ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

Astron. Astrophys. Suppl. Ser. **97**, 335-336 (1993)

Observation of the X-ray pulsar A0535+26 with the FIGARO II experiment

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Received June 3; accepted July 20, 1992

Abstract. — The FIGARO II experiment observed the transient X-ray pulsar A0535+26 in the 0.15–4 MeV range, only 11.1 ± 4 days after an expected outburst. We found evidence for periodicity at 103.2 sec close to the extrapolated value. The light-curve and the spectral shape of this low energy gamma-ray emission are presented here.

Key words: X-rays: binaries, X-ray pulsars: A0535+26.

1. Introduction.

Associated with a Be star (HDE 245770), the massive binary system A0535+26 undergoes recurrent outbursts with a period of 111.38 days and a typical decay time of ~ 20 days (see Giovannelli and Sabau Graziati 1992, as a general reference).

On July 9, 1990 (JD=2448081.5) the balloon-borne experiment FIGARO II observed the region of the Crab and A0535+26 for a total useful time of 5.8 hours (7:06 UT to 14:30 UT). The main detector of this experiment is a large area (60×60 cm^2) NaI(Tl) scintillator (Agnetta *et al.* 1989) with a wide field of view (72° FWHM).

The observation occurred 11.1 ± 4 days after the expected date of an outburst (Motch *et al.* 1991). Considering the decay time of these events, the source should be in an active phase. We found a statistically significant flux from this source and present here some preliminary results; a more detailed report is given in Cusumano *et al.*, 1992.

2. Data analysis and results.

A search for a periodicity in the range 103.0 to 103.3 s (step 0.02) for the photons in the 150–300 keV energy range provided evidence of a signal at $P = 103.20 \pm 0.02$ s (3.5σ) in agreement with the expected value (103.1 ± 0.1 s) for A0535+26 at the epoch of our observation (see Cusumano *et al.* 1992 for details). The resulting light curve in the band 167–277 keV is plotted in Figure 1 (χ^2_{red}(14 d.o.f.)=1.75). The general shape is compatible with lower energy observations showing two broad peaks and a short ~ 8 sec. dip (Sembay *et al.* 1990, Hameury *et al.* 1983). No pulsed signal was detected outside the above energy range: $\chi^2_{red}(14)=0.55$ in 148–167 keV and $\chi^2_{red}(14)=0.59$ in 277–388 keV.

The spectrum of the pulsed component from A0535+26 was obtained by subtracting the spectrum measured in the dip region $\varphi = (0.81 - 0.9)$ from that of the pulsed region $\varphi = (0 - 0.81) + (0.9 - 1)$ and then fitting to the data a power law by means of the transfer matrix of experiment and of the residual atmosphere. The resulting fluxes are given in Figure 2 together with previous data in lower energy ranges. The significance of the present measurement of the source flux in the 167–277 keV range was 3.7σ, while we were able to give only an upper limit in the 148–167 keV range well below the low energy extrapolation of the other points. In this energy range, a 2σ upper limit (1.8×10^{-5} ph/cm^2 s keV) can be compared to the expected flux (3.1×10^{-5} ph/cm^2 s keV) according the best fit ($1.9 \times 10^4 \times (E$ / 1 keV$)^{-4}$ ph/cm^2 s keV).

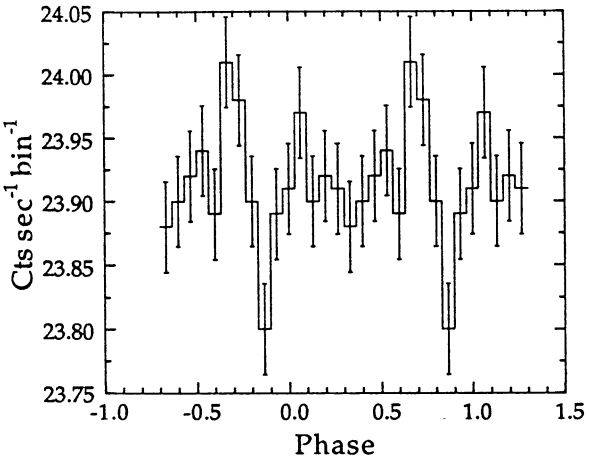

FIGURE 1. 167–277 keV light curve of A0535+26.

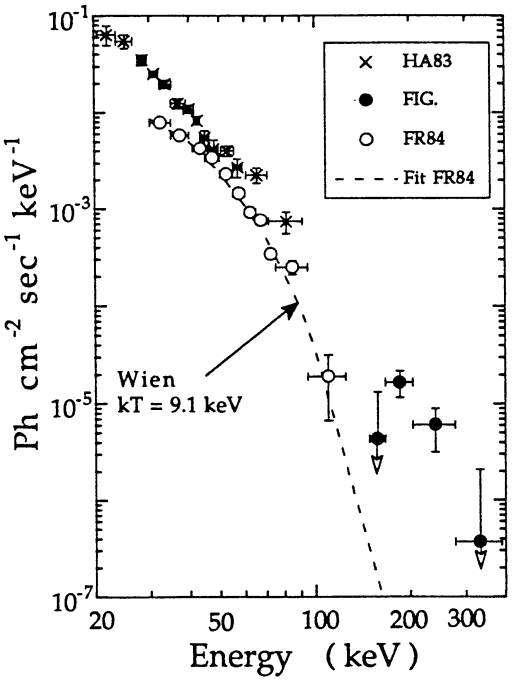

FIGURE 2. Spectrum of A0535+26 (HA83 (total flux): Hameury *et al.* 1983, FR84 (pulsed flux): Frontera *et al.* 1984, FIG (pulsed flux): our results).

The experimental threshold was located in the channel 22 around 140 keV and we checked that the measured Crab intensity in the 148–167 keV channel was not affected by systematic effect. However, we remark that the significance of this turn-over is strongly dependent on the assumed spectral parameters, which are quite uncertain. We stress that the results of this analysis are fully consistent with those reported in Cusumano *et al.*, 1992, where the background level was estimated by means of a template light curve derived by considering the first four harmonic components.

3. Discussion

The present result is the first evidence of emission from a Be-type binary pulsar at these energies.

Because A0535+26 is a highly variable source, a comparison with previous lower energy data is not straightfoward. However, because simultaneous data in different energy ranges are not available, the FIGARO points are compared with spectra of A0535+26 reported in the literature (Fig. 2). We see that previous outbursts spectra (pulsed: Frontera *et al.* 1984, total: Hameury *et al.* 1983) are generally well described by exponential laws and that the extrapolated fluxes above 150 keV lie below the fluxes reported here. Possible interpretations of this new spectral component are discussed in Cusumano *et al.*, 1992.

Observations covering the range from 50 to 300 keV would provide an undoubtedly new important piece to understand the physics of this puzzling transient X-ray pulsar.

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