AGN with HE sharp spectral drops: Status and Issues for the coming decade

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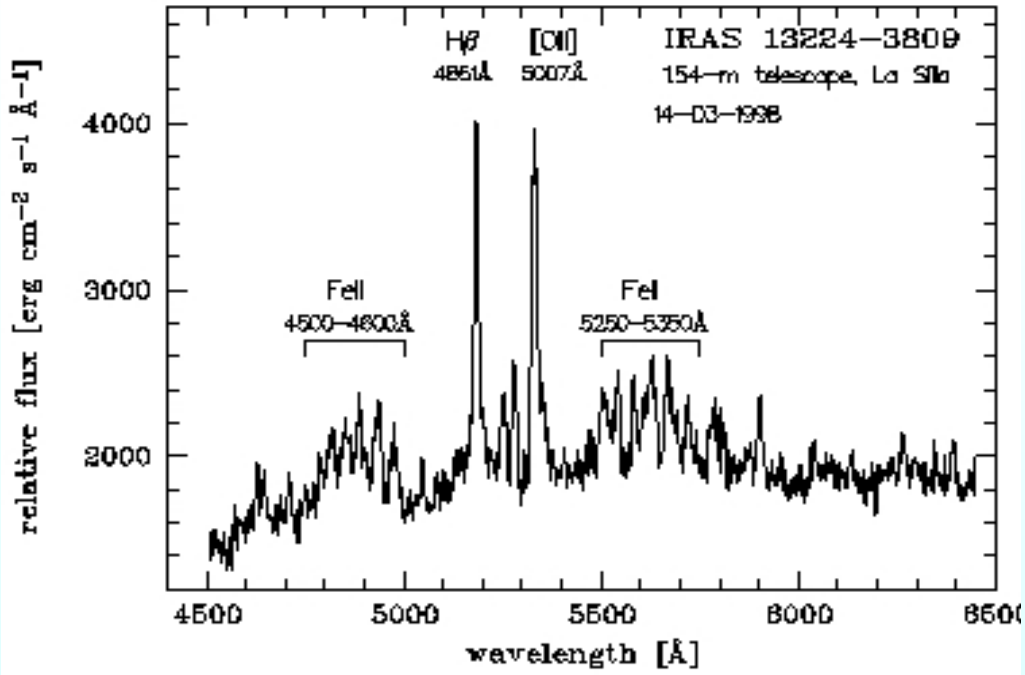
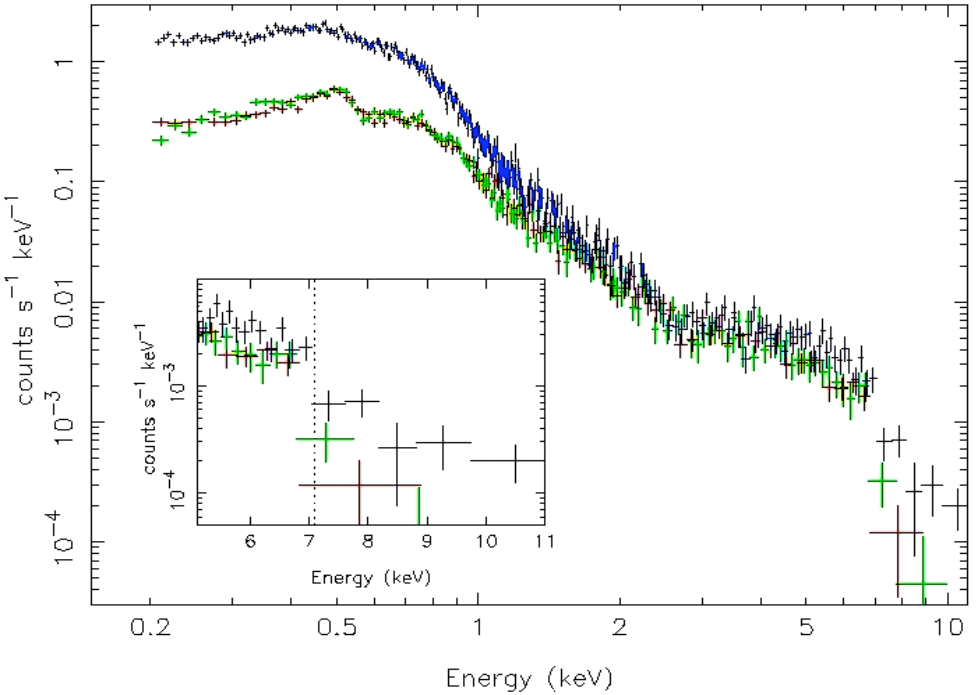
In collaboration with
AF, YT, LG, NB,SV,RS

NLS1s with sharp spectral drops

OPTICAL



X-rays



-FWHM Hβ < 2000 km s^{-1}
-Strongest Fe II emitters in the Universe
- [OIII]/Hβ <3

Strongest soft excess ever observed
Sharp spectral drop at 7.1,7.5,8.2 keV
No Fe K line at all

Historical Review

1971 Zwicky: first report on extreme variability
'optical outbursts in I Zw1`

1983 Osterbrock: initiates systematic investigation on NLS1

1992 Puchnarewicz: report on steep X-ray spectra

1996 Boller,Brandt &Fink:
soft X-ray continuum and optical line width relation

2000 Boller, Fabian, Sunyaev:
Detection of sharp spectral drops, PC interpretation

2003 Fabian, Miniutti et al:
Reflection model, extreme Kerr Black hole Space time

2004 Gallo et al: Alternating lags, detailed var. studies

2004-2006: no real physical understanding emerged

How to interprete the nature of the soft X-ray emission

Reflection spectrum interpretation (ACF et al., all?)

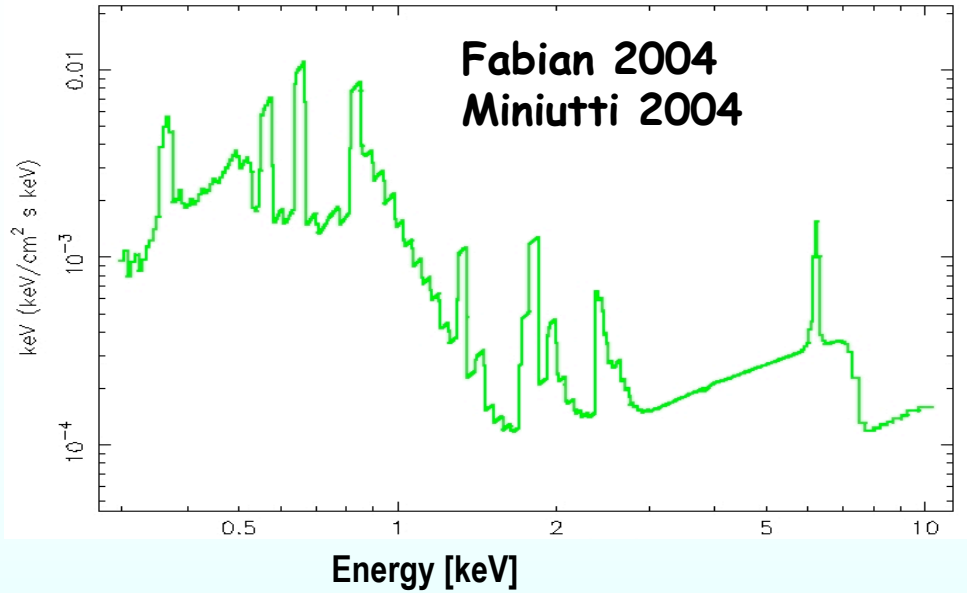
or

Thermal disc interpretation (TB?, YT?)

