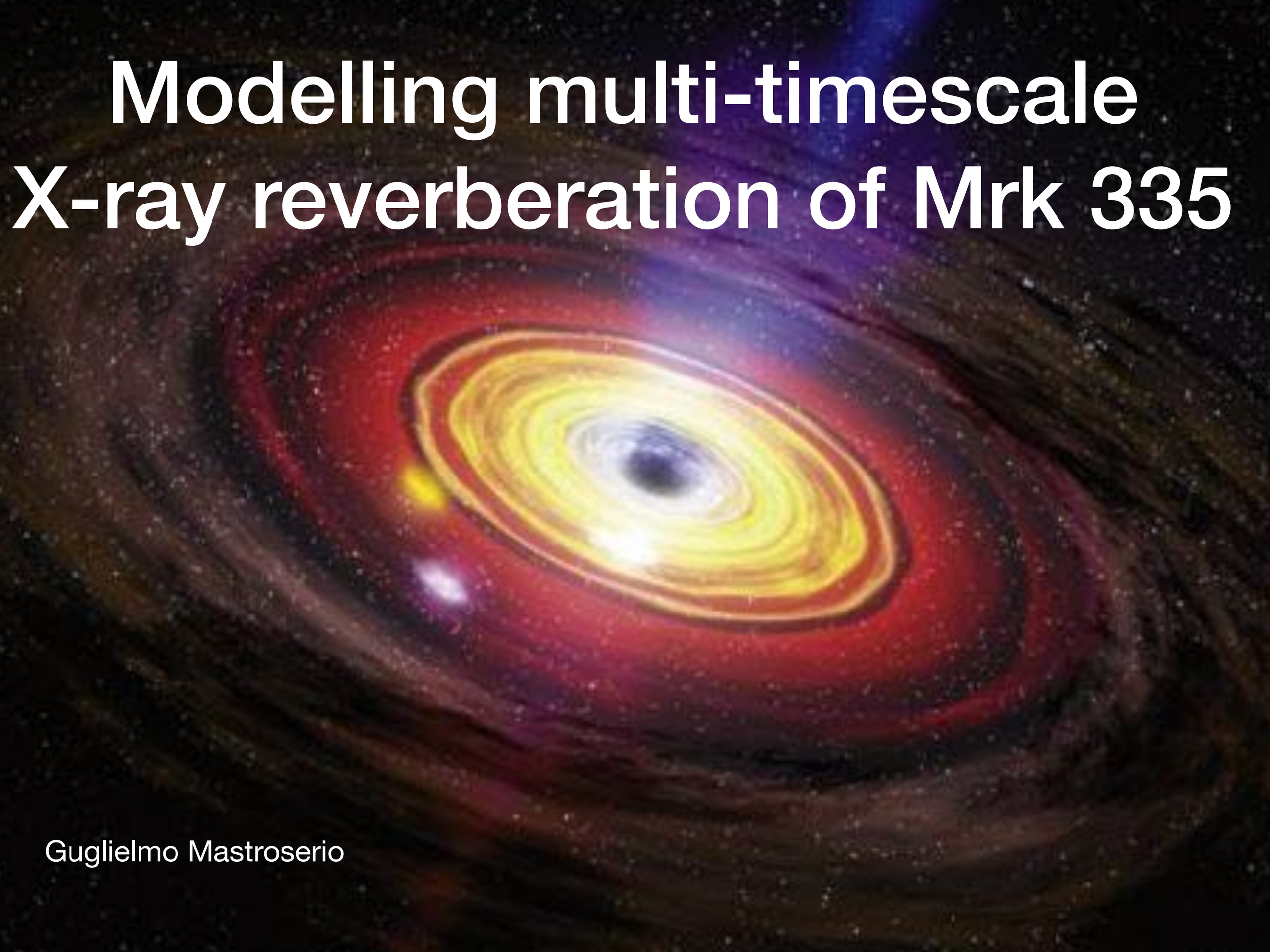
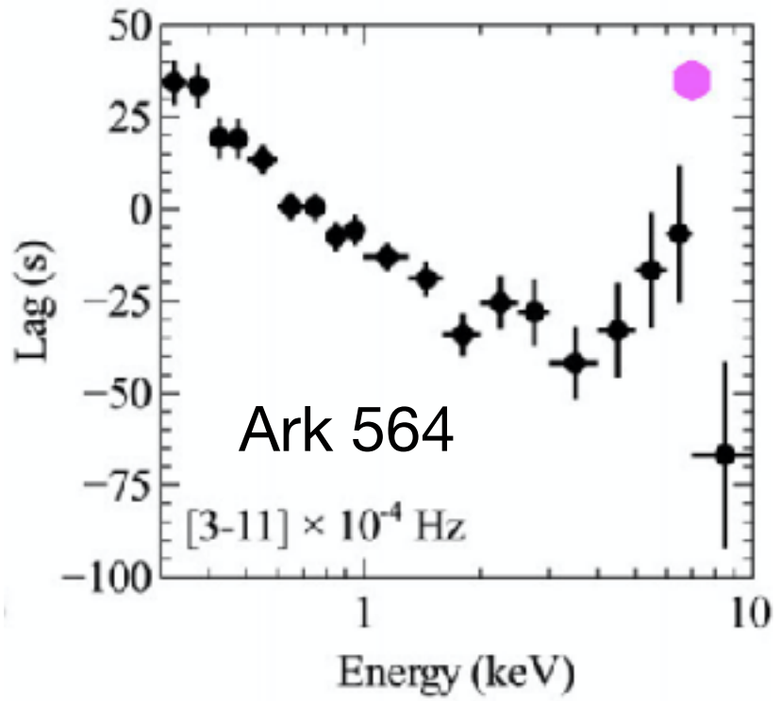
Modelling multi-timescale X-ray reverberation of Mrk 335

