Table 1. Spectral parameters of the energy spectra corresponding to the LFQPO peak phase, trough phase and the average. All errors indicate 68% of the uncertainty interval

Parameter	Total	Peak	Trough
$T_{\rm in}$ (keV)	$0.32^{+0.03}_{-0.03}$	$0.32^{+0.12}_{-0.03}$	$0.33^{+0.11}_{-0.02}$
$R_{\rm in}$ ($R_{\rm g}$)	$2.58^{+0.34}_{-0.2}$	$2.78^{+0.38}_{-0.76}$	$2.84^{+0.51}_{-0.78}$
$A_{\rm Fe}$	$3.53^{+0.19}_{-0.35}$	—	—
τ	$4.43^{+0.12}_{-0.17}$	$4.39^{+0.21}_{-0.1}$	$4.59^{+0.22}_{-0.15}$
kT e (keV)	$44.36^{+1.59}_{-1.08}$	$45.1^{+1.24}_{-2.18}$	$43.6^{+0.96}_{-1.62}$
$\log \xi$	$3.78^{+0.06}_{-0.04}$	—	—
$\mathcal{R}$	$1.18^{+0.07}_{-0.04}$	$1.28^{+0.1}_{-0.1}$	$1.05^{+0.1}_{-0.11}$
$norm$	$1.65^{+0.09}_{-0.11}$	$2.03^{+0.14}_{-0.35}$	$1.0^{+0.09}_{-0.21}$
χ^2/dof	1138/1235	1286/1226	1412/1184

Table 2. Best-fitting results for LFQPO around 0.044 Hz in different energy bands

	$\nu_{\rm QPO}$ (Hz)	FWHM	RMS	χ^2/dof
2-8keV(LE)	$0.044^{+0.001}_{-0.002}$	$0.013^{+0.005}_{-0.005}$	$0.156^{+0.026}_{-0.025}$	146/136
10-30keV(ME)	$0.043^{+0.002}_{-0.001}$	$0.014^{+0.005}_{-0.004}$	$0.106^{+0.023}_{-0.018}$	132/136
35-150keV(HE)	$0.044^{+0.001}_{-0.001}$	$0.01^{+0.004}_{-0.003}$	$0.093^{+0.007}_{-0.013}$	159/136
100-150keV(HE)	$0.044^{+0.002}_{-0.001}$	$0.009^{+0.003}_{-0.002}$	$0.08^{+0.007}_{-0.007}$	138/136
150-200keV(HE)	$0.044^{+0.004}_{-0.003}$	$0.007^{+0.006}_{-0.005}$	$0.06^{+0.02}_{-0.01}$	140/136

the trough phase we selected represent those of the QPO waveforms. Thus the differences of the energy spectra corresponding to the peak and the trough phases indeed indicate the spectral variation within the LFQPO cycle.

2.4 Short-timescale energy spectra of the LFQPO: the peak phase vs. the trough phase

Then we performed spectral fits to all the energy spectra on 5 second time scales which were extracted in the time intervals corresponding to the peak phase and the trough phase, respectively. For each energy spectrum, we performed Markov Chain Monte Carlo sampling in XSPEC, with the sampling algorithm from the `emcee` software package (Foreman-Mackey et al. 2013). We fixed the following three parameters: the constant value, the iron abundance $A_{\rm Fe}$, and the ionization parameter $\log \xi$ to the same as the average energy spectrum. We set 20 walkers with the prior parameters from the average energy spectrum fitting result in subsection 2.2. We used a Gaussian prior with a center as the best-fitting value from the parameters of the averaged energy spectrum and a width as 20%. We set 5,000 walkers and 5,000 burn-in steps. The median value of the posterior samples is taken as the best-fitting value for each free parameter. The 68% interval of reduced chi-square extracted from the median value of posterior chi-squares is 0.93 to 1.1, which indicates that all the 5s energy spectra are well-fitted by the model.

