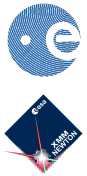
BLACK HOLE SPIN MEASUREMENTS IN AGN: WHERE DO WE STAND?

Matteo Guainazzi (ESA)

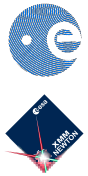
Subject

- This talk is about lies. There are three types thereof:
  - Small lies
  - Big Lies
  - Spectral fitting *(I.Mc Hardy, 2004)*



Outline

- Where do we stand with measuring spin in SMBHs?
- Why do we astrophysically care?
- What do the measurements available so far tell us?
- Future perspectives



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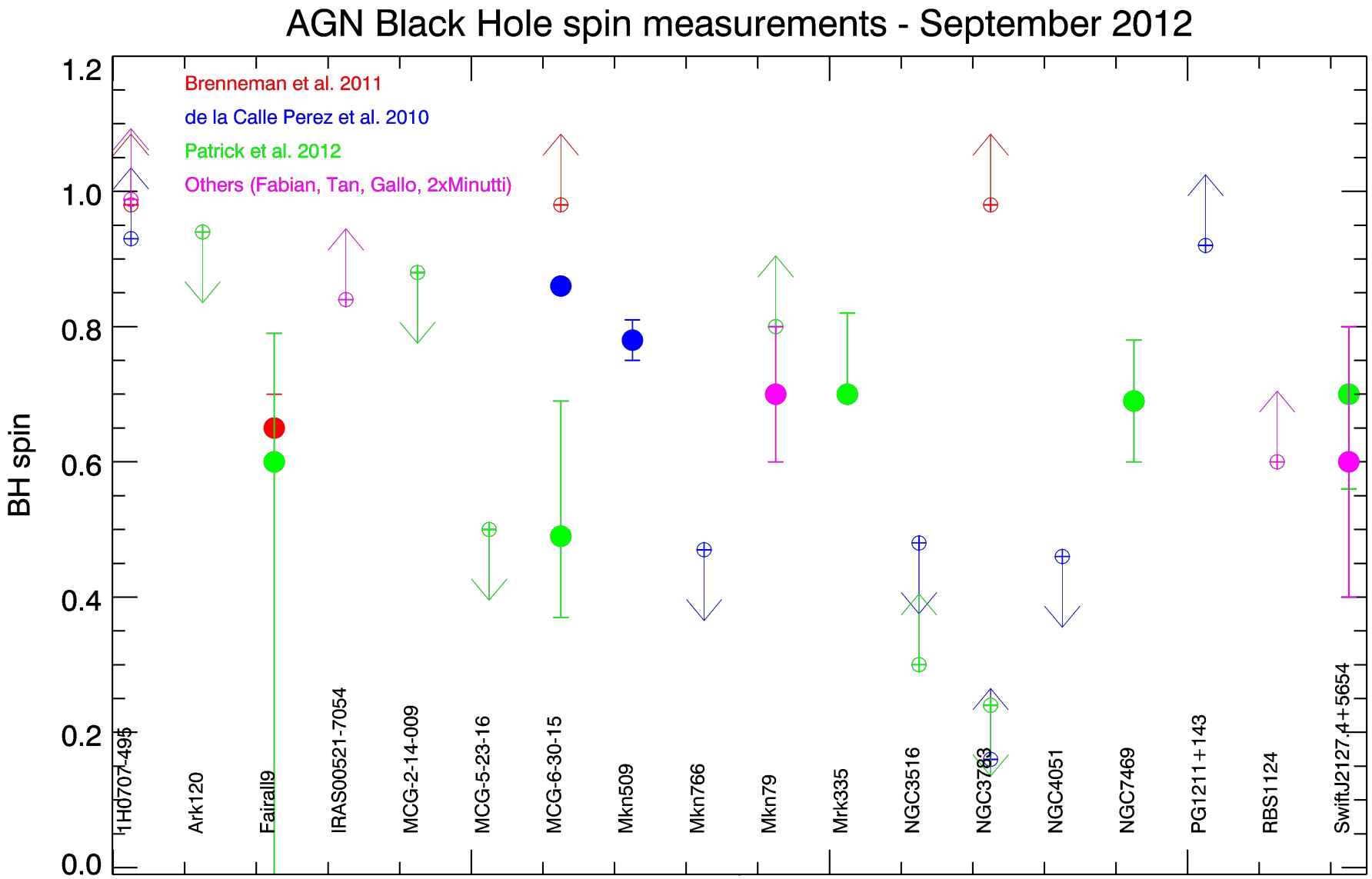
Published sample studies so far

