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THE FIRST PRECISION CCD OBSERVATIONS OF THE NEGLECTED, DWARF CONTACT BINARY V524 MONOCEROTIS

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Wachmann (1966) discovered V524 Monocerotis [HBV 463, GSC 153 1410, RA(2000)= $6^{\rm h}59^{\rm m}1\overset{\rm s}{.}2$, DEC(2000) = $+02^\circ12'51''$] in his study of 38 variables in the field SA 98. An ephemeris (P = 0.28361714 d) and 39 times of minimum light are given in his paper. His photographic light curve indicates that V524 Monocerotis is a W UMa contact binary. Hoffmann (1981) presented a low-precision B light curve along with two times of minimum light. He suggested that it is of A-type (more massive component is hotter). During a recent observing run at Cerro Tololo InterAmerican Observatory in Chile, we were able to include this 15th mag neglected very short period system in our observing schedule. Our present observations were taken with the 0.9-m reflector and the CFIM T2K CCD with standard UBV$(RI)_C$ filters on 31 December 2002 and 1 January 2003, by RGS. The observations are available through the IBVS-website as `5404-t2.txt`. The images were calibrated and the magnitudes extracted using standard IRAF procedures. Around 100 observations were taken in each pass band. An unnamed comparison star [RA(2000) = $06^{\rm h}59^{\rm m}3\overset{\rm s}{.}8$, DEC(2000) = $+02^\circ14'52''$] and the check star [GSC 153 1435, RA(2000) = $6^{\rm h}58^{\rm m}54\overset{\rm s}{.}8$, DEC(2000) = $+02^\circ15'37''$] are shown in Figure 1 as C and K, with the variable, V. Both BBSAG (1998, 1987, 1986, 1984) and Zejda (2002) give additional times of minimum light.

Table 1: Times of Minimum Light, V524 Mon

JD Hel. 2450000+	Min	Cycles	$O-C_1$	$O-C_2$
2640.74555 (28)	II	−3.5	0.00086	0.00024
2641.73843 (66)	I	−0.0	0.00108	0.00046

Two mean epochs of minimum light were determined from a primary and secondary eclipse using and comparing the results from bisection of chords and parabola fits. These precision epochs of minimum light are given in Table 1 along with their standard errors shown in parentheses. The data indicates a variable period. A linear ephemeris was calculated using the most recent timings from the last 29,000 orbits.

$$\mathrm{HJD}_{\mathrm{MinI}} = 2452641.73735(213)d + 0.283616062(126)E(1).$$

The following quadratic ephemeris provides a good fit to the available minima. Fifty minima spanning some 82,500 cycles or 64 years were used in this study.

$$\mathrm{HJD_{MinI}} = 2452641.73797(113)d + 0.2836160386(9)E - 1.1(1) \times 10^{-11}E^2.(2)$$

The linear residuals from the equations 1 and 2 are given as $O - C_1$ and $O - C_2$ above. The $O - C_2$ residuals are shown in Figure 2. Our quadratic result is significant at the 5 sigma level. This may indicate that the system is losing angular momentum via magnetic braking, i.e., it is slowly coalescing.

The $UBVRI$ normalized flux light curves and the $U-B$, $B-V$ and $R-I$ color curves of the variable are shown as Figure 4 as calculated from the differential magnitudes (VAR - COMP) versus phase. The probable errors of a single observation were under 1% in B, V, and R and I and about 2.5% in U.

