

Systematic Errors on Black Hole Spin

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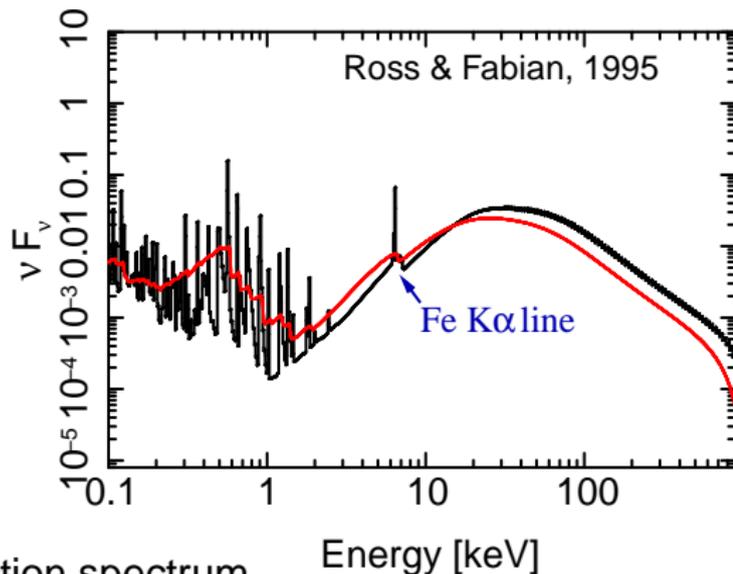
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Measuring Black Hole Spin?

⇒ Measurement from relativistic Fe $K\alpha$ line

BUT: Line is only **a part** of reflection spectrum!



We need to ...

- ... model the entire reflection spectrum
- ... understand the entire continuum

Current Status: some measurements made for AGN (~ 10)
(e.g. Dabrowski et al. 1997, Nandra et al. 1997, 2007, Brenneman & Reynolds 2006, Gallo et al. 2010)

⇒ What about **systematic errors**?

Most cited possible error sources:

- narrow components in iron K-band (Weaver & Reynolds 1998)
- unknown emissivity profile
- no line emission from within ISCO (Reynolds & Fabian 2008)

→ There must be many more!

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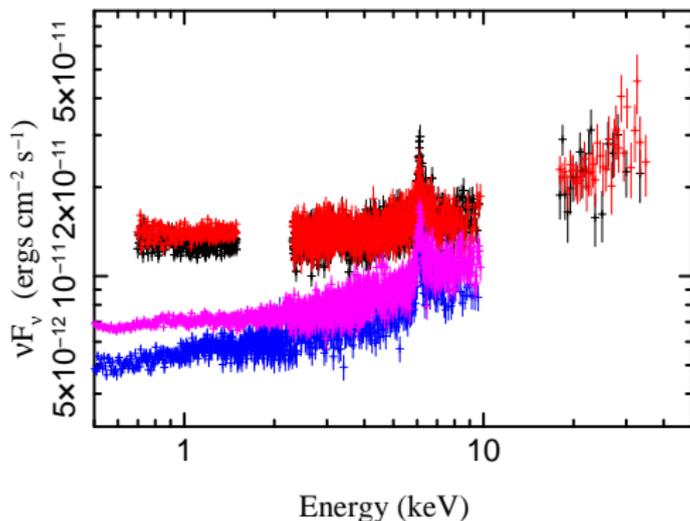
Goals for this project:

- 1) Identify errors
- 2) Determine their impact
- 3) Try to improve measurements

Previous Spin Studies on Fairall 9 ($z = 0.047$):

	Soft Excess	Spin
Schmoll et al. 2009	Blurred Reflection	0.60 ± 0.07
Emmanoulopoulos et al., 2011	Blurred Reflection	$0.39^{+0.49}_{-0.30}$
Patrick et al., 2011	Comptonization	$0.67^{+0.10}_{-0.11}$

⇒ All previous studies note the absence of warm absorption!



- $2 \times$ *Suzaku*
(140 ks & 190 ks)
(2007 & 2010)
- $2 \times$ *XMM*
(15 ks & 90 ks)
(2000 & 2009)

⇒

Broad line seen!

