

New frontiers in AGN astrophysics: The X-ray perspective

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Theorem I: We have not lost the scattering from the relativistic accretion disc

Theorem II: Some open questions of accreting black holes are explained by light bending effects

Theorem III: Unique spectral and timing features in NLS1s poses new challenging problems

Theorem IV: Age determination in the early universe constrain dark energy and BH formation time

Theorem V: The standard Sy1/Sy2 unification scheme is oversimplified

Theorem I:

We have not lost the scattering from the relativistic accretion disc

I Individual XMM-Newton/Chandra spectra

II Fe K line simulations

III The first stacked XMM-Newton spectrum of type I AGN in the local universe

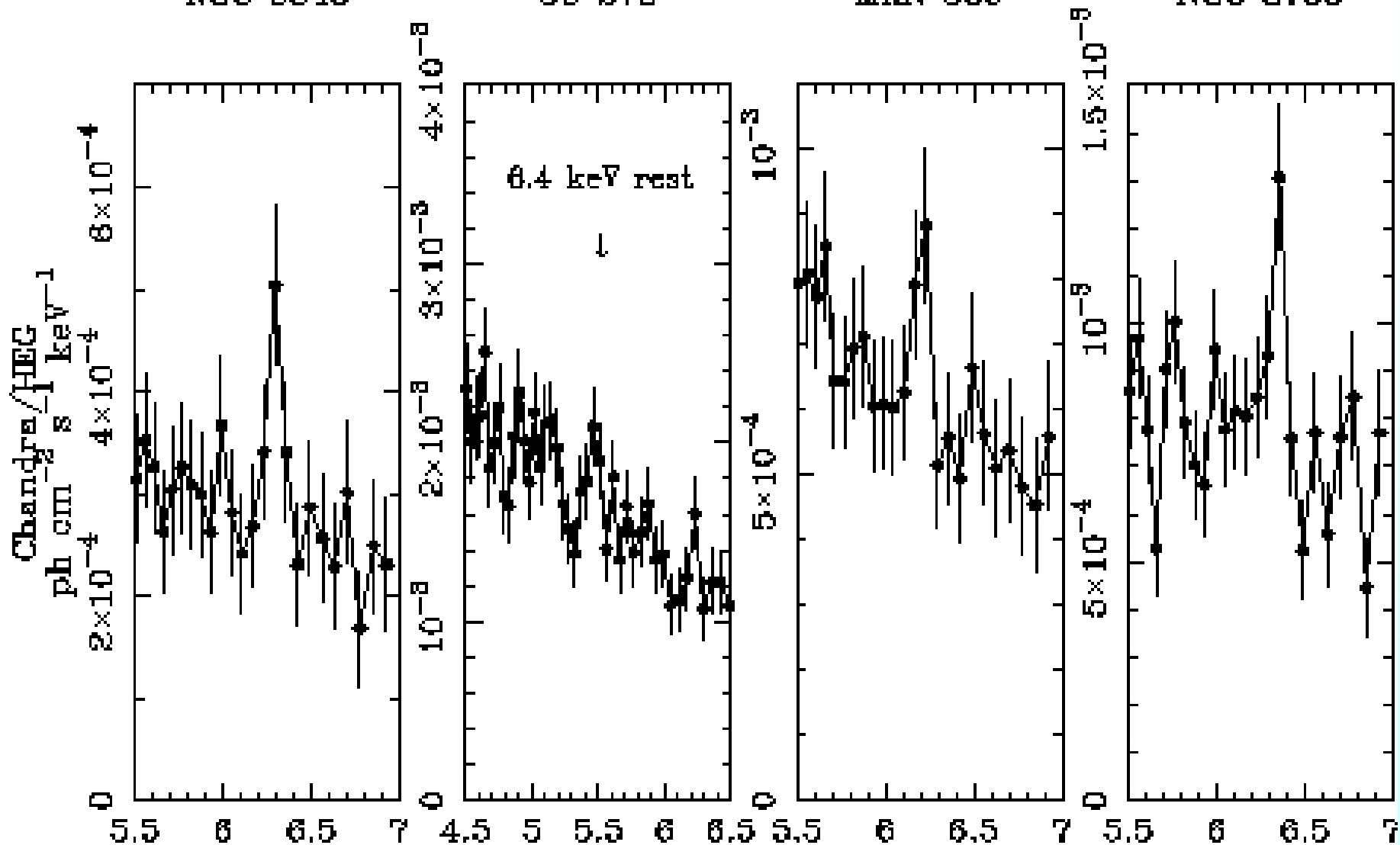
I Individual XMM-Newton/Chandra spectra

NGC 5548

3C 279

MKN 509

NGC 3788



The XMM-Newton/Chandra data

Boller & Gallo 2004

60 XMM-Newton/Chandra observations

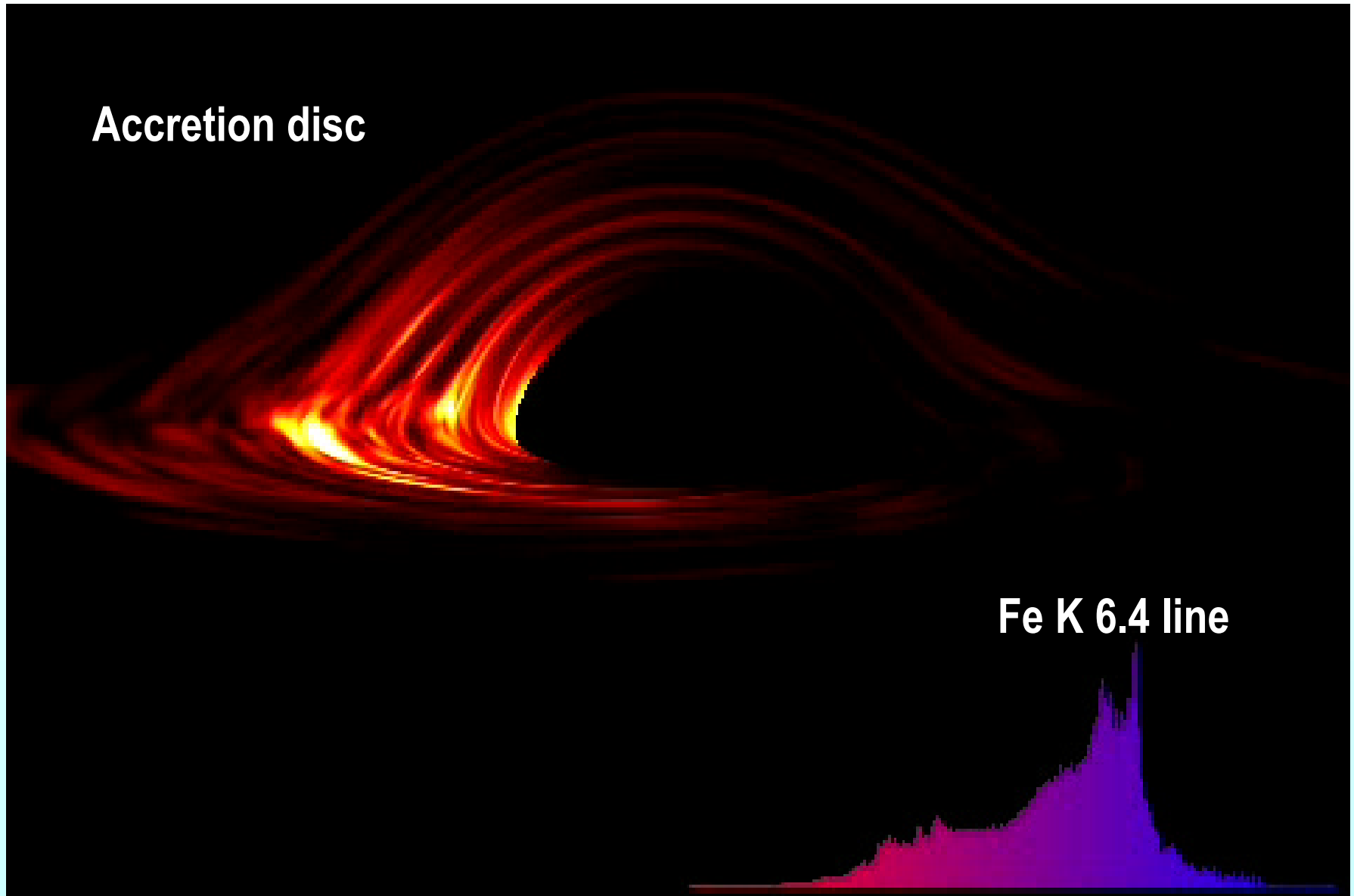
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graph TD; A[60 XMM-Newton/Chandra observations] --> B[4 objects with relativistically blurred Fe K-lines]; A --> C[56 objects do not show convincing evidence for relativistic scattering at the accretion disc];
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4 objects with
relativistically blurred
Fe K-lines

56 objects do not show convincing
evidence for relativistic scattering
at the accretion disc

WHY?