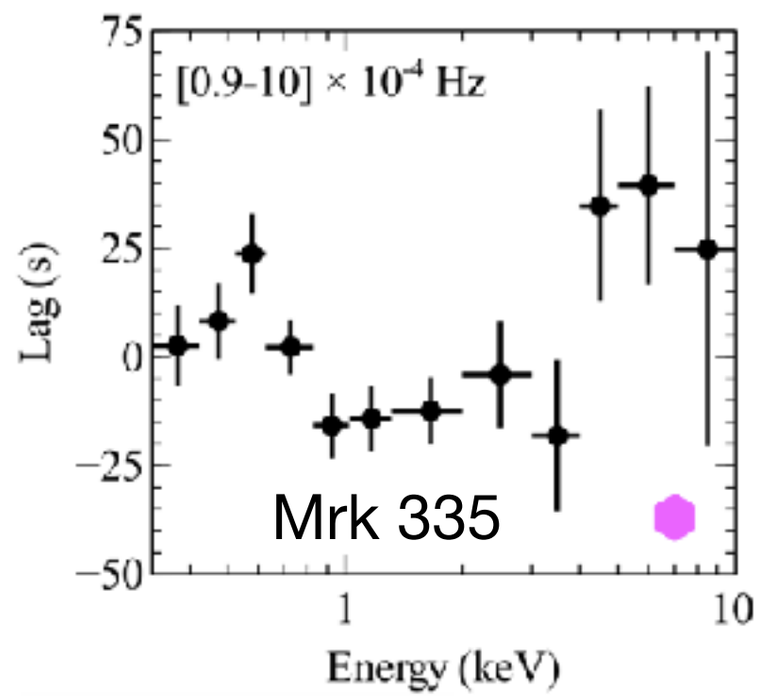


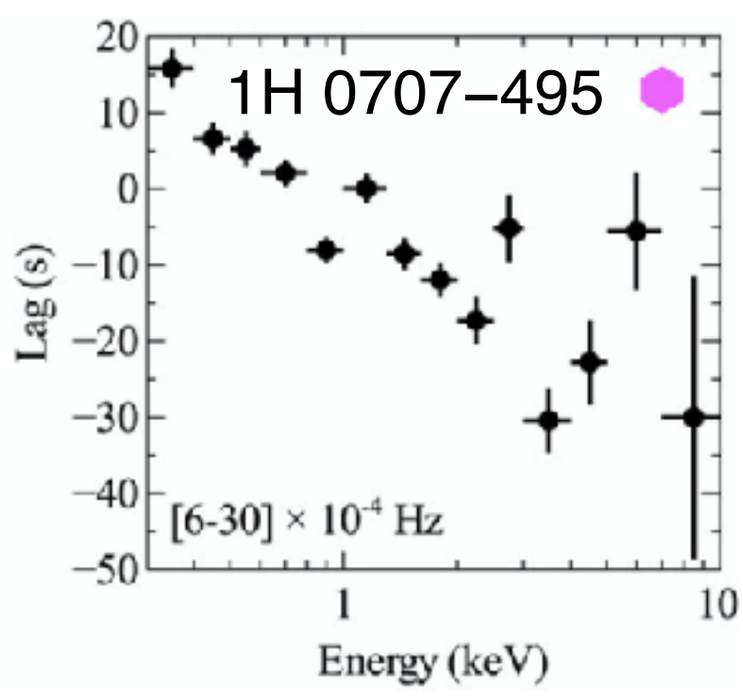
Guglielmo Mastroserio

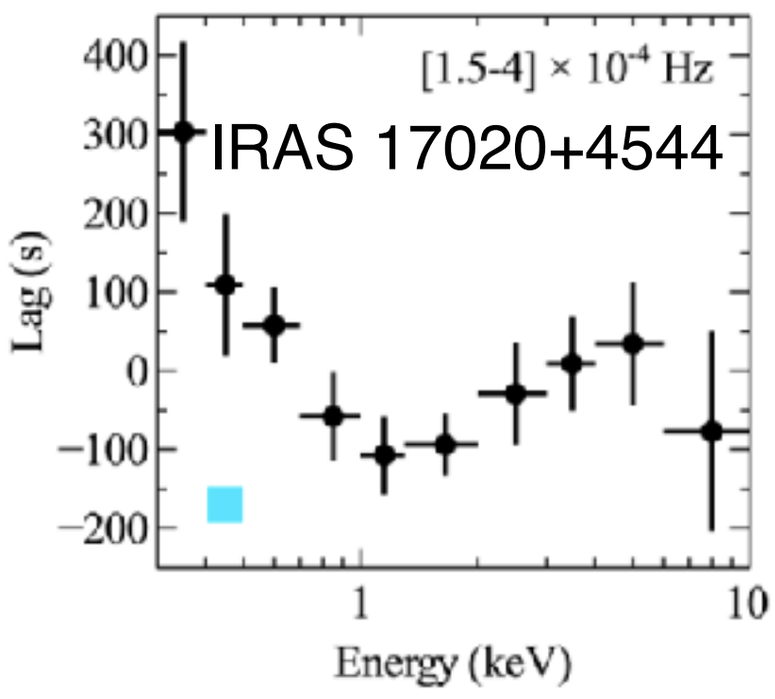
X-ray reverberation in AGN

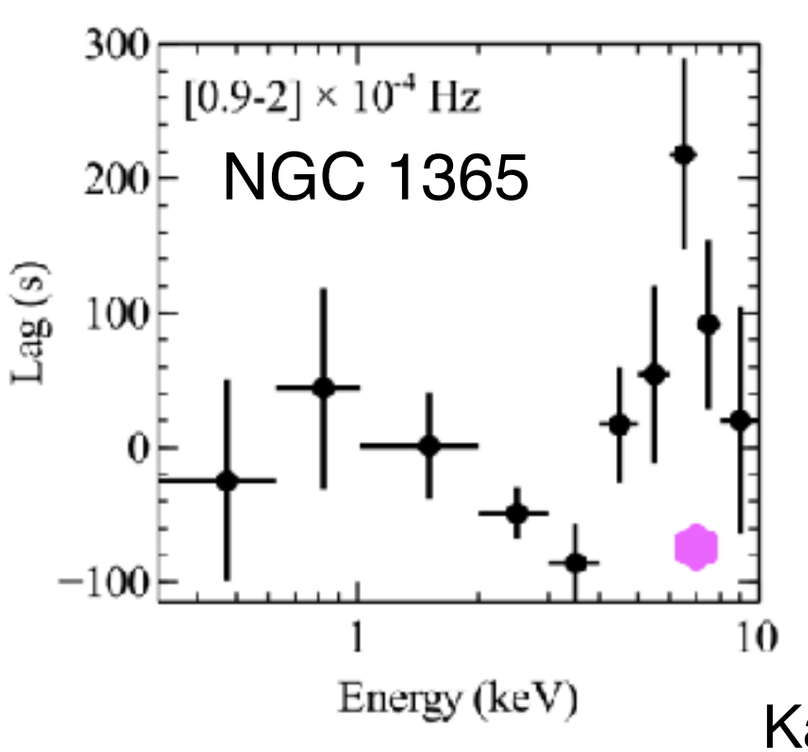
"Well behaving" sources

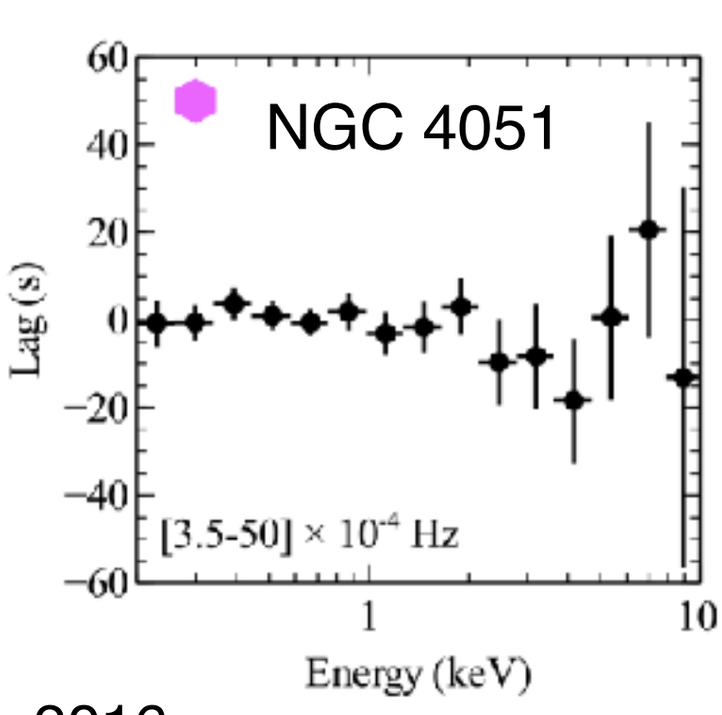








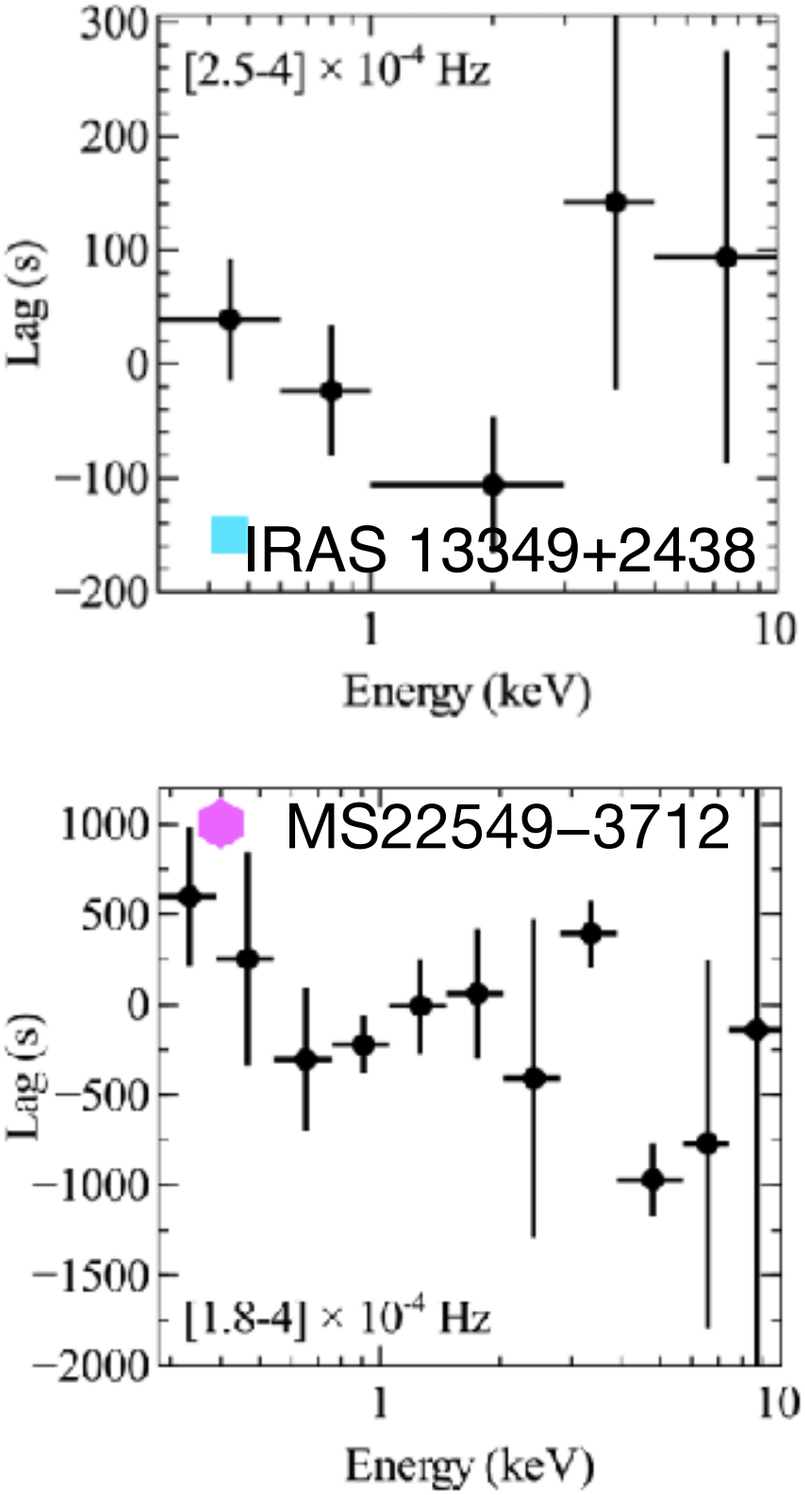


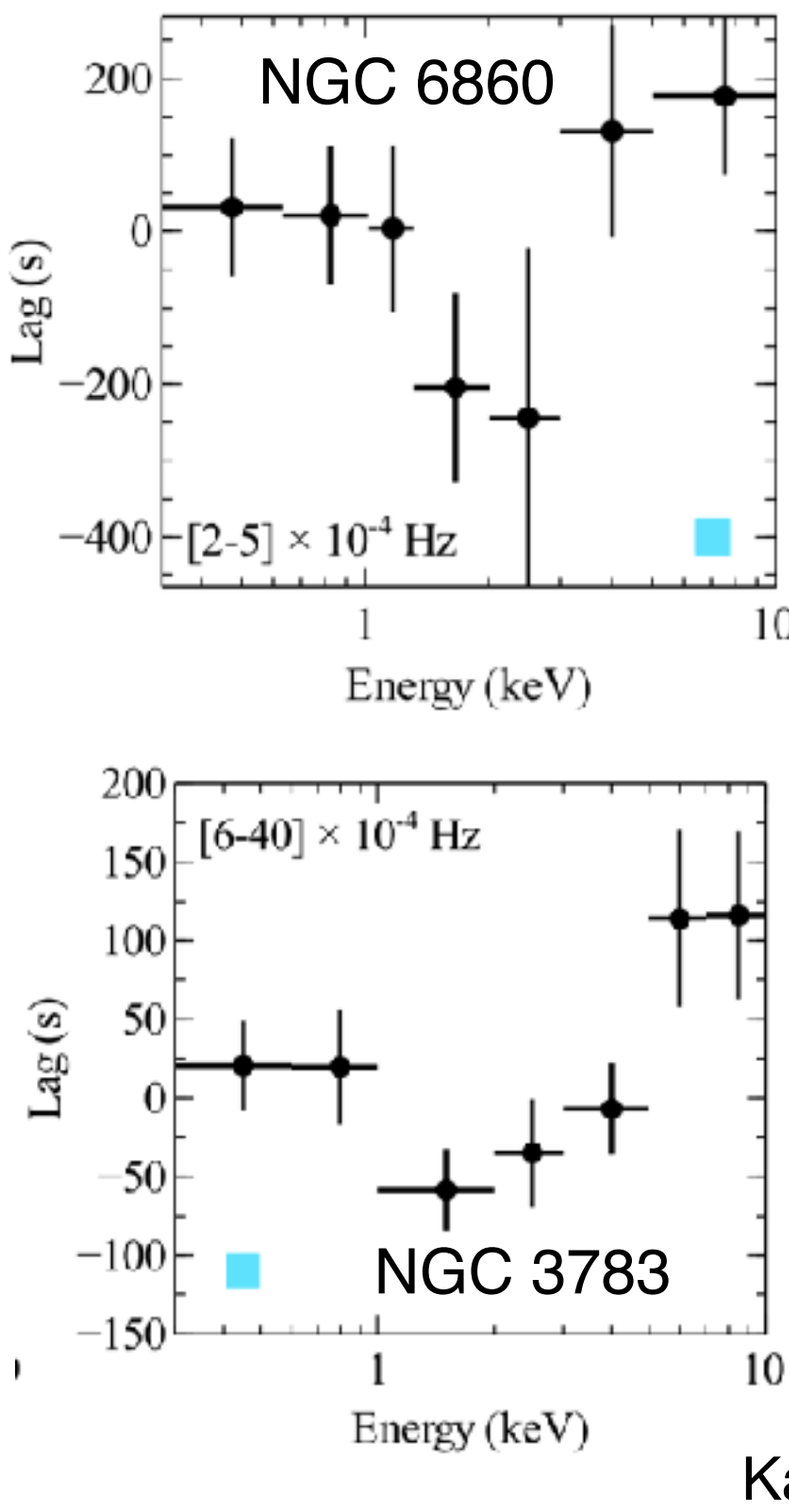


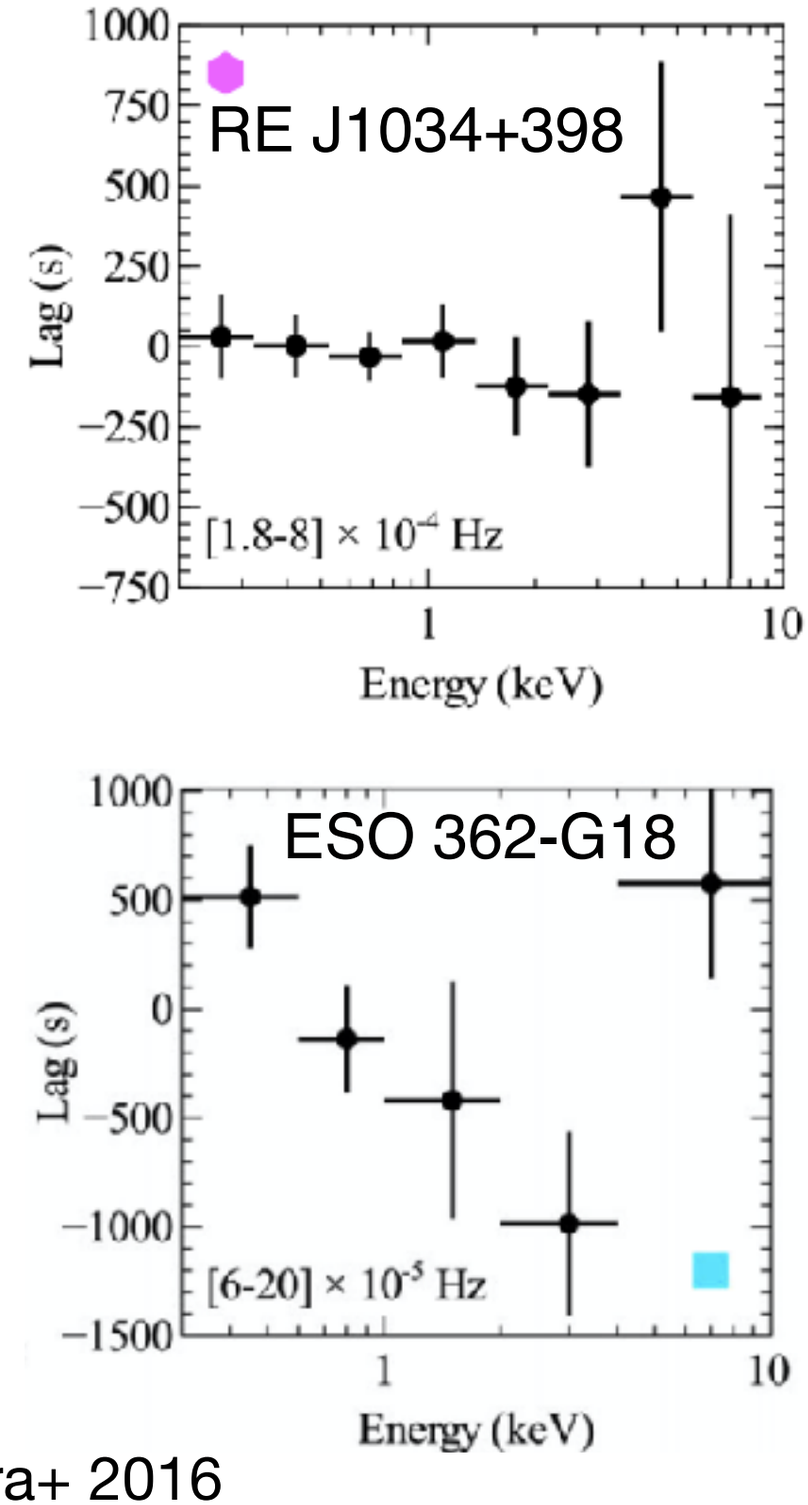
Kara+ 2016

