COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 6127

Konkoly Observatory
Budapest
12 January 2015

HU ISSN 0374 – 0676

NULL CORRELATION BETWEEN THE O'CONNELL EFFECT AND ORBITAL PERIOD CHANGE FOR SW Lac, CN And, AND V502 Oph

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Introduction

One peculiar feature observed in the light curves of some eclipsing binaries is the asymmetry in the heights of the maxima, known as the O'Connell effect. Although it has been called "one of the celebrated difficult problems in the field of close binary systems" (Liu and Yang 2003), the O'Connell effect has still not been conclusively explained for the majority of the systems exhibiting it.

The first careful study of this phenomenon was carried out by Mergentaler (1950), followed by a statistical study of the asymmetry by O'Connell (1951). O'Connell searched for correlations between the size of the asymmetry and other parameters, such as the orbital period and the depths of the eclipses, the relative dimensions of the component stars, and their atmospheric densities. He found that the size of the asymmetry tended to be greater at shorter optical wavelengths. A similar result was found by Davidge and Milone (1984), although the color correlation they determined was opposite in sign.

Eclipsing binary systems such as SX Cassiopeiae, ST Centauri, and RV Ophiuchi have maintained a constant O'Connell effect over many decades (Davidge and Milone 1984). However, in many other systems, e.g. CG Cygni, YY Eridani, RT Lacertae, and XY Ursae Majoris (Milone et al. 1979; Yang and Liu 1999; Cakirli et al. 2003; and Pribulla et al. 2001), this effect is observed to vary significantly over many cycles.

Many theoretical models have been developed for explaining the O'Connell effect, such as the presence of starspots on one or both components in the binary system (see Berdyugina 2005 for an introduction to starspot theory), the impact of a mass-transferring gas stream flowing from one component to the other, circumstellar matter, and asymmetric circumfluence due to Coriolis forces (Liu and Yang 2003).

In this paper, we present the results of our investigations of three eclipsing binary systems that exhibit a variable O'Connell effect: SW Lacertae, CN Andromedae, and V502 Ophiuchi. Each of these systems is known to also have a variable orbital period. In addition to making new photometric observations of these systems, we looked for evidence of correlation between the change in the orbital period of the systems and the size of the asymmetry in the maxima.

Remarks on Individual Systems

SW Lacertae

Photometric variability of SW Lacertae was discovered by Miss Ashall (Leavitt 1918) on plates taken at Harvard Observatory. Since that time, the system has been observed photoelectrically and photometrically by many observers, including Jordan (1929), Schilt (1924), Serkowski (1956), Brownlee (1957), Hinderer (1960), Broglia (1962), Bookmyer (1965), Faulkner and Bookmyer (1980), Essam (1992), Lee et al. (1991), Djuraševic et al. (2005), Gazeas et al. (2005), and Alton & Terrell (2006). The system has been of continuous interest due to its short orbital period of 0.3207209 d, conspicuous changes in the period of the system, and variability in the light of the system at out-of-eclipse phases. Panchatsaram and Abhyankar (1981) and Pribulla et al. (1999) suggest that the variation in the orbital period of the binary system is due to the presence of two additional unseen components, making it a quadruple system. Light curve variations in this system are usually attributed to the presence of starspots in one or both of the components of the system (Stepien 1980, Binnendijk 1984, Leung et al. 1984, Lee et al. 1991, Eaton 1986, Jeong et al. 1994, Djuraševic and Erkapic 1997, Pribulla et al. 1999, Djuraševic et al. 2005). SW Lac belongs to the W-type subclass of W UMa binaries (Binnendijk 1984) with spectral type G5V (Gazeas et al. 2005).

CN Andromedae

Variability of CN Andromedae was discovered by Hoffmeister (1949) and was first classified as an Algol-type binary with an orbital period of 2.599 d (Tsesevich 1956). Löchel (1960) later classified it as a W UMa-type binary with the period of 0.462798 d. Additional photometric observations of the systems have been carried out by Bozkurt et al. (1976), Seeds and Abernethy (1982), Kaluzny (1983), Michaels et al. (1984), Evren et al. (1987), Keskin (1989), Samec et al. (1998), Van Hamme et al. (2001), Zola et al. (2005), Jassur and Khodadadi (2006), and Lee & Lee (2006). Kaluzny (1983) reclassified the system as β Lyrae-type because of the difference in the depths of the minima. The change in the orbital period of the system has been explained by the mass transfer from the primary to the secondary component and/or by magnetic breaking as a result of strong system activity (Samec et al. 1998). CN And is an active solar type binary with components of spectral type in the F5 to G5 range (Zola et al. 2005). Flare events (Yang and Liu 1985) and X-ray emission (Shaw et al. 1996) have also been detected in the system.

