
Spectral Variability of Type 1 AGNs Observed with Suzaku

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X-ray Spectral Variability in AGN

AGN spectral variability

Trend

Brighter

--> apparent spectrum becomes softer

Physical origin unknown

Possible origins of spectral variability:

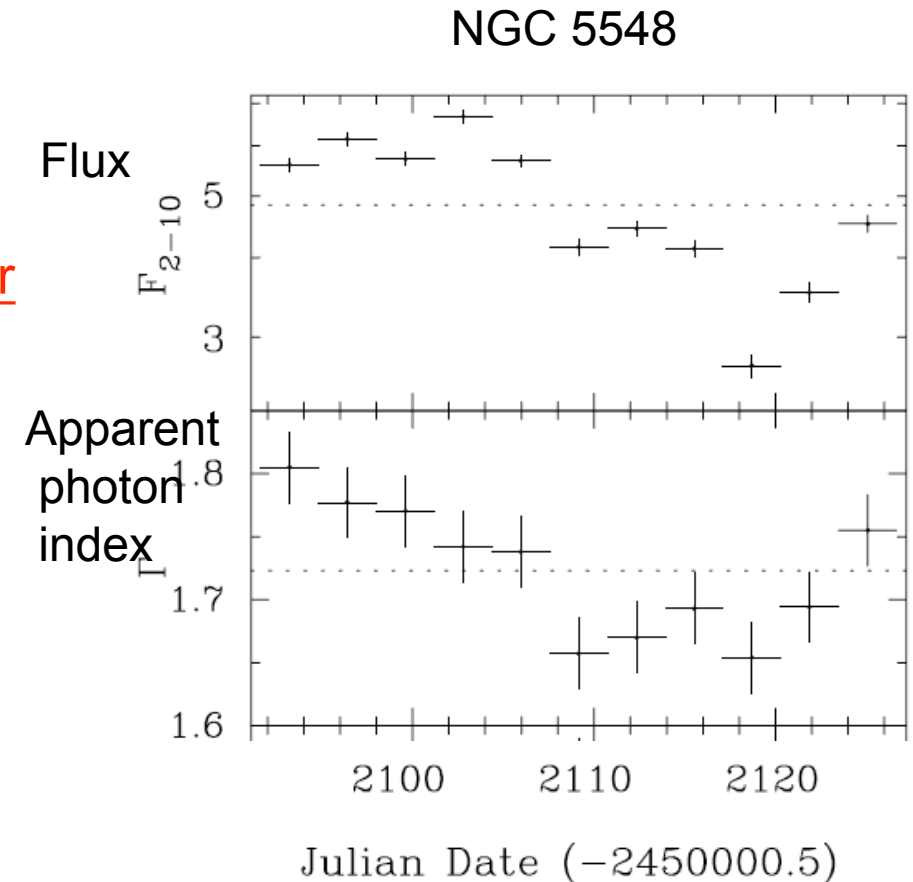
1. pivoting (intrinsic spec. changes)

2. Two component

constant flat spec.

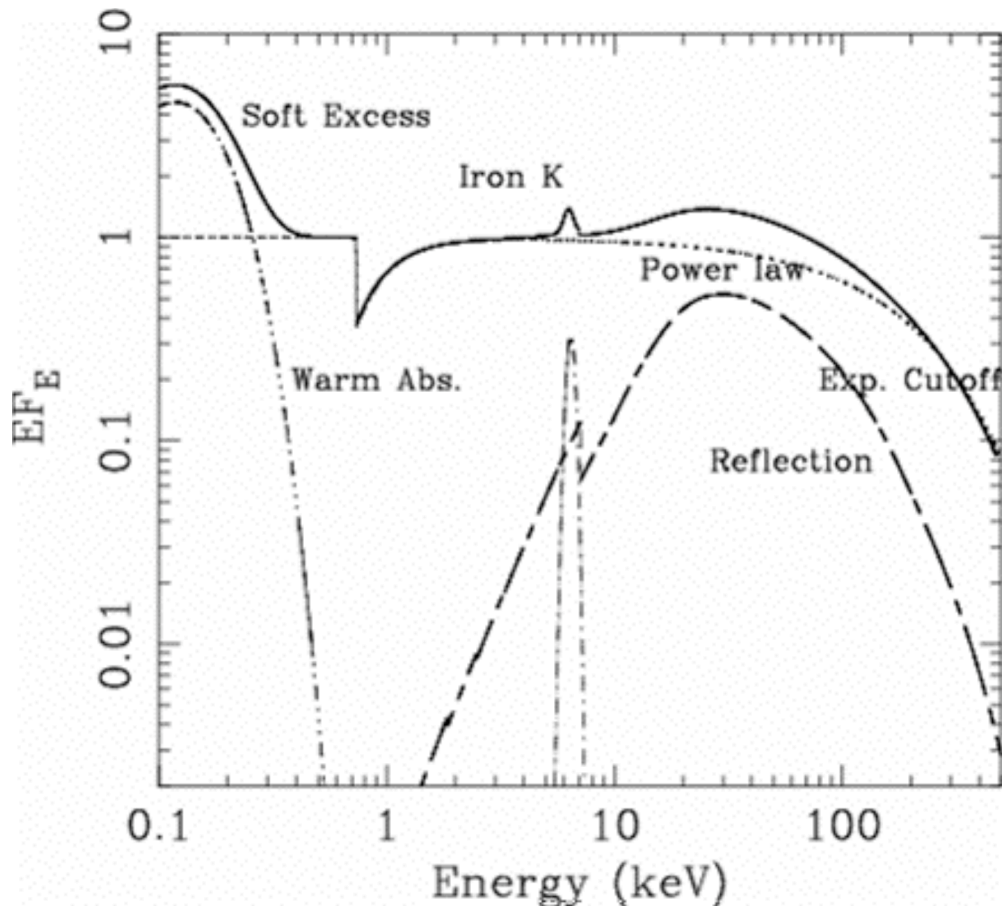
+ variable steep spec.