We then obtained the best-fitting parameters for all the X-ray spectra extracted on the 5 second time scale. The histogram of the best-fitting spectral parameters in the peak, trough and other phases are plotted(Figure 3). Then the mean value and 68% interval (16%-84%) for each parameter of each phase are also calculated. We can see that the inner disk radius $R_{\rm in}$, the electron temperature $kT_{\rm e}$ and the optical depth τ show almost identical distribution between peak and trough. The other three parameters are larger in the peak phase than in the trough phase. Especially, the 68% intervals of the normalization $norm$ and the reflection fraction $\mathcal{R}$ show no overlap, indicating a significant difference between these two parameters between peak and trough phases. According to the results, we obtain that the peak and trough phase short timescale spectral parameters T_{in}, $\mathcal{R}$ and $norm$ are different at least 50%, 76% and 96% significance level. So at least the spectral parameter $norm$ significantly changes with the QPO phases . We also generated the respective PDSs for all best-fitting parameters of the short timescale spectra, but only the PDS of the $norm$ shows an apparent QPO feature at the same frequency.

The most significant difference between the energy spectra corresponding to the peak and trough phases is the normalization (see Figure 3). The normalization determines the photon flux of both Compton and reflection components by the same factor. The reflection fraction $\mathcal{R}$ also varies between peak and trough phases. The photon flux of the reflection component is determined by $norm \times \mathcal{R}$ (Niedzwiecki et al. 2019). So the variation of $\mathcal{R}$ makes the flux variability of the reflection component different from that of the Compton component. The normalization and reflection fraction are also found to significantly vary with the QPO phase in another BHXRB H1743−322, in which the normalization is also the parameter that bears the most significant change (Ingram et al. 2017). There is also difference in the inner disk temperature $T_{\rm in}$ between that of the peak and of the trough. Since the disk component was very weak in the observation and the inner disk temperature is tied to the seed photon temperature for Compotonization in the model we applied, we can not distinguish whether the variation in $T_{\rm in}$ was due to intrinsic disk variability or potential variation in the Compton component.

2.5 Averaged energy spectra corresponding to the LFQPO peak and trough phases

In order to compare the energy spectra corresponding to the peak and trough phases in detail with enough statistics, we stacked all the 5-second energy spectra corresponding to either phase. Corresponding response files were generated using the tool `ADDSPEC` and the background file was generated using the tool `MATHPHA`, respectively. We also used the same spectral model that was used to fit the average energy spectrum to fit the stacked energy spectra. We fixed the constant value, the iron abundance $A_{\rm Fe}$ and the ionization parameter $\log \xi$ in the model at the same values obtained in the spectral fit of the average energy spectrum. The best-fitting spectral parameters corresponding to the peak and the trough phases are listed in Table 1. The best-fitting spectral parameters corresponding to the peak and trough phases agree with each other, except for the normalization $norm$, the reflection fraction $\mathcal{R}$. The $norm$ and $\mathcal{R}$ of the peak and trough phases are different by at least 97% and 70% significance levels, which is consistent with the statistical results of the 5-seconds spectra.

We plotted the unfolded energy spectra of peak/trough phases in the top panel of Figure 4. The best-fitting models of the Compton and reflection components are also added in the Figure 4. The spectral shape of the Compton components are almost the same at the peak and the trough phases, since only $norm$ changes and other parameters related to Compton (such as $kT_{\rm e}$ and τ) remain nearly constant. On the other hand, the spectral shape of the reflection component at the peak phase is different from that at the trough phase, since the reflection fraction $\mathcal{R}$ is larger. The reflection component dominates over the Compton below ~30 keV, and the Compton component becomes dominated above ~70 keV in both peak and trough phases.

The fractional photon flux change in the Compton component between peak and trough phases ($C_{\rm P}$-$C_{\rm T}$) is almost the same for different energies since the normalization is the only parameter that