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

Number 5726

Konkoly Observatory
Budapest
12 September 2006

HU ISSN 0374 – 0676

PHOTOMETRIC ANALYSIS OF THE W UMa TYPE BINARY V566 OPHIUCHI

DEĞİRMENCİ, Ö.L.

Ege University Observatory, 35100, Bornova, İzmir, Turkey, e-mail: omer.degirmenci@ege.edu.tr

The variability of V566 Ophiuchi (BD +05°3547) was discovered by Hoffmeister (1935). According to Binnendijk (1970), the system is an A-type W UMa eclipsing binary. Important photoelectric light curves exist in the literature are: B, V light curves obtained by Binnendijk (1959), Bookmyer (1969, 1976) and Niarchos et al. (1993) and ultraviolet (λ 2585–3200 band) light curve obtained with IUE satellite by Eaton (1986).

The photometric solutions of the system were given by Binnendijk (1965), Bookmyer (1969, 1976), Mochnacki & Doughty (1972), Hutchings & Hill (1973), Berthier (1975), Nagy (1977), Van Hamme & Wilson (1985), Eaton (1986), Niarchos et al. (1993) and Niarchos & Manimanis (2003). These solutions give the values of photometric mass ratio in the range $0.23 < q_{\rm ptm} < 0.24$.

Radial velocities of the system were published by Heard (1965), McLean (1983), Hill et al. (1989) and Pribulla et al. (2006). The first spectroscopic mass ratio of the system was given by Heard (1965) as $q_{\rm sp} = 0.34$ but McLean (1983) found $q_{\rm sp} = 0.24 \pm 0.03$ which agrees well with the photometric mass ratio derived previously. Later Van Hamme & Wilson (1985) reanalyzed the radial velocity curves of McLean by taking into account the proximity and eclipsing effects and obtained $q_{\rm sp} = 0.216 \pm 0.018$. Hill et al. (1989) obtained new radial velocity curves based on reticon observations and found $q_{\rm sp} = 0.266 \pm 0.006$. They obtained the mean spectral type of the system as F2 and mean effective temperature as 6700 K using the mean reddening in the field. Lastly, Pribulla et al. (2006) obtained $q_{\rm sp} = 0.263 \pm 0.012$ using the BF (broadening function) extraction technique and the rotational-profile fitting. They also obtained the spectral classification of the system as F4V, indicates a slightly later spectral type than that found by Hill et al. (1989).

The observations of V566 Oph were carried from June 18 to 21 (four nights) at the TÜBITAK National Observatory (TUG) using 40-cm (F/12.5) reflector and on July 24 at the Ege University Observatory (EUO) with the 48-cm (F/13) Cassegrain telescope in 1997. The SSP5 photometers were used at both observatory; the observations were made in U, B, V, R filters at TUG and in B, V, R filters at EUO. A total of 201, 232, 234 and 233 observational points were obtained in U, B, V and R filters, respectively. Differential measurements were made using BD+04°3553 as a comparison and BD+04°3556 as a check star. The differential magnitudes, in the sense variable minus comparison, were corrected for atmospheric extinction and the times of individual observations were reduced to the Sun's center. The extinction coefficients were determined for each night from the

observations of the comparison and the color effect on the atmospheric extinction was taken into account.

The unpublished differential magnitudes in U, B, V and R filters are available on request from the author. The instrumental differential $U-B$, $B-V$ and $V-R$ color and the U, B, V, R light curves of the system are also plotted against the orbital phases in Fig. 1. As seen from the figure the levels of maxima I and II are almost equal to each other in B, V, R light curves while in U band the system is slightly brighter at maximum II than that at maximum I.