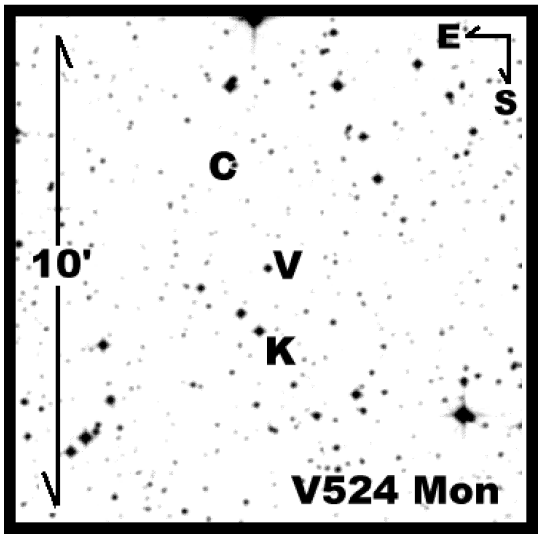

Figure 1. Finder chart

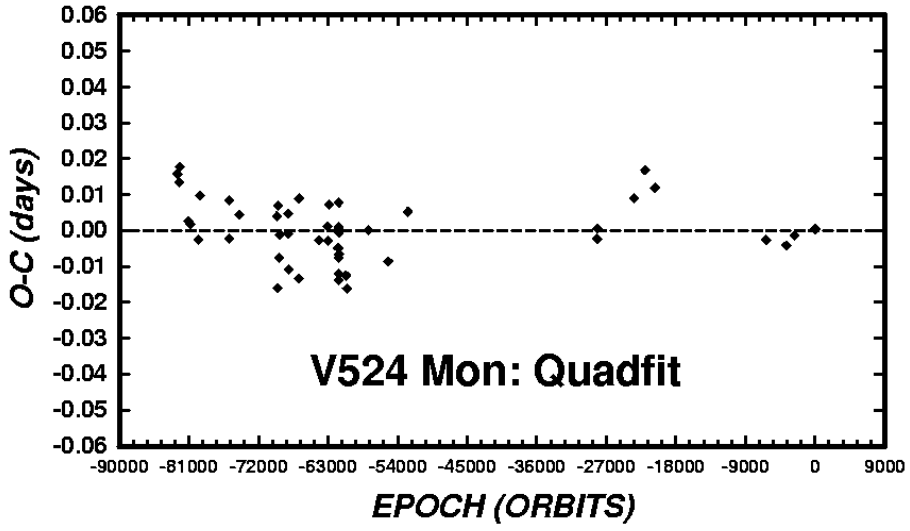

Figure 2. $O - C$ residual plot

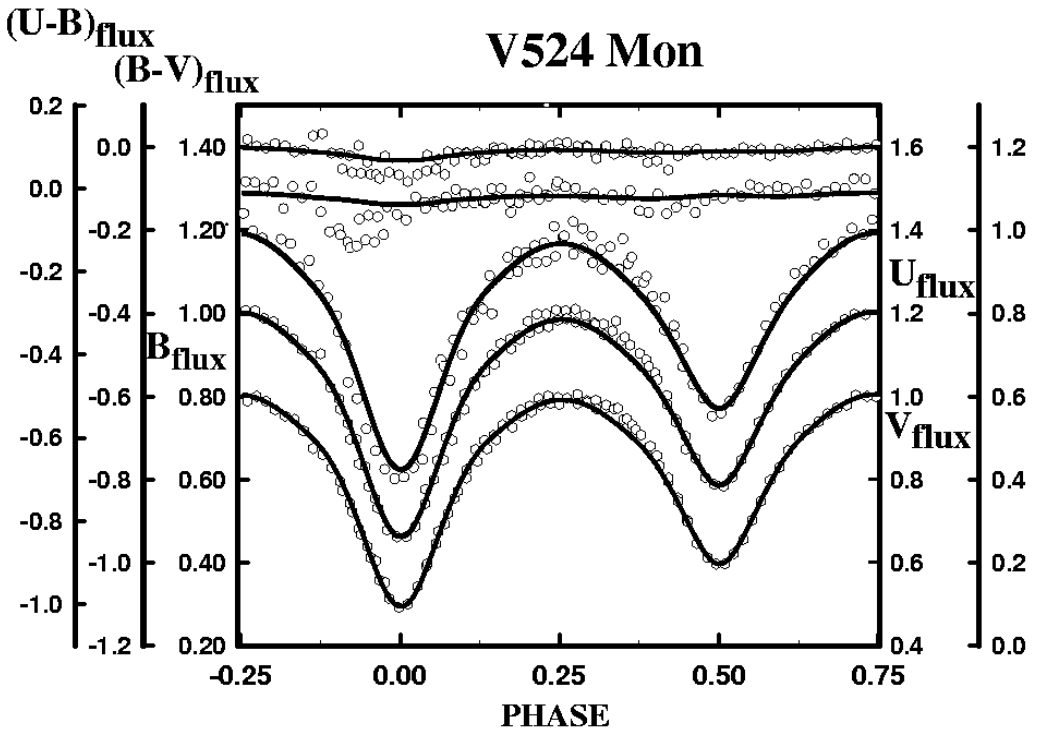

Figure 3. UBV light curves

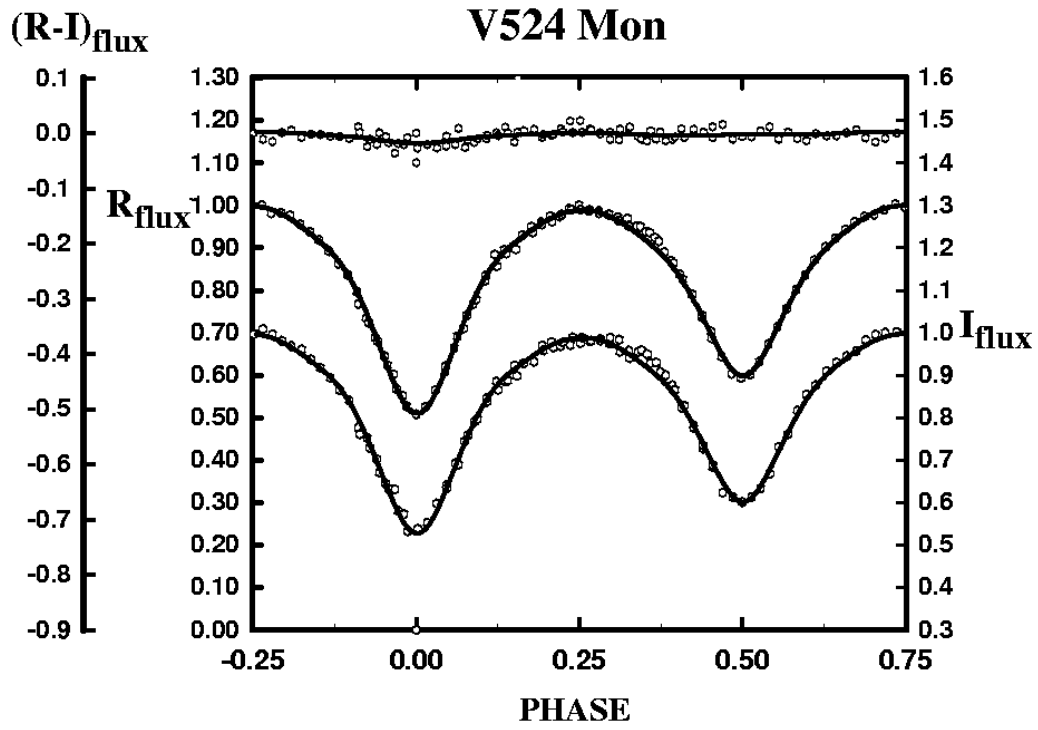

Figure 4. RI curves

We have calculated models for the light curve. First we hand modelled a Binary Maker 2.0 (Bradstreet, 1992) solution in B and V. A shallow contact W-type model gave the best fit. It included $m2/m1 = 1.4$ with a fill-out of only 5%. From these starting values a simultaneous 5 color synthetic light curve solution was calculated using the Wilson Code (Wilson & Devinney, 1971; Wilson, 1990, 1994). The