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

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

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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

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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 $N_h < 2 \times 10^{22}$ cm$^{-2}$

157 AGNs (221 spectra)

For $\sim$65% of sources $H\beta$ FWHM available

- Broad lines sources
- Narrow lines sources

See Bianchi’s talk

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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

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Detections of Fe K lines

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

EW = 400 eV

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

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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%

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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

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Stacked Spectra II: AGN types

Seyfert

Broad lines objects

Quasar

Narrow lines objects

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…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

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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?