COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4806

Konkoly Observatory
Budapest
24 November 1999

HU ISSN 0374 – 0676

1998 PHOTOMETRY OF UV PISCIUM

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UV Psc (#11 in the catalog of Strassmeier et al. 1993) is a member of the short period group of eclipsing RS CVns. Busso et al. (1986) and Budding et al. (1996) analyze published and archived light curves to study both the spot cycles and stellar parameters of this system. Popper (1991, 1993, and 1997) analyze spectroscopy of UV Psc to determine its fundamental parameters.

I observed UV Psc on the nights of 6, 7, 8, 11, 15, and 16 August 1998 with the San Diego State University 61-cm telescope on Mt. Laguna. I used SAO 109761 as the comparison star. The light curves, with 119 data points in each filter, are plotted in Figure 1. Data are in the standard Johnson–Cousins system. The phases are computed using the ephemeris of Ibanoğlu (1987):

$$\mathrm{Min\,I} = 2444932.2985 + 0.86104771 \times E.$$

I modeled the data using Budding and Zeilik's (1987) Information Limit Optimization Technique (ILOT). Initial guesses for stellar parameters were from the models of Budding and Zeilik (1987) and Popper (1993). I adopted temperatures of 5860 K and 4900 K for the primary and secondary stars. After the initial fit, the ILOT extracts a distortion wave which I then fit for two circular 0 K spots. The fits for each color are performed independently. Figure 3 shows the V band spot fit. The ILOT is designed to fit the various parameters simultaneously and return a solution only if the solution is mathematically determinant. If the solution is not determinant, the operator must then try to fit fewer parameters by holding some of the desired parameters at a fixed value. I was unable to fit the latitude of one spot in the V band simultaneously with the other parameters. I therefore fixed the value at where it seemed to be converging in trial fits. By comparing the R or I data to the 0 K spot solutions at B or V, the ILOT can estimate spot temperatures. Doing so I find an average value of the spot temperature of $T_s = 3842$ K $\pm$ 228 K. The reported longitude, latitude and radius of each spot are in degrees. I get:

Spot Fits

	B band	V band	R band	I band
Longitude$_1$	248.8 ± 11.7	259.2 ± 7.2	254.0 ± 11.3	247.9 ± 6.9
Latitude$_1$	61.3 ± 7.3	61.1 (fixed)	53.4 ± 23.9	54.2 ± 15.1
Radius$_1$	22.2 ± 4.6	21.6 ± 1.0	17.8 ± 7.6	17.0 ± 4.2
Longitude$_2$	329.3 ± 9.8	340.5 ± 9.3	344.1 ± 16.4	341.5 ± 9.6
Latitude$_2$	9.9 ± 17.5	4.4 ± 20.1	38.1 ± 24.9	39.8 ± 30.9
Radius$_2$	10.9 ± 1.7	9.4 ± 1.1	11.8 ± 2.4	12.0 ± 3.2
χ^2	269.1	169.1	141.5	93.7

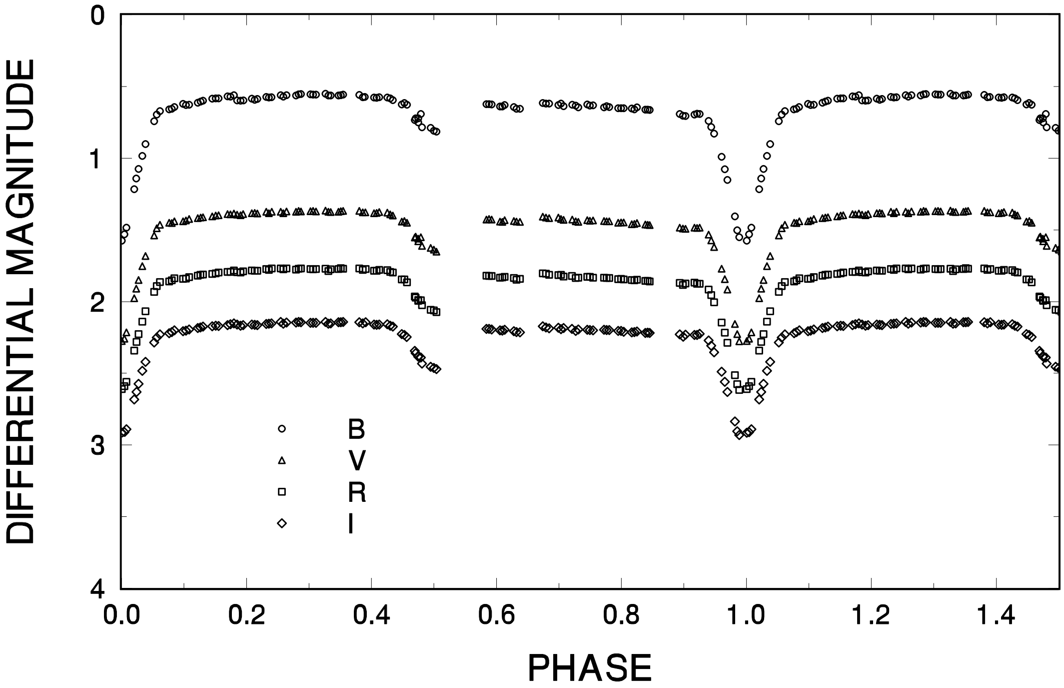

Figure 1.

