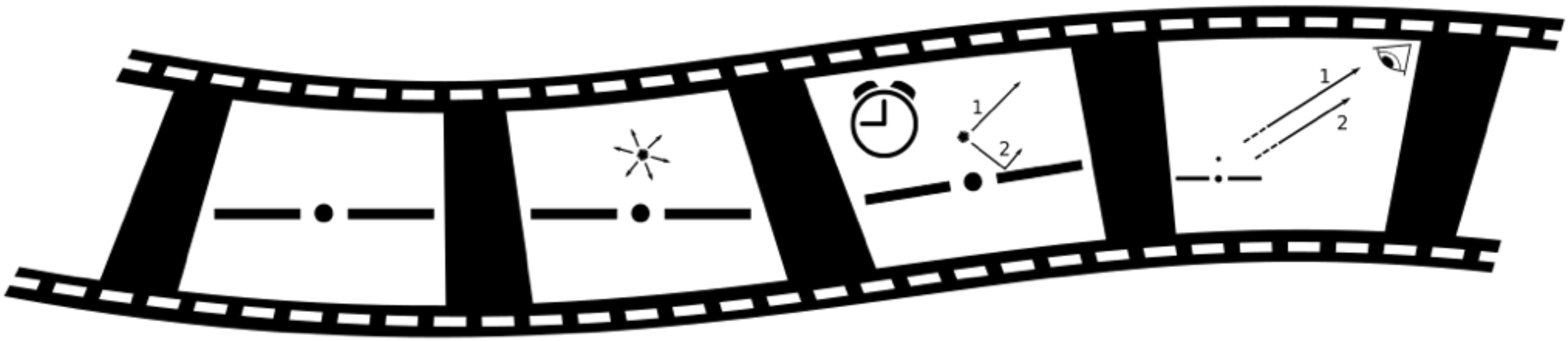
UNIVERSITY OF AMSTERDAM

ANTON PANNEKOEK INSTITUTE

The effects of spectral hardness changes on reverberation lags

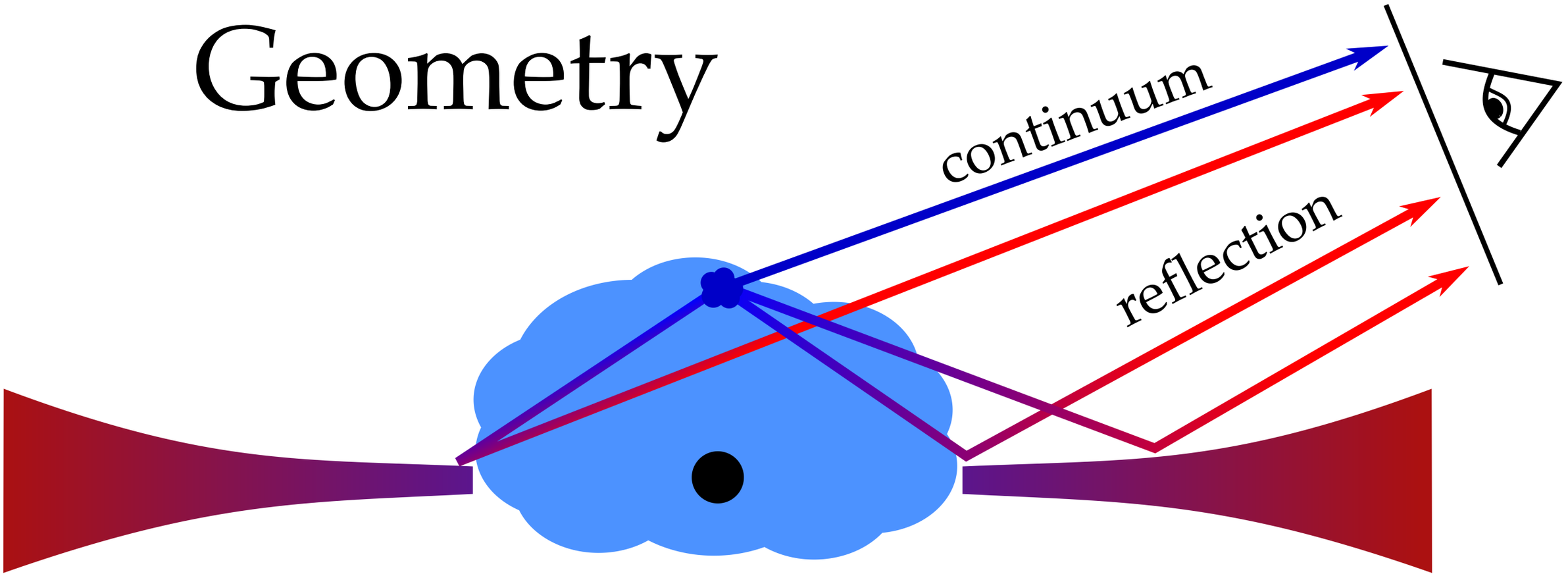
G. Mastroserio, A. Ingram, M. van der Klis

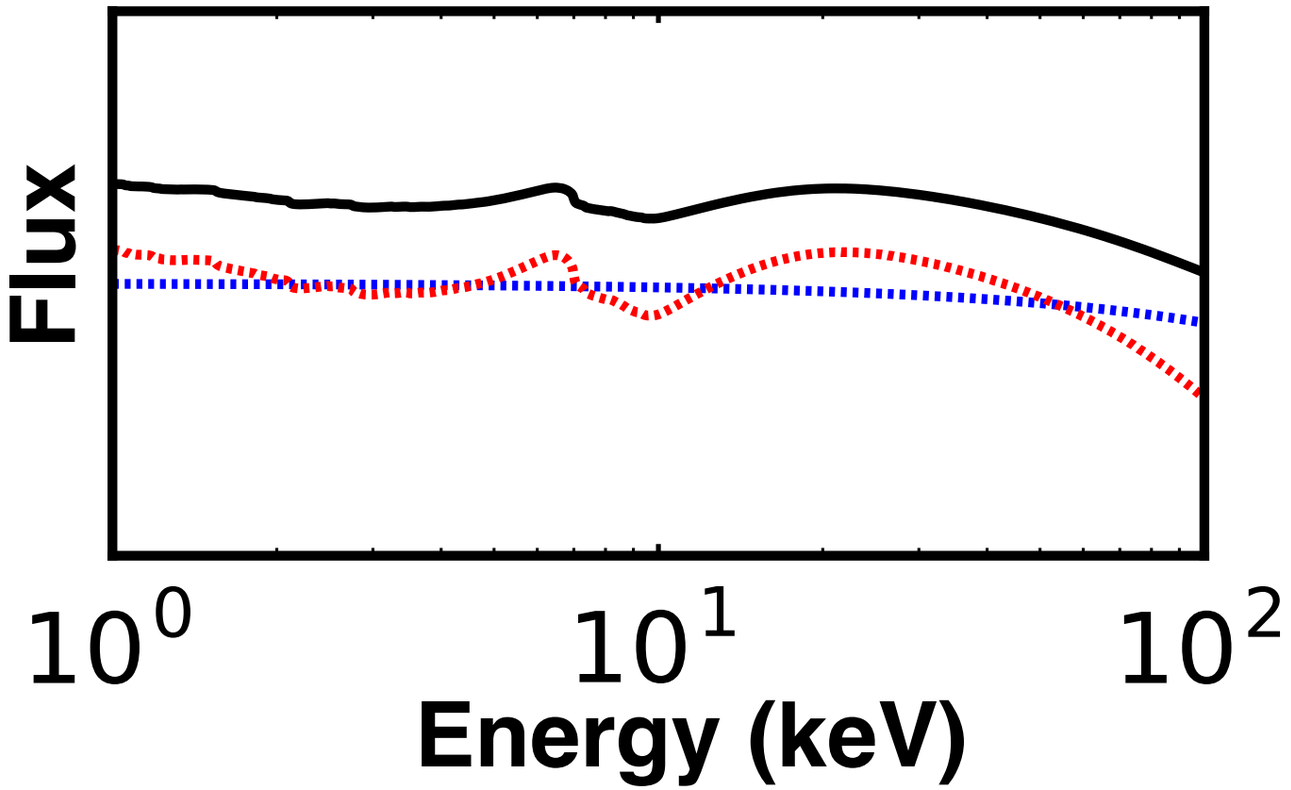


Overview

- Geometry of the systems
- Modelling the lag
- Reverberation with eXTP

Geometry





Inverse Compton scattering

Reflection

Continuum + Reflection

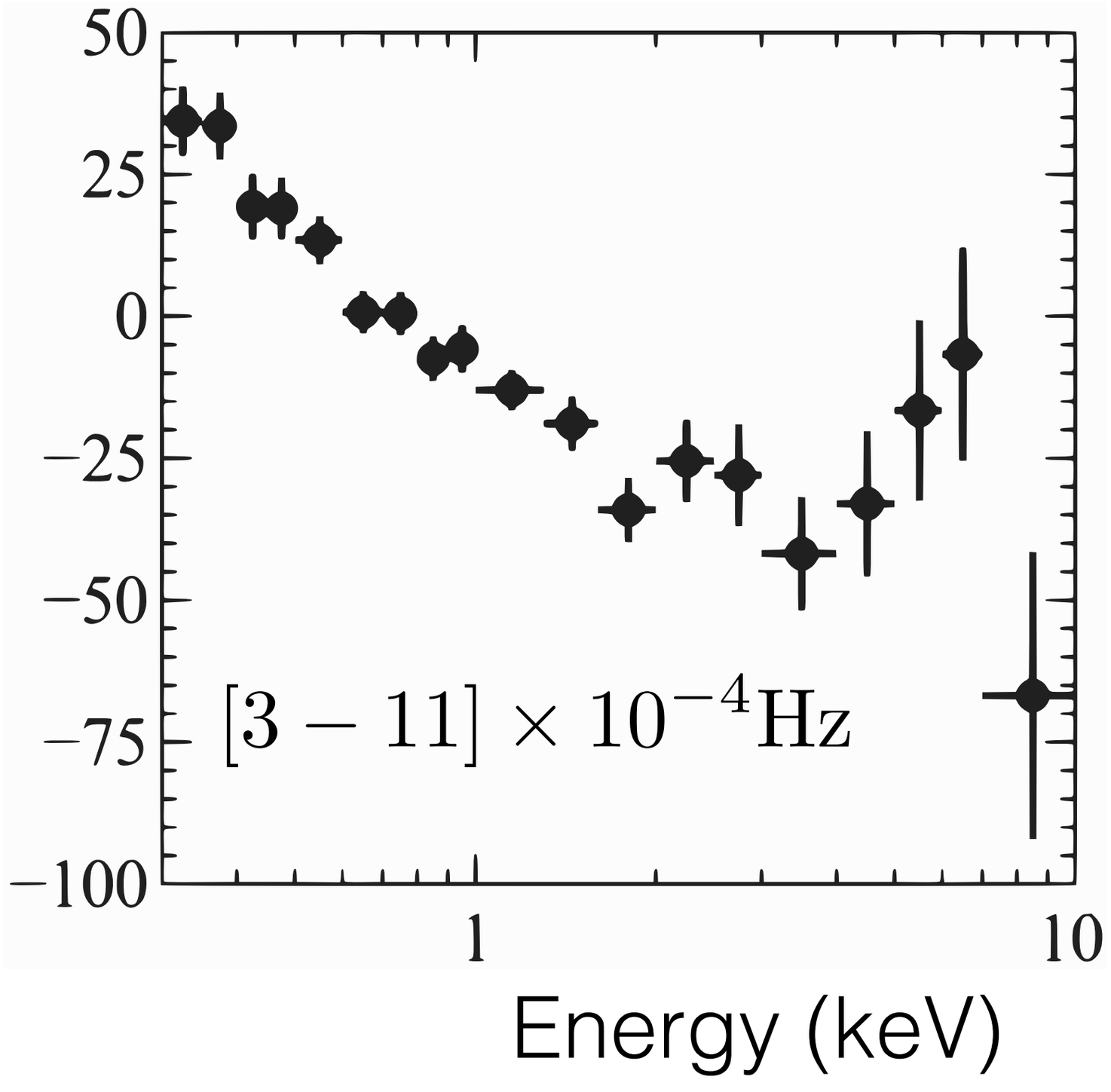
Lag-Energy Spectrum

AGN

Ark 564

$M \simeq 10^6 M_\odot$

Kara+ 2016



Lag-Energy Spectrum

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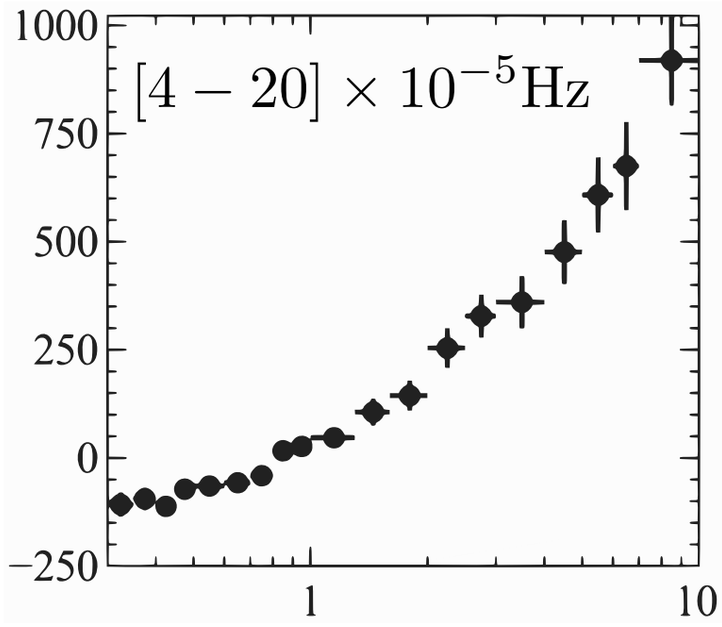

