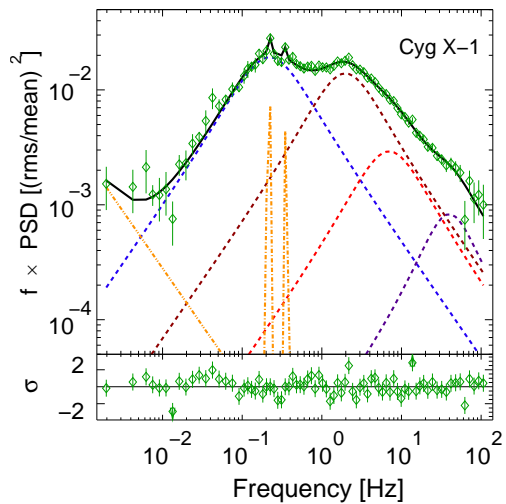




Timing: PSDs, I



Power spectrum in the hard state can be well described as superposition of broad Lorentzians.

(Pottschmidt et al., 2003b)

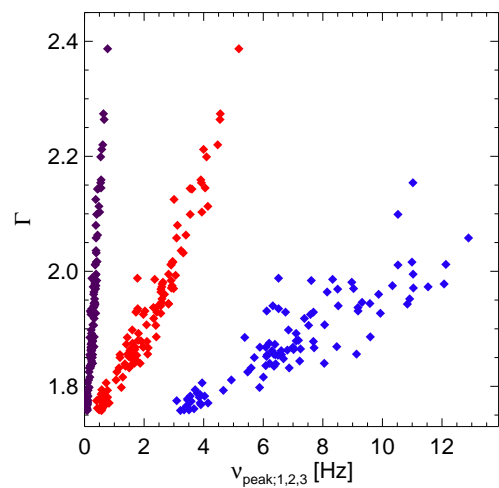
(Nowak, 2000)

Timing

1



Timing: PSDs, II



Peak frequencies are strongly correlated with spectral shape:

Does timing imply a simple disk with a varying radius?

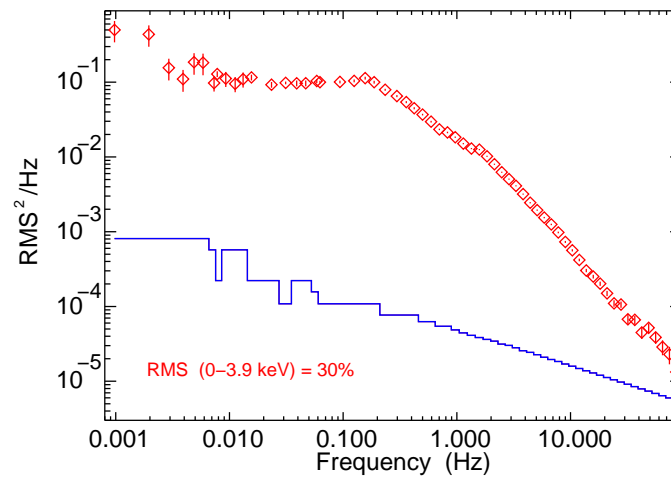
(Pottschmidt et al., 2000)

Timing

2



Timing: PSDs: Energy Dependence, I



(Nowak et al., 1999a)

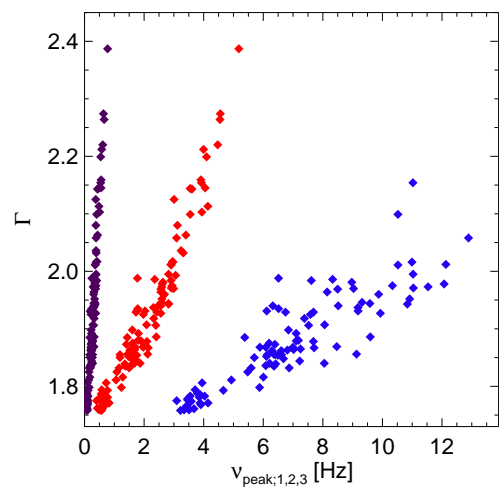
PSD is energy dependent: softer bands: higher rms at *low* frequencies.

