NON-DETECTION OF KHZ QPOS IN GX 9+1 AND GX 9+9

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1. Introduction

In numerous low-mass X-ray binaries quasi-periodic oscillations (QPOs) between 300 and 1200 Hz have been discovered (the kHz QPOs; see van der Klis 1997 for a recent review on kHz QPOs). Here we present the search for kHz QPOs in the atoll sources GX 9+1 and GX 9+9.

2. Observations and analysis

We observed GX 9+1 on 1996 Feb 29, Apr 21, May 29, and 1997 Feb 10 and Mar 9, and GX 9+9 on 1996 Aug 12, Oct 16, and Oct 30 with the RXTE satellite. We obtained a total of 23.3 ksec (GX 9+1) and 15.2 ksec (GX 9+9) of data. The X-ray hardness-intensity diagrams (HIDs) were made using the *Standard 2* data. Due to gain changes the GX 9+1 HID for the 1996 Feb 29 observation can not be directly compared with those of the other observations. The power density spectra were made using the 250μs time resolution data. We calculated rms amplitude upper limits (95% confidence) on QPOs with a FWHM of 150 Hz in the frequency range 100–1500 Hz.

3. Results

The HIDs for GX 9+1 and GX 9+9 are shown in Figure 1. According to the HID (Fig. 1a) and the high-frequency noise in the power spectrum GX 9+1 was on the lower banana during the 1996 Feb 29 observation. During the other observations GX 9+1 moved along the banana branch (Fig. 1b). The power spectrum and the HID of GX 9+9 suggest that this source was on the

K. Koyama et al. (eds.), The Hot Universe, 370-371.

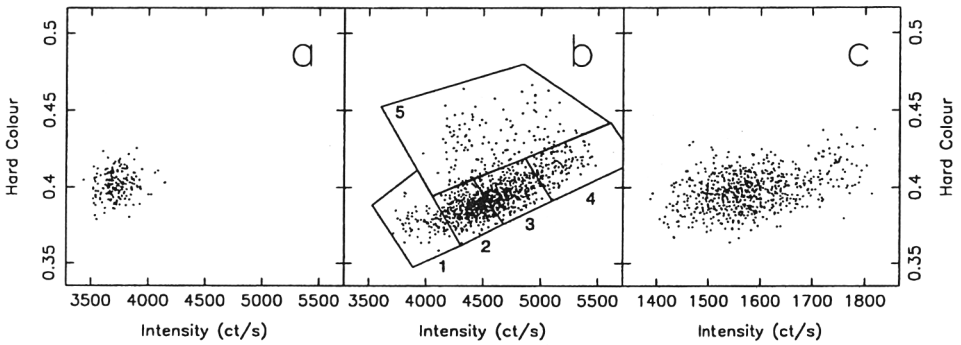

Figure 1. The HIDs of GX 9+1 (*a* and *b*) and GX 9+9 (*c*). The data of 1996 Feb 29 of GX 9+1 (*a*) were taken with a different PCA gain compared to the data of the other observations (*b* and *c*). The intensity is the count rate in the photon energy range 2.0–15.9 keV (*a*) or 2.1–16.0 keV (*b* and *c*); the hard colour is the count rate ratio between 9.7–15.9 kev and 6.5–9.7 keV in *a*, and between 9.7–16.0 keV and 6.4–9.7 keV in *b* and *c*. All points are 16s averages. The count rates are background subtracted, but not dead-time corrected. The regions in *b* have been used to calculate the upper limits.

banana branch during the observations. We find for GX 9+1 upper limits of 1.6% (the 1996 Feb 29 observation; energy range 2–60 keV) and 1.3% (all other observations combined; energy range 2–18.2 keV), and for GX 9+9 an upper limit of 1.8% (all data; energy range 2–18.2 keV). We divided the GX 9+1 banana in Figure 1b into different regions. For each region we calculated the rms upper limit on kHz QPOs. We find rms amplitude upper limits of 3.2%, 1.3%, 1.9%, 2.7%, and 3.4% (energy range 2–18.2 keV), for region 1, 2, 3, 4, and 5, respectively.

4. Discussion

The non-detection of kHz QPOs in GX 9+1 and GX 9+9 is consistent with the predictions of the sonic-point model proposed to explain the kHz QPOs (Miller et al. 1997). It is known from other atoll sources (e.g. 4U 1636−53: Wijnands et al. 1997; 4U 1820-30: Smale et al. 1997) that when they are in the upper banana branch the kHz QPOs are not detected. Thus, it remains possible that when GX 9+1 and GX 9+9 are observed longer on the lower banana, or even in the island state, kHz QPOs are detected in these sources.

References

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