3. Variable absorption along L.O.S.



RXTE; Markowitz, Edelson, & Vaughan 2003

X-ray Spectral Components and Variability in AGNs

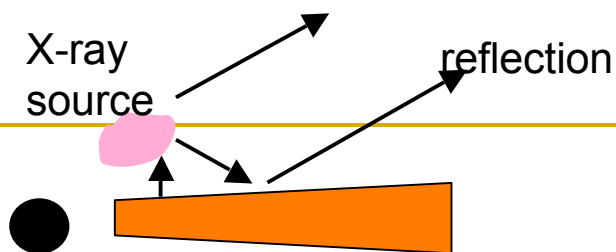


AGN spectral components -
Power law, Compton reflection,
Fe-K line etc.

Hard X-ray (>10 keV) essential for
unambiguous interpretation of
continuum and broad Fe line

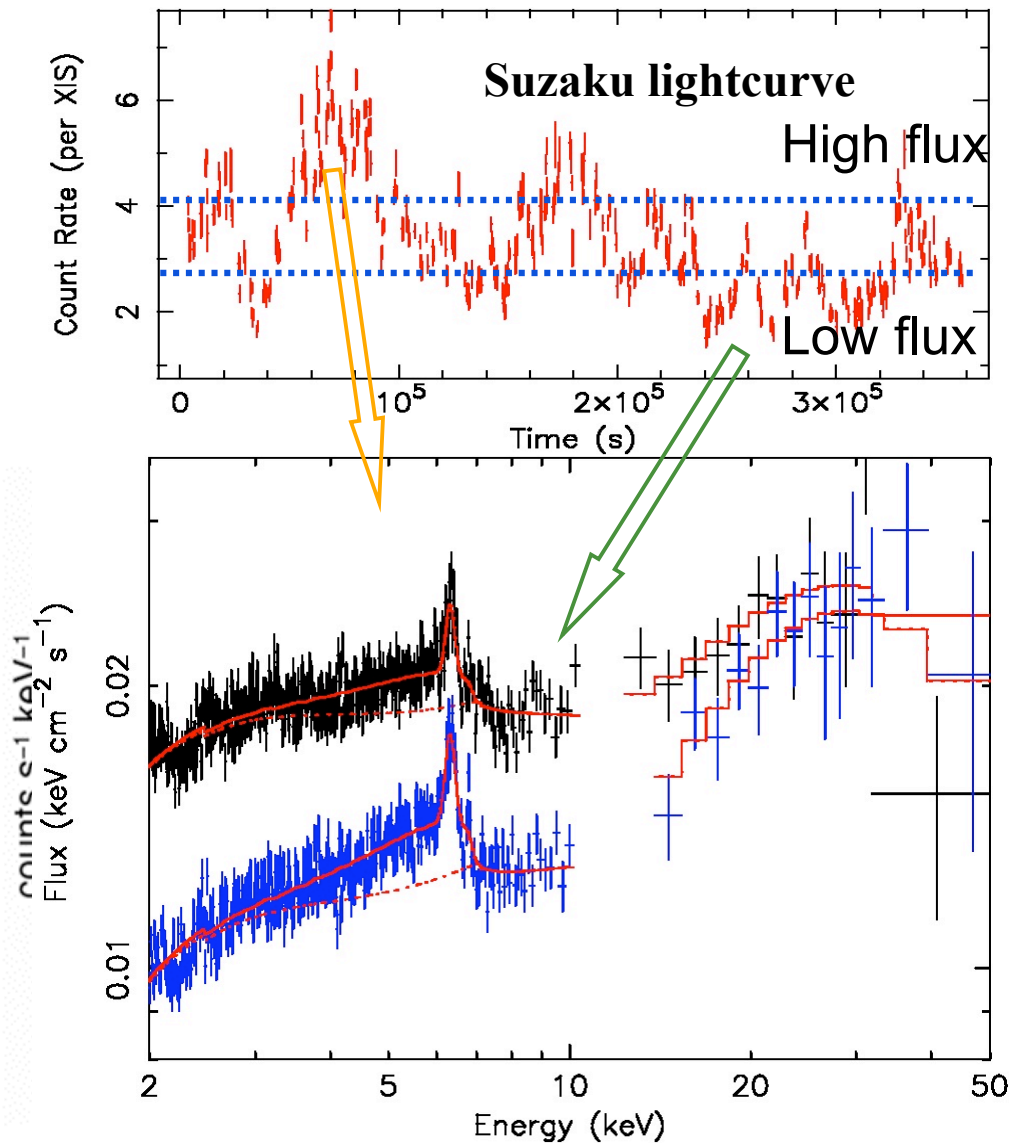
Possible origins of spectral variability:

1. pivoting (intrinsic spec. changes)
2. multi component
constant flat spec.
+ variable steep spec.
3. Variable absorption along L.O.S.



