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STRÖMGREN uvby PHOTOMETRY OF THE RS CVn-LIKE BINARIES σ CrB AND HD 166181

An observational program is currently being developed to obtain accurate four-colour uvby as well as Hβ light curves of some selected RS CVn binary stars. Since the information contained in the Strömgren uvby indices has proven to be highly rewarding in the study of active late type stars (Rucinski, 1983), we present here the standard indices derived for the binary systems σ CrB and HD 166181. They have been monitored with particular interest due to existing contradictions between previous photometric studies as well as their conspicuous chromospheric emission lines detected in the optical and the ultraviolet.

TZ CrB = σ^2 CrB is the brighter component of the visual binary ADS 9979 = σ CrB and is known to present important cromospheric and coronal activity (Bopp, 1984) from observations in the ultraviolet and X-ray ranges (Tarafdar and Agrawal, 1984). The system does not present eclipses but Skillman and Hall (1978) suggested the existence of a wavelike distortion with an amplitude of $\sim 0^m.05$ in V, characteristic of most of the RS CVn-like binary systems. Since the observations presented considerable scatter, they also proposed the existence of a superposed δ Scuti type cyclic variability with a period of around 0.1 days. Although these results were not in contradiction with later observations carried out by Bakos (1984), a more detailed, but still uncomplete, photometric study by Vivekananda Rao et al. (1985) did not confirm the proposed variations and amplitudes.

With respect to HD 166181 there exist only few photometric observations. It is known to be a single-lined spectroscopic binary with important CaII H and K emissions (Nadal et

al. (1974) and Eggen (1978) reported a variation of $\sim 0^m.1$ in V later confirmed in a more detailed photometric study by Mekkadan et al. (1980), which also show a well-defined wavelike distortion light curve.

The observations presented in this note were carried out during one single night (JD 2446256) using the 75cm reflecting telescope at the Observatory of Sierra Nevada (Granada, Spain) located at 3000m over the sea level. A 4+2 channel, Danish design, photometer was used which measures simultaneously in the four uvby bands and, respectively, in the n and w bands centered on the Hβ line. A detailed description of this instrument is given by Florentin-Nielsen (1983). Throughout the observations we used a 45" circular diaphragm, which means that for TZ CrB, the close visual companion σ^1 CrB was also included in the field.

Almost continuous monitoring of σ CrB and HD 166181 was performed during around $0^d.1$ each. Particular attention was paid to the extintion coefficients during the night. The comparison and constant stars were analyzed searching for possible instrumental drifts and second order terms. A linear extinction curve was found to reproduce perfectly the observations in all four colours with the following coefficients: $k_u = 0.486 \pm 0.008$, $k_v = 0.267 \pm 0.004$, $k_b = 0.173 \pm 0.005$ and $k_y = 0.130 \pm 0.004$.

In Figure 1, we have plotted the y-band instrumental magnitude difference of σ CrB with respect to the comparison star HR 5968 in the sense comparison-variable. In Figure 2, a similar plot has been made for the variable star HD 166181 with respect to the comparison star HD 166435. In both cases fractions of the above mentioned Julian Date, including heliocentric corrections, are given on the abscissa.

Average values of the instrumental colour differences with respect to the mentioned comparison stars, in the sense variable-comparison, were found to be as follows:

