INTENSIFIER-DISSECTOR-SCANNER OBSERVATIONS OF THE BRIGHT NORTHERN Be STARS

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ABSTRACT. Early results are presented from an extensive program of regular Balmer-line spectroscopy; during eight months in 1980 Hα profiles were obtained of over 100 northern Be stars. Transient emission events have been observed in the very early rapid rotator 59 Cygni; sequential variations in Hα are quasi-periodic.

The University of Western Ontario intensifier-dissector-scanner (IDS) is a 512-channel instrument which when mounted on the Cassegrain spectrograph of the 1.2m telescope gives a channel center separation of about 0.7Å at Hα and 0.3Å at the other Balmer lines; resolution is two or three pixels. The IDS is described by Tomaszewski (1980) and Tomaszewski et al. (1980). Systematic observations were begun in 1980 April; by the end of November, Hα scans were secured of the program Be stars as well as of 60 normal B stars and 30 A and Ap stars. Of the Be stars, one-third were also observed at Hβ and in the near-infrared. Standard stars are observed on every clear night. This continuing long term survey work is complemented by intensive observations of selected active Be stars.

59 Cygni is renowned for its spectral variations--almost ceaseless since the turn of the century--culminating in the spectacular shell episode of 1974-75 (Barker 1981). The more recent optical history is summarized by Hubert-Delplace and Hubert (1979); UV variability and wind structure is discussed by Doazan et al. (1980) and by Marlborough and Snow (1980). IDS scans of Hα were obtained on the dates listed in Figure 1.

The Figure shows that from July onwards the profile undergoes a regular sequence of variations: an initial asymmetric emission peak, shallow on the red side, develops a redward shoulder within about 2 days; a day or so later the strong blue peak subsides, leaving an essentially flat-topped profile which sometimes shows a weak central reversal. The flat-topped profile persists for at least 4 days. The April profile alone has a strong red peak with a blue shoulder.

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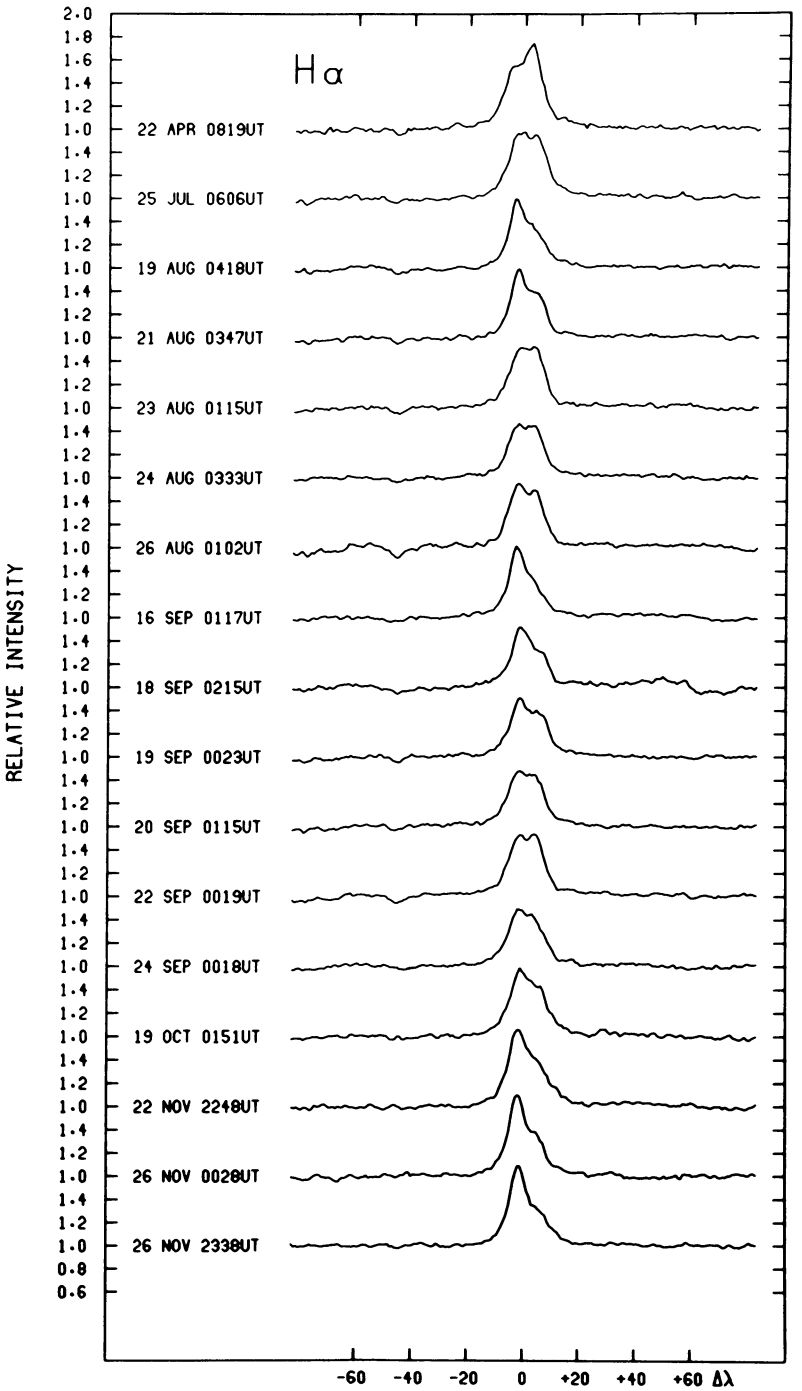