Broad-band & time resolved
Spectroscopy with *Suzaku*

Broad-band Spectral Variability with Suzaku



MCG-6-30-15 Miniutti+ 07
Net exposure ~ 300 ks

Brighter \rightarrow steeper spectral slope

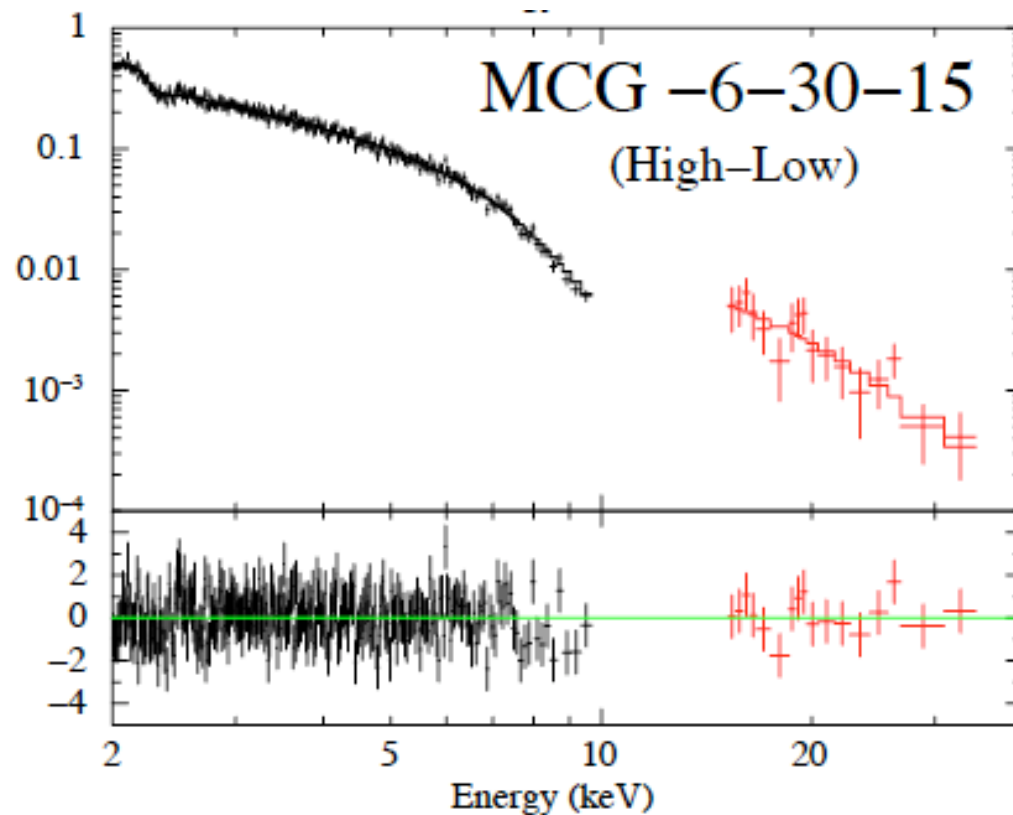
Small amplitude at higher energies

Averaged spectrum:
Power law + relativistic line
+ blurred reflection

Difference Spectrum

Miniutti+ 07

High - Low flux state



Difference spectrum:
well fitted with **simple power law**
photon index ~ 2.1

Only **normalization of power-law**
varies

Reflection comp. remains constant

---> **“Two component picture”**

The Sample

Type 1 AGNs in SWG and AO-1 program

Net HXD exposure ~ 70-110 ks (250 ks for MCG-6)