final parameters include $m2/m1 = 1.84$ (1), fill-out 4.5%, $T1 - T2 = 353(20)$ K, and an inclination 79.1(1). A hot spot was modelled on the primary component (star 1). This included a co-latitude of 125(2) degrees and longitude 116(4) degrees, spot radius 14.3(7) and temperature factor of 1.142(9). Our UBVRI solution is shown overlaying the data in Figure 3 and 4. The curves are of W-type, with the larger star having the cooler surface. This indicates the presence of heavy, saturated magnetic activity. The Roche lobe model is shown as Figure 5.

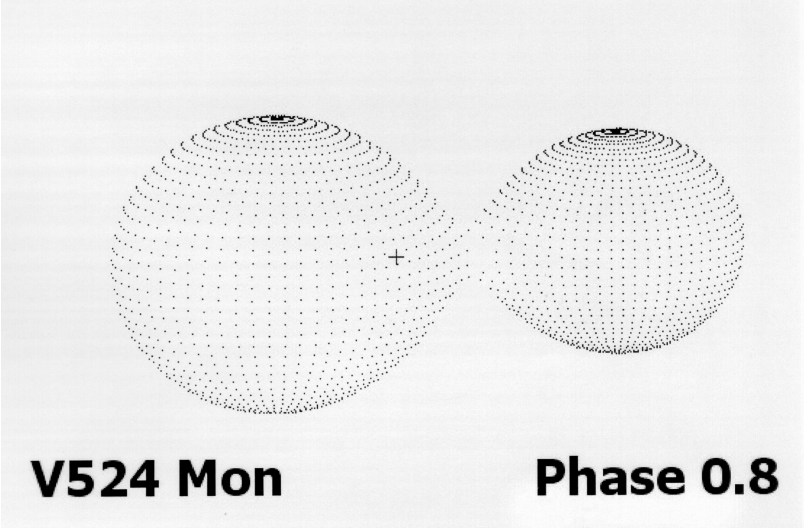

Figure 5. Roche lobe figure

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