X-ray reverberation in AGN

"Badly behaving" sources



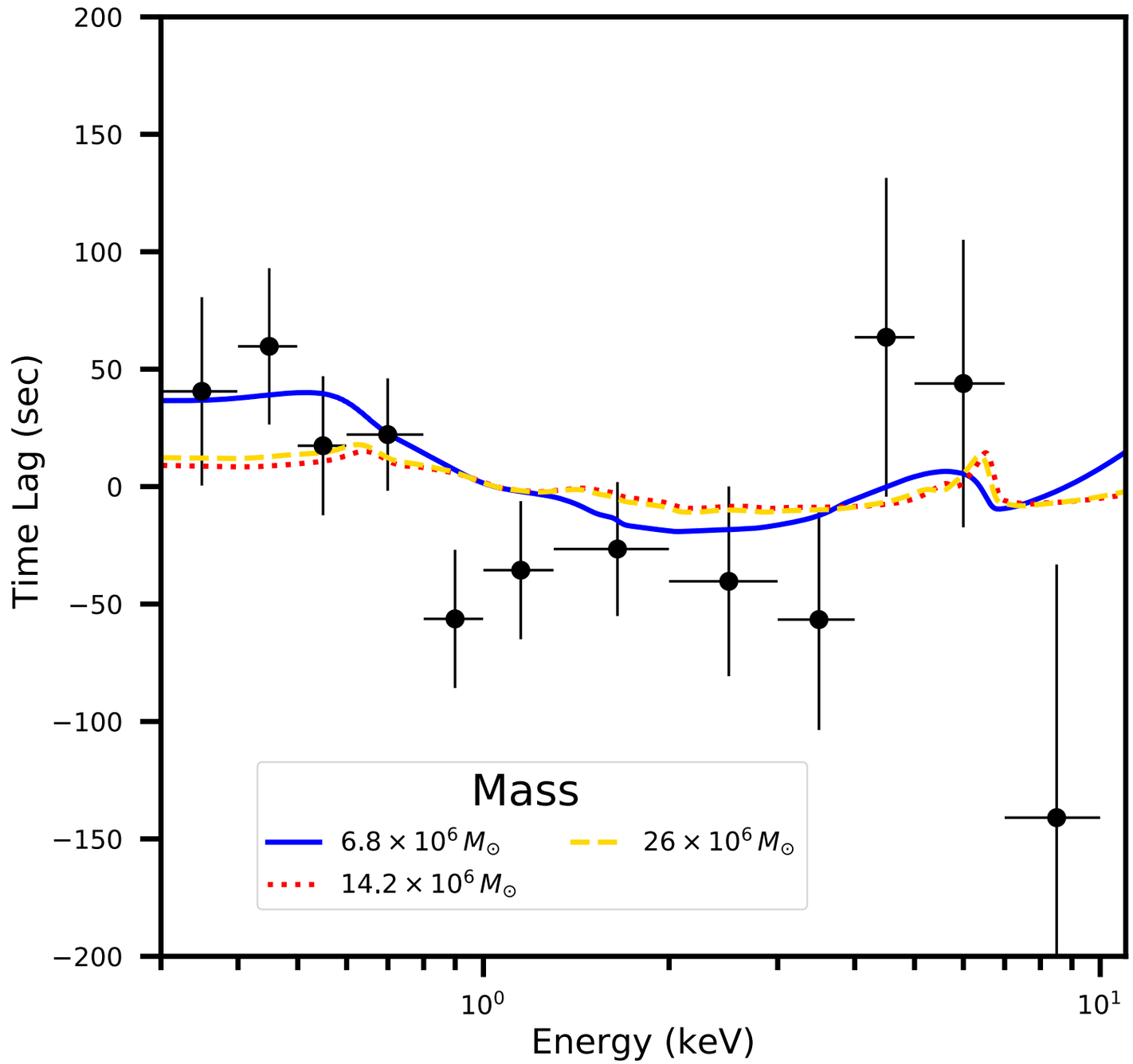




Kara+ 2016

Mrk 335

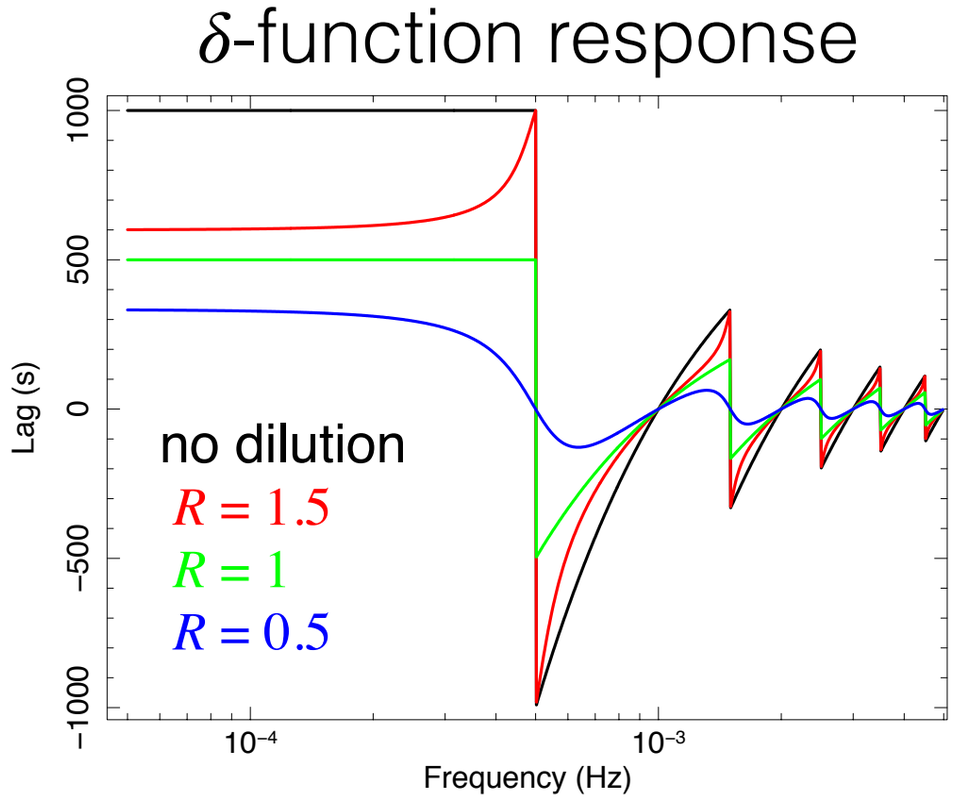
Fit to the lag spectrum only in a single frequency range



The fit with reltrans model has one less degree of freedom than the a power law + Gaussian fit and gives a better χ2

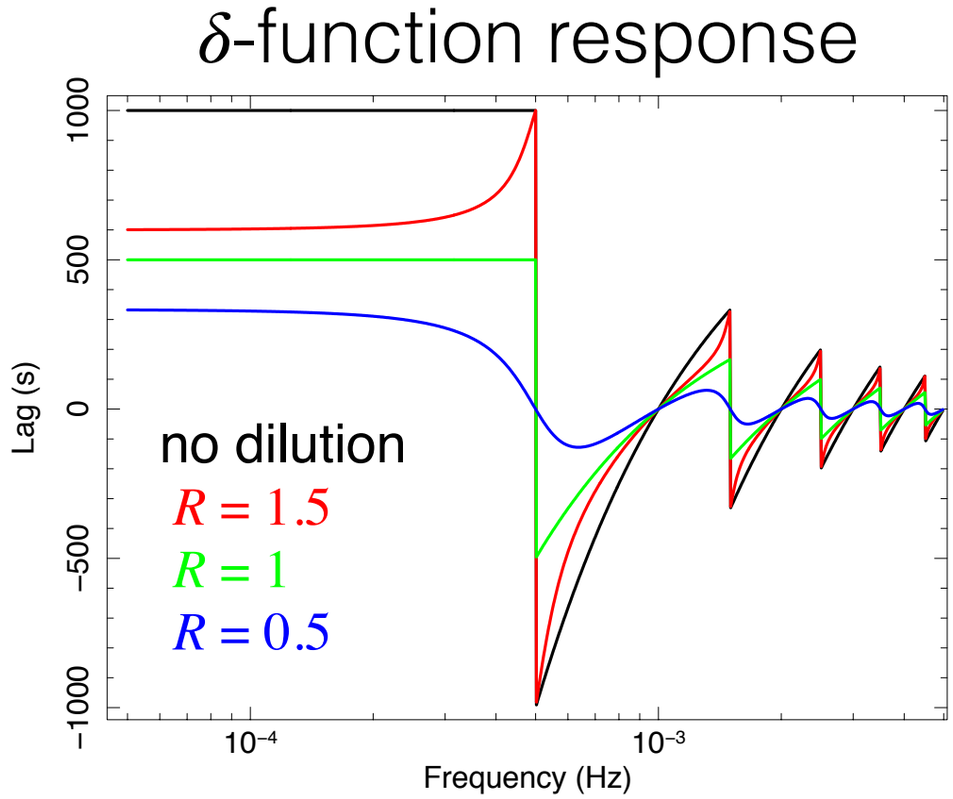
Different BH masses lead to a equally good fit to the data