5 Seyfert 1s

MCG-6-30-15

MCG-5-23-16

NGC 3516

Ark 120

NGC 7314*

3 Narrow-line Seyfert 1s

NGC 4051

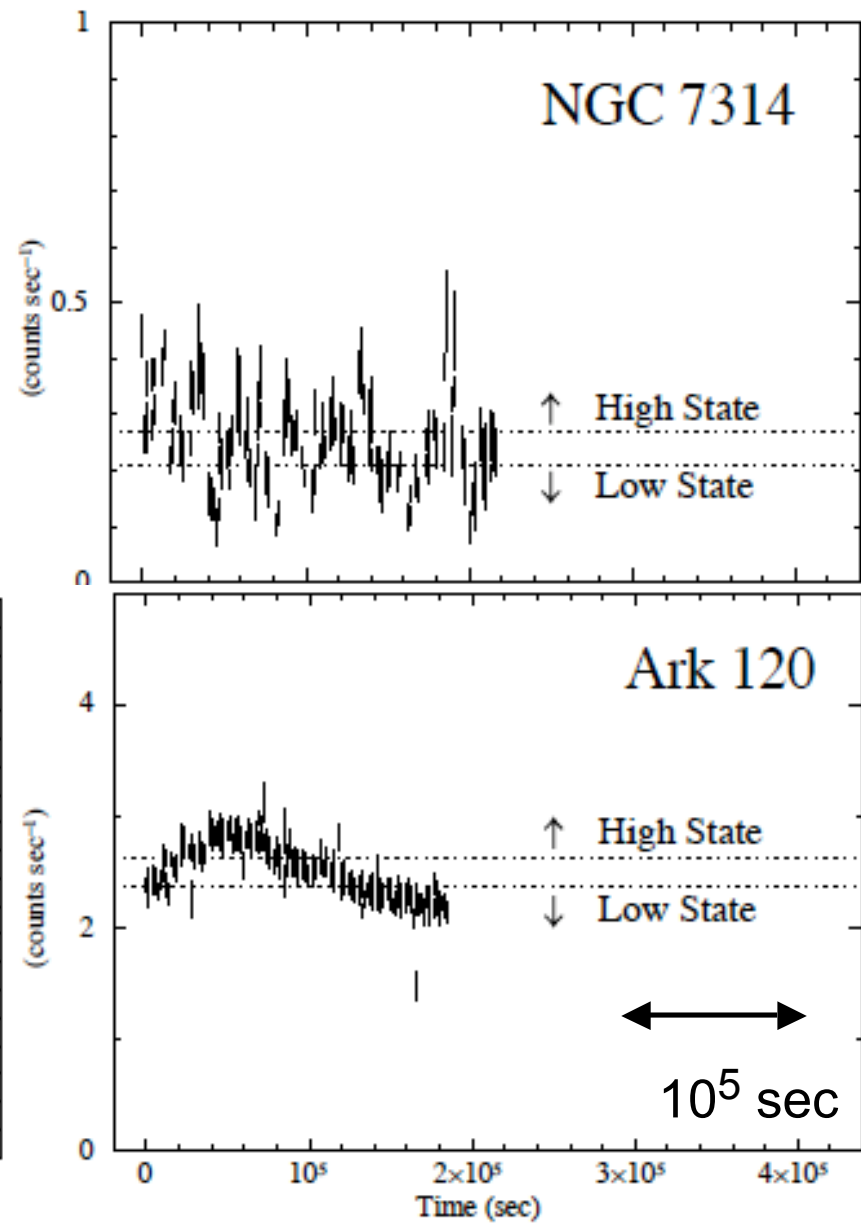
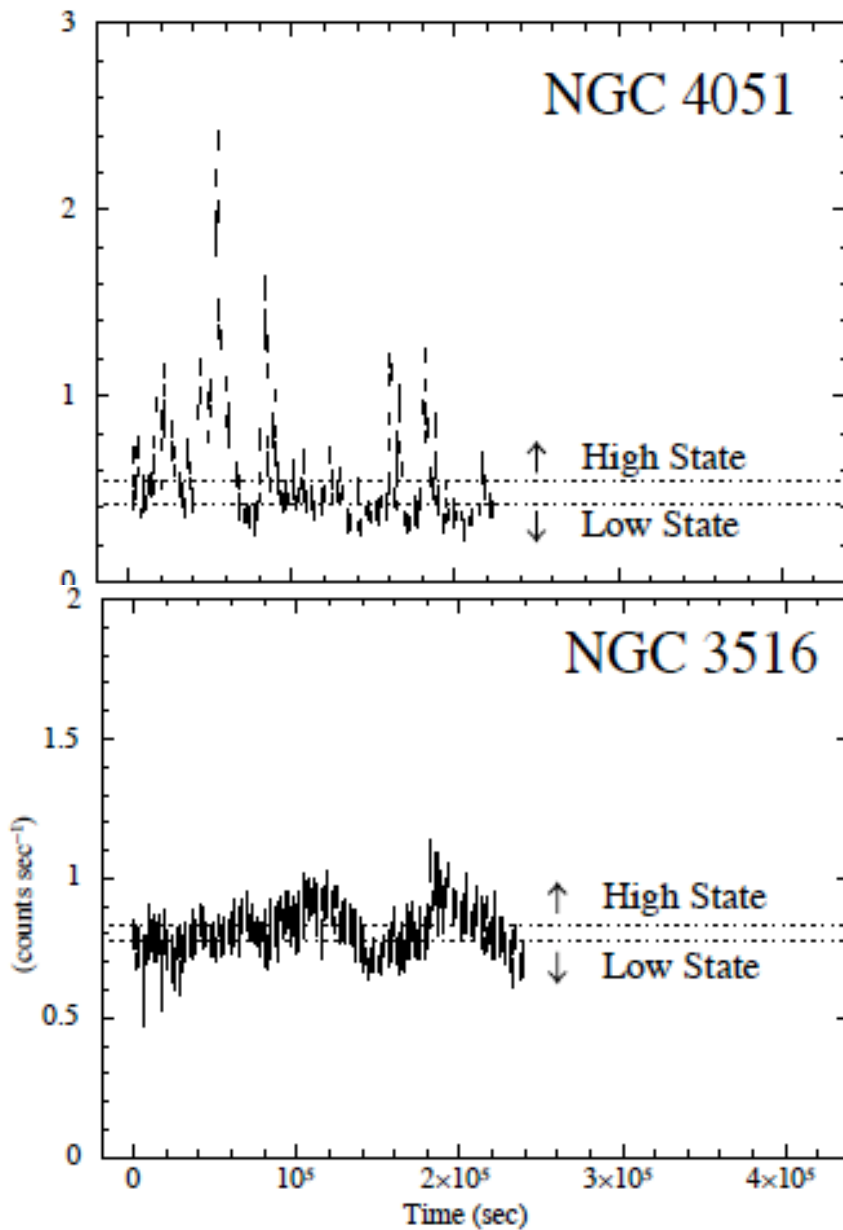
PG1211+143*

