Hard Questions of Active Galactic Nuclei

Paris
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Image: ESO

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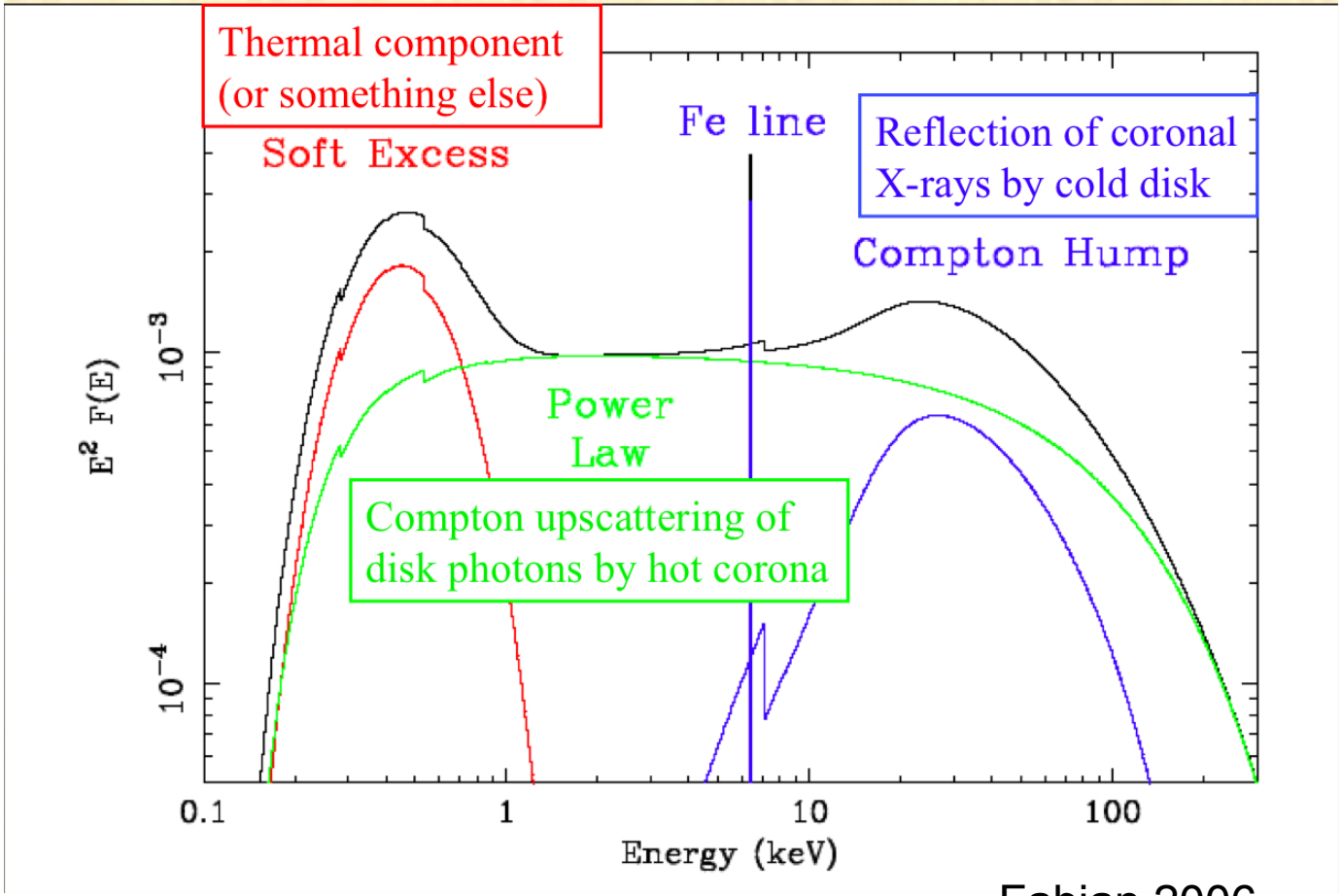
Outstanding Questions

What is the spin of Black holes in AGN?

