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A *Beppo*SAX observation of HD 9770: a visual triple system containing a recently discovered short-period eclipsing binary

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Abstract. We have studied the coronal X-ray emission of the recently discovered short-period eclipsing binary HD 9770 with the *Beppo*SAX satellite. The data from the Low Energy and Medium Energy Concentrator Spectrometers (LECS & MECS) onboard *Beppo*SAX allow studying the spectrum of this star from 0.1 to 8 keV, confirming that this is a very active coronal source, with strong flaring activity. The X-ray emission most likely originates from the eclipsing binary itself, rather than from the other visual component of the system. The X-ray light curves could be modulated with the orbital period of the eclipsing binary, with a hint for a different orbital modulation of the cooler and hotter plasma. The X-ray spectrum is characterized by hot plasma, with the Fe K complex at 6.7 keV clearly detected in the MECS spectrum, and it is well fitted by a 2-temperature optically thin plasma model with low metal abundances ($\sim 0.3\,Z_\odot$). These results are in line with those found for many other active stars. As expected, during the flare the X-ray emission is dominated by hotter plasma with a temperature > 4 keV. There is an indication that the metal abundance may be somewhat higher during the flare.

Key words: stars: activity – stars: binaries: eclipsing – stars: coronae – stars: flare – stars: individual: HD 9770 – X-rays: stars

1. Introduction

HD 9770 (SAO 193189; CD–30529; PPM 244106; GSC 06428 01616; BB Scl) is a very interesting nearby (24 pc as determined by the *Hipparcos* satellite) visual triple system with a total magnitude V = 7.1. Components AB and C were classified as K3V and M2V, respectively (Edwars 1976; Gliese 1969). Components A and B are separated by 0.17 arcsec, while the much weaker component C is at 1.44 arcsec from A + B (Gliese 1969). Cutispoto et al. (1997), on the basis of multicolour UBV(RI)$_c$ photometry, have classified component A as a K1/2V type star; they also showed that the B component is itself a short period (~ 0.48 days) eclipsing binary formed by two nearly identical stars of spectral type K4/5 V and K5 V, respectively. It shows two almost identical primary and secondary eclipses that last for about 70 minutes each, and out-of-eclipse variability that indicates that HD 9770 belongs to the BY Dra type of variable stars (Fig. 1). The conclusion that component B is indeed the eclipsing binary comes from the peculiar behavior of the colour indices at both primary and secondary eclipses. In fact at both minima, the star is bluer indicating that the cooler eclipsing component (B_1 + B_2) is contributing less to the total integrated light of the A + B system (component C is too faint to generate the observed light variations). More recently Cutispoto et al. (1999) revised the spectral classification of the A, B_1 and B_2 components to K0/1 V, K3 V and K3/4 V, respectively, in more agreement also with the *Hipparcos* distance.

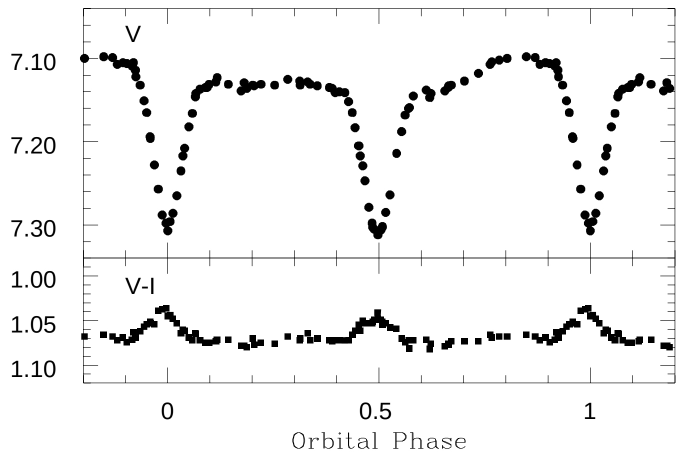

Fig. 1. HD 9770 V-band light curve and $V-I$ color obtained over the interval 7–25 Dec 1996, folded with the period of P=0.4765318 days.

HD 9770 was clearly detected during the all-sky EUV surveys obtained with both the WFC on board the ROSAT satellite (Pounds et al. 1993, Pye et al. 1995; RE 0135–295) and with the EUVE satellite (Malina et al. 1994; EUVE J0135). It was also detected in the ROSAT all-sky survey (RASS, Snowden & Schmitt 1990; 1RXS J013500.7–295430) with an average PSPC count rate of ~ 3.5 cts s^{-1} in the spectral band 0.1–2.4 keV. The star was observed by the PSPC in individual scans about 30 s long spaced by 96 min, covering more than 2 days, with an additional single scan obtained after a gap of about 160 days.

