Pulse Profile Variation in NS-LMXB 4U1608-52

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Abstract-

We present result of Rossi X-ray timing explorer observations of the low mass X-ray binary 4U1608-52 from the study of timing properties. We plot energy dependent pulse profiles in the energy range 2-60 Kev. We study 49 observations of the year 2003 from March 01 to October 30 and we detect twin quasi periodic oscillation (QPO) of frequencies 0.203 Hz and 0.26Hz. we study pulse profile variations and plot pulse profile of different energy range for different observations, one in which QPO is detected and other in which QPO is not detected. The pulse profile in which QPO is found is completely different from the pulse profile in which we did not find QPO. The result of our analysis of pulse profile of RXTE data of the pulsar are presented in the paper.

1.INTRODUCTION:

Neutron stars are most observable objects in our universe. The core density of these stars exceeds the nuclear density. Due to this reason they are interesting and practically unattainable in the terrestrial laboratories [6]. Low mass X-ray binary consists of a black hole or neutron star with a companion star. Soft X-ray transients are low mass X-ray binary [3], [7]. Most of the neutron star low mass X-ray binary are divided into two classes: Z and atoll sources, based on their timing properties at low frequencies (below 200 Hz) and X-ray spectral properties [4]. Both z sources and atoll sources show quasi periodic oscillations with frequencies ranging from few hundred hertz to some kilo hertz.

NS-LMXB 4U1608-52 was first observed in 1971 [13]. It is a soft X-ray transient, shows outburst varying from 100 days to several years. 4U 1608-52 is classified as an atoll source[4]. It is like Norma bursts, from which first X-ray bursts were discovered independent from 4U1820-30 [2]. 4U1608−52 is famous transient NS-LMXBs, where Type I X-ray bursts have also been detected. Neutron star spin period reported in 4U 1608-52 is 1.61 ms. its distance is estimated to be 3.6 kpc from observations of flux-saturated type-I X-ray bursts [12].

2. OBSERVATION OF DATA AND PLOTTING OF PULSE PROFILE FOR DIFFERENT ENERGY RANGE:

Almost all the X-ray sources in the sky are variable. Their intensity changes with time. This change maybe highly periodic, quasi periodic or totally aperiodic. Time scale of such variation ranges from few mill seconds to tens of years [1]. RXTE was launched on 31 December 1995. The main objective of launching of RXTE is to study the timing properties of celestial objects. It consists five Xenon filled detectors [5], [10]. Data are maintained by NASA's High Energy Astrophysics Science Archive Research Centre (HEASARC). Data will be analysed by using appropriate operating system software HEAsoft and different models [14], [8]. We have used the data from RXTE from their respective archives at HEASARC using the site hftp:\\heasarc.gsfc.nasa.gov. The data received from satellite are in instrument specific format. The mission operation centre converts the data into FITS (Flexible Image Transport System) format[9], [15]. We carried out timing analysis for this data from all the RXTE/PCA observations during 2003 outburst using 49 observations.

Pulse profile represent the normalised intensity as the function of the pulse phase (0-2). All the energy resolved background subtracted light curve were folded with the above-mentioned pulse period and the resultant pulse profiles in different energy ranges 2-5 Kev, 5-8 Kev, 8-12 Kev, 12-15 Kev, 15-25 Kev, 25-35 Kev, 35-45 Kev, 45-60 Kev are shown in figures below. In plotting pulse profiles, we use standard 2f data instead of standerd-1 data and bin size used is 16. In this analysis we show result obtained by two Ids. 80406-01-04-08 on 29 March 2003 and 80406-01-09-03 23 October 2003.

Figure 1 shows pulse profiles for Id 80406-01-04-08 in which QPO is detected and figure 2 shows pulse profiles for Id 80406-01-09-03 in which QPO is not detected. Both are very different. In first, pulse become sinusoidal at higher range (above 45 Kev) where as in second, pulse is sinusoidal at lower range (below 25 Kev).
Pulse height variation for the mono-energetic incident radiation of the energy arises due to the excitation of the gas molecules instead of ionization in the proportional counter due to this the Pulse height is proportional to the square root of the energy whereas the energy resolution is inversely proportional to the square root of energy [11]. The pulse fraction is defined as (maximum – minimum)/ maximum or the ratio of pulse flux to the total flux. In the timing analysis it is worthwhile to measure the % Pulse – fraction, by the following equation as:

$$\Delta = (\text{Pulse height} / \text{total height}) \times 100$$

Pulse fraction is varying from 9 to 97% for this source.