Nature and behaviour of Primary emission component

Lack of 511 keV detection from individual AGN

Quick AGN Spectra Recap



Fabian 2006

BH Spin

Implications for BH formation, Galaxy evolution
(i.e. record of accretion history, lots of heavy correlated events a> 0.9, small uncorrelated events a<0.5, growth slowly through Galactic mergers a~0.7

Morphology Link?
(Spin connected to jet production, could explain why so many radio loud AGN are in Early type Galaxies)

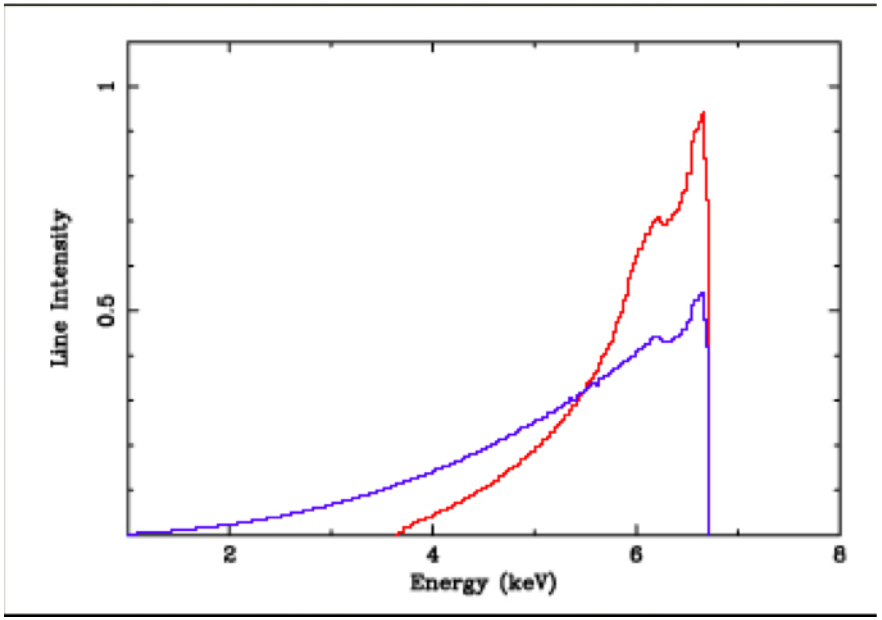
Measuring Spin

Central Hard X-ray source irradiates inner Accretion disc
Produces REFLECTION component
Most prominent feature Fe complex

When Mdot < 0.3 Medd, Fe emitting region extends to ISCO
Broadened by relativistic effects

BUT broadening could be the result of complex absorption by other compton-thin clouds/clumps – describe XMM data equally well

Measuring Spin



Fabian 2006

NGC 1365 – NuSTAR Result

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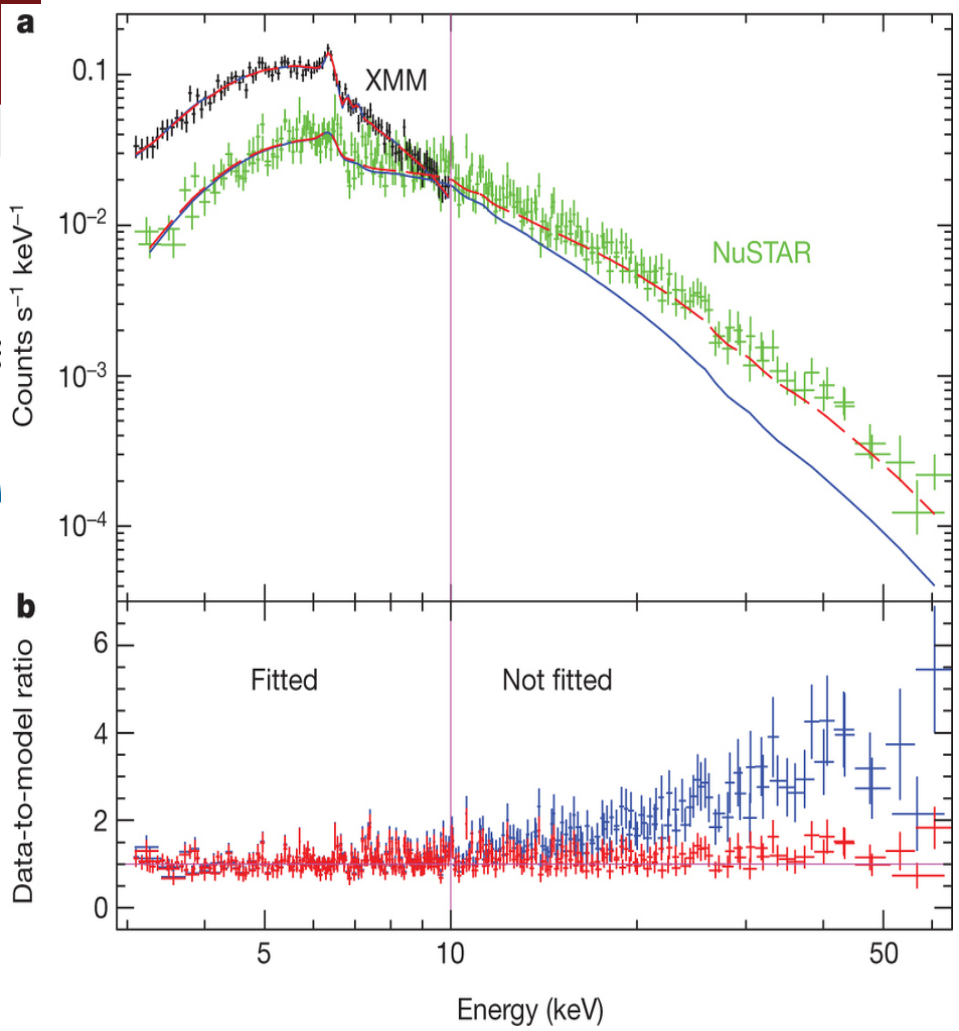