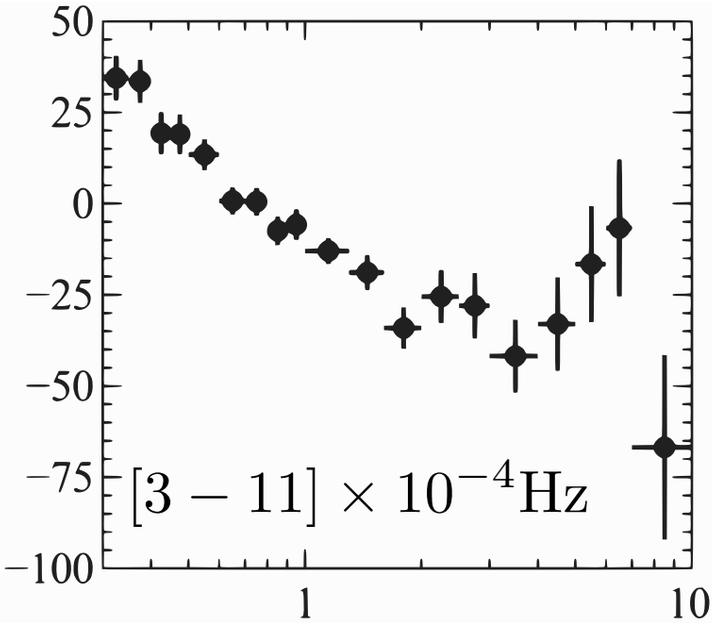

Lag-Energy Spectrum

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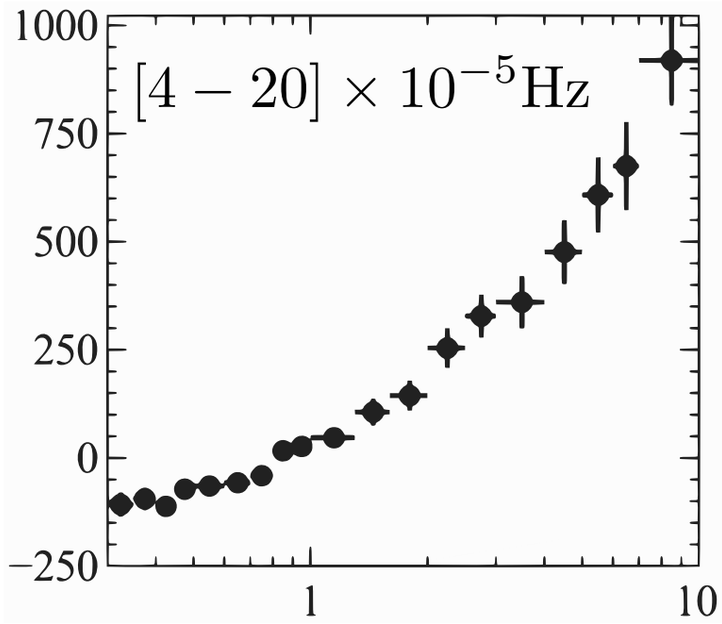
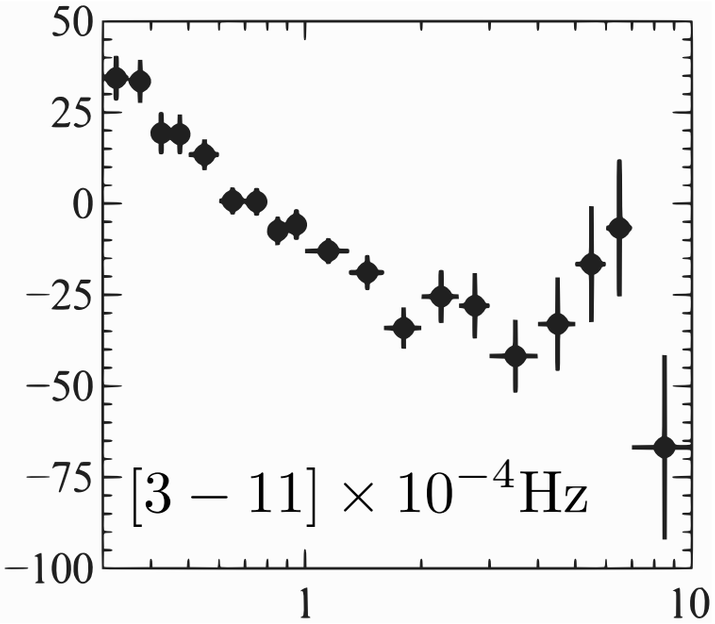


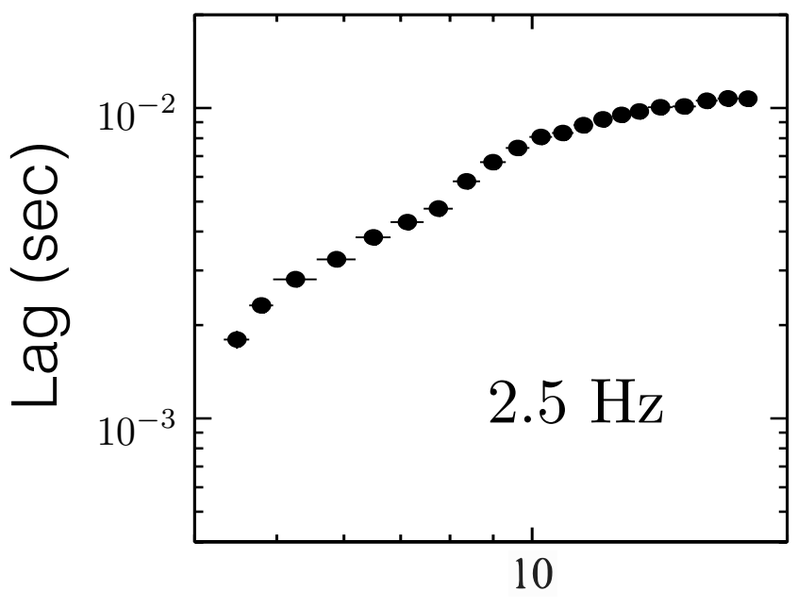


BH binaries

Cyg X-1

$M \simeq 10 M_\odot$

Kotov+ 2001



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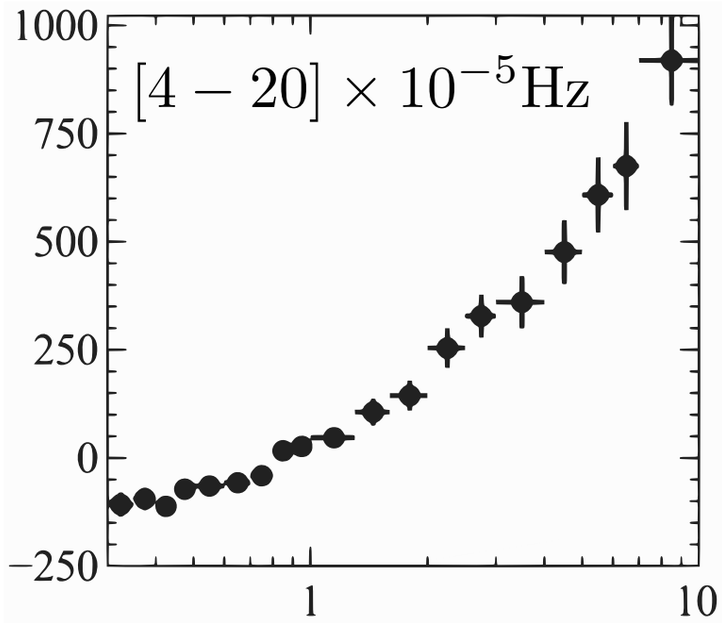

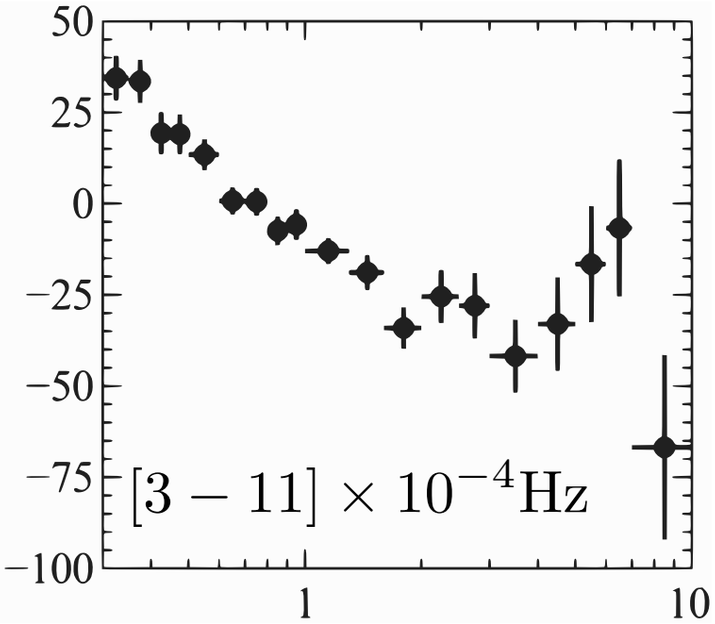

Lag (sec)

BH binaries

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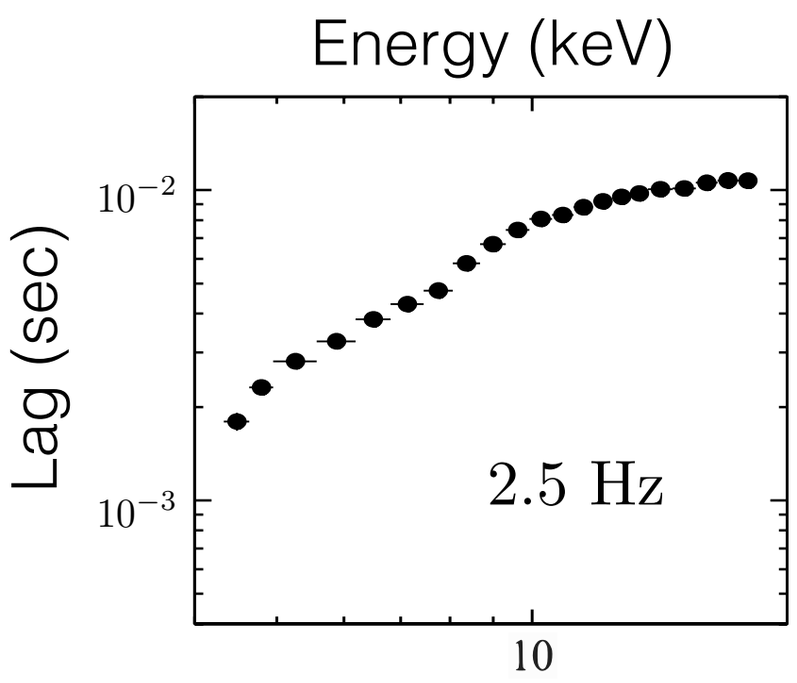