or

Absorption (CD)

Reflection spectrum interpretation



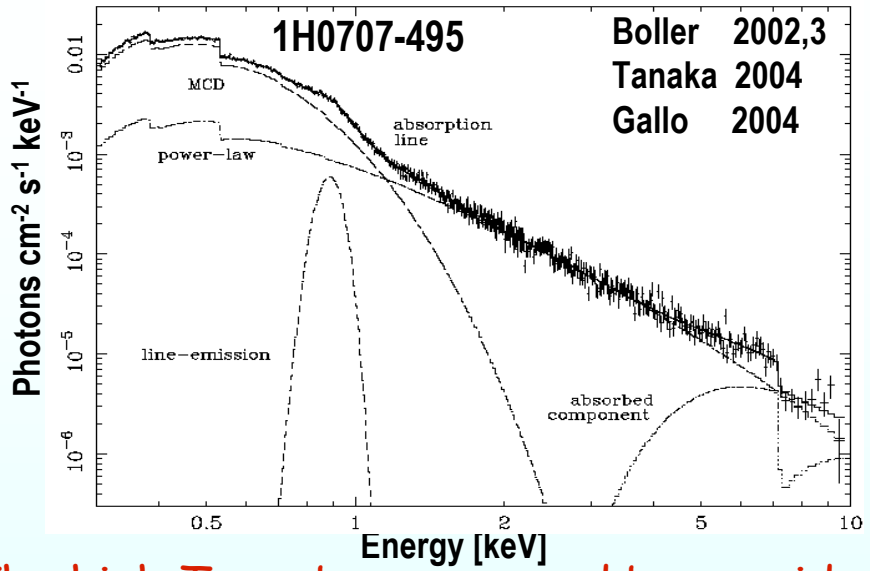
Ross & Fabian suggest that the soft-excess is explained by blurred emission lines and bremsstrahlung from the hot disc surface

Benefit of the reflection model is that the bumps in the soft energy band of 1H0707 can be naturally attributed to reflection as a complex Fe-L lines

AND

The missing response of the Fe K line to a varying illumination strength

Thermal disc interpretation



The high T can be recovered by considering super-Eddington accretion

Rather uniform shape of the soft-excess a characteristic T of about 120 eV emerges, the spread inT is small, however the L in samples span three orders of mag. This is not simple to understand in terms of any existing accretion disc theories.

Sharp spectral drops in the HE spectra of NLS1s

The **sharpness** of the feature

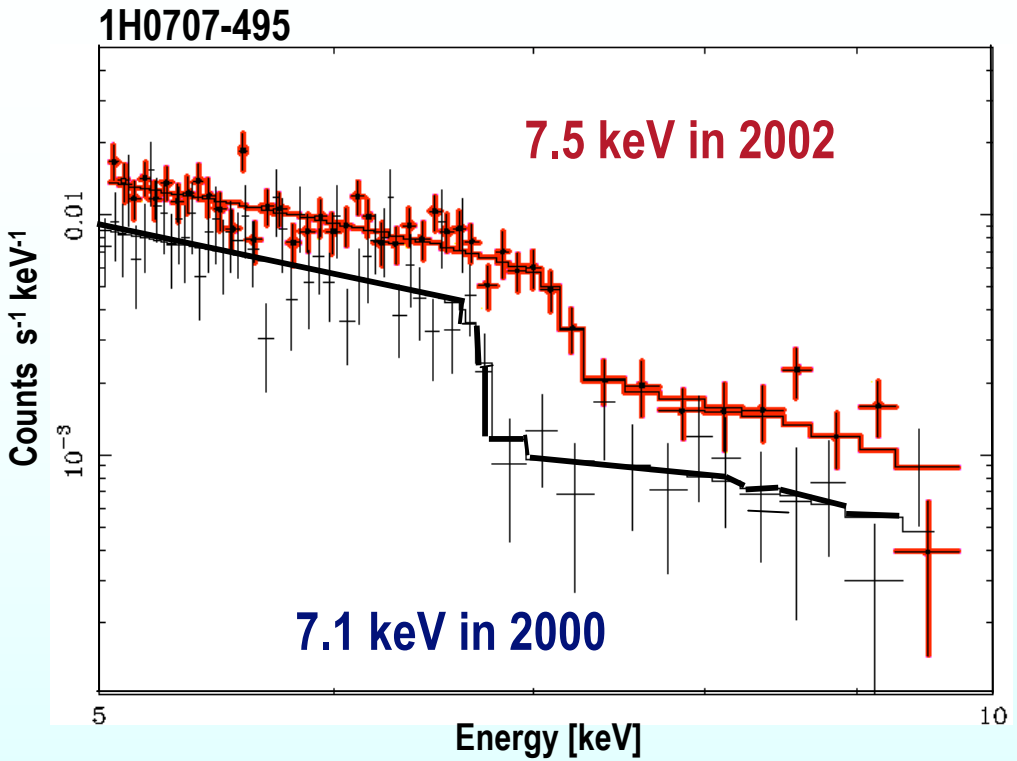
- most fundamental discriminator between partial covering and reflection models

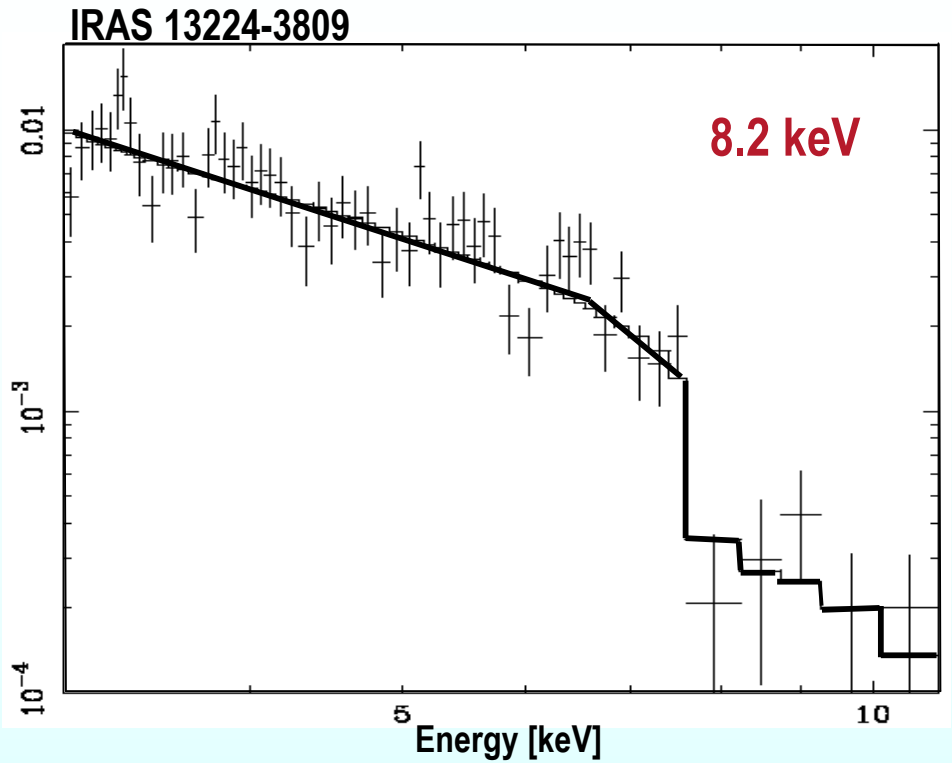
-feature always sharp (<200 eV, resolution of the EPIC pn detector) in case of neutral absorption, whereas it will be broader in the line interpretation

