Recent results on the X-ray emission of radio-quiet AGN

Giorgio Matt

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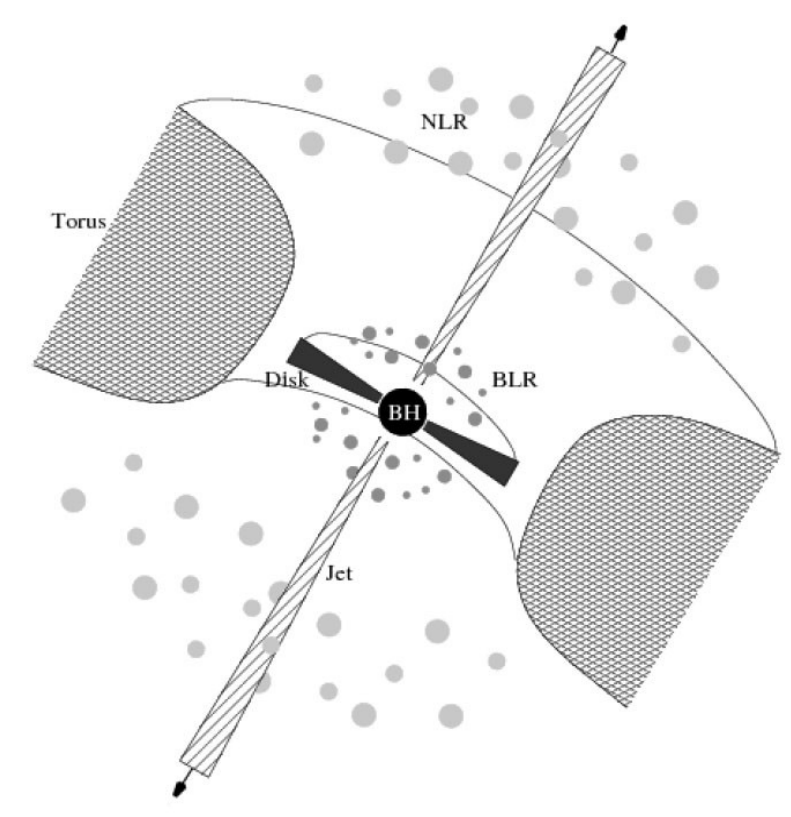
STRONