The XRB analogy to the first AGN QPO

Matthew Middleton
Chris Done
Marek Gierliński
The first AGN QPO - RE J1034+396

Gierliński et al. 2008

The XRB analogy to the first AGN QPO
Correctly modelling the red-noise (Vaughan et al. 2006)

>5σ detection (Gierliński et al. 2008)
RE J1034+396 – a unique source

Large Soft Excess

′hot-disc′ SED

X-ray Astronomy 2009
Matt Middleton – The XRB analogy to the first AGN QPO
QPO fractional variability increases with energy.
Finding the origin: RMS spectra

Use $\Delta t$ to create rms spectra of different frequency bands

Green: rapid variability (inc QPO 135-5000$\mu$Hz)

Blue: QPO (270$\mu$Hz)
Finding the origin: Spectral fitting

Must fit both the variability and energy spectrum!

Middleton et al. 2009
Finding the origin: Spectral fitting

By varying spectral components in model gives test rms spectrum

Match to rapid variability to get QPO origin
What the models tell us...

i) Spectrum well fit by low-temperature Comptonisation

ii) Also provides soft excess but not a generic origin!

iii) Changing model parameters reproduces rms shape
**X-ray binary LFQPOs**

The XRB analogy to the first AGN QPO –

**Mass scaling with frequency >10L_{Edd}**

**XRBs show LFQPO sub-Edd so not the LFQPO!**

Remillard & McClintock 2006
X-ray binary HFQPOs

Scaling gives $0.3-0.5L_{\text{Edd}}$

AGN seen with this but not same SED
‘Unique QPOs’ of GRS 1915+105

67Hz and 41 Hz QPOs do not obey this prediction!

Remillard & McClintock 2006
‘Unique QPOs’ of GRS 1915+105

Morgan, Remillard & Greiner 1997
SED comparison

XRB and AGN should show the same spectral state when showing the analogous QPO

OM data gives optical/X-ray SED for REJ1034+396

Middleton & Done 2009
Observations with the most significant 67Hz QPOs (+HEXTE)

Looks same as REJ1034+396!
**RMS comparison**

Morgan & Remillard 1997

Middleton et al. 2009
The XRB analogy to the first AGN QPO

Simulations show that the slope under REJ1034+396 is $\nu^{-1.3}$

Normalisation different!

Middleton & Done 2009
Bandpass effects

Middleton & Done 2009

X-ray Astronomy 2009

Matt Middleton – The XRB analogy to the first AGN QPO
**PDS comparison - BP corrected**

Middleton & Done 2009
Conclusions

1. RMS and energy spectra point towards low-temperature Comptonisation as source of soft excess (in this source) and diluting component.

2. Many XRB QPOs are seen, cannot be standard LF or HFQPO from mass scaling.

3. 67Hz QPO of GRS 1915+105 provides a ‘good’ mass accretion rate and is seen in same state but power spectrum normalisations differ.

4. Correcting bandpass makes normalisations agree!