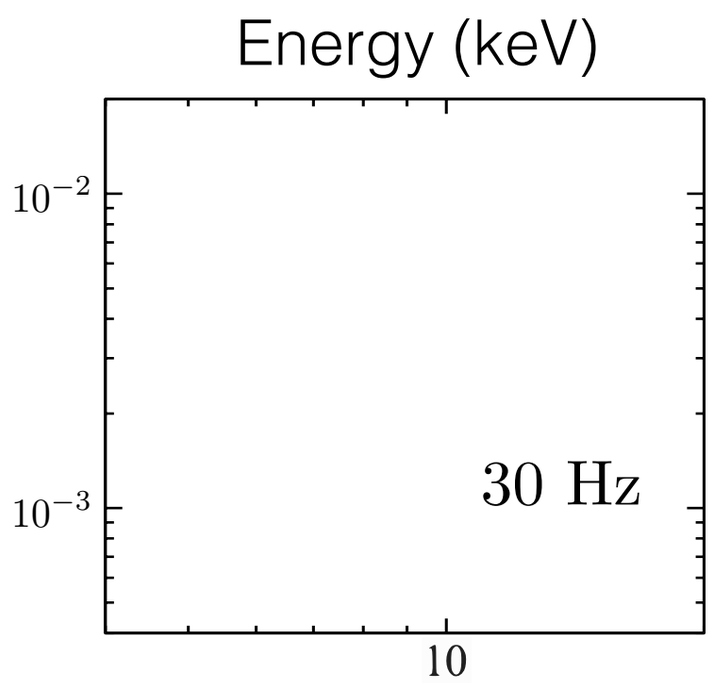

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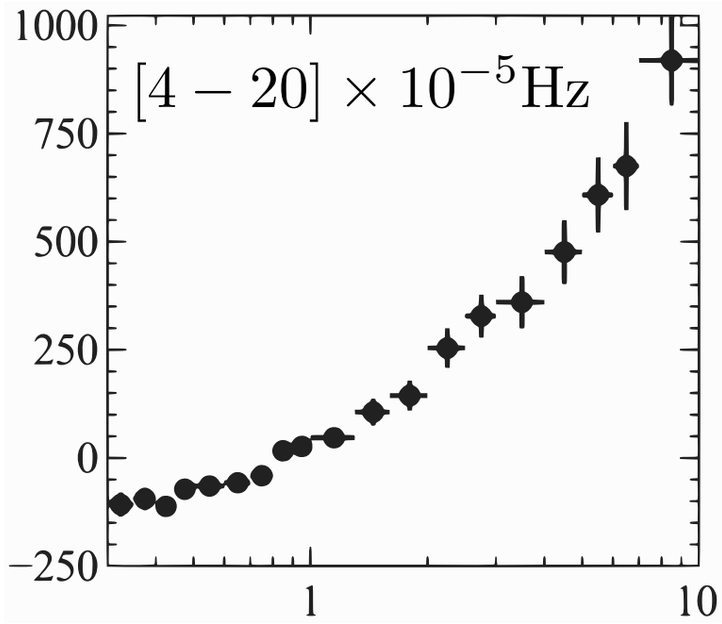

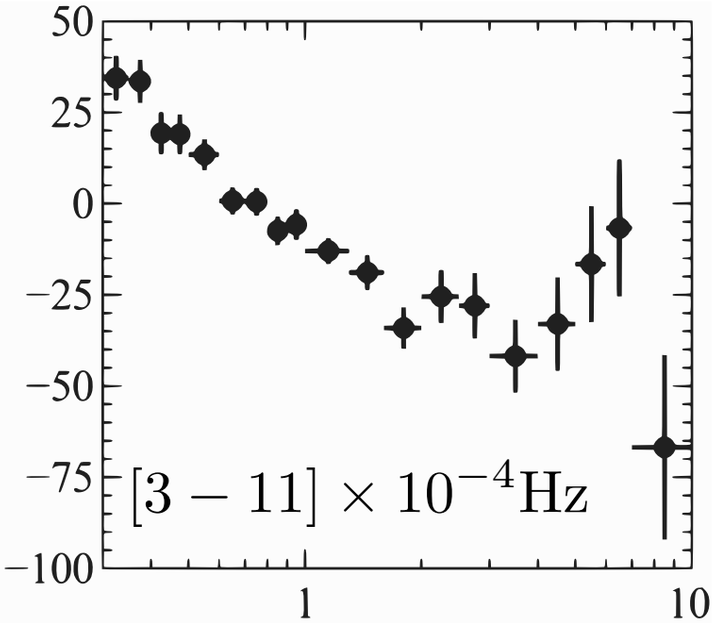

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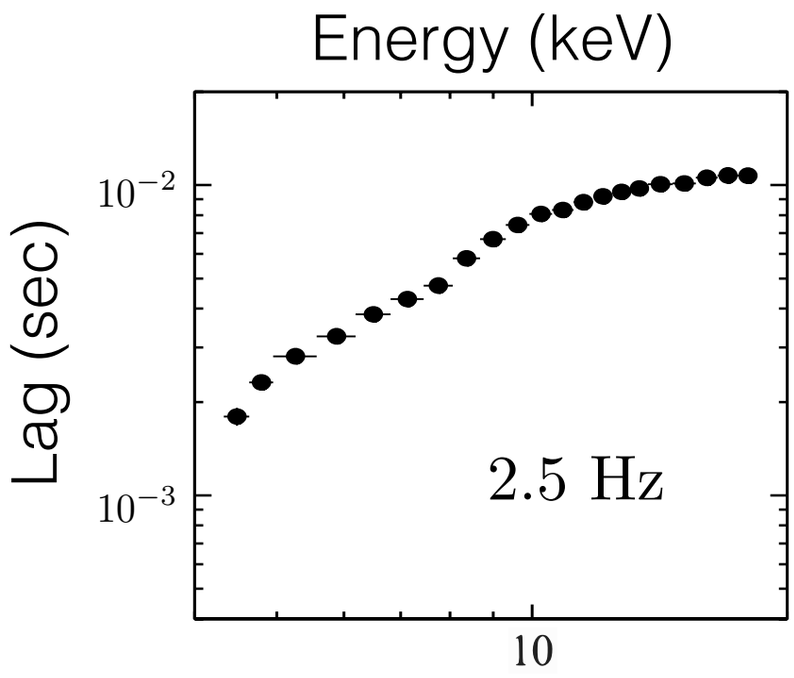
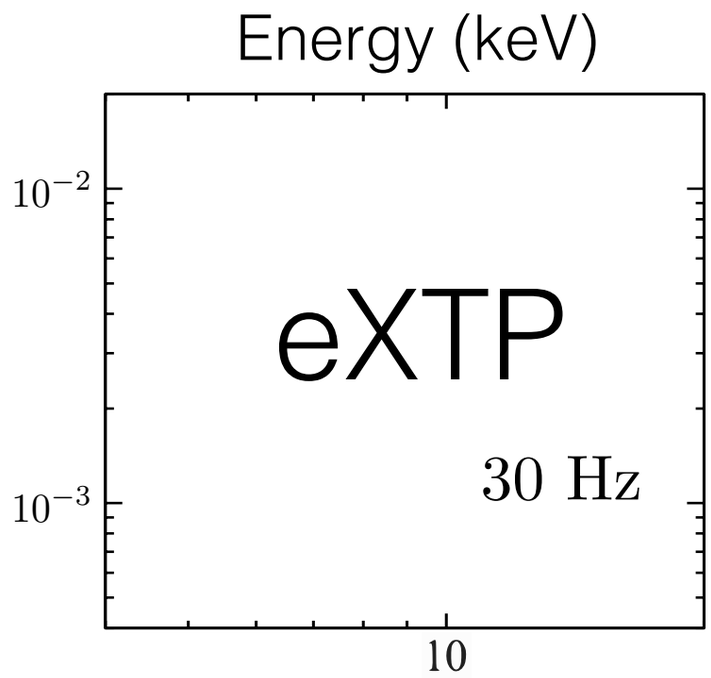




Response Function

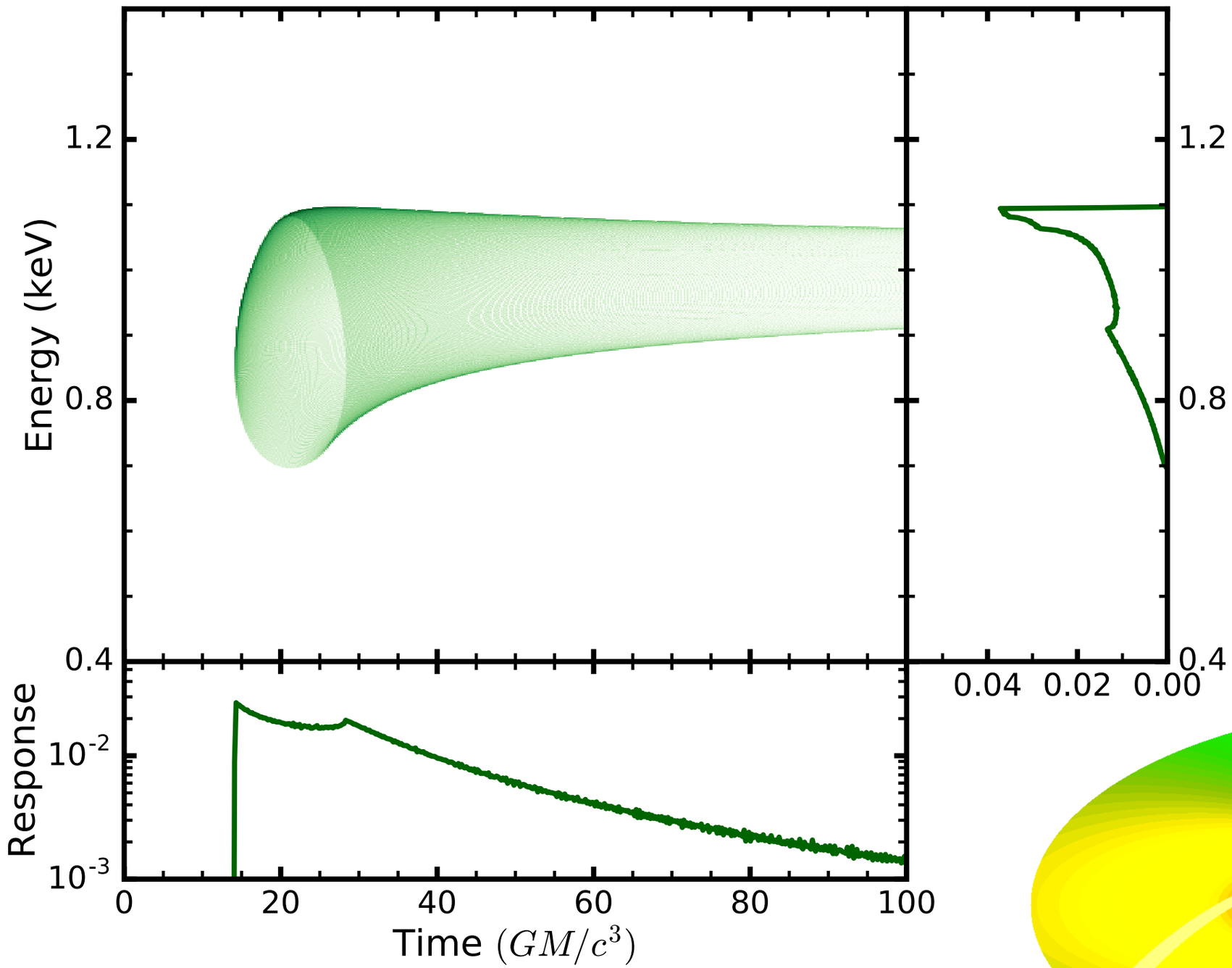
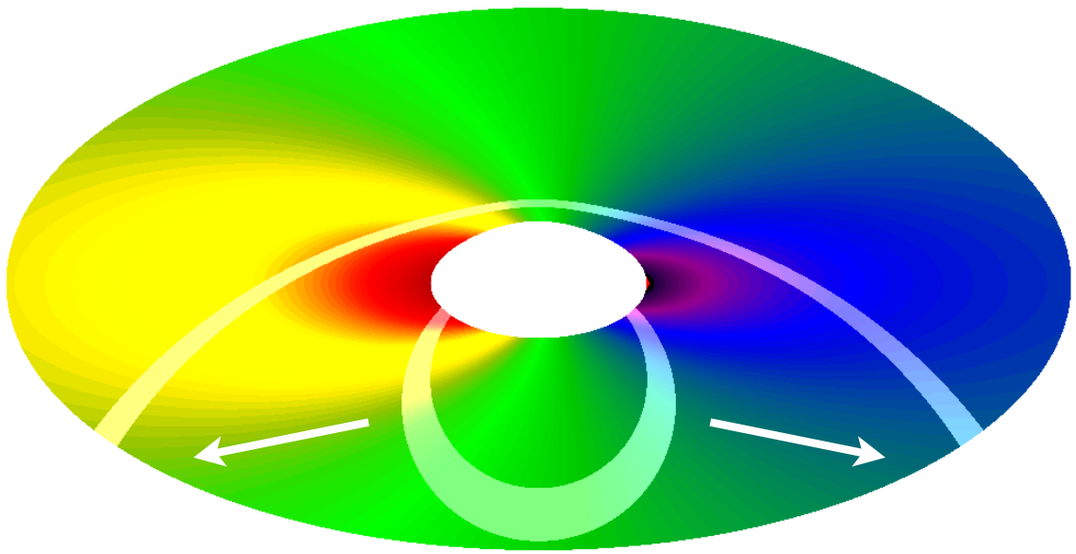
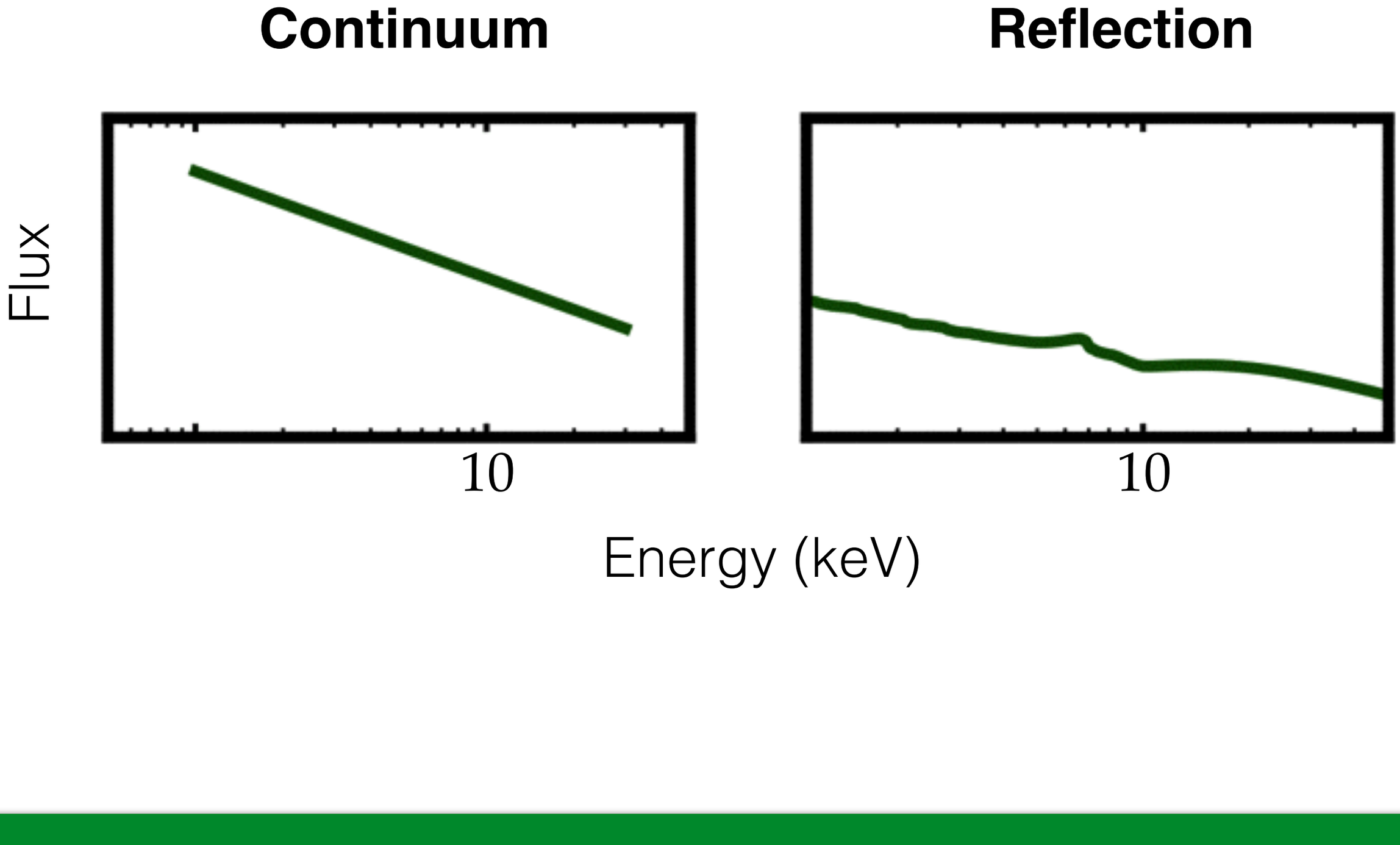