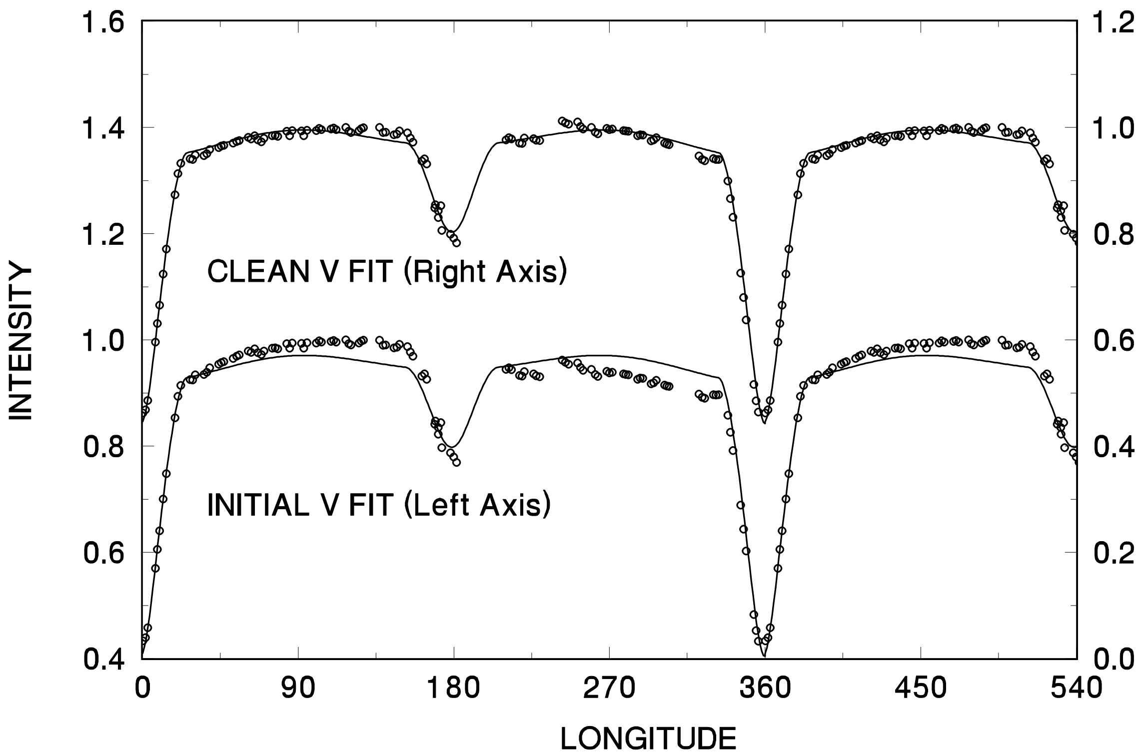

Figure 2.