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The source was clearly variable, with a mean X-ray luminosity of $L_{\rm x} = 1.6 \times 10^{30}$ erg sec^{-1} (Cutispoto et al. 1997). During the two-day observation, the X-ray luminosity ranged from $\sim 9 \times 10^{29}$ to 2.3×10^{30} erg s^{-1}, with a single flaring data point as high as 3.7×10^{30} erg s^{-1}. In all these X-ray and EUV observations, the triple visual system was observed as a single unresolved source. The high X-ray luminosity of the source strongly suggests that most of the X-ray flux originated from the eclipsing binary, due to its short period and more efficient dynamo activity. The contribution of components A and C is expected to be at least one order of magnitude less if these components behave as normal K and M field dwarfs (Schmitt et al. 1995). K and M stars could provide a meaningful contribution to the X-ray flux only if they were very young. This does not seem to be the case, since in optical spectra obtained recently by us at ESO we do not detect any lithium line (with an upper limit of EW < 12 mÅ for the 6707.8 Å lithium line) and there are no indications for a very young age of this system (actually, we find [Fe/H]~ -0.5, see Sect. 4).

Thanks to its short period, we monitored ~ 3.5 contiguous orbital cycles of HD 9770 with the *Beppo*SAX satellite. The purpose was to study the short-term variability of this source in search of rotational/orbital modulation as well as of eclipses, while at the same time determining the spectral properties of the source. Although *Beppo*SAX has a lower energy resolution, typical of gas-scintillation proportional counters, than the ASCA CCD detectors, its extended spectral range, from 0.1 to 10 keV for coronal sources, is well suited to study the coronal temperature and emission measure distribution (see also Favata et al. 1997c). Here we present the spectral results together with the optical monitoring of the *Beppo*SAX observation of HD 9770.

2. Observations

The *Beppo*SAX satellite carries on board various X-ray detectors covering a very large energy band from 0.1 to 300 keV (Boella et al. 1997a). For the study of typical coronal sources the most suitable detectors are the Low Energy Concentrator Spectrometer (LECS, Parmar et al. 1997) and the three Medium Energy Concentrator Spectrometers (MECS, Boella et al. 1997b). The LECS has a wide energy range, 0.1–10 keV, and good spectral resolution, comparable to CCD detectors at low energies where it fills the gap between EUVE and ASCA. On the contrary, the three MECS detectors cover only the 1.7–10 keV energy range, but they have an effective area about three times larger than the LECS, thus allowing the study of the Fe K complex at ~ 6.7 keV much more effectively than with the LECS, although at a lower spectral resolution than with ASCA.

*Beppo*SAX observed HD 9770 on December 7–9, 1996 for about 42 hours, resulting in 40 ks and 83 ks of observing time in the LECS and MECS detectors, respectively. The difference is due to the LECS being operated only when the spacecraft was in the Earth shadow. The data analysis was based on the linearized, cleaned event files obtained from the *Beppo*SAX Science Data Center (SDC) on-line archive (Giommi & Fiore 1998). Light curves and spectra were accumulated with the FTOOLS package (v. 4.0), using an extraction region of 8.5 and 4 arcmin radius for the LECS and MECS, respectively. At low energies the LECS has a broader Point Spread Function (PSF) than the MECS, while above 2 keV the PSFs are similar. The adopted regions provide more than 90% of the source counts at all energies both for the LECS and MECS. The LECS and MECS background is low, but not uniformly distributed across the detectors, on the other hand it is rather stable. For this reason, it is better to evaluate the background from blank fields, rather than in annuli around the source region. Thus, after having checked that the background was stable during the whole observation by analyzing a light curve extracted from a source-free region, for the spectral analysis we used the background files accumulated from long blank field exposures and available from the SDC public ftp site (see Fiore et al. 1999, Parmar et al. 1999). We did not subtract the background from the light curves given that it is stable and it amounts to only $\sim 1/6$ and $\sim 1/5$ of the MECS and LECS source flux, respectively.