1H0707-495*

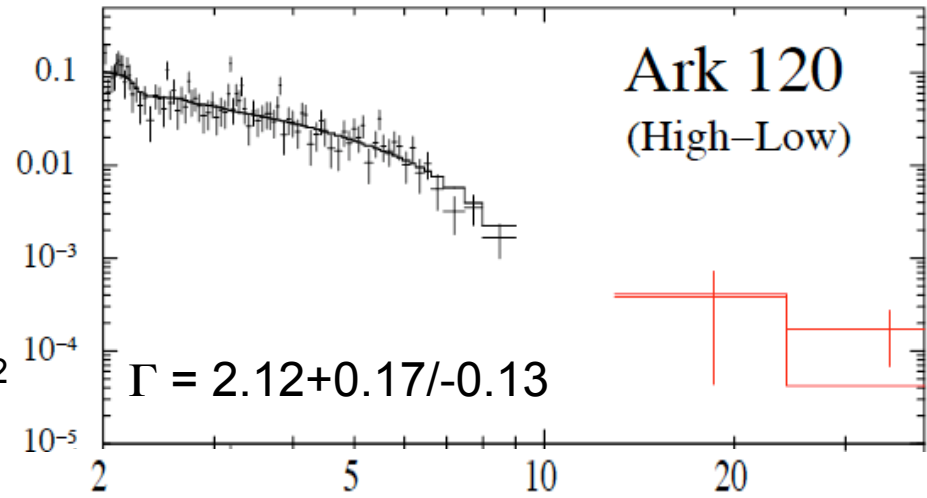
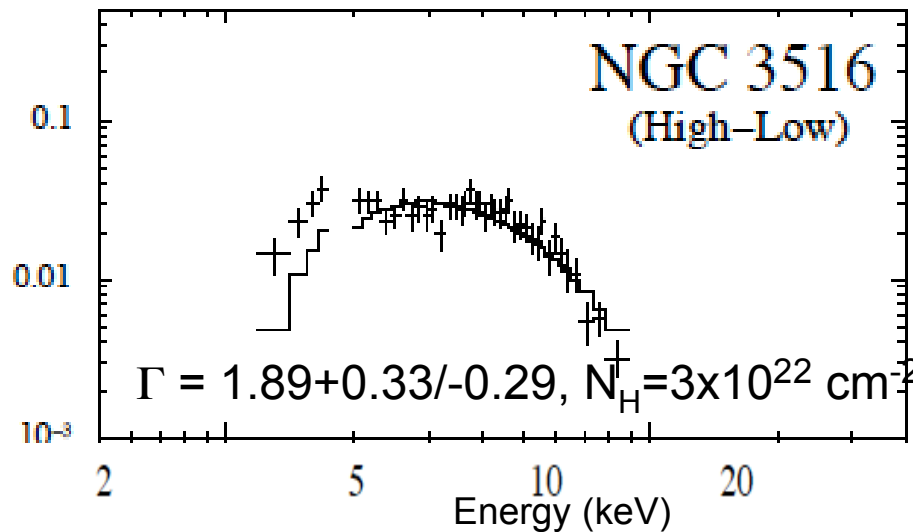
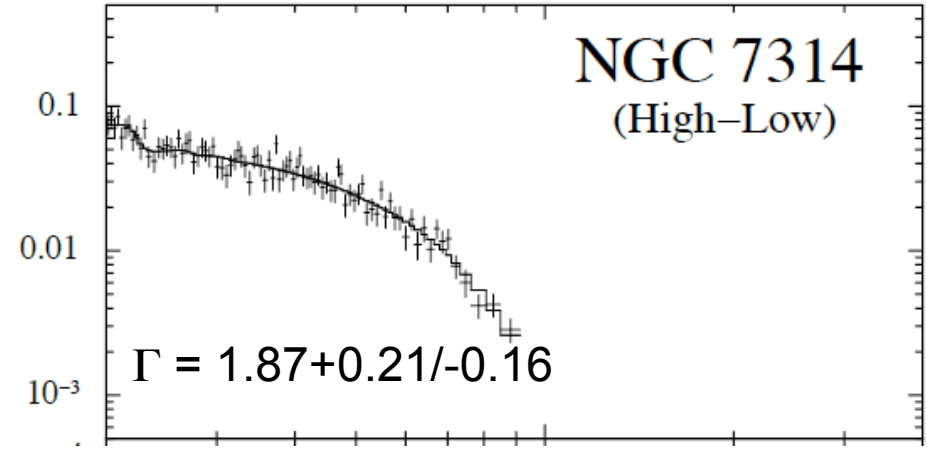
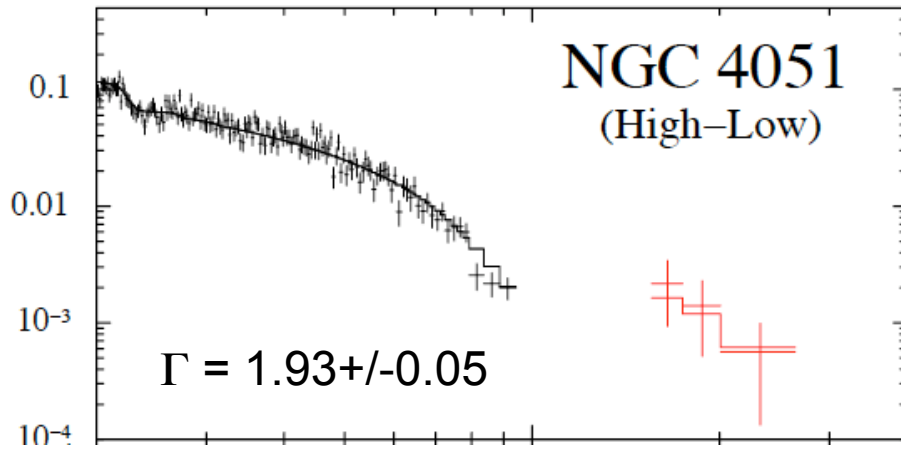
3/8 (*): ver. 1 HXD PIN no detection

