SIMULTANEOUS SPECTROSCOPIC AND PHOTOMETRIC OBSERVATIONS OF THE YY ORIONIS STAR S CrA*

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Abstract:

The YY Orionis stars are a subclass of the T Tauri stars which show in their spectra evidence for infalling envelopes. They are interpreted as protostars in the final stages of their hydrodynamical evolution (Walker 1972, Appenzeller and Wolf 1977, Wolf et al. 1977).

To get more information about the behaviour of these highly variable stars simultaneous spectroscopic and photoelectric (UBV) observations have been carried out in July 1977 at the ESO observatory at La Silla. Such observations of YY Orionis stars have never been done before.

The most frequently observed star during our run was the bright YY Orionis star S CrA. The observational material is still under evaluation and therefore only some preliminary results are presented here. A more extended description and discussion of the observations will be published elsewhere (Mundt and Wolf, 1977).

Our discussion is based on Cassegrain image tube spectrograms (dispersion 40 Å/mm, resolution 3 Å), which were obtained in four successive nights (from 23.7.-26.7.1977). The present results on S CrA concern the behaviour of the redshifted absorption component of the Balmer lines in relation to the photometric variations. The redshifted absorption component was always visible but showed strong variations. To get a measure for the strength of the redshifted absorption the depth A of the H_δ- line relative to the adjacent continuum C was determined from intensity tracings of our spectrograms. We found a correlation between the above defined absorption strength (i.e. A/C), the brightness, and the UV-excess of S CrA. The results are illustrated in Fig. 1 to 3. A general increase in the ratio A/C with increasing brightness is indicated in Fig. 1, although the scat-

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ter is considerable. Walker (1972) found a similar correlation for the YY Orionis star SU Ori. From Fig. 2 furthermore it is evident, that A/C decreases with increasing UV-excess (note that $(U-B)_o$ of Fig. 2 is the (U-B) colour of a main-sequence star with the same (B-V) value as measured for S CrA). Fig. 3 shows the variation of the UV-excess as a function of the brightness in the blue. The correlation between A/C and the UV-excess (Fig. 2) obviously has consequences for the detection probability of inverse P Cygni profiles in T Tauri stars with UV-excess (c.f. Appenzeller, 1977) and it means that it is more probable to identify a YY Orionis star when it has a low UV-excess.

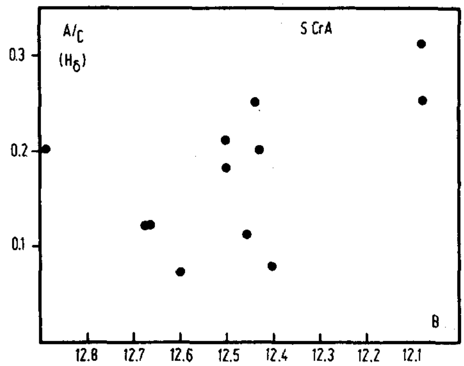

Fig. 1: Ratio A/C as a function of the brightness in the blue range

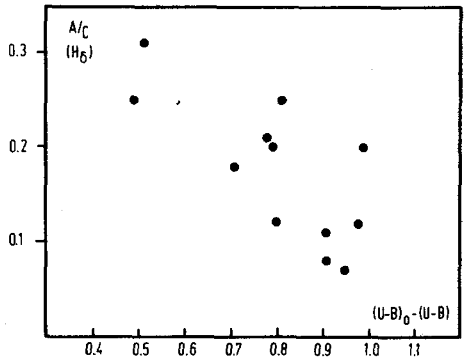

Fig. 2: Ratio A/C as a function of the UV-excess

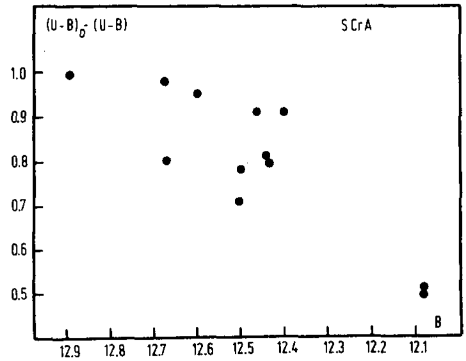

Fig. 3: Variation of the UV-excess as a function of the brightness in the blue range

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The correlation described above can be explained in the following model: The star gets its radiation energy mainly from the dissipation of the kinetic energy of the infalling matter. The increase in brightness and in the strength of the redshifted absorption is supposed to be caused by an increase of the density of the infalling matter only. Note that significant radial velocity variations of the redshifted absorption component have not been observed for S CrA (c.f. Appenzeller and Wolf, 1977). A similar explanation was given by Walker (1972) for his observations of SU Ori. However, variations in the strength of the redshifted absorption are also caused by temperature variations, which are to be expected as a consequence of the density variations (see below). This could be the reason for the considerable scatter of Fig. 1.