The spectral analysis was performed with the XSPEC 10.0 package, using the response matrices released by the SDC in September 1997. We binned the spectra using the rebinning template files provided by the SDC. These files contain a specific rebinning to sample the instrument resolution with the same number of channels, three in our case, at all energies (i.e. the rebinning factor is not constant with energy). For the spectral analysis, the LECS data have been considered only in the range 0.1–4 keV, due to still unsolved calibration problems at higher energies (Fiore et al. 1999). To fit the LECS and MECS spectra together, one has to introduce a constant rescaling factor to account for uncertainties in the inter-calibration of the instruments. The acceptable values for this constant is within 0.7 and 1 (Fiore et al. 1999). The best fit value in our case using the full datasets is 0.83, in full agreement with the acceptable range. Thus we kept this constant value fixed to 0.83 in all our spectral analysis[1]. For a full description of the *Beppo*SAX data analysis see Fiore et al. (1999).

Additional spectral information can be obtained by the Phoswich Detector System (PDS, Frontera et al. 1997) on board *Beppo*SAX albeit this detector was designed to provide the maximum sensitivity at energies somewhat higher than for typical coronal sources. The energy range covered by the PDS is 15 to 300 keV and the experiment can perform sensitive spectral and temporal studies over this energy range. Hard (> 10 keV) X-ray emission has been detected by the PDS from large flares on active stars (e.g. Favata 1998, Pallavicini & Tagliaferri 1998, Pallavicini et al. 1999); however, no X-ray emission was detected by the PDS for HD 9770, not even during flares, so we will not consider this instrument anymore in the following discussion.

The photometric optical data presented in Fig. 1, are part of the *UBV(RI)*$_c$ observations carried out in the period 7–25

[1] A preliminary analysis of this *Beppo*SAX observation of HD 9770 (Tagliaferri et al. 1999a, 1998) gave slightly different results with respect to those reported here. This is due to the adoption for the present analyses of new calibration files provided by the SDC.

Dec, 1996 at the European Southern Observatory (La Silla, Chile). We used the 50 cm ESO telescope equipped with a single-channel photon-counting photometer, a thermoelectrically cooled R943–02 Hamamatzu photomultiplier and standard ESO filters matching the $UBV(RI)_c$ system. Details on the observation and reduction procedures can be found in Cutispoto (1995). These data allowed us to extend the time window over which to perform the period search. In this way we were able to obtain a new, more accurate, period of 0.4765318 ± 0.0000012 days (to be compared with the previous period of 0.476533 ± 0.000033 days, obtained by Cutispoto et al. 1997).

3. Results

In Fig. 2 we plot the total MECS light curve of HD 9770. Times are measured starting from December 7, 1996 00:00 UT. A strong flare is clearly detected at the beginning of the observation at phase ~ 0.2. A second smaller flare was detected about 15 hours later, during the second observed cycle of the binary, at phase ~ 0.5. Another flare was probably just missed, due to Earth occultation, at the end of the observation, during the fourth cycle, again at phase 0.5 (note that the primary and secondary eclipses are centered at phases 0 and 0.5 and that the whole observation in Fig. 2 comprises ~ 3.5 orbital cycles). The light curves were then folded (Fig. 3) using the new ephemerides derived by us with optical observations (see previous section and Fig. 1). A narrow time window around the main flare was removed, otherwise the flare would have dominated the folded light curve, while we are interested instead in the presence of an orbital modulation. We also removed the two smaller flares detected at ~ 28 and 51 hours (see Fig. 2). For the exact time windows see caption of Fig. 3. The top and the middle panels of Fig. 3 show the MECS and LECS folded light curves, respectively. If present, an orbital modulation would imply that the size of the coronal loop structures are smaller than or at most comparable to the stellar radius and that they are distributed not uniformly across the stellar disk. Unfortunately, due to the large error bars, a period search did not give conclusive answers, even if we assume the known optical period. In fact, with our statistics, we could only detect an orbital modulation if this would be greater than 50% ($3\,\sigma$ detection). Nevertheless, simply from a visual inspection of the folded light curve with the optical period, a modulation appears to be present. This seems more pronounced in the harder band (MECS, > 1.5 keV), where two maxima can be identified at orbital phases between $0.4 \div 0.5$ and $0.8 \div 0.9$. To put this on more solid statistical ground, we fitted the LECS (< 1 keV), MECS (> 1.5 keV) and hardness ratio (MECS [> 1.5 keV]/LECS [< 1 keV]) folded light curves with a constant in order to check the amount of variability. The reduced χ^2 are 1.45, 2.79, 1.36 for the LECS, MECS and hardness ratio folded light curve, respectively. In all three cases the hypothesis of a constant curve can be rejected with a probability greater than 99.9%, however the variability is clearly more pronounced in the MECS. For this analysis we selected only simultaneous LECS and MECS data, to avoid bias introduced by the larger gaps in the LECS light curve. We also excluded the flare activity using the same windows reported in the caption of Fig. 3. However, we plot in Fig. 3 the MECS folded light curve obtained using the full MECS data set, but the flare windows, in order to show to the reader as much information as possible. We also fitted the curves with a constant plus a sinusoidal model to verify if it can reproduce the observed variability. The reduced χ^2 are 1.18, 1.51, 1.03 for the three curves, respectively. A formal F test shows that the improving of the χ^2 is significant at a

