Environments of Active Binaries

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Abstract. We present high-resolution spectroscopic observations of the active close binary systems ER Vulpeculae, GK Hydrae and TY Pyxidis. The spectral subtraction technique has been used in an investigation of the existence of prominence-like and plage-like material in these systems. We show that prominences are not a characteristic of the RS CVn class.

1. Introduction

In recent years evidence has been found for cool coronal condensations analogous to solar prominences around some single stars (e.g. Collier Cameron et al. 1990). Using the technique of *spectral subtraction* (Gunn 1995) and observations taken during occultations of eclipsing binary systems, some authors have claimed the existence of long-lived extended regions corotating with the components of RS CVn binaries (e.g. Hall & Ramsey 1992). Such work has concluded that prominence-like features are common in active close binaries. We have attempted to investigate this assertion using high-resolution eclipse observations of selected RS CVns.

2. Observations & Analysis

We obtained high-resolution optical spectroscopy of the RS CVn-type binaries ER Vul, GK Hya and TY Pyx using the William Herschel Telescope (August 1993) and the Anglo-Australian Telescope (January 1994). Calibrated data were analysed using the *spectral subtraction* technique. This involves simulating the inactive spectrum of the binary star from observed spectral standard stars and simply performing a linear subtraction of this from the observed spectrum. Any manifestation of activity above that of the reference inactive chromosphere is then readily observable in the subtracted spectrum as excess emission or absorption features.

3. Results

For *ER Vul* excess emission was found in the Hα, the Ca II IRT and the Mg I b lines and excess absorption in the He I D_3 line. The emission appeared to be from a global phenomenon with the secondary component the more active. Based on the analysis of a substantial amount of absorption in the He I D_3 line we conclude that the emission arises in mostly plage-like material. We estimate

the fractional area coverage of these active regions on ER Vul at approximately 50%. No firm spectroscopic evidence for the existence of extended material around ER Vul was found. A consistent velocity offset of $\sim$10 km s^{-1} in the Hα emission may represent the first observation of the equivalent of solar spicule emission in a stellar system other than the Sun. For *GK Hya* excess emission was found in the Hα, Hβ and Mg I b lines. The emission appeared to arise from a global phenomenon associated solely with the secondary component. The lack of significant He I D_3 excess absorption and an analysis of the flux ratio in the Balmer lines suggests that the emission originates in prominence-like material seen off the limb of the star. A broad excess absorption band centred around the Balmer emission peaks may be caused by this material absorbing the stellar continuum against the disk with very high line-of-sight turbulent velocities. However this may also be a result of spectral type mismatch between observed and standard stars. The inference that plage-like regions and associated star-spots are not substantial on this star are in agreement with its lack of spot modulation in the photometric light curve. No spectroscopic evidence for *discrete* prominence-like material was found for GK Hya. For *TY Pyx* excess emission was detected in the Hβ line and the cores of the Ca II H and K lines. The majority of the Hβ excess and a larger proportion of the Ca II core emission could be attributed to a global phenomenon on the primary component. It was concluded that the emission arises in prominence-like material, although this assertion is in need of confirmation. An excess absorption band surrounding the Hβ line, similar to that seen in the GK Hya system, also supports the suggestion that prominence-like material exists in this system. However no firm evidence for the existence of *discrete* prominence structures was found.

4. Conclusions

The existence of prominence-like material has been postulated in a number of active close binaries. However the results presented here have failed to show spectroscopic signatures which can unambiguously be associated with such structures. It is possible that large extended regions exist in the systems studied which were not conveniently positioned to be seen during the observations. On the basis of our observational data it is appropriate to conclude that extended matter is not a characteristic of RS CVns in general although prominence-like material probably exists in many.

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