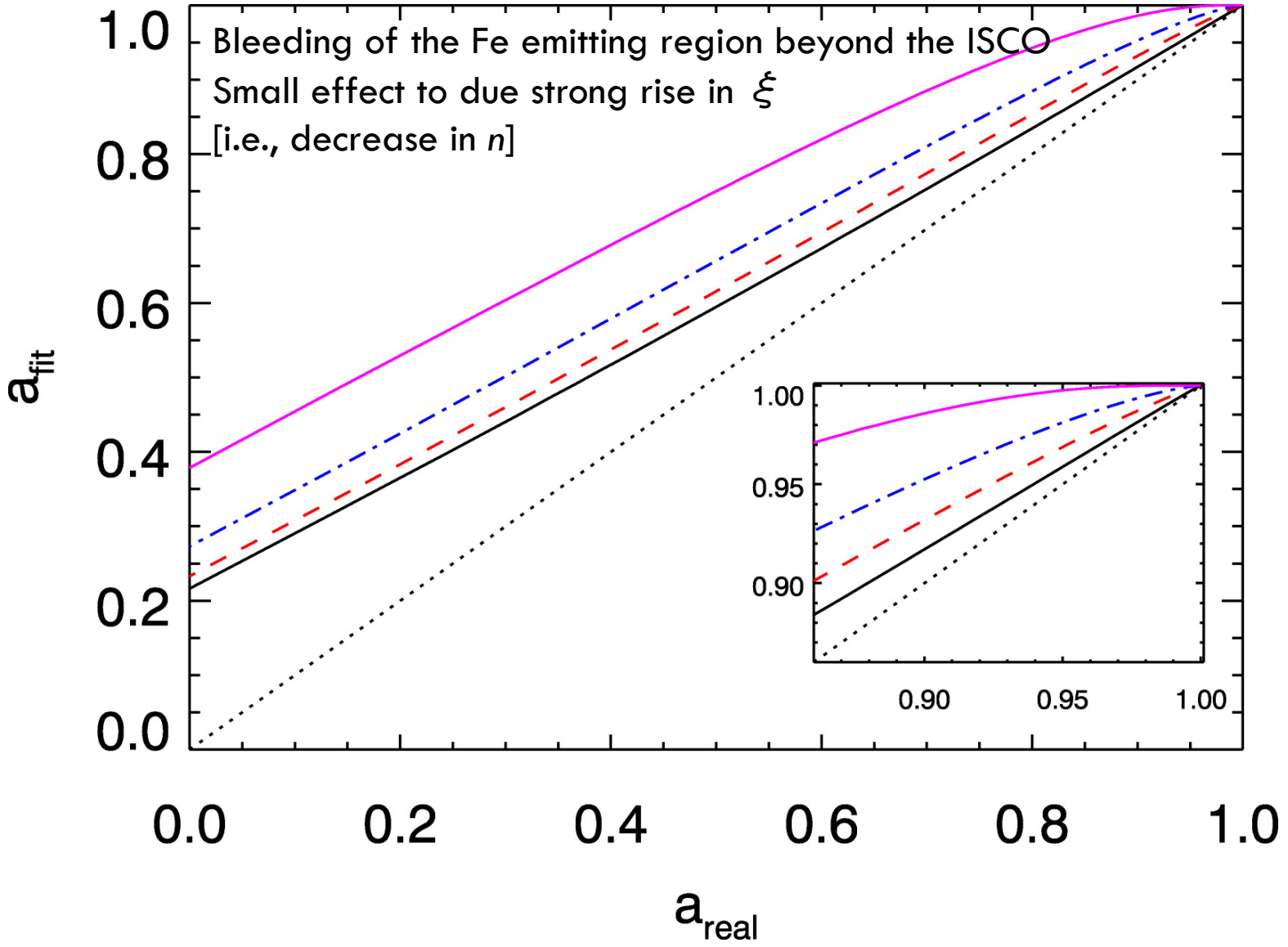
- FERO+GREDOS
  - de la Calle-Pérez et al. (2010), A&A, 524, 50
  - Guainazzi et al. (2011), A&A, 531, 131 (no new BH spin)
- *[The Nandra et al. XMM-Newton sample did not explicitly calculate the BH spin]*
- Suzaku AGN spin Key Project + archive:
  - *Orthodox*: Brenneman et al. (2011), ApJ, 736, 103
  - *Heterodox*: Patrick et al., (2012), MNRAS in press

Current measurements



Systematic errors on a: disk structure

(Reynolds & Fabian 2008)