Timing

3



Timing: PSDs, II



Peak frequencies are strongly correlated with spectral shape:

Does timing imply a simple disk with a varying radius?

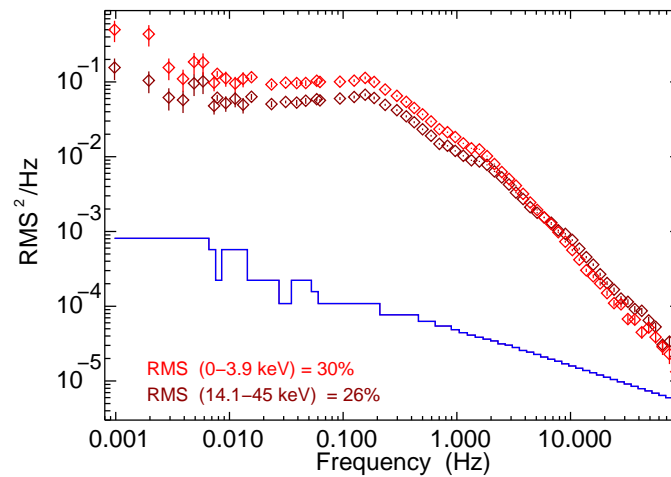
(Pottschmidt et al., 2000)

Timing

2



Timing: PSDs: Energy Dependence, II



(Nowak et al., 1999a)

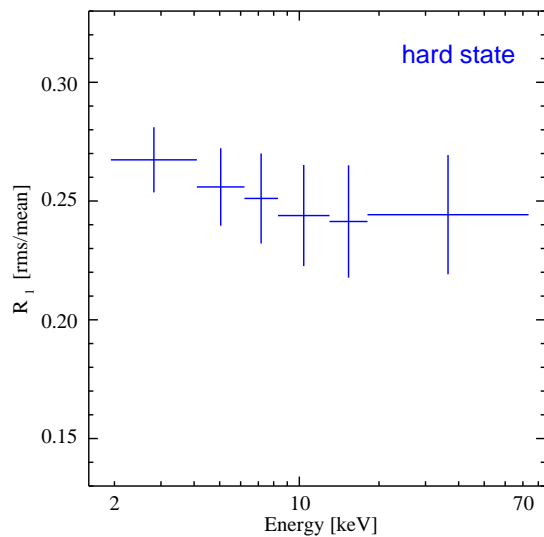
PSD is energy dependent: softer bands: higher rms at *low* frequencies.

Timing

4



Timing: PSDs: Energy Dependence, III



Amplitude of individual Lorentzians is energy and state dependent

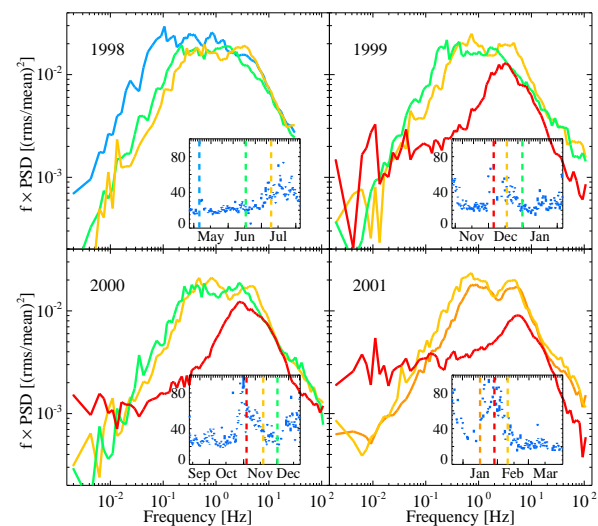
(Pottschmidt et al., 2003b)

Timing

5



Timing: PSDs: Transitions, I



PSD shows dramatic changes during failed state transitions.

