Bull. Astr. Soc. India (2000) **28**, 277-280

Near absence of hard X-ray pulsation from GS 1843+00 in the middle of burst phase

R.K. Manchanda

Tata Institute of Fundamental Research, Colaba, Bombay 400 005, India

Abstract. Hard X-ray transient pulsar GS 1843+00 was observed in the 20-200keV region using a high sensitivity large area scintillation counter instrument during its 1997 flare on March 30. The data indicates a near absence of 29.5^s pulsation in the hard X-ray energy band of 30-70 keV, even though our observations correspond near to intensity maximum in the burst phase. Along with the RXTE and Compton observatory data taken during this burst, we discuss the present results in terms of geometrical constraints and the X-ray emission mechanism.

1. Introduction

The transient X-ray pulsar GS 1843+00 with a period of 29.5 sec and intensity level of ~30 mCrab was first discovered in the 2-30 keV energy band during the observation of galactic plane by the Ginga satellite (Koyama et al. 1990). Second flare in the source was only seen in 1997 when the BATSE payload on-board CGRO satellite detected pulsations from the source on March 3 (Wilson et al., IAUC 6586). The count-rate history of the source obtained with All Sky Monitor onboard RXTE satellite indicates that source intensity in the 2-10 keV band increased to a level of 15 mCrab between Jan. 26 and Feb. 1 and remained within a range of 15-30 mCrab until May 1.

2. Experimental details

The source was observed using a high sensitivity large area scintillation counter instrument code named LASE, which is a newly developed balloon-borne payload for the study of temporal and spectral features of the X-ray sources in hard X-ray energy band of 20-200 keV. The balloon was launched on March 30, 1997 from Hyderabad and reached an altitude of 3.3 mbs.

LASE payload consists of three identical modeles of specially developed large area scintillation detectors each having an area of 400 cm^2 and shielded by both an active and a passive shield. Each detector consists of a combination of thin and thick sodium iodide detectors arranged in a back to back configuration. The detectors are mounted on a fully steerable alt-azimuth platform. The field of view of each detector is 4.5^0 x 4.5^0 and is defined by a passive collimator. Each detector in LASE payload is stand alone unit with its independent high voltage supply, front-end event selection logic and analog to digital conversion. The payload used in March 1997 balloon flight used only two modules. For further details of the X-ray detectors and the associated instrumentation refer to D'Silva et. al. (1998) and Manchanda (1996).

The X-ray source GS 1843+00 was observed for a period of 55 minutes in two sightings of 25 and 30 minutes. The background was derived from three observations of a nearby source free region, before midway and after the source pointing. A total of 15500 counts were detected from the source in the entire energy range of 20-200 keV from the two detectors which corresponds to a combined statistical significance of~37σ. A positive excess due to the X-ray source was detected right up to 150 keV in our data. The time averaged deconvolved photon

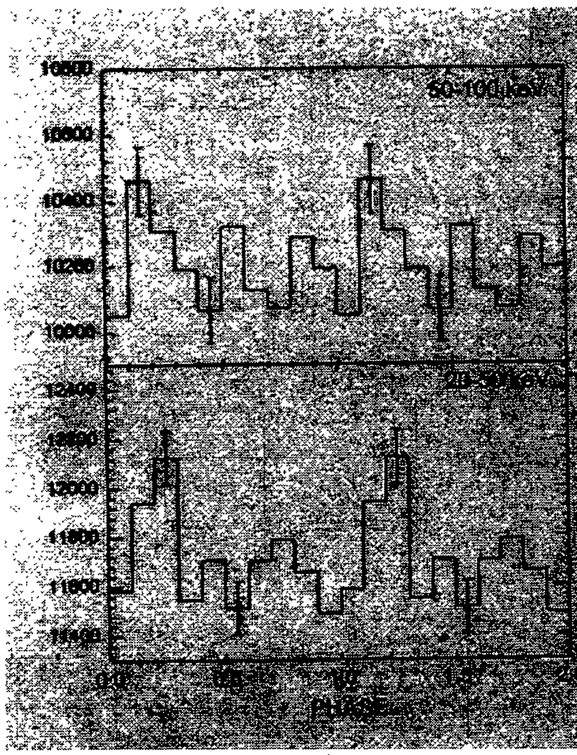

Figure 1. Pulse profile of GS 1843+00 in two energy bands. P=29.49 sec.