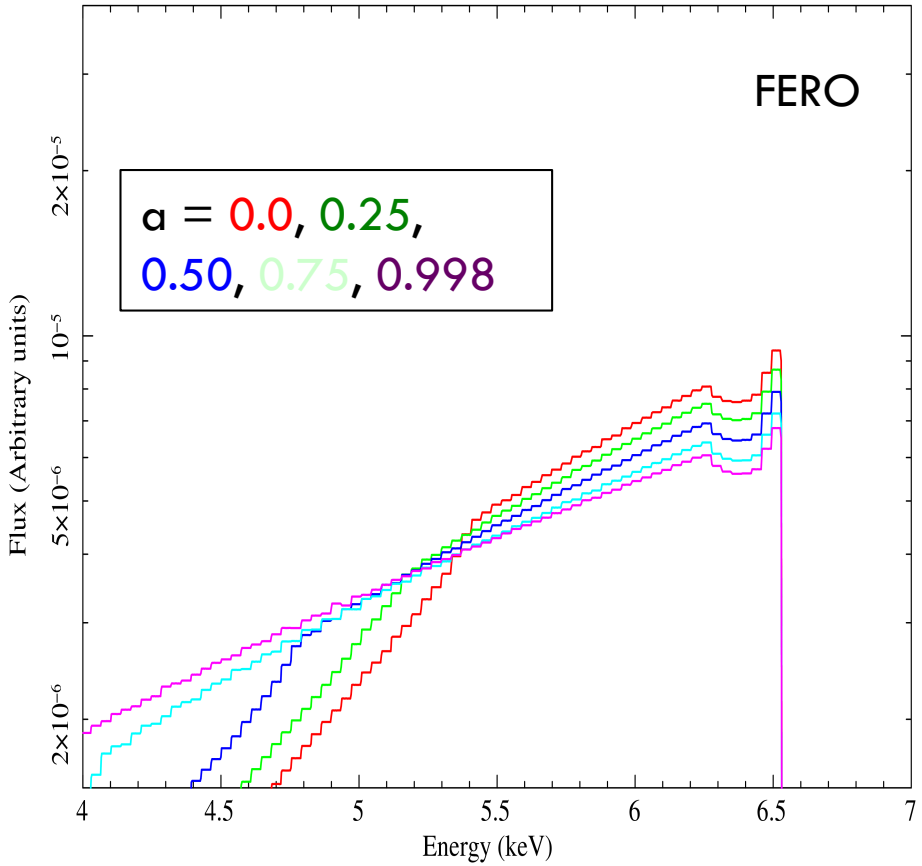
Two "ways" of measuring BH spin

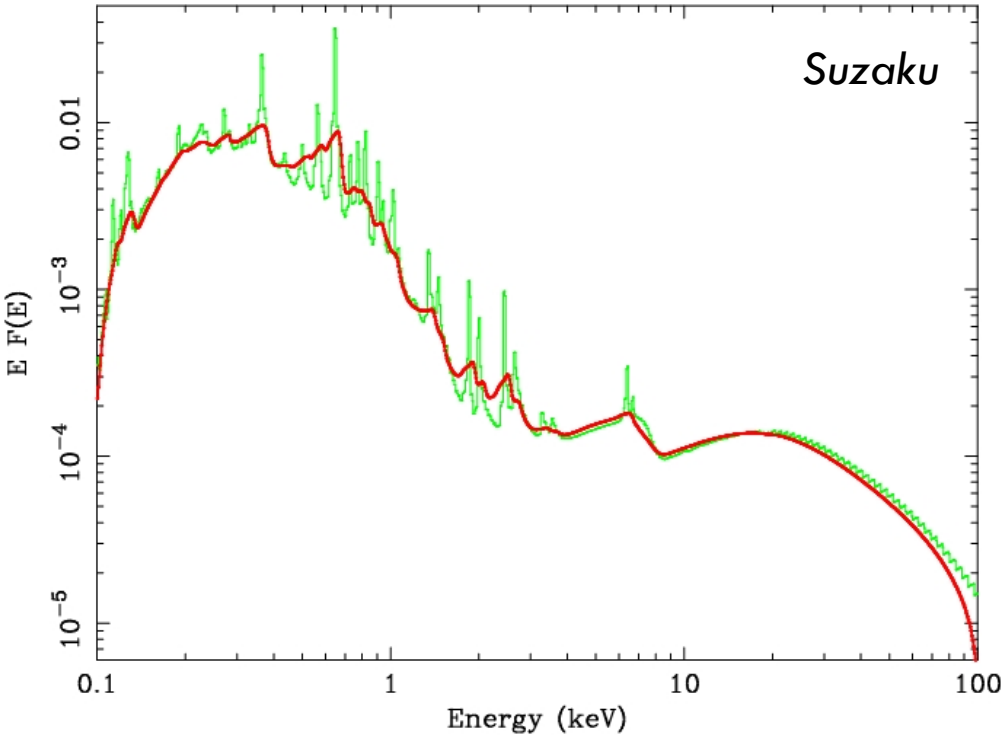
(simulations based on Dovčiak et al. 2004)

(Courtesy G.Miniutti)

