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OBSERVATIONS OF H-ALPHA EMISSION IN VV CEPHEI

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VV Cep is an eclipsing binary with a period of about 20.4 years that is comprised of a M2 Iab primary star and an early B secondary star. Goedicke (1939) was first to spectroscopically observe it. Wright (1977) inferred the existence of intermittent mass transfer and an Hα emitting disk. Kawabata et al. (1981) and Moellenhoff et al. (1978, 1981) further described what appears to be an accretion disk around the B star.

Appropriately equipped amateur astronomers are now able to make scientific contributions in spectroscopy. This is largely due to the availability of highly efficient CCD cameras. The author built a Maksutov type mirror-prism- spectrograph with a CCD camera as the detector. The instrument has a 100 mm aperture, 1000 mm focal length, and a prism with breaking angle of 30 degrees. Its central wavelength is fixed at 6563 Å and its dispersion is 3 Å/pixel. With this equipment the author observed VV Cep from July 1996 until May 2001 and obtained 148 spectra. This period included an eclipse of the B star from 1997 to 1999.

With the binary at magnitude 4.9, exposure times were about 4 minutes for each spectrum to achieve 70-80range of the sensor. 20 spectra were combined for measurement. The integration width for computation of equivalent width (W) for the Hα emission line was 6 nm. The formula to compute W was

$$W = \int_{\mathrm{line}} (1 - I(\lambda)/I_c(\lambda))\,\mathrm{d}\lambda.$$

$I_c(\lambda)$ is the continuum intensity at wavelength λ and $I(\lambda)$ is intensity of the emission line at the same wavelength. A linear function was usually sufficient to fit the continuum over the 6 nm wavelength range centered on Hα. This was done in a trial and error process. Figure 1 is a representative spectrum.

Figure 2 is a plot of W for Hα emission as a function of time. The eclipse of the emitting disk began in March 1997 (JD 2450511) and ended 673 days later. Ingress and egress lasted 128 and 171 days, respectively. The B star and disk were eclipsed for 373 days. Saito et al. (1980) observed the 1976–78 eclipse with UBV photometry. In that case, totality lasted about 300 days, significantly shorter than the latest eclipse, and the entire event required about 1000 days.

While after the ephemeris of Gaposchkin (1937) the mid-point of the eclipse was to be expected at JD 2450790, this time can be determined from Fig. 2 at JD 2450827, thus with a delay of 37 d (in the table the individual values of EW with the belonging Julian Date are specified). Graczyk et al. (1999) determine the mid-point of the eclipse 1997/99

