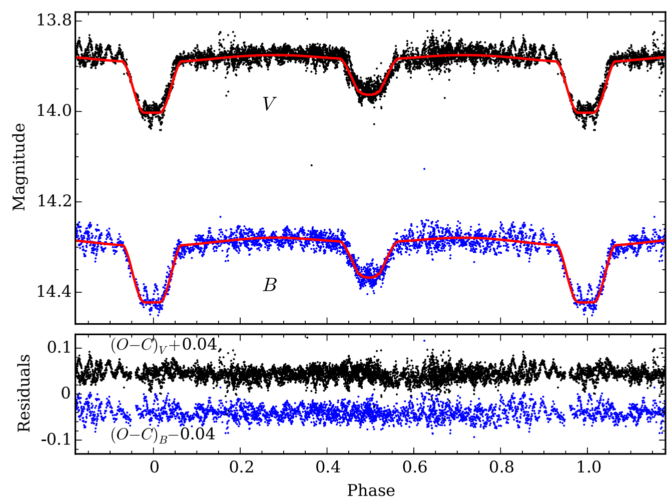

Figure 3. Top panel: phase-folded light curves of V1224 Cas compared to the theoretical synthesis (red solid lines). Bottom panel: the O–C residuals of light curves calculated as observed minus the theoretical value.

Table 2
Photometric Solutions and Physical Parameters of the Binary System V1224 Cas

Parameter	Component 1	System	Component 2
P_{orb} (days)	⋯	2.27537 ± 0.00001	⋯
i (degree)	⋯	76.3 ± 0.1	⋯
$q = M_2/M_1$	⋯	11.47 ± 0.07	⋯
$T_{eff}(K)$	9516 ± 26	⋯	8395[a]
Ω	21.549 ± 0.038	⋯	27.829 ± 0.045
$L_i/(L_1 + L_2)_B$	0.072 ± 0.003	⋯	0.928 ± 0.003
$L_i/(L_1 + L_2)_V$	0.068 ± 0.002	⋯	0.932 ± 0.003
r (pole)	0.0989 ± 0.0005	⋯	0.3581 ± 0.0016
r (point)	0.1015 ± 0.0005	⋯	0.3713 ± 0.0019
r (side)	0.0996 ± 0.0005	⋯	0.3678 ± 0.0018
r (back)	0.1012 ± 0.0005	⋯	0.3698 ± 0.0019
Absolute parameters:			
Semimajor axis ($R_\odot$)	⋯	9.67 ± 0.33	⋯
M ($M_\odot$)	0.19 ± 0.02	⋯	2.16 ± 0.22
R ($R_\odot$)	0.97 ± 0.04	⋯	3.54 ± 0.12
L ($L_\odot$)	6.9 ± 0.6	⋯	55.9 ± 6.9

Note.
[a] Fixed; $L_i/(L_1 + L_2)$ and r refer to the fractional luminosity and the equivalent radii of the two component stars, respectively.

Table 3
Results of the Fourier Analysis of the Residual Light Curves

Band	ID	Frequency (c/d)	Amplitude (mmag)	Phase	S/N
B	f_1	15.4516±0.0004	7.5 ± 0.3	0.385 ± 0.006	14.5
	f_2	19.2354 ± 0.0005	6.8 ± 0.3	0.860 ± 0.007	9.6
	f_3	17.6267 ± 0.0005	6.3 ± 0.3	0.833 ± 0.007	10.3
	f_4	18.1342 ± 0.0009	3.5 ± 0.3	0.964 ± 0.014	6.7
	f_5	25.7949 ± 0.0013	2.5 ± 0.3	0.516 ± 0.019	5.6
V	f_1	15.4516 ± 0.0004	5.9 ± 0.2	0.390 ± 0.006	9.8
	f_2	19.2347 ± 0.0004	5.5 ± 0.2	0.081 ± 0.006	9.8
	f_3	17.6263 ± 0.0004	5.4 ± 0.2	0.954 ± 0.006	10.4
	f_4	18.1330 ± 0.0008	2.9 ± 0.2	0.306 ± 0.012	6.2
	f_5	25.7943 ± 0.0016	1.4 ± 0.2	0.668 ± 0.024	4.8

adjustable parameters in the binary model are the mean surface temperature of star 1 (T_1), the phase shift, the orbital inclination (i), the mass ratio ($q = M_2/M_1$), the dimensionless potential of both components (Ω_1, Ω_2), and the monochromatic luminosity of star 1 (L_{1B}, L_{1V}). The subscripts 1 and 2 in this paper represent the two components being eclipsed at orbital phases 0.0 and 0.5, respectively.

