Statistics of relativistic Fe K lines in AGN

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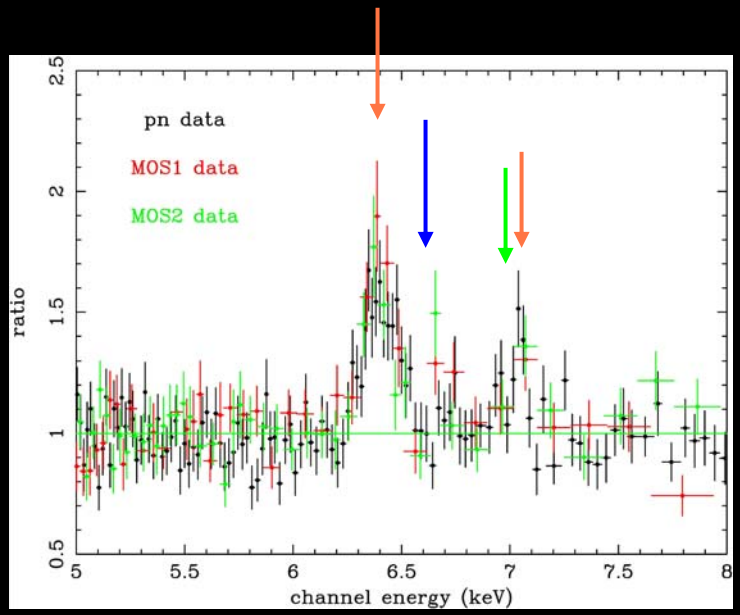
Fe K emission in AGN

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

Neutral Fe Kα 6.4 keV
Fe Kβ 7.06 keV
(Reflection on distant torus)

Fe XXV 6.7 keV
Fe XXVI 6.97 keV
(circumnuclear warm gas)

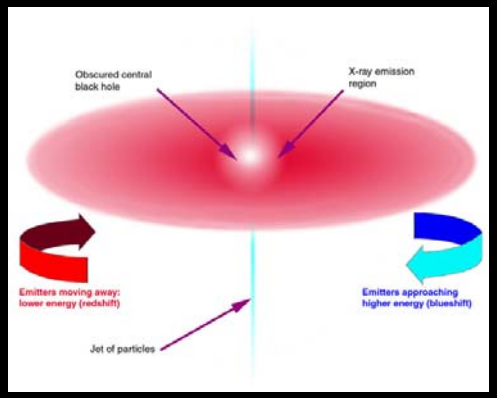


Xmm-Newton EPIC data

Seyfert 1 Galaxy Mrk 590

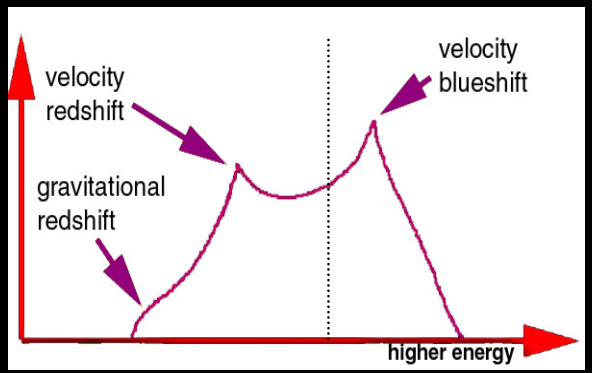
Relativistic Fe K lines

Receding

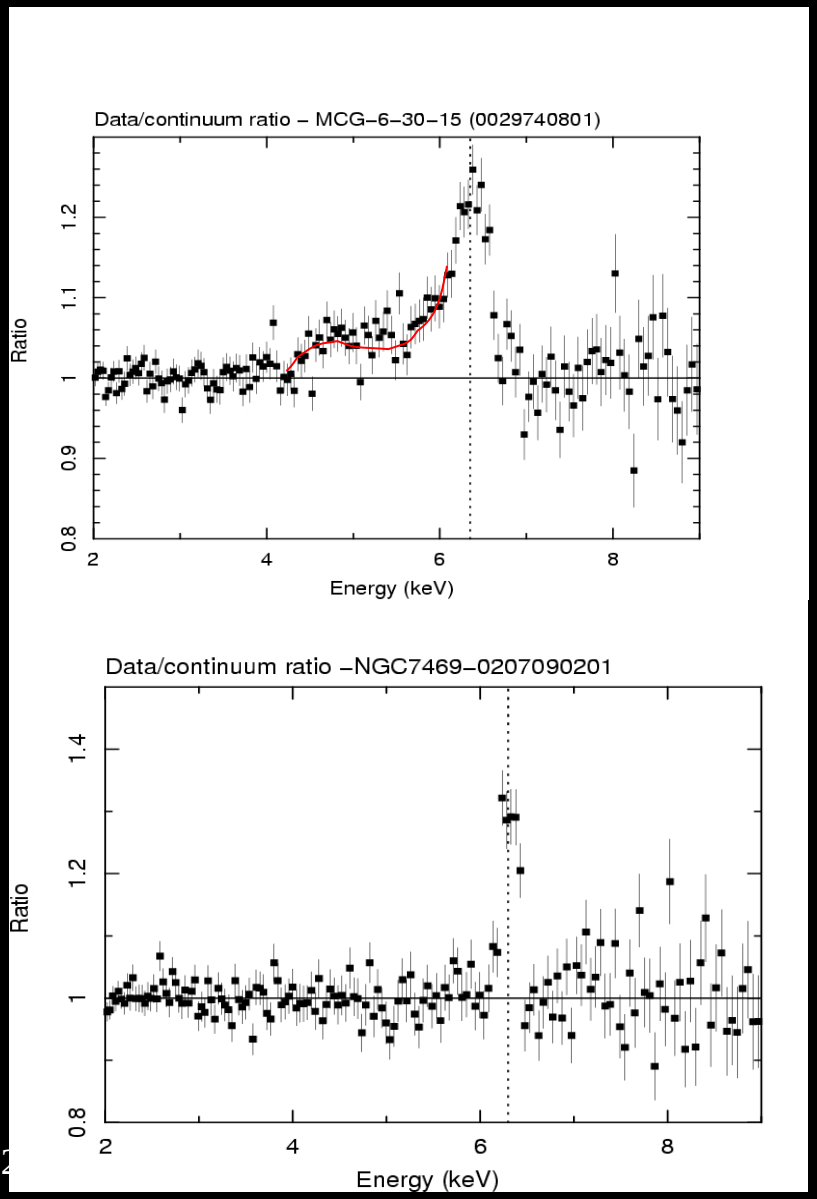


approaching

Flux



Energy



If emission in inner disc, relativistic effects modify line profile…

NOT ALWAYS!

Relativistic lines: why caring ?

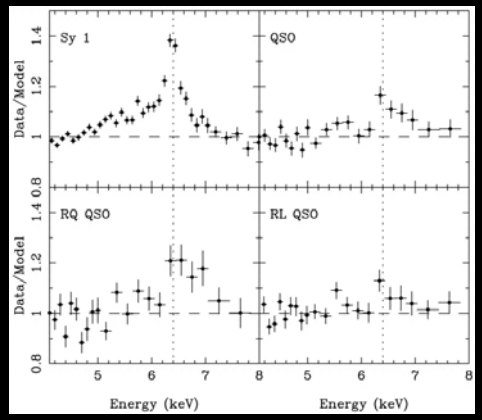
Probe of strong gravity and accretion flow in innermost region of AGN: diagnostic of accretion disc structure (extension, ionisation state), potentiality to measure black holes spin. Very common feature in ASCA spectra, not as common in XMM-Newton and Chandra data…

How often relativistic broadening appears in AGN spectra?

