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XMM-Newton observations of PSR B1259–63 near the 2004 periastron passage

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Abstract. We present here the results of new *XMM-Newton* observations of the PSR B1259–63 system during the beginning of 2004, as the pulsar approaches the disc of the Be star. We combine these results with earlier X-ray data from *Beppo*SAX, *XMM-Newton*, and *ASCA*. The X-ray light curve looks similar to the radio light curve with a rapid increase in the flux around the time of the disc crossing. This supports a model in which the X-ray emission from the system is due to inverse Compton scattering of the pulsar wind relativistic particles with moderate Lorentz factor $\gamma \sim 10$–100 on the Be star soft photons.

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1. Introduction

PSR B1259–63 is a ∼48 ms radio pulsar in a highly eccentric ($e \sim 0.87$), 3.4 year orbit with a Be star (SS 2883), located at a distance of about 2 kpc. Timing analysis of the PSR B1259–63 system shows that the disc of Be star is highly tilted with respect to the orbital plane and thus the pulsar crosses the Be star disc twice per orbit, just prior to and just after periastron (Wang *et al.* 2004). The properties of the radio emission from this system are very different before and after the periastron passage. Unpulsed radio and X-ray emission is observed from this system with a similar double peak lightcurve around the periastron, see details in Johnston *et al.* (2005), Hirayama *et al.* (1999).

2. *XMM-Newton* observations

X-ray data available up to 2004 are much more sparse than radio ones, and it was not clear whether similarly to radio data X-ray emission rapidly grows around the moment of the first disk crossing, or its behaviour is much smoother. To answer this question we have organized a set of *XMM-Newton* observations of the system, as the pulsar approaches the disk. Here we present the results of these observations along with the analysis of the previously unpublished *Beppo*SAX (1997) and *XMM-Newton* (2001–2003) observations. A simple power law with a photoelectrical absorption describes the data well. In Figure 1a the time variation of the X-ray luminosity (top panel), spectral slope (middle panel)

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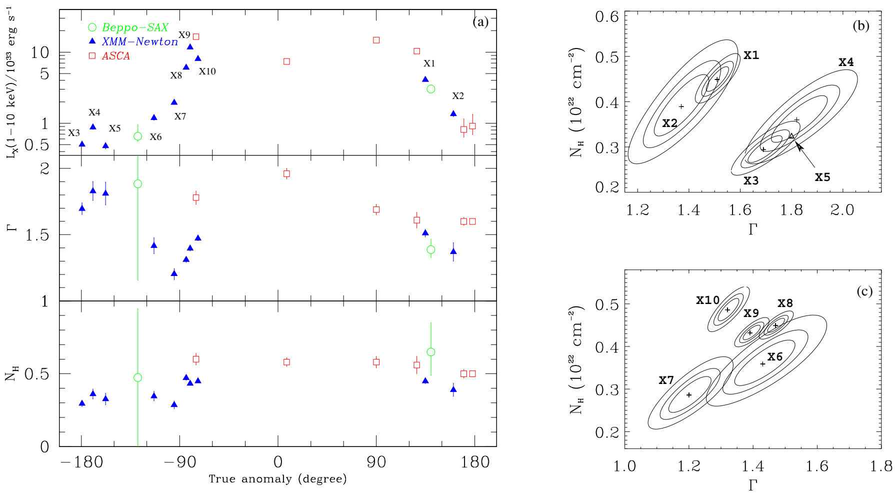

Figure 1. (a)Evolution of the PSR B1259–63 spectral parameters along the orbit; (b,c)Contour plots of N_H versus photon spectral index Γ.

and the column density (bottom panel) as a function of orbital phase are shown. In Figures 1b, 1c we show contour plots of N_H versus photon spectral index Γ, holding the 1–10 keV flux fixed at the values given in Figure 1a. The contours plotted are the 68%, 90%, and 99% confidence levels.

It is clearly seen that the behaviour of both L_X and N_H as a function of orbital phase is highly asymmetric, rising by a factor of several in five days at the time of the disc pre-periastron crossing. Following the empirical model of the Be-star equatorial disk (Waters *et al.* 1987) we found that the disk is dense enough to explain the observed extra absorption column gained within the system.

A sharp rise of the X-ray flux at the time of the disk crossing along with the increase of the column density strongly support the model of Chernyakova & Illarionov (1999, 2000), in which the observed X-ray emission is explained as an inverse Compton emission of the relativistic electrons of the pulsar wind (Lorentz factor $\gamma \sim 10$–100) on the Be star soft photons. Unpulsed radio emission in this model is due to the synchrotron emission of the relativistic particles. More details on the *XMM-Newton* 2004 observations can be found in Chernyakova *et al.* (2005).

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