Owing to the fact that there are no spectroscopic radial velocity measurements available for V1224 Cas, we first applied a photometric q-search method (Zhang et al. 2015) to look for an approximate mass ratio. This was then taken as a free parameter to be adjusted along with other adjustable parameters. Table 2 shows the final results from the best-fitting solution. Based on that information, we made the theoretical light curve and geometric configuration of V1224 Cas using the W-D binary model. We plotted the synthetic light curves (red solid lines) and the O–C residuals (observations minus calculations) in Figure 3.

The photometric solution suggests a detached configuration for V1224 Cas. The geometric configurations of the binary system at phases 0.0, 0.25, 0.50, and 0.75 are illustrated in Figure 4. It is impossible to calculate directly the physical parameters of the binary system due to no spectroscopic orbital element. Following Lee et al. (2017), the mass of the primary

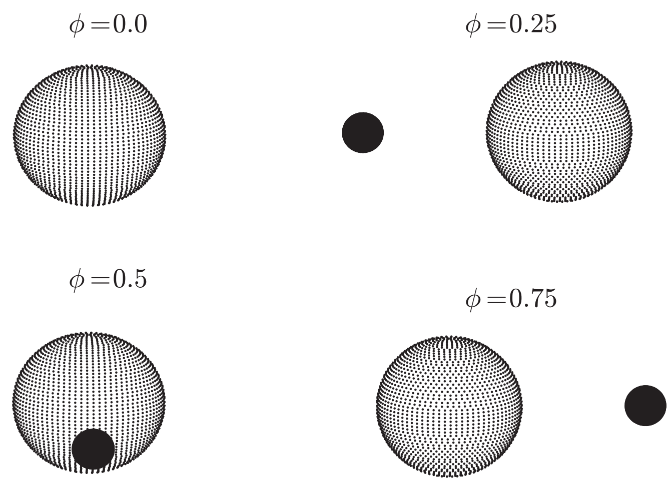

Figure 4. Geometric configurations of V1224 Cas at phases 0.0, 0.25, 0.5, and 0.75.

component was estimated to be 2.16 ± 0.22 $M_\odot$ using an empirical relation of the mass as a function of the observed T_{eff}, log g, and [Fe/H] (Torres et al. 2010), with an error of 10% assumed. The mass of 0.19 ± 0.02 $M_\odot$ for the secondary component can be easily obtained from the photometric mass ratio ($q = M_2/M_1$). The semimajor axis of the binary system was calculated to be 9.67 ± 0.33 $R_\odot$ according to Kepler's third law. The luminosity and radius of the two components were then computed and given in the bottom of Table 2. The bolometric corrections (BCs) corresponding to the effective temperature of each component were derived from the relationship between log T and BC (Flower 1996). With an interstellar absorption of $A_V = 0.868$ mag (Wu et al. 2007) and an apparent magnitude of $V_{max} = 13.857$ mag, the distance modulus $(m - M)_o$ of the system was estimated to be about 12.6 mag. This star appears in the *Gaia* second data release (DR2) catalog with a parallax of 0.2869 ± 0.0236 mas (Gaia Collaboration et al. 2018). Based on the parallax, the distance modulus of V1224 Cas is calculated to be about 12.71 mag,