V502 Ophiuchi

V502 Ophiuchi was discovered by Hoffmeister (1935) to be an eclipsing binary. Photometric observations of the system have been carried out by Kwee (1968), Wilson (1967), Binnendijk (1969), Vader & van der Wal (1973), Maceroni et al. (1982), Rovithis et al. (1988), Zola and Krzesinski (1988), and recently by Selam et al. (2009). The system has an orbital period of 0.453388 d, but its period variation has not been observed over as long a time as the other systems examined in this paper. This change in the period of the system can be explained in terms of the mass transfer from more massive to less massive component, or angular momentum loss from the system by magnetically driven wind (Vilhu 1982). The asymmetric maxima of the light curves have been attributed to the existence of the cool spot on the secondary component (Rovithis et al. 1988). The primary and the secondary component have been classified as having the spectral type of G1V and F9V, respectively (Struve and Zebergs 1959).

New Photometric Observations

We observed the three eclipsing binary systems V502 Oph, SW Lac, and CN And, using a 20-cm Meade LX200GPS telescope at the Truman State University Observatory in Kirksville, Missouri. An SBIG ST-9XE CCD camera with Johnson BVRI filters was used for all observations.

V502 Oph was observed for 11 nights between June 29 and July 18, 2010. SW Lac and CN And were observed for 7 nights between July 10 and 19, 2010 and 4 nights between August 7 and 12, 2010, respectively. Astronomers Control Panel (ACP) was used to communicate between the telescope, CCD camera, focuser, and observatory dome. The telescope and CCD camera were controlled by Maxim DL, which was also used to analyze the acquired images and to create the light curves.

The resulting differential light curves for SW Lac, CN And, and V502 Oph in *B, V, R,* and *I* filters are shown in Figures 1, 2, and 3 respectively. Some of the light curves have been adjusted by adding a constant offset in order to improve the legibility of the figures.

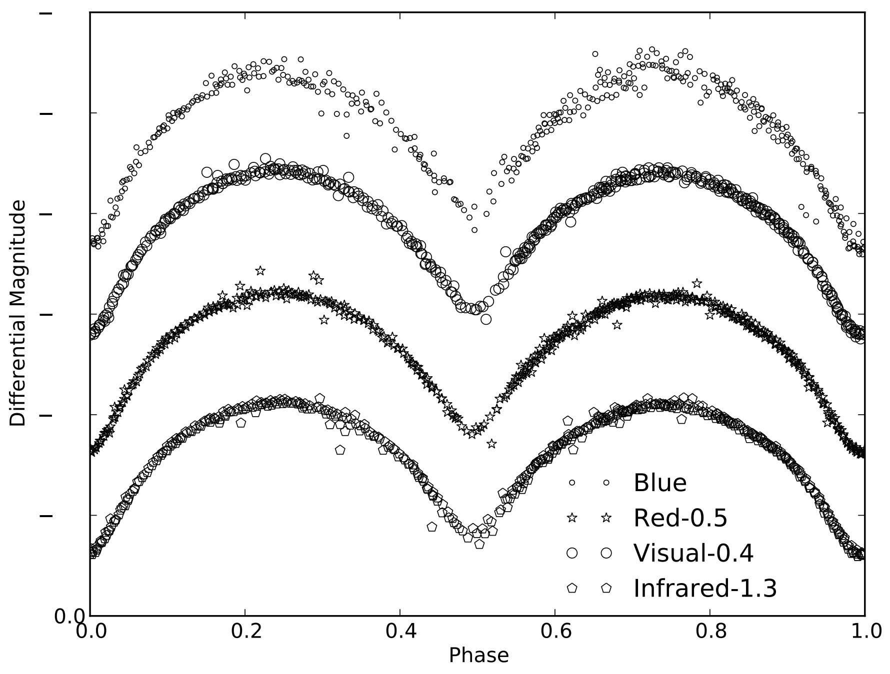

Figure 1. *BVRI* light curves of SW Lac acquired in 2010, August. Data for the *V, R,* and *I* filters are offset for clarity.

