ON THE DIFFERENCES AT CHROMOSPHERIC LEVELS BETWEEN RS CVn-TYPE BINARIES, ACTIVE AND QUIET CHROMOSPHERE SINGLE STARS, AND ACTIVE AND QUIET REGIONS IN THE SUN

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RS CVn-type systems exhibit many similarities to active regions on the Sun. In the last few years considerable progress has been made in quantifying the differences between the atmospheric properties of solar plages and quiet regions. These differences, as summarized in Linsky's (1979) review, can be simply explained by additional nonradiative heating and include the following: (1) temperature enhancements in the photosphere, (2) heating of the temperature minimum and its displacement downward in mass column density, (3) enhanced radiative losses in the chromosphere and transition region (typically by a factor of 10), (4) steeper chromospheric temperature gradients, and (5) enhanced pressures and densities at the top of the chromosphere, throughout the transition region, and at the base of the corona (again typically by a factor of 10).

Observations and chromospheric modeling are now leading us to very similar conclusions concerning the differences between active and quiet chromosphere stars (Kelch *et al.* 1979). In a recent study of Mg II emission, Basri and Linsky (1979) find a factor of 10 range in surface fluxes at each effective temperature, implying that active chromosphere stars may be covered largely by solar-like plages.

The detailed study of the 104-day period system Capella (G6 III + F9 III) based on high dispersion IUE spectra by Ayres and Linsky (1979) provides some important insight into the RS CVn phenomenon. They show that most of the emission in lines formed at 2×10^4 - 2×10^5 K comes from the hotter secondary (Capella B), that the surface fluxes in these lines are typically 50 times those of the quiet Sun, that the X-ray emission probably comes mainly from Capella B, and that there is no evidence for a strong wind. They conclude that the transition region pressure in Capella B is 0.3 - 0.5 dynes cm^{-2} and that it is not conductively heated. The transition region lines are very broad, typically with FWHM = 150 km/s. They suggest that this might result from the rapid rotation of Capella B ($v \sin i$ = 20 km/s) with considerable emission from large corotating magnetic loops which extend above the limb. Thus Capella B is an

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RS CVn-type star with its properties due to its rapid rotation. By comparison, the usual RS CVn-type systems with 1 - 20 day periods exhibit similar properties also due to rapid rotation, but as a consequence of orbital synchronism.

Simon and Linsky are now analyzing IUE spectra of UX Ari and HR 1099 taken when both stars were quiescent. They are finding no important changes with phase and estimate pressures at the top of the chromosphere in the range 0.18 - 0.55 dynes cm^{-2} by analyzing spectra of C II, Si II, and Si III. These pressures and coronal temperatures of 10^7 K, lead to estimated flux tube lengths of 4 - 11 $R_\odot$ using the flux tube model of Rosner, Tucker and Vaiana (1978). These lengths are larger than the radius of a K0 IV star ($\approx$ 2.5 $R_\odot$) and are comparable to the semimajor axis of the UX Ari orbit ($a \approx 16\ R_\odot$).

On January 1, 1979, we obtained IUE spectra of UX Ari near maximum of an important flare. These data show a factor of 5.5 enhancement of the emission lines, and the Mg II resonance lines are asymmetric with broad wings extending 475 km/s to the red, implying downfalling material with velocities up to 475 km/s. Since the escape velocity from a K0 IV star is about 400 km/s, these data suggest free fall from a large distance, presumably along a flux tube. Thus flux tubes are likely to be several radii in extent for RS CVn-type stars.

This flare spectrum suggests the following very speculative picture of a flare in these systems. Large flux tubes from the K0 IV secondary star may, due to differential rotation (spot migration) or for other reasons, come close to the G5 V primary. When this happens, magnetic reconnection provides the energy for the excess X-ray, ultraviolet, and visible emission which characterize the flare. Also the two stars may be temporarily connected by the flux tube, facilitating large mass exchange, which may explain the observed period changes. Material falling down the flux tube to one or both stars can lead to large red asymmetries, such as we saw in UX Ari and the ± 250 km/s velocity components seen by Weiler (1978) and by Weiler *et al.* (1978). Finally this model predicts considerable hot material between these stars and suggests that the radio emission comes from this material.

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