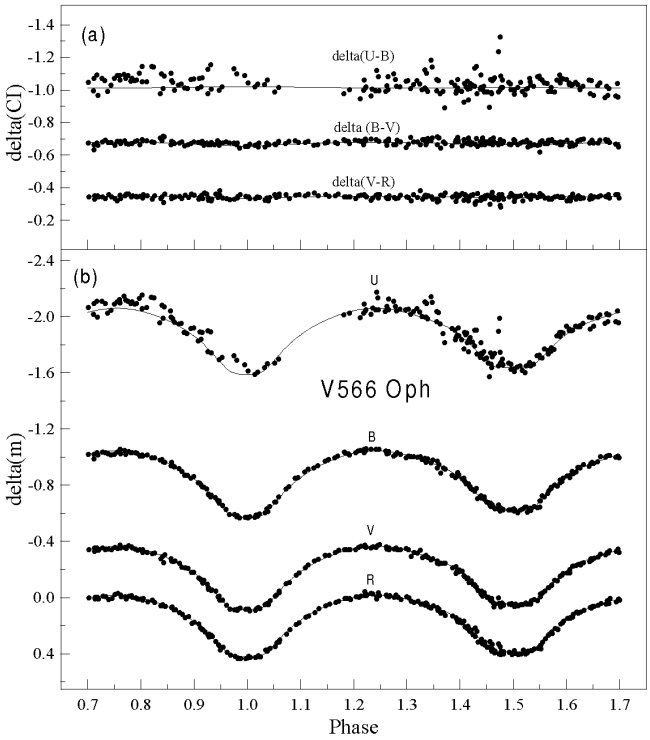

Figure 1. Observed differential (a) color and (b) light curves of V566 Oph. The upper panel shows the observed $U-B$, $B-V$ and $V-R$ color curves while the bottom panel shows computed light curves among the observations

We used the Wilson–Devinney method (Wilson & Devinney, 1971; Wilson, 1994) to analyze the light curves. The analyses were made in MODE 3 which corresponds to over-contact configurations. The temperature of the primary component was taken from Popper (1980) as 7000 K, corresponding to F2 spectral type (Hill et al., 1989). The logarithmic limb darkening coefficients were used in the computations. Assuming a solar chemical composition and $\log g = 4.25$, bolometric and monochromatic limb darkening coefficients were taken from Claret (2000). The bolometric albedos A_h and A_c were set to be equal to 0.5 and synchronized rotation ($F_h = F_c = 1.0$) was assumed. The solutions were obtained with model atmosphere approximation and multiple reflections were assumed. The results are given in Table 1 and the agreements of the computed curves with the observed light curves are shown in Fig. 1. For comparison, the results obtained by Van Hamme & Wilson (1985) (H&W85), in which they also used the Wilson–Devinney method, are also presented in Table 1. The parameters obtained in the solution are in good agreement with those of van Hamme and Wilson.

Table 1: Comparison of the photometric results with those of Van Hamme & Wilson (1985)

Parameter	This study	H&W85
Pshift	-0.0015 ± 0.0002	0.0001
i (degree)	80.8 ± 0.2	80.32 ± 0.17
$x_h = x_c$	0.786 (U), 0.770 (B), 0.674 (V), 0.596 (R)	0.564 (B), 0.452 (V)
$A_h = A_c$	0.5	0.5
$g_h = g_c$	0.39 ± 0.06	0.399 ± 0.030
T_h	7000 K	7000 K
T_c	6902 ± 19 K	6881 ± 9 K
$\Omega_h = \Omega_c$	2.288 ± 0.004	2.2575 ± 0.0026
q	0.2389 ± 0.0007	0.23686 ± 0.00084
$L_h/(L_h + L_c)_U$	0.792 ± 0.005 (U)	–
$L_h/(L_h + L_c)_B$	0.792 ± 0.004 (B)	0.7901 ± 0.0023
$L_h/(L_h + L_c)_V$	0.789 ± 0.003 (V)	0.7879 ± 0.0019
$L_h/(L_h + L_c)_R$	0.788 ± 0.002 (R)	–
r_h (mean)	0.519 ± 0.001	0.5278 ± 0.0010
r_c (mean)	0.275 ± 0.002	0.2848 ± 0.0014
$\sum W(O-C)^2$	0.0020	–