Image credit:
A. Ingram

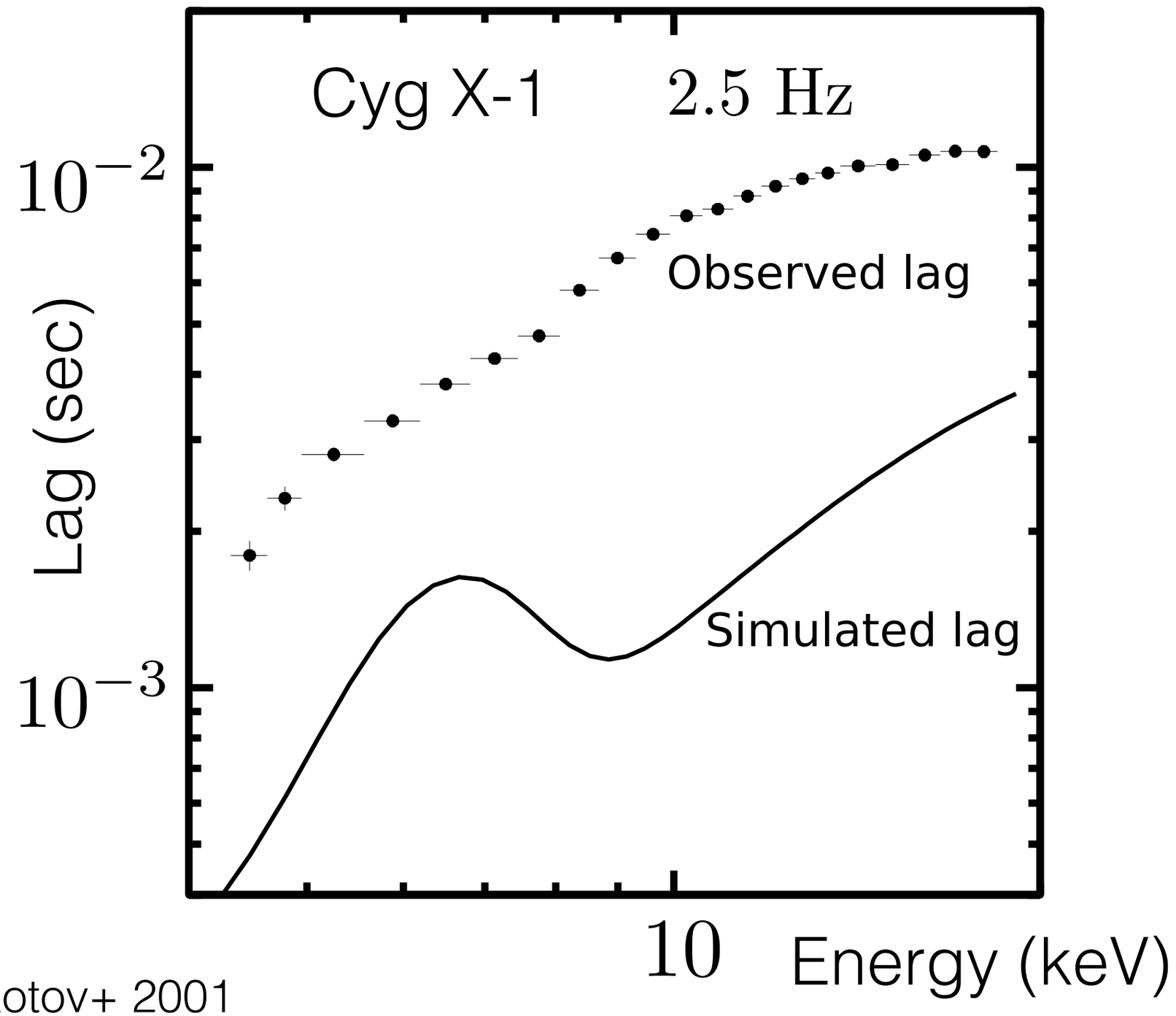


Previous models



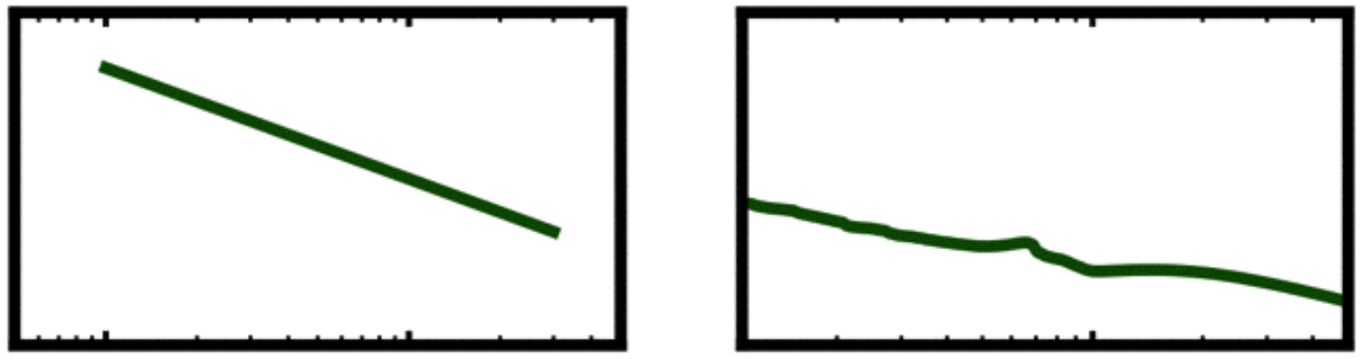
Previous models

for black hole binaries



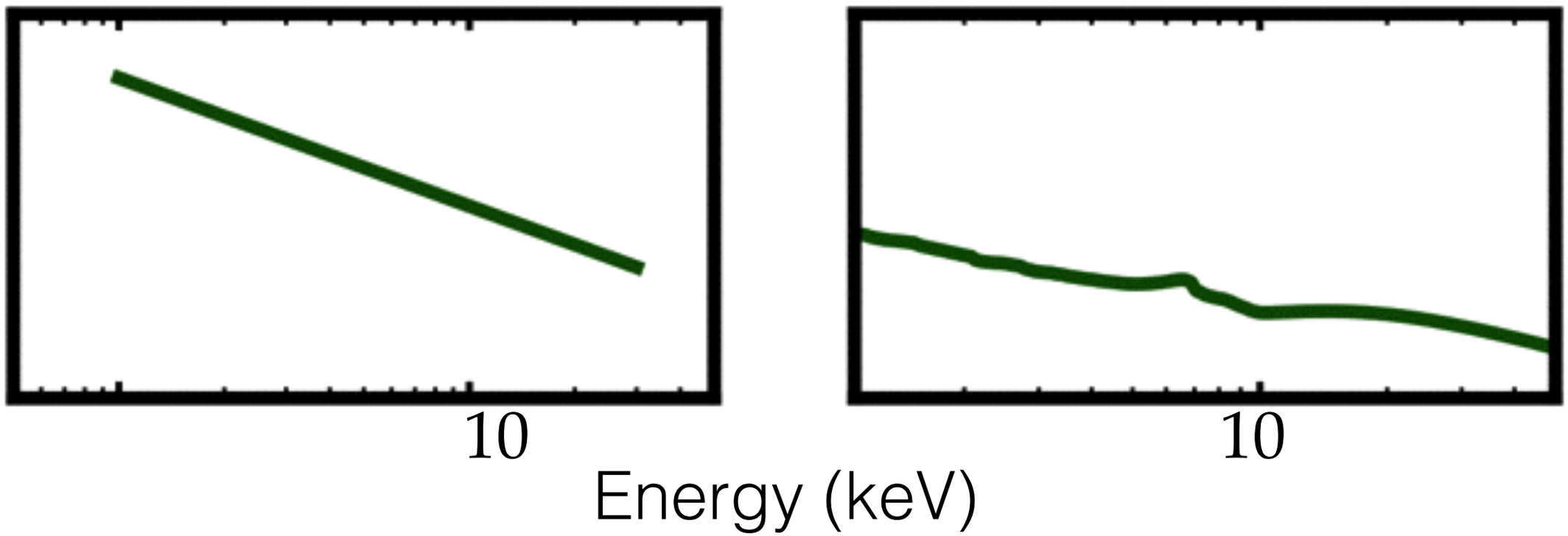
Kotov+ 2001

Spectral Hardness Changes



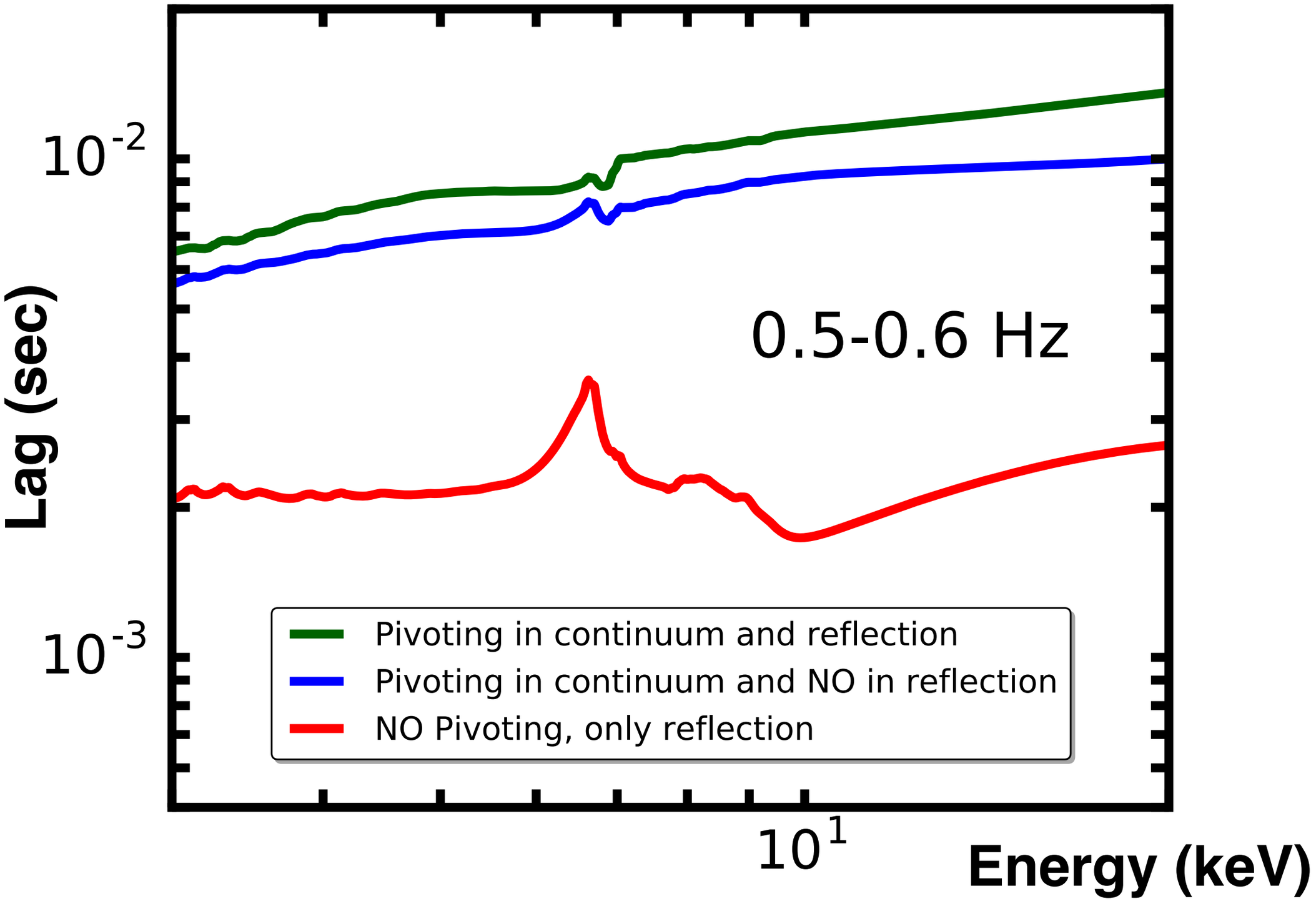