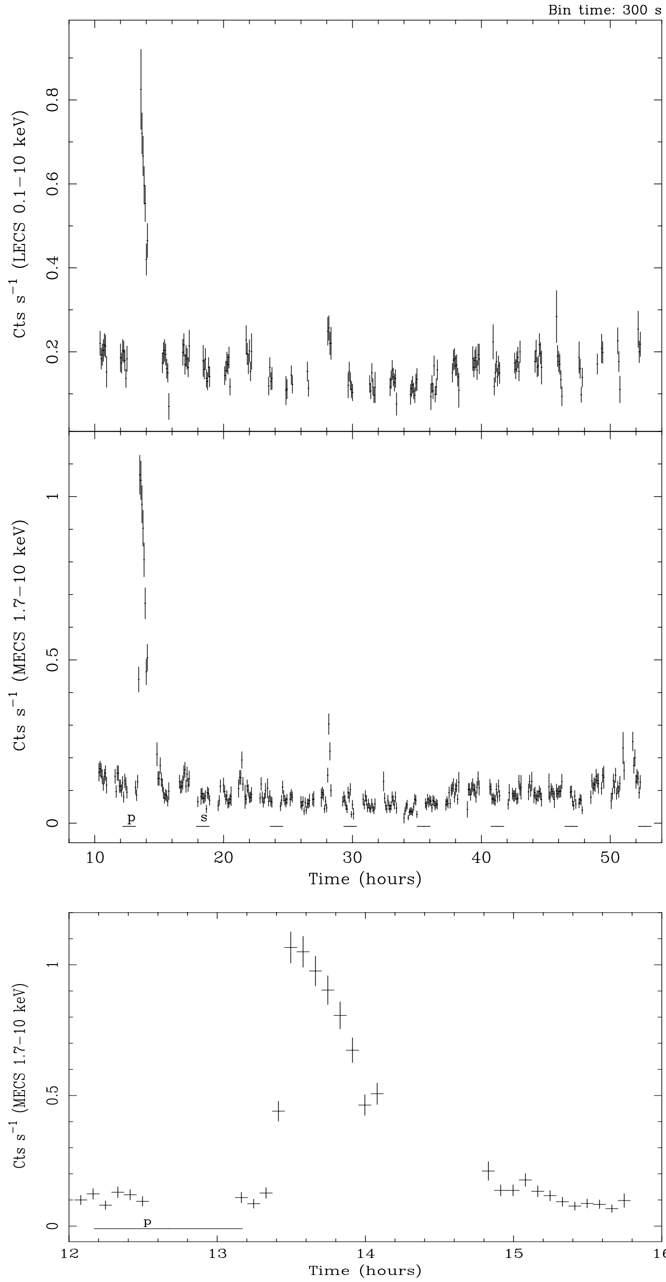

Fig. 2. SAX LECS and MECS light curves for HD 9770 (*top panel*) and the region around the main flare for the MECS (*bottom panel*), binned over time bins of 300 s. The observation started on December 7, 1996. The dashes below the MECS light curves show the position and duration of the primary and secondary optical eclipses.

level greater than 99%. Clearly, there is more variability in the folded light curves than what is reflected by this simple model, but the improvement is significant. In the MECS folded light curve, which is the one with more information, the primary eclipse at phase 0 seems detected, immediately after the second maximum. The secondary eclipse is not detected, actually at this position we have no data due to the windowing. Otherwise, we would have a maximum in the flux at phase ~ 0.5 due to the small flare seen during the second cycle and to the one partly missed at the end of the observation, during the fourth cycle. This probably implies that there is an active region on the primary star rotating in front while it is eclipsing the secondary. The bottom panel of Fig. 3 finally shows the hardness ratio MECS/LECS; a softening of the X-ray spectrum during the minima seems to be present. This would indicate that the hotter coronal plasma occupies a smaller volume.