Table 2: The absolute parameters of the components

Parameter	Present work	H&W85	NEA93
$M_h/M_\odot$	1.41 ± 0.18	1.40	1.56
$M_c/M_\odot$	0.34 ± 0.08	0.33	0.41
$R_h/R_\odot$	1.45 ± 0.07	1.47	1.51
$R_c/R_\odot$	0.77 ± 0.04	0.79	0.86
$(T_e)_h$ (K)	7000 ± 100	7000	–
$(T_e)_c$ (K)	6902 ± 100	6881	–
$\log(L_h/L_\odot)$	0.65 ± 0.04	0.66	0.62
$\log(L_c/L_\odot)$	0.09 ± 0.04	0.10	0.12
$\log g_h$ (cgs)	4.26 ± 0.10	–	–
$\log g_c$ (cgs)	4.19 ± 0.10	–	–

Van Hamme & Wilson (1985) solved the radial velocity curves of McLean (1983) and found the semi-major axis of the relative orbit of V566 Oph as $2.788 \pm 0.097\ R_\odot$. Using this value and the photometric parameters given in Table 1 (column 2), the absolute parameters of the components were obtained and presented in Table 2 together with those given by Van Hamme & Wilson (1985) and Niarchos et al. (1993) (NEA93). According to the Hipparcos Catalogue, the $B-V$ color of the system is 0.449 ± 0.025. So, I have estimated the errors on the temperatures of the components as about 100 K using the above value in Popper (1980) table. The large errors in the absolute parameters are due to uncertainties in the determination of radial velocities. If we take into account Kopal's theoretical approach (Kopal, 1978) for W UMa systems, $L \sim M^{2\beta}$ with $\beta = 0.49$, our results seem to be more acceptable.

References:

Berthier, E., 1975, *A&A*, **40**, 237
Binnendijk, L., 1959, *AJ*, **64**, 65
Binnendijk, L., 1965, *AJ*, **70**, 209

Binnendijk, L., 1970, *Vistas in Astr.*, **12**, 217
Bookmyer, B.B., 1969, *AJ*, **74**, 1197
Bookmyer, B.B., 1976, *PASP*, **88**, 473
Claret, A., 2000, *A&A*, **363**, 1081
Eaton, J.A., 1986, *AcA*, **36**, 275
Heard, J.F., 1965, *JRASC*, **59**, 258
Hill, G., Fisher, W.A., Holmgren, D., 1989, *A&A*, **218**, 152
Hoffmeister, C., 1935, *AN*, **255**, 401
Hutchings, J.B., Hill, G., 1973, *ApJ*, **179**, 539
Kopal, Z., 1978, *Astrophysics and Space Science Library*, **68**, 1, Dynamics of Close Binary Systems, Dordrecht, D. Reidel Publishing Co.
McLean, B.J., 1983, *MNRAS*, **204**, 817
Mochnacki, S.W., Doughty, N.A., 1972, *MNRAS*, **156**, 51
Nagy, T.A., 1977, *PASP*, **89**, 366
Niarchos, P.G., Manimanis, V.N., 2003, *A&A*, **405**, 263
Niarchos, P.G., Rovithis-Livaniou, H., Rovithis, P., 1993, *Ap&SS*, **203**, 197
Popper, D.M., 1980, *ARA&A*, **18**, 115
Pribulla, T., Rucinski, S.M., Lu, W., Mochnacki, W., Conidis, G., Blake, R.M., DeBond, H., Thomson, J.R., Pych, W., Ogloza, W., Siwak, M., 2006, astro-ph/0605357
Van Hamme, W., Wilson, R.E., 1985, *A&A*, **152**, 25
Wilson, R.E., 1994, *PASP*, **106**, 921
Wilson, R.E., Devinney, E.J., 1971, *ApJ*, **166**, 605

ERRATUM FOR IBVS 5714

The true shape of the eclipsing binary light curve and the modified, correct period of V1898 Cyg was already published in IBVS 5699/76 (2005, July 20) by Caton & Smith (http://www.konkoly.hu/cgi-bin/IBVS?5699#76).

The Editors