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Discovery of an X-Ray Off-State in the Supersoft Source CAL 83

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Abstract. An X-ray off state of CAL 83 has been observed in April 1996 with the *ROSAT HRI* three weeks after a normal on state. An upper limit for a linear decline time of the observed flux of ~20 days (and of an e-folding decline time of ~6 days) is deduced. This decline may be due to the response of the white dwarf envelope to a temporary increased mass accretion rate giving rise to an envelope expansion. CAL 83 may resemble the recurrent supersoft LMC transient RX J0513.9-6951 with episodes of disappearance in X-rays.

1. Introduction

CAL 83 can be considered as the prototype supersoft X-ray source. It was discovered with the *Einstein* satellite (Long et al. 1981) and identified in the optical with a blue emission line star in a binary system with an orbital period of 1.04 days.

2. Discussion and conclusions

CAL 83 has been considered as a persistent supersoft source as it has never been reported to be observed during an X-ray off state. *ROSAT* observations did not reveal strong variability in X-rays. The variability found in *Einstain* data (Brown et al. 1994) may be due to instrumental effects (E. Gotthelf, private communication). The source has been found to be variable in the UV (Gänsicke et al. 1996) and in the optical (Crampton et al. 1996). A recent X-ray off state has been discovered from this source which turned out to be of temporary nature (cf. Figure 1, Kahabka 1996b,c). CAL 83 may resemble the recurrent supersoft LMC transient RX J0513.9-6951 which turns off in X-rays every 100-200 days. In this transient it is believed that mass accretion rates close to 10^{-6} $M_\odot$ yr^{-1} (Southwell et al. 1996) lead occasionally to a bloated white dwarf with an extended envelope so large that it avoids the detection of the source in X-rays during these periods. The mechanism behind this recurrent blow-up of the white dwarf envelope may be due to recurrent nuclear burning on a massive ($M_{WD} \sim 1.3$ $M_\odot$) white dwarf (Kahabka 1996a) or due to episodic mass-transfer from the donor star, caused by a mechanism like magnetic star spots crossing episodically the L1 point (cf. Southwell et al. 1996). The short e-folding decline time for the X-ray turn-off of CAL 83 of <6 days) allows to constrain the underlying physical mechanism. If it is due to the response of the white dwarf envelope to a temporary increase of the mass accretion rate, then it may be determined by the envelope expansion time. An X-ray decline (by a

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factor of 50) within ~66 days has been observed in the symbiotic star AG Dra which is supposed to contain a lower mass white dwarf ($M_{WD} \sim 0.53\ M_{\odot}$, Mikolajewska & Keyon 1992). The X-ray decline is supposed to be due to an expanding white dwarf envelope responding to an increase in the mass transfer rate onto the white dwarf by a factor of ~30% (Greiner et al. 1996).

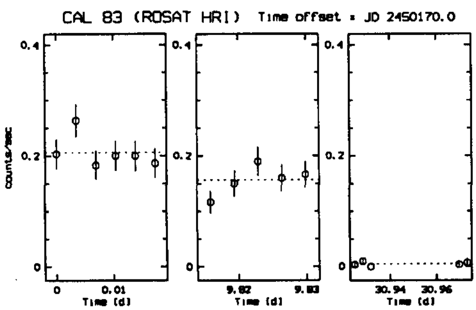

Figure 1. X-ray light curve of CAL 83. Data points and the mean count rate (dashed line) are given. Time offset is JD 2450170.0 (27.5 Mar 1996).

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