Fe-line profile only
The hard X-ray band dominates

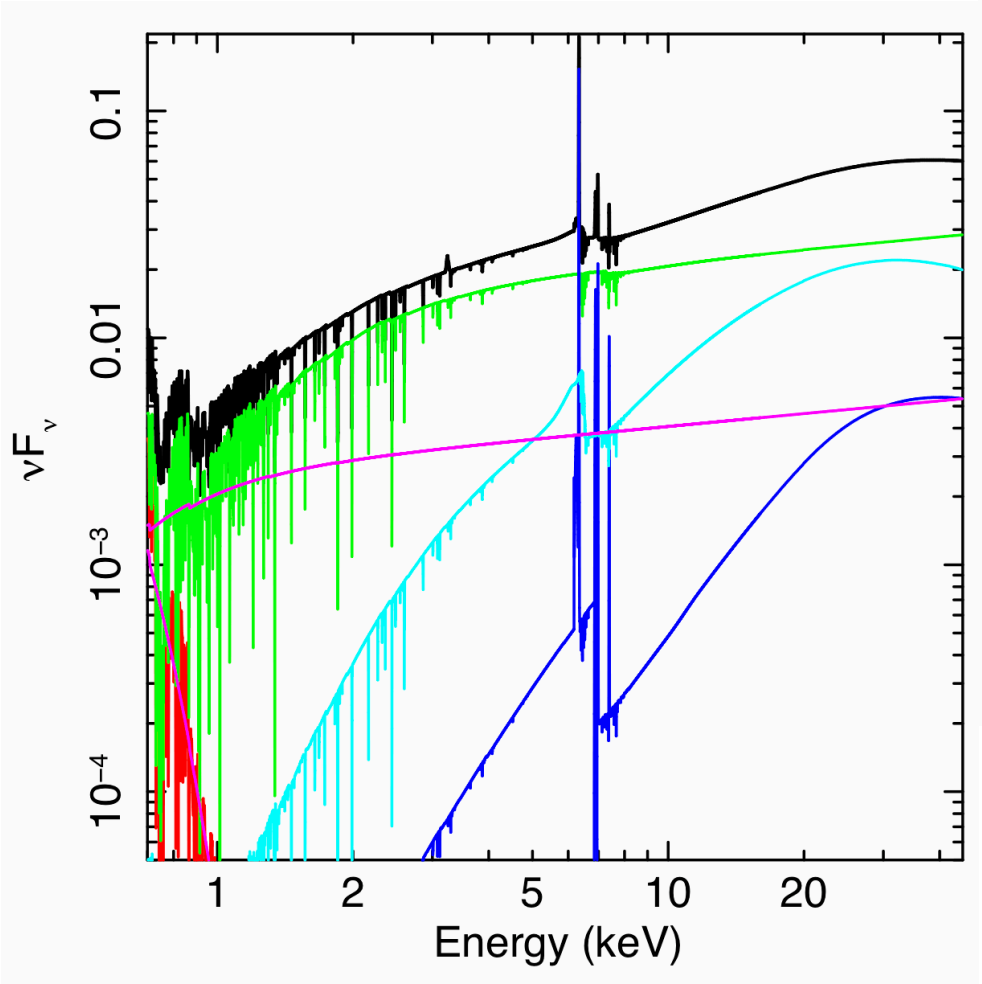
Full X-ray broadband spectrum
The soft X-ray band dominates





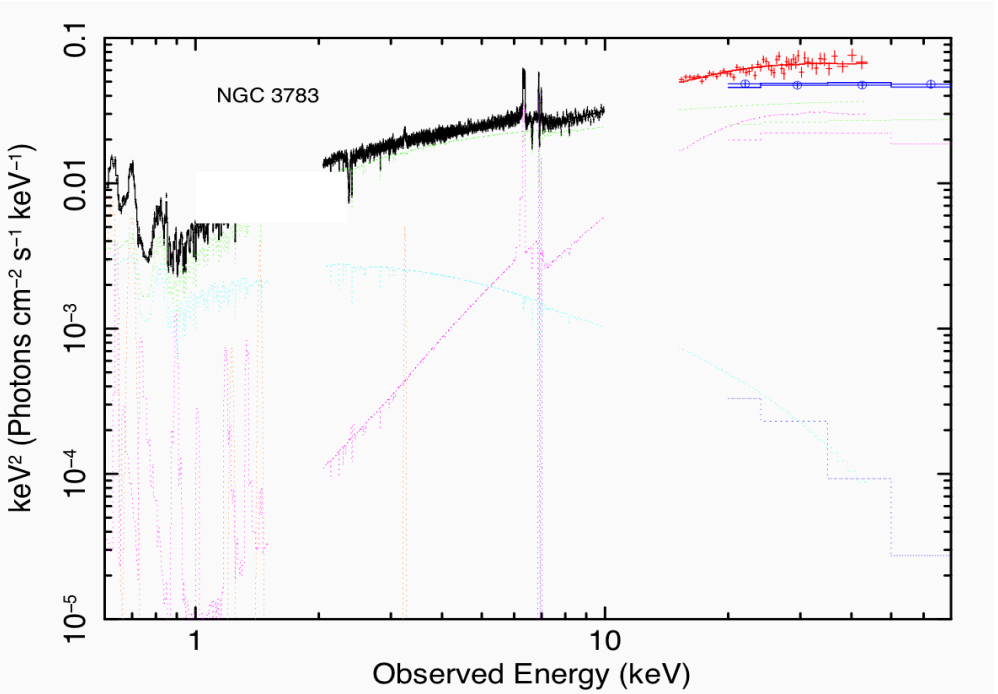
Systematic errors on a: spectral fitting