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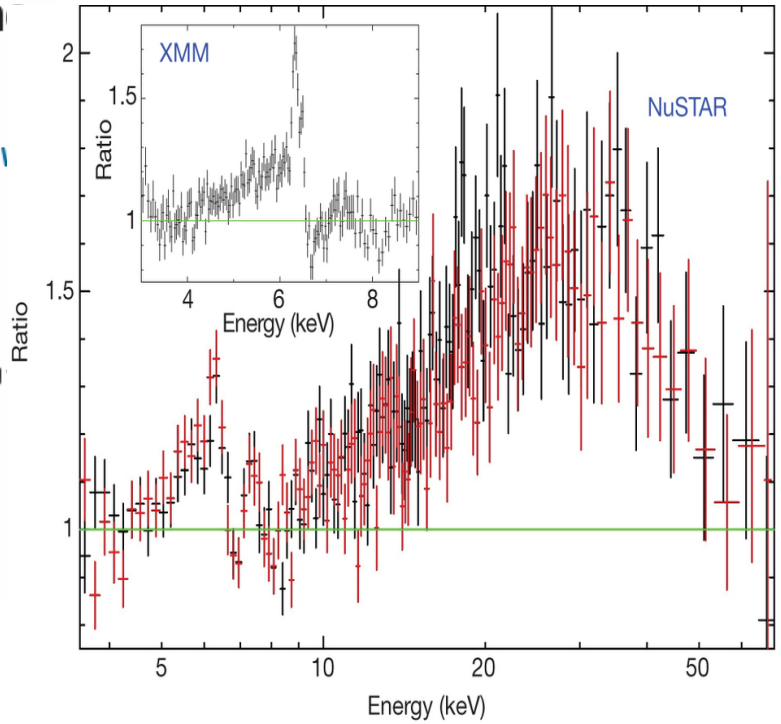

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THE HARD X-RAY SPECTRUM OF NGC 1365: SCATTERED LIGHT, NOT BLACK HOLE SPIN

