Mem. S.A.It. Vol. 75, 484

Memorie della

The eclipsing bursting X-ray binary EXO 0748−676 with EPIC on XMM-Newton

J.M. Bonnet-Bidaud[1] and F. Haberl[2]

[1] Service d'Astrophysique, DSM/DAPNIA/SAp, CE Saclay, F-91191 Gif sur Yvette Cedex, France e-mail: `bonnetbidaud@cea.fr`

[2] Max-Planck-Institut für Extraterrestrische Physik, Giessenbachstrasse, 85748 Garching, Germany e-mail: `fwh@mpe.mpg.de`

Abstract. *XMM*-EPIC observations of the bright eclipsing and bursting low-mass X-ray binary EXO 0748−676 have revealed that, apart from several type-I X-ray bursts, the source shows a high degree of variability with the presence of soft flares. With the wide energy coverage and high sensitivity of *XMM-Newton*, the source is found to be the superposition of a central ($\sim 2\times10^{8}$ cm) Comptonized emission, most probably a corona surrounding the inner edge of an accretion disk, associated with a more extended ($\sim 3\times10^{10}$ cm) thermal halo at a typical temperature of ∼ 0.6 keV with an indication of non-solar abundances. Most of the variations of the source can be accounted for by a variable absorption affecting only the central comptonized component and reaching up to $N_H \sim 1.3\times10^{23}$ cm^{-2}.

Key words. EXO 0748−676/UY Vol – eclipsing binaries – accretion corona

1. Introduction

The X-ray binary EXO 0748−676 is a key source among LMXB (Low-mass X-ray binaries) as it is known to show all types of variability commonly seen in these systems: a close binary with a 3.82 hr orbit seen at high inclination, sharp (∼8.3 min.) eclipses, regular (∼ 20 min.) absorption dips, (∼ 1 hour) flaring activity as well as repetitive type I bursts and (∼ 0.5 Hz and ∼ 2.5 kHz) quasi-periodic oscillations (Parmar et al. 1986; Homan & van der Klis 2000). The very rich variability of EXO 0748−676 makes it an ideal target for the high throughput and large energy coverage of the EPIC cameras onboard *XMM*. The results presented here are the first *XMM* observations of the source, obtained in the early CAL/PV phase.

2. Observations and results

Scientific data of EXO 0748−676 were secured in 2000 April 4 and 21 during two ∼ 20 ksec intervals. Fig. 1 shows the source soft and hard X-ray light curves covering nearly two orbital cycles. Clearly visible are the presence of two type I bursts and the nearly total eclipse seen at high energy without significant counterpart in the soft band. Two bright soft flares (marked F1 and F2) as well dips (D) and interflare quiescent interval (Q) are also shown. Source spectra representative of these different levels of the source were accumulated from the EPIC-pn data and compared to theoretical models. Descriptions with a power-law

Send offprint requests to: J.M. Bonnet-Bidaud

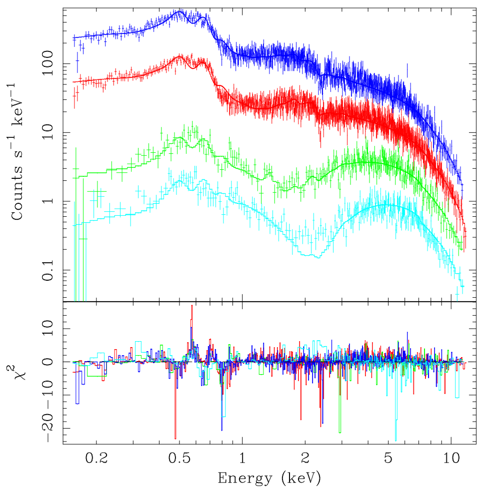

Fig. 2. Spectra of the four different levels : from top to bottom, F1, F2, Q, D.

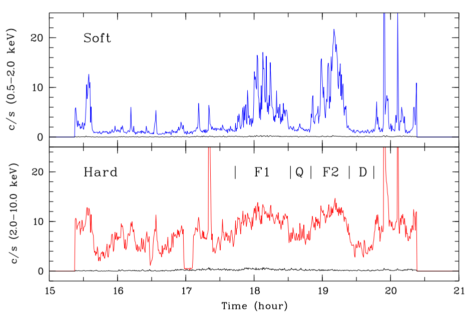

Fig. 1. Left : EPIC-pn light curves of EXO 0748−676 observed on 2000 April 21 in the 0.5 - 2.0 keV (top) and 2.0 - 10.0 keV energy bands. Shown by letters are the different levels of activity of the source : F(flare), Q (quiescent), D (dip).

and either a blackbody or a multi-temperature blackbody accretion disc model, as suggested from previous EXOSAT (PA86) and ASCA observations (Church et al. 1998) were found inadequate. Best fits in the range 0.15 - 10 keV were obtained with a combination of a power-law (PL) and a Raymond-Smith thermal component (RS), each attenuated by individual photo-electric absorption. Elemental abundances were treated relative to solar.

The four representative spectra were jointly fitted by the same (PL+RS) model (see Fig. 2) . The abundances of Si and higher Z elements were fixed to zero as suggested by the RGS spectrum where no emission lines of these elements are found (Cottam et al. 2001). The best fit RS model is found for a ~0.6 keV temperature with non-solar abundances of N (10±2), O (0.6±0.1), Ne (0.02±0.02) and Mg (0.31±0.23) and the best PL photon index is found to be $\alpha = -1.35$.

The modulation of the source is mainly due to a strong PL absorption varying from 13.0×10^{22} cm^{-2} in the dip to ~ 6×10^{22} cm^{-2} in quiescence and down to (1.5 - 2.2)$\times10^{22}$ cm^{-2} during flares. In the same time, the soft RS component is affected by a much lower (0.04 - 0.1)$\times10^{22}$ cm^{-2} absorption increasing only to 0.2×10^{22} cm^{-2} during the dip. However, the flares are marked also by a significant increase in the RS intensity.

The hard component, best described by a power-law, is suggestive of a Comptonized-type spectrum associated with a central eclipsed accretion disc corona. Its size may be inferred from the eclipse duration as ~ 2×10^8 cm. The thermal emission is uneclipsed and mostly unabsorbed, indicative of an extended halo above the accretion disc, in accordance with the RGS (Cottam et al. 2001) and the more recent *Chandra* results (Jimenez al. 2003). More details can be found in Bonnet-Bidaud et al. (2001).

References

Bonnet-Bidaud J.M., Haberl F., Ferrando P., Bennie P.J., Kendziorra E. 2001, A&A 365, L282
Cottam J. et al. 2001, A&A 365, L277
Church M., Balucinska-Church M., Dotani T., Asai K. 1998, ApJ 504, 516
Jimenez-Garate M.A., Schulz N., Marshall H. 2003, ApJ 590, 432
Parmar A. et al. 1986, (PA86), ApJ 308, 199
Homan J. & van der Klis M. 2000, ApJ 539, 847