NGC3783 – Suzaku – a>0.98



(Brenneman et al., 2012)

NGC3783 – Suzaku – a<0.31

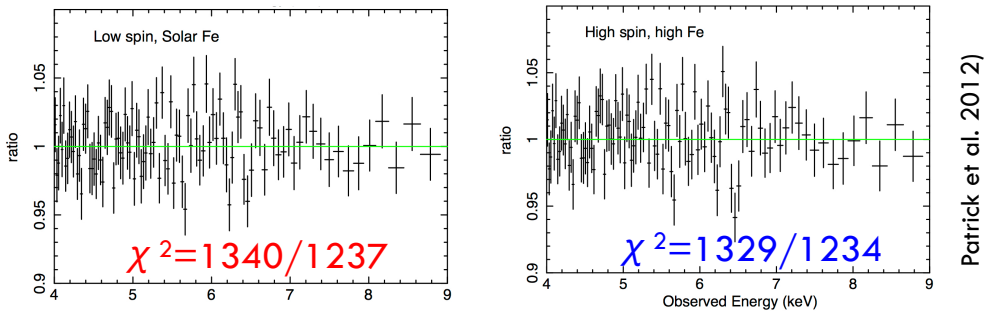


(Patrick et al., 2011)

The difference still holds if a double reflector model is used by both authors (see the discussion in Sect.4.3.4 in Patrick et al. 2012)

Where is the problem (Patrick/Brenneman)?

- Soft excess
  - Comptonization versus blackbody
  - Full versus partial covering warm absorbers
- Mixture of physical and phenomenological models:
  - `wabs*3(warmabs)*(po+comptt+pexrav+zga(FeKα)+zga(FeKβ)+Σzga +reflconv*reflionx)`
- Over-interpreting
- Analysis of *some* data

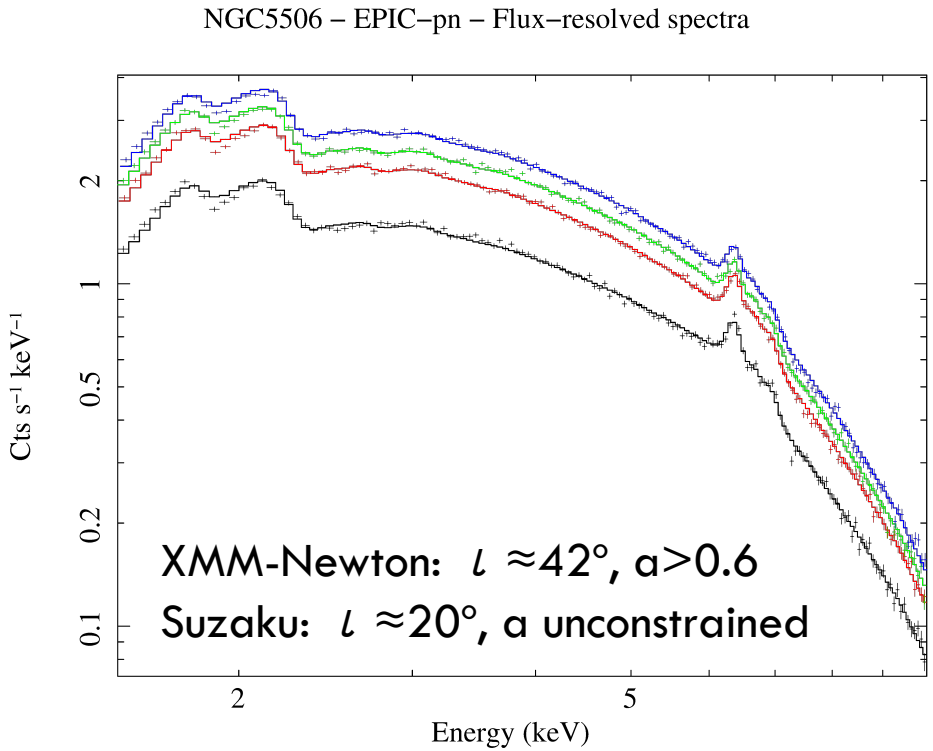


- Usage of observation-based time-averaged spectra, while what matter are the different spectral states
- There are sources which are simply too complicated