see Yaqoob+ poster

Light Curves



Difference Spectra

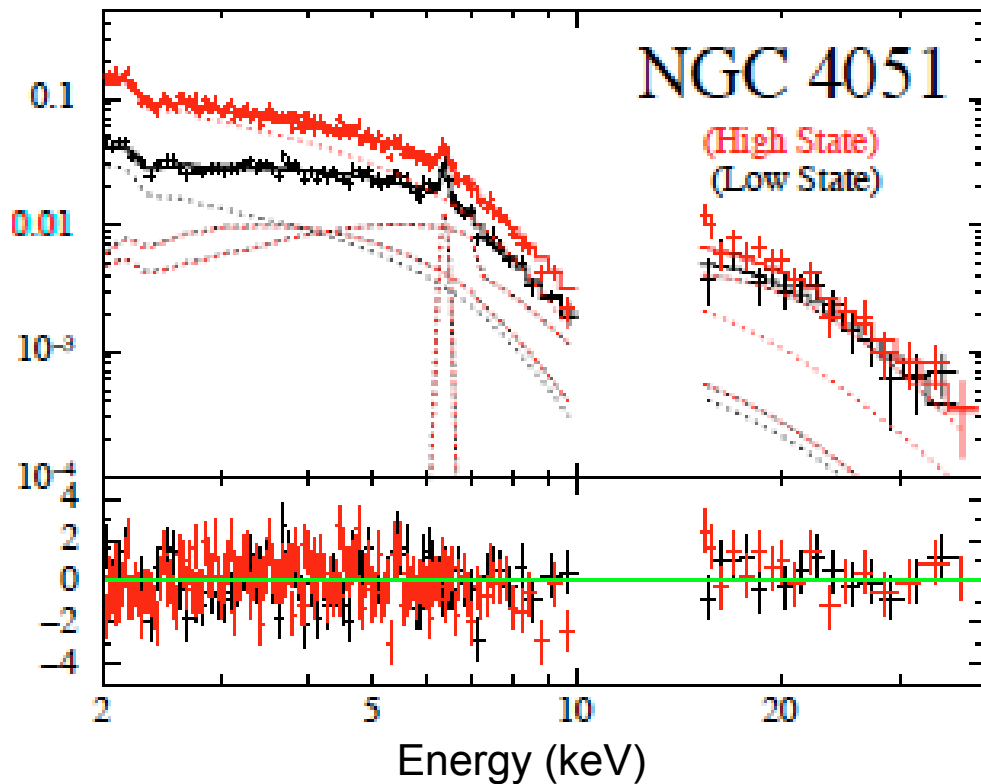


6/8 objects: Difference spectrum well represented by a simple power law.

Photon indices agree with observed in mean spec.

2/8 : Curvature in difference spectrum (variable absorbed power law)

Two Component Model Fits



Power-law + reflection continuum
+ Fe line

Simultaneous fits to high/low flux
spectra

Common parameters except
for normalization of power law

---> excellent fit

Typical limits on variability

$\Delta\Gamma < 0.1$

$\Delta\text{Fe intensity} < 10\%$

$\Delta\text{reflection cont.} < 40\text{-}100\%$

Two Component behavior (6/8 obj.)
variable power law

+ constant reflection

on time scales of \sim day

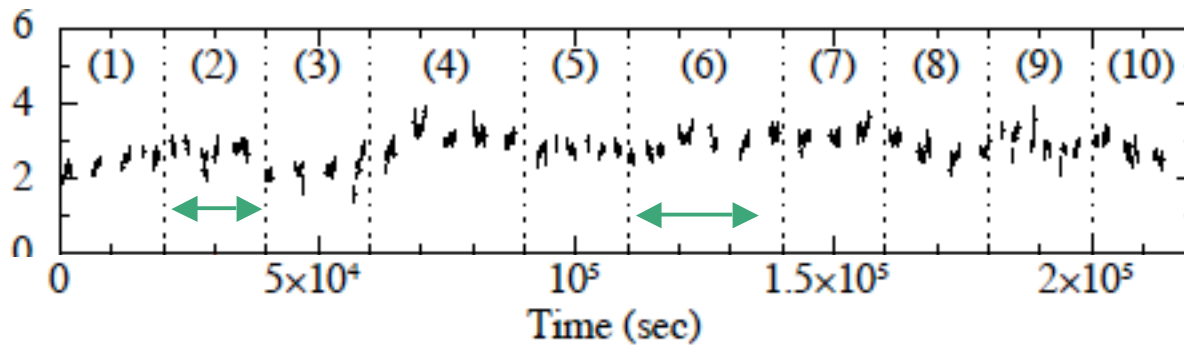
Is There Fe-K line from Inner Part of Accretion Disk?

■ Suzaku examples

- ❑ Taken from papers
 - ❑ Ark 120 fig and parameters

 - ❑ Short term variability + broad line
 - ❑ support high/soft analogy
 - ❑ N.B. $R_{in} \sim 3$ does not necessarily required
 - ❑ Nandra+07 results --- w/ much better data.
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Fe-K line: Short-term Variability

