Narrow energy-shifted lines in AGNs spectra in the XMM-Newton archive

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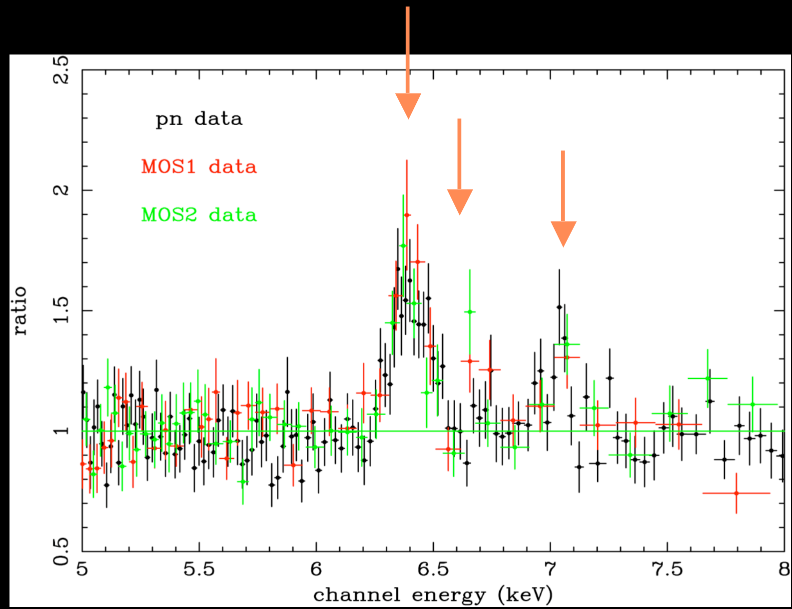
Outline

- ♠ What are energy-shifted lines ?
- ♠ Why are they important in AGN studies?
- ♠ Search over a large sample of objects: description of project and method
- ♠ (First Results): yet to come!

Fe K emission in AGN

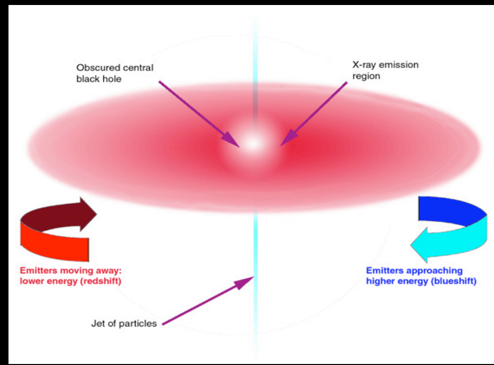
Fe Kα transitions give rise to prominent fluorescence lines in AGN spectra:

Neutral Fe 6.4 keV Fe XXV 6.7 keV Fe XXVI 6.97 keV



Mrk 590, Xmm/EPIC, Longinotti et al in prep

If emission in inner disc, relativistic effects modify line profile



Shifted emission lines

Observations of narrow features

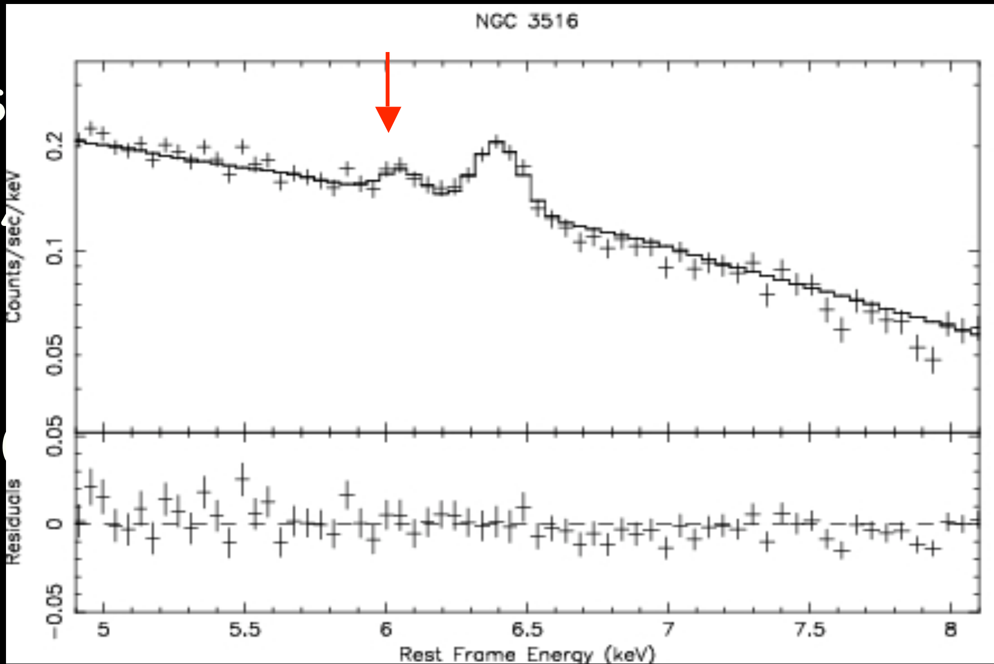
NGC3516 (Turner 02, Iwasawa 04

Mrk 766 (Turner 2004)