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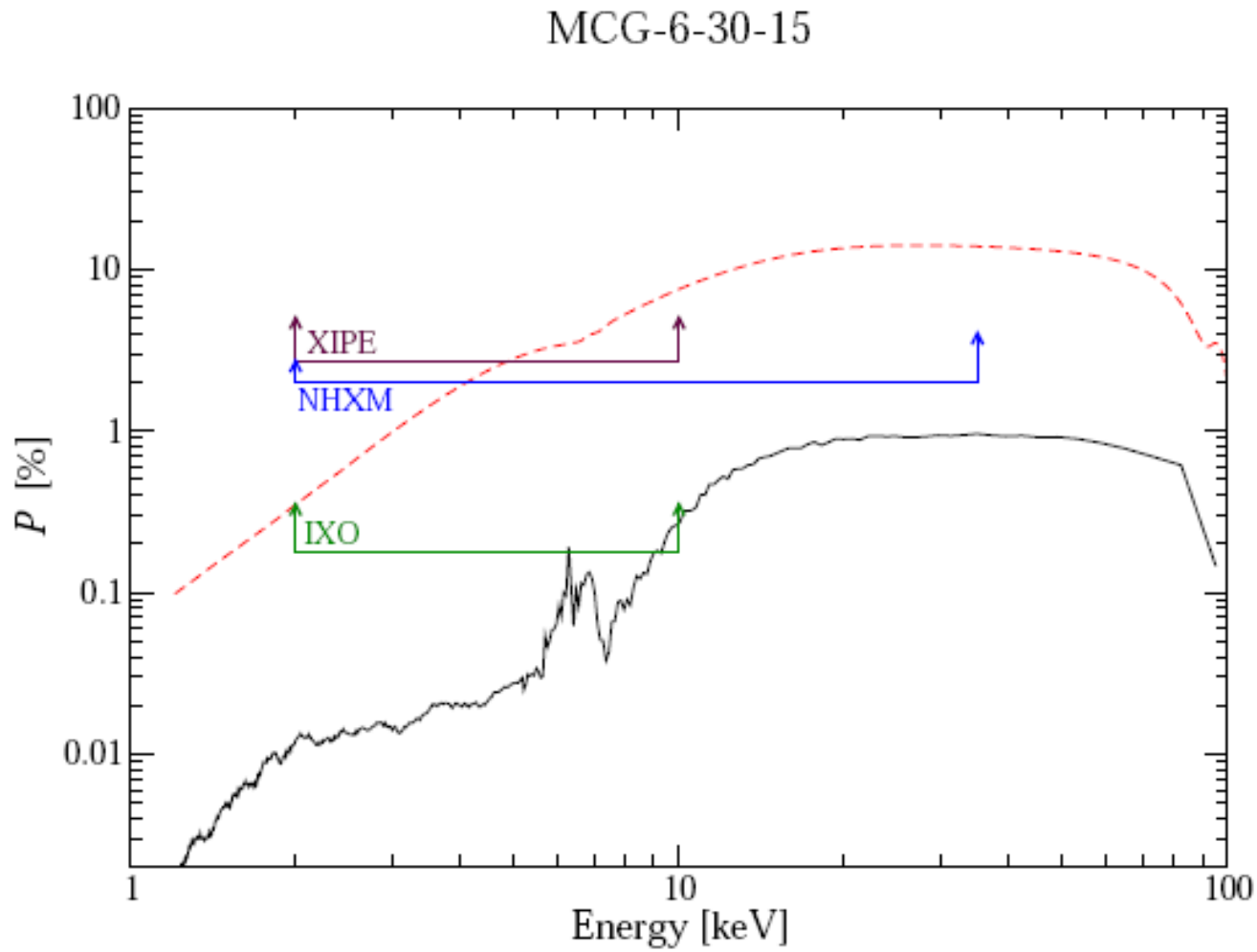
"measuring black hole spin is not possible."

so the controversy continues...

a solution might be to look at the polarization fraction at high energy (next slide)



Marin & Tamborra 2013 http://arxiv.org/abs/1309.1684

Figure 6: 1 Ms observation minimum detectable polarization of MCG-6-30-15 for the two scenarios of the broad iron line. The MDP for *XIPE* is represented by the maroon line, *NHXM* in blue and *IXO* in green. *Legend*: a fragmented absorption region (solid line) and a relativistic reflection model with an extreme Kerr SMBH with $a = 1$ (red dashed line).

Nature of the Hard X-ray source

- Corona? Jet?

Thermal compton emission, SSC or both?

- TC will have characteristic cut-off energy

defined by the temperature of the electron distribution

- Evidence to suggest this cut-off <200 keV

usually > 100 keV

Nature of the Hard X-ray source

- Outside of the bandpass of NuSTAR

- Does this matter? – YES!

Simulated NuSTAR example of Cen A, fit with the same model, Ecut could not be constrained

				Simulated	**Ecutoff=150 keV**	**Ecutoff=800 keV**
>	**par**	**comp**				
>	phabs	nH	10^22	9.55	9.32616	9.42971
>	cutoffpl	PhoIndex		1.67	1.62602	1.60776
>	**cutoffpl**	**HighECut**	**keV**	**-**	**88.2343**	**253.261**
>	cutoffpl	norm		0.1139	0.106	0.105
>	reflionx	Fe/solar		0.60	0.65	1.36
>	reflionx	Gamma		1.67	1.63	1.61
>	reflionx	Xi		10.0	99.	73.5
>	reflionx	norm		2.43E-04	2.68E-05	2.09E-05
>						

Nature of the Hard X-ray Component

- In X-ray binaries, evidence of link between thermal temperature of the plasma and other parameters, e.g. Motta et al. 2009