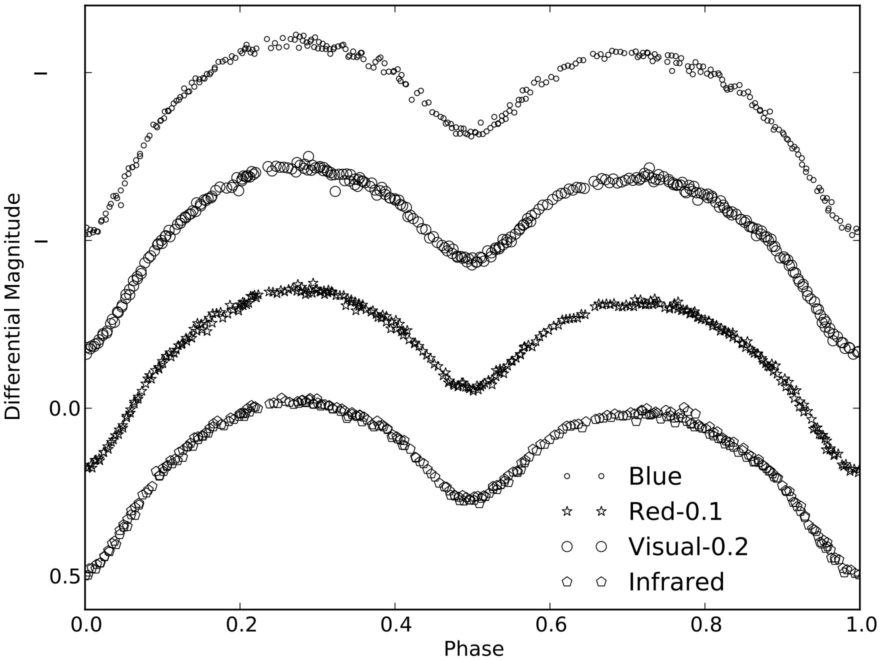

Figure 2. *BVRI* light curves of CN And acquired in 2010, July. Data for the *V* and *R* filters are offset for clarity.

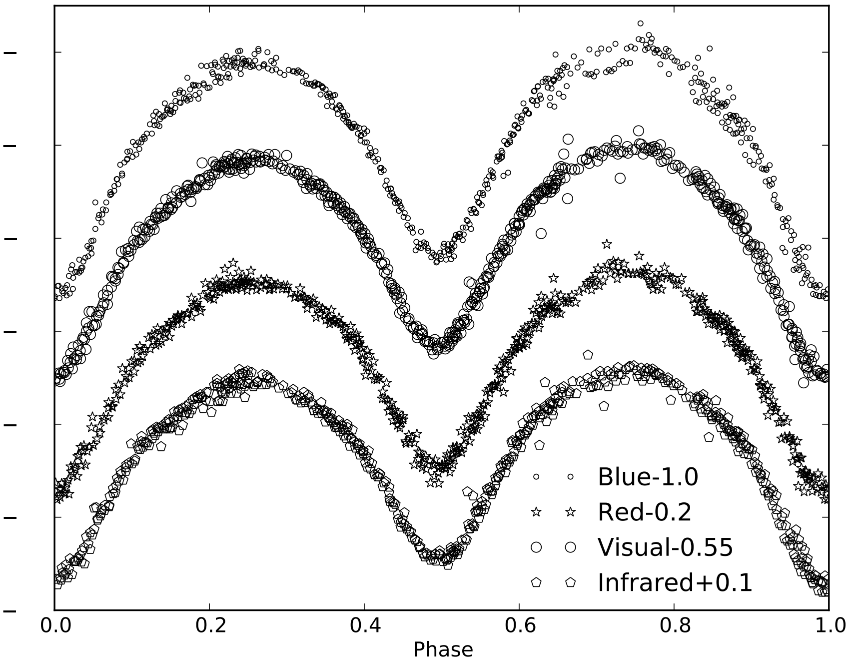

Figure 3. *BVRI* light curves of V502 Oph acquired in 2010, June-July. Data for the *V* and *R* filters are offset for clarity.

Analysis of Historical Data

A key element of our study is the investigation of the relationship between the change in the orbital period and the variation in the asymmetry in the maxima in some eclipsing binaries. For this reason, we chose the well-studied O'Connell effect systems SW Lac, CN And, and V502 Oph. We have combined our new photometric data with a reexamination of light curves from the literature in order to explore relationships between the size and sign of the O'Connell effect and variations in the orbital period of the binary systems.

To compute the O'Connell effect (Δm), we fit a 16-term Fourier series to the observational data (Wilsey and Beaky 2009). Using the fitted curve, Δm is calculated as the difference between the two maxima given as

$$\Delta m = (\text{magII} - \text{magI}) \times 1000 \text{ mmag},$$

where magI and magII are the magnitudes of primary and secondary maxima respectively. Thus, the brighter primary maximum corresponds to the positive O'Connell effect, whereas the brighter secondary maximum corresponds to the negative O'Connell effect. Table 1 gives the values of the O'Connell effect of the three systems studied in all filters based on our photometric data from 2010.

Table 1: Δm (millimagnitudes) for the light curves in Figs. 1, 2, and 3.