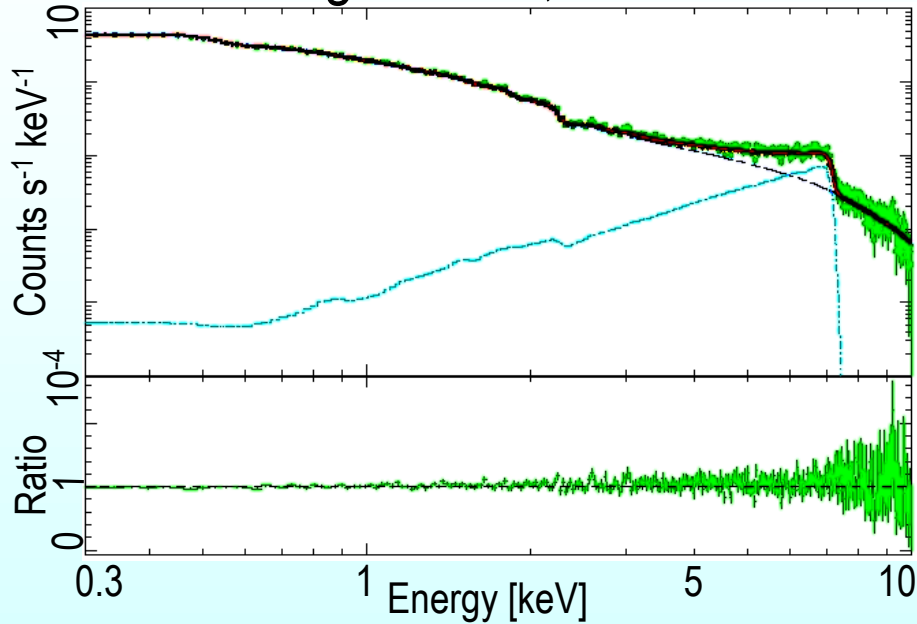
**Relativistic motions are expected for all radio-quiet,
moderately luminous AGN**



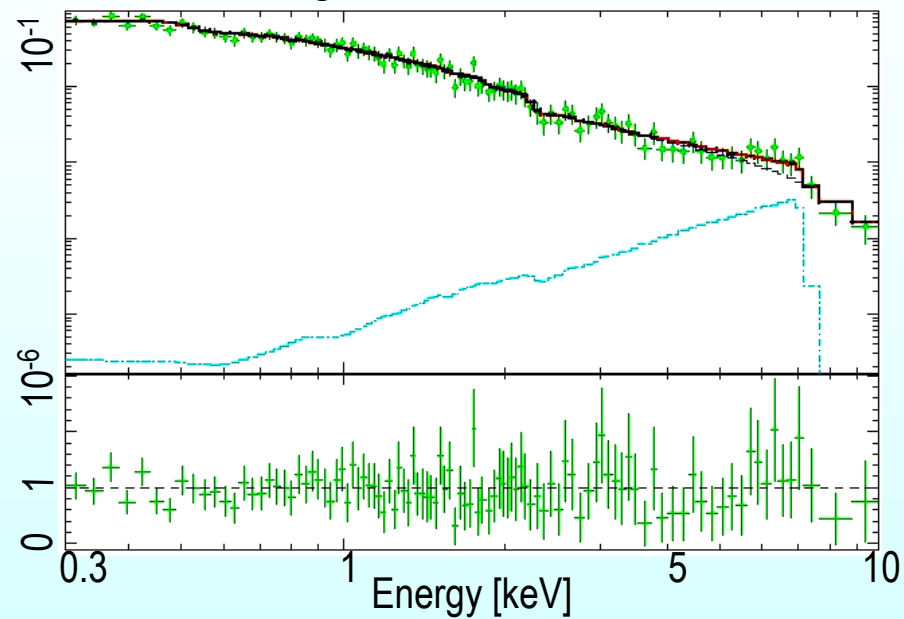
XMM-Newton Fe K line simulations

I Neutral discs

$f = 10^{-11}$ erg cm $^{-2}$ s $^{-1}$; EW = 400 eV



$f = 10^{-14}$ erg cm $^{-2}$ s $^{-1}$; EW = 100 eV

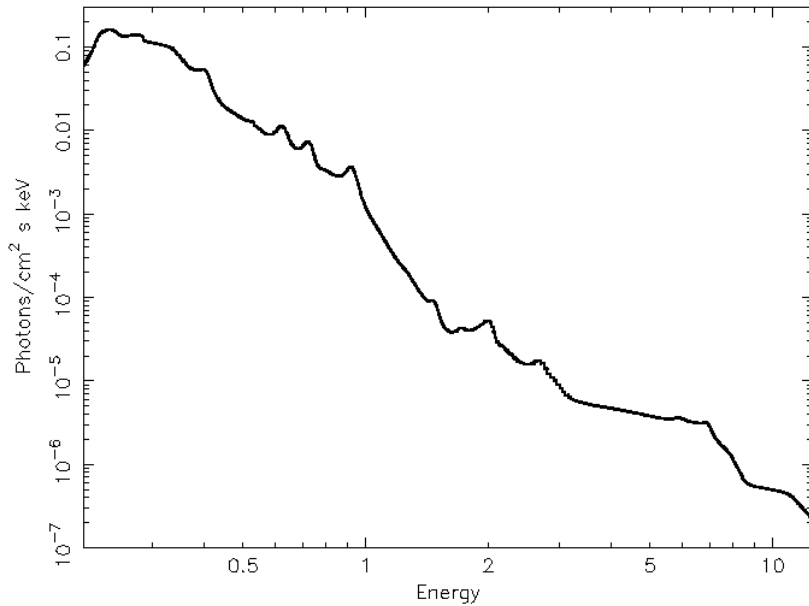


Relativistic lines are definitively detectable for 0.3-10 keV fluxes between 10^{-11} and 10^{-14} erg cm $^{-2}$ s $^{-1}$ and EW values from 400 down 100 eV

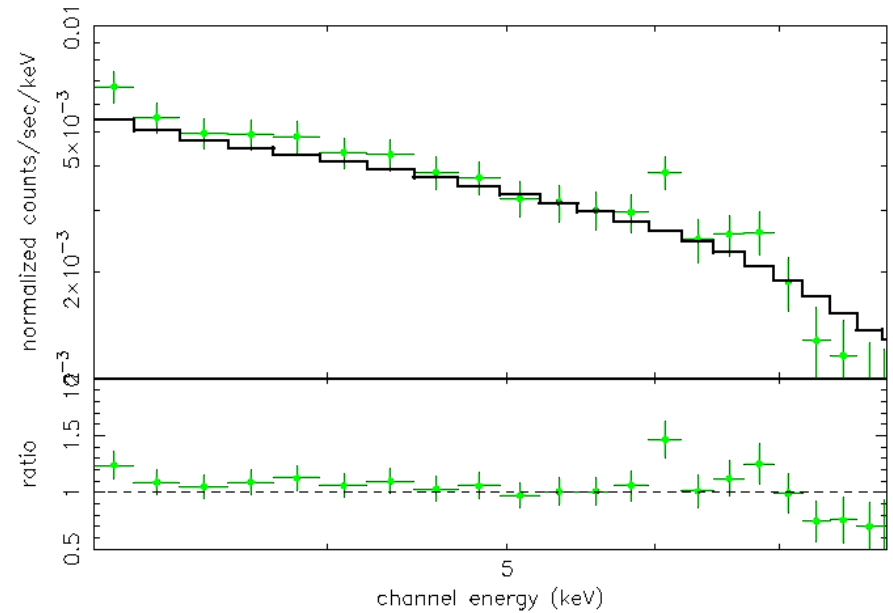
Neutral discs do show relativistic lines

II Ionized discs ($\xi = 1000$)

Reflection model (blurred)



Powerlaw fit



Extreme Compton broadening
of the Fe K line

Fe K line not detectable

XMM-Newton cannot detect relativistic Fe K lines for ionized discs

Disc Ionization and XMM-Newton:

