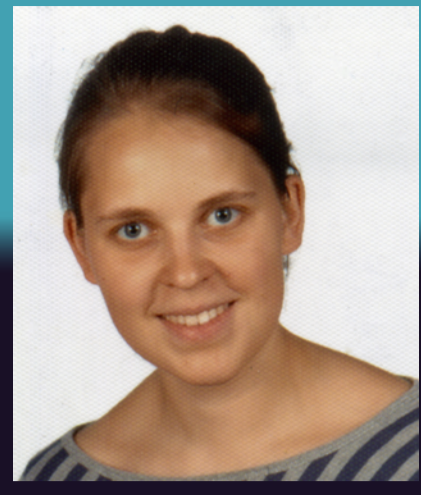


Searching for QPOs in Fermi GBM observations of SGR 0501+4516



Daniela Huppenkothen,

Astronomical Institute Anton Pannekoek, Universiteit van Amsterdam

d.huppenkothen@uva.nl

on behalf of the GBM Magnetar Collaboration



Introduction

The discovery of quasi-periodic oscillations (QPOs) in the tails of magnetar giant flares, and their interpretation as oscillations of the stellar crust and interior, has resulted in important constraints on theoretical neutron star models. Giant flares, however, are very rare, with an occurrence of once every ten years or so. Many soft gamma repeaters, on the other hand, show smaller flares that could in principle also excite QPOs. Given our complete lack of knowledge of the QPO excitation and emission modulation mechanism, a systematic search for QPOs in gamma-ray data of these smaller flares seems worthwhile. Here, we present first results from a search for QPOs from SGR 0501+4516 using data from Fermi GBM.

Methods and Analysis

The raw Fermi GBM time-tagged event (TTE) data of 27 observations between 2008-08-22 and 2008-09-03 was barycentered and energy selected, leaving only photons between 8 and 100 keV. We combined data from all active detectors with a small zenith angle to the source during the observation. Subsequently, we performed timing analysis around each of the 29 bursts (26 triggered, 3 untriggered). The bursts themselves were excluded, using T90 burst durations from Lin et al (2011). We searched for oscillations in time segments of length 1 second and 10 seconds before and after each burst, using a frequency resolution of 1 Hz. We also searched averaged power spectra of all bursts.