Continuum **Reflection**

PIVOTING

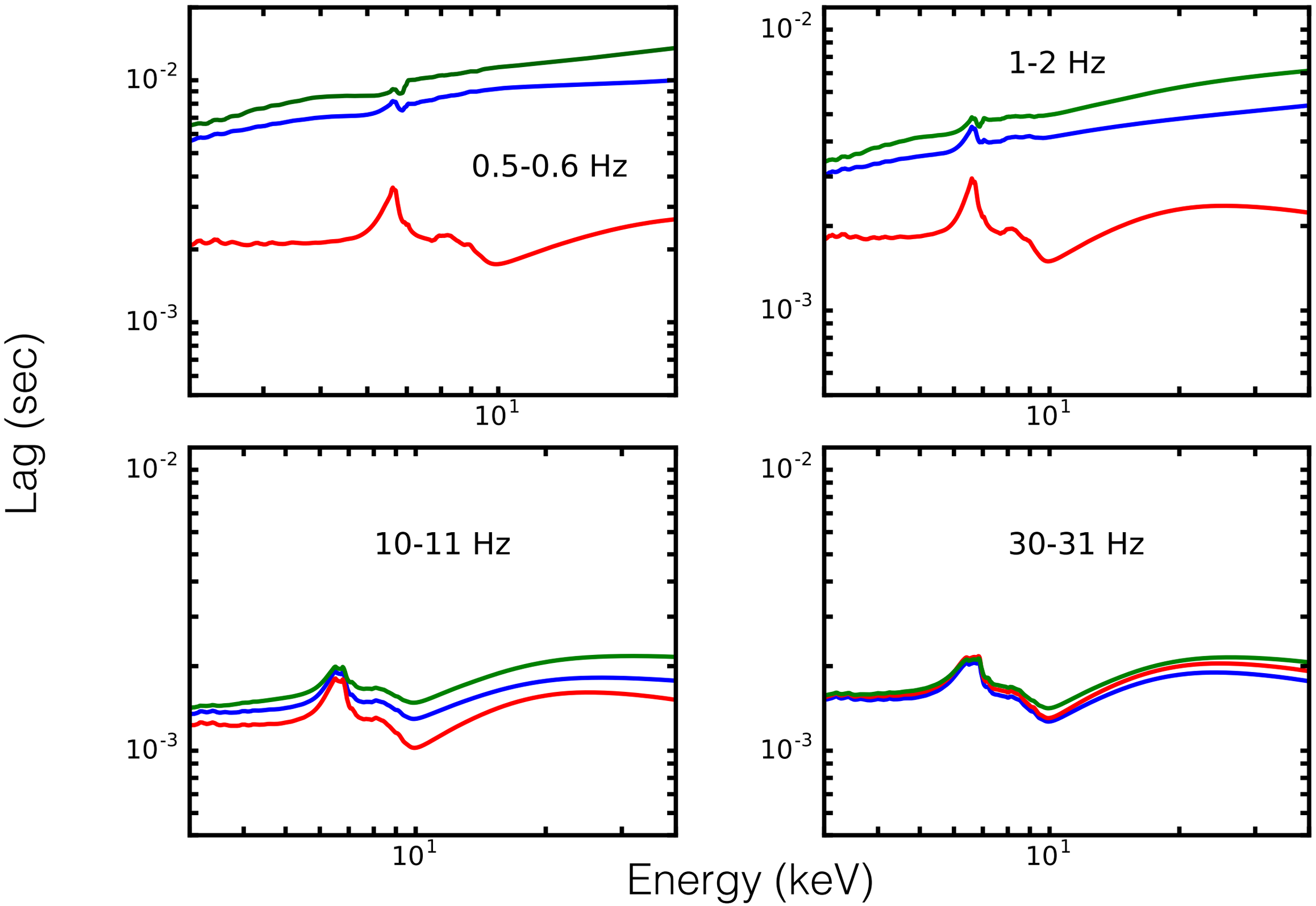


Pivoting Model

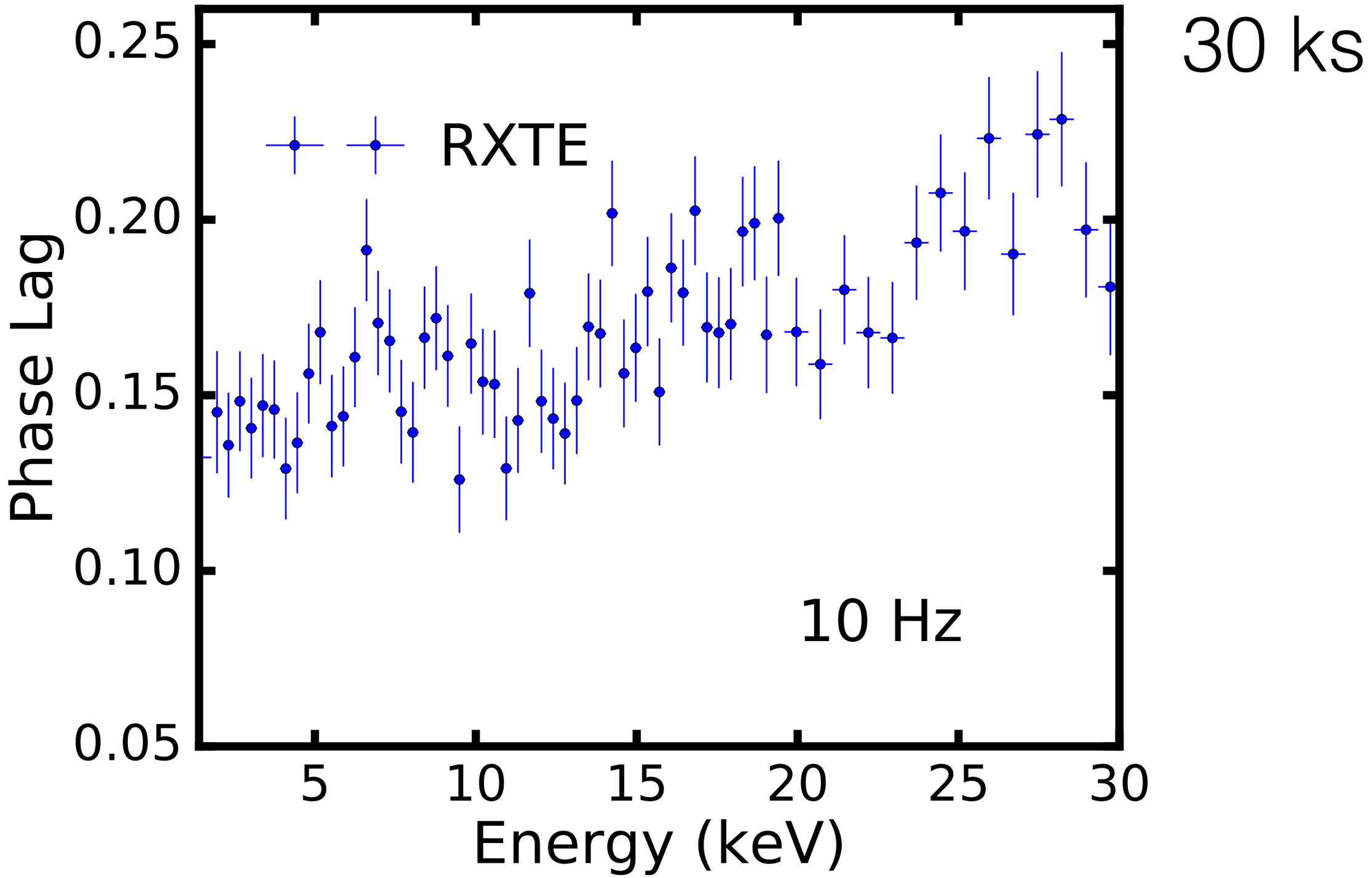
for black hole binaries



Pivoting Model



eXTP Simulations



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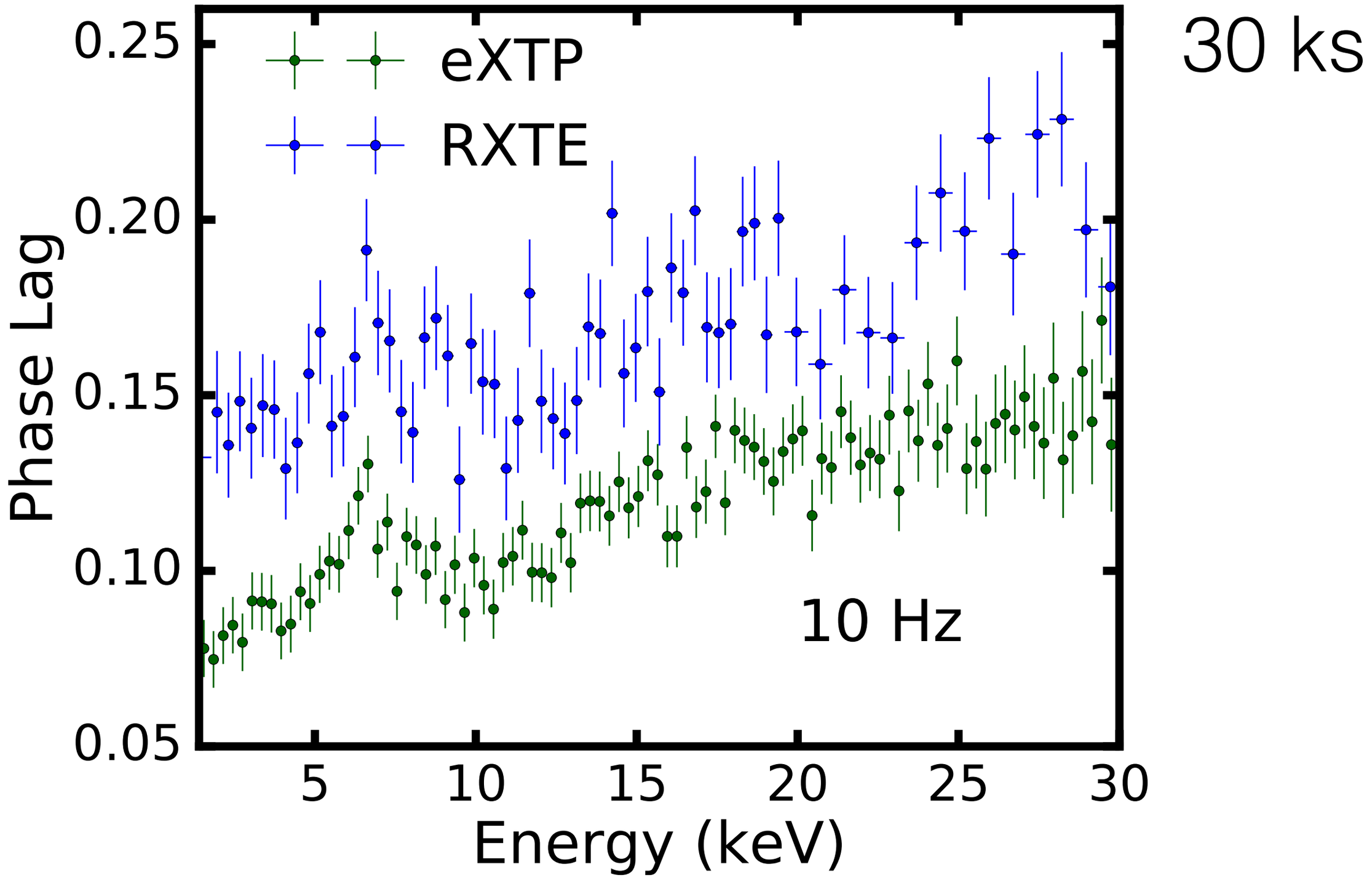