3. RESULTS:
In this paper we analyze RXTE data of NS-LMXB 4U 1608-52 and drew pulse profile of two different observations for different energy ranges. There is a significant deference between pulse profile curves for observations in which QPO is detected and in which QPO is not detected. The pulse curves are sinusoidal in higher energy range for later and for former it is sinusoidal in lower energy range.

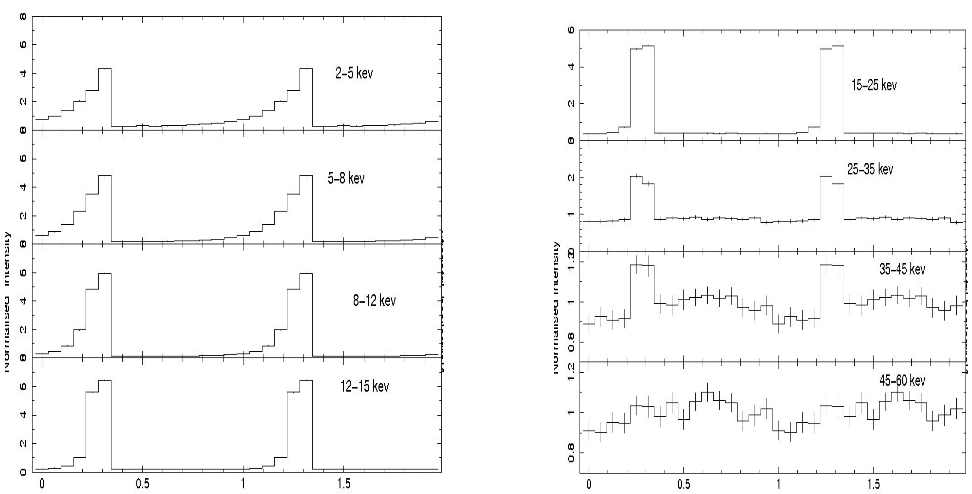

Figure 1: Representative PDS showing pulse profile for energy range 2-5 Kev, 5-8 Kev, 8-12 Kev, 12-15 Kev, 15-25 Kev, 35-45 Kev, 45-60 Kev for observation Id 80406-01-04-08 in which QPO is detected.

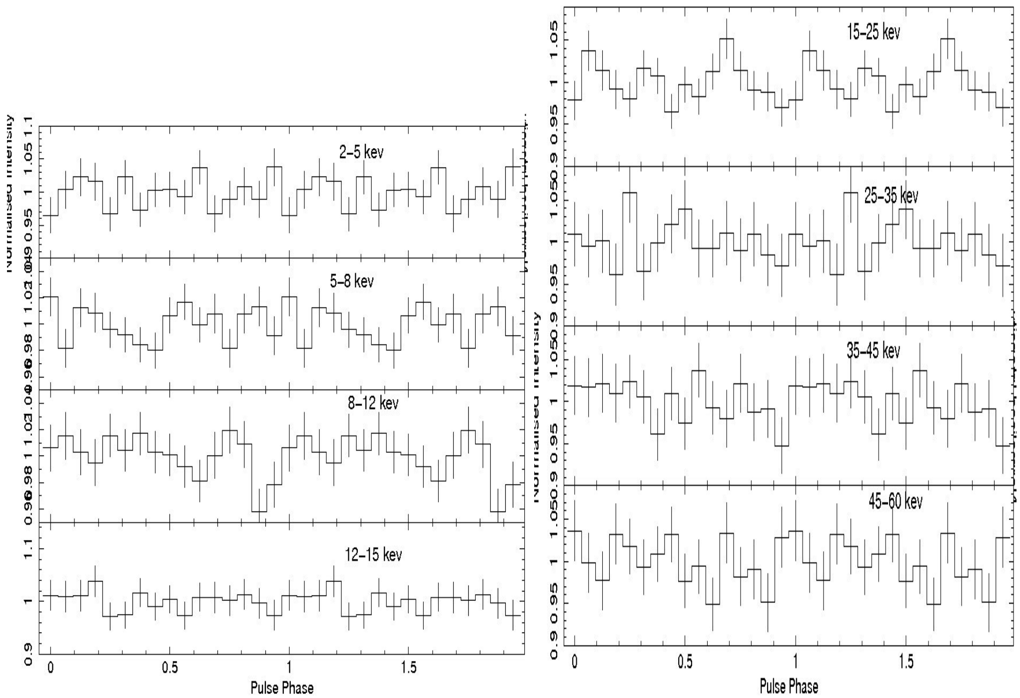

Figure 2: Representative PDS showing pulse profile for energy range 2-5 Kev, 5-8 Kev, 8-12 Kev, 12-15 Kev, 15-25 Kev, 35-45 Kev, and 45-60 Kev for observation Id80406-01-09-03 in which QPO is not detected

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