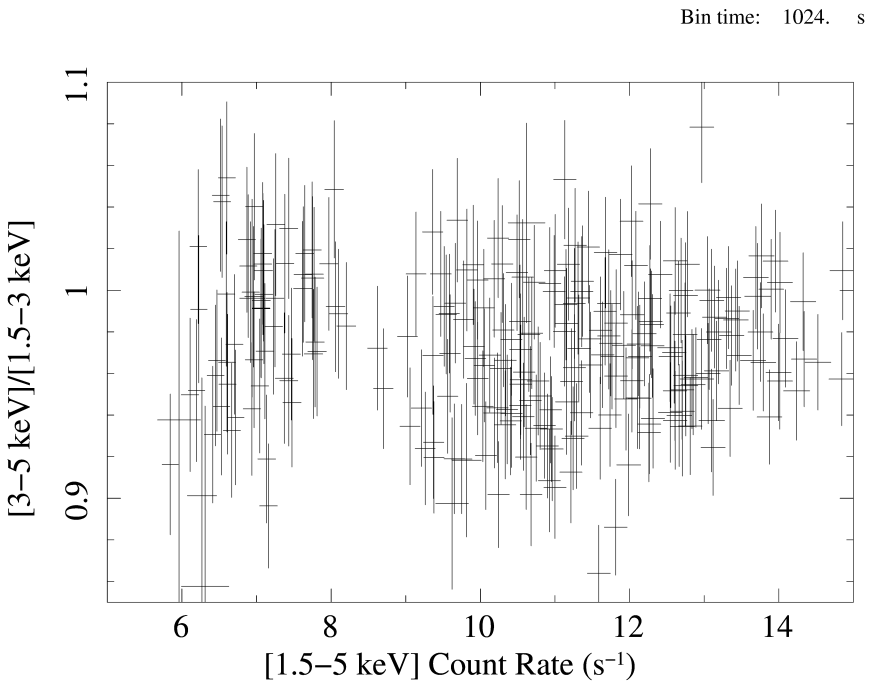
My contribution: NGC5506

(Guainazzi et al., 2010, MNRAS, 406, 201)

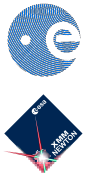
Multi-epoch, intensity-resolved analysis of all XMM-Newton/*Suzaku* spectra of NGC5506 on going



Moderate spectral variability



Similar approach on MCG-6-30-15 (complex, highly spectrally variable) in Miller et al., 2008, A&A, 43, 487



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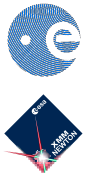

Why do we care?

- SMBH spin distribution in the local Universe may carry the imprinting of the accretion history
- SMBH spin may ultimately power relativistic jets
- The detailed profile of relativistically broadened lines could test General Relativity
- SMBH spin may be telling us how energy can be extracted from a black hole
- BH high spin may driver of high-speed black hole recoil
- Generation of gravitational waves