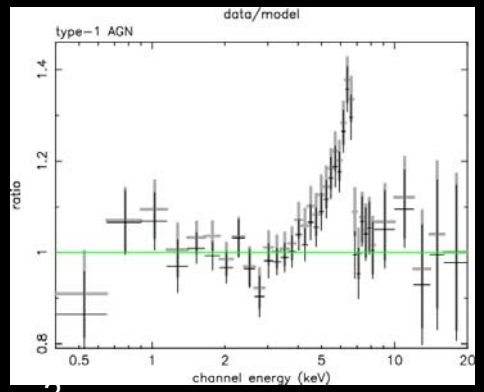
Observed in individual sources with XMM-Newton:
MCG-6-30-15 (Wilms+ 01, Fabian+ 02, 03), NGC3516 (Turner+ 02, 05), Mrk 335 (Longinotti+ 07), IRAS18325-5926 (Iwasawa+ 04), 1H 0707-495 (Fabian+ 04), 4U 1344-60 (Piconcelli+ 06) …more

A bit of History

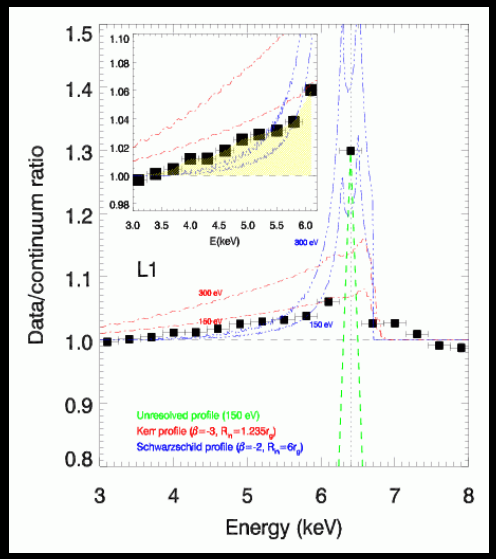
ASCA data
39 AGNs
(Sy1 & QSO)
Nandra+ 97



Streblyanska+ 05
XMM-Newton
Lockman Hole
(faint sources)
EW~500 eV
F=10^{-15}-10^{-13} ergs/s/cm^2



Guainazzi+ 06:
XMM-Newton
107 pointed AGN
Broad lines detected 25% of the total sample, EW ~200 eV, strongest lines in low L sources



Other studies: Broad lines detected in 38 XMM-Newton PG QSO <10%
Jimenez-Bailon+ 05

Similar results same sample
Inoue+ astro-ph/0703350

The present sample: Guainazzi 06 expanded

- Radio-quiet AGN observed as pointed targets in the XMM-Newton archive
- Public up to March 2007
- Intrinsic column density 2-10 keV Nh < $2x10^{22}$ cm^{-2}

