

1. Quasi-periodic oscillations in the AGN RE J1034+396

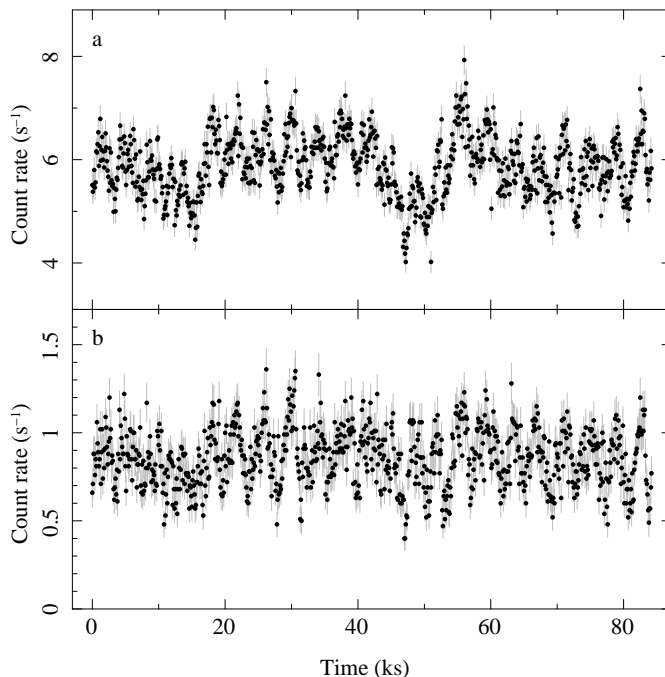


Figure 1: Light curve of RE J1034+396 in (top) 0.3–10 keV and (bottom) 1–10 keV bands, observed by the XMM-Newton satellite (Middleton et al. 2008, <http://arxiv.org/abs/0807.4847>).

Quasi-periodic oscillations (QPOs) are oscillations that are not precisely periodic, but show up as enhanced power over a narrow range of frequencies in Fourier space. QPOs are commonly observed in x-ray binary systems containing either neutron stars or black holes. So far the only QPO observed in an Active Galactic Nucleus (AGN) is RE J1034+396, Figure 1. The count rates graphed in Figure 1 are contained in two files `lightcurve_lo.dat` and `lightcurve_hi.dat` downloadable from the class website. Each file contains values giving counts of photons in each of 843 successive 100-second bins of time.

Use a Fast Fourier Transform to measure the power spectrum of each of the two data sets. Things to do:

1. Remember to subtract the mean;
2. Try padding the data with zeros;
3. Try windowing the data with a function of the form $(1 - x^2)^n$.

What do you find? Is there a QPO, and if so what is its frequency? [Hint: You may use any FFT, such as or those in `mathematica` or `IDL`, or `FFTW` from <http://www.fftw.org/>.]