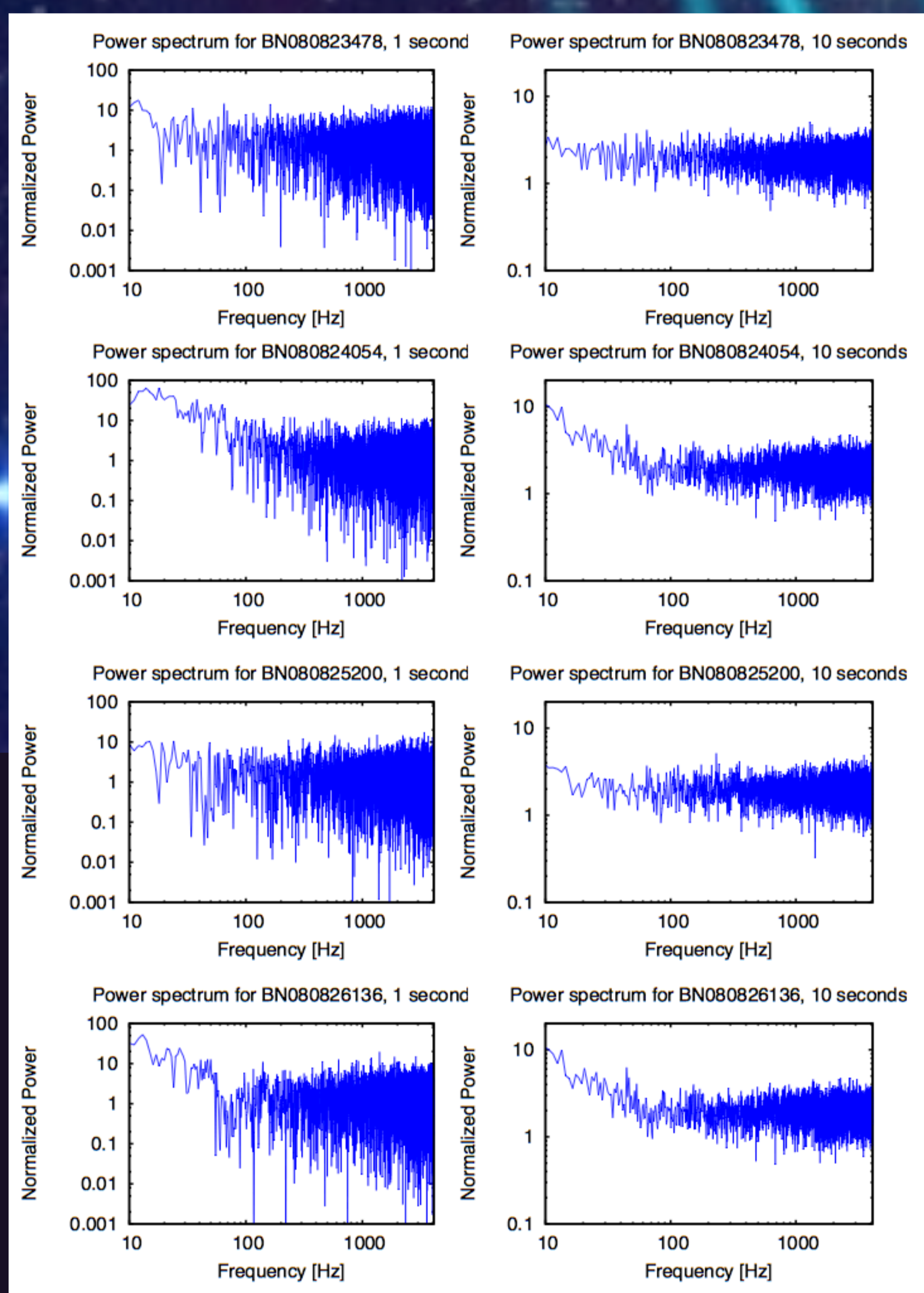


Figure 1: Power spectra for the 4 brightest bursts

References

- Groth, Probability distributions related to power spectra, ApJS, 1975
- Israel et al., The Discovery of Rapid X-Ray Oscillations in the Tail of the SGR 1806-20 Hyperflare, ApJ, 2005
- Kaneko et al., Magnetar Twists: Fermi/Gamma-Ray Burst Monitor Detection of SGR J1550-5418, ApJ, 2010
- Lin et al., Fermi/GBM Observations of SGRJ0501+4516 Bursts, 2011, submitted
- Illustration credit: European Space Agency

Burst ID	RMS power (1 s) [%]	RMS power (10 s) [%]
080823478	14.4	3.5
080824054	13.6	3.7
080825200	20.9	5.5
080826136	20.6	4.6