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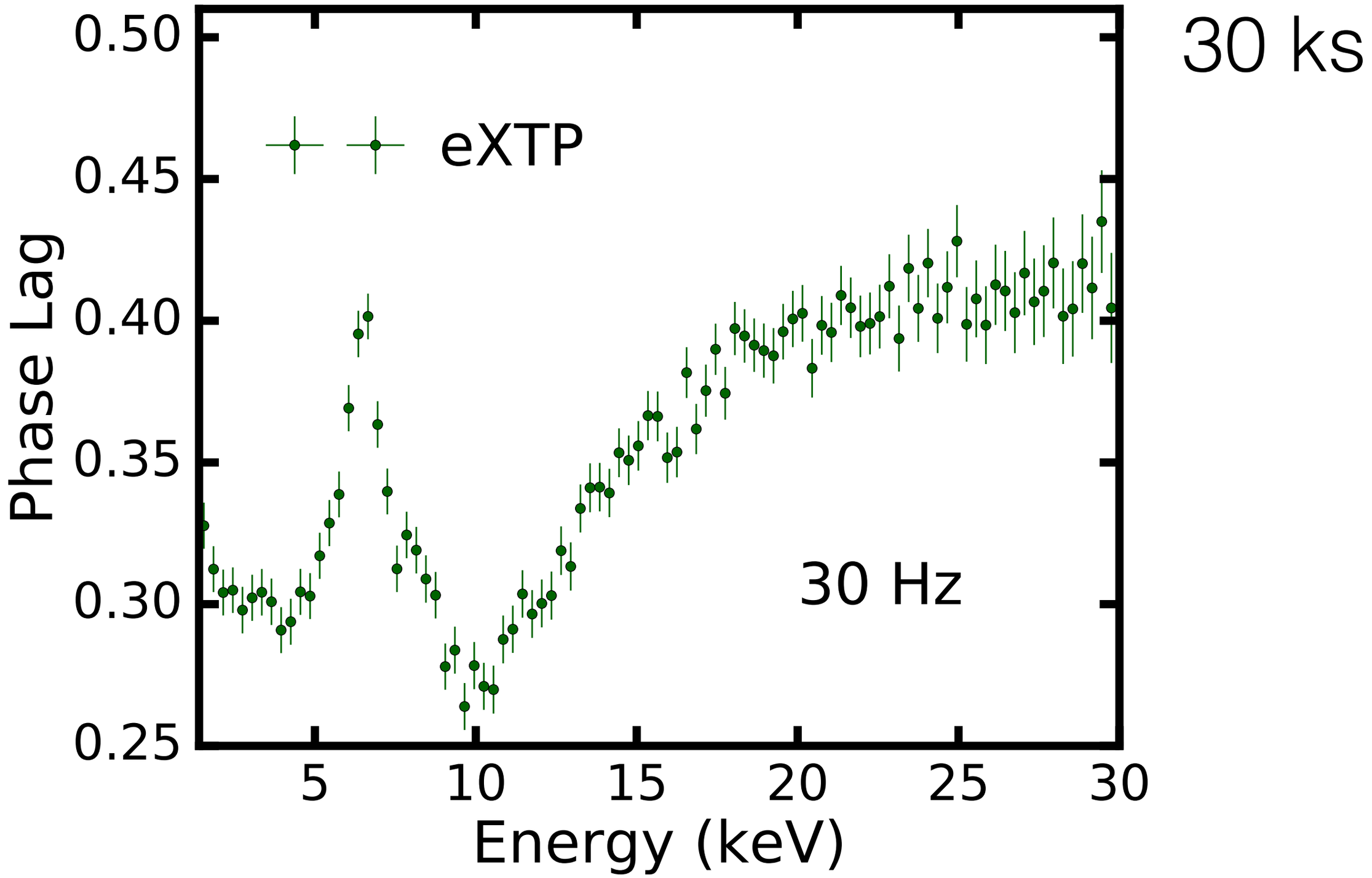

Lag-Energy Spectrum

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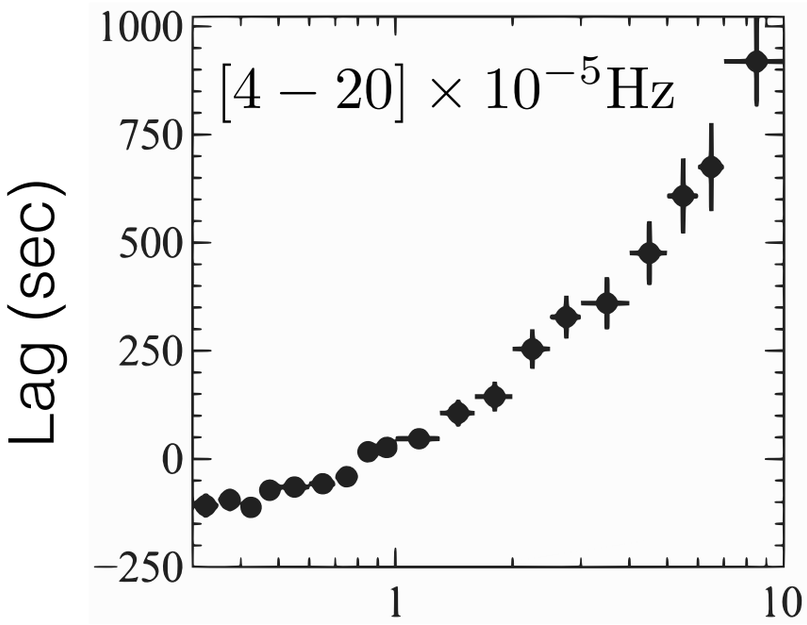
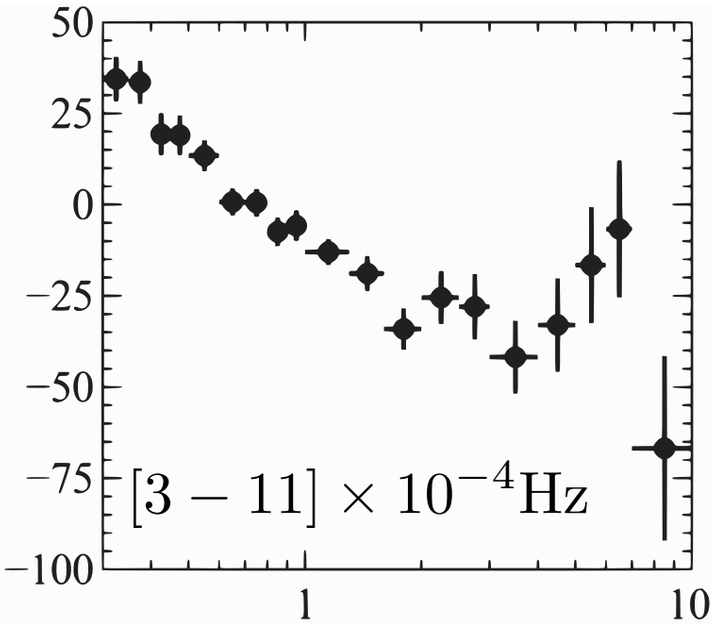
Kara+ 2016





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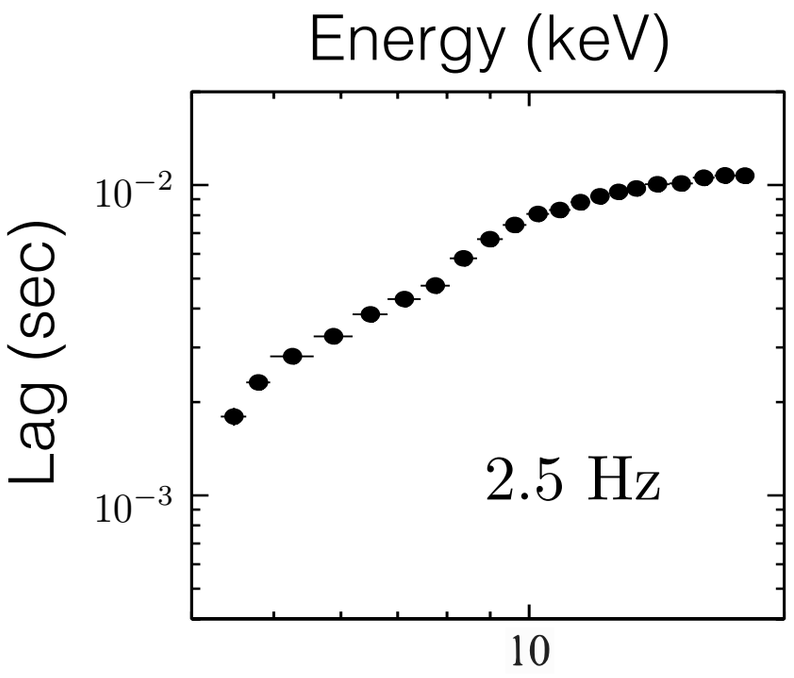
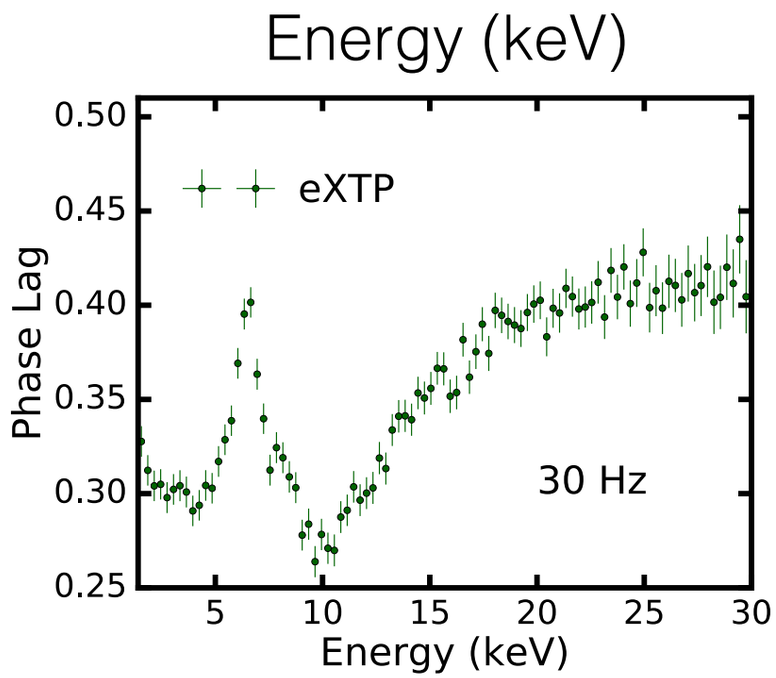