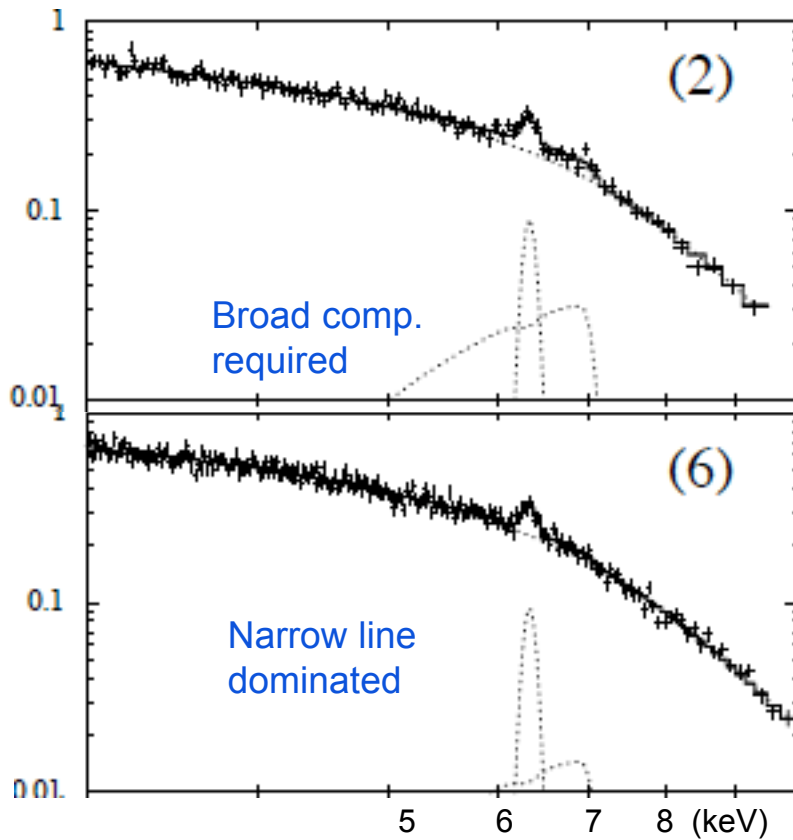


MCG-5-23-16

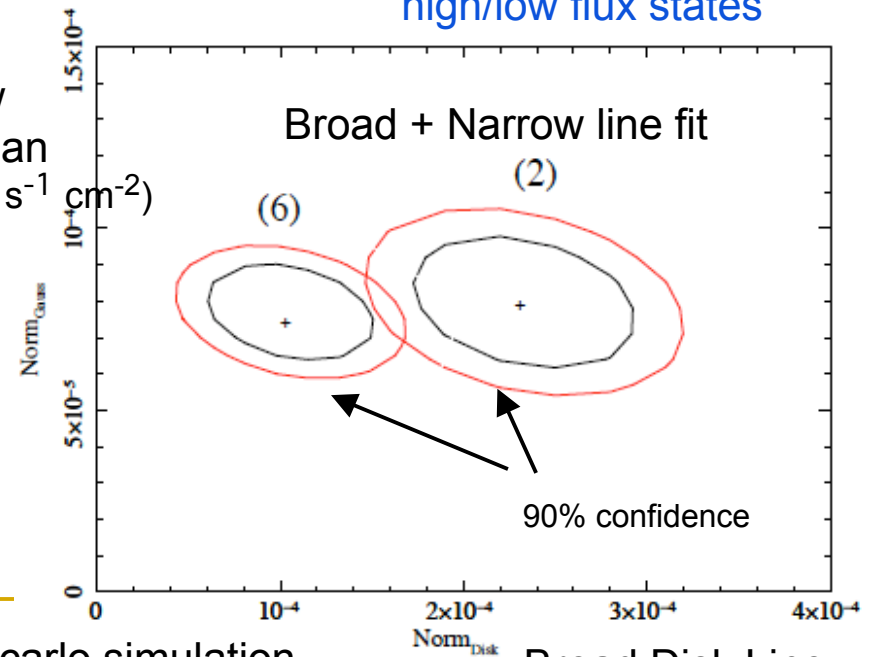
Fe-K line profile: Variable in
~ a few 10 ksec

Do not simply follow
continuum variation

--> variability NOT significant
in spectra averaged over
high/low flux states



Narrow
Gaussian
(photon $s^{-1} cm^{-2}$)