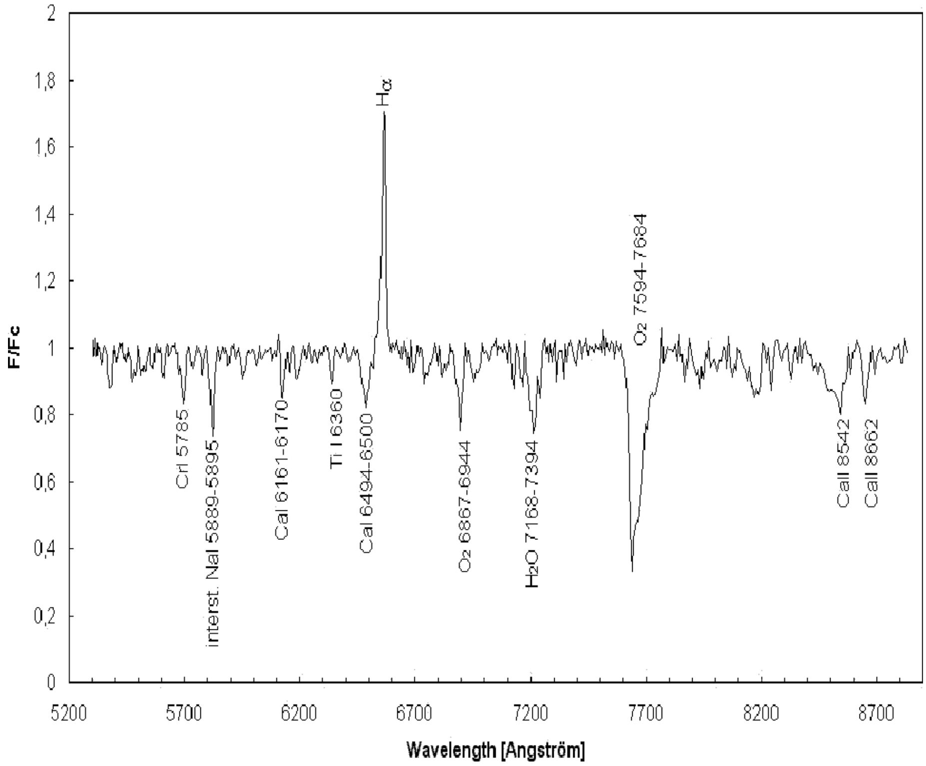

Figure 1. Standardized CCD spectrum of VV Cep

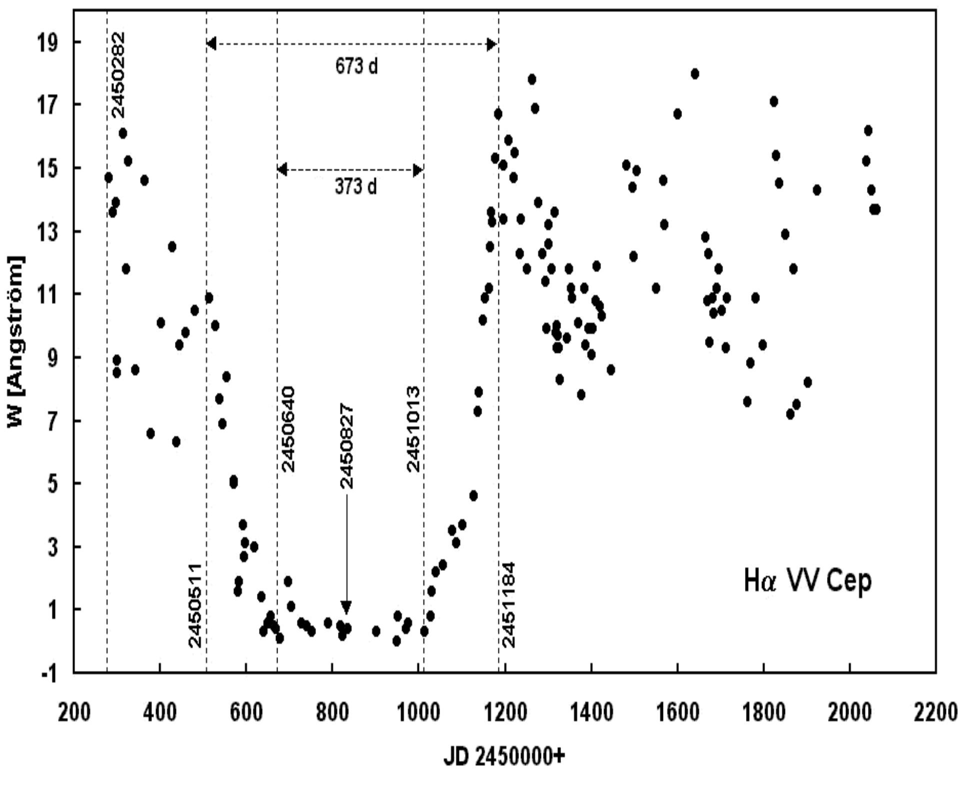

Figure 2. Plot of W for Hα emission as a function of time

from UBV photometry at approximately JD 2450855, thus with 65 d delay. Leedjärv et al. (1999) obtained a similar value of 68 d compared with the ephemeris in Gaposchkin (1937) likewise from UBV photometry as well as optical spectroscopy.

Perhaps the most interesting feature of Figure 2 is the behavior of Hα emission outside of eclipse. Large fluctuations in W occurred continuously over about 4.8 years. A possible explanation is variable mass accretion from the M supergiant to the accretion disk as described by Wright (1977) and Stencel et al. (1993). There may also be related variations in the disk's temperature and density. Further, the M supergiant has a semiregular pulsation period of 116 days (Saito et al. 1980) that may affect the rate of accretion. Since the disk is the apparent source of Hα emission, it is the best candidate to explain ongoing changes in intensity.

V/R measurements of Hα by Kawabata et al. (1981) during the 1976-1978 eclipse may indicate that the distribution of matter in the disk is not homogeneous. The stronger violet emission peak may be formed by greater density in the left side of the disk which rotates anticlockwise. Different strengths of the violet and red peaks during the 1997–1999 eclipse can be inferred from the ingress and egress branches of the plot in Figure 2. During ingress, with the disk's left side hidden and its right side in view, on average $W = 11$ Å. At egress, with the left side emerging from eclipse, $W = 17$ Å.

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