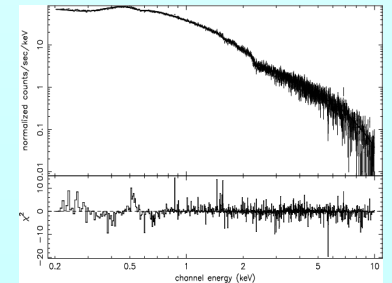
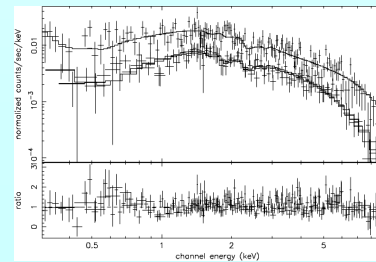
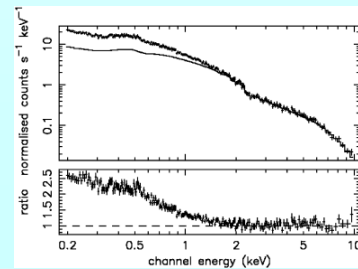
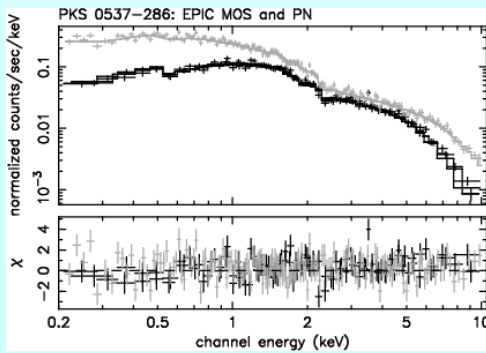
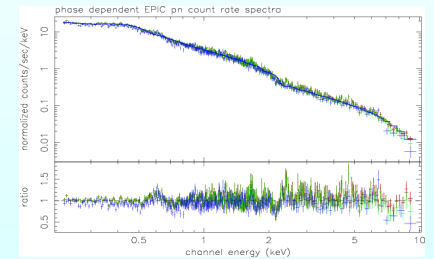
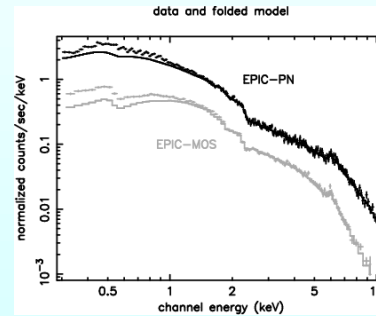
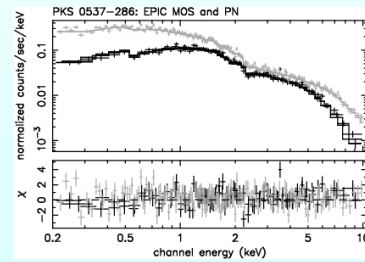
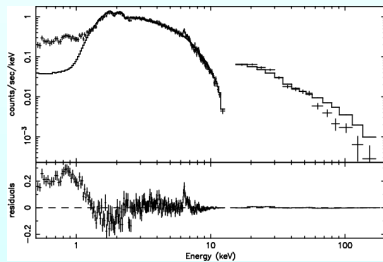
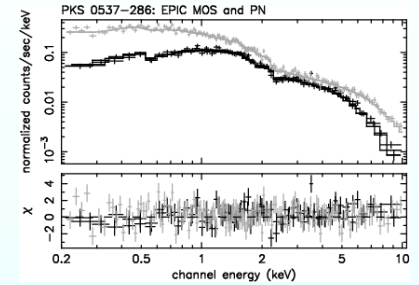
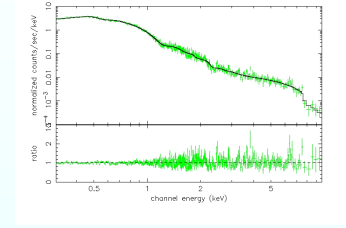
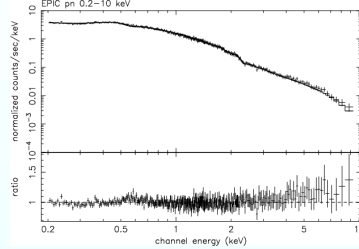
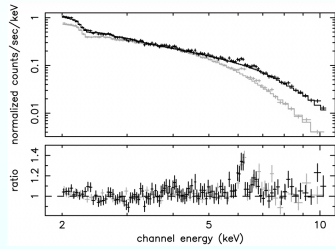
No Fe K line detectable for: $\xi \geq 10$ $f \leq 10^{-12}$ $EW = 400$ eV

Simulations indicate that XMM-Newton cannot detect relativistic Fe K lines from ionized disc due to sensitivity problems, i.e. we have not lost the scattering on the relativistic accretion disc

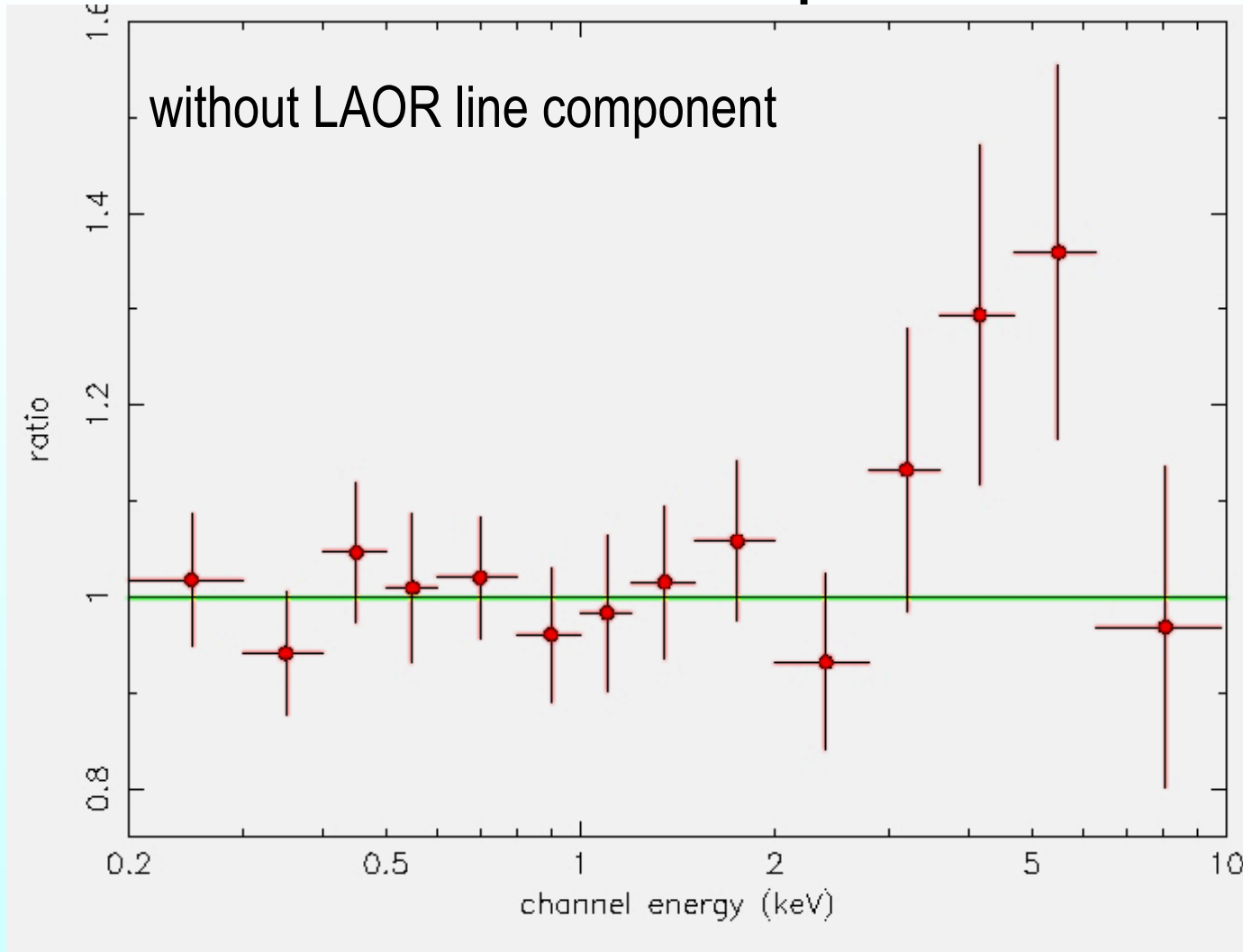
Is this confirmed by nature?

Apply stacking analysis of local type 1 AGN without relativistic features

The first stacked XMM-Newton spectrum of local type 1 AGN in the local universe



Stacked XMM-Newton spectrum of type 1 AGN in the local universe: ratio plot



Excess above
about 3 keV,
above an
underlying
power-law with
 $\Gamma = 1.8(0.1)$

Statistically
acceptable
LAOR line fit

Relativistic
effects from
accretion
disc detected

Similar results obtained by Streblyanskaya, Hasinger in LH stacking

Theorem II: Some open questions of accreting black holes are explained by light bending effects

1. Missing Fe K line response to the varying X-ray continuum
2. Different spectral variability in low- and high flux states

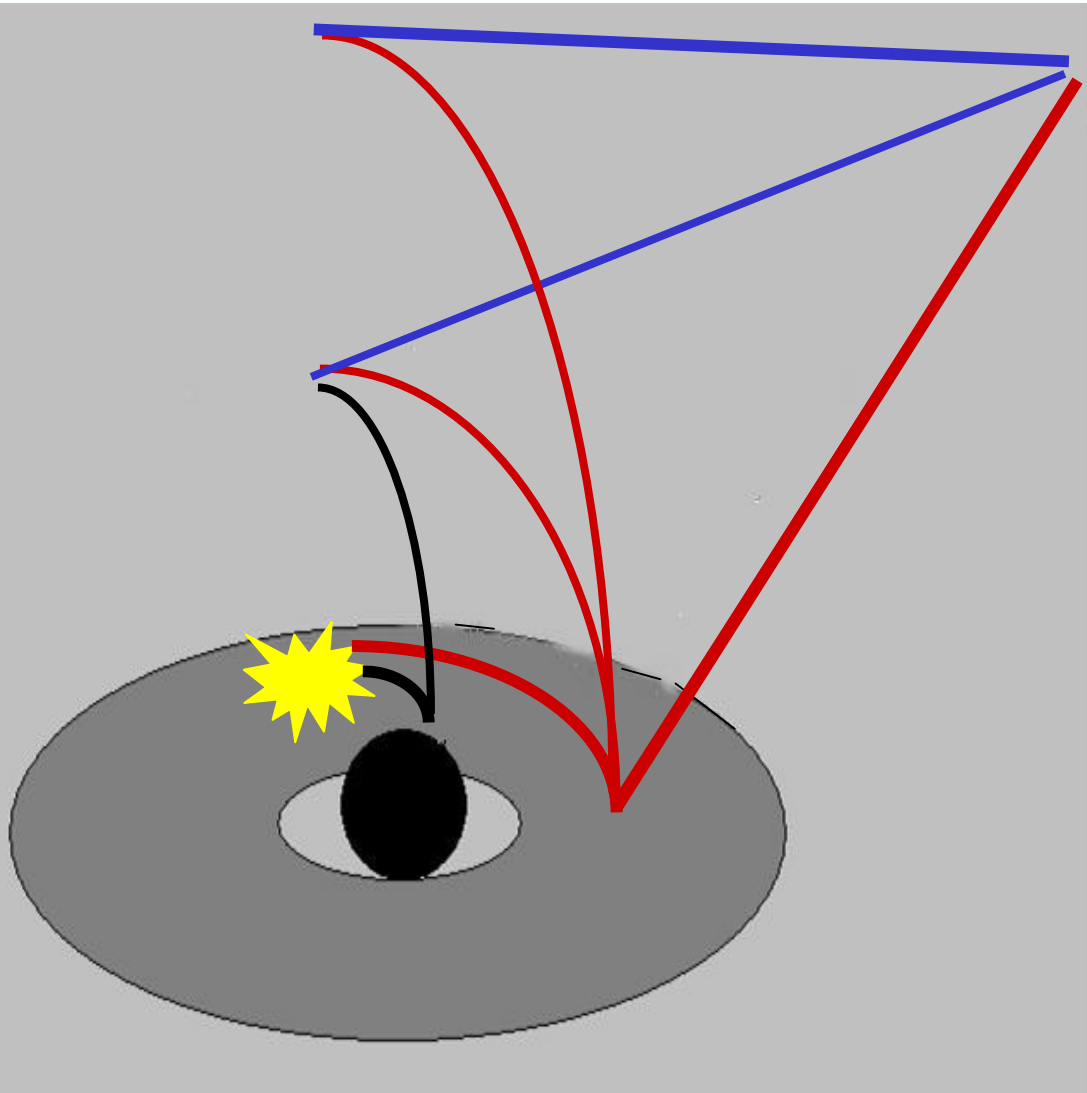
A light bending model in the Kerr BH spacetime

Miniutti 03, Fabian 04

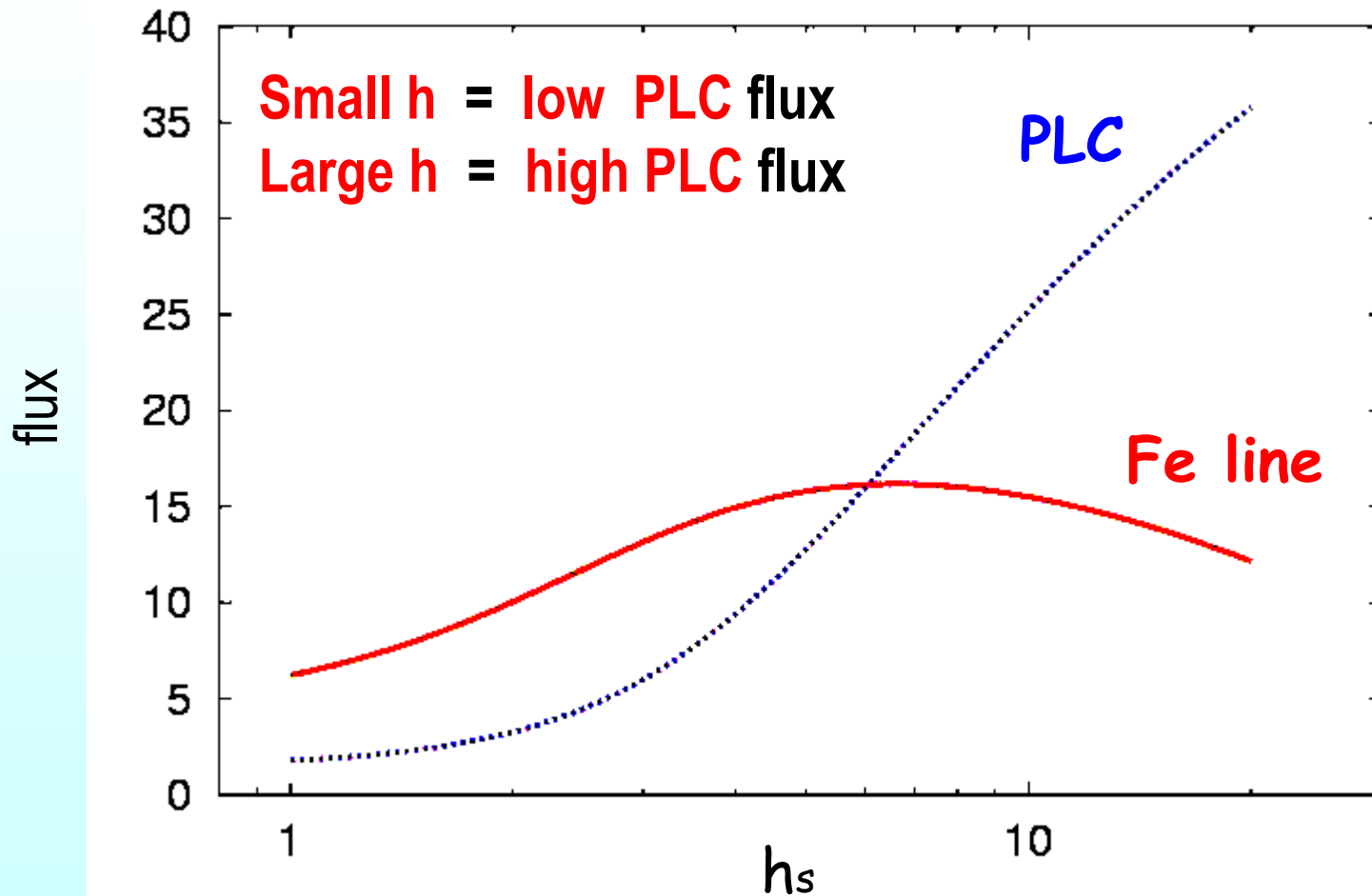
Source height is very large:
standard picture, light bending not effective, half of the photons are intercepted by the disc and half reach the observer, PLC is recovered

Source height increases:
Gravitational potential that power-law photons have to overcome is reduced, so that more photons reach infinity and PLC increases, reflection continuum increases slightly