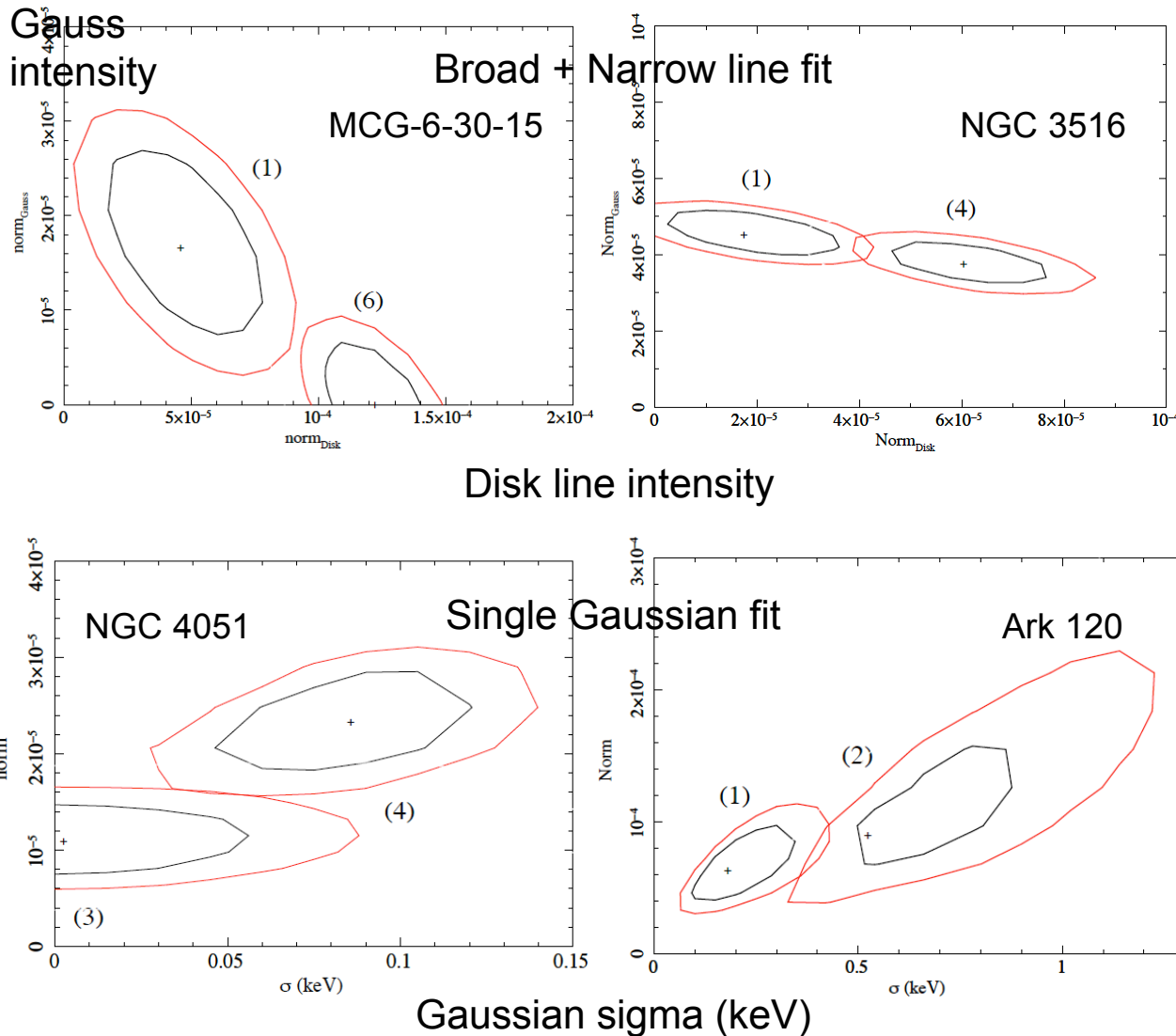


Monte carlo simulation
--- significant at > 99.9% conf.

Broad Disk Line
(photon $s^{-1} cm^{-2}$)

Fe-K line: Short-term Variability

20 - 30 ksec slices; Suzaku



Many more detections in ASCA/Chandra/XMM Observations.

Fe-K line varies on time scales <30 ksec

At least part of Fe-line should come from inner part of accretion disk

Spectral fits to time averaged spectra:

broad : narrow

~ 100 eV : 70 eV

~ 1 : 0.7

(on average)

detailed number depends on obj.,

Decomposing Distant and Inner Matter

- Spectral fits to averaged spectra
 - Fe line (narrow Gaussian + Disk line)
-

Summary: Origin of Constant and Variable Components

(1) AGN variability (~ day) ... "Two component model"

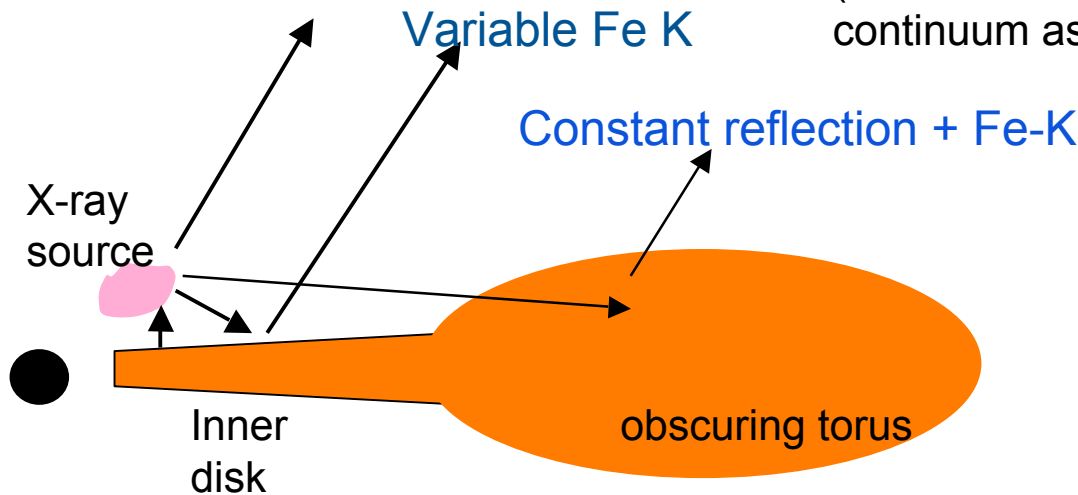
Variable power law + constant reflection

(photon index remains nearly constant)

(cf. MCG-6: Extremely small contribution from distant matter)

(2) Fe-K line varies (~a few 10 ksec)

(Fe-K line: intensity & profile do NOT simply follow continuum as suggested by many previous obs.)



(3) Broad & narrow components contribute to Fe-K nearly equal amount

See Nandra+07; poster using XMM spectra.

Summary

- AGN spectral variability:

Variable power law + constant reflection

(~day average)

(+ Variable absorption)

- + Variable reflection (Fe-K)

(< 30 ksec)

- Both distant matter and Inner disk contribute to reflection/Fe-K
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