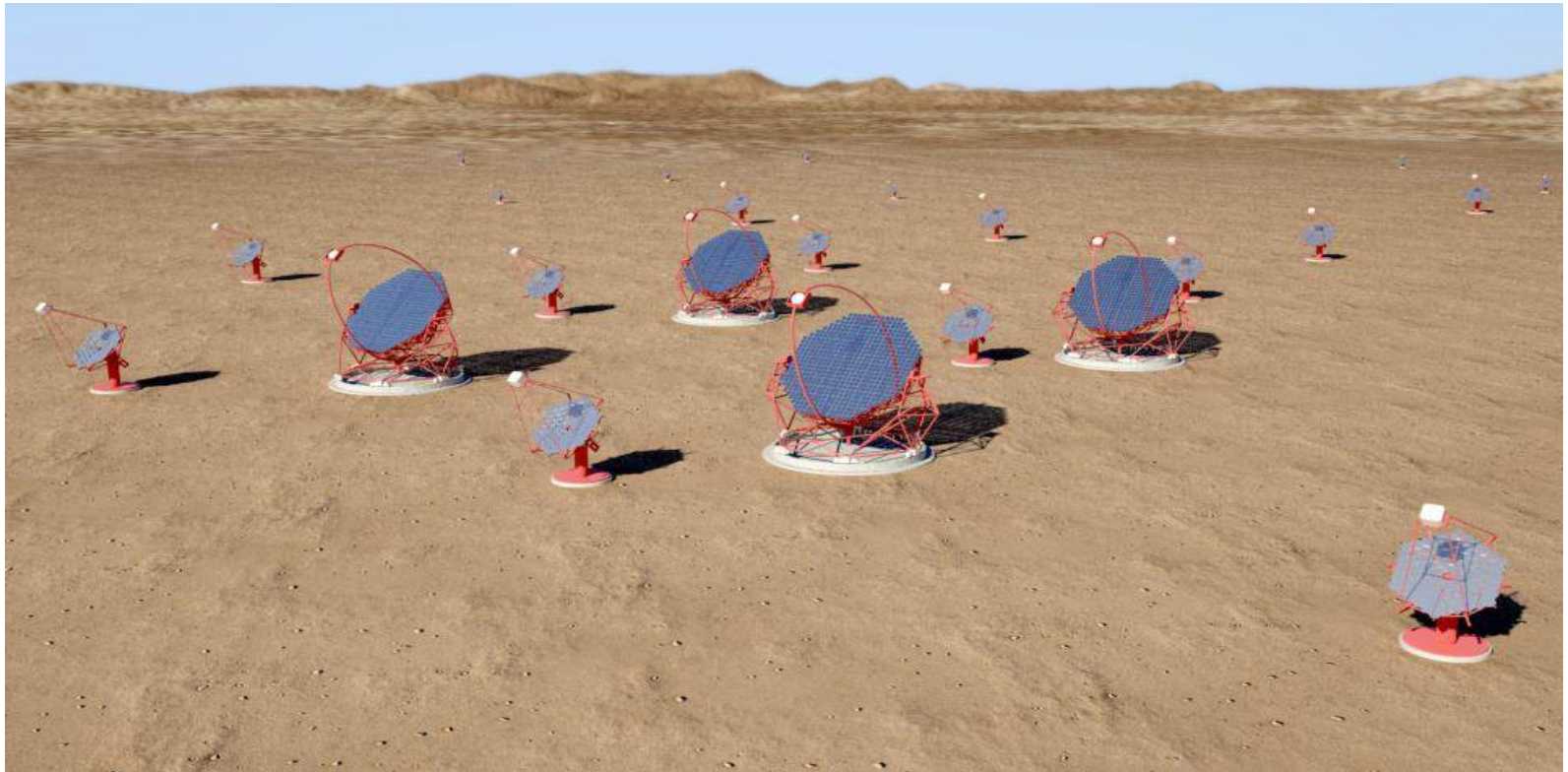
- New instrument sensitive upto 200 keV or higher would allow similar relationships to be studied in AGN

511 keV Line

- Why don't we see 511 keV annihilation line from individual AGN?
- It could be the case that they are being produced in regions where gravitational redshift is large, smearing out the line over SPI's sharp spectral resolution
- Maybe a bigger instrument but with broader resolution?

Supporting other Missions

- TeV Blazars tend to emit upto 200 keV without a cut-off
- There's a danger of CTA going live with no support in this regime



Summary

- Spin – Issues can be resolved by excellent polarization sensitivity. Can be measured by excellent sensitivity 6-7 keV and 10-60 keV
- Primary Emission Component – Coverage >100 keV required to show thermal compton (disc) or SSC (jet) nature, and to measure temperature of the plasma
- 511 keV annihilation line – Why don't we detect from AGN? Smoothed out? Perhaps solved by large effective area instrument with moderate spectral resolution?
- Need to provide coverage upto at least 200 keV ready for investigation of TeV blazars in the CTA eras