- The measurements appears to rule out high photoionization, but is still not sufficient to exclude either partial covering or reflection, from statistical reasons

- though it becomes a concerning for reflection

Details of the deep spectral drop:relevant for high accretion rates





drop energy not always the same

for 1H 0707, it strikingly it shifted from **7.1** to **7.5** keV (>5 σ)

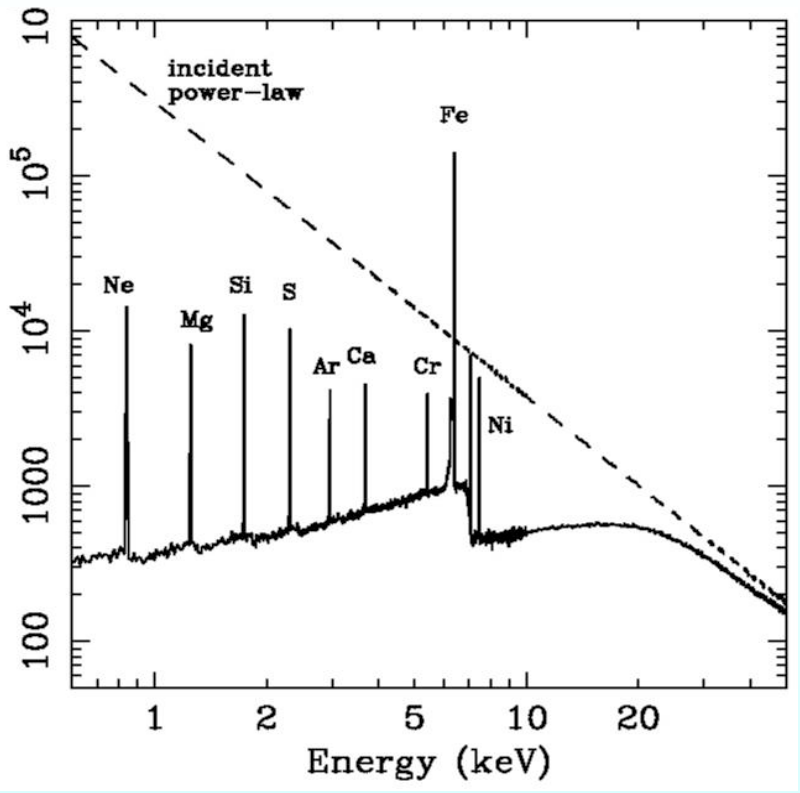
for IRAS 13224 is found even higher at **8.2 keV**

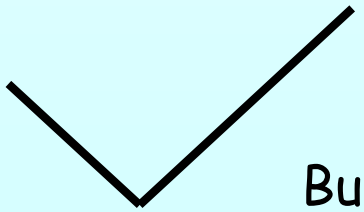
PCM: higher ionization (Fe VII-X, Fe XIX-XXIII) unlikely, missing Kβ absorption
high outflow v of 0.05 and 0.15 c required

RDM: energy shift due to different ξ

The present models

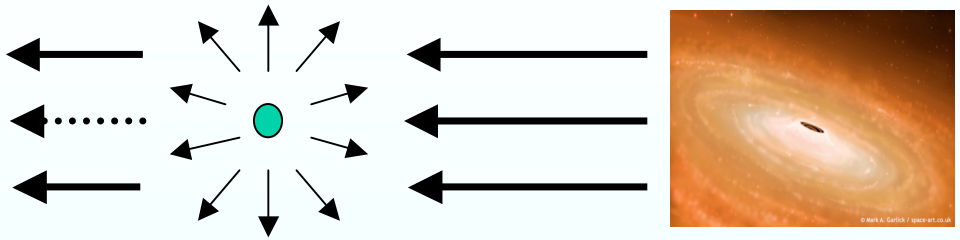
Reflection dominated





But .....

Partial Covering



Absorber in the disc region
small clouds with extremely high densities to keep Fe neutral

theoretical predicted by Rees 1987 and .....

The thermal soft excess interpretation appears to be out, BUT, optically thick Clouds as proposed by Rees and others may also exist in the RM
i.e., dense, small, high column density absorbers are not proven to be out

A physical scenario for the partial coverer model

Place the absorber within the accretion disk emission region

Magnetic confinement of broad-line clouds in active galactic nuclei

Martin J. Rees *Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA*

Accepted 1987 August 7. Received 1987 August 4

Summary. The region containing the clouds that emit the broad spectral lines in active galactic nuclei may be pervaded by a magnetic field of strength ~1 G. Magnetic stresses could then confine the clouds, obviating the need for a Compton-heated medium in pressure balance with the clouds.

Dense thin clouds in the central regions of active galactic nuclei

A. Celotti,[1,2] A. C. Fabian[1] and M. J. Rees[1]
[1]*Institute of Astronomy, Madingley Road, Cambridge CB3 0HA*
[2]*International School for Advanced Studies, Trieste, Italy*

Accepted 1991 October 28. Received 1991 October 25; in original form 1991 September 20

Dense, thin clouds and reprocessed radiation in the central regions of active galactic nuclei

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[1]*Institute of Astronomy, Madingley Road, Cambridge CB3 0HA*
[2]*SISSA/ISAS, via Beirut 4, 34014 Trieste, Italy*

Accepted 1996 September 12. Received 1996 August 7; in original form 1996 May 29

Physical constraints on the sizes of dense clouds in the central magnetospheres of active galactic nuclei

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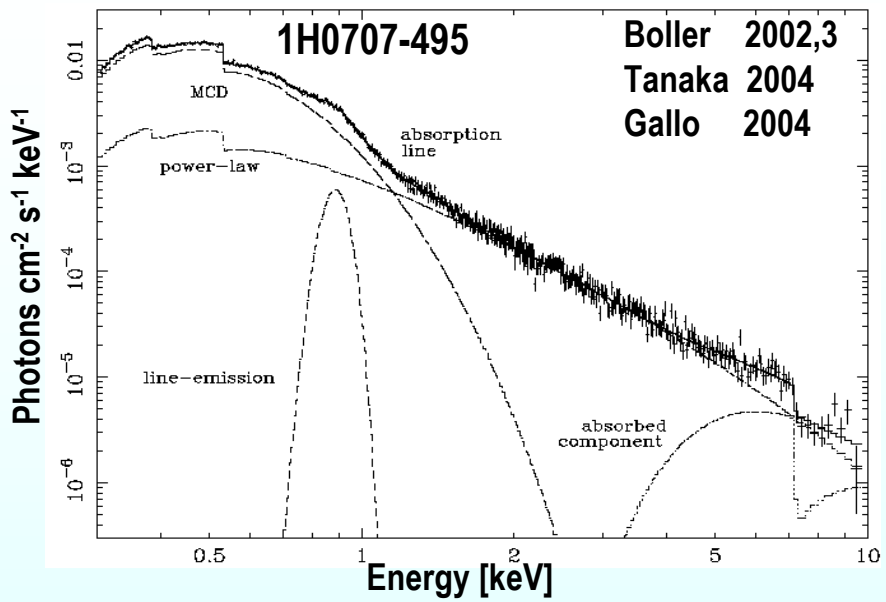
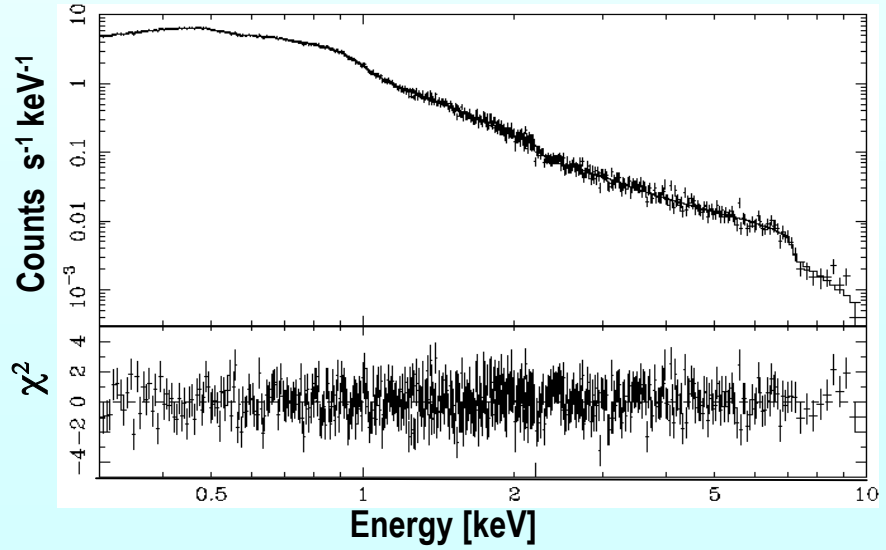
Institute of Astronomy, Madingley Road, Cambridge CB3 0HA

Accepted 1996 August 5. Received 1995 July 31; in original form 1996 May 13

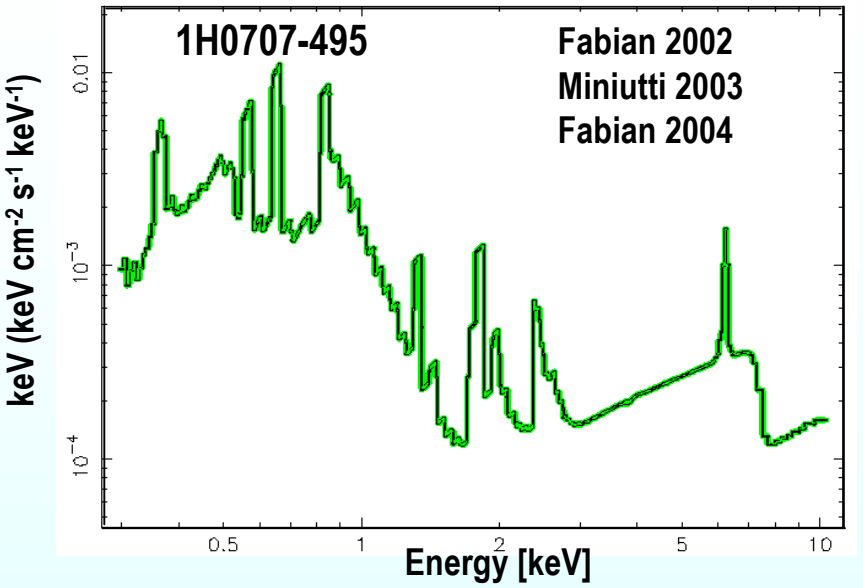
The simplied models

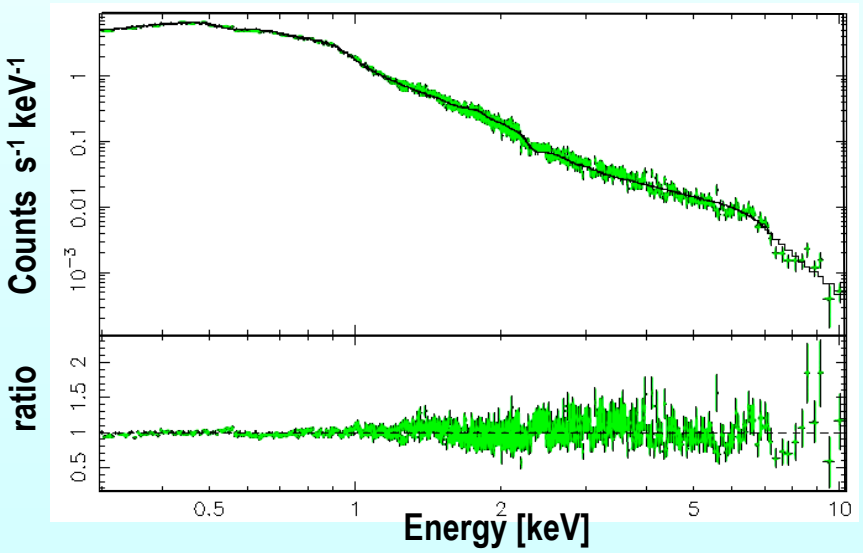
Photoelectric absorption





X-ray reflection (light bending)





XMM-Newton cannot disentangle absorption from reflection

Some observational facts which do not completely agree with the model predictions

and some which support RM and PC model

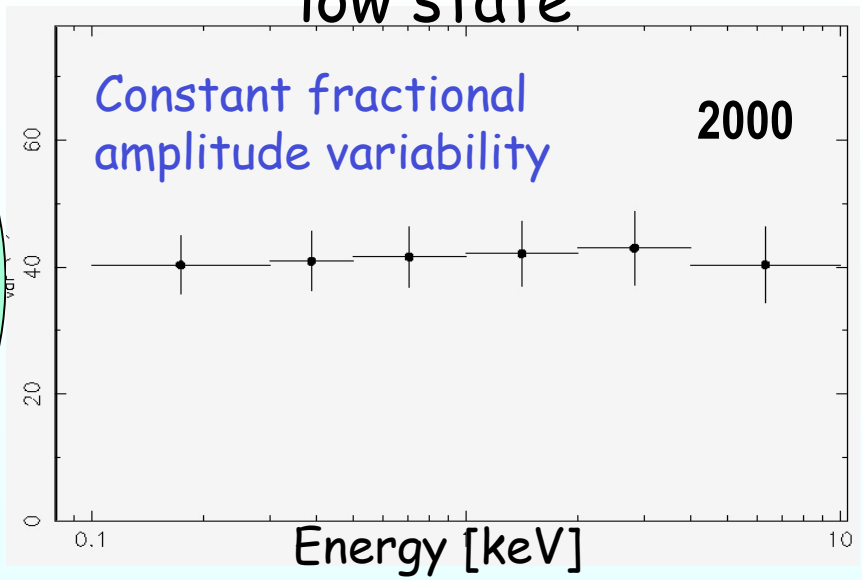
The picture is maybe a bit more complicated

Soft questions

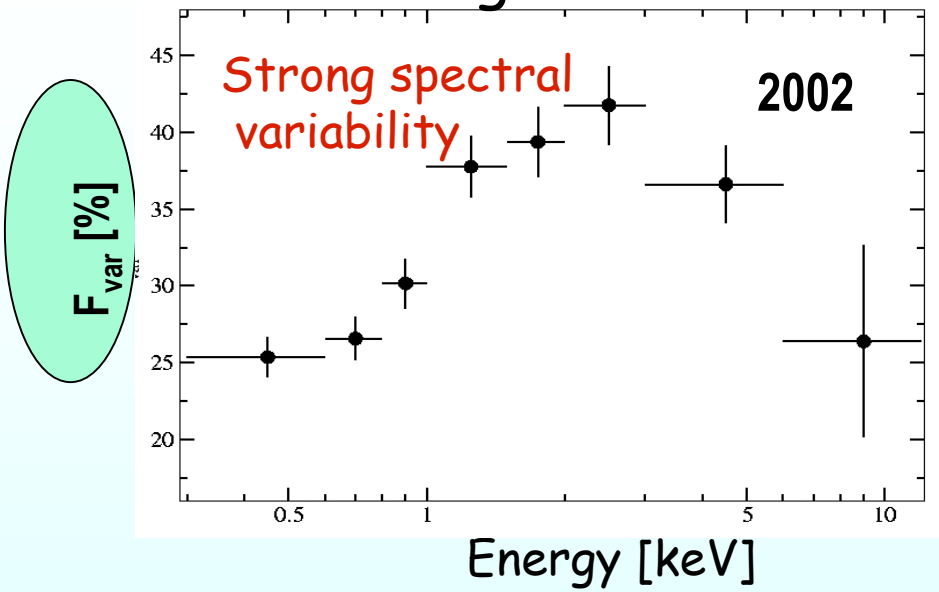
Confirming prediction of the RM on spectral var.

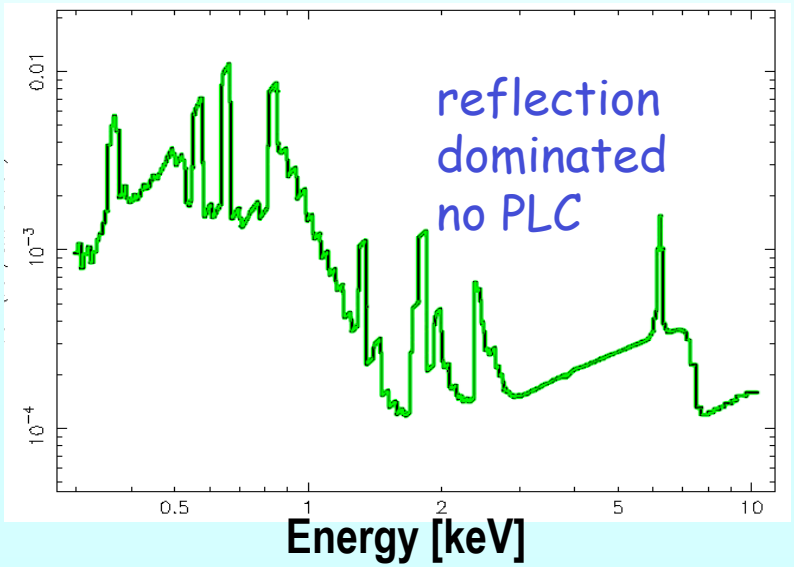
1H0707-495 (Gallo et al.)

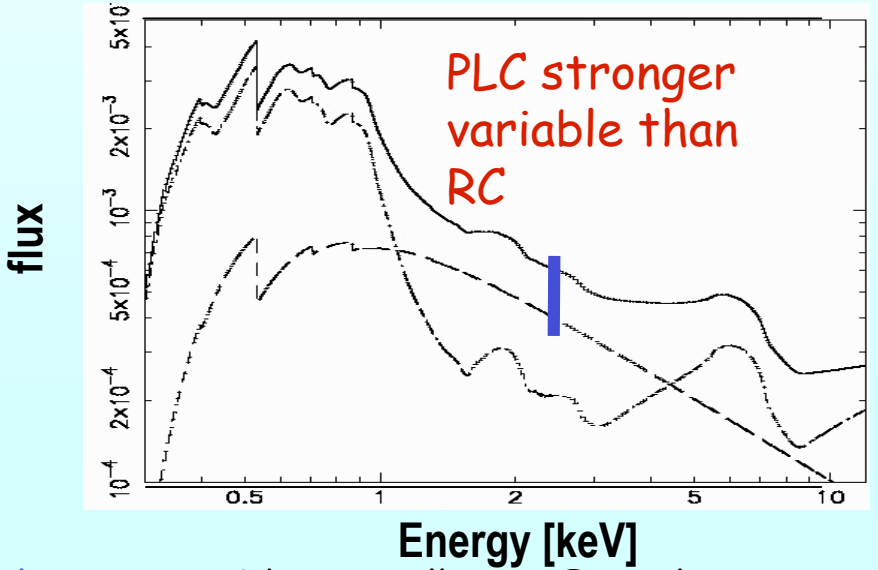
low state



high state

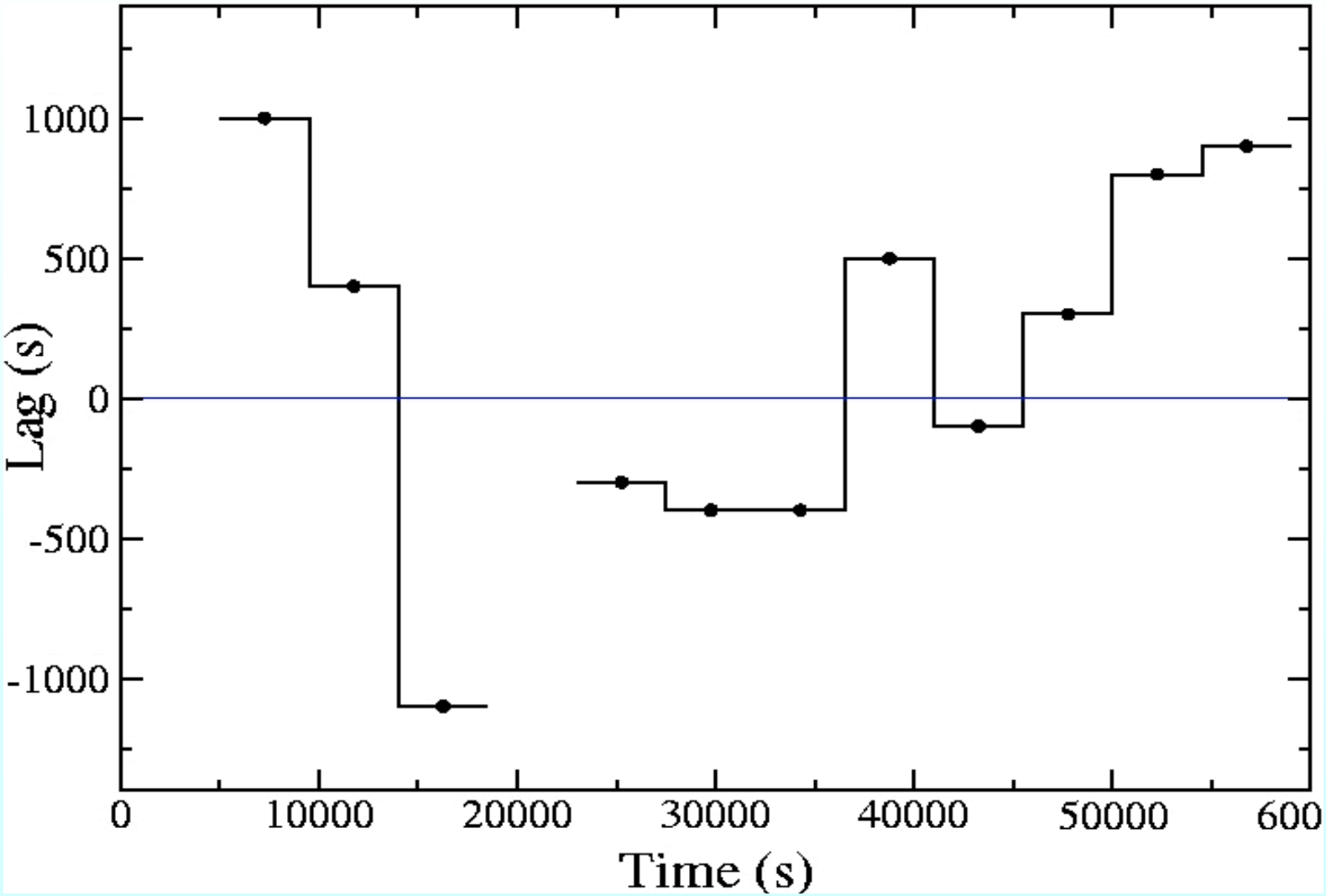






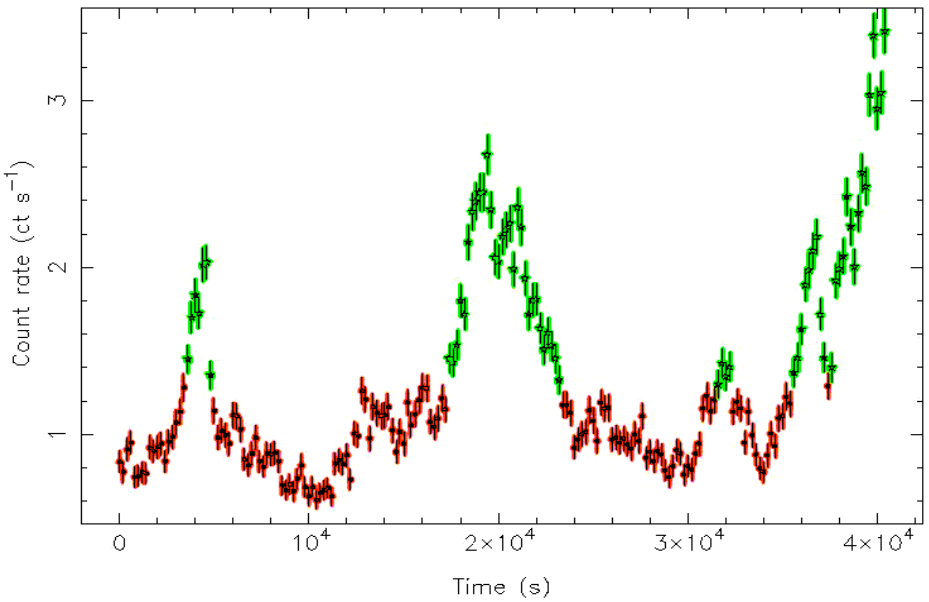
Alternating lags may be due to the ~0.1c height change of the compact PL source

Gallo et al. 2004

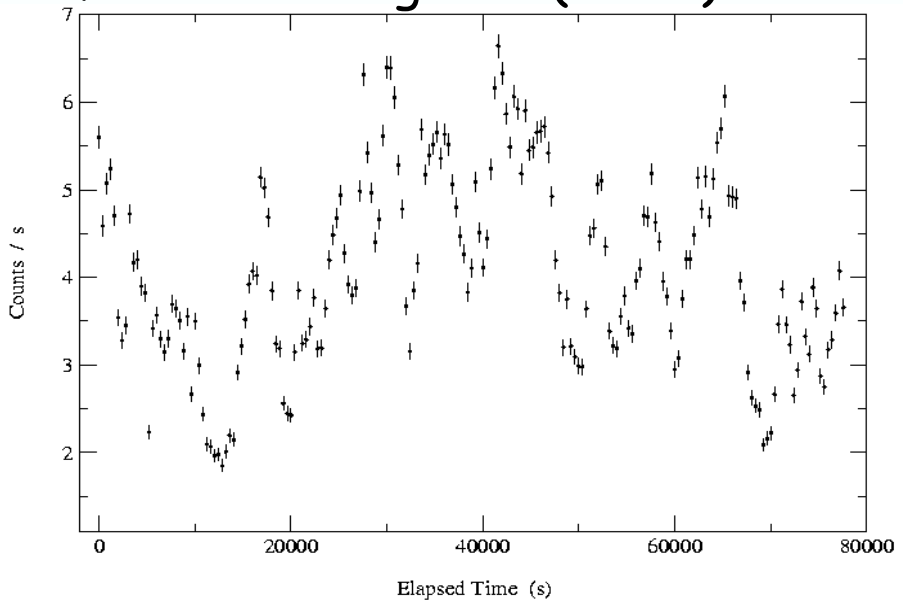


Variability problem in reflection model?

Low flux state (2000)



High flux state:
factor 10 brighter (2002)



Variability stays constant, but should not according to the RM

Spectral problem between high and low state?

Reflection modell for 1H0707 in 2002: HIGH STATE

In the high-flux state (Leighly 2002) the soft excess was still dominated over the power-law, and the 0.9 keV line (not required in the RM MODEL) were present, both should be significantly suppresed

Reflection modell for 1H0707 in 2000: LOW STATE

spectral line emission at ~ 0.9 keV line were not al all

Problems with the Fe K EW value in the RM?

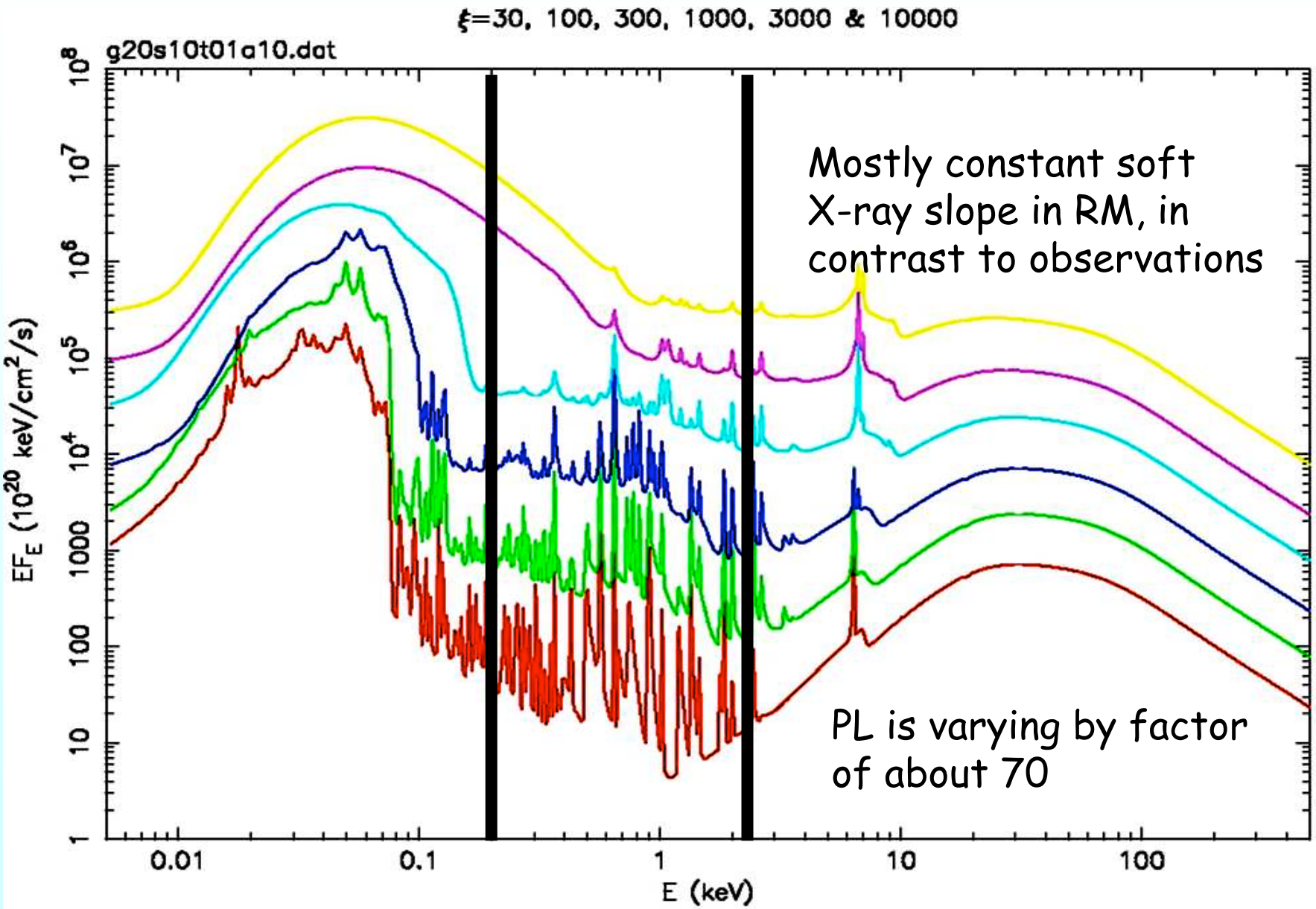
If it is reflection, than AC has discovered the strongest Fe K lines in the universe!!!

The EW is about 5 keV

Can we really explain 5 keV EW values, one order of magnitude above the usually measured values

Ionized line emission (rest frame)

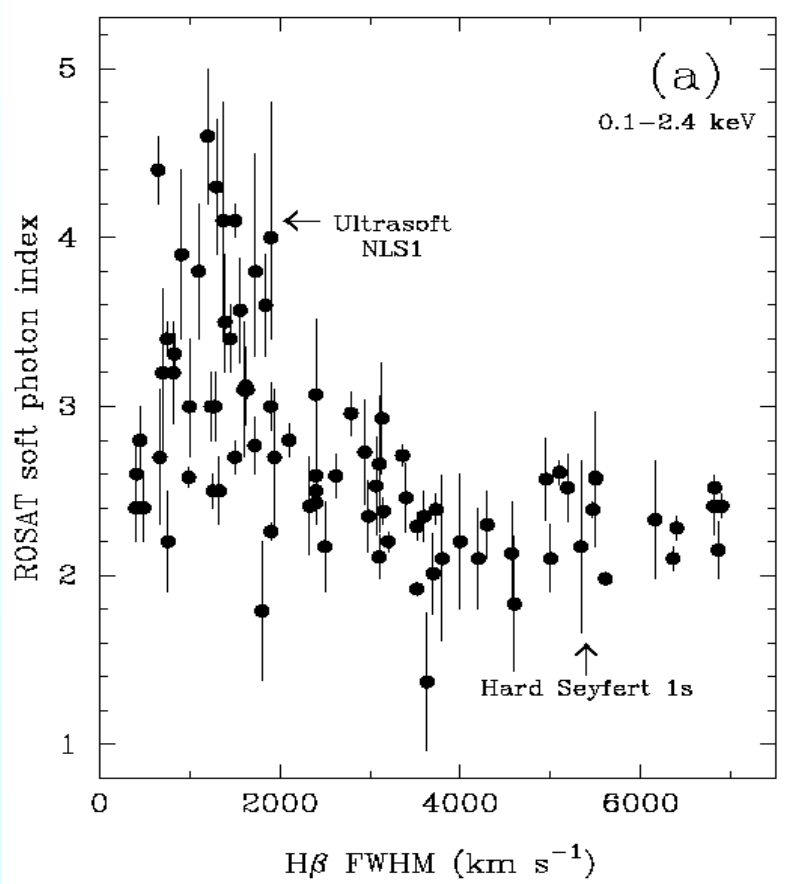
(Ross & Fabian 93, 04)