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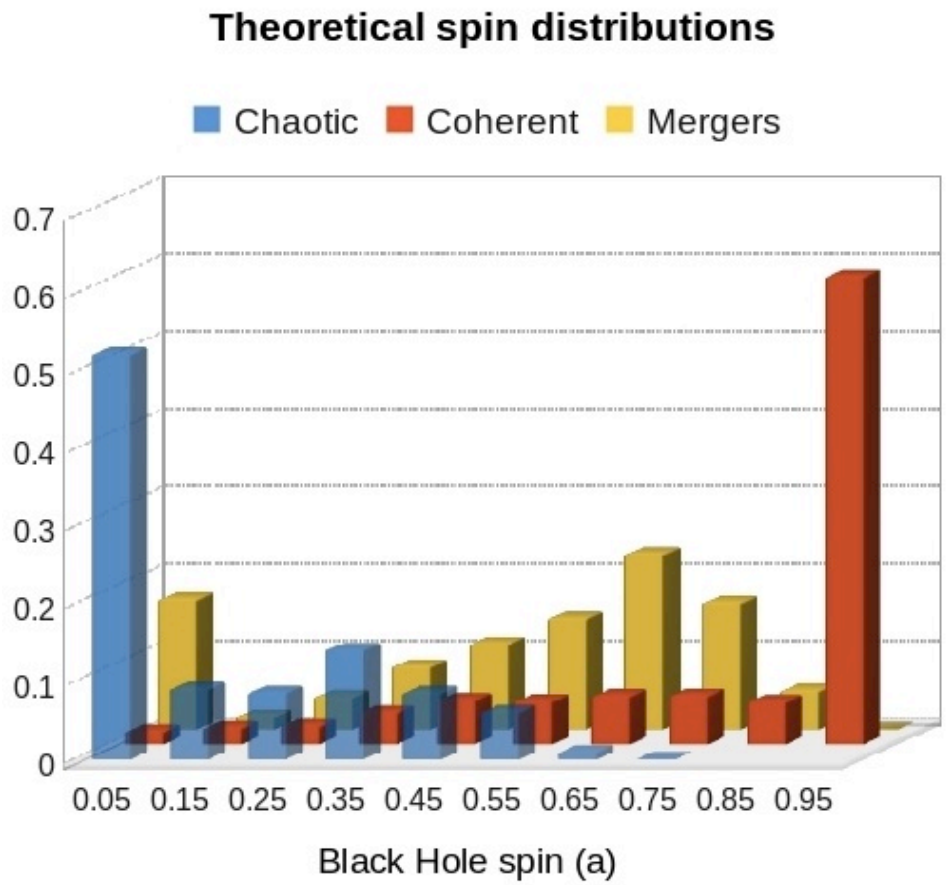
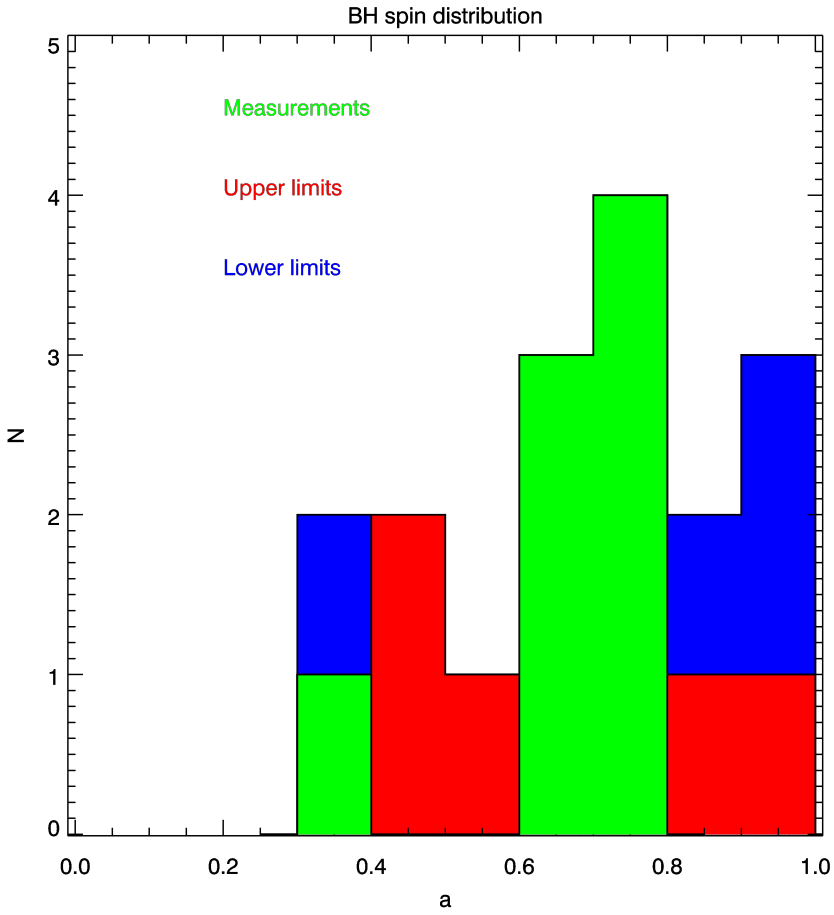
BH spin and the accretion history

Theoretical distributions



(Courtesy G.Miniutti; data from Berti & Volonteri 2008)

Observed distribution (so far)