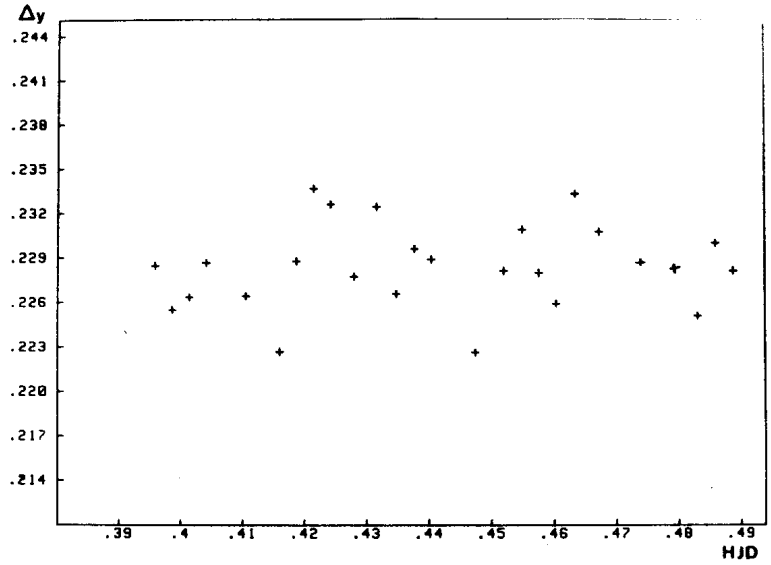

Figure 1

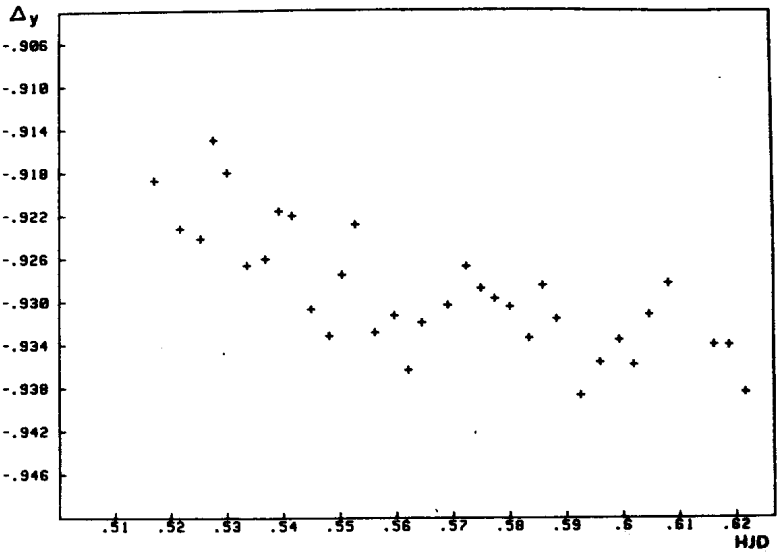

Figure 2

	Δy	$\Delta b-y$	Δm_1	Δc_1
σ CrB - HR5968	-0.228	-0.012	+0.011	-0.024
	3	2	4	5
HD166181 - HD166435	+0.929	+0.072	+0.028	-0.029
	6	4	6	10

The phase coverage was around $0^p.08$ (centered at $0^p.37$) for σ CrB according to the ephemeris given by Bakos (1984) and $0^p.06$ (centered at $0^p.96$) for HD166181 using the values given by Mekkadan et al. (1980).

A slight tendency in the instrumental magnitude difference between HD166181 and its comparison star is clearly seen in Figure 2 contrary to the constant light level shown by Figure 1 in the case of σ CrB. It should be expected thence, considering the different orbital periods and phase coverage, that the photometric variations of σ CrB, if any, be considerably smaller than in the case of HD 166181. A detailed discussion of the complete light curves in the four uvby colours will, however, be published elsewhere.

Concerning the suggested δ Scuti type variability of σ CrB (Skillman and Hall, 1978), our observations which cover one complete cycle according to the proposed period of 0.1 days during one single night, confirms the previous result by Vivekananda Rao et al. (1985) that no such variations are present in σ CrB.

After transformation to the standard Strömgren uvby photometric system, the following magnitudes and colour indices were obtained:

	V	b-y	m_1	c_1
σ CrB	5.18	0.384	0.185	0.308
HD 166181	7.77	0.480	0.239	0.295

Comparison of these values with preliminary empirical calibrations for late type stars by Olsen (1984) indicate that σ CrB behaves as anormal dwarf star with a slightly low m_1 index. On the other hand, HD 166181 is apparently more

evolved but resembling a metal-deficient dwarf star in its photometric properties.

Concerning the visual binary σ CrB, we could observe separately the component stars using a smaller diaphragm during one night of very good seeing. As a result, we finally obtained the following magnitude differences in the sense σ^1 CrB - TZ CrB:

$$\Delta V = 0.98, \quad \Delta b-y = 0.011, \quad \Delta m_1 = 0.022, \quad \Delta c_1 = -0.018,$$

after correction for dead time and sky background and transformation to the standard system. These values are in good agreement with the spectral type difference and the preliminary calibration by Olsen (1984). Using the combined light values and the magnitude differences, the standard indices for TZ CrB isolated from its visual companion could be obtained and, as a result, the observed slight metal deficiency appeared to be more evident.

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