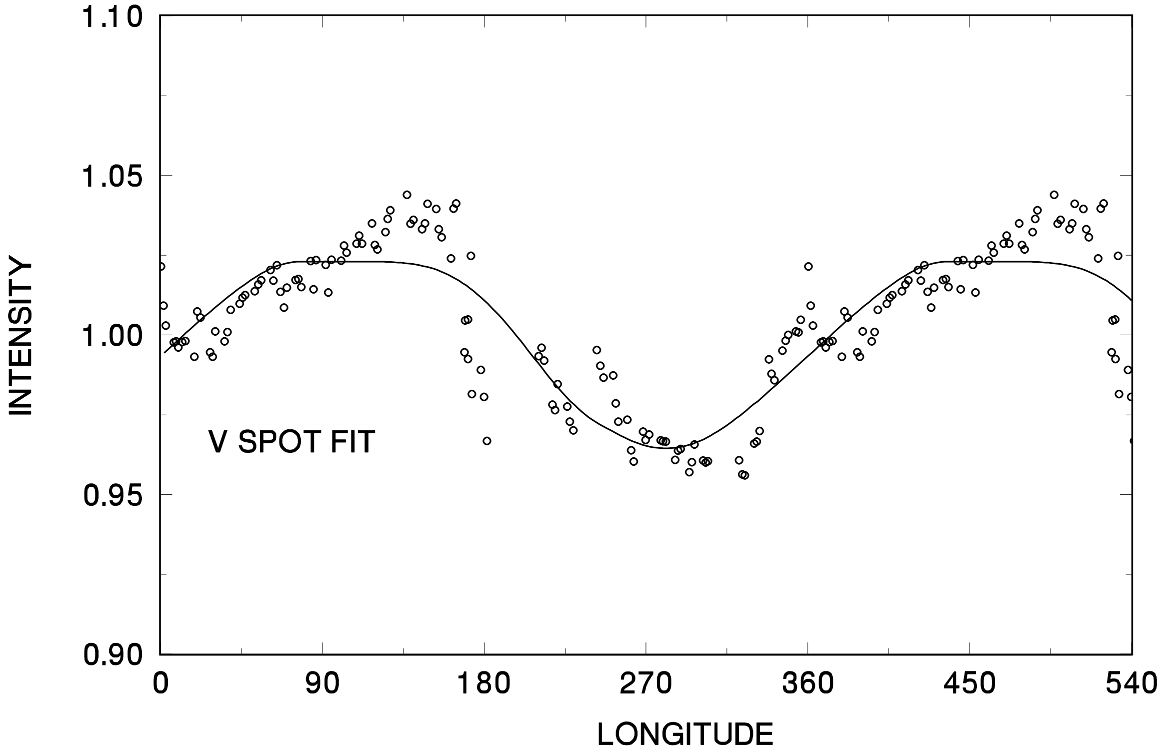

Figure 3.

Both spots are in what could loosely be thought of as the 270° active longitude belt (ALB), however the smaller spot is at the extreme edge of what could be considered the ALB. It seems that the tendency for spots to occur in ALBs at the quadratures is a tendency only, not an absolute requirement. Being more difficult to fit, the latitudes are less reliable. However the two spots include both high and low latitudes.

After the spot fits, I performed clean fits to the light curves removing the effects of the distortion wave from the spot as modeled in that filter. The fits at each wavelength were done independently. Figure 2 shows both the initial and clean fits in the V band. Note that the light curves are missing a portion of the secondary eclipse. They were complete enough to perform clean fits, but these fits would be more reliable without this small gap in the light curves. There is however good agreement between the clean fits at different wavelengths. The color independent parameters generally agree to within the quoted errors. The table below shows values for each filter and the mean for the wavelength independent parameters. I get:

Clean Fits

	B band	V band	R band	I band	Mean
L_1	0.870 ± 0.008	0.834 ± 0.012	0.815 ± 0.012	0.794 ± 0.006	
$k(= r_2/\mathrm{r}_1)$	0.784 ± 0.026	0.790 ± 0.035	0.758 ± 0.034	0.744 ± 0.008	0.769 ± 0.022
$\Delta\theta_0$	0.933 ± 0.097	1.040 ± 0.100	1.053 ± 0.108	0.990 ± 0.108	1.004 ± 0.055
r_1	0.255 ± 0.005	0.251 ± 0.006	0.252 ± 0.005	0.249 ± 0.003	0.252 ± 0.003
i (deg)	85.2 ± 0.6	85.4 ± 0.8	86.4 ± 1.2	88.0 ± 0.9	86.3 ± 1.3
L_2	0.105 ± 0.009	0.147 ± 0.013	0.168 ± 0.013	0.191 ± 0.007	
$q(= m_2/m_1)$	0.647 ± 0.081	0.764 ± 0.113	0.836 ± 0.119	0.811 ± 0.139	0.765 ± 0.084
χ^2	219.8	126.9	105.3	73.6	

The quantities above are as defined by Budding and Zeilik (1987). The fractional luminosities of the primary and secondary components, L_1 and L_2, are normalized to sum to approximately but not exactly 1. The sum can deviate from unity because the normalization is performed before the light curve is corrected for the spot effects, and subtracting the spot causes the out of eclipse intensity to be slightly more or less than 1. These results agree to within the errors with previous work. Both Budding et al. (1996) and Popper (1993) get the mass ratio, $q = 0.77$, which agrees with my value averaged over four filters. My average value for the ratio of the radii, $k = 0.769$, agrees well with 0.75 and 0.76 obtained by Popper (1991), Budding and Zeilik (1987) and Budding et al. (1996). The primary radius r_1 expressed as a fraction of the orbital separation agrees well with Budding and Zeilik's (1987) value of 0.246. The average inclination compares well with Popper's (1993) value of 88°.0.

I thank Ron Angione for scheduling generous amounts of observing time at Mt. Laguna. I also acknowledge support from a Western Carolina University Faculty Research Grant for this work.

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