On the basis of this model we are able to explain the photometric variations (Fig. 3), if we assume that the increase in the density of the infalling matter causes also an increase in the temperature in those regions where the continuum is formed. The continuum is assumed to be strong Paschen- und Balmer emission superimposed on a quasi-photospheric continuum of a late type star. It is evident from the schematic picture of Fig. 4, that a small increase in temperature means a considerable decrease in the Balmer emission coefficient in the U-range and a small change of the Paschen emission coefficient in the B-range (the curves of Fig. 4 are valid in the case of an optically thick medium for Lyman radiation [Anderson and Kuhi, 1968], which is certainly fullfilled in the inner parts of the envelope). This means that in agreement with the observations an increase in B is correlated with a decrease in the UV-excess.

We have started simultaneous spectroscopic and photometric observations with the newly found bright YY Orionis star CoD -35° 10525 = BV 1387 (Appenzeller et al., 1977). A comparison with S CrA is up to now not very meaningful, since we have not yet obtained a statistically sufficient and homogeneous observing material for this star.

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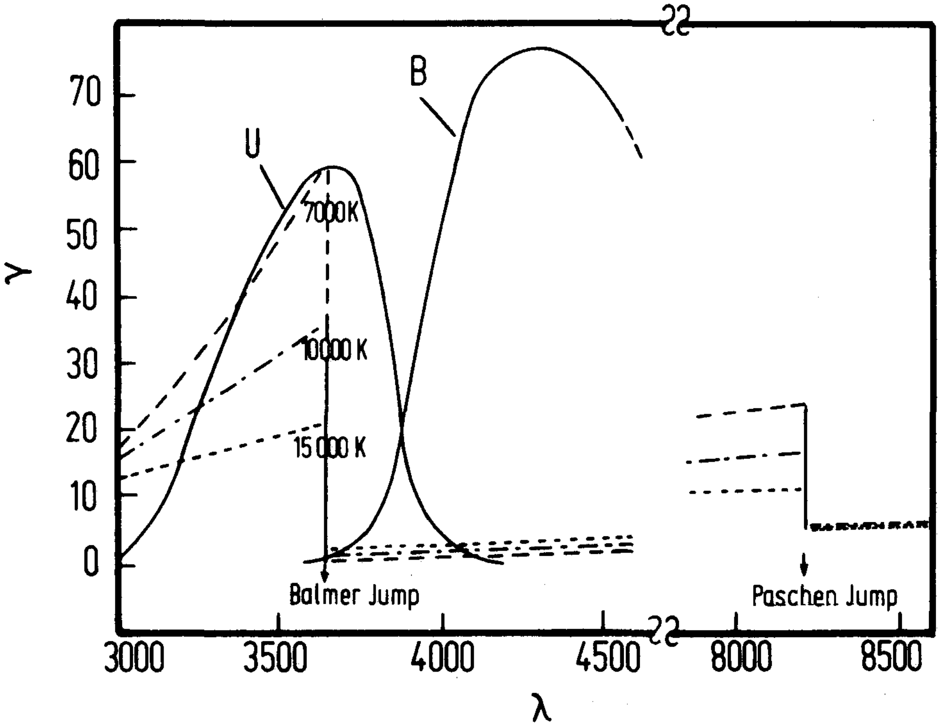

Fig. 4: Schematic picture of the temperature dependency of the Paschen- and Balmer emission coefficient (from Anderson and Kuhi, 1968) together with the sensivity functions of U and B of the photoelectric UBV_4 system (from Matthews and Sandage, 1963). The units of γ are 10^{-14} cm^3 sec^{-1}; λ is in Angströms.

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