Hα VARIABILITY ON HK AQR: CORONAL CONDENSATIONS OR PLAGES?

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INTRODUCTION

Hα in active stars is characterised by large optical depths (Houdebine & Panagi 1990), and so line transfer broadening dominates its profile. HK Aqr is an exception because it rotates rapidly (v sin i = 70 km s⁻¹; Young et al. 1990). Doppler broadening dominates over all other sources (Byrne & Mathioudakis 1993) thus providing the possibility to image Hα-bright regions on the disk.

Young et al. (1990) reported peculiar behaviour of both Hα intensity and bisector which they interpreted as high latitude plages rotating on and off the disk. Byrne & McKay (1990) observed with IUE a sharp drop in MgII emission at similar phase and suggested that both this and the Hα behaviour could be due to occulting material transiting the disk. Doyle & Cameron (1990) suggested that “coronal condensations” similar to AB Dor (Cameron 1988; Cameron & Robinson 1989a,b) might be the cause.

Here we present further Hα observations which show that the Young et al. phenomenon is present at later epochs but is more complex than the above interpretations.

OBSERVATIONS

One data set was obtained at the Kitt Peak 2.1m using the coudé spectrograph on 3 nights, 2-4 Nov 1985. Spectral resolution was ≈15000 and ≈1 spectrum was obtained per 30 min. Another data set was taken at the Anglo Australian Observatory’s (AAO) 3.9m AAT using the UCLES spectrograph on 24 August 1991. Spectral resolution was ≈50000 and 1 spectrum was made per 5 min.

DISCUSSION

Fig. 1 shows the EW and centroid wavelength, λcent, of Hα against phase for the Kitt Peak data. These were determined by fitting gaussians to the observed line in the program DIPSO (Howarth & Murray 1987). A drop in Hα EW of ≈50% occurs at φ ≈0.7-0.9. This Hα behaviour is similar to that seen in MgII 13 months previously (Byrne & McKay 1990). There is a small shift in phase (Δφ ≈ +0.1-0.2), which could be due to uncertainty in the period which was determined photometrically from a single epoch (Young et al. 1990). We note,
however, that the Hα variation in 1985 is smooth, reminiscent of spot variations. Furthermore, EW variations appear to repeat perfectly over the 3 nights.

We see a far less systematic behaviour of the emission line centroid than reported by Young et al. (1990) or Byrne et al. (1992). Indeed, it is difficult to argue for other than stochastic behaviour of the line centroid, at least at the present epoch and at the present spectral resolution.

Fig. II Shows the same quantities for 24 November 1991 derived from the AAO data. Hα EW is clearly variable on time scales from 15 min (φ ≈ 0.05) to several hours (≈0.05-0.4). Variation in EW is similar to but somewhat greater than that of the Kitt Peak data, i.e. from 1-2Å. In detail, however, the variation is much less smooth and more reminiscent of flaring.

λ_{cent} shows a great deal more significant and coherent variability than the lower resolution Kitt Peak data. Between φ ≈ 0.83-0.05 we see an almost linear drift in λ_{cent} similar to that reported by Young et al. (1990). Velocity amplitude is ≈20 km s\(^{-1}\), also similar to that seen by the latter. Between φ ≈ 0.1-0.3, however, λ_{cent} swings first red to blue by the same amount and then back again.
by the same amount. The behaviour at \( \varphi \approx 0.83-0.05 \) is consistent with a high-latitude plage transiting the disk, but this latter behaviour is not. Precisely the same objection applies to the "coronal condensation" interpretation. Corotating neutral hydrogen clouds would produce a signature in \( \lambda_{\text{cent}} \) from red to blue but not vice versa.

Maximum blue displacement of \( \lambda_{\text{cent}} \) occurs at \( \varphi \approx 0.23 \), just at the onset of the H\( \alpha \) EW increase. This behaviour is reminiscent of flaring, wherein blue shifted H\( \alpha \) often accompanies flare onset (Byrne 1989).

CONCLUSIONS

3 nights’ Kitt Peak data show a smooth variation of H\( \alpha \) EW which repeats night-to-night and so is qualitatively similar to spot variations. It therefore argues for rotational modulation of spot associated plages. We note, however, that the scatter of \( \lambda_{\text{cent}} \) is greater near H\( \alpha \) minimum, the opposite of what would be expected in the latter interpretation. The AAO data, with its better spectral and time resolution, shows rapid variations which are consistent with rotational modulation of plages and superimposed flaring.

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