For the spectral analysis the whole dataset was subdivided into two parts. The "flare" set, composed only of events related to the main flare starting at $\sim$ 13:25 hours of the observing time, and the "out of flare" dataset with all events but those associated with the main flare. Note that the count rate and the duration of the flare were not sufficiently high/long to allow time-resolved spectroscopy throughout the flare. For this reason, we do not attempt a modeling of this event.

The spectral fits were performed with the optically thin plasma models of Raymond & Smith (1977; hereafter RS) and Mewe et al. (1996a; hereafter MK) models, as implemented inside XSPEC. One- and two-temperature models were assumed with metal abundances Z either fixed to the solar value or varied in a fixed proportion with respect to solar. The interstellar absorption $N_{\rm H}$ was also included in the fit. We first left $N_{\rm H}$ free to vary in the fit procedure, obtaining a best-fit value of the order of 3×10^{19} cm^{-2}. This value is quite high for a star whose distance is 24 pc (as measured by Hipparcos); for instance if we apply the relation H ~ 0.07 cm^{-3} from Paresce (1984) with the above distance we get $N_{\rm H} \sim 5.2 \times 10^{18}$ cm^{-2}. High value of $N_{\rm H}$ are obtained also for other *Beppo*SAX observations of coronal sources: VY Ari, II Peg, UX Ari and AB Dor (Favata et al. 1997b, Tagliaferri et al. 1999b, Pallavicini et al. 1999). This anomaly could either be due to a problem in the calibration of the LECS detector below 0.5 keV (which is where the $N_{\rm H}$ is estimated in the case of values lower than $\sim \times 10^{20}$ cm^{-2}) or to a wrong modeling, whose deficiency is revealed by the large energy range covered by the *Beppo*SAX data. In order to minimize the number of free parameters and also the influence that $N_{\rm H}$ could have on the derived metallicities at the low resolution of our detector (a higher $N_{\rm H}$ would mimic the same effect as a lower metallicity, although for the $N_{\rm H}$ range here involved this is practically negligible), we fixed the value of $N_{\rm H}$ to 5×10^{18} cm^{-2}. Moreover, for the evaluation of the count errors, we adopted the approximation of Gehrels (1986) for data following the Poisson statistics, instead of the less accurate Gaussian approximation.

In Fig. 4 we report the LECS + MECS spectra, and their best fits for the flare only and for the quiescent emission outside the main flare. In both cases it was impossible to fit a single temperature model, as expected, or a 2-temperatures model with abundances fixed to solar values. Good fits to the data could only be obtained with a 2-T model with the metal abundance Z free to vary. The models shown in Fig. 4 refer to the 2-T MK model; the best-fit parameters together with errors (90% confidence) are reported in Table 1 for both the 2-T MK and RS models.