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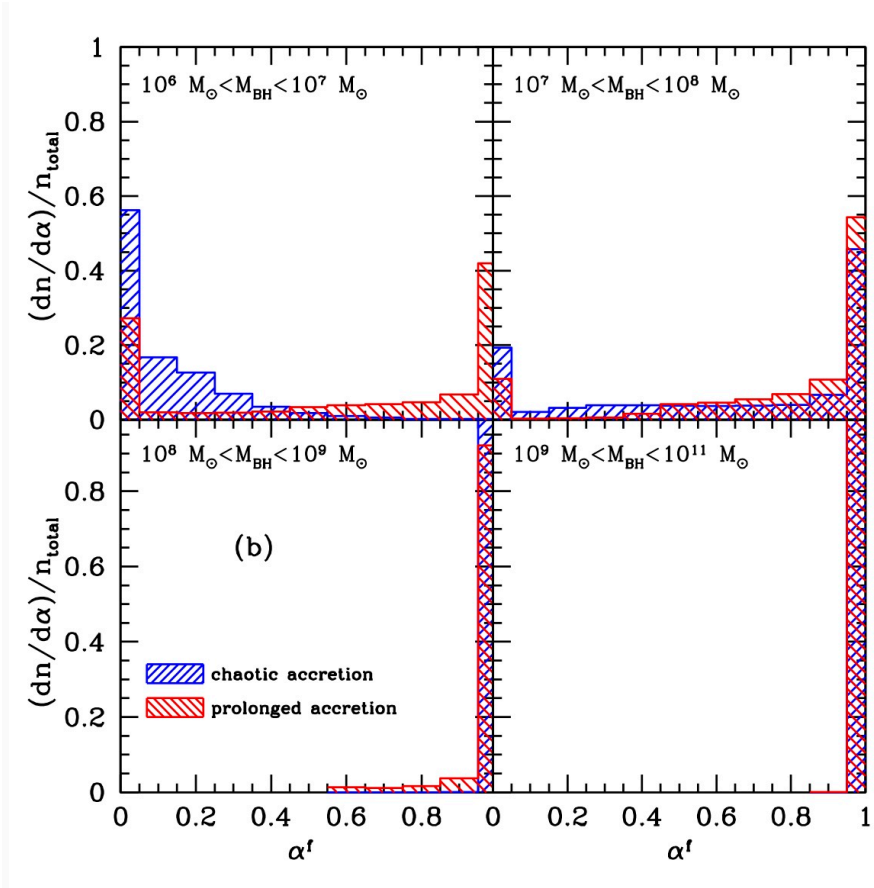

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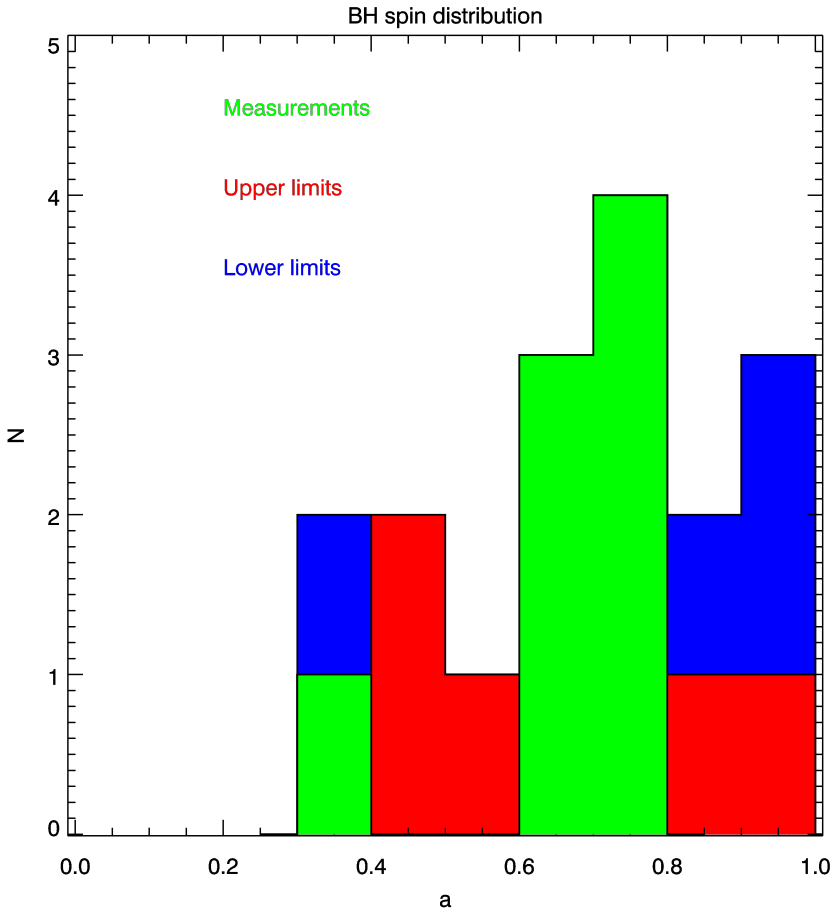
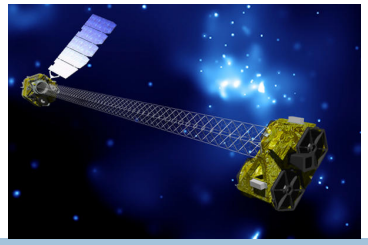


(Fanidakis et al. 2010; see also King et al. 2008)

NuSTAR



(Matt et al. 2011)

NuSTAR operational!

- 14/6 – launch
- 28/6 – first light

6 AGN to be observed simultaneously with ***Suzaku***: IC4329A, NGC4151 and **XMM-Newton:** 3C120, Ark120, MCG-6-30-15 SwiftJ2127.4+5654

Thanks to the unprecedented sensitivity in the 10-80 keV range we hope to be able to solve the degeneracy between "reflection-" and "absorption-dominated" models as well as to constrain the continuum underneath the broad Fe K_α profile