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PHOTOELECTRIC PHOTOMETRY OF THE BRIGHT METALLIC-LINE ECLIPSING BINARY δ CAPRICORNI

δ Capricorni (HR 8322; HD 207098; ADS 15314) is one of the nearest (d ~ 15pc) and brightest (V_{max}=+2.83) eclipsing binary systems, consisting of a metallic-line A7-type primary and a cooler, less massive component. Although it has been known to be a variable star for about 25 years, little attention has been paid to it, and no light curve has yet been published. Spectrographic studies of the system have been made by Crump (1921), Stewart (1958), and Batten (1961) where only the spectrum of the Am star has been seen. The light variability of δ Cap was discovered by Eggen (1956) when the primary eclipse with a depth of about 0.16 mag in V was observed. Subsequent photoelectric observations made by Wood and Lampert (1963) confirm Eggen's result and reveal possible variations in the depth of the primary eclipse. They suggest that this may be due to variations in the light of the comparison star.

Photoelectric observations of δ Cap were obtained on 39 nights from September 1977 through October 1978 at Biruni Observatory using the 51 cm reflector and at Villanova University Observatory using the 38 cm reflector. The Biruni telescope is equipped with an RCA 4509 photomultiplier tube and a chart recorder was used to record the observations. The photoelectric photometer employed with the Villanova telescope is equipped with a thermoelectrically cooled (to $-10^{o}C$) RCA C31034A gallium-arsenide photocell and a microprocessor-controlled integrating system. Pairs of matched intermediate- and narrow band interference filters centered near the wave-length of the Balmer Hα line (λ 6563) were used at both observatories. The Hα filter pairs are similar to those used by

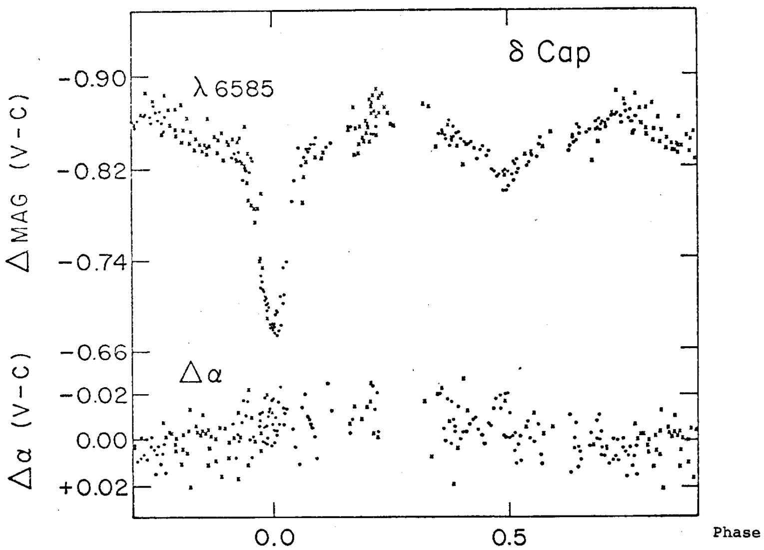

Figure 1. The λ6585 light curve and α-index of δ Capricorni plotted against orbital phase. Circles (•) are Biruni observations, crosses (×) are Villanova observations.

Baliunas, Ciccone and Guinan (1975) in the definition of the Villanova Hα system. The Hα intermediate bandpass filter is centered at 6585Å. with a FWHM = 280Å. It is broad enough to be little affected by the presence of the Hα feature within the bandpass. Additional observations were obtained at Biruni Observatory using a Strömgren u filter and at Villanova using an intermediate-band filter centered near 7790Å, with a FWHM = 180Å.

The comparison star was γ Cap while κ Cap and μ Cap served as check stars. The observing sequence was the standard pattern of sky-comparison-variable-comparison-sky with each observation lasting about 50 seconds. The effects of differential atmospheric extinction were removed, and 2 point normals were formed. In Fig. 1, differential magnitudes in the Hα intermediate bandpass are plotted against the phase, computed from the ephemeris given by Eq. 1 where zero phase corresponds to the time of mid-primary eclipse. Also shown in Fig. 1 is the α-index, defined in the usual way (Dorren et.al, 1980) which yields a measure of the net strength of the Hα line.

As shown in the figure, the light curve is well defined and shows two minima of unequal depths and two rounded maxima. The secondary minimum appears to occur close to 0.50 phase in agreement with the circular orbit indicated spectroscopically by Batten. The depths of primary and secondary minima are about 0.18 mag and 0.05 mag, respectively. The depths of primary and secondary minima for the u and the λ 7790 bandpasses are essentially identical with the values given above for λ 6585.

It is clear that there is considerable scatter in the observations. No significant variations were found between the comparison star and the check stars above the level of ±0.008 mag, however, so that the observed scatter in the light curve appears intrinsic to δ Cap. Light variations on a time scale of several hours also appear in the data. As shown in the figure, the scatter in the α-index is relatively large. A peculiar phase-dependent variation appears to be present with Δα having the smallest (negative) values from 0.1 to 0.5 phases and its largest value from about 0.7 to 0.9 phase. This behaviour indicates that the net Hα (absorption) line strengh is weakest from 0.1 to 0.5 phase and strongest at 0.7 to 0.9 phase. A small decrease in the α-index is expected at primary eclipse when the A7m star with its strong Hα line is partially eclipsed by a cooler star with relatively weak hydrogen lines. Although the effect of the eclipse can be seen in the α-index from 0.95 to 0.05 phases, the behaviour of the α-index described above is anomalous and could indicate the presence of a gas stream or a hot (or cool) spot on the surface of the hotter component. Similar behaviour in Hβ and Hα has been observed by Guinan (1971) for the 0.667 day eclipsing binary V1010 Oph.

A more refined light ephemeris was determined by combining the two previous times of primary minimum given by Eggen and by Wood and Lampert with our own timings to obtain:

$$T\ (\mathrm{MIN.I}) = \mathrm{HJD}\ 2435656.\underset{\pm 2}{913} + 1\overset{d}{.}022768\underset{\pm 3}{8} \cdot E \qquad (1)$$

There is no evidence of any significant change in the apparent period.

A preliminary analysis of the observations indicates an orbital inclination of $i \sim 67^{\circ}$, with the primary eclipse a partial transit. It would appear that the system is composed of an A7m primary and a cooler ($\sim 4700^{\circ}$K) secondary near its Roche lobe. A detailed analysis of the light curves using the Wilson-Devinney program will be published later.

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References:

Baliunas, S.L., Ciccone, M.A. and Guinan, E.F., 1975, Pub.Astron. Soc.Pac. 87, 969
Batten, A.H., 1961, Pub. Dominion Astrophys. Obs. 11, 395
Crump, C.C., 1921, Astrophys. J. 54, 127
Dorren, J.D., Guinan, E.F., Hart, M.K. and Riazi, N., 1980, I.B.V.S. No. 1745
Eggen, O.J., 1956, Pub.Astron.Soc.Pac. 68, 542
Guinan, E.F., 1971, Bull.Am.Astron.Soc., 3, 444
Stewart, M., 1958, J.Roy.Astron.Soc.Can., 52, 11
Wood, F.B. and Lampert, G., 1963, Pub.Astron.Soc.Pac., 75, 281