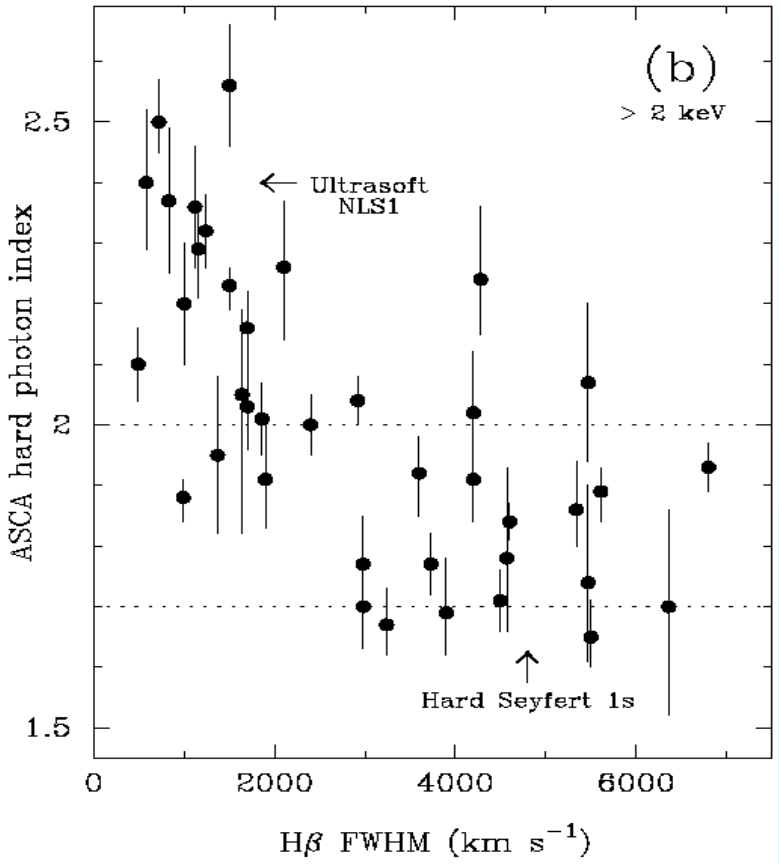


Problem with the steepness of the soft X-ray spectra ?

Nature tells us that AGN have orders of mag. different spectral slopes
Soft Band: f ~ E^{2-6} RM: constant reflection and constant incident PL sp.
Hard Band: f~ $E^{1.7-2.6}$ RM might fit

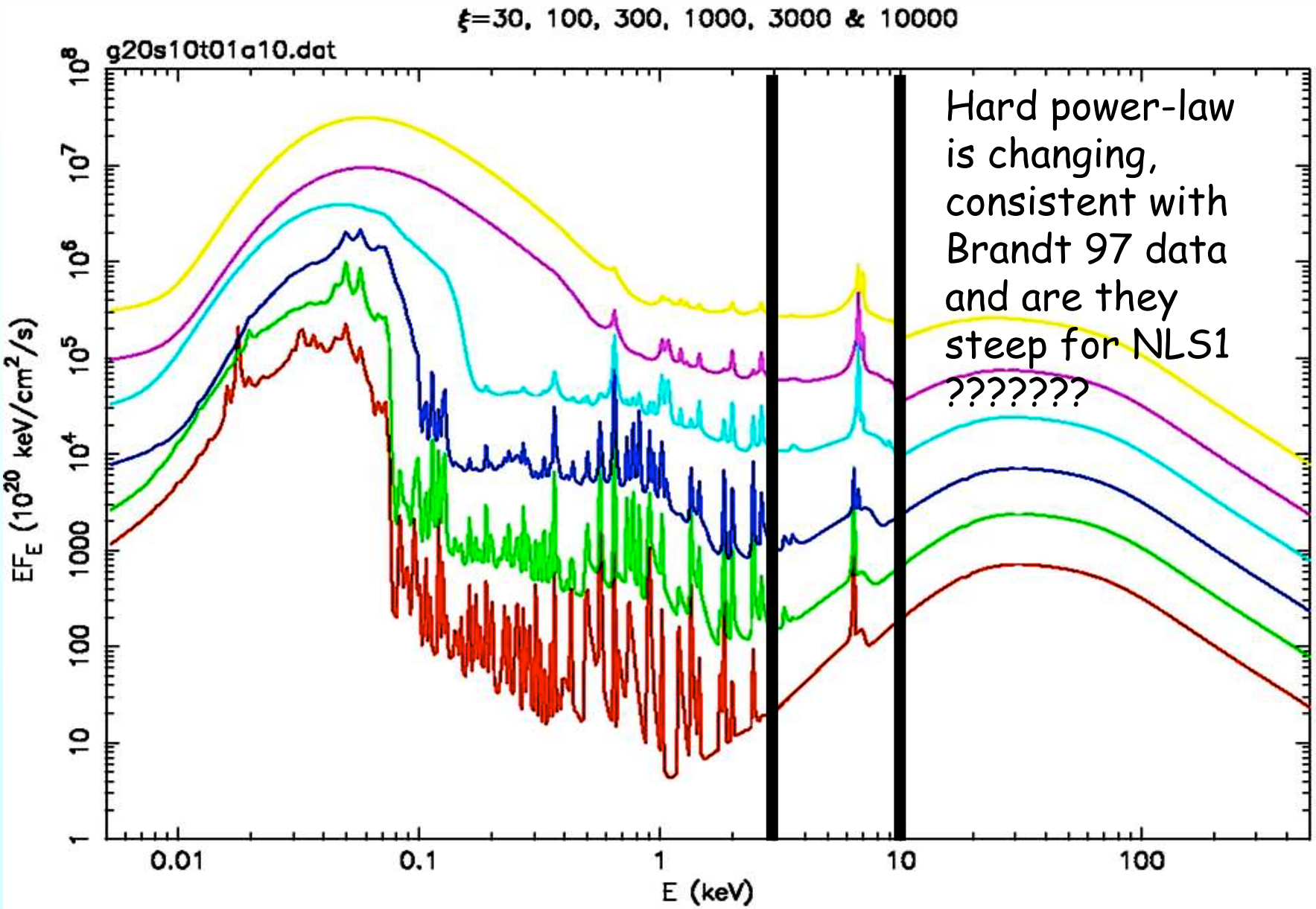
Can the large steepness parameter range be achived in the RM?





Ionized line emission (rest frame)

2-10 keV slopes



Serious Problems with the MCD model

T small range, but L scales over 3 orders of magnitude

T saturates at around 120 eV, no explanations from the theory

Fe abundance is 30 times solar for a simple power-law (unphysical)

Fe reduced by introducing 2 curved power-laws, artifically

Neutral Fe in outflow with 0.15 c in 13224, but spectral drop still remains sharp

Spectral fit requires more than 10 parameters, instead of just simply 2 in the RM

MCD unlikely, but absorber is not at all related to the soft excess, might still be present in nature

Advantages from the simplied picture

THESE OBJECTS KEEP US BUSY IN THINKING, DISCUSSING SINCE

6 YEARS, THAT´s GOOD FOR OUR ONGOING WORK (IOA;MPE;PENN),

AND PROGRESS IN AGN SCIENCE

Alternatives to waiting 10 years for XEUS

High-quality XMM-Newton observations of NLS1s in different flux states may give more high quality data to solve the open questions

The intrinsic X-ray spectrum is highly absorbed if optically thick clouds cover the disc, therefore extreme variations of α_{ox} could be an indicator.

IRAS 13224 and 1H0707 are extreme, but not unique.
As such, there should be many more similar objects (in progress)

SOLVING THE PROBLEM OF SHARP SPECTRAL DROPS?

AVOIDING ALL OF THESE COMPLICATED ASPECTS ASSOCIATED WITH PC AND LB MODELS?

The answer might be that neither

Partial Covering
nor
The reflection model
nor
Kallman UTA features

will be the answer, although RM is in favour

The End - Thanks