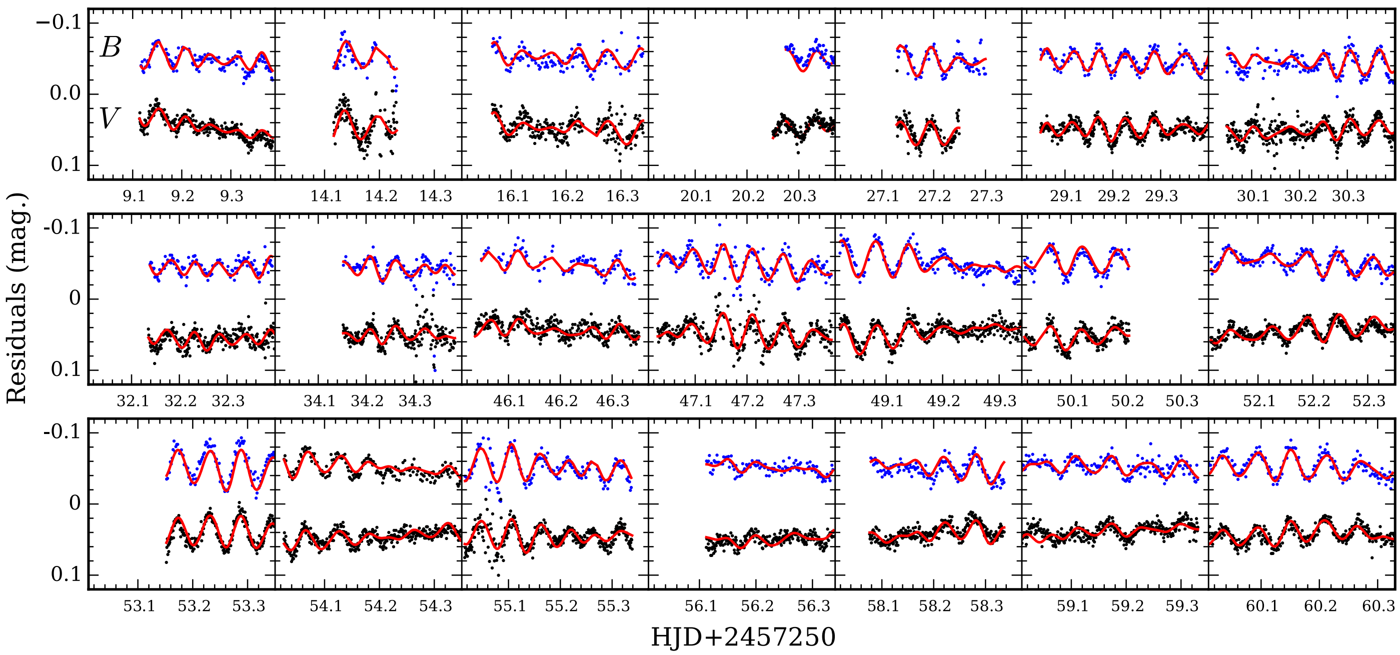

Figure 5. Light curve residuals of V1224 Cas after removing the binary curve and Fourier fitting using the five-frequency in Table 3.

which agrees very well with our previous estimate. It shows that the previous assumptions made in the analysis are reasonable. As a result, V1224 Cas is not a member of NGC 7789, because it is too large compared with the distance of the open cluster (see Table 1 in Wu et al. 2007).

4. Light Residuals and Frequency Analysis

The light curve residuals, obtained after subtracting the eclipsing light variations from the real-time light curves, are displayed in Figure 5 in the form of the magnitude versus HJD time instead of orbital phase. Here, the multi-periodic light variability of this star is clear. The peak-to-peak magnitude of the light variations is estimated to be about 60 mmag. To investigate the pulsation nature of V1224 Cas, we performed a frequency analysis on the *B*- and *V*-band residual light curves using the software package Period04 v.1.2 (Lenz & Breger 2005). The pre-whitening technique was also employed for consecutive detection of periodic signals in the light residuals. Only those peaks that have a signal-to-noise amplitude ratio (S/N) larger than 4.0 in both filters were picked out for further analysis (following Breger et al. 1993). Table 3 gives the main results of frequency analysis. The amplitudes and phases of all detected frequencies were determined by a nonlinear, least-squares fitting routine in Period04. Their uncertainties were calculated with the relations reported by Montgomery & Odonoghue (1999). We computed the noise levels on the basis of the residuals from the original data after pre-whitening all of the trial frequencies. The fitting curves to the original *B*- and *V*-band light curves were then made and displayed in Figure 5 with solid red lines. It indicates that the synthetic light curves adequately describe the observed light variations. In Figure 6, we plot the spectral windows and step-by-step amplitude spectra of both the *B*- and *V*-band data, wherein each spectrum panel was calculated based on the residuals that all the previous frequencies were pre-whitened.