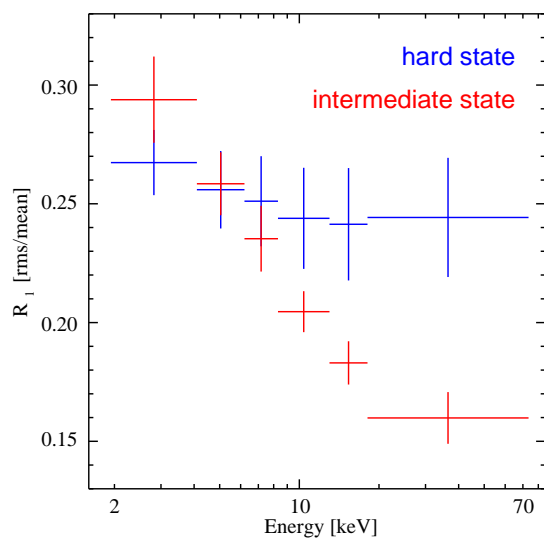
(Pottschmidt et al., 2003b)

Timing

7



Timing: PSDs: Energy Dependence, IV



Amplitude of individual Lorentzians is energy and state dependent

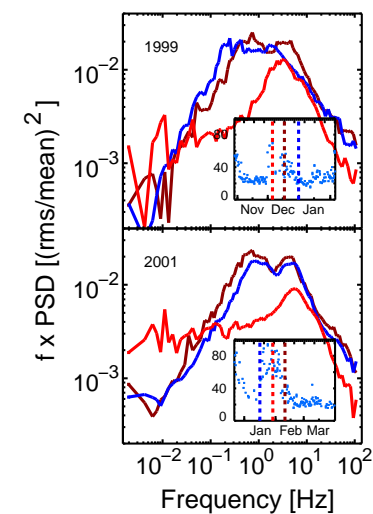
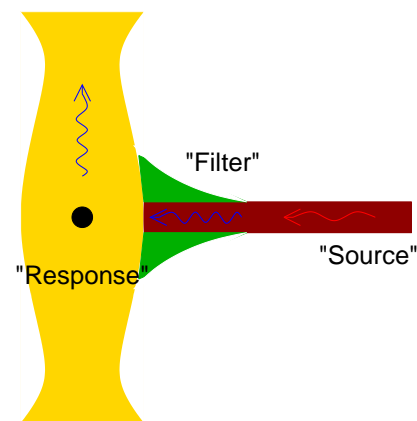
(Pottschmidt et al., 2003b)

Timing

6



Timing: PSDs: Transitions, II



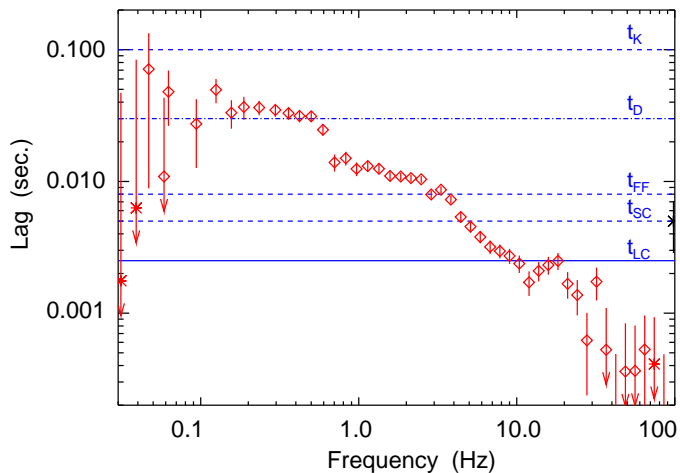
(Psaltis & Norman, 2001; Nowak et al., 1999b; Miyamoto & Kitamoto, 1989)

Timing

8



Timing: Lags



Miyamoto & Kitamoto (1989): Hard X-rays lag soft X-rays

Lag has strong dependence on Fourier frequency: *inconsistent with simple variability models.*