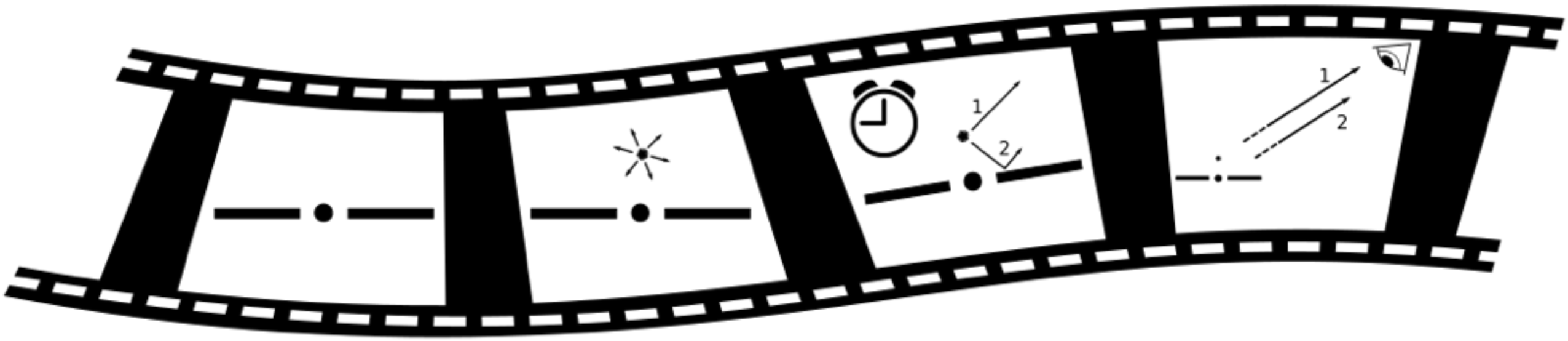


Conclusions

The new model explains both the continuum and the reflection lag consistently

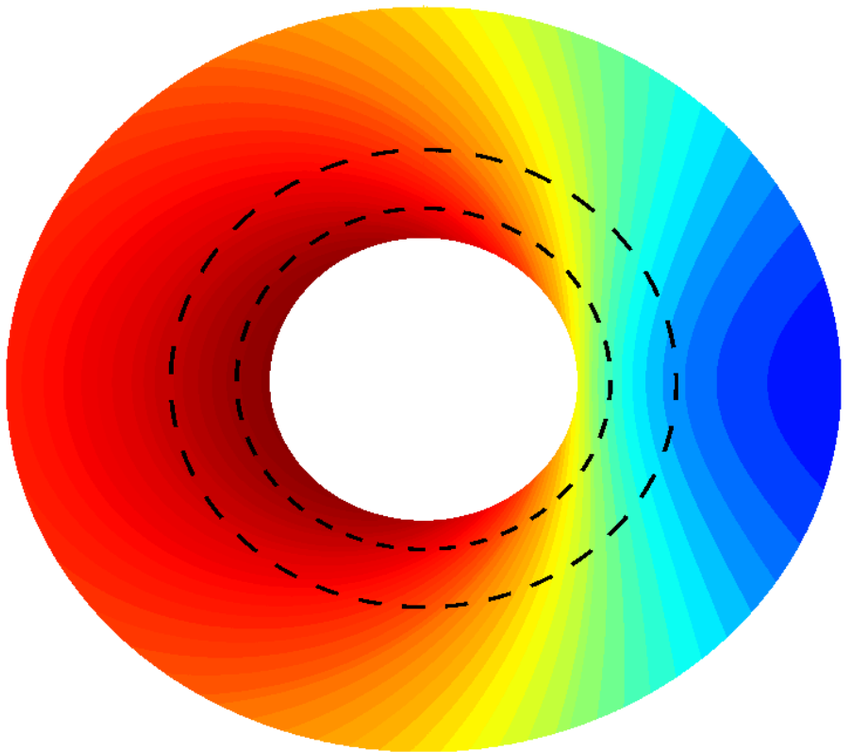
- The model depends on the disk geometry and black hole parameters
- The model is analytical and very flexible for introducing new components
- We can fit our model with the cross-spectrum not only with the lag spectrum
- eXTP will provide a great improvement in the detection of reverberation lag