The general features of the periodograms are typical of δ Scuti stars with multi-periodicity. Five significant peaks were detected in both the *B*- and *V*-filter data, with frequencies from 15.45 to 25.80 c/d and semi-amplitudes between 7.5 and 1.4 mmag. We examined the frequencies for possible combination ($f_i + f_j$ or $f_i + f_{\rm orb}$) or harmonic terms (Nf). The differences of f_3–$f_1 = 2.1749$ c/d, f_4–$f_1 = 2.682$ c/d, and f_5–$f_2 = 6.5595$ c/d are close to the values of $5f_{\rm orb} = 2.1975$ c/d, $6f_{\rm orb} = 2.6369$ c/d, and $15f_{\rm orb} = 6.5924$ c/d, respectively. All of this suggests that the three frequencies f_3, f_4, and f_5 are unlikely to be eigenmodes, but splitting components of f_1 and f_2 related to the orbital frequency $f_{\rm orb} = 0.43949$ c/d, respectively. The three frequencies f_3, f_4, and f_5 are excluded from the following discussion.

5. Summary and Conclusion

We have presented the time-series photometry and low-resolution spectroscopy of the eclipsing binary V1224 Cas. Based on this, we have studied the properties of light variations and the physical nature of the system. The spectroscopy reveals a spectral type of A3 for V1224 Cas. The light curves in both filters closely resemble those of the EL CVn-type systems with multi-periodic pulsations. We analyzed the eclipsing light curves by applying the W-D method. The photometric solution suggests that V1224 Cas is in a detached state with a very small mass ratio of $\sim$0.087. The derived physical parameters in Table 2 indicate that the primary component of V1224 Cas is somewhat evolved, over-luminous, and oversized, but still resides within the main sequence band after a comparison of the mass–radius and mass–luminosity diagrams (Ibanoğlu et al. 2006). On the contrary, the secondary star is highly evolved, remarkably oversized, and over-luminous. Based on a mass of $\sim$0.19 $M_\odot$, the secondary component of V1224 Cas can be thought to be a low-mass pre-He-WD. V1224 Cas can be further classified as a new EL CVn-type binary candidate consisting of a low-mass pre-He-WD and an A-type star.

The light curves of V1224 Cas shows multi-periodic pulsations in addition to the eclipse-like light changes. The photometric solutions reveal that the less-massive secondary