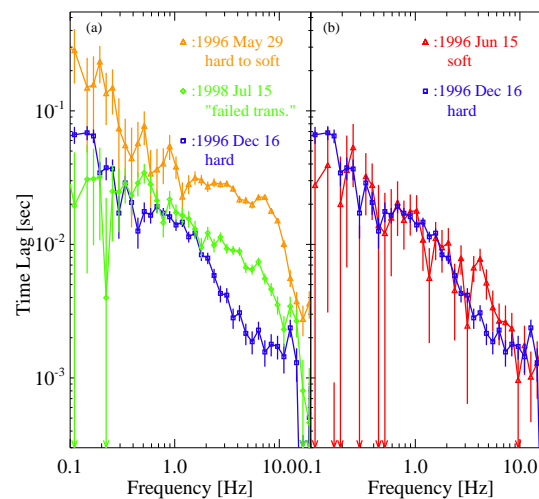
(Nowak et al., 1999b, lines show typical timescales based on coronal radius of $50GM/c^2$ for $M = 10 M_{\odot}$)

Timing

9



Timing: Lags



(Pottschmidt et al., 2000)

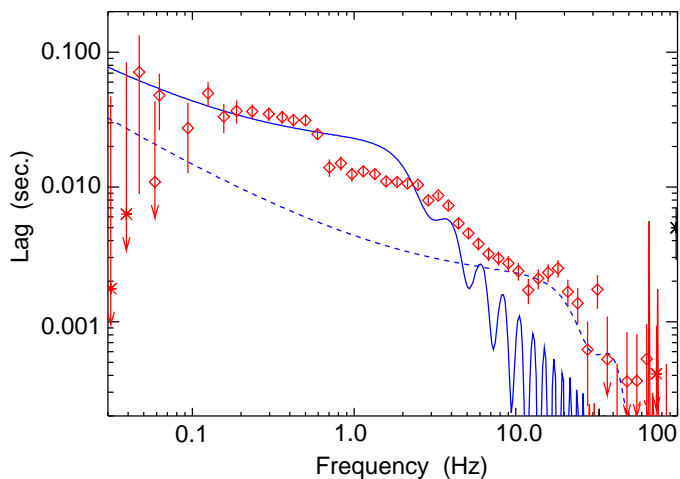
- Lags are variable: "shelves" consistent with Lorentzians!
- Lags change during transitions
⇒ changing geometry?
- Soft state and hard state lag \sim similar.
contradicts geometry change?

Timing

11



Timing: Lags



Possible explanation for X-ray lags:

- Nowak et al. (1999b): wave propagation in accretion disk
See also Manmoto et al. (1996)
- K rding & Falcke (2004): pivoting power law spectra plus Lorentzian PSDs

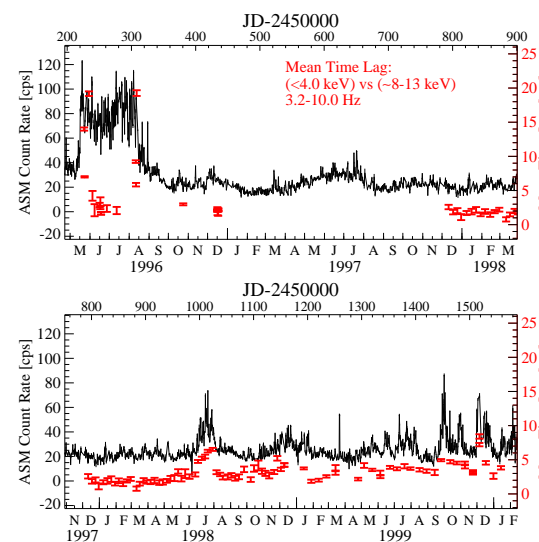
(Nowak et al., 1999b, solid: time lag for $c_p = 0.01c$, dashed: $c_p = 0.1c$)

Timing

10



Timing: Lags



(Pottschmidt et al., 2000)

Enhanced lag during (failed) transitions
⇒ Extremely sharp transition indicator!

Also true in other BHC (e.g., Kalemci et al., 2001, 2003, 2005)

Timing

12

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