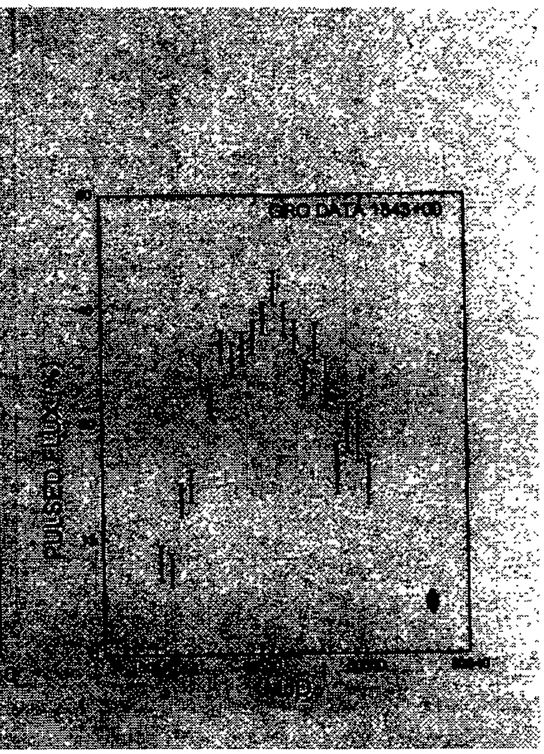

Figure 2. Temporal behaviour of pulse fraction in 20-50 keV band.

spectrum of the source does not fit a single power law or a simple exponential fit. A composite fit with two components was found to best fit the data. Spectral details of the source are presented elsewhere (Manchanda, 1999).

3. Results and discussion

Search for the periodic component in the observed data was made by folding the data with trial periods close to the extrapolated value of 29.486^S derived from the BATSE measurements. The maximum χ^2 deviation was seen for the trial period of 29.49±01. *sec.* A larger error for the period is due to limited stretch of continuous data and the low pulsed fraction which generates comparable χ^2 value for a small change in the trial period. During the period search, the statistically significant χ^2 deviation was seen only for the low energy channels corresponding to 20-50 keV and 50-100 keV. The pulse period derived in the present analysis compares well with the derived value from the BATSE data.

The phase histograms were then constructed by folding the data in different energy bands with the best fit period. Figure 1 shows the folded data for the two energy bands corresponding to 20-50 keV and 50-100 keV. No significant peak was detected in the 100-150 keV data. It is seen from the figure that the pulse profile has a single peak in both energy bands and this differs from the low energy data of Koyama et al. (1990), which showed a broad double hump pulse structure. Pulse profile seen by the BATSE data at high pulse fraction phase also show a broad double peaked structure.

The X-ray luminosity of source in the 20-200 keV band during the present observations corresponds to 2×10^{36} erg s^{-1} at a source distance of 10 kpc. The pulsed fraction in the 20-50 keV energy band is however, only ~7% of the continuum emission from source. The present measurement along with the light curve for the pulsed fraction obtained from the BATSE data is shown in the figure 2. The source was not observed by the BATSE detectors after March 22. Additionally, due to omni-directional response of the BATSE detectors only pulsed flux can be determined through FFT analysis of the data. No other data is available in the hard X-ray region from the source.

It is clearly seen from the figure that consistent with the earlier measurements, the pulsed fraction continued to decrease further even though our spectral measurements give a continuum luminosity of ~ 100 mCrab for the source. The X-ray light curve in the 2-10 keV band from the all sky monitor on-board RXTE satellite indicates that the present observations correspond to the mid-point of the active phase. The disappearance of the pulsed emission in spite of a strong continuum flux from the source can therefore, be only attributed to geometrical effects in the orbital motion.

In the current theoretical models, transient X-ray sources are believed to be High Mass X-ray Binary (HMXB) sources, with generally a Be star companion which provides the accreting material through mass ejection episodes. The high energy spectral measurements of GS 1843+00 made in the present experiments also compare well with HMXB system 0535+26, which is a 104 sec transient pulsar and contains a Be star companion (Polcaro et al. 1983).

In the X-ray emission models for Be star transient sources, sporadic accretion of the matter onto the neutron star takes place during its passage through either the expanding gas envelope of the primary star caused due to mass ejection episode or traversal of the slow wind emanating from the primary companion during the perihelion passage in the orbit. In any of the above scenario, the X-ray active phase will show almost a triangular response consistent with the changing mass accretion rate. Therefore, the disappearance of the pulsed radiation can only be caused by the geometrical effects. We propose that magnetic axis of the pulsar is so aligned compared to the line of sight such that as the compact object nears the perihelion point, lesser and lesser area of the pulse cone sweeps the observer. Almost a triangular shape of the pulse fraction does support this argument. Leahy (1991) has shown that in the polar cap emission models, X-ray pulsar profiles can be modelled by a suitable choice of orientation parameters of the neutron star.

Acknowledgements

I wish to thank the dedicated support of the LASE team consisting of sarvashri J.A.R. D'Silva, P.P. Madhwani, N.V. Bhagat, B.G. Bagade and Ms. N. Tembhurne for fabrication of the payload and flight support.

References

D'Silva J.A.R., Madhwani P., Tembhurne N. and Manchanda R.K., 1998, N.I.M. A 412, 342.

Leahy D.A., 1991, M. N. R. A. S, 251, 203.

Manchanda R. K., 1996, Advances in Space Research, it in print.

Manchanda, R. K., 1999, M. N. R. A. S., *in print*.

Koyama K., Kawada M., Takeuchi, T., Tawara Y. and Uchimaru N., 1990, Ap. J. (Letters), 356, L47.

Polcaro et al., 1983, Astron Astrophys., 127, 336.