Star Name	*B*	*V*	*R*	*I*
SW Lac	−1±10	18±6	18±6	11±7
CN And	32±3	34±3	41±5	38±4
V502 Oph	−27±5	−23±5	−24±4	−15±6

Figures 4, 5, and 6 show the measure of the O'Connell effect in SW Lac, CN And, and V502 Oph, respectively, together with the Eclipse Timing Variations (ETV) data for the systems, plotted against the year of observation. In all cases the size of the O'Connell effect varied only slightly between measurements made with different filters. Figure 4 through 6 contain the data for *V* filter (left) and *B* filter (right). ETV data for each of the three systems was acquired from the website (`var.astro.cz/ocgate/`), using the default ephemeris provided. The ETV data for SW Lac represent an average value per year, but those for CN And and V502 Oph are not averaged due to the lack of sufficient data points.

Discussion

Observational Light Curves

The O'Connell effect in SW Lac has switched from positive and negative several times in the past 60 years. During our observation period in the summer of 2010, SW Lac was observed to have a small positive O'Connell effect, which is difficult to detect visually in the light curves shown in Figure 1. The light curve in the B filter is comparatively noisier than those in other filters, especially at the secondary maximum. Its effect can be seen in the value of Δm for the *B* filter, which has a different sign than the values for *VRI* filters.

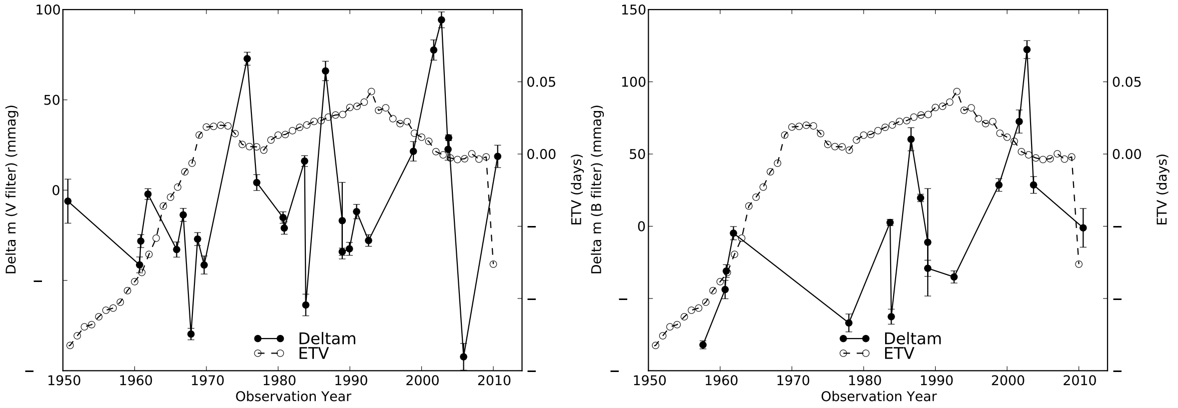

Figure 4. Measurement of the O'Connell effect Δm (left axis) and ETV values (right axis) for SW Lac between 1949 and 2010. The left and right plots represent the data for Visual and Blue filters respectively. The list of references and observation dates for SW Lac is presented in Table 2. Each ETV data point represents an average value per year.

Table 2: Observers and dates of observation for the photometric data on SW Lac in Figure 4.

Reference	Observation Date
Eaton (1986)	Dec., 1976
Eaton (1986)	Oct. and early Nov., 1980
Lafta & Grainger (1985)	Aug. 6 - Sept. 7, 1983
Lee et al. (1991)	Oct. 9 - Nov. 21, 1988
Mikolajewska & Mikolajewski (1981)	Autumn 1975
Mikolajewska & Mikolajewski (1981)	Autumn 1980
Muthsam & Rakos (1974)	Autumn 1960
Gazeas et al. (2005)	Sept. 20 - 21, 2003
Semeniuk (1971)	Aug. 28 - Sept. 26, 1968
Semeniuk (1971)	Aug. 6 - Sept. 8, 1969
Serkowski (1956)	July 10 - Oct. 5, 1950
Bookmyer (1965)	Aug. 29 - Nov. 23, 1960
Bookmyer (1965)	Aug. - Nov., 1961
Essam et al. (1992)	July 1 - 14, 1986
Albayrak et al. (2004)	2001
Albayrak et al. (2004)	2002
Djurašević et al. (2005)	2003
Hrivnak & Goehring (1991)	Oct. - Nov., 1990
Jeong et al. (1994)	Oct. 9 - Nov. 21, 1988
Alton & Terrell (2006)	Oct. 1, 2005
Zhang et al. (1992)	July 29 - 30, 1992
Niarchos (1987)	Oct. 1 - 4, 1983
Peña et al. (1993)	Nov. 1 - 6, 1989
Pribulla et al. (1999)	Aug. - Dec., 1998
Ruciński (1968)	Oct. 5 - 7, 1965
Ruciński (1968)	Sept. 10 - 25, 1966
Stepien (1980)	Sept. 26 - Oct. 9, 1967