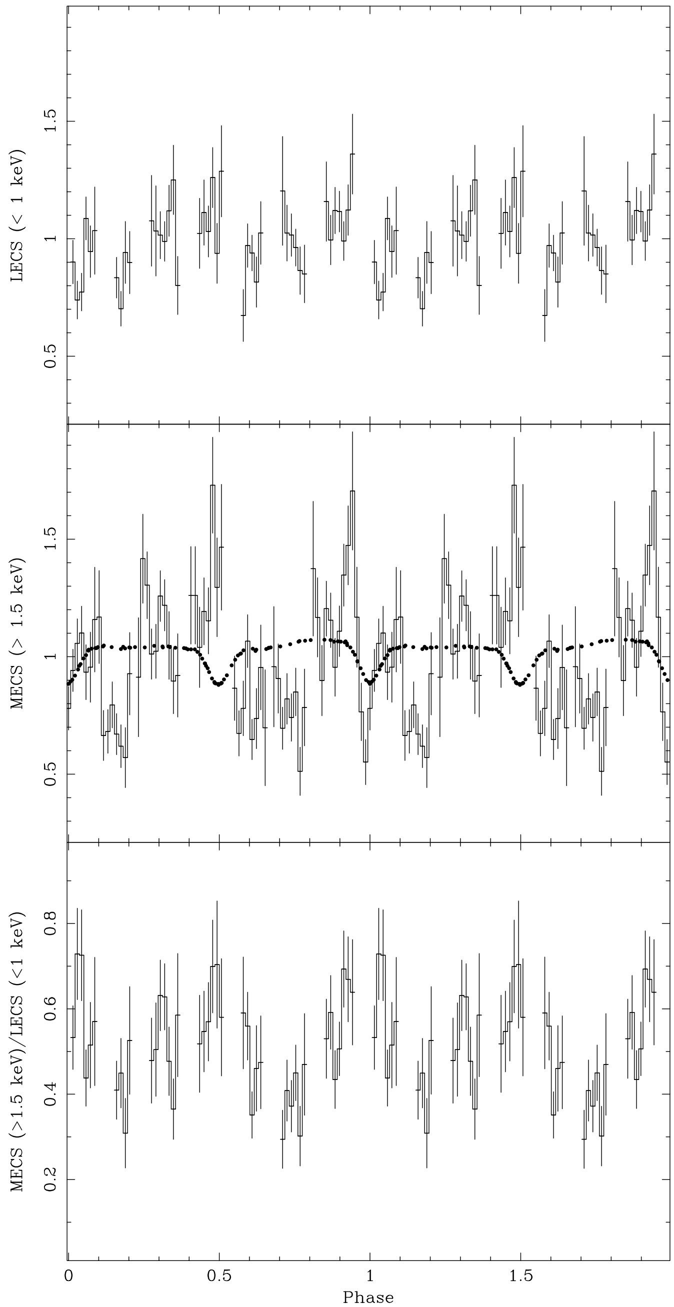

Fig. 3. SAX LECS (*top panel*), MECS (*middle panel*), and MECS/LECS light curves for HD 9770, binned over time bins of 600 s. The folded, with the optical period, light curves have been obtained within the following time windows: December 7, 1996; UT 10:17-13:12, 14:38-27:21, 28:48-50:24. The curves, but the hardness ratio, are normalized dividing by the average source intensity. The relative energy bands used for the MECS and LECS data are also given.

Table 1. Two-temperature RS and MK best fit parameters. Spectra are analyzed considering both the strong flare and the whole observation but this flare. The energy bins are 110 for each dataset and the corresponding degrees of freedom are 105. Errors are computed at the 90% confidence level assuming three interesting parameters ($\Delta\chi^2 = 6.21$).

	KT_1 (keV)	EM_1 10^{52} cm^{-3}	KT_2 (keV)	EM_2 10^{52} cm^{-3}	Z $Z/Z_\odot$	χ^2_ν
Flare RS	$0.82\pm^{0.27}_{0.30}$	2.95	$4.26\pm^{1.68}_{0.85}$	15.55	$0.51\pm^{0.25}_{0.26}$	0.85
Flare MK	$0.80\pm^{0.42}_{0.30}$	3.00	$4.23\pm^{1.60}_{0.83}$	18.31	$0.52\pm^{0.40}_{0.27}$	0.86
Out of Flare RS	$0.84\pm^{0.04}_{0.06}$	3.43	$1.98\pm^{0.40}_{0.28}$	2.52	$0.30\pm^{0.09}_{0.07}$	0.88
Out of Flare MK	$0.71\pm^{0.09}_{0.09}$	2.43	$1.75\pm^{0.24}_{0.15}$	3.36	$0.35\pm^{0.11}_{0.09}$	0.82

Table 2. Two-temperature best fit LECS fluxes in three different bands and X-ray luminosities in the ROSAT 0.1–2.5 keV band. The reported fluxes are the same for both the RS and MK models.

	$\mathrm{flux}_{0.1-10\,\mathrm{keV}}$ erg cm^{-2} sec^{-1}	$\mathrm{flux}_{0.1-2.5\,\mathrm{keV}}$ erg cm^{-2} sec^{-1}	$\mathrm{flux}_{0.5-10\,\mathrm{keV}}$ erg cm^{-2} sec^{-1}	$L_{0.1-2.5\,\mathrm{keV}}$ erg sec^{-1}
Flare	6.5×10^{-11}	4.2×10^{-11}	5.4×10^{-11}	2.9×10^{30}
Out of Flare	1.3×10^{-11}	1.2×10^{-11}	9.9×10^{-12}	8.2×10^{29}

There is no significant difference between the results obtained with the two plasma codes.