Phase wrapping



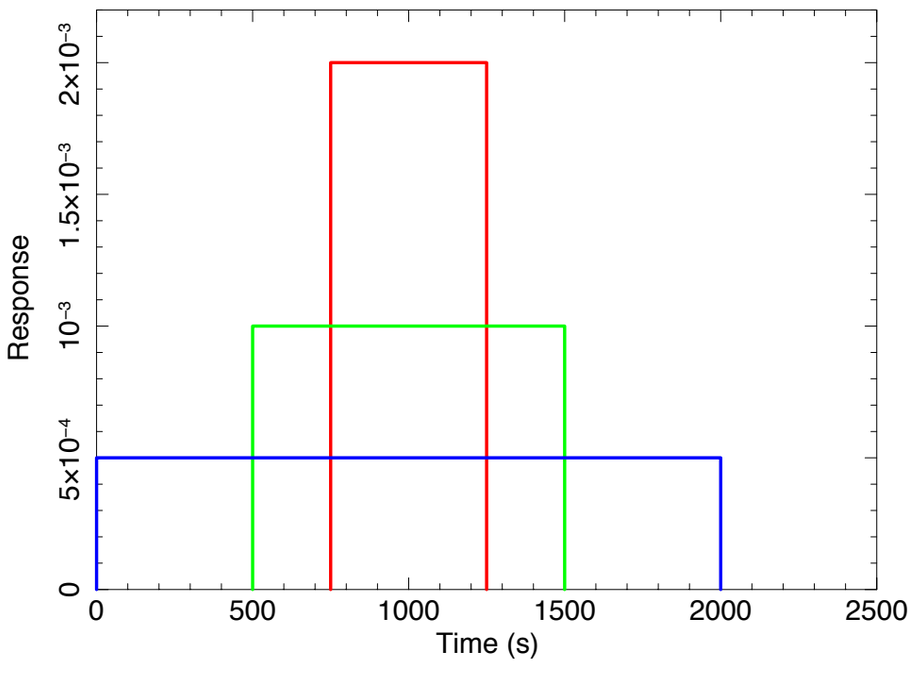
Uttley+ 2014

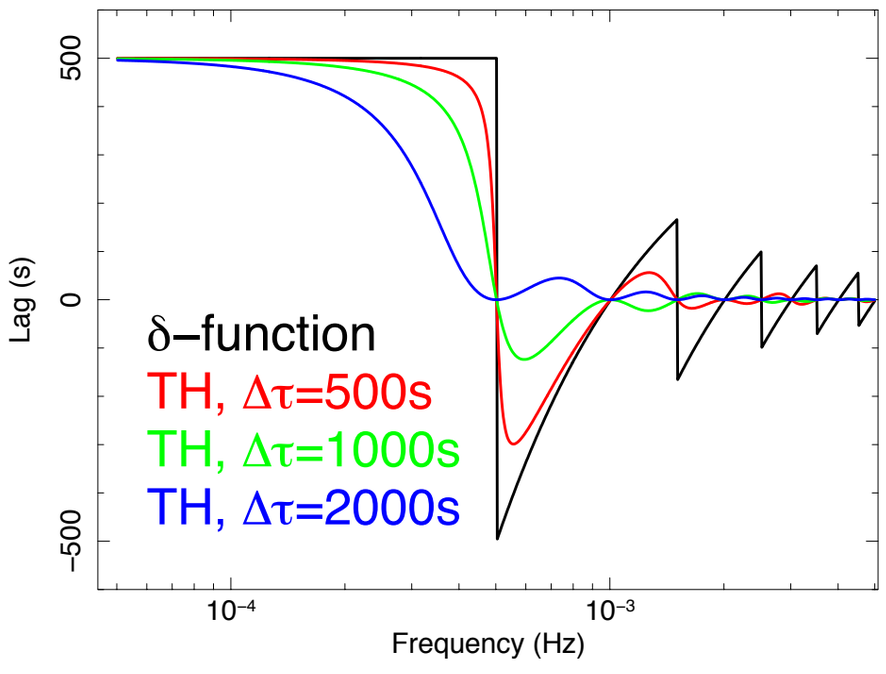
Phase wrapping



Uttley+ 2014

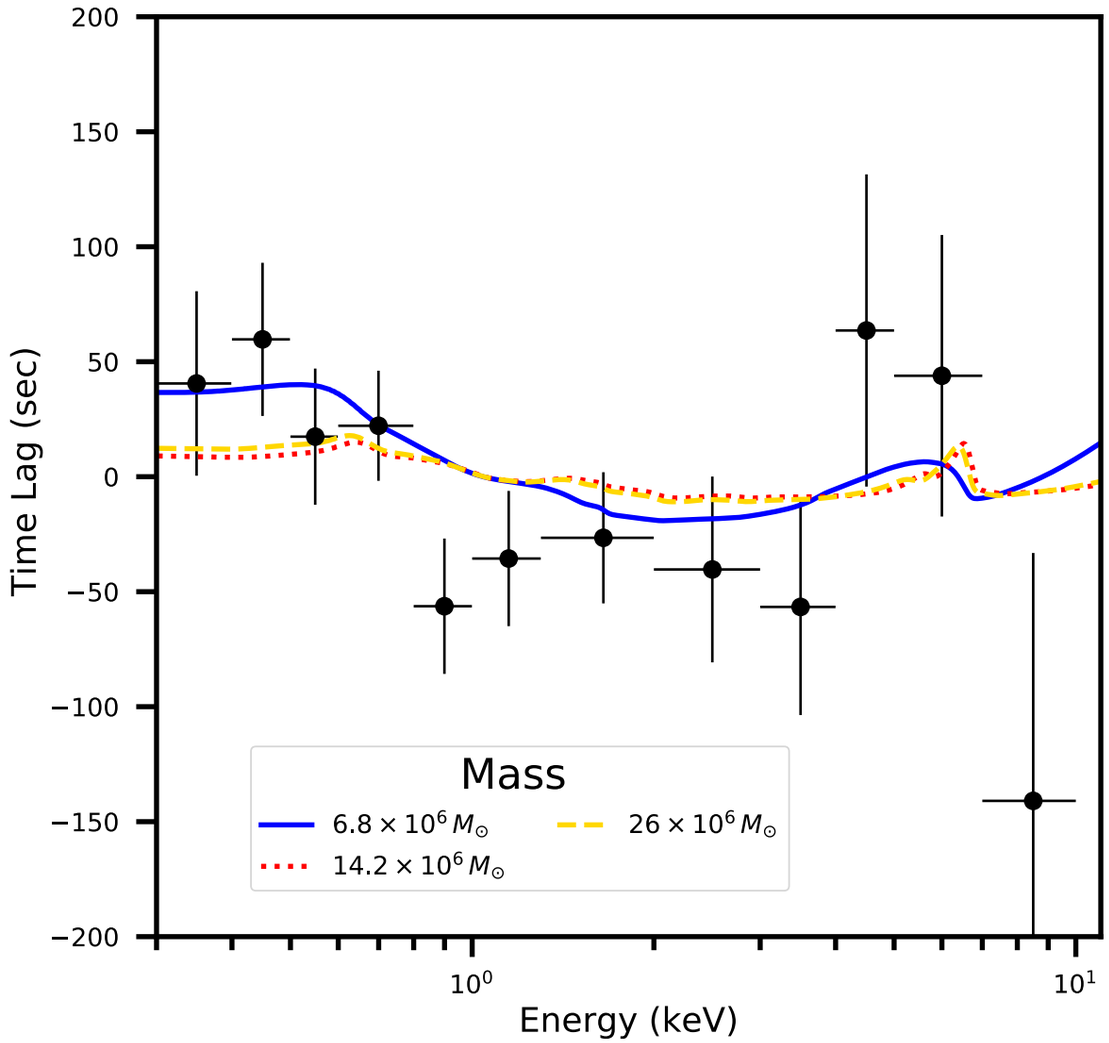
Top-hat response function

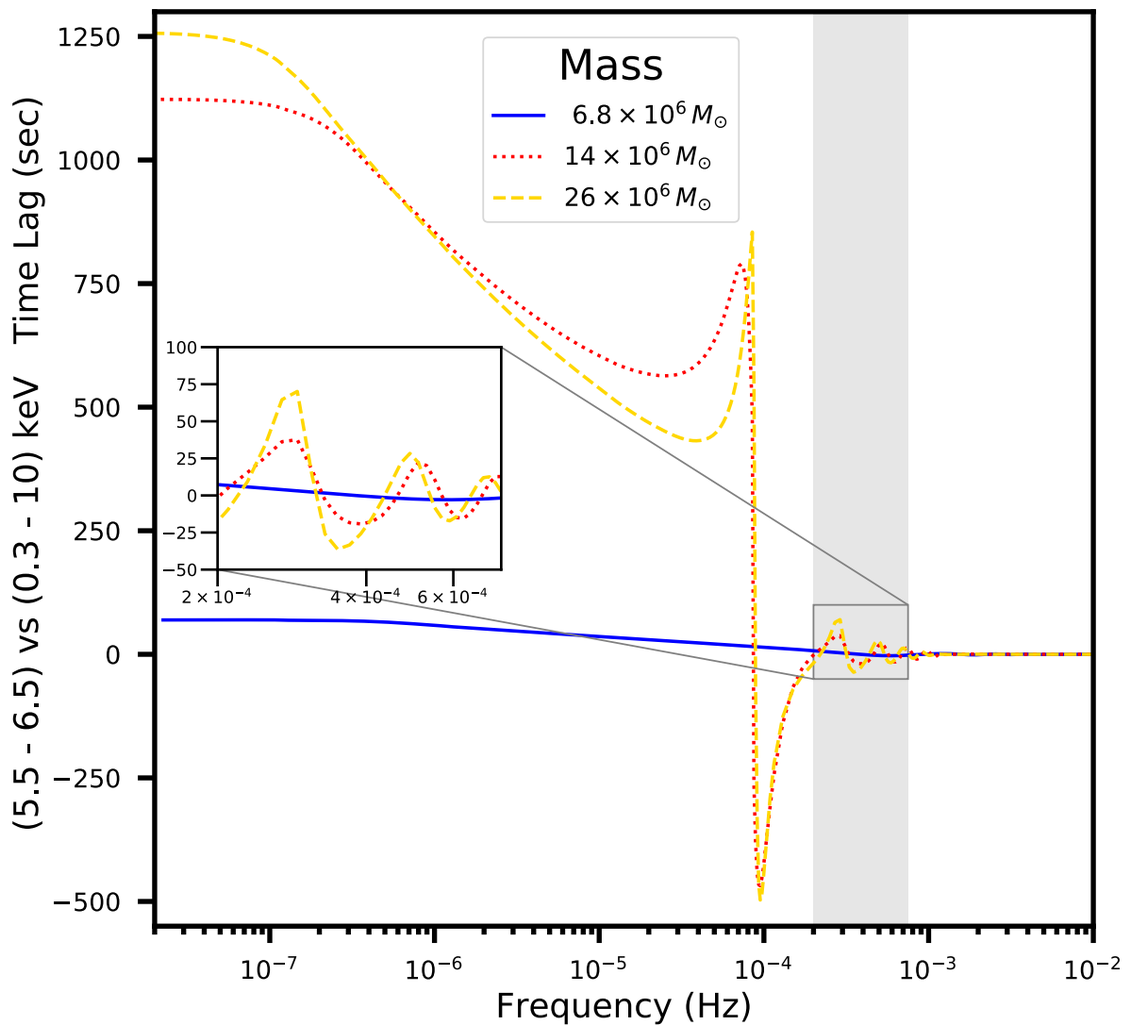




Mrk 335

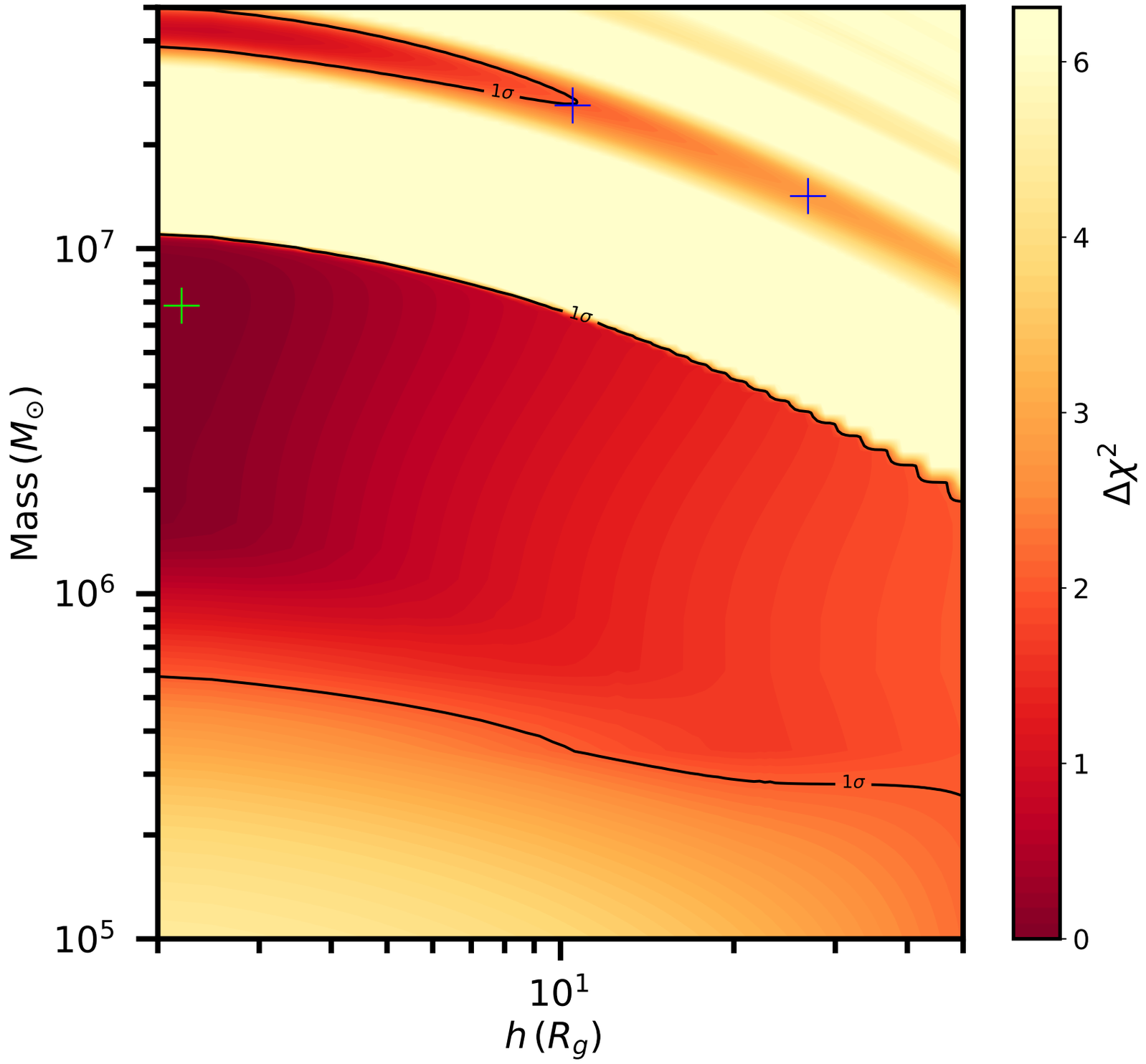
Fit to the lag spectrum only in a single frequency range