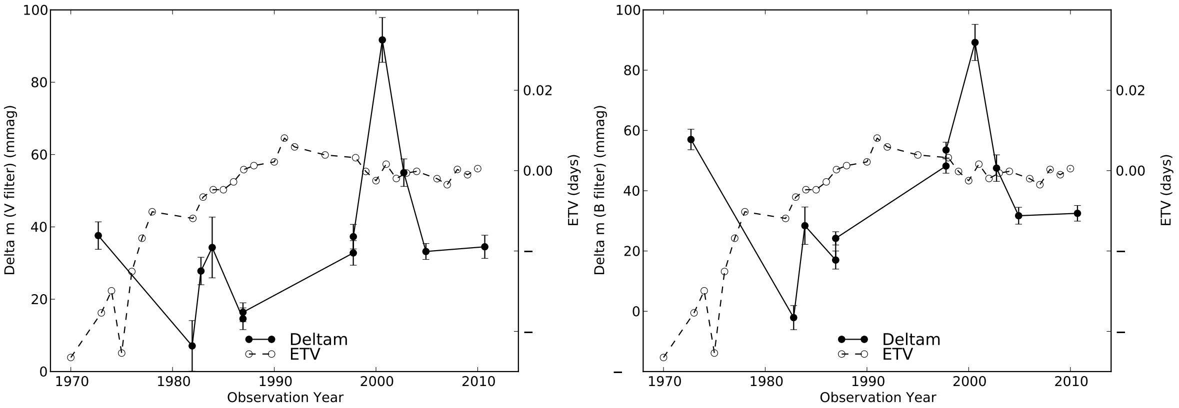

Figure 5. Measurement of the O'Connell effect Δm (left axis) and ETV values (right axis) for CN And between 1970 and 2010. The left and right plots represent the data for Visual and Blue filters respectively. The list of references and observation dates for CN And is presented in Table 3. Each ETV data point represents an average value per year.

Table 3: Observers and dates of observation for the photometric data on CN And in Figure 5.

Reference	Observation Date
Van Hamme et al. (2001)	Sept. 7 - 11, 1997
Jassur & Khodadadi (2006)	Summer 2000
Kaluzny (1983)	Aug. 15 - Oct. 18, 1982
Keskin (1989)	Oct. 8 - Nov. 27, 1986
Bozkurt et al. (1976)	July 13 - Sept. 12, 1972
Michaels et al. (1984)	Sept. 30 - Nov. 15, 1984
Evren et al. (1987)	Oct. 8 - Nov. 28, 1986
Lee & Lee (2006)	Sept. 24 - Dec. 1, 2004
Samec et al. (1998)	Sept. 4 - 10, 1997
Seeds & Abernethy (1982)	Oct. 3 - Dec. 7, 1981
Zola et al. (2005)	Aug. 19 - Sept. 4, 2002

Like SW Lac, the O'Connell effect in both CN And and V502 Oph have varied significantly over the past several decades. In 2010, CN And exhibited a positive O'Connell effect, while V502 Oph had a negative O'Connell effect. For both systems, the sign and magnitude of our new values of Δm is consistent across all filters and with the most recently observed light curves (2004 for CN And, and 2005 for V502 Oph). The O'Connell effect in CN And has always been observed to be positive, but has varied from a few millimagnitudes to almost 100 mmag. Likewise, V502 Oph has also exhibited large swings in the size of the O'Connell effect. At some point between 1987 and 2005, the value of Δm changed from positive to negative, and remained negative in our 2010 measurements.

The variations in the O'Connell effect (Figures 4, 5 and 6) suggest that the cause of the light curve asymmetries in the three systems is highly dynamic. Ideally, a model which accounts for the change in the asymmetry as some function of time (Lanza et al. 1993, 1994) should be adopted, though no such model currently exists. In the case of SW Lac, a recent Doppler imaging study has identified the presence and location of starspots on both components (Şenavcı et al. 2011).