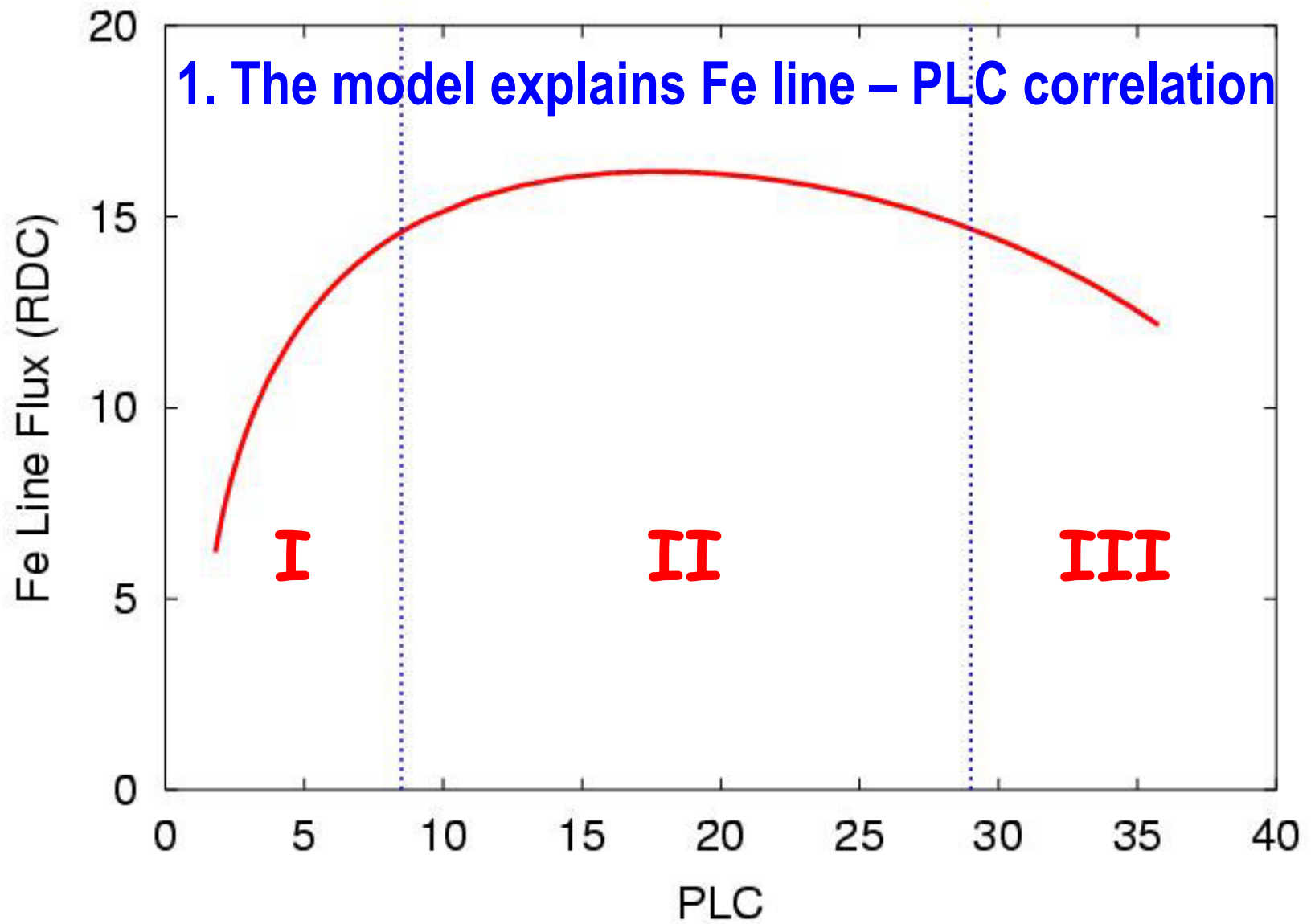
Source height of power-law is small:
Most of the photons are bent towards the disc and lost in the BH reducing the PLC at infinity, spectrum is reflection dominated



