X-ray spectroscopy of RS CVn binaries: the EXOSAT and SSS spectra revisited

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1. Introduction

We have performed a systematic re-analysis of EXOSAT spectra of RS CVn binaries during both quiescent and flaring conditions. The sample comprises, in addition to Algol, all catalogued RS CVn binaries observed by EXOSAT. Several flares were detected during the EXOSAT observations.

We have compared the results with those obtained previously for the same sources with the Einstein IPC and ROSAT PSPC detectors. We have also re-analysed spectra from the Einstein SSS taking into account ice formation on the detector surface.

Although these data have a much lower resolution and sensitivity than the ones being obtained at present with ASCA, we believe that a homogeneous re-analysis of the entire EXOSAT sample provides a useful comparison with the ASCA data and with data to be obtained shortly with SAX.

2. Spectral analysis

Thermal X-ray spectra at temperatures characteristic of late type stars are very rich in emission lines, but the spectral resolution of the detectors on board EXOSAT or Einstein was generally too modest to resolve individual lines or to allow detailed plasma diagnostics. Fits with theoretical model spectra are necessary to evaluate the coronal parameters such as temperatures, emission measures and elemental abundances.

We analysed data from the EXOSAT medium energy ME and low energy LE detectors, as well as from the Einstein SSS using the Mewe-Kaastra code for optically thin plasmas. The interstellar absorption was taken into account.

Best fit values for temperature $T$ and emission measure $EM$ were derived minimising the $\chi^2$ statistics. The $\chi^2$ value as well as the distribution of the residuals were used as indicators of the goodness of the fit. Results of the spectral fits are given in Ortolani et al. (1996). Significant differences were found in some cases with published results based on the same data sets, which
indicates the need of a homogeneous re-analysis of the entire data sample before meaningful conclusions can be drawn.

Evidence for the presence of a multi temperature structure was found in all but one of the observed RS CVn systems from both the EXOSAT and *Einstein* SSS data. One component is typically around $\approx 5 \times 10^6$ K, while the other is at $\approx 20 \times 10^6$ K. In general two temperature models were sufficient to get acceptable fits, although in some EXOSAT spectra no error computation (at the 90% confidence level for a single parameter) was possible for the low temperature component.

No relevant differences from solar abundances were detected using the EXOSAT spectra. A few SSS spectra showed a different pattern, but the derived abundances were affected by large uncertainties, and the differences are most likely not significant.

3. Discussion

The comparison of the EXOSAT results with the *Einstein* IPC results (Majer et al., 1986) showed a general agreement, if the possibility of time variability is taken into account.

A similar conclusion holds when comparing the EXOSAT results with those of the ROSAT PSPC (Dempsey et al., 1993), which indicates that the detector response has only a marginal effect on the derived parameters.

Less agreement was found between *Einstein* SSS and EXOSAT, although possible calibration errors induced by ice formation on the SSS detector may be responsible at least in part for the disagreement.

If the bimodal temperature distribution found for both the EXOSAT and the *Einstein* SSS data is compared with the stability regions in the cooling curve of hot plasmas (Geherels & Williams, 1993), only a partial agreement is found. This suggests that the radiative cooling cannot be the only factor determining the temperature structure of RS CVn's coronae.

Time resolved spectra of a number of flares were also analysed and the derived parameters were used to infer the properties of large flares on RS CVn binaries.

References