Table 1: Upper limits on QPO amplitudes for the four brightest bursts

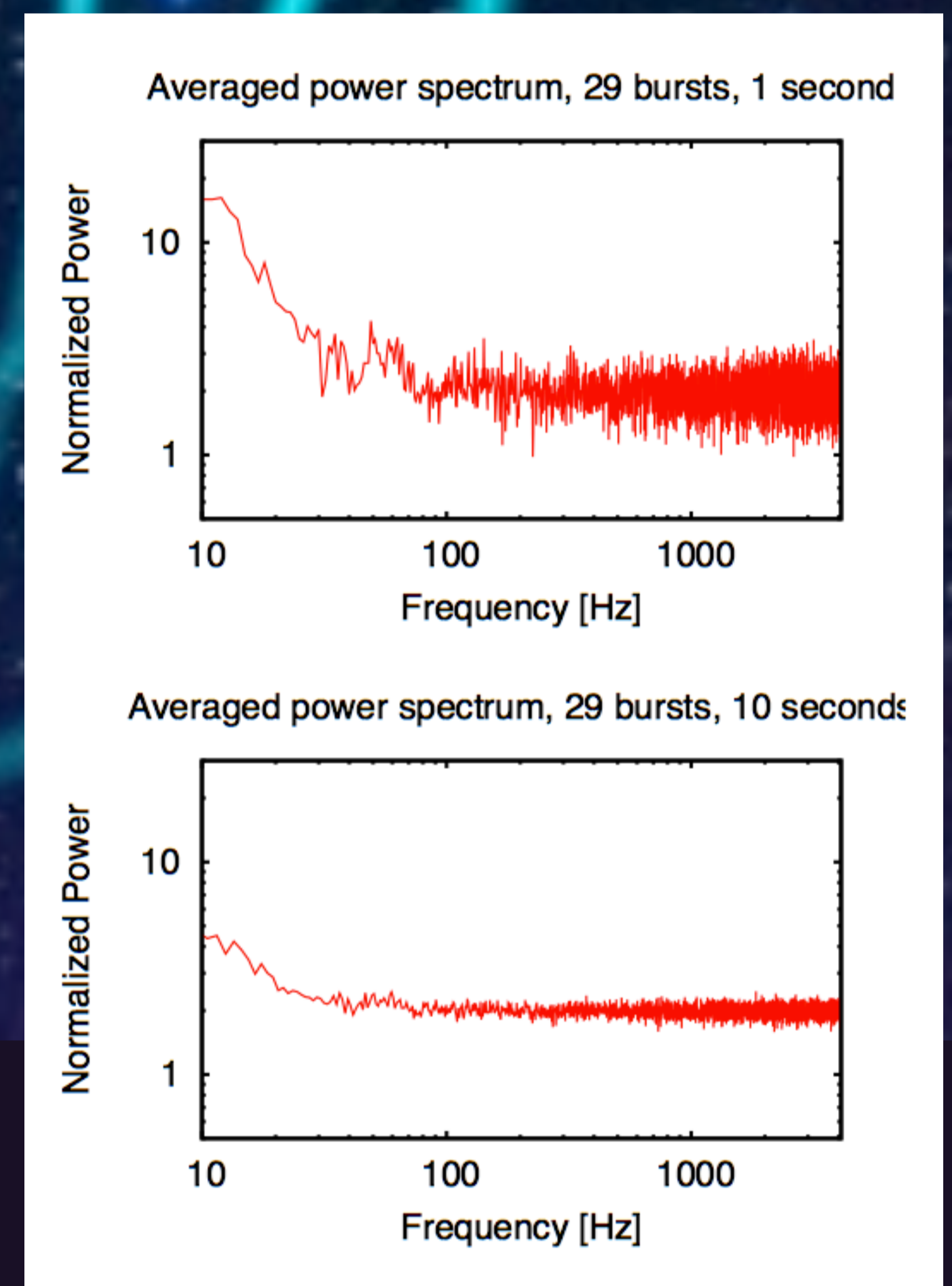


Figure 2: Averaged power spectra (all 29 bursts)

Results and Interpretation

In Figure (1), we present the power spectra of the 1 second and 10 second segments after the four brightest bursts. In Figure (2), the averaged power spectra combining all bursts for the same time segments are shown. No significant signals were detected in any of the observations, including the averaged power spectra.

The 3 σ upper limits on the amplitude of QPOs with frequencies in the range of 100-4096 Hz are quoted in Table (1). A more careful analysis to take into account frequencies below 100 Hz contaminated by power law noise, as well as to look carefully at the averaged power spectra, is currently underway.

The absence of a signal may partly be due to the large difference in fluence between these smaller flares (in the range 213 to 1537 $\times 10^{-8}$ erg cm^{-2} between 8 and 200 keV for the four brightest bursts; lower limit to the total fluence of all bursts: 3.75 $\times 10^{-5}$ erg cm^{-2}) and the giant flares ($\sim 10^{-3}$ erg cm^{-2}).

A similar analysis was done for SGR J1550-5418 (Kaneko et al., 2010). No significant detections of a QPO were made, with upper limits on the amplitude, 7.5 %, broadly consistent with what we find here.