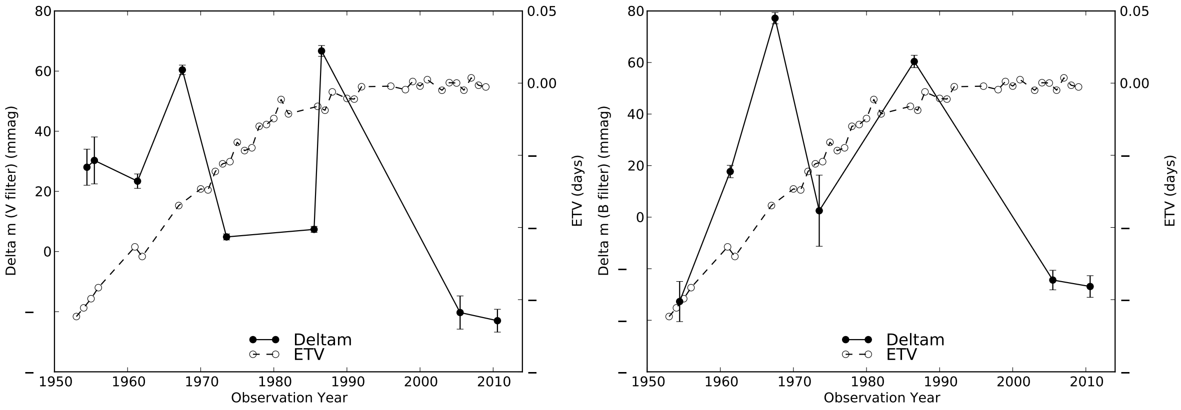

Figure 6. Measurement of the O'Connell effect Δm (left axis) and ETV values (right axis) for V502 Oph between 1953 and 2010. The left and right plots represent the data for Visual and Blue filters respectively. The list of references and observation dates for V502 Oph is presented in Table 4. Each ETV data point represents an average value per year.

Table 4: Observers and dates of observation for the photometric data on V502 Oph in Figure 6.

Reference	Observation Date
Binnendijk (1969)	May 20 - June 3, 1967
Kwee (1968)	April - June, 1955
Rovithis et al. (1988)	May - June, 1986
Selam et al. (2009)	2005
Vader & van der Wal (1973)	May 30 - June 26, 1973
Wilson (1967)	Apr. 4 - 16, 1961
Zola & Krzesinski (1988)	1985

Orbital Period Change and the O'Connell effect

In addition to a varying O'Connell effect, SW Lac, CN And, and V502 Oph have exhibited a continuous change in their orbital period for as long as they have been observations. The ETV diagrams for CN And and V502 Oph are close to parabolic, while that for SW Lac is more irregular.

The variation in the period of SW Lac might be due to the existence of a third component or may be attributed to the intrinsic variability of the system, mainly to mass-loss by one or both components caused by dynamic instability (Kopal 1959). A detailed analysis of the ETV diagram performed by Pribulla et al. (1999) revealed the presence of two possible extraneous bodies, and they suggested a mass transfer rate of $2.32 \times 10^{-7} M_{\odot} y^{-1}$ to explain the period increase observed in SW Lac. The decrease in the orbital period of CN And could be interpreted in terms of mass transfer form the Roche lobe-filling primary to the slightly underfilling secondary component at the rate of $4.82(6) \times 10^{-8} M_{\odot} y^{-1}$. Similarly, the decrease of the period in V502 Oph can be explained in terms of the mass transfer from more massive to less massive component, or angular momentum loss from the system by magnetically driven wind (Vilhu 1981, 1982), or the presence of a third body (Derman et al. 1991).

The magnetically induced structural variations during the magnetic cycle of a convective component of a close binary system, together with tidal spin-orbit coupling, has an effect in the period of such systems (Applegate 1989). Thus, a correlation between variations in orbital period change and other measures of the magnetic activity might be expected. If the asymmetry in the maxima is alleged to be caused by starspot, which is an indicator of magnetic, activity, then there may be a correlation between changes in the orbital period and the light curve asymmetry (Derman et al. 1991; Lanza & Rodonò, 2004).

Figures 4 through 6 do not indicate any strong correlation between the orbital period change and the size of the asymmetry in the maxima of the light curves in any of the three systems over the past 60 years. Variations in Δm appear to be largely random, while the ETV diagrams indicate a generally steady change in orbital period. One could make the claim for periodicity in the Δm values for SW Lac, with a period of about 10 to 15 years. Likewise, the meandering nature of the ETV diagram for SW Lac could arguably arise from a superposition of a parabolic term and an oscillating term with a period of 10 to 20 years.

Future Directions

The greatest impediment to identifying patterns in long-term variations of the O'Connell effect in contact binaries over time is the irregularity with which light curves have been acquired. Both CN And and V502 Oph are interesting and dynamic systems, yet their light curves have been obtained only once or twice per decade, on average. Even SW Lac, one of the best observed contact binaries, has gaps spanning several years between successive photometric observations. As a consequence, it is impossible to extract information about starspot cycles or differential rotation, if indeed such phenomena are present in the binary system.

A superior approach to monitoring the dynamical evolution of starspots on a contact binary system would be through uninterrupted photometric coverage, such as that provided by the NASA Kepler Space Mission. The Prša et al. (2011) catalog contains 1879 unique objects, out of $\sim$ 150,000 stars, identified as eclipsing binaries, and a check of even a few of the observational light curves available through the Kepler Eclipsing Binary

Catalog (`http://keplerebs.villanova.edu`) shows that many of these systems exhibit a variable O'Connell effect. Clearly, this is a unique and invaluable resource for studying the real-time evolution and migration of starspots in contact eclipsing binaries.