PLC and Fe line variability induced by light bending

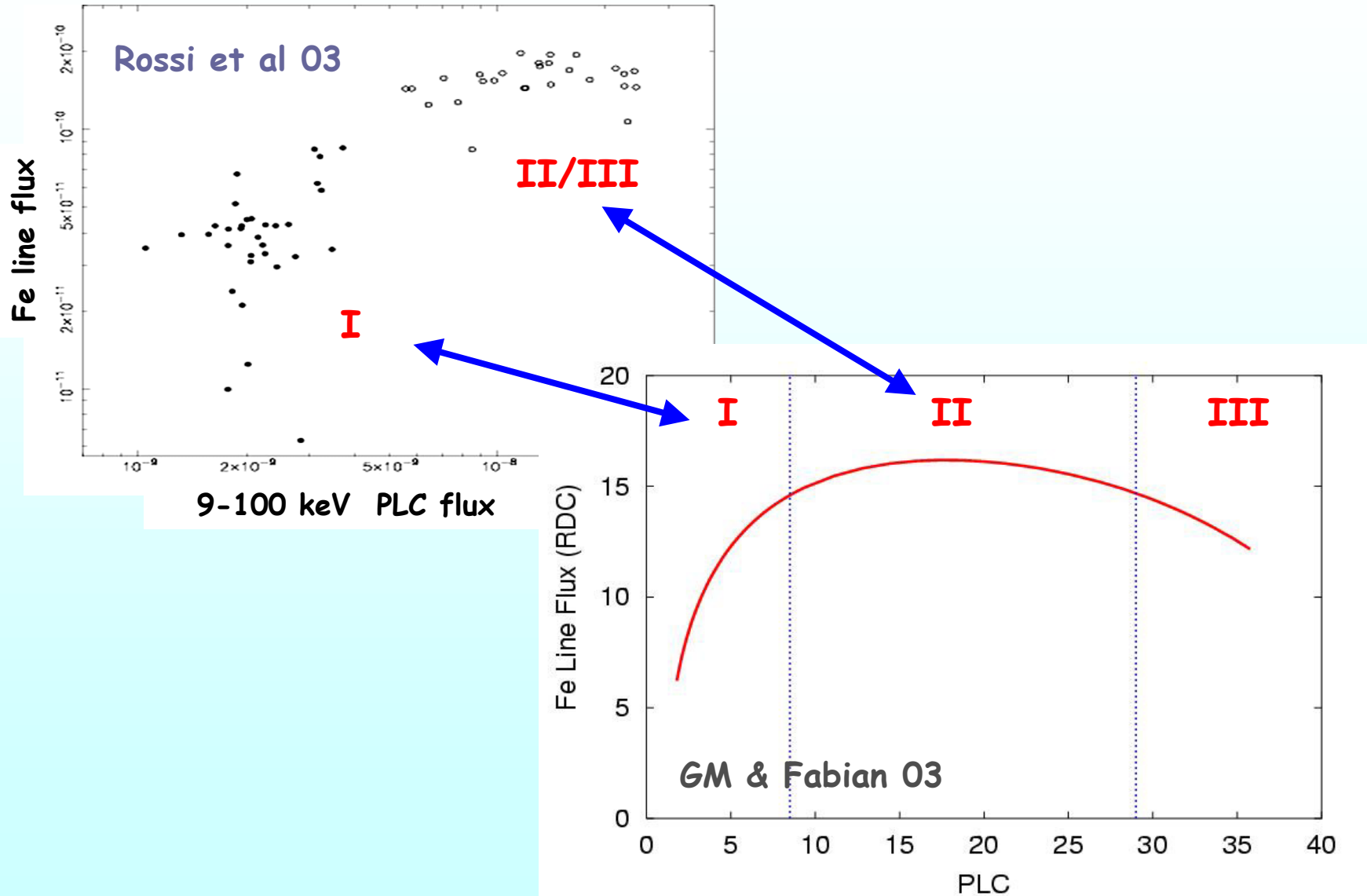


PLC varies with larger amplitude compared to Fe line



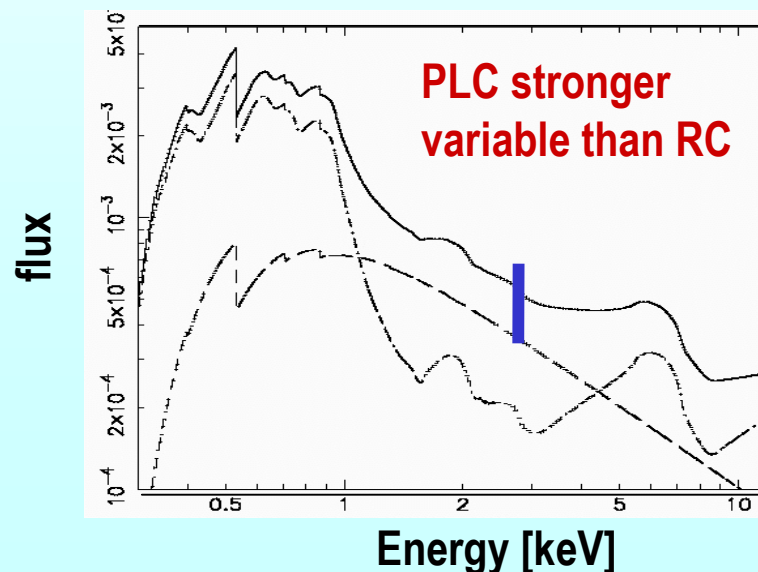
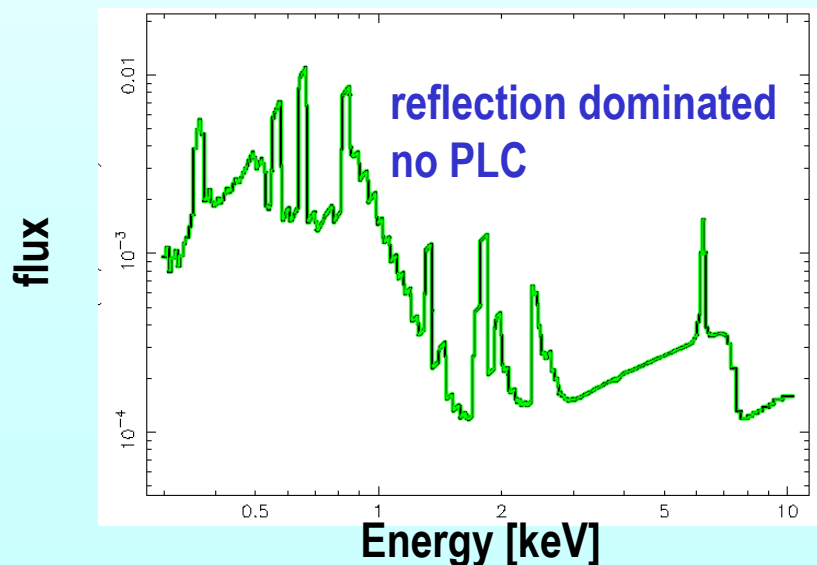
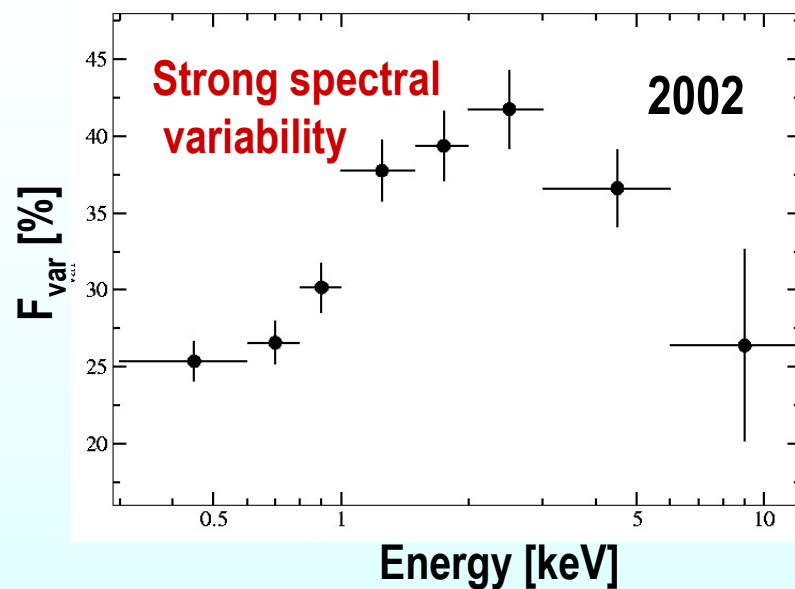
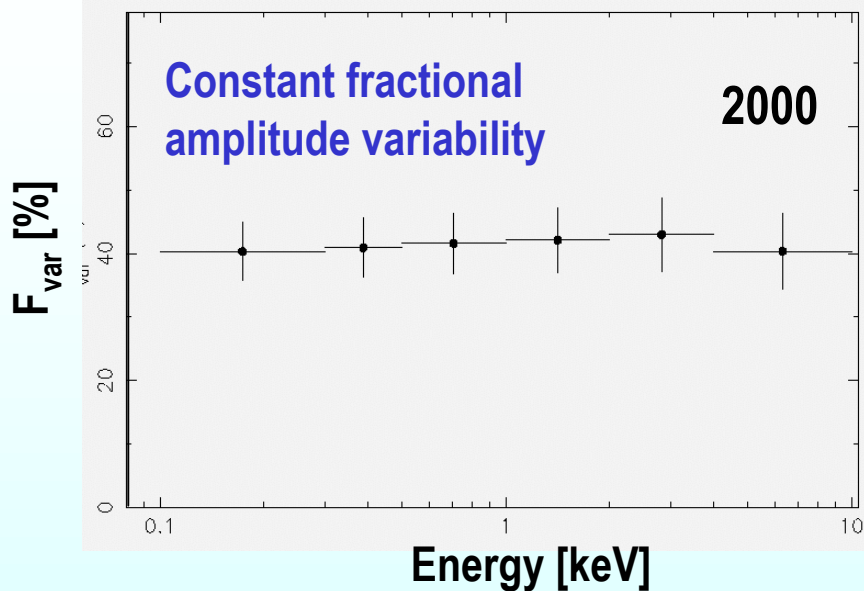
Regime **I**: small source height and correlation

XTE J1650-500 during outburst



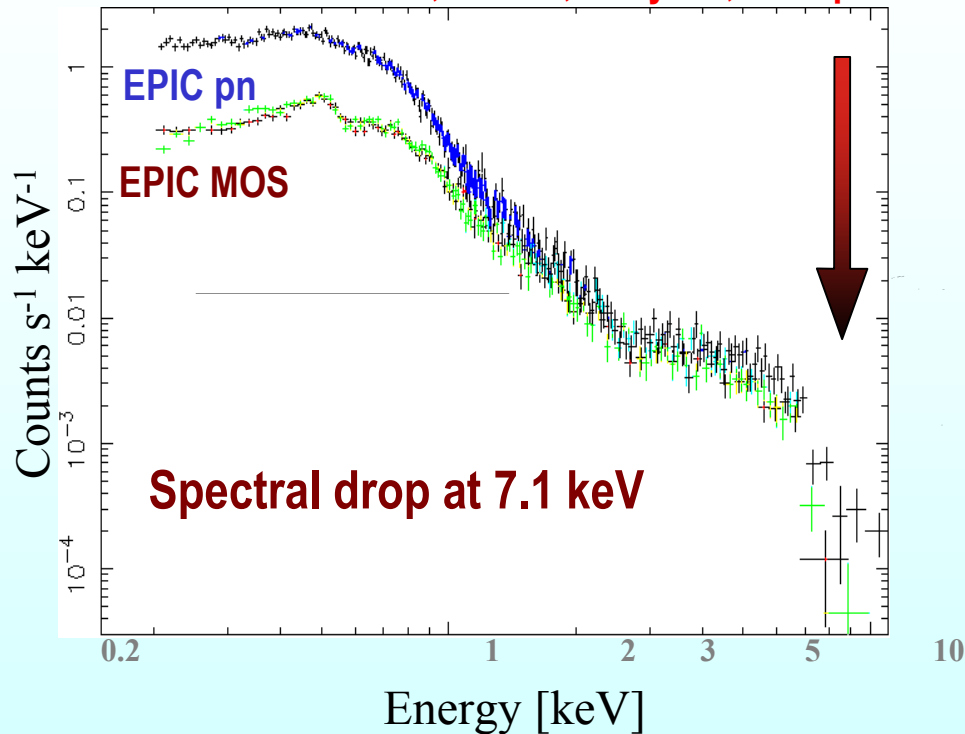
2. Explains spectral variability in low and high flux states

1H0707-495

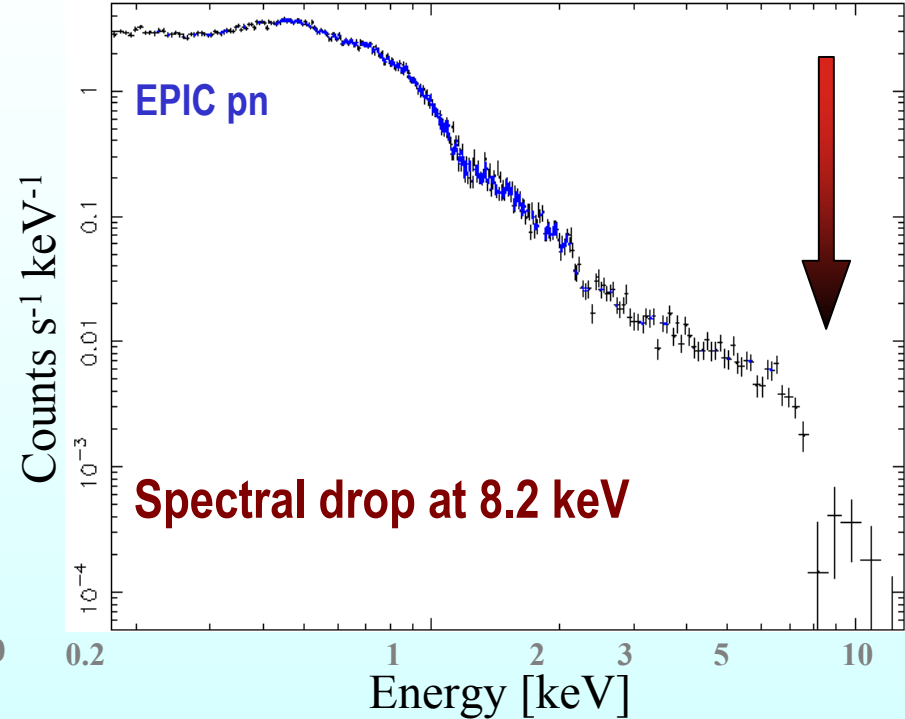


Theorem III: Unique spectral and timing features in NLS1s poses new challenging problems