⇒

Study **Typical AGN!**

Base model:

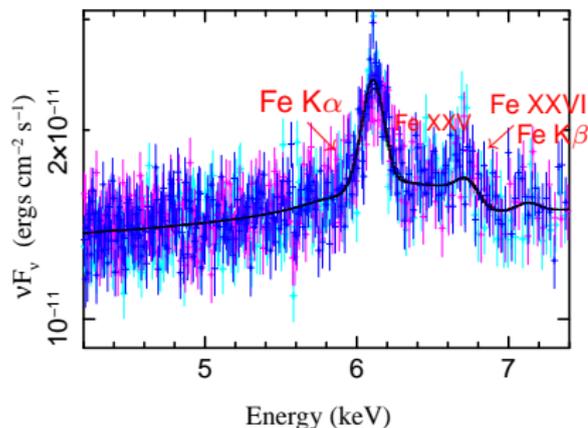
continuum + cold reflection + blurred ionized reflection → Galactic absorption

Details:

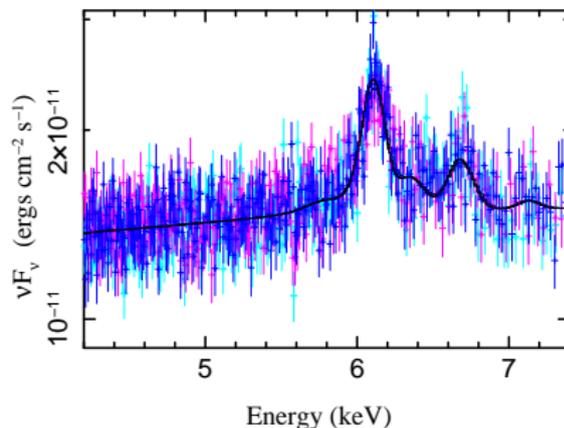
- continuum & cold reflection:** `pexmon` (Nandra et al. 2007)
models power law + Fe $K\alpha$, Fe $K\beta$, Ni $K\alpha$ + Compton hump
- ionized reflection:** `relionx` (Ross et al. 2004)
computes reflection spectrum for irradiation by a power law
- blurring:** `relconv` (Dauser et al. 2010)
relativistic blurring kernel, that assumes broken power law emissivity profile
- photoelectric absorption:** `TBnew` (Wilms et al. 2001)

Narrow lines?!?

without lines



with lines



Two possibilities: Collisionally Excited Plasma OR
Photoionization

⇒ We cannot differentiate...but lines improve fit!

⇒ Ionization state is high!

⇒ Spectral Parameters are scattered and spin is rather high!

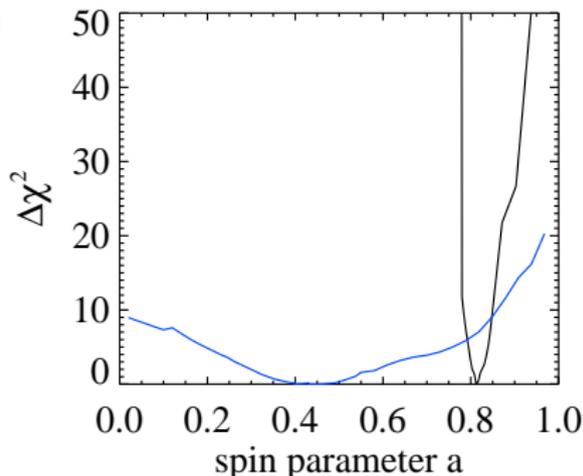
⇒ Try Multi-Epoch Fitting!

Possibilities for the soft excess:

blurred reflection + ...

- ... nothing
- ... bremsstrahlung
- ... **luke warm Comptonization**
- ... power law

⇒ **Soft excess improves fits!**



⇒ **Soft excess can drive spin constraints!**

(because the signal-to-noise is very high at lower energies)

For Fairall 9, we can say that...

