# ABUNDANCES AND FLARES IN THE ASCA OBSERVATION OF THE YOUNG K0 STAR AB DORADUS

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**Abstract**

The ASCA observation of the young, rapidly–rotating active K0 dwarf AB Doradus showed very steady quiescent emission for the first 6 hours, followed by 10 hours during which a series of flares occurred. We summarize the highlights of the analysis of these data: the quiescent spectrum implies abundances in the corona reduced by factors of 2–4 compared to AB Dor's photospheric abundances, which are solar; and the flares have count rates sufficiently large to permit time–resolved spectroscopy. Fits to the flare spectra are consistent with very little change in the amount of cool material present during the flare. The hot flare component produced by the flares is clearly seen to decay more rapidly in emission measure than in temperature. No rotational modulation is evident in either the quiescent or flare emission.

## 1. Introduction

AB Doradus is a very active nearby southern K dwarf star. This object has attracted attention for a number of reasons. It is one of the most rapidly–rotating single stars known, with a period of only 12.4 hours, and it is very close, at 15 pc. Further, it is a young star: it has a strong Li absorption line and kinematic properties characteristic of the Pleiades group. This makes it probably the nearest pre–main–sequence star known, with an age of approximately 50 million years. ASCA acquired 40 ksec on AB Dor over a period of 17 hours. The light curve was remarkably flat for the first 6 hours, but then a succession of flares dominated the remaining time.

## 2. Abundances

The ASCA observation took place during a much longer EUVE observation of AB Doradus (Rucinski et al. 1995). The EUVE data have a ratio of the Fe line strengths to the continuum too low to be consistent with solar abundances, and the ASCA data during the quiescent period also require low abundances (White et al. 1995). The simultaneous quiescent ASCA and EUVE spectra have now been analyzed jointly (Mewe et al. 1996). The differential emission measure (DEM) is typical of active stars, with peaks at 7 and 20 $\times$ $10^6$ K. However, the fitted abundances are remarkably small: relative to to solar photospheric abundances, they are: O, 0.42$\pm$0.08; Ne, 1.20$\pm$0.15; Mg, 0.58$\pm$0.10; Si, 0.35$\pm$0.08; S, 0.37$\pm$0.14; Fe, 0.23$\pm$0.02;

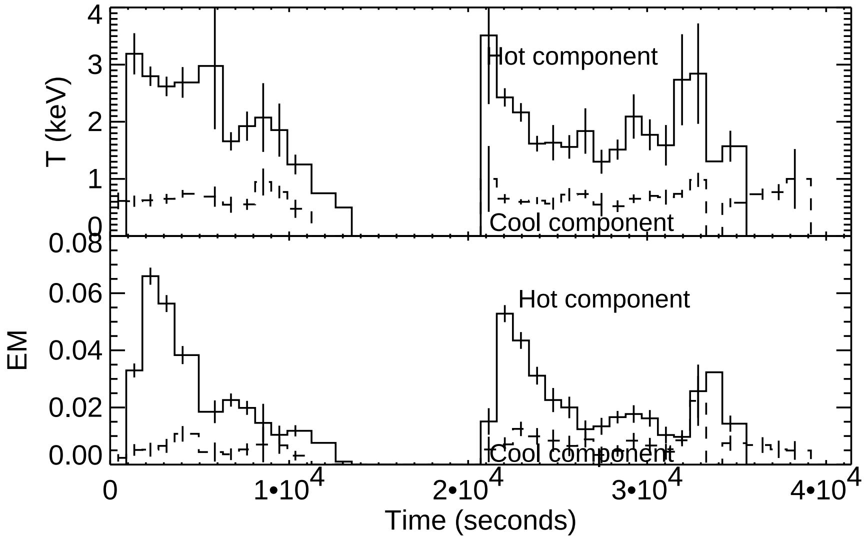


Fig. 1. Two-temperature fits to the pre-flare subtracted ASCA SIS0 and GIS3 spectra during the period of flaring. The data are binned into 900 s intervals. Data are only plotted when satisfactory fits were obtained and thus there are no points between the two large flares when the count rates returned to the preflare level.

Ar, 0.98±0.47; Ca, 0.49±0.43; Ni, 0.45±0.25. We emphasize that both the EUVE and ASCA spectra independently suggest the presence of a low abundance for Fe relative to H.

## 3. Time–Resolved Spectroscopy

The high count rate of AB Dor allows us to carry out time–resolved spectroscopy and thereby study the evolution of temperature and emission measure during the flares. To reduce the number of free parameters we fix the abundances at values determined from the quiescent ASCA spectrum, which are similar to those quoted above. We fit the data from the SIS0 and GIS3 detectors (binned to 900 s resolution) simultaneously using a two–temperature `meka` model and the known $N_H$. We use the spectrum of the quiet period as a background for the flare data, which amounts to assuming that the flare material did not make up a major fraction of the quiet corona beforehand. The fits (Fig. 1) indicate that the flare produces a hot component but very little additional change in the amount of cool material present. The emission measure of the hot component tracks the total count rate well, whereas the EM of the cool component does not. The temperature of the cool component remains at $\sim$ 0.6 keV during the flares, even in the preflare–subtracted fits. The hot component peaks at around 3 – 3.5 keV, which is typical of previously–observed values. The total emission measure in the corona increases in these events and the additional material presumably comes from chromospheric evaporation, as in solar flares.

## 4. References


1. Mewe, R., Kaastra, J. S., White, S. M., & Pallavicini, R. 1996, *A&A*, in press.
2. Rucinski, S., Mewe, R., Kaastra, J. S., Vilhu, O., & White, S. M. 1995, *ApJ*, 449, 900.
3. White, S. M., Pallavicini, R., & Lim, J. 1995, in *Flares and Flashes (IAU Coll. 151)*, ed. R. Gershberg, H. Duerbeck, & J. Greiner (Berlin: Springer), p. 168