1H 0707-495 Boller, Fabian, Sunyaev, Trümper 2002



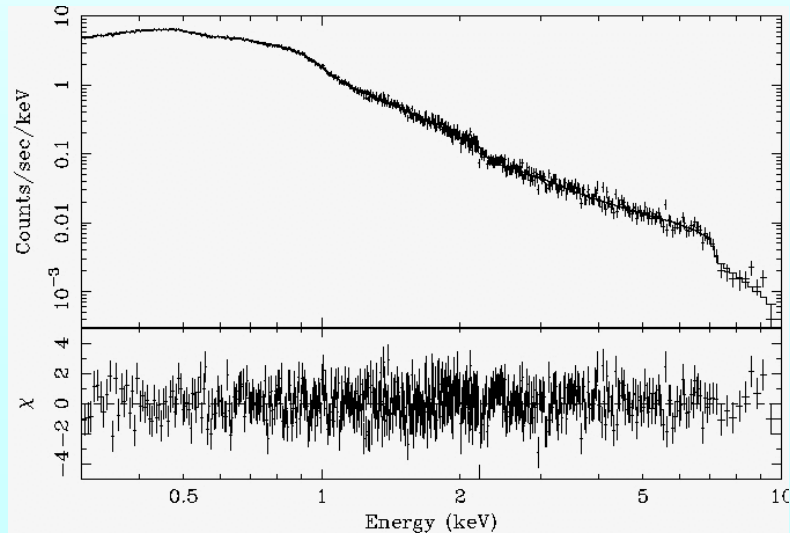
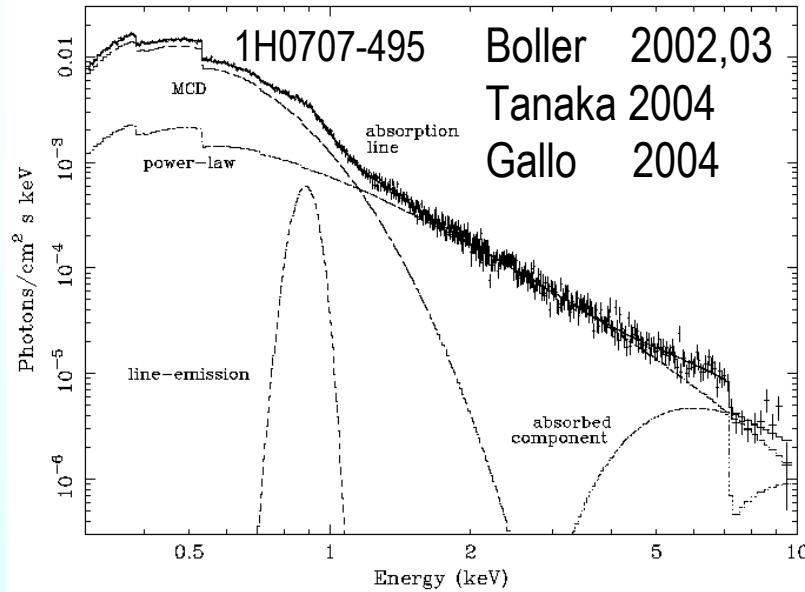
IRAS 13224-3809 Boller, Tanaka, Fabian 2003



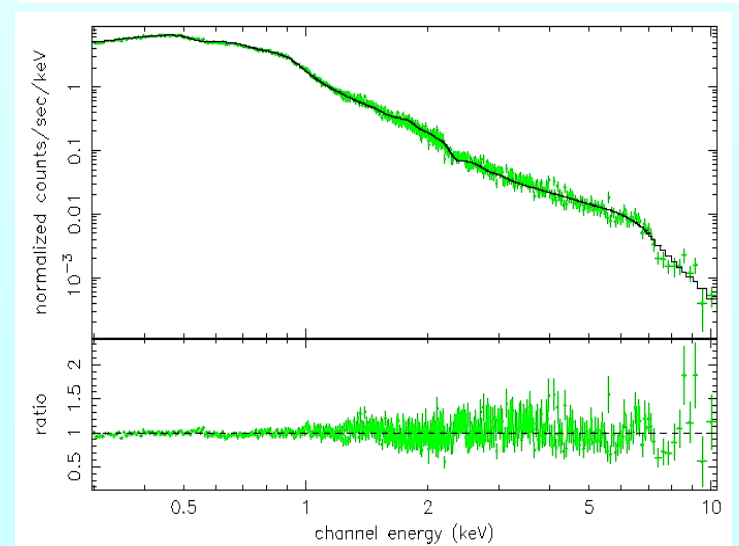
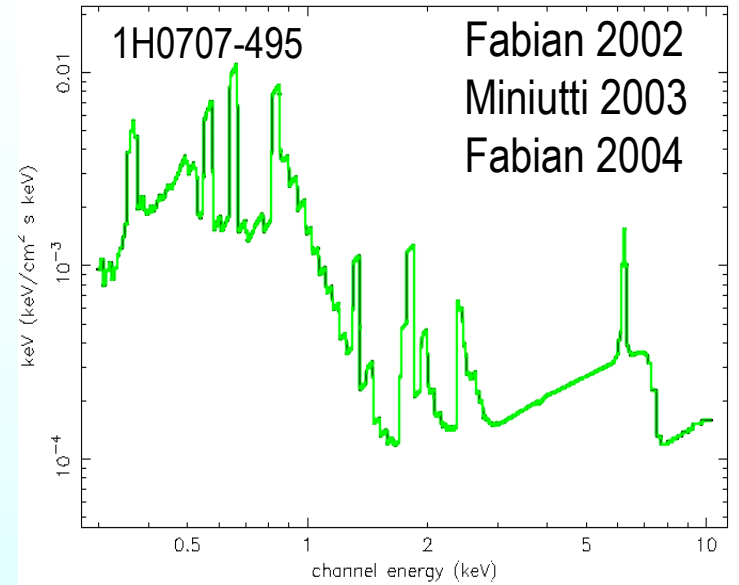
XMM-Newton detection of dramatic spectral drops above 7 keV in NLS1s

Interpretation is still not unique

Photoelectric absorption

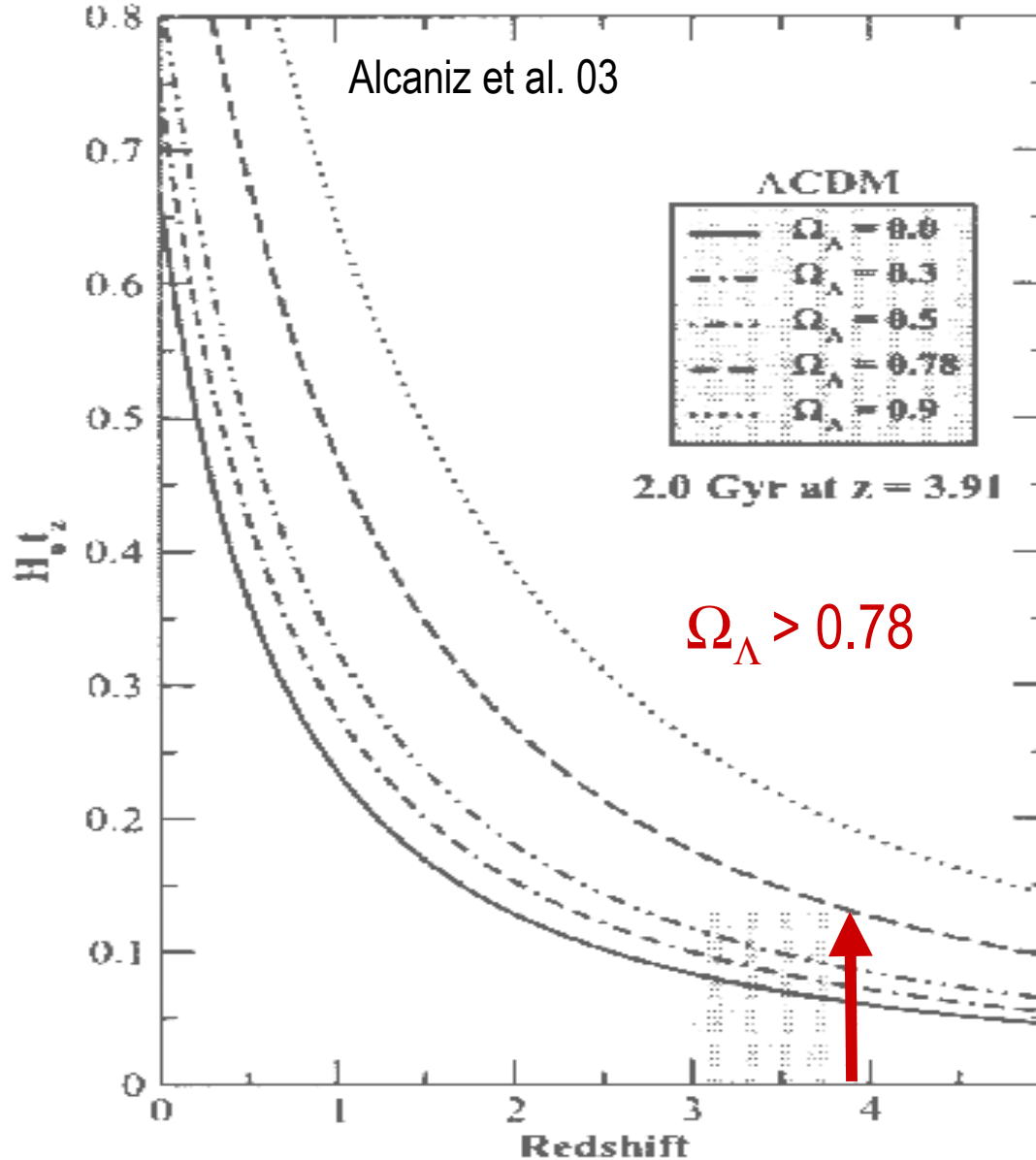


X-ray reflection, light bending



Theorem IV: Age determination in the early universe constrain dark energy and BH formation time