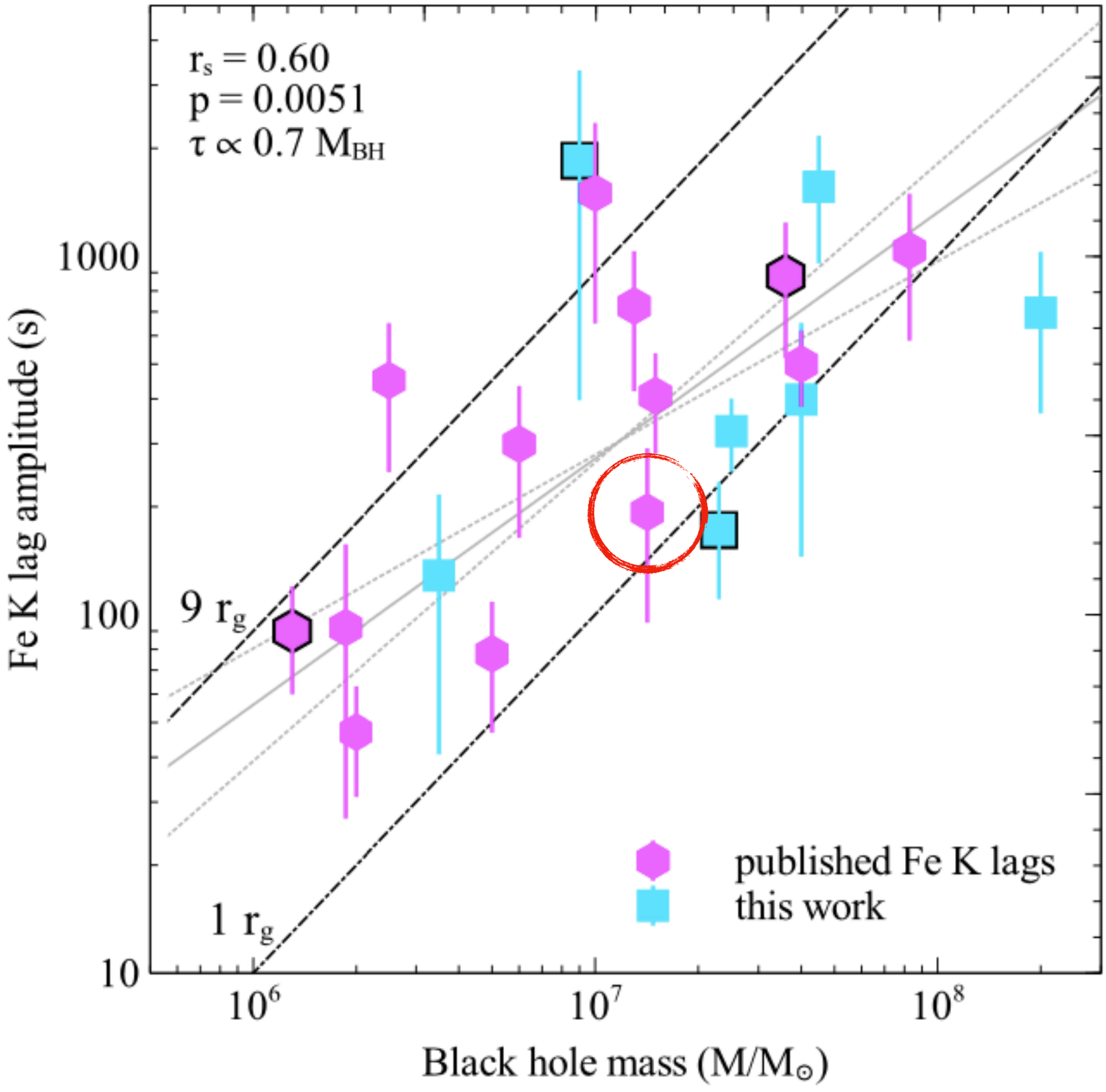


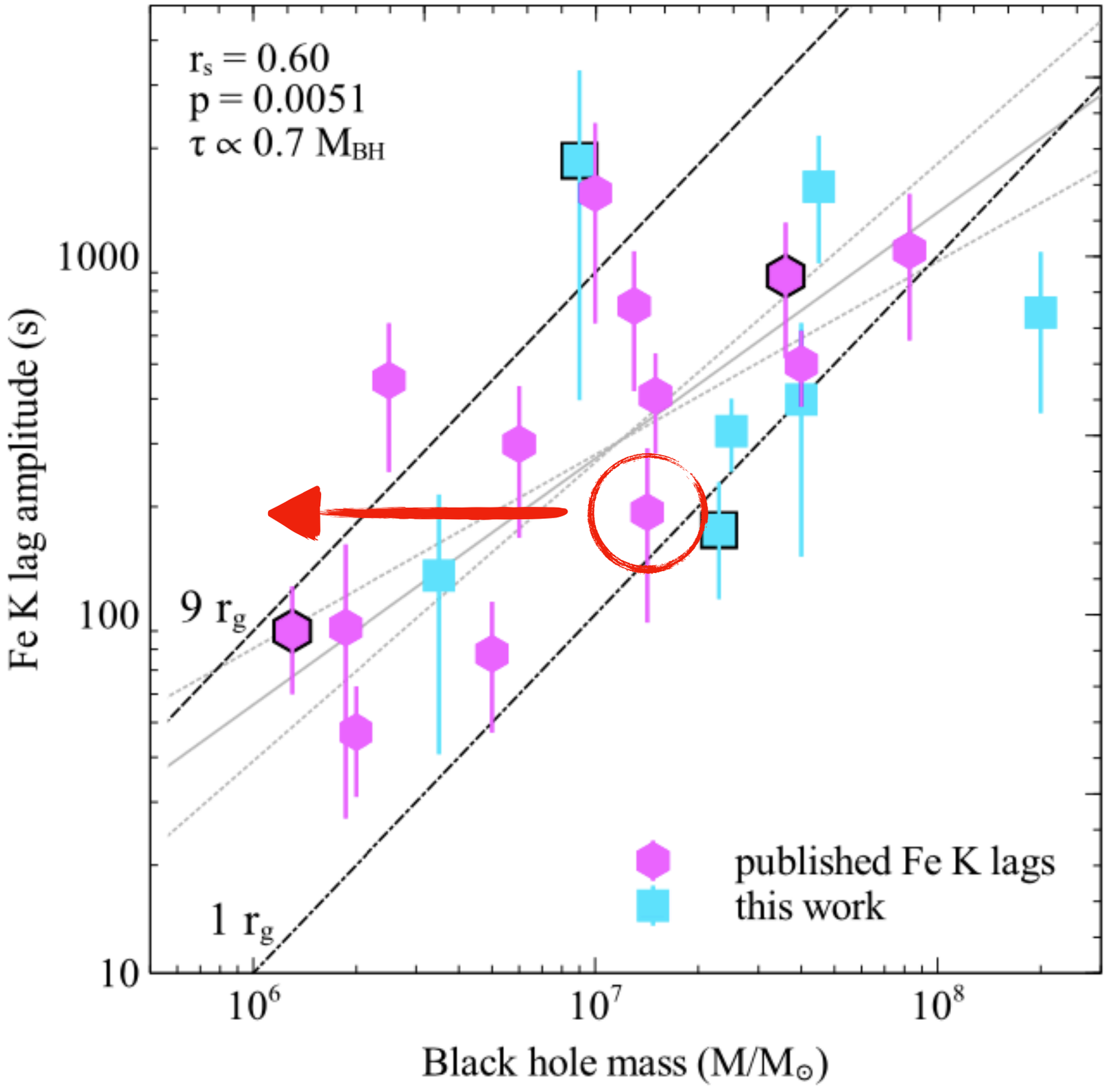


Mrk 335

Contour plot between BH mass and height of the lamppost

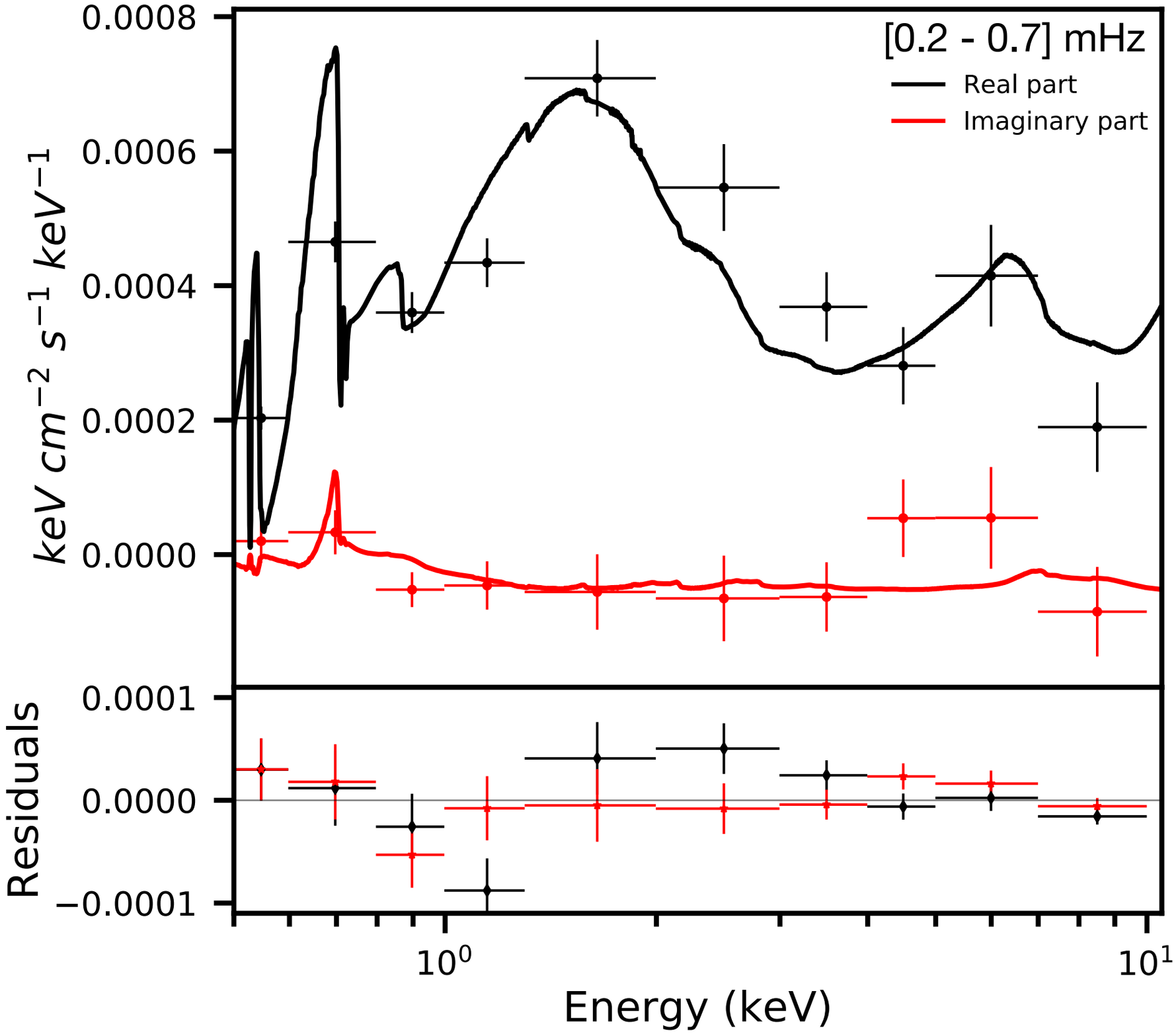


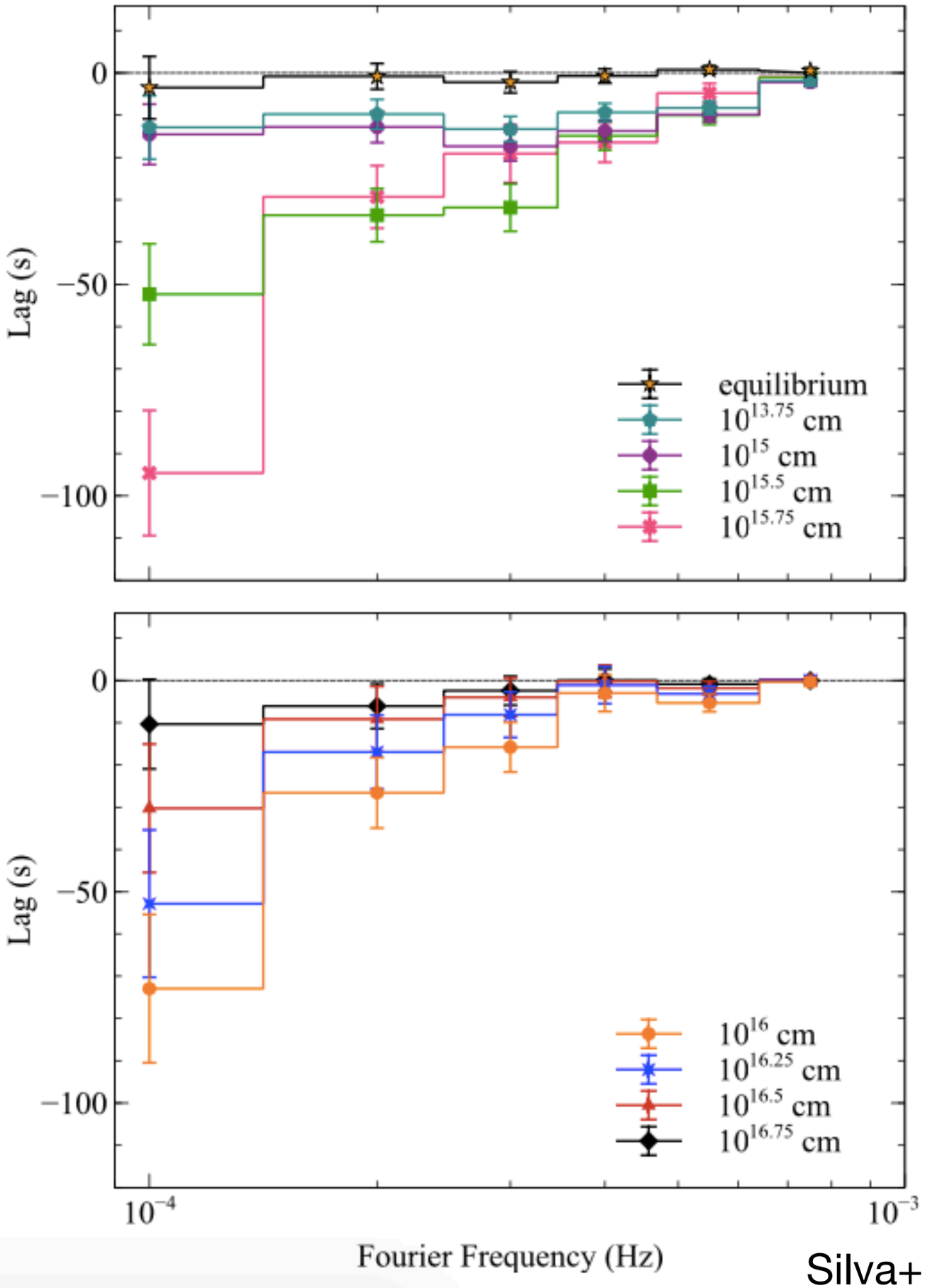

$r_s = 0.60$
$p = 0.0051$
$\tau \propto 0.7\ M_{BH}$
1000
100
10
Fe K lag amplitude (s)
9 r_g
1 r_g
published Fe K lags
this work
10^6
10^7
10^8
Black hole mass ($M/M_\odot$)