NGC7314 (Yaqoob 2003)

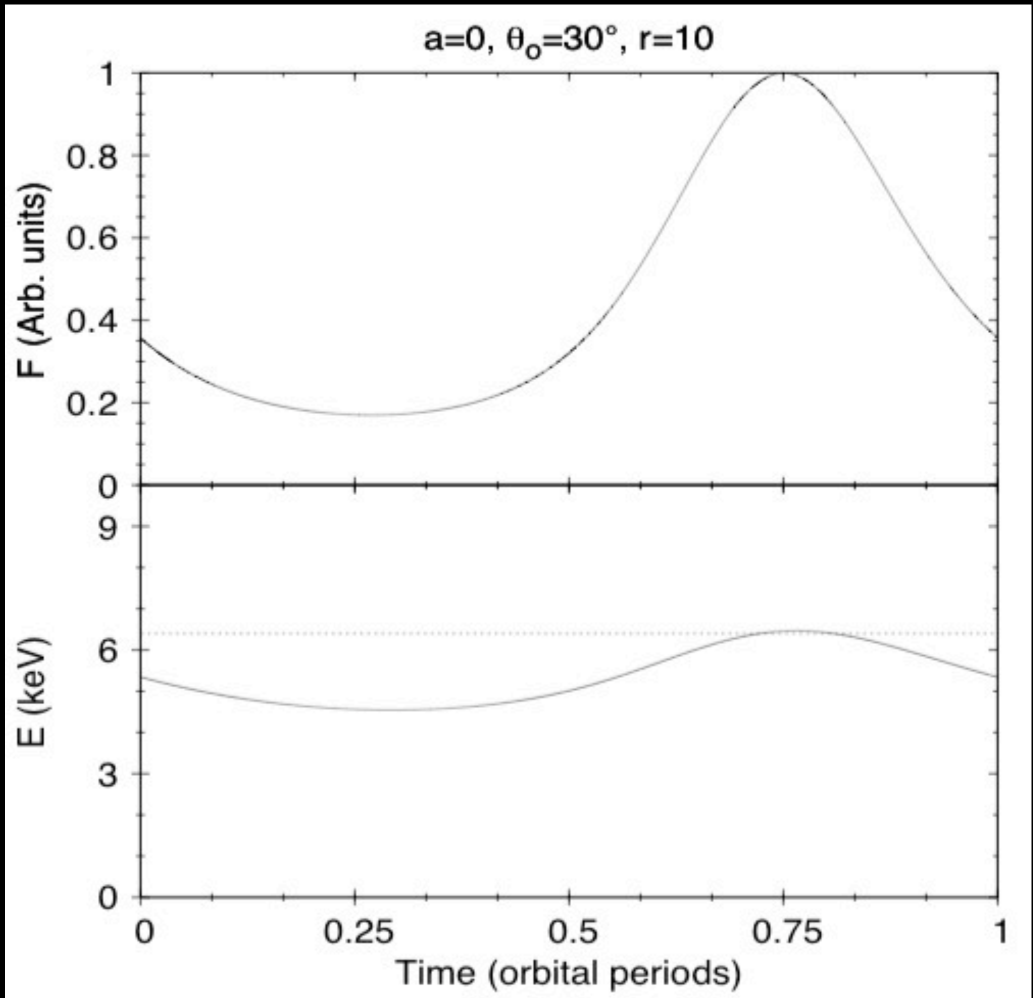
Mrk841 (Petrucci 02, Longinotti (

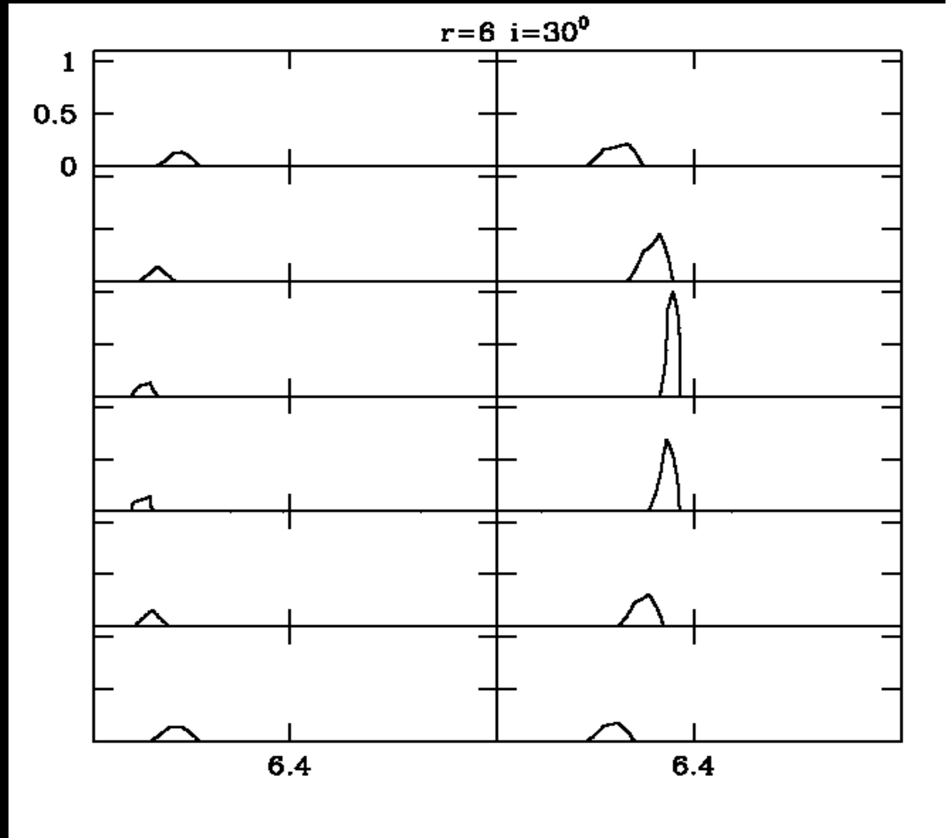
ESO113-G010 (Porquet 2004)



Theory (Nayakshin 2001, Dovciak 2004):

Localized spots or narrow arches on the inner accretion disc illuminated by flares





Time (orbital periods)

Dovciak et al. 2004

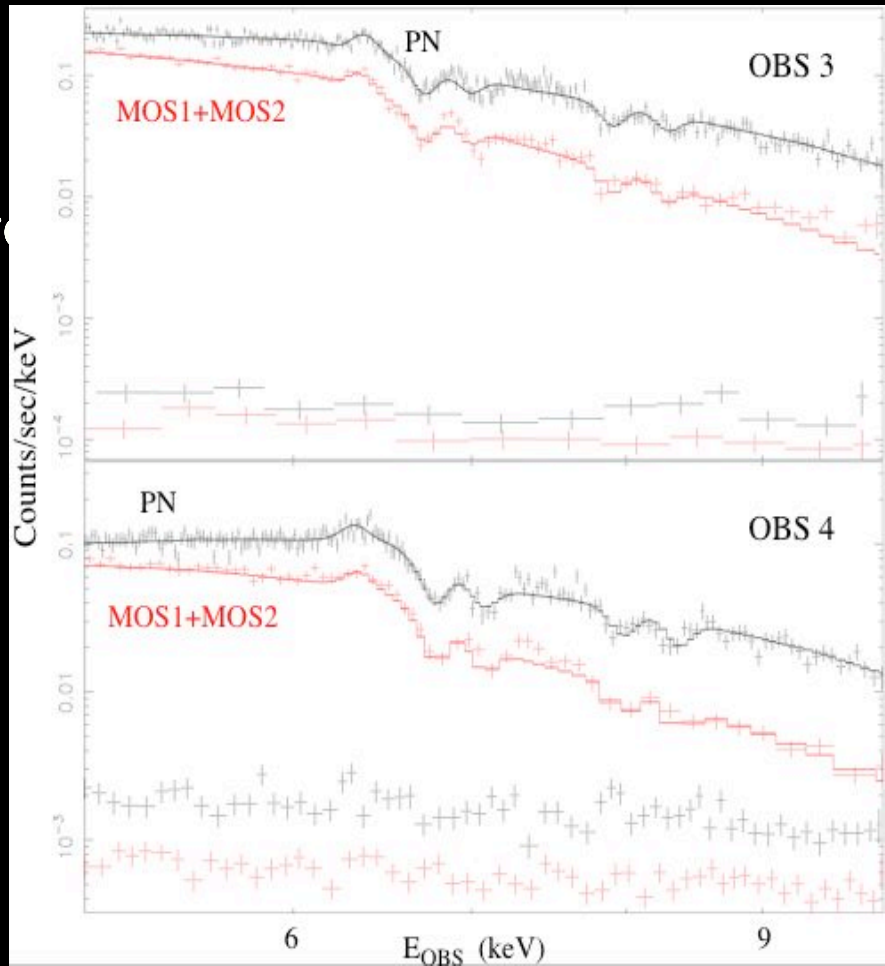
Fe K absorption in AGNs

Resonance transitions from Fe XXV
XXVI give rise to absorption featur
@6.7-6.97 keV

If the absorbing material is moving, the lines are observed with some velocity shifts

Blue-shifted → outflowing gas

red-shifted → inflowing gas

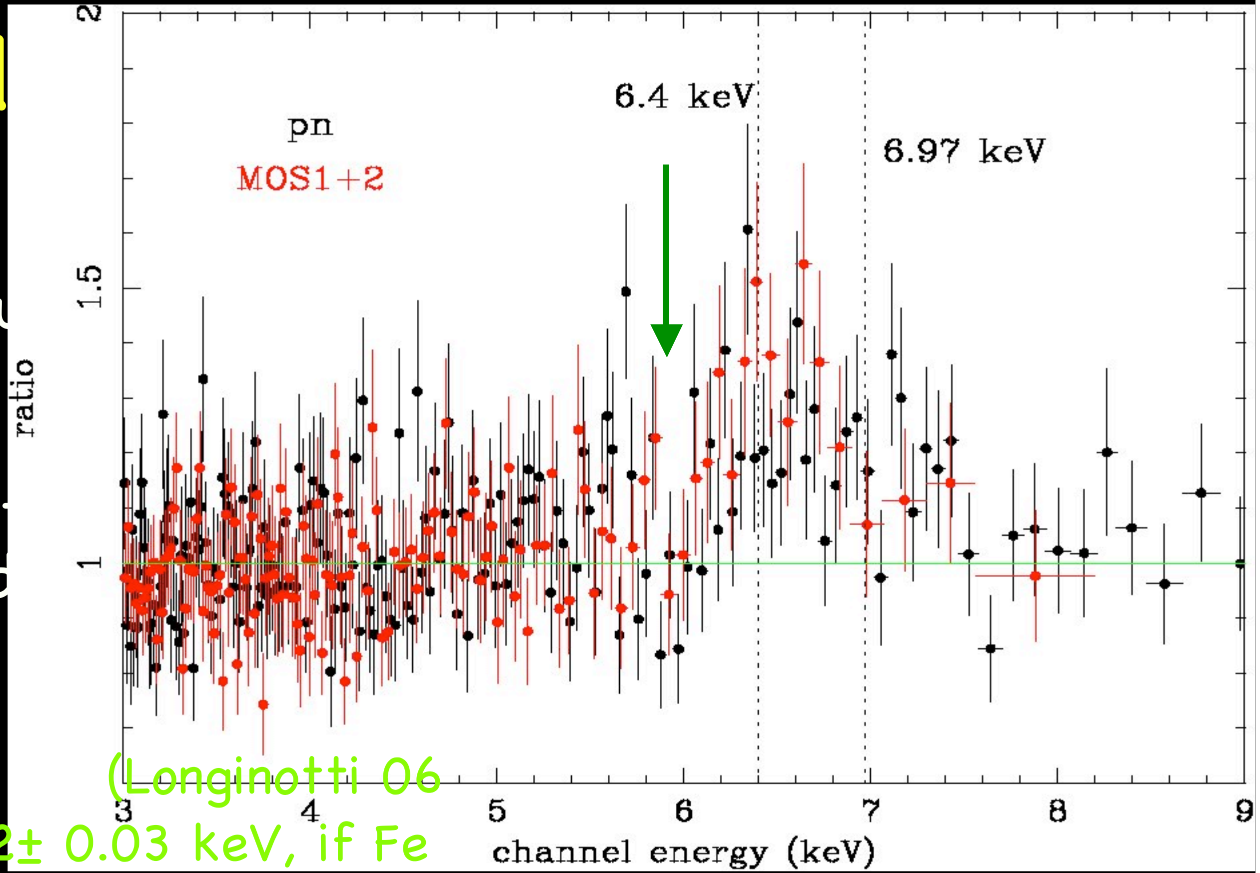


NGC 1365,
Risaliti et al. 05

Shifted

Observations of abs. featu

NGC3516 (Nandra 1999)
(Dadina 2005) 1E1821
2003) PG1211+143 (Pound
05)



Mrk335 (Longinotti 06 submitted) E=5.92± 0.03 keV, if Fe XXVI Kα v ~ 0.15c

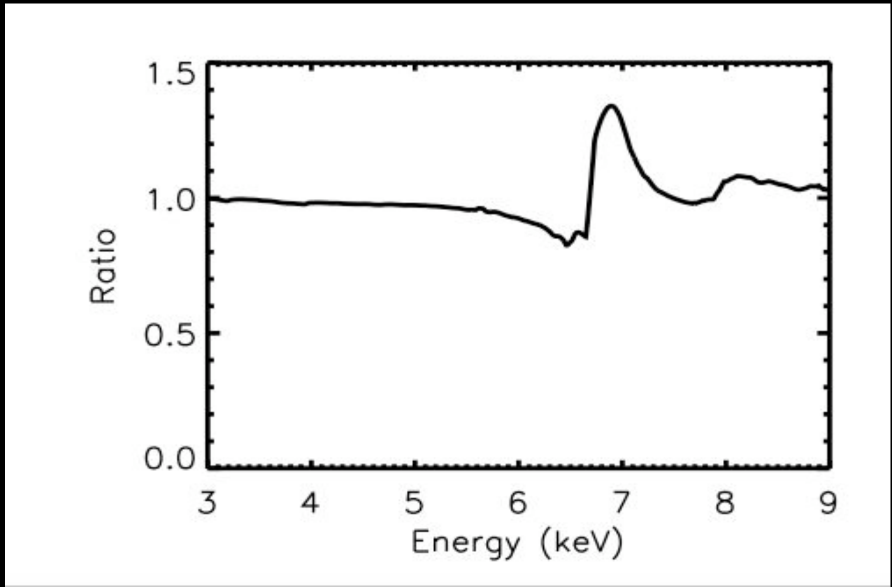
Theory: motion of the absorbing gas and/or gravitational redshift due to BH

Inflow model
(developed by S. Sim)

- Synthetic spectra simulated with Monte Carlo radiative transfer code (Sim 2005, MNRAS)
- Infalling gas in spherical symmetry extending from R_{in} to R_{out}
- Including relativistic effects (Doppler shift and Gravitational)

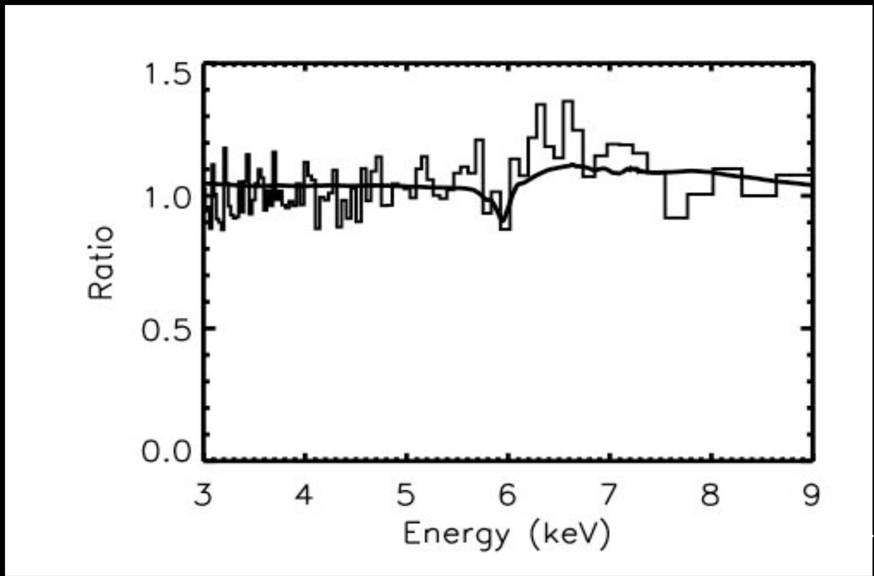
Included in Longinotti et al. submitted

Spectra from model



Wide range of radii 20-10^3Rg

Absorption line too wide for our data +broad inverse P Cygni Fe XXVI Kα line.



Small range of radii: 24-48 Rg

Narrow line in good agreement with our Mrk 335 data.

Questions on their reality

Shifted lines in emission and absorption are clearly two distinct phenomena

BUT SOME COMMON ISSUES:

- Probably transient nature
- Very interesting: signature of BH and gravity
- Found with marginal significance (2-3 sigma)
- Found in individual objects by individual authors (heterogeneous calibrations, data reduction and methods of analysis)

The project:
search in a large sample

Sources selection:

- ALL sources flagged as included in AGN panel in the XMM archive
- Public up to 03/2006
- With N counts 2-10 keV >1000

Processed and analysed with:

- SAS 6.5.0
- XSPEC 12

124 spectra
85 sources
SY1, RQQ, NLS1

(All data in Bianchi et al. in prep.)

Methodology (I):

Each 2-10 keV spectrum fitted by a baseline model

POWER LAW + 3 Fe K LINES at 6.4, 6.7, 6.97 keV

(rest energies for Fe Kα transitions)

Test presence of additional narrow lines

described by Gaussian profile with

$4 < E < 9$ keV and σ=1 eV

Methodology (II)

Some conditions for including additional lines:

- Threshold of significance 99% (F-test)
- 6.4 - 7 keV range excluded

All deviations above 99% are recorded

N Gaussian lines added to the baseline model to find the best fit

Simulations

BEST FIT = P LAW + 3 Fe LINES + N Gaussian lines

For each of N lines, the significance is checked with F-test against the best fit model.

If > 99% it is tested through Montecarlo simulations (10^3 realizations).

Input model for the simulations	=	best fit excluding the line to be tested

Goodness and Badness of the method

BAD: Does not account well for spectral curvature and may get confused if broad features are present in the spectra

Would place many narrow lines in adjacent bins

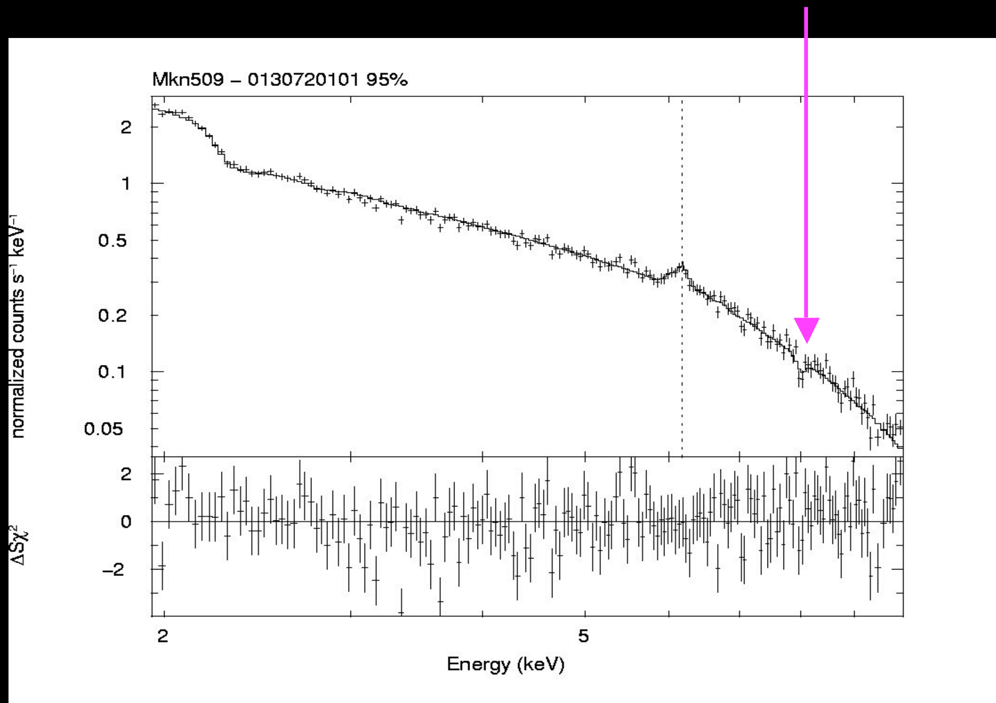
Estimate of the significance and increase sim number

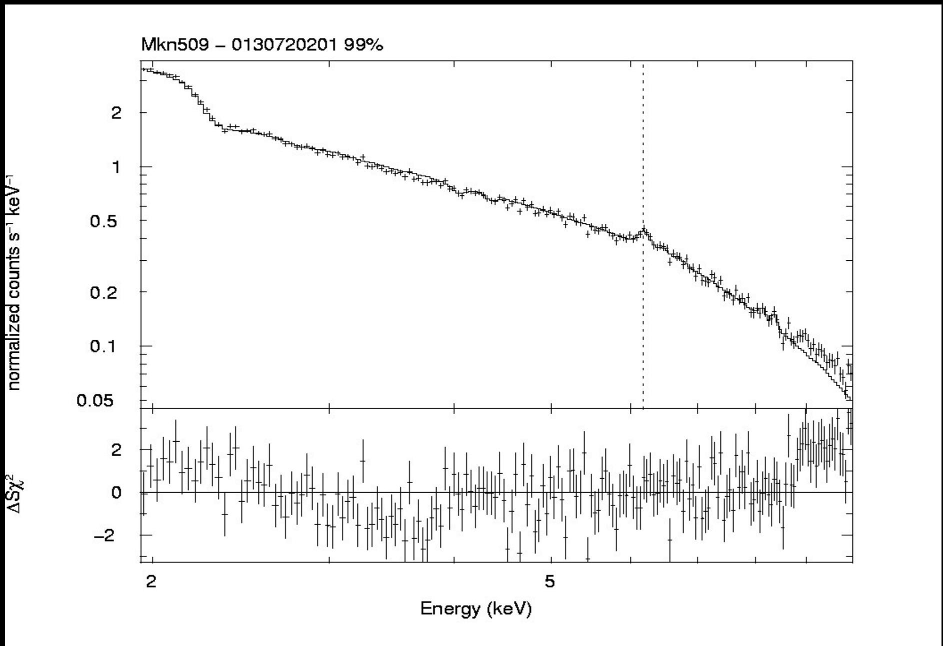
GOOD: It does exactly what it is supposed, finding as many lines as possible above the threshold !

Examples (I)

Mrk 509: 2 exposures

Oct 2000 - detection @~8.3 keV
(Dadina et al. 05)



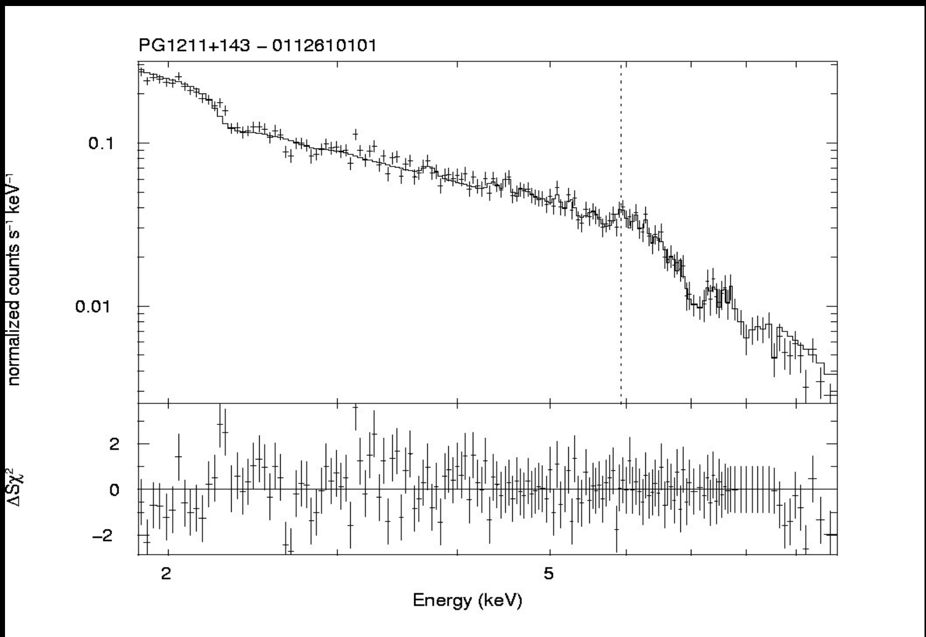


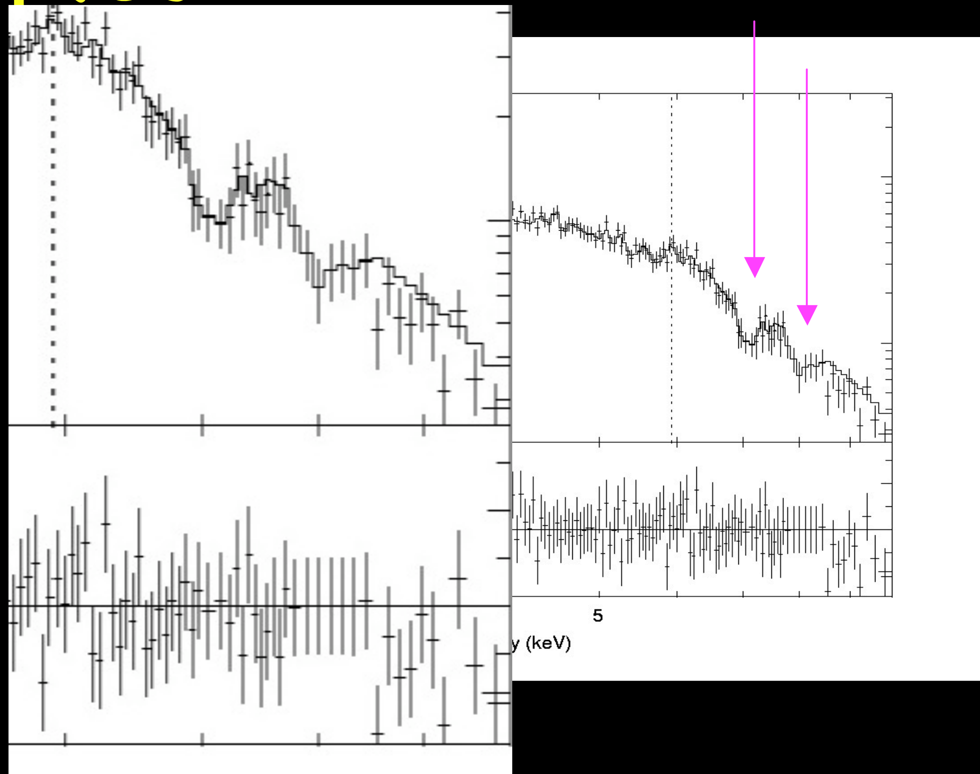
Our method finds a feature at 95% and nothing at 99%

Examples II

PG1211+143: detections @~7.6 and ~8.7 keV

(Pounds et al. 03)

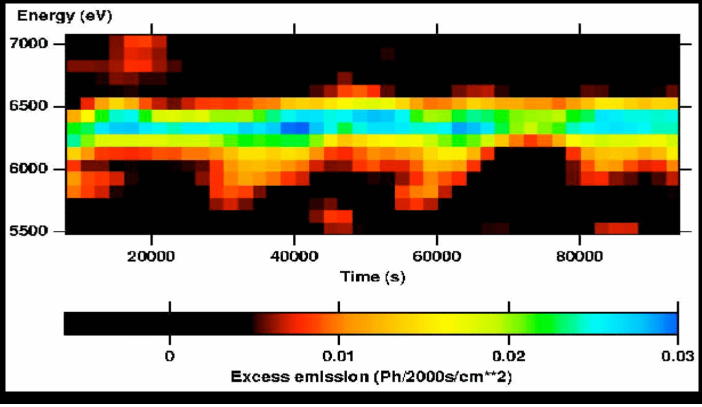




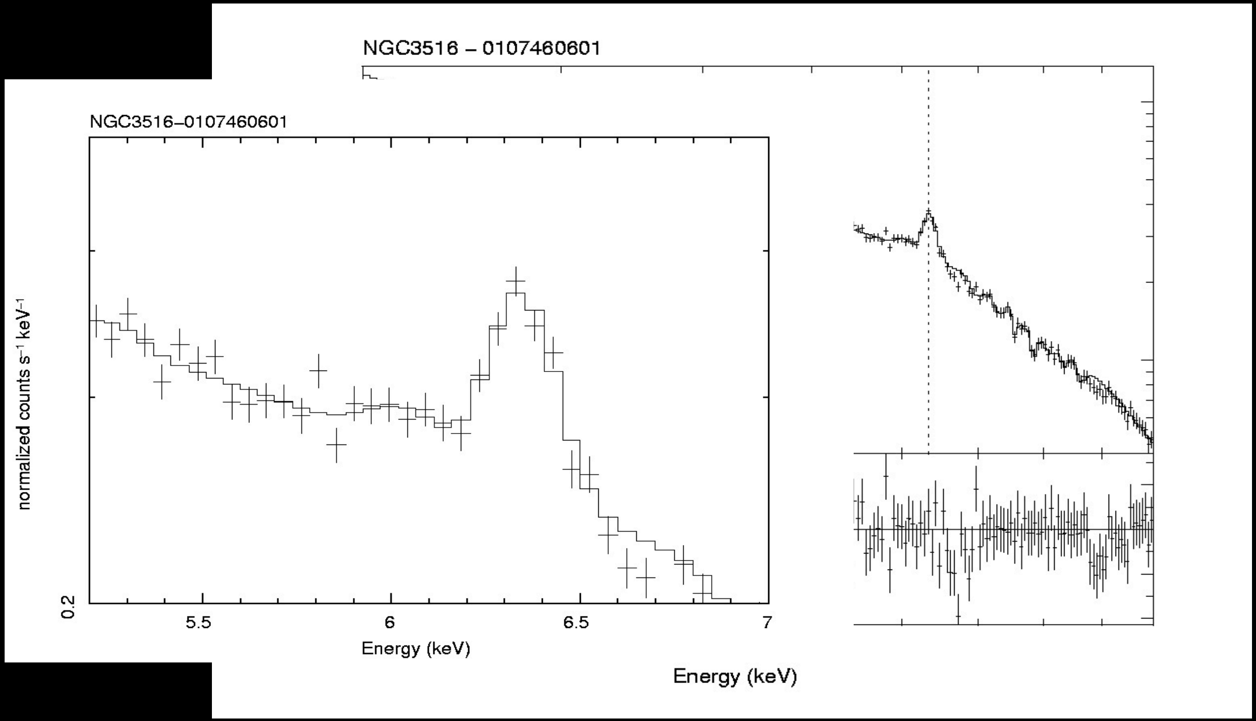
Our method would ignore them, mimicking a broad feature with many narrow Gaussians

Example III

NGC3516: transient emission line in 5.7--6.5 keV (Iwasawa 04)



Our method does not seem to find only one feature, very likely because it is less significant in the integrated spectrum



Future directions (many!)

- Test on samples of different objects (e.g. Blazar)
- Test with different binning of the spectra
- Test varying the baseline models
- Take into account the transient nature of the features performing the search in time-resolved spectra

THANKS !