Publ. Astron. Inst. ASCR 93, 44 – 46 (2005)

Observations of Hα Emission in VV Cephei

E. Pollmann

Spectroscopy Group of the Vereinigung der Sternfreunde (VdS), Charlottenburgerstraße 26c, D–51377 Leverkusen, Germany

Spectroscopic Hα observations during the recent eclipse of the long-periodic M2 Iab+B binary VV Cephei are reported. Next to the delay of mid-eclipse with respect to the published ephemeris, an increase of the line emission after the event is reported.

Keywords: Spectroscopy – Emission line star – Binary star

The data presented were taken by a amateur astronomers organized in the Spectroscopy Group of the Vereinigung der Sternfreunde. This group has spectrographs available with resolving power up to 12000 and is collaborating with professional astronomers on various projects.

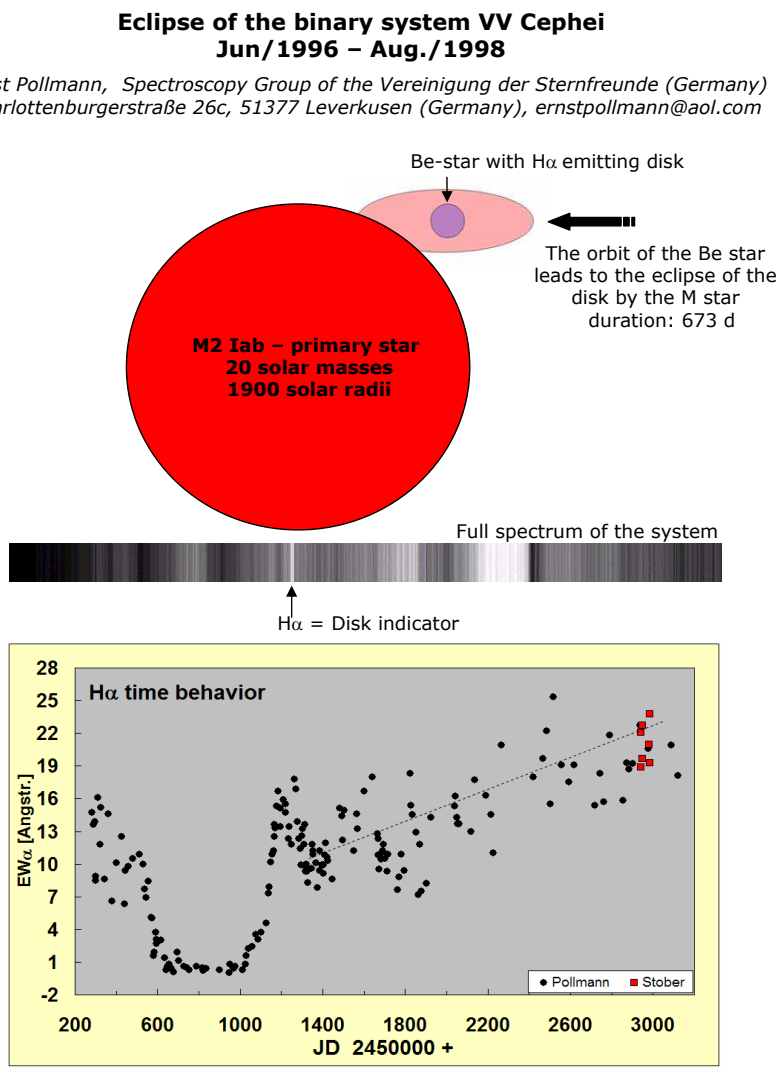
VV Cep is an eclipsing binary with a period of about 20.4 years that is comprised of a M2 Iab primary star and an early B secondary star. The orbit of the Be star leads to the eclipse of the disk by the M star. Goedicke (1939) was first to spectroscopically observe it. Wright (1977) inferred the existence of intermittent mass transfer and an Hα emitting disk. Kawabata et al. (1981) and Möllenhoff 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 detector. The instrument has a 100 mm aperture, 1000 mm focal length, and a prism with breaking angle of 30 degrees. The central wavelength of the instrumental range is fixed at 6563 Å and its dispersion is 3 Å per pixel. With this equipment the author observed VV Cep from July 1996 until Mai 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 70−80% saturation of the total dynamic range of the sensor. 20 spectra were combined for each measurement. The integration width for computation of equivalent width (W) for the Hα emission line was 6 nm. 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 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 the time behavior diagram at JD 2450827, thus with a delay of 37d. To obtain the mid-point of the eclipse both decline and rise were approximated linearly. Where these linear fits crossed the minimum level, the beginning and end of the minimum were defined. The mid between both times defines the mid-point with an accuracy of ±2 days. Graczyk et al. (1999) against determine the mid-point of the eclipse 1997/99 from UBV photometry at approximately JD 2450855, thus with 65d delay. Leedjärv et al. (1999) obtains a similar value of 68d compared with the ephemeris in Gaposchkin (1937) likewise from UBV photometry as well as optical spectroscopy.

Perhaps the most interesting feature is the behavior of Hα emission outside of eclipse. Large fluctuations in W occurred continuously over about 4.8 years. A possible explanation is a 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)



Data plotted in red were taken by B. Stober, also member of the group

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 differences of the ingress and egress branches of the plot. During ingress, with the disk's left side hidden and it s right side in view, on average $W = 11$ Å. At egress, with the left side emerging from eclipse, it is rather $W = 17$ Å. After the eclipse the Hα equivalent width increased represented shown an upward gradient of aproximately 1 Å/200 d. This increase is superimposed by large fluctuations, however. A possible explanation is a mass flow from the M supergiant to the accretion disk.

References

Gaposchkin S.: 1937, Harvard Coll. Obs. Circ. 421
Goedicke V.: 1939, Publ. Obs. Univ. Michigan 8, 1
Graczyk D., Mikolajewski M., Janowski J. L.: 1999, IBVS 4679
Kawabata S., Saijo K., Sato H., Saito M.: 1981, PASJ 33, 177
Leedjärv L., Graczyk D., Mikolajewski M., Puss A.: 1999, A&A 349, 511
Möllenhoff C., Schaifers K.: 1978, A&A 64, 253
Möllenhoff C., Schaifers K.: 1981, A&A 94, 333
Saito, M., Sato, H., Saijo, K., Hayasaka, T., 1980, PASJ, 32, 163
Stencel R. E., Potter D. E., Bauer W. H.: 1993, PASP 105, 45
Wright K. O.: 1977, JRASC 71, 152