It can be seen that HD 9770 is characterized by a hot plasma, with values that are normally found for this class of sources (e.g. Dempsey et al. 1997). The Fe K complex at ~ 6.7 keV is clearly detected in the MECS spectrum during the flare, while outside the flare, it is much weaker. As expected, during the flare the X-ray emission is dominated by hotter plasma with a temperature of more than 4 keV. Fluxes estimated with the RS and MK model are reported in Table 2 for three different bands and for both considered datasets. Note that these values are very similar to the ones detected with ROSAT (Cutispoto et al. 1997).

4. Discussion

We have observed the visual triple system HD 9770 for 42 hours, i.e. for 3.7 orbital cycles of the eclipsing binary component present in the system. Our *Beppo*SAX observation confirms that HD 9770 is a strong and variable coronal source, with most of the emission likely coming from the eclipsing binary itself. We have detected significant variability in the quiescent emission of the star, plus localized variability in a couple of short-lived flares. The variability observed outside the flares can be explained in terms of orbital modulation and/or eclipses. In fact these variations are smooth and detected over more than 3 orbital cycles, thus they should be due primarily to geometric effects, rather than intrinsic variability. The optical eclipse at phase zero seems detected also in the X-rays, immediately after a maximum in the light curve. In correspondence to the secondary eclipse we have no data in the folded light curve due to the windowing. Otherwise, if we use all data but the strongest flare, we would have a maximum in the flux at phase ~ 0.5 due to the small flares seen during the second orbital cycle and at the end of the observation. Thus, although there is not much similarity between the optical and the x-ray folded light curve besides the eclipse at phase 0, the modulation seems to apply to the full x-ray light curve. This could indicate that, beside the eclipsing effect, there is also a self-eclipsing modulation of the coronal emission. Note that Cutispoto et al. (1997) could not find, in the ROSAT all sky survey data, any modulation since the sampling was very poor (see Sect. 1).

The fact that the hardness ratio seems also modulated by the system rotation is an indication that hotter and cooler plasmas are likely confined in coronal structures of different sizes, with the hotter plasma confined in smaller structures. This is the opposite of what has been reported for the RS CVn systems AR Lac and TY Pyx on the basis of EXOSAT data (White et al. 1990, Culhane et al. 1990). However, Ottmann et al. (1993) did not find differences between the rotational modulation of soft and hard X-rays in a ROSAT observation of AR Lac, rising some doubts about the EXOSAT results. These differences could also be explained by coronal variability, but the higher S/N and larger bandwidth ASCA observation of White et al. (1994) seems to support the ROSAT results. In any case, our data are of low S/N and do not allow us to firmly assess the existence of two different families of loops with widely different sizes. Clearly this source should be observed with larger effective area detectors.

A 2-T thermal model is a good representation of the spectra with a reduced $\chi^2_r \sim 1$. The low-temperature component has a value of about 0.7 keV and the high-temperature component a value of about 2 keV. The two components have comparable emission measures. During the flare, the high-temperature component increases both in temperature and emission measure, while the low-temperature component remains essentially unaffected. The average temperature throughout the flare is in excess of 4 keV and the emission measure is a factor ~ 6 higher than during quiescence. These values are consistent with those