Figure 1. Hα profiles of 59 Cygni from 1980 April to November.

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It is well known that instruments of the IDS breed are subject to electronic variability on a variety of timescales. Therefore repeated observations of presumed non-variable standard stars were made throughout the 59 Cygni sequence. Profiles of Hα in ν Cyg (A5V) and ρ Cyg (G8III) do not vary beyond the 3% noise level typical of the IDS. Thus the variations in the Hα profile of 59 Cygni are undeniably stellar in origin. Further, 17 scans of Hα in 59 Cygni acquired during August 23 and 24 do not show significant changes above the 3% level, so the stellar activity has a characteristic timescale of days and not hours.

The other Balmer lines were observed less frequently. Hβ is largely filled in by emission. At times when Hα is flat-topped, Hβ shows a weak central reversal; when Hα has the strong blue peak, Hβ has a weak blue emission peak. Apparently analogous changes in Hγ are scarcely visible above the IDS noise, while Hδ is more nearly photospheric and unvarying. Between June 23 (when only a flat continuum was seen) and July 25 the Paschen lines P13 to P17 appeared in emission with flat-topped profiles of width 600 km s^{-1} and intensity 1.1 (Barker 1980). No changes were seen in this wavelength region correlated with Hα variations, but a gradual decline of the Paschen lines took place from July to November.

Notice that beginning August 19 and September 16, Hα shows an effectively identical sequence of changes occurring in the same time intervals. This suggests the possibility that these variations may be truly periodic. Any periodicity must be short-lived however, because the November profiles show that a phase shift or other transformation has taken place. Intermittent periodicity has been observed in γ Cas (Hutchings 1970) on a timescale identified as the stellar rotation period. In the case of 59 Cygni, it is interesting that for any realistic choice of stellar radius and rotation velocity, the photospheric rotation period must be less than a day, so the emission variations cannot be associated with photospheric rotation. There is no spectroscopic evidence that the star is a binary. Speculative interpretation of these emission transients is avoided pending the next season of observations; undoubtedly other observers have Hα profiles from the current season which will help elucidate Figure 1.

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DISCUSSION

Metz: Can you exclude 59 Cyg being a binary?

Barker: Photographic spectra obtained from 1974 to 1979 at 37 A/mm show complex line profile changes during the second shell phase of 59 Cyg, but at times when the lines appear to be photospheric there is no evidence for any radial velocity variations.

Andrillat: Did you observe the OI line λ 7772 in 59 Cyg and have you compared its behaviour with respect to λ 8446A?

Barker: The 1-2 A resolution near-infrared spectra show a peculiar asymmetric emission feature near (but not at) λ 8446, which shares the general decline of the Paschen emission from July to November 1980. I have not observed 59 Cyg in the λ 7700 A region.

Fehrenbach: En 59 Cyg les contours pourraient s'expliquer par une raie d'absorption centrale qui se déplace. Elle est centrale quand on observe un plateau.

Barker: That is one possible description of the observed variability However, higher resolution spectra of H_α obtained by Dr. Doazan do not show significant central absorption when the profile is flatt-topped.

Harmanec: Have you serious problems with H_2O atmospheric lines in the neighbourhood of the H_α line?

Barker: Even when the skies at Western Ontario are clear, there are severe problems with water vapour because we are surrounded by the Great Lakes; the atmosphere is usually hazy and the humidity is high. However the repeated observations of H_α in P Cyg show that there are no effects larger than the instrumental noise level of 3%.

Hubert-Delplace: Have you observed, in the case of 59 Cyg, significant variation of H line profiles in one night?

Barker: For none of the observation dates from 1980 April to November were any variations detected within a single night (above the instrumental noise level of 3%).