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PSR J0218+4232 in the energy band 1–10 keV observed with BeppoSAX

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Abstract. On behalf of a large collaboration (see Mineo et al. (1999) for details) I present the results of a BSAX observation of PSR J0218+4232 which, for the first time, provides detailed information on the pulsar temporal and spectral emission properties in the broad energy band 1–10 keV.

1. Introduction

PSR J0218+4232 is a 2.3 ms pulsar in a two day orbit around a $\sim 0.2 M_{\odot}$ white dwarf companion (Navarro et al. 1995). Its period derivative of $\dot{P} = 8 \times 10^{-20}$ implies a spin-down energy of $\dot{E} = 2.5 \times 10^{35}$ erg s^{-1}, a magnetic dipole component of $B_{\perp} = 4.3 \times 10^{8}$ G and a spin-down age of $\leq 4.6 \times 10^{8}$ years. The pulsar distance inferred from its dispersion measure is ≥ 5.7 kpc.

Soft X-ray emission from the pulsar was first detected by Verbunt et al. (1996) using the ROSAT HRI. The pulsed fraction inferred from the ROSAT HRI data is 37±13 %. The HRI provides no spectral information and the number of counts recorded in the serendipitous PSPC observation does not allow spectral modeling so no information on the pulsars X-ray spectrum is available so far.

2. Data analysis

The results presented here come from the analysis of the BSAX–MECS data only. All the details are given in Mineo et al. (1999). The total exposure time was $\sim$ 83 ks. A 100 ks ROSAT HRI (0.1–2.4 keV) observation of PSR J0218+4232 (see Kuiper et al. 1998) revealed that 7 X-ray sources are within a radius of 10′ from our target. We used a Maximum Likelihood approach for searching for single sources on top of a flat background model. The total number of counts assigned by this analysis to the pulsar is 403 ± 29.

Arrival times of all selected events were converted to the Solar System Baricentric Frame and data were folded according to the radio ephemeris after correction for the pulsar binary motion. The pulse phase distribution deviates from a statistical flat distribution at a 6.8 σ level applying a Z^2 test on the first two harmonics. Figure 1 shows the ROSAT pulse profile (Kuiper at al. 1998) together with the MECS 1.6–4 keV and 4–10 keV.

The total pulsed spectrum (P1+P2) was fitted with a power-law fixing the absorbing electron column density to 5×10^{20} cm^{-2} (see Verbunt et al. 1996). The resulting photon index is $\alpha = 0.61 \pm 0.32$, with a 2–10 keV flux

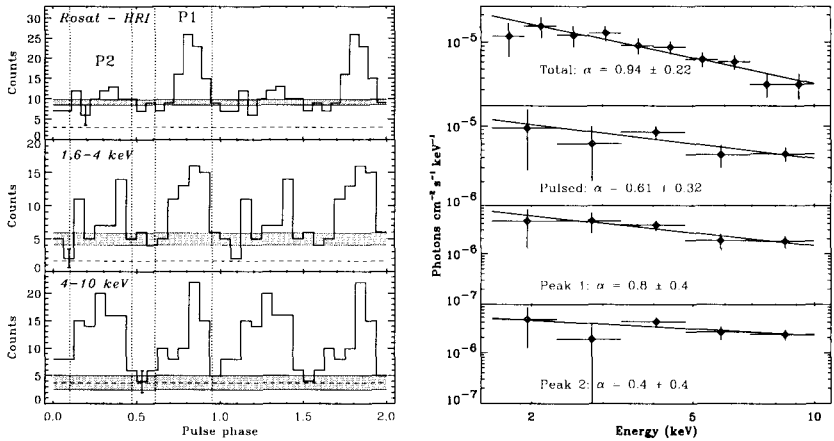

Figure 1. (*left*) Light curve in the ROSAT HRI and two MECS ranges. Background level is shown as dashed line and includes the contributions from the neighbouring sources, while the grey shaded area refers to the DC level. (*right*) MECS total and phase selected photon spectra. Data and power-law spectral indices of the best fit model are shown.

$F = 3.9 \times 10^{-13}$ erg cm^{-2} s^{-1}. The lower limit to the X-ray luminosity is then $L_x = 1.2 \times 10^{32}(d/5.7 \text{ kpc})^2 \times \Omega$ erg s^{-1}, where Ω is the emission beam solid angle, and the X-ray efficiency is $\eta = L_x/\dot{E} = 4.6 \times 10^{-4} \times \Omega$. Figure 1 shows the total, pulsed, P1 and P2 photon spectra.

3. Conclusions

The BSAX observation of PSR J0218+4232 provided three main results: 1. for the first time the pulsation was clearly detected at energies higher than 5 keV with a *double* peak pulse shape; 2. the peaks intensity ratio depends on the photon energy, with P2 becoming dominant above 5 keV; 3. the spectral distribution is flat. The average total pulsed X-ray spectrum is the hardest spectrum measured so far for any ms-pulsar, and extrapolates over four decades in energy to the EGRET flux reported by Verbunt et al. (1999) (see also Kuiper et al. this meeting). These results point to non-thermal origin of the detected X-ray emission.

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