$\sim 10^4$ years. Unlike the phenomena seen in many pulsars, there is no compelling evidence for partial recovery from glitch or a permanent change in the spin-down rate after the glitch.

The RXTE monitoring of PSR J0537-6910 is continuing. It should provide improved information about the frequency of glitches, their amplitude distribution, and any transient behavior related to glitches. With a long baseline, it will be possible to examine variations in the rotation rate between bursts and attempt to determine the braking index.

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Fine Phase Resolved X-ray Spectroscopy of the Crab Pulsar with BeppoSAX

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Abstract. We present the results of a phase resolved spectroscopy of the Crab pulsar in the band 0.1 - 200 keV based on many observations performed with BeppoSAX. The spectrum was found soft in the main peak and significantly harder in the Interpeak region. This behaviour is explained by means of a two component model.

1. Introduction

The Italian-Dutch satellite BeppoSAX observed the Crab Nebula and Pulsar in 1996 during the Science Verification Phase (Mineo et al. 1997). From that epoch to the spring of 1999 this source was pointed several times because it is used for the calibration checking of the four Narrow Field Instruments (NFI: LECS, MECS, HPGSPC, PDS). All these observations were used for a very accurate phase resolved spectroscopy over an energy range from about 0.5 up to 200 keV. In this contribution we present the results of the analysis of all BeppoSAX observations summed together.

2. Observations and Data Reduction

Phase histograms of the Crab pulsar were evaluated for each NFIs and each pointing period using the standard folding technique, after conversion of the UTC arrival times of all selected events to the Solar System Barycentre using the DE200 ephemeris. We constructed a large set of 300 bin phase histograms for every energy channel of each NFI. The zero phase was fixed at the centre of P1, evaluated by means of gaussian fits; also, we verified that all the pulse profiles had statistically compatible shapes. All the histograms for the same energy channel were then added together.

Spectral analysis was performed adopting a minimum phase interval of 0.0067 and applying the standard response matrices of the four NFIs. In the Interpeak region (Ip), however, where the signal level is low, we used wider phase intervals up to obtain statistical errors on the spectral slopes less than 0.05. Spectral indices were evaluated after subtraction of the off-pulse level, taken in the phase interval (0.47 - 0.77). Here we present some MECS and PDS results.

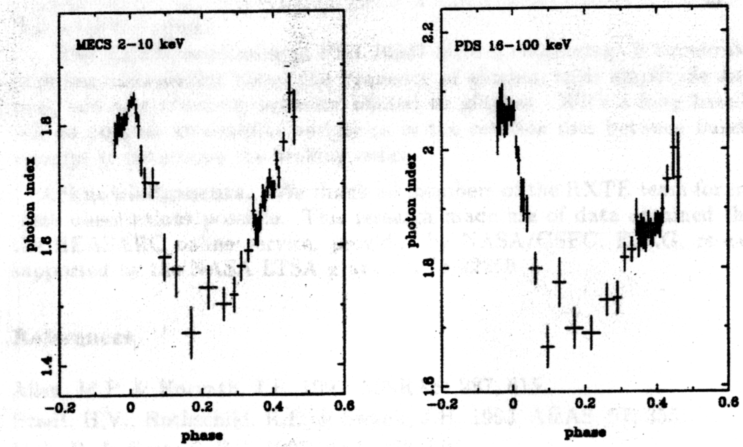

Figure 1. The phase evolution of the photon spectral indices for the MECS and PDS energy ranges.

3. Results

The photon spectral indices for single power law fits of the MECS and PDS data are shown in Fig. 1. The same behaviour along the phase is clearly apparent in both plots: the feature with the softest spectrum is P1, while the middle of the Ip is the hardest with a spectral index difference of about 0.30, as already found by Pravdo et al. (1997).

This behaviour suggests that the X-ray emission of the Crab pulsar is the sum of two components having different energy and phase distributions. We verified that adding to the optical profile a harder second component, with a roughly triangular shape peaked at the phase 0.4 and a very steep trailing edge, all data in Fig.1 are well reproduced. It is an open problem the understanding the emission mechanisms and the locations in the magnetosphere for both these components. Likely, they could be related to particles accelerated in various possible sites, like polar and outer gaps. In this case, the different spectral shapes could be due to the relative contributions of the radiation from secondary electrons and positrons, originated by primary high energy γ rays. A more detailed model is necessary to confirm this hypothesis and to unveil the nature of the two components.

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ASCA Observations of the Crab-Like Pulsar PSR B0540−69

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Abstract. We report on the spectral and temporal properties of the 50 ms pulsar PSR B0540−69 using ASCA archival data obtained during 1993 to 1995. From the spectral analysis it was found that the spectra of the whole (nebular and pulsed) emission and pulsed emission in the range 1-10 keV can be represented by a single power law of photon index, $\Gamma = 2.00 \pm 0.02$ and $\Gamma_{\rm pulsed} = 1.7 \pm 0.3$ respectively. The parameters for pulse frequency change during 1993-1995 were obtained using the 9 pulse frequency measurements with ASCA. The parameters derived from the ASCA observations are consistent with the previous measurements, suggesting high stability of this pulsar, $\Delta\Omega/\Omega \lesssim 0.5 \times 10^{-7}$ over the past 10 years. These results confirm similarity of this pulsar with the Crab pulsar.

1. Introduction

The 50 ms pulsar PSR B0540−69 in the Large Magellanic Cloud was first discovered in soft X-ray band near the center of a synchrotron nebula (Seward et al. 1984). Follow-up ground-based observations revealed optical pulsations of magnitude $m_V \sim 22.5$ (Middleditch & Pennypacker 1985). This pulsar is faint (~ 0.4 mJy) in radio band, although the radio pulsation was detected from long time integration (Manchester et al. 1993). HST observations (Hill et al. 1997) confirmed the astrometric position of the pulsar given by Caraveo et al. (1992) and provided a high quality optical spectrum of the pulsar.