$r_s = 0.60$
$p = 0.0051$
$\tau \propto 0.7\ M_{BH}$
1000
100
10
Fe K lag amplitude (s)
9 r_g
1 r_g
published Fe K lags
this work
10^6
10^7
10^8
Black hole mass ($M/M_\odot$)

Mrk 335

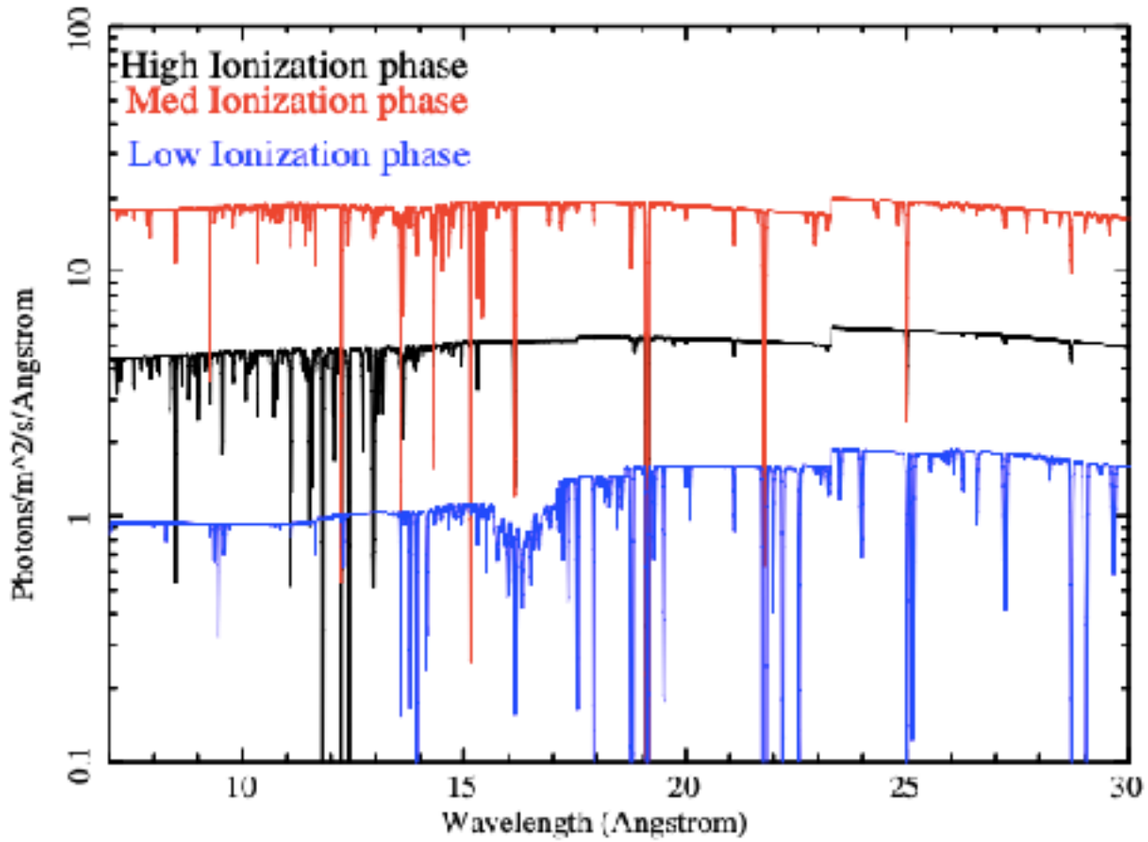
Fitting the complex cross-spectrum in the reverberation lag frequency





Silva+ 2016

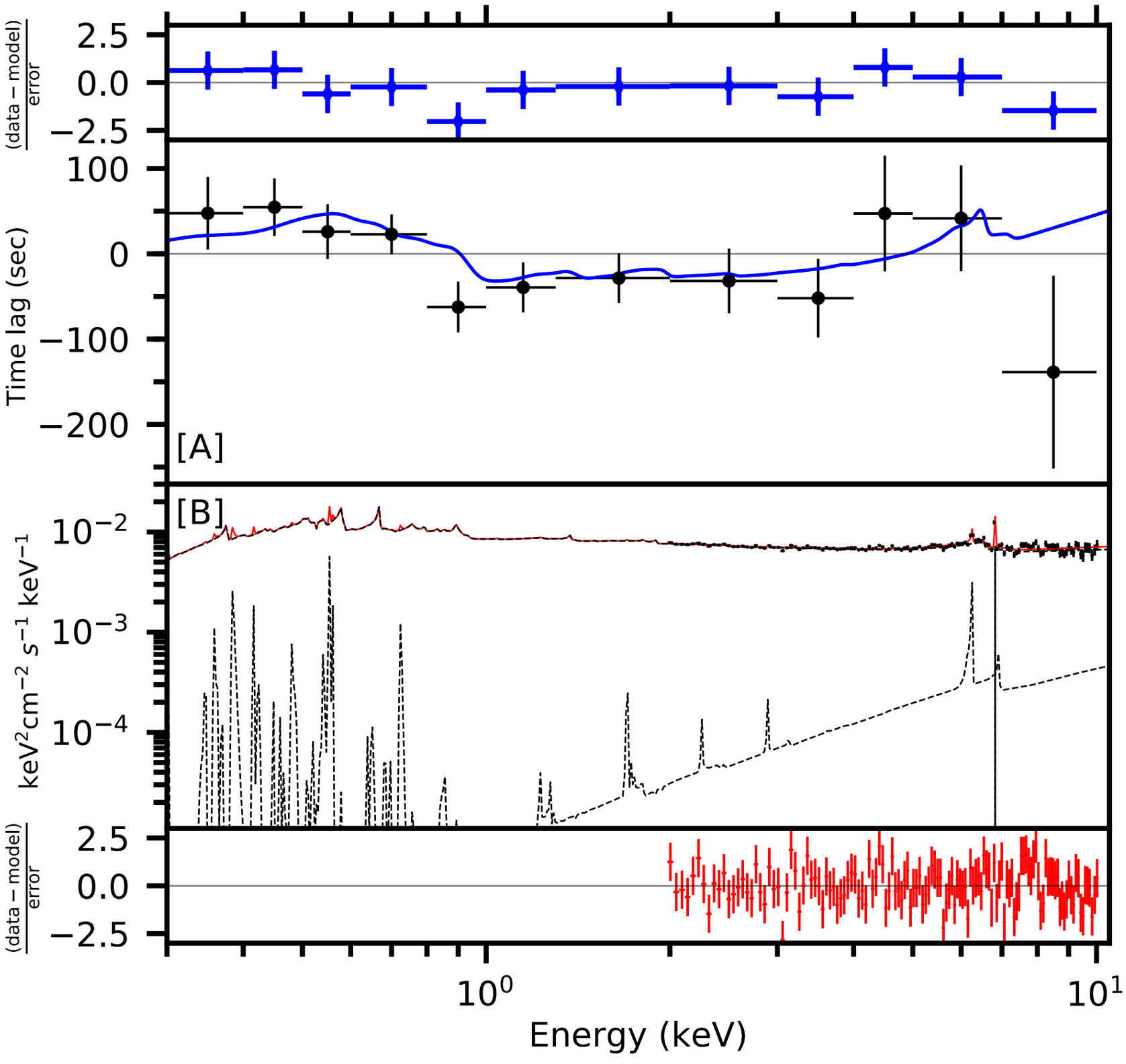
Three warm absorption layers detected in Mrk 335 in this obs