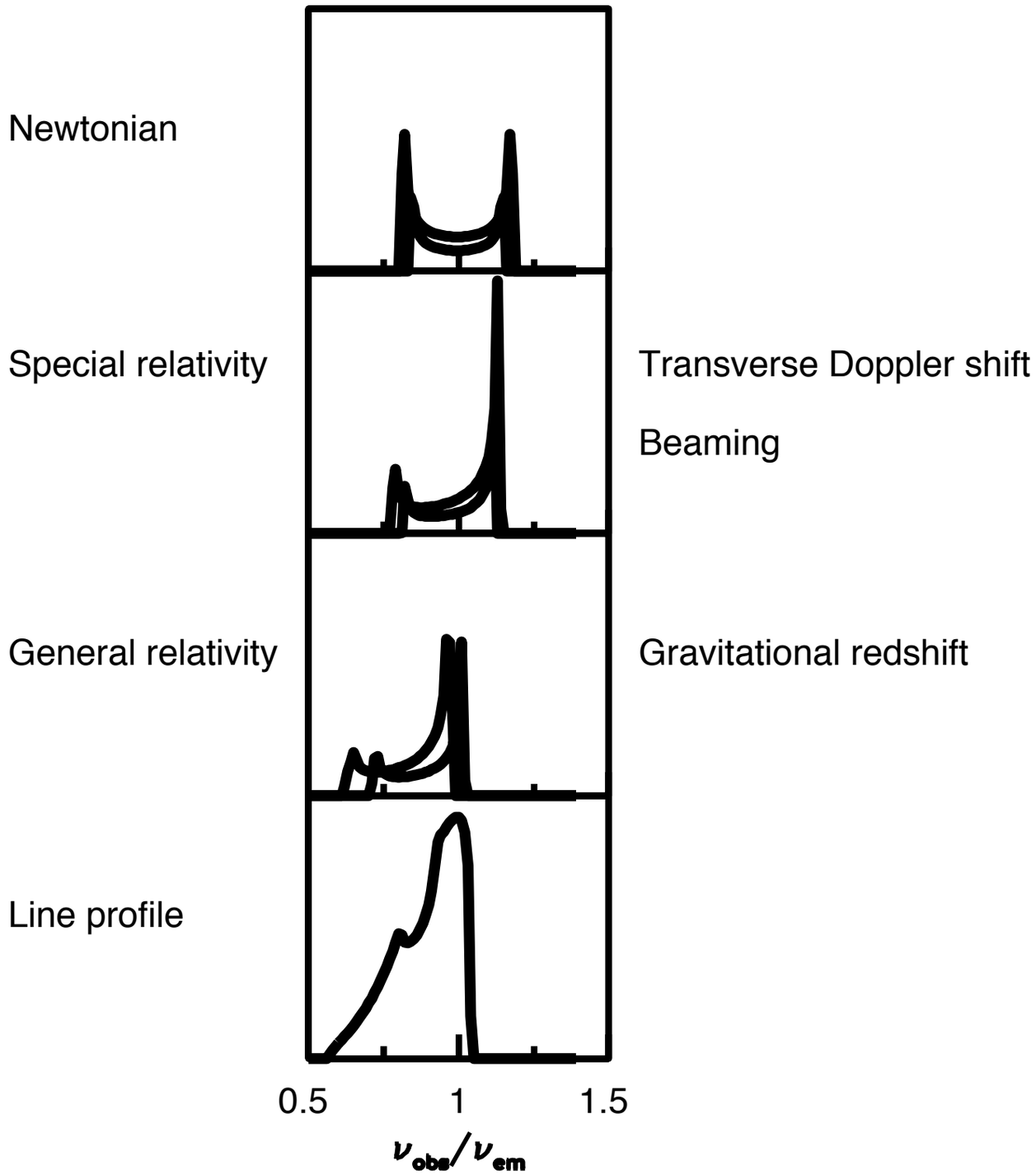
Thank you



Kα Iron Line Profile

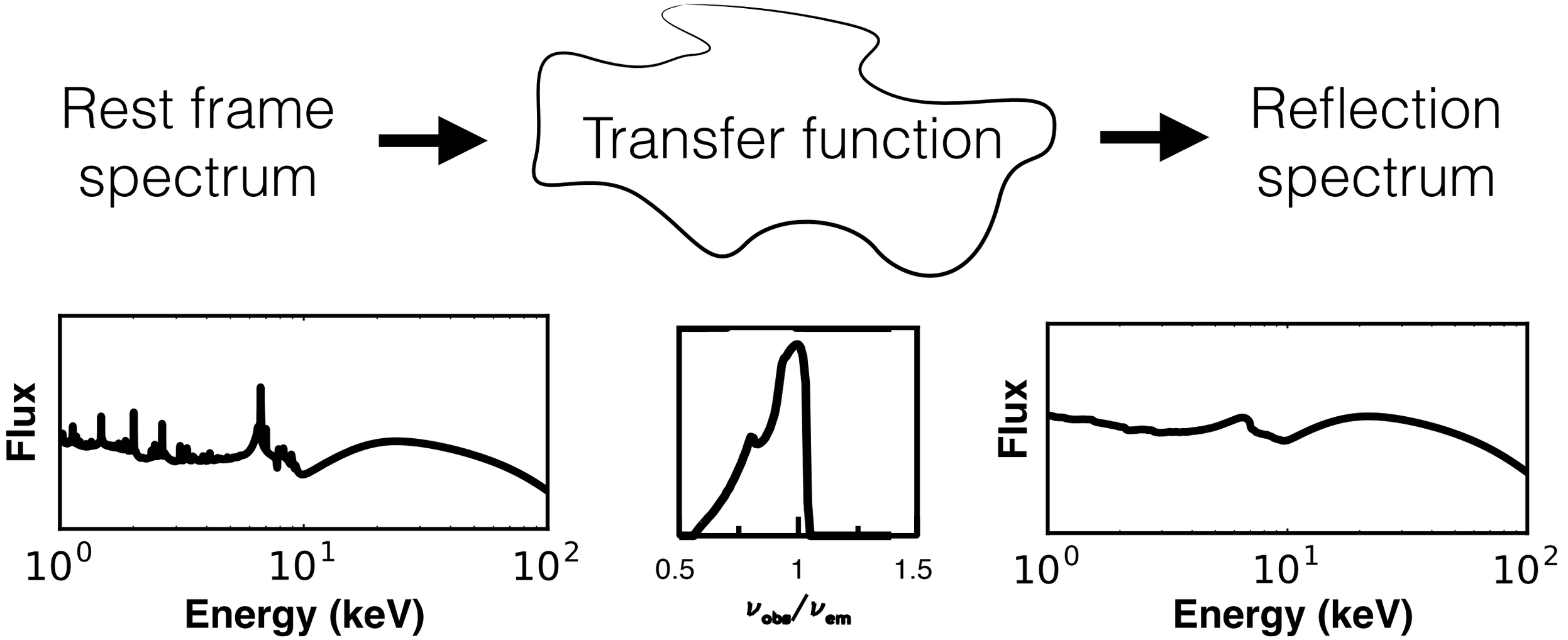
Fabian+ 2000





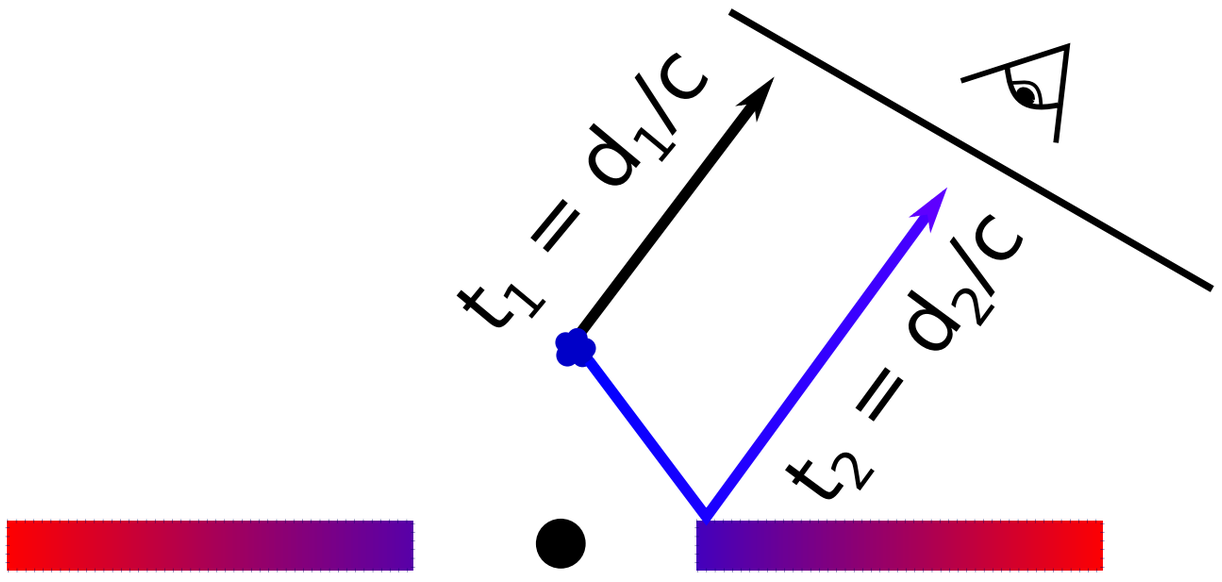
Transfer Function

Rest frame spectrum → Transfer function → Reflection spectrum

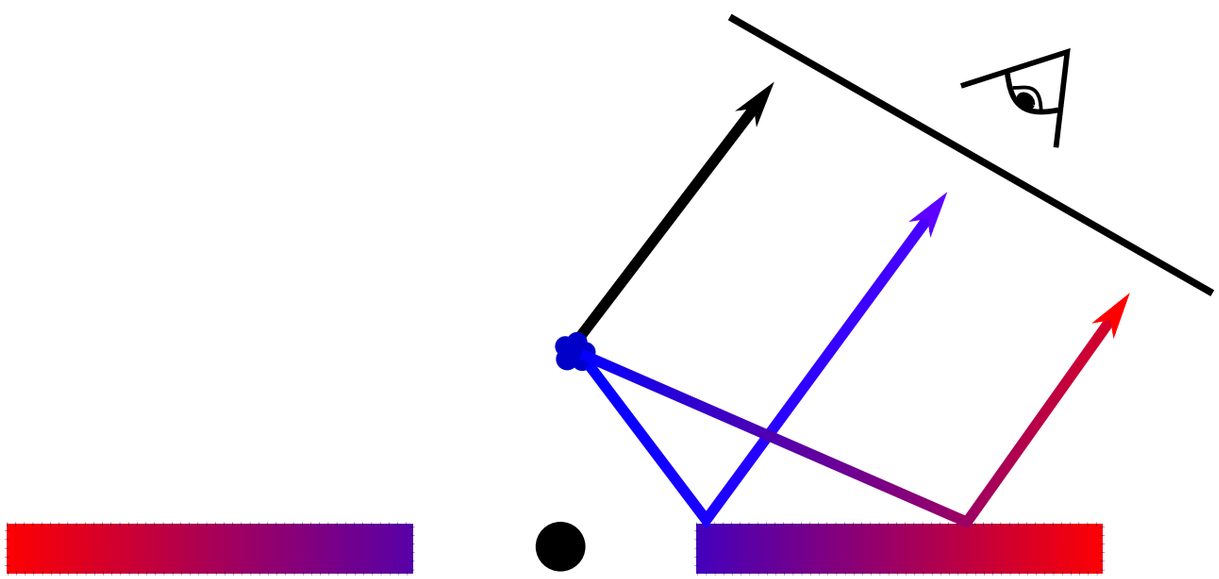


XILLVER model
García&Kallman 2010

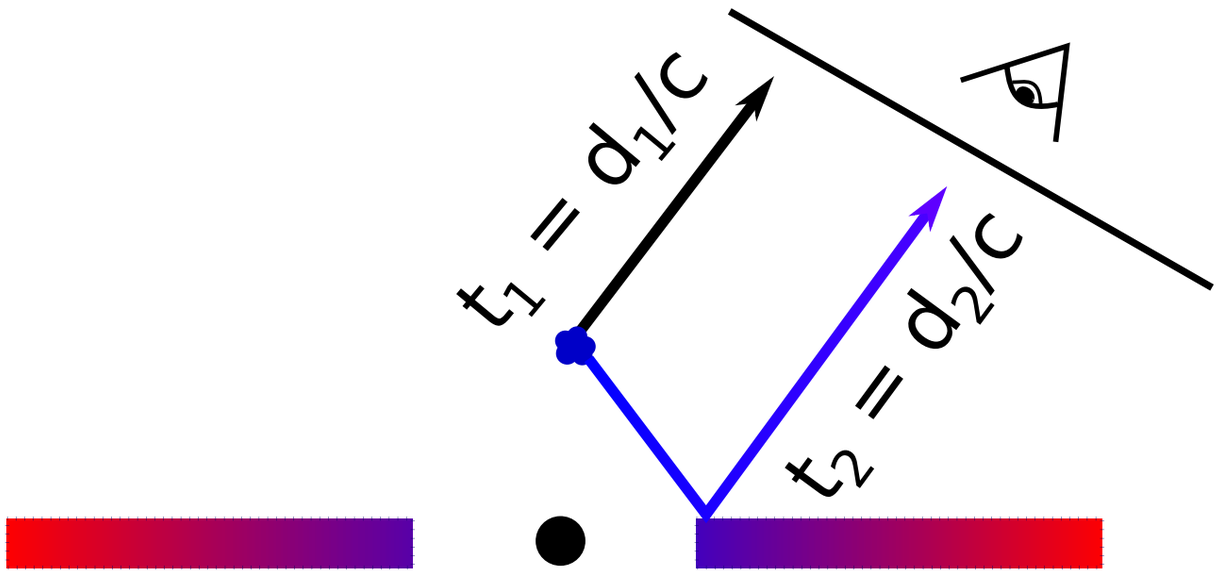
Reverberation Lag

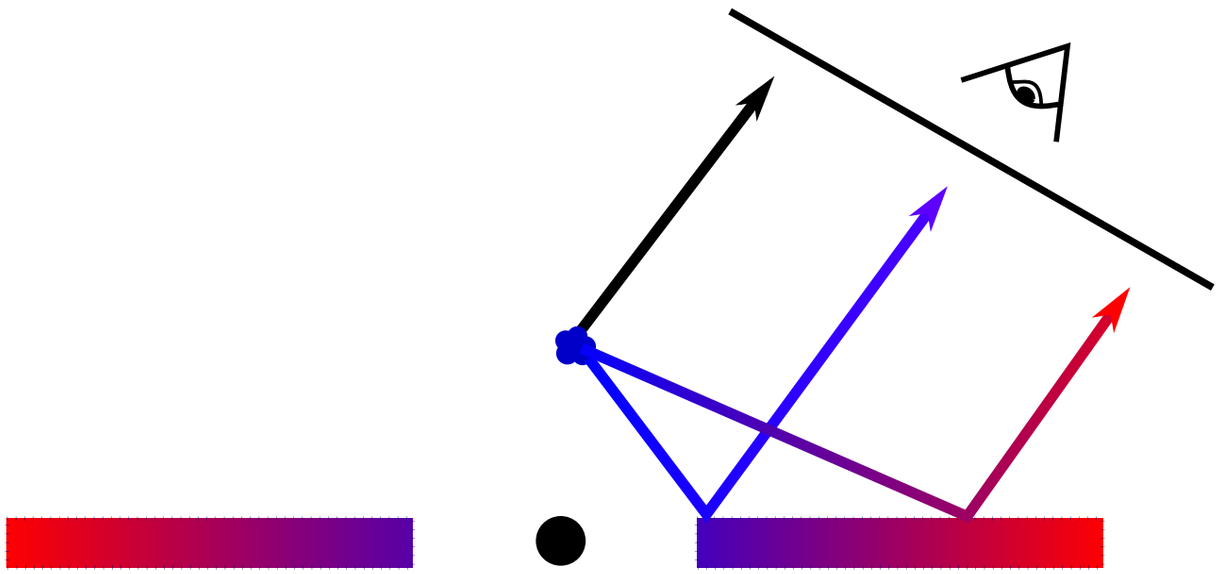


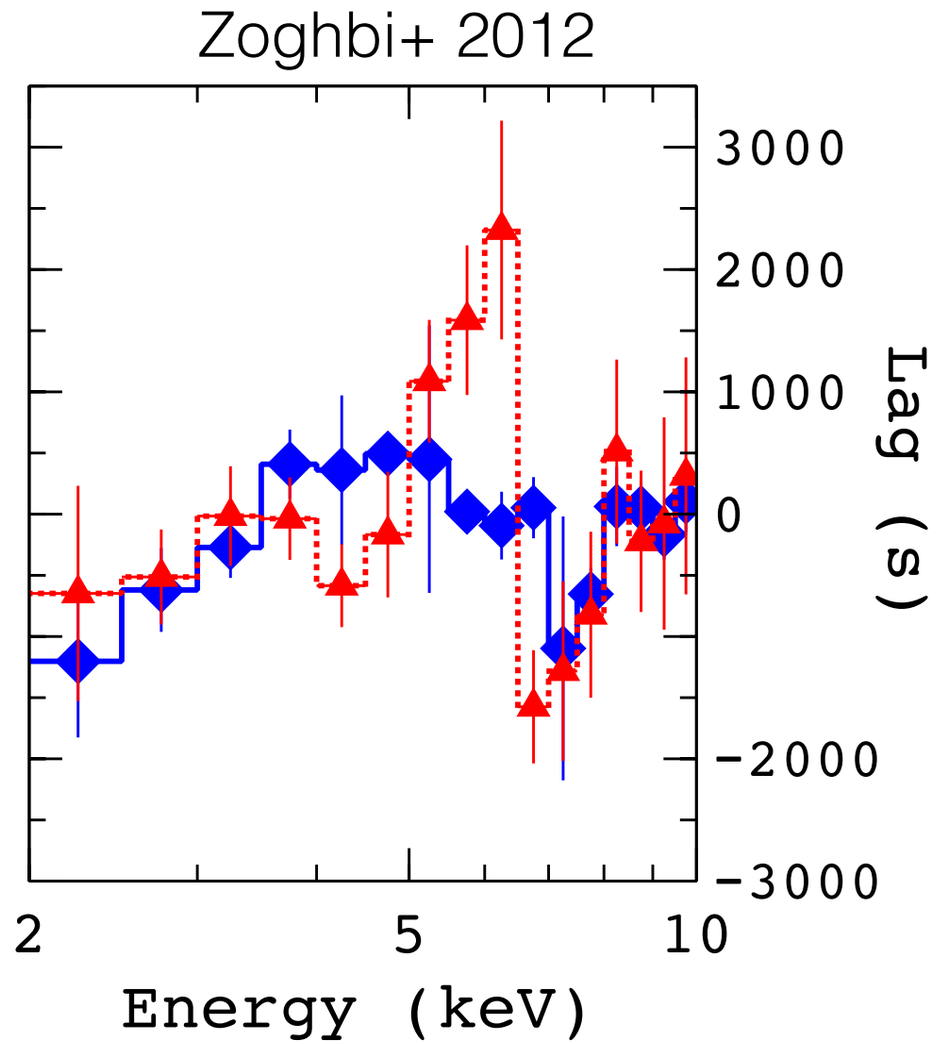
$\Delta t = t_1 - t_2$

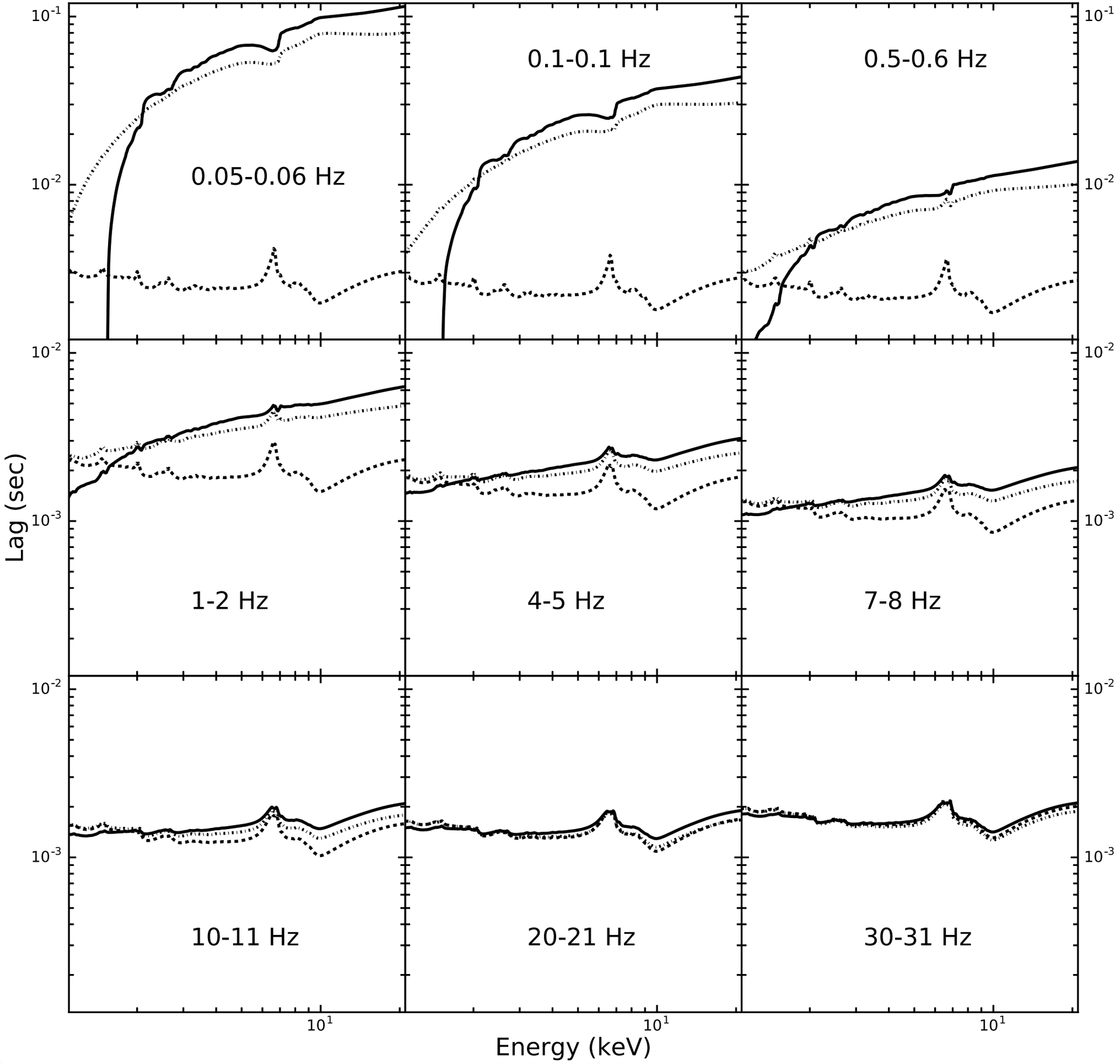


Reverberation lag








0.05-0.06 Hz
0.1-0.1 Hz
0.5-0.6 Hz
1-2 Hz
4-5 Hz
7-8 Hz
10-11 Hz
20-21 Hz
30-31 Hz
Lag (sec)
Energy (keV)