157 AGNs (221 spectra)

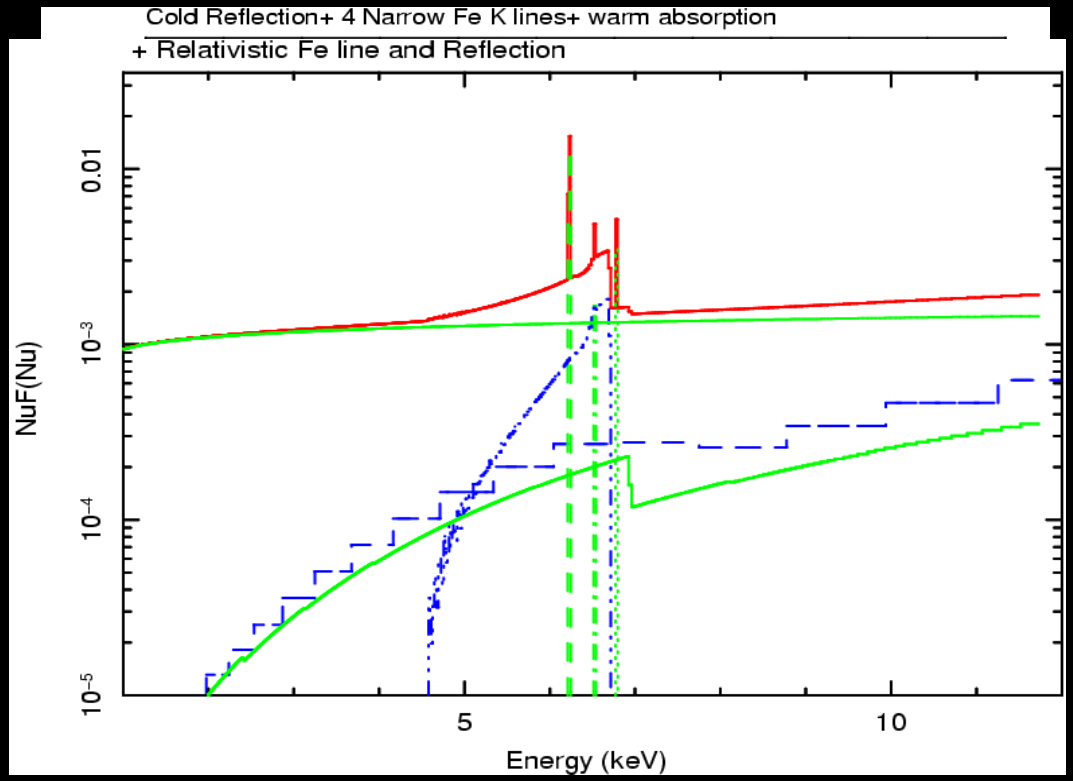
For ~65% of sources
Hβ FWHM available

-Broad lines sources

-Narrow lines sources

See Bianchi's talk

Assumed theoretical model



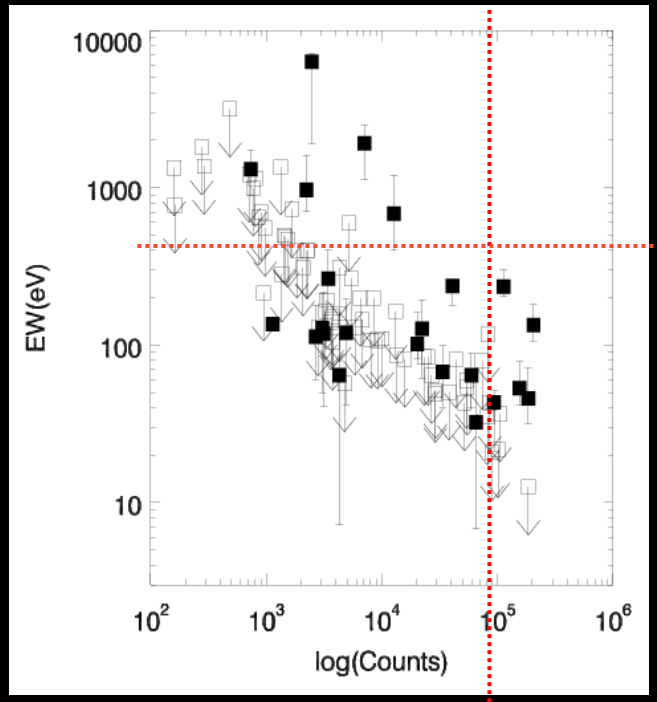
Primary X-ray power Law+ Cold Reflection+ 4 narrow Fe K lines + warm absorption (x-ray nuclear source, torus reflection and circumnuclear ionised material)

+disc reflection + Fe line relativistically distorted (inner accretion disc)

Broad Fe Kα line:
full relativistic model
Dovciak+ 2005

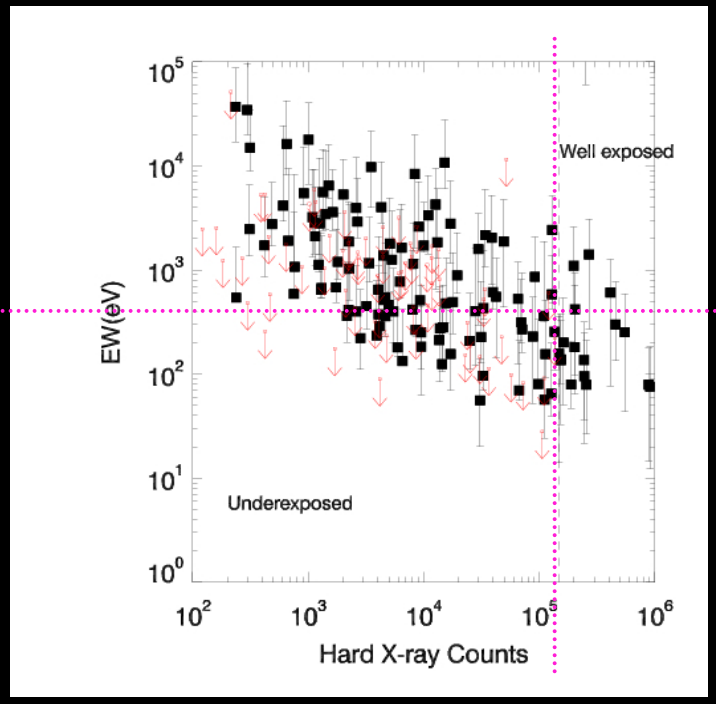
Detections of Fe K lines

Guainazzi 06: detections strongly Dependent on N of counts, few very strong Fe lines detected



EW=400 eV

10^5 2-10 keV counts

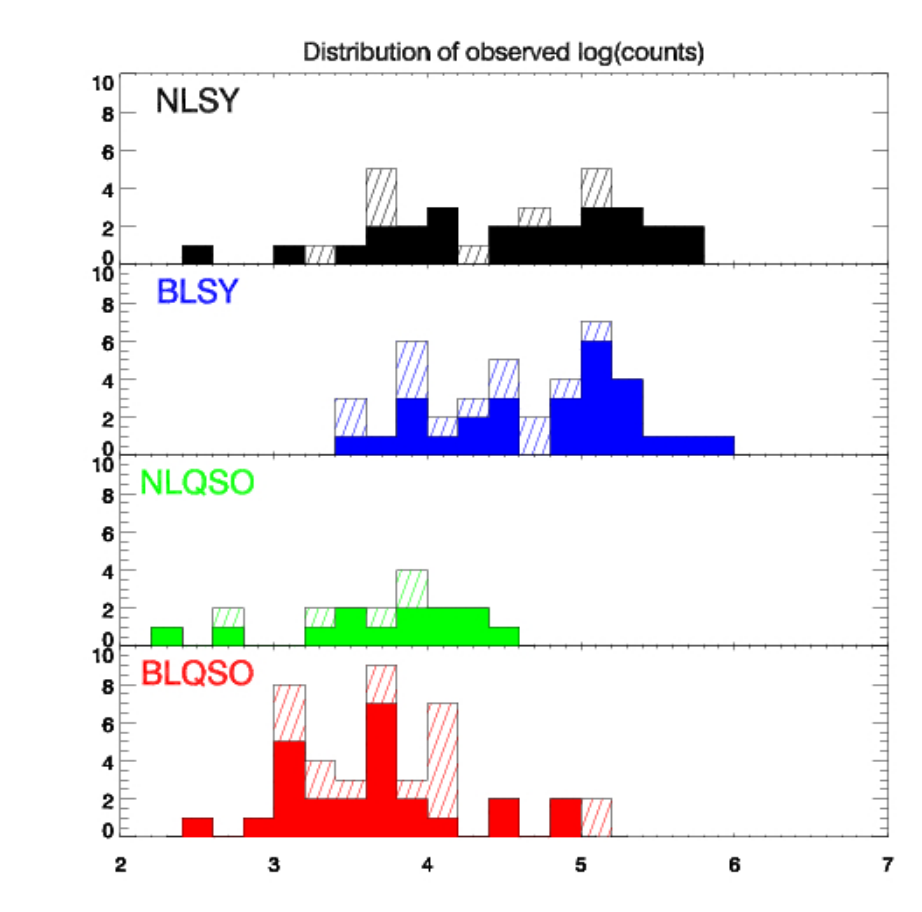


Expanded sample: Too many fake Fe lines in low counts sources, EW very high, no upper limits in region of well exposed sources

Fe K lines and AGN types

Shaded: sources with no detections

Filled: sources with detections of relativistic Fe K lines



All Sey 70%
All Qso 56%

Narrow Line 75%
Broad Line 63%

TOTAL: 125/195 spectra 64%

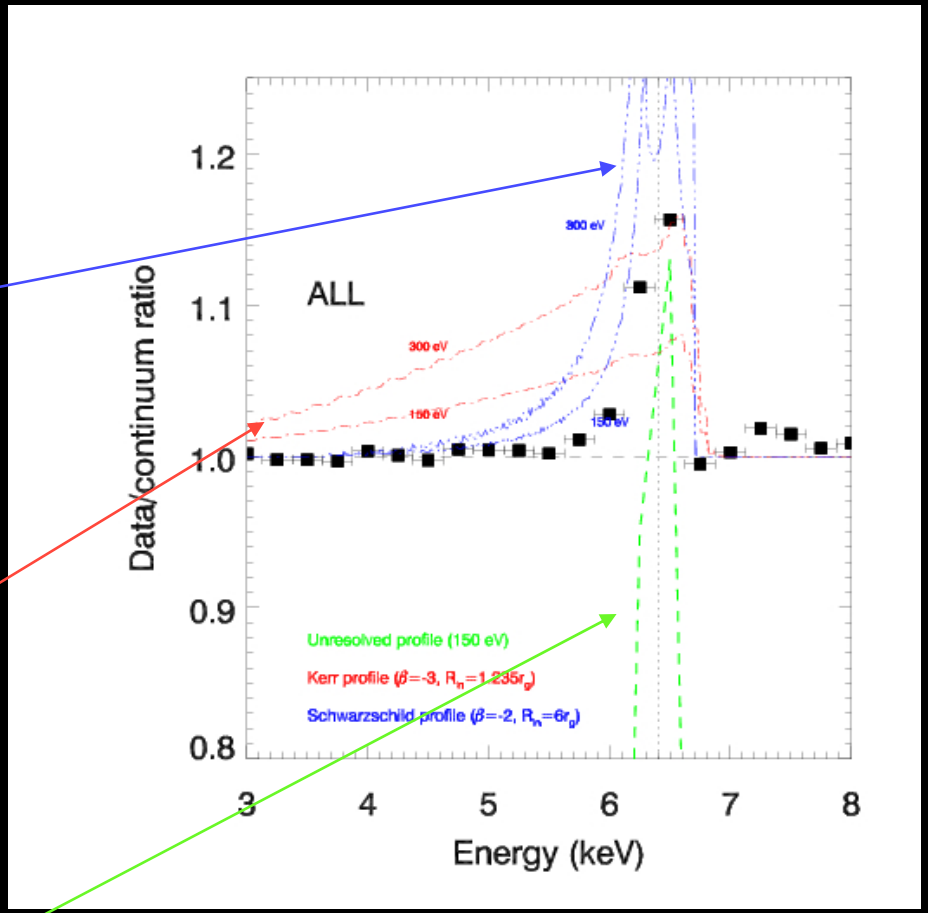
Stacked spectra I: ALL sources

Continuum model:
No Fe lines included

Blue profiles:
Fe line from non-rotating BH, with intensity 150 and 300 eV

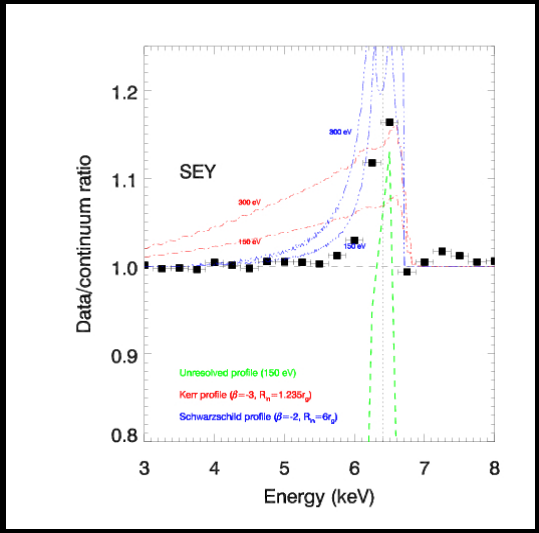
Red profiles:
Fe Line from spinning BH, intensity 150 and 300 eV

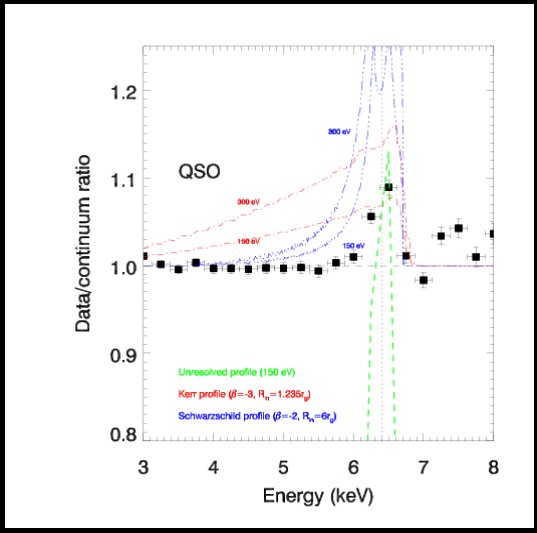
Green profile: unresolved Fe k line, 150 eV



Stacked Spectra II: AGN types

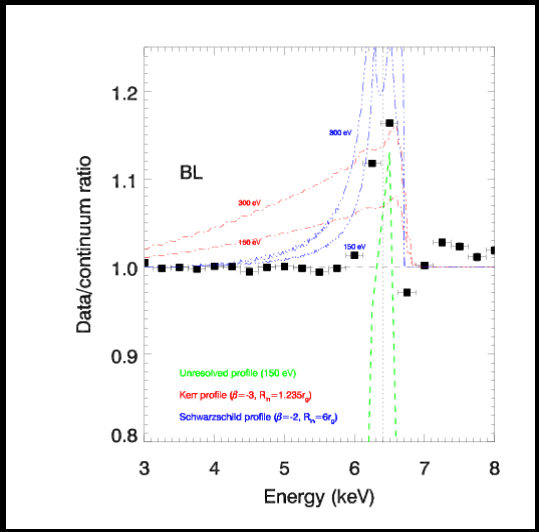
Seyfert

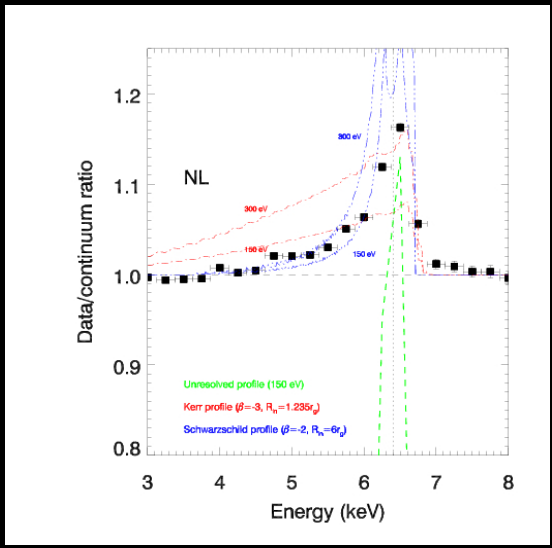




Quasar

Broad lines objects





Narrow lines objects

…to be done

To date the sample includes multiple observations of same source, overestimate of detection fraction

The assumed model is too sophisticated for the data: Detections in low counts sources and detections of 1 keV lines are NOT trustable

Still to do before interpreting stacked spectra:
Look at residuals ONE-BY-ONE to make sure we are stacking well-fitted spectra

Background subtraction effects to be taken into account

Summary

Expanded sample:
-high fraction of detected Fe lines (upper limit ~64%)

-full relativistic model maybe too sophisticated for quality of the data

-profiles in stacked spectra do not support evidence for strong Fe lines (< 10^2 eV) with exception for NL sources

-apparent (intriguing) difference between Fe line profile in BL and NL sources: red wing more pronounced in NL, maybe distinct accretion mechanism involved ?