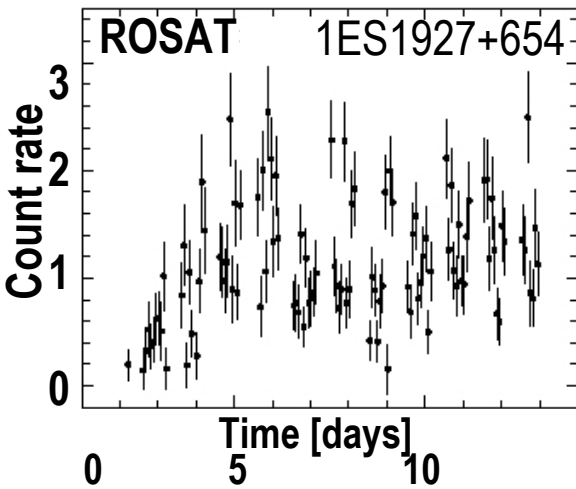
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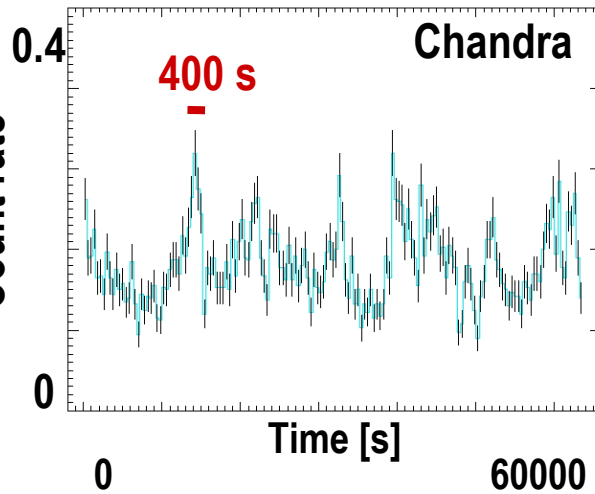
t al. 2003)
dark energy

Theorem V: The standard Sy1/Sy2 unification scheme is oversimplified

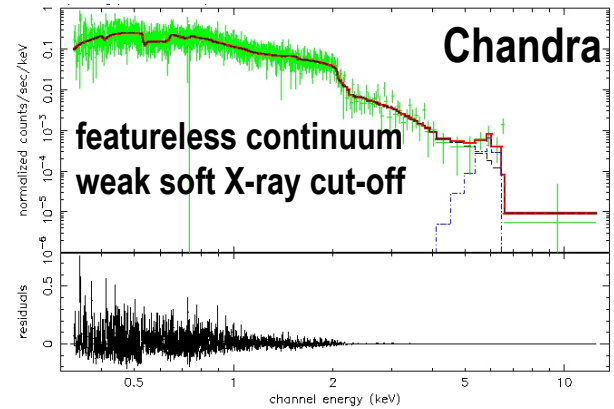
X-rays - direct view to central AGN



amplitude variability with factor of 17



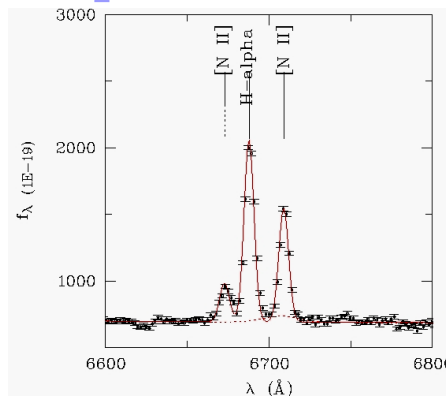
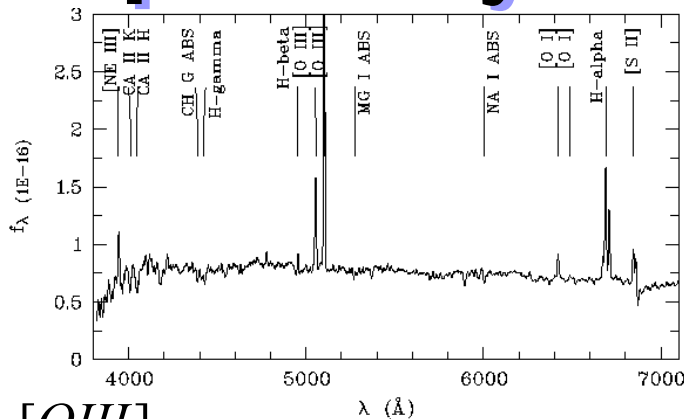
type 1 nature at X-rays



$$N_H^{intr} = 3 \cdot 10^{20} \text{ cm}^{-2} \Rightarrow A_V(X) = 0.15$$

low intrinsic neutral N_H

Optical Seyfert 2 spectrum - no broad wings



$$A_V(NLR) = 1.7$$

$$A_V(BLR) = 3.7 \Leftrightarrow A_V(X) = 0.15$$

$$\frac{[OIII]}{H_\beta} = 15 \quad \text{no Fe multiplet lines} \quad \text{no broad } H_\alpha \text{ line detectable}$$

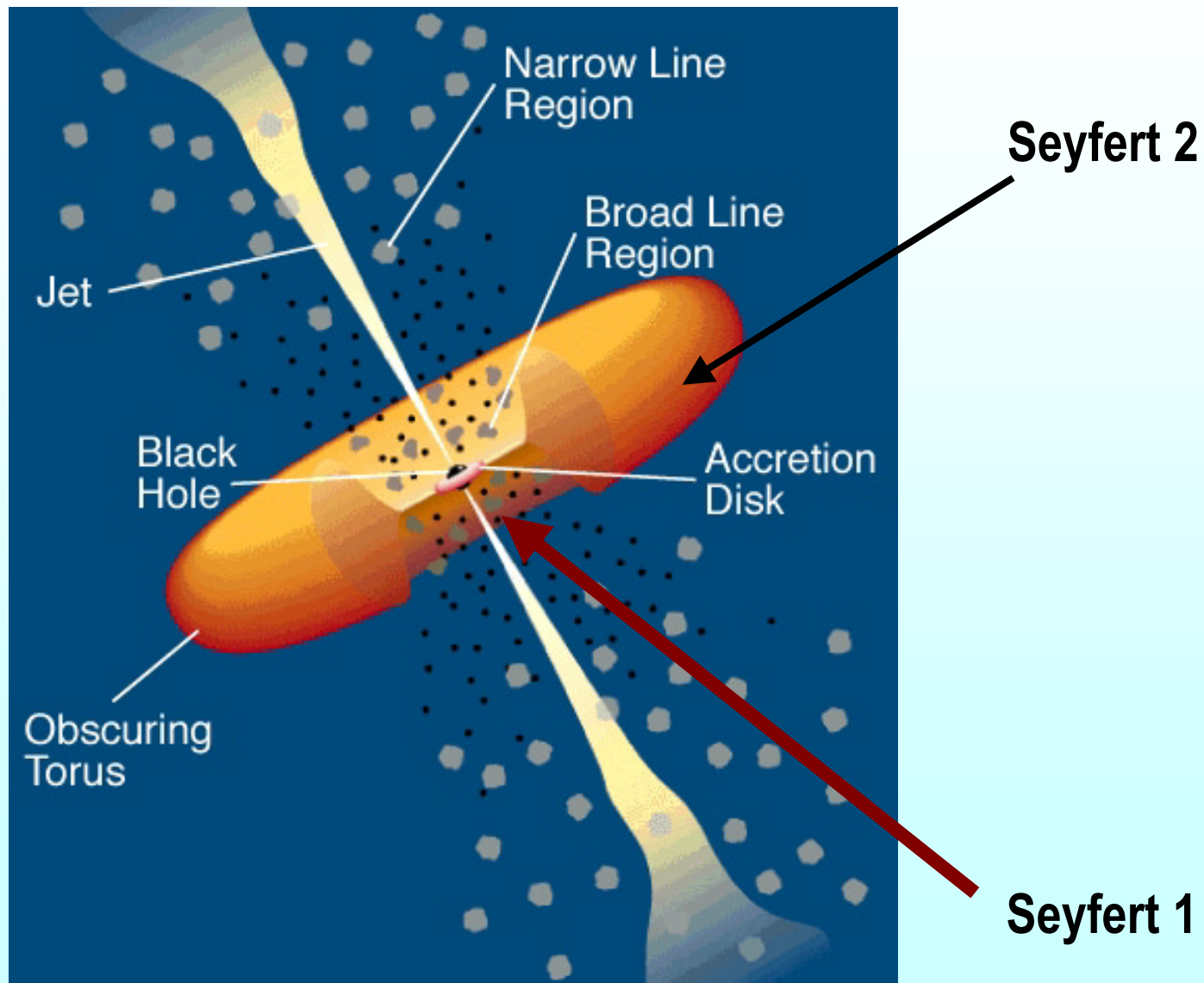
X-ray: direct view to central BH,
Optical: BLR not visible (view blocked)

Plausible scenarios:

Underluminous BLR

Dust optically thick for X-rays

High column ionized X-ray gas



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The end – thank you