Coronal and Transition Region Structure in RS CVn Binaries

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1. Introduction

Emission measure distributions have been derived for the active components of V711 Tau, AR Lac and II Peg, using EUVE line fluxes and the Fe emissivities of Brickhouse, Raymond and Smith (1995). These have been compared with distributions derived from spherically symmetric energy balance models.

2. EUVE Spectral Analysis and Emission Measure Loci

EUVE SW and MW spectrometer data were analysed for each system. The line fluxes were corrected for the effects of continuum radiation and interstellar absorption. The corrected fluxes were used to calculate emission measure loci using the emissivities of Brickhouse et al. (1995) and source distances from Strassmeier et al. (1993).

The emission measure loci derived for the K star of V711 Tau are shown in Figure 1.

The Fe XXI density sensitive line ratios (λ97.88/λ128.73 and λ102.22/λ128.73) show that the coronal electron density in all three systems lies at or below a value of log\(N_e\) = 12.5.

3. Coronal Models - Spherically Symmetric Geometry

It is assumed that emission predominantly originates from regions below that where heating is likely to occur. The energy deposited by thermal conduction from the heated region is then balanced by energy lost through radiation. The energy balance equation was solved for an atmosphere in hydrostatic equilibrium and possible emission measure distributions were derived from assumed 'coronal' values of the emission measure and temperature. The lower of the two broken lines in Figure 1 shows the spherically symmetric model. For all the sources a model of this form gives coronal electron pressures two or three orders of magnitude below the EUVE estimate. The upper line is a model in which the pressure is maximised by changing the form of the radiative power loss term and increasing the starting emission measure to find the maximum at which an energy balance solution is possible. This is equivalent to restricting the emission to some fraction of the surface area. The pressures predicted are still about two orders of magnitude too low.
Figure 1. The emission measure distribution \( EM = \int N_e N_H \, dr \) for the K star of V711 Tau. The individual points are spectral fits to X-ray data. Solid Triangle - 2T fit to *Einstein* SSS data: Swank et al. (1981). Open Triangle - 1T fit to *Einstein* IPC data: Schmitt et al. (1990). Solid Square - 1T fit to EXOSAT ME data: performed by the authors. Cross - 2T fit to ROSAT PSPC data: Dempsey et al. (1993)

4. Conclusion

Coronal models based on spherically symmetric geometry do not reproduce the observed emission measure distribution or the measured coronal electron density. Most of the emitting material lies at temperatures above the proton escape temperature and the critical temperature for a stellar wind (typically \( \sim 1 - 2 \times 10^6 K \)). The hottest material must therefore be confined in magnetic loops. We are currently modelling coronae composed of both loops and open regions.

References