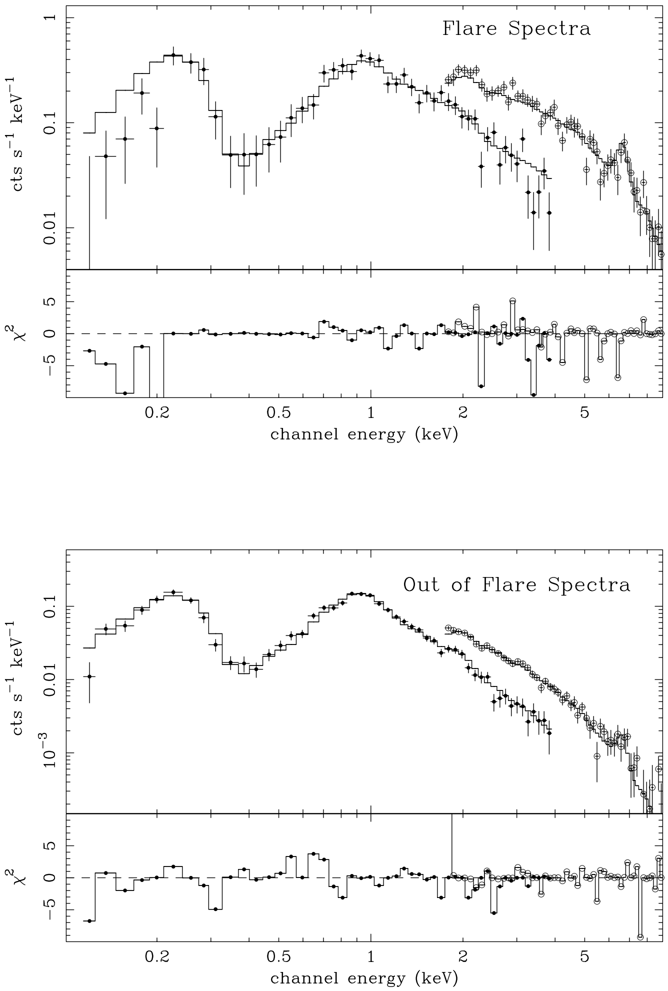

Fig. 4. SAX LECS + MECS spectra of HD 9770. Spectra were collected during the flare (*top panel*), and outside the flare (*bottom panel*). In both cases, the signed contributions to χ^2 are plotted in the lower panel.

typically found in X-ray observations of active stars (Schmitt et al. 1990, Dempsey et al. 1993, 1997; Ortolani et al. 1997a, 1997b).

As discussed by Cutispoto et al. (1997), HD 9770 confirms the correlation between $L_{\rm bol}$ and L_X found by Pallavicini et al. (1990) for the full sample of UV Ceti and BY Dra-type of stars observed with EXOSAT. For HD 9770 this is confirmed both by ROSAT and *Beppo*SAX data. For a discussion of the implications of this point see Cutispoto et al. (1997).

Although we do not, yet, know accurately the photospheric metallicity of HD 9770, from a preliminary spectral synthesis analysis of an high resolution optical spectrum obtained recently by us at ESO, we find that [Fe/H]~ -0.5. We are currently doing a more detailed analysis of these data, however the indication is that the coronal abundance of HD 9770 is consistent with the photospheric value and that both are subsolar. Similar results have also been obtained recently for a *Beppo*SAX observation of the star VY Ari (Favata et al. 1997b). VY Ari is an active non eclipsing SB1 binary with the visible star classified as K3–4/V–VI (Bopp et al. 1989), i.e. a source very similar to HD 9770. Subsolar coronal metal abundances are found in many active stars, both with or without subsolar photospheric metal abundances. This has become evident with the study of many ASCA spectra (e.g. White et al. 1994, White 1996; Singh et al. 1995, 1996; Tagliaferri et al. 1997, Ortolani et al. 1997a, Mewe et al. 1996b, 1997), and by other satellites (Tsuru et al. 1989; Stern et al. 1992, 1995; Ottmann & Schmitt 1996; Schmitt et al. 1996; Mewe et al. 1996b, 1997). Thus, it is by now clear that the coronal metal abundances found for most of the very active stars are sub-solar. However, it is by no means obvious that these low coronal metallicities are also in contradiction with the measured photospheric abundances in the same stars. Indeed the low metal abundances found by ROSAT and ASCA for the coronae of CF Tuc (Schmitt et al. 1996) and λ And (Ortolani et al. 1997a), as well as the first results from *Beppo*SAX for Capella (Favata et al. 1997a) and β Ceti (Maggio et al. 1998), do not seem to be in contradiction with their photospheric values. On the contrary, the low metal abundance found for the young stars AB Dor (Mewe et al. 1996b, Pallavicini et al. 1999) and HD 35850 (Tagliaferri et al. 1997) are in contradiction with their photospheric abundances which are solar.

Finally we note that the coronal metallicity found from fitting the X-ray spectra seems to be somewhat higher during the flare than outside of it. However, the change is not statistically significant, and can only be considered as a hint for a behavior similar to that seen previously in strong flares detected in Algol with ROSAT (Ottmann & Schmitt 1996) and in AB Dor and II Peg with ASCA (Mewe et al 1997, Ortolani et al. 1999). If confirmed, these time dependent abundances would give some support to the possibility of real abundance differences between the photosphere and the corona of some active stars, possibly induced by magnetic activity.

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