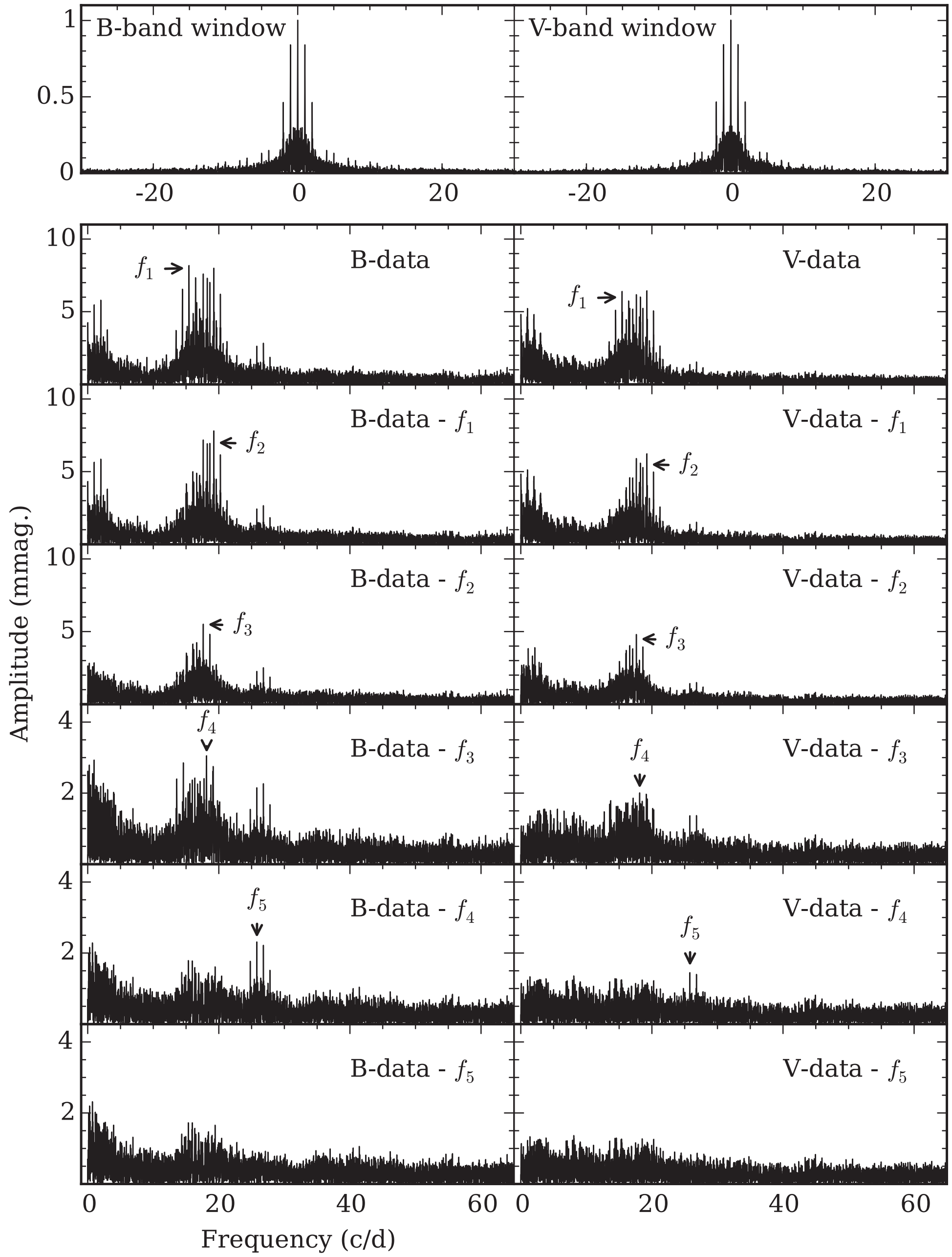

Figure 6. Spectral windows and the step-by-step amplitude spectrum of V1224 Cas after subtracting the final binary model from the original light curves.

component is quite faint and contributes only ∼7% to the total luminosity of the system. Accordingly, the short-term light variations can be put down to the intrinsic pulsations of the A-type primary star rather than the low-mass pre-WD component, as it cannot cause such pulsations with a semi-amplitude as high as ∼30 mmag. It can be seen in Figure 2 that the pulsations at the deeper primary light minimum appear to be more significant than those at the slightly shallower secondary light minimum. This indicates that the deeper eclipse could be attributed to the eclipse of the hotter pre-WD star by the A-type primary component, which in turn supports an EL CVn-type system for V1224 Cas.

After subtracting the binary effects from the original observational data, we carried out a Fourier analysis of the light residuals to investigate the pulsation properties in detail. This led to the detection of five confident pulsating frequencies in both *B*- and *V*-band data, including two eigenmodes ($f_1 = 15.4516\ c/d$, $f_2 = 19.2351\ c/d$) and three probable harmonics. The ratios of the pulsational to the orbital periods are determined to be 0.028 and 0.023, both of which are within the upper limit of 0.09 for δ Sct stars in binaries (Zhang et al. 2013). Following Zhang et al. (2013), the mean density of the pulsating primary component is calculated to be $\rho_1/\rho_\odot = 0.049$. Based on the well-known equation $Q = P_{\rm pul}(\rho_1/\rho_\odot)^{1/2}$, the pulsation constants of f_1 and f_2 are computed to be 0.0143 and 0.0115 days, respectively, corresponding to p modes of δ Sct stars. The behaviors of the light curves, the period ratios, and the pulsation constants all suggest that the primary component of V1224 Cas is a δ Sct variable. As a conclusion, V1224 Cas could be a new EL CVn-type binary consisting a low-mass pre-He-WD and a δ Sct pulsator.

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Software: Period04 v.1.2[4] (Lenz & Breger 2005), IRAF (Tody 1986, 1993), Wilson–Devinney (W-D) binary code[5] (Wilson & Devinney 1971; Wilson 1979, 1990, 2012), Matplotlib (Hunter 2007).

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