The visual inspection of the historical light curves that we conducted in the course of this project revealed clearly that in addition to an asymmetry in the light curve maxima, the classical O'Connell effect, there was also a significant variation in the depth of the minima. Figure 7 shows the variation of the difference between the primary minimum and the secondary minimum, represented by Δm_{min}, for SW Lac, using the same light curves for which Δm_{max} was determined in Figure 4. The degree of variation is dramatic, ranging over 300 millimagnitudes and even becoming negative in 1991, meaning that the secondary minimum was deeper than the primary (Hrivnak & Goehring 1991). While such phenomena have been noted occasionally in the literature (e.g. Ruciński, 1968), it is more often overlooked. The light curve minima of EBs are generally of different depths, however their difference is of constant magnitude which is attributed to the difference in temperatures of the component stars. The large and random variations in the difference between the two minima over time (Figure 7) can potentially be significant in understanding the temporal dynamics of EBs. One possible cause for this random variations can be the presence of different sized starspots on the visible (front) star during the eclipses.

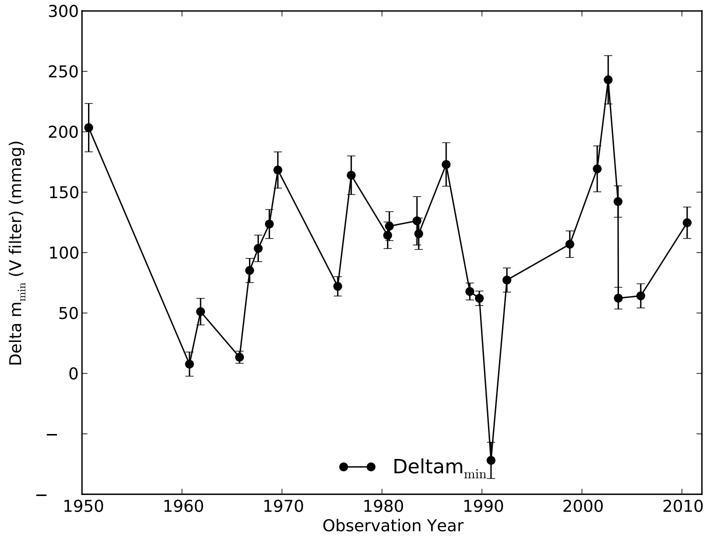

Figure 7. Difference between the primary and secondary minima of SW Lac, denoted Δm_{min}, between 1949 and 2010.

Acknowledgements: This work was funded Truman State University under the TruScholars Summer Undergraduate Research Program, 2010.

References:

Albayrak, B., et al., 2004, *A&A*, **420**, 1039
Alton, K. B., & Terrell, D., 2006, *JAAVSO*, **34**, 188
Applegate, J. H., 1989, *ApJ*, **337**, 865