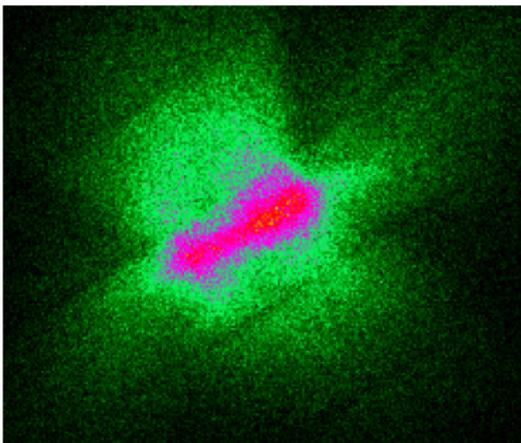
- the base model works
- indications for narrow emission features (Fe XXV and Fe XXVI) that can skew the measured accretion disk parameters
- multi-epoch fitting is necessary to allow for consistent modeling of spectra
- a composite soft excess model is required
- systematic effects on BH spin \gg statistical errors

\Rightarrow Preliminary spin measurement: 0.4 ± 0.2

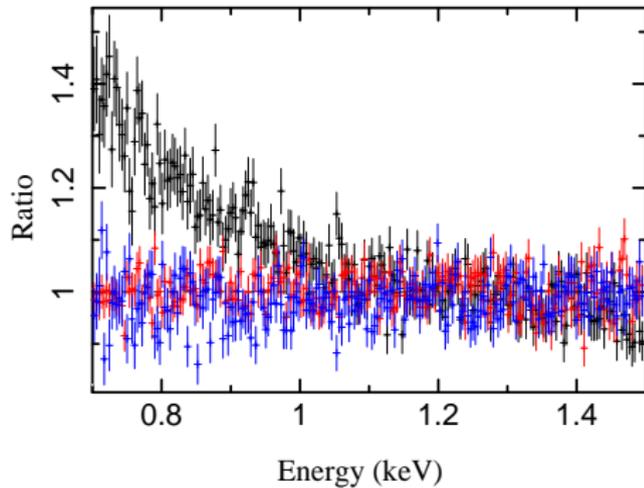
(for soft excess modeled by `comptt` and narrow lines included)

Applies to other bare Seyferts as well!

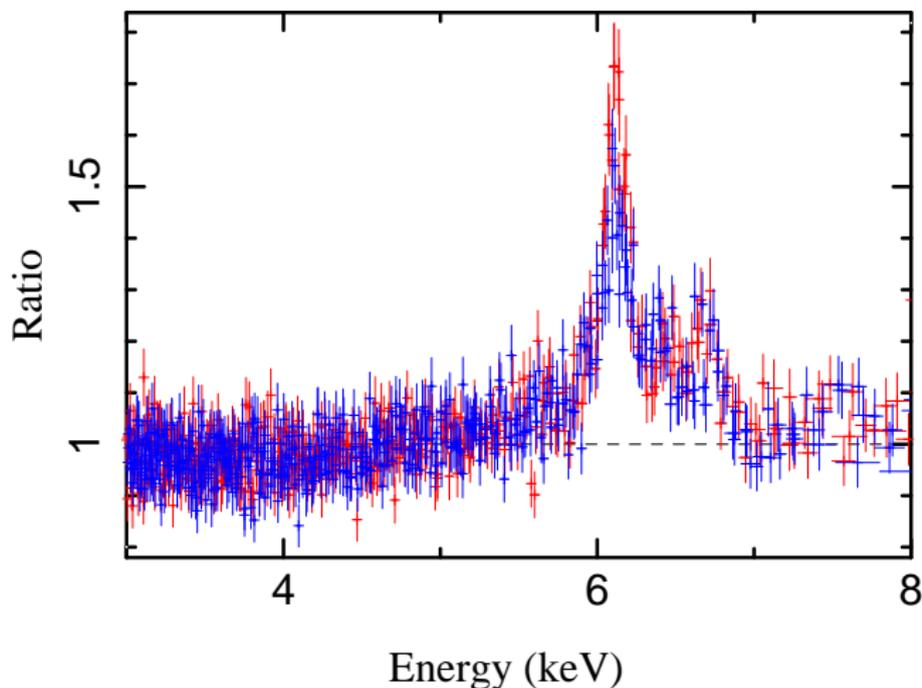
Back-Up frames



Need to perform attitude correction!



Contamination issue makes soft energy part of the spectrum unusable for XIS0!



- ⇒ Relativistic Line is present in spectra!
- ⇒ Line required in all fits!

- blue wing of relativistic line \Leftrightarrow FeXXV & FeXXVI
- continuum/soft excess
- emissivity profile
- uncertainties in models (reflection models, etc.)
- accretion disk & reflection Physics
- ...

BUT: depends on object and exact line shape

\Rightarrow Try Multi-Epoch Fitting!

Which parameters are tied?

- iron abundance
- spin
- inclination of accretion disk