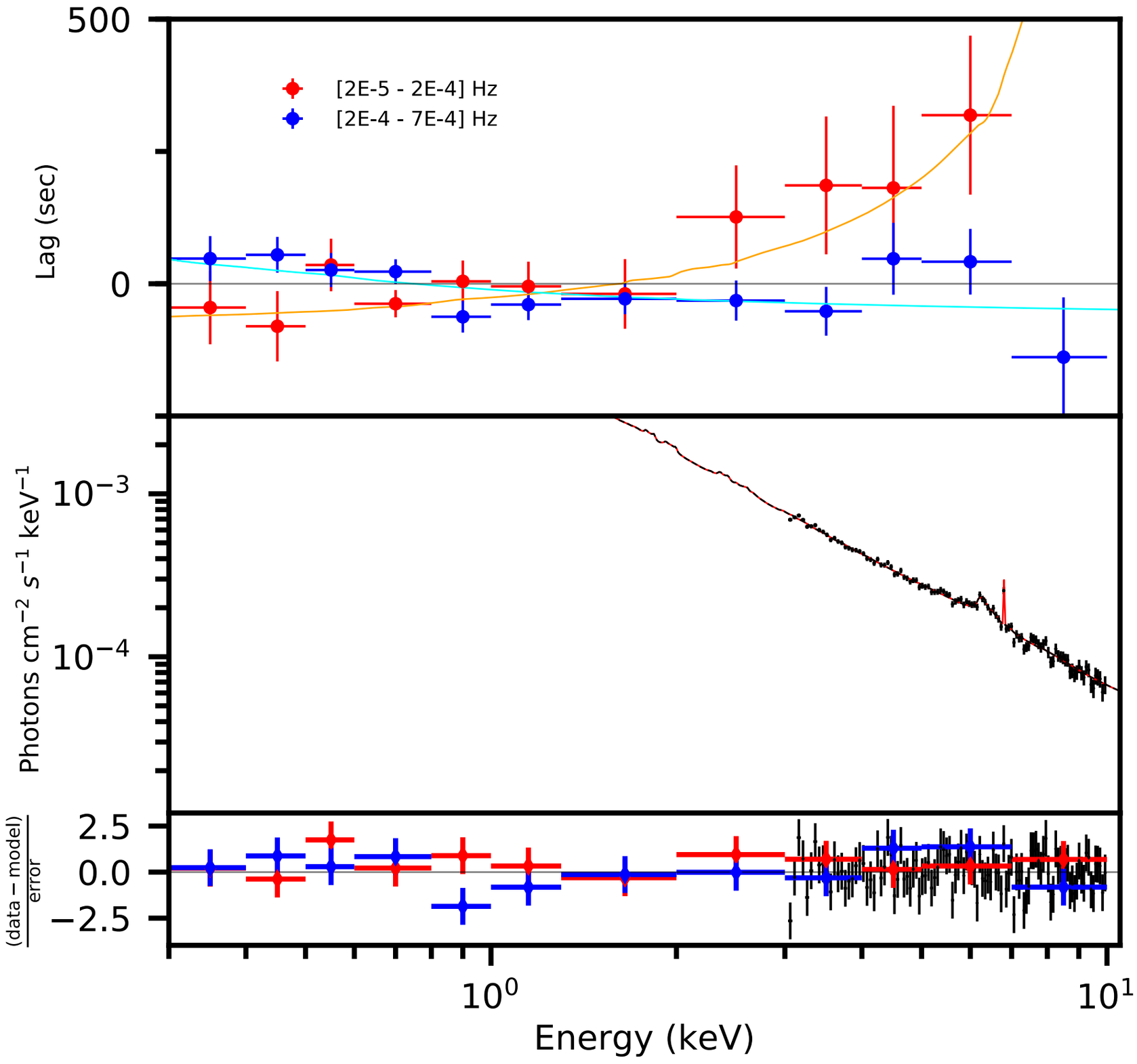
Longinotti+ 2013

Mrk 335

Fit to time averaged spectrum and reverberation lag spectrum



Mrk 335



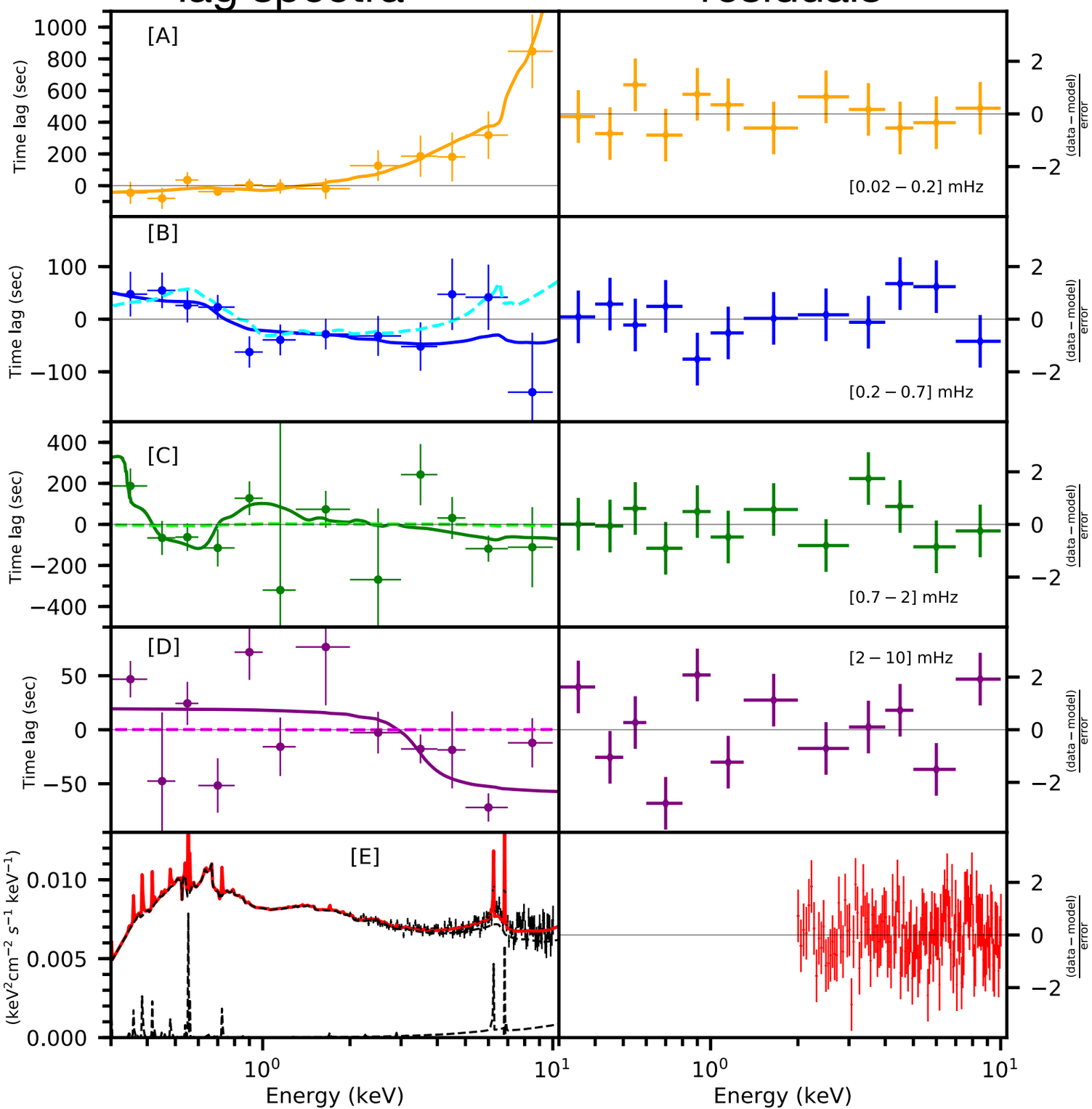
Hard lags

Soft lags

Time averaged spectrum

Mrk 335

Fit to the time averaged spectrum and the lag spectra at multiple frequencies simultaneously



Hard lag frequency range [0.02 - 0.2 mHz]

Soft lag frequency range [0.2 - 0.7 mHz]

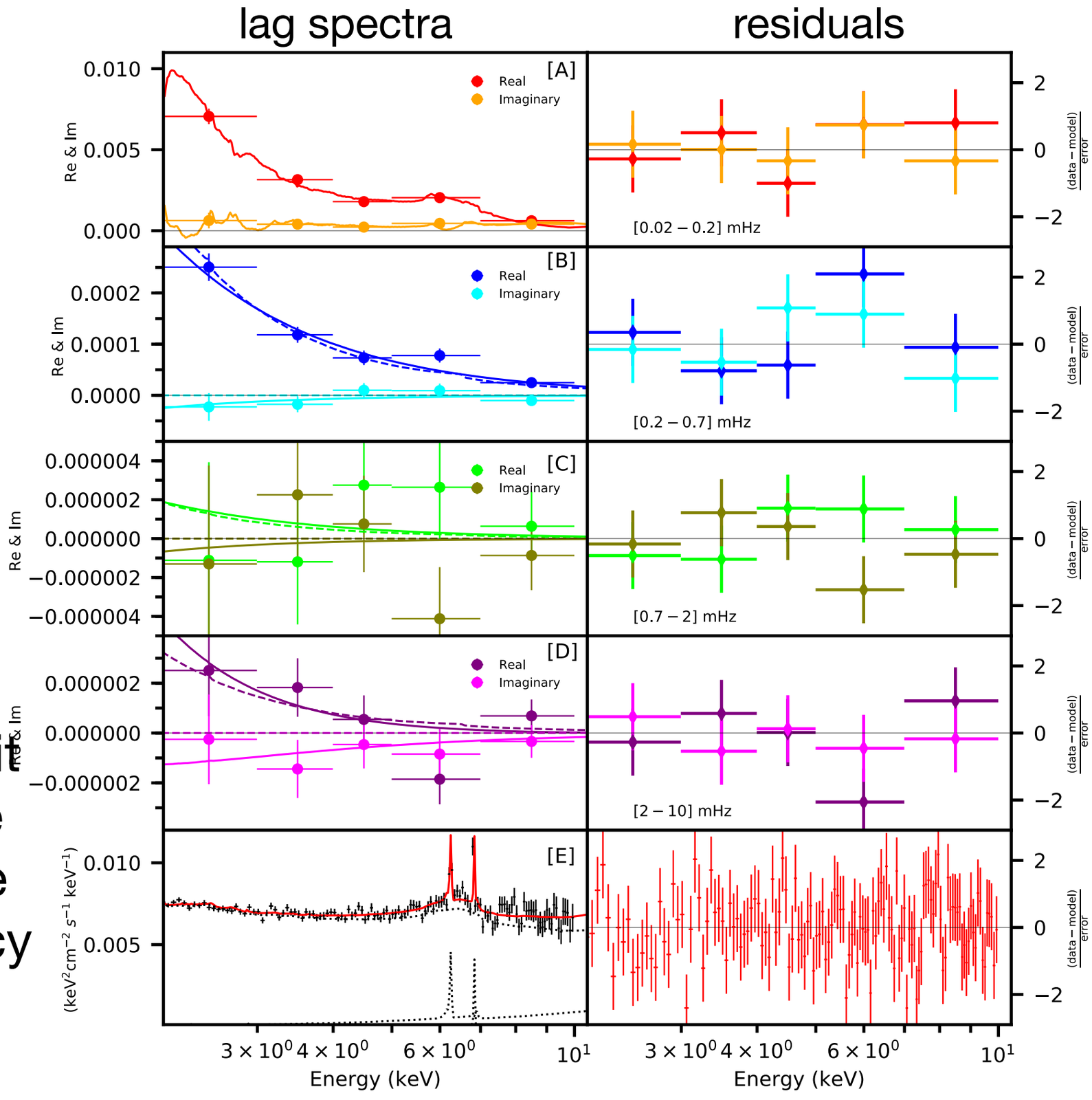
[0.7 - 2 mHz]

[2 - 10 mHz]

Time averaged spectrum

Cross-spectrum

Fit to the cross-spectra at all frequencies simultaneously



Hard lag frequency range [0.02 - 0.2 mHz]

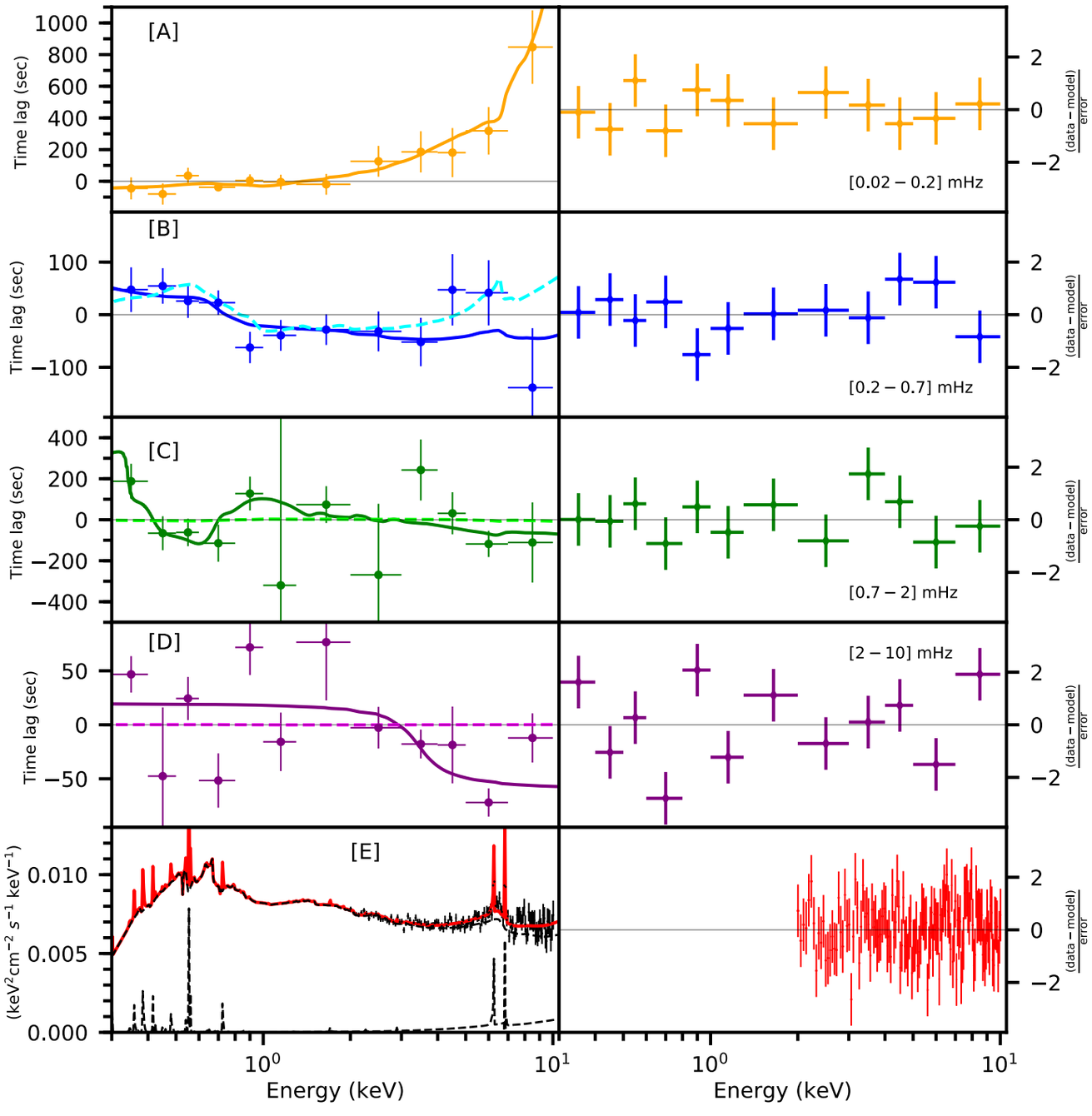
Soft lag frequency range [0.2 - 0.7 mHz]