Berdyugina, S. V., 2005, *Living Rev. Solar Phys*, **2**, 8
Binnendijk, L., 1969, *AJ*, **74**, 218
Binnendijk, L., 1984, *PASP*, **96**, 646
Bookmyer, B. B., 1965, *AJ*, **70**, 415
Bozkurt, S., et al., 1976, *IBVS*, **1087**, 1
Broglia, P., 1962, *Mem. Soc. Astron. Ital.*, **33**, 43
Brownlee, R. R., 1957, *ApJ*, **125**, 372
Çakirli, Ö., et al., 2003, *A&A*, **405**, 733
Davidge, T. J., & Milone, E. F., 1984, *ApJS*, **55**, 571
Derman, E., et al., 1991, *A&AS*, **90**, 301
Djurašević, G., & Erkapić, S., 1997, *Bull. Astr. de Belgrade*, **155**, 55
Djurašević, G. et al., 2005, *ApSS*, **296**, 261
Eaton, J. A., 1986, *AcA*, **36**, 79
Essam, A., et al., 1992, *Ap&SS*, **188**, 117
Evren, S., et al., 1987, *IBVS*, **3109**, 1
Faulkner, D. R., & Bookmyer, B. B., 1980, *PASP*, **92**, 92
Gazeas, K. D., et al., 2005, *AcA*, **55**, 123
Hinderer, F., 1960, *JO*, **43**, 161
Hoffmeister, C., 1935, *AN*, **255**, 401
Hoffmeister, C., 1949, *AN*, **278**, 24
Hrivnak, B. J., & Goehring, C. A., 1991, *IAPPP Comm.*, **45**, 29
Jassur, D. M. Z., & Khodadadi, A., 2006, *JApA*, **27**, 47
Jeong, J. H., et al., 1994, *ApJ*, **421**, 779
Jordan, F. C., 1929, *PAllO*, **7**, 125
Kaluzny, J., 1983, *AcA*, **33**, 345
Keskin, V., 1989, *Ap&SS*, **153**, 191
Kopal, Z., 1959, Close binary systems, *The international Astrophysics Series*, Chapman & Hall, London
Kwee, K. K., 1968, *BANS*, **2**, 277
Lafta, S. J., & Grainger, J. F., 1985, *Ap&SS*, **114**, 23
Lanza, A. F. et al., 1993, *A&A*, **269**, 351
Lanza, A. F. et al., 1994, *A&A*, **290**, 861
Lanza, A. F. and Rodonò, M., 2004, *AN* **325**, 393
Leavitt, H. S., 1918, *Harvard Circ.*, 207
Lee, W. B., et al., 1991, *Proc. ASA*, **9**, 297
Lee, C.-U., & Lee, J. W., 2006, *JKAS*, **39**, 25
Leung, K.-C., et al., 1984, *PASP*, **96**, 634
Liu, Q.-Y., & Yang, Y.-L., 2003, *ChJAA*, **3**, 142
Löchel, K., 1960, *M.V.S.*, 457
Maceroni, C., et al., 1982, *A&AS*, **49**, 123
Mergentaler, J., 1950, *Contr. Wroclaw Astron. Obs.*, **4**, 1
Michaels, E. J., et al., 1984, *IBVS*, **2474**, 1
Mikolajewska, J., & Mikolajewski, M., 1981, *IBVS*, **1953**, 1
Milone, E. F., et al., 1979, *AJ*, **84**, 417
Muthsam, H., & Rakos, K. D., 1974, *A&AS*, **13**, 127
Niarchos, P. G., 1987, *A&AS*, **67**, 365
O'Connell, D. J. K., 1951, *PRCO*, **2**, 85
Panchatsaram, T., & Abhyankar, K. D., 1981, *Bull. Astron. Soc. India*, **9**, 31
Peña, J. H., et al., 1993, *Rev. Mex. Astron. Astrofis.*, **25**, 63

Pribulla, T., et al., 1999, *Contrib. Astron. Obs. Skalnaté Pleso*, **29**, 111
Pribulla, T., et al., 2001, *A&A*, **371**, 997
Prša, A., et al., 2011, *AJ*, **141**, 83
Rovithis, P., et al., 1988, *A&AS*, **74**, 265
Ruciński, S. M., 1968, *AcA*, **18**, 49
Samec, R. G., et al., 1998, *IBVS*, **4616**, 1
Schilt, J., 1924, *BAN*, **2**, 175
Seeds, M. A., & Abernethy, D. K., 1982, *PASP*, **94**, 1001
Selam, S. O., et al., 2009, *Journal of Arts & Science*, **12**, 151
Semeniuk, I., 1971, *AcA*, **21**, 49
Şenavcı, H. V., et al., 2011, *A&A* **529**, A11
Serkowski, K., 1956, *AcA*, **6**, 95
Shaw, J. S., et al., 1996, *ApJ*, **461**, 951
Stepien, K., 1980, *AcA*, **30**, 315
Struve, O., & Zebergs, V., 1959, *ApJ*, **130**, 789
Tsesevich, W., 1956, *A.C.Kasan*, **170**, 14
Vader, P., & van der Wal, N. A., 1973, *IBVS*, **842**, 1
Van Hamme, W., et al., 2001, *AJ*, **122**, 3436
Vilhu, O., 1981, *Ap&SS*, **78**, 401
Vilhu, O., 1982, *A&A*, **109**, 17
Wilsey, N. J., & Beaky, M. M., 2009, *SASS*, **28**, 107
Wilson, E. R., 1967, *AJ*, **72**, 1028
Yang, Y.-L., & Liu, Q.-Y., 1985, *IBVS*, **2705**, 1
Yang, Y., & Liu, Q., 1999, *A&AS*, **136**, 139
Zhang, R.-X., et al., 1992, *IBVS*, **3772**, 1
Zola, S., & Krzesinski, J., 1988, *IBVS*, **3218**, 1
Zola, S., et al., 2005, *AcA*, **55**, 389

Light curves from the new photometric observations are accessible online at the IBVS website:

Star	Filter	File Name
CN And	B	6127-t5.txt
CN And	I	6127-t6.txt
CN And	R	6127-t7.txt
CN And	V	6127-t8.txt
SW Lac	B	6127-t9.txt
SW Lac	I	6127-t10.txt
SW Lac	R	6127-t11.txt
SW Lac	V	6127-t12.txt
V502 Oph	B	6127-t13.txt
V502 Oph	I	6127-t14.txt
V502 Oph	R	6127-t15.txt
V502 Oph	V	6127-t16.txt