[0.7 - 2 mHz]

[2 - 10 mHz]

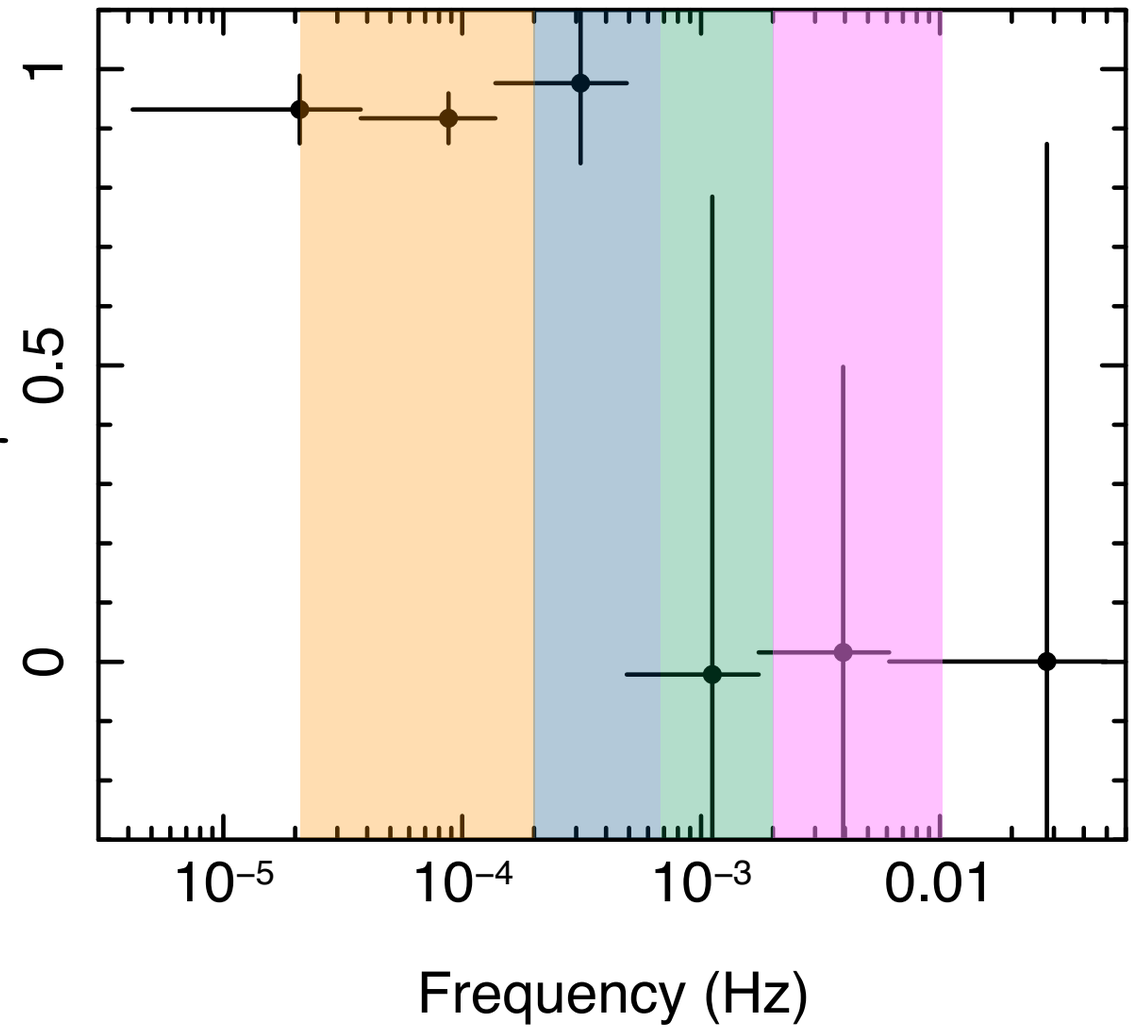
Time averaged spectrum

The model fit the iron line ONLY in the low frequency range



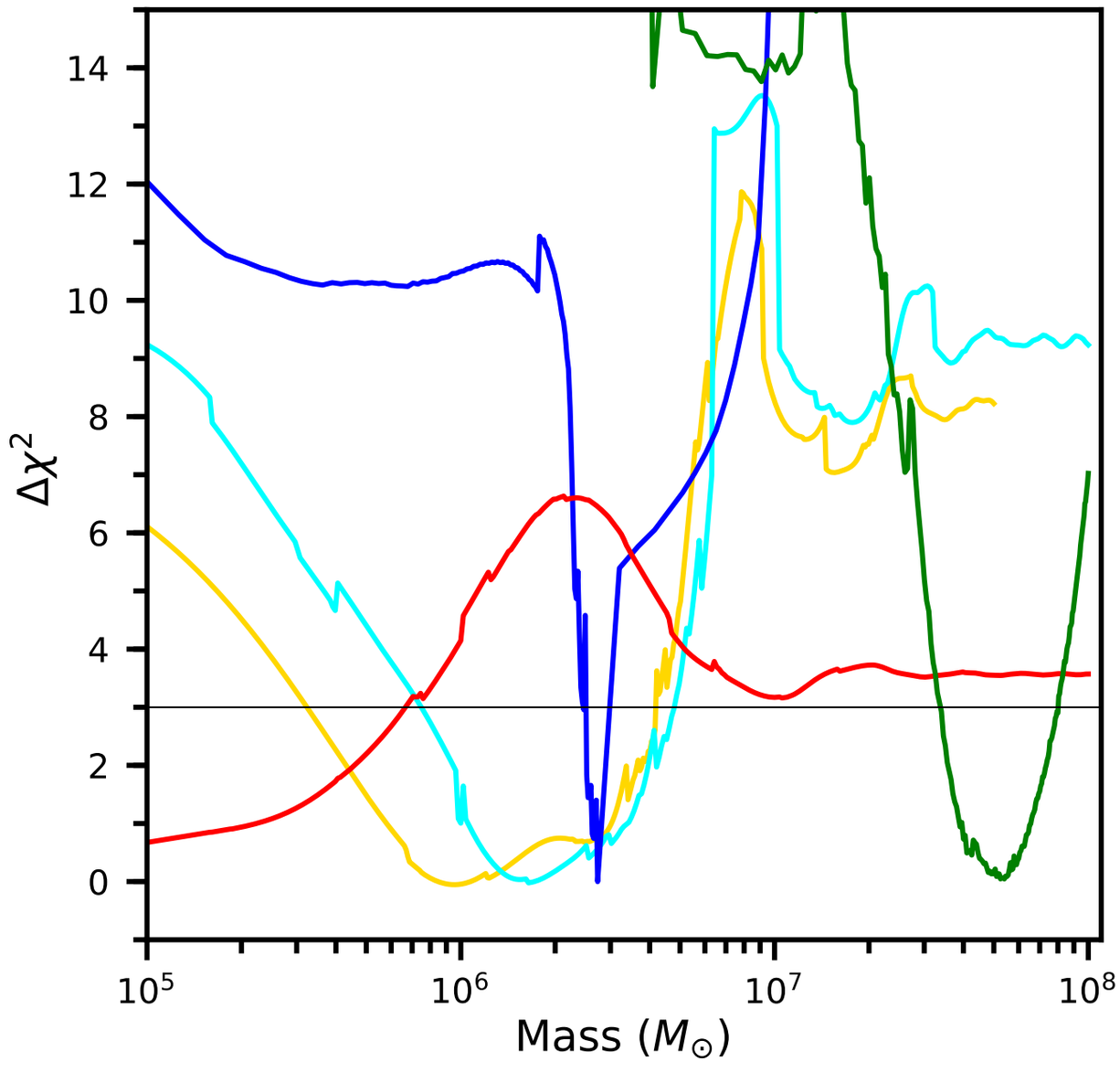
Intrinsic coherence

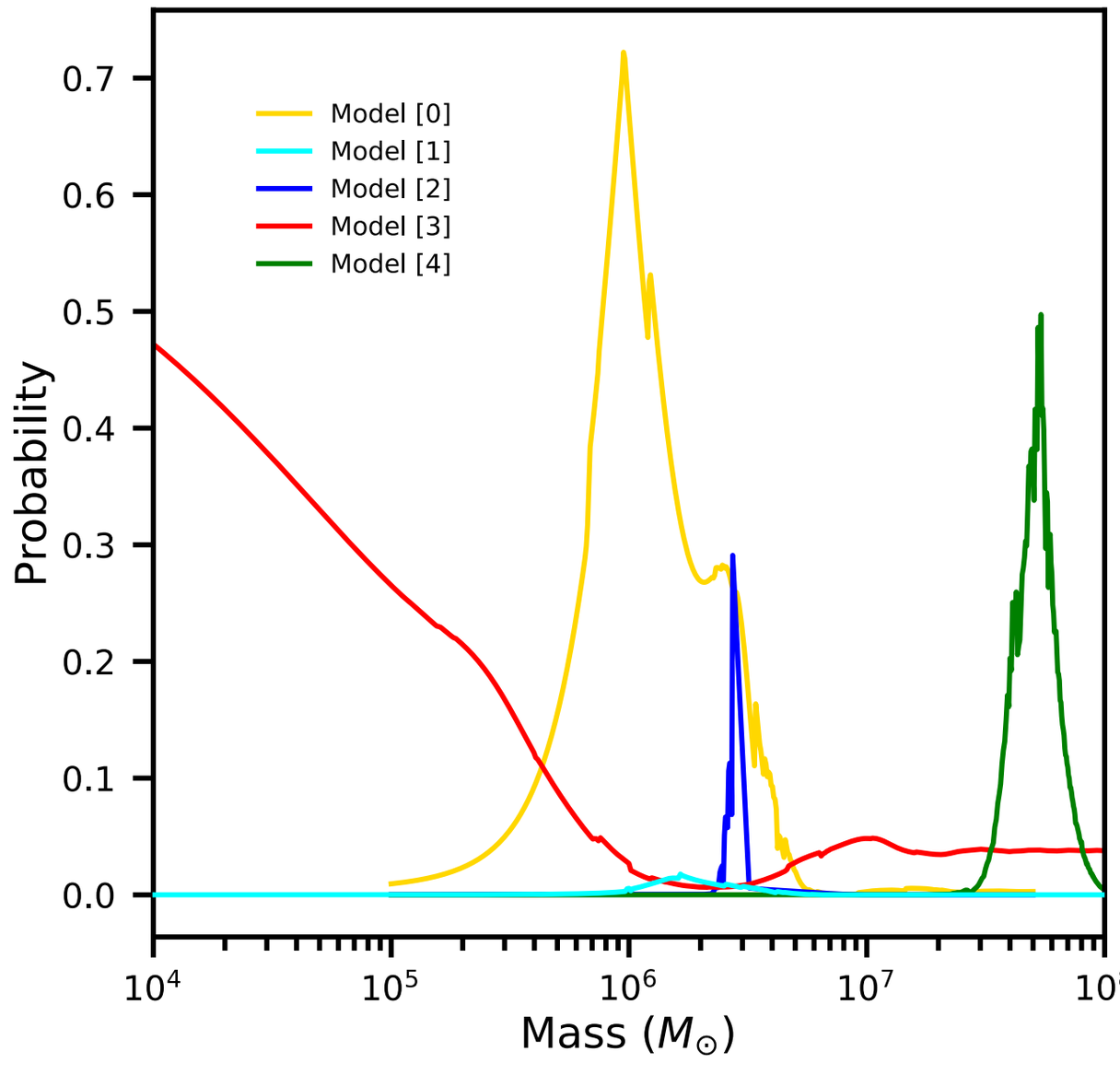
between the iron line energy band (5–7 keV) and the continuum dominated (1 – 4 keV) energy band



Mrk 335

Mass estimation





We AGREE with:

- There is a Comptonization component in the spectra
- It needs to be emitted from a hot electron plasma (corona)
- This corona evolves during the hard state
- The corona is not a layer on top of the disc

We DISAGREE with:

- Where to place the corona
- Truncation radius of the disc (model to produce the iron line)
- Lense-Thirring precession model to create QPOs

Evidences:

- The iron line shape does NOT change over the transition between states
- The QPO frequency DOES change in the transition between states

Questions:

- Where is it possible to produce the corona?
- What drives the corona evolution?
- Is that possible according to the simulations?

What do we need to test:

The transition phase

- **If the models that predict a large truncation radius for the iron line are able to predict the same shape of the iron line when the disc is not truncated.**
- **What is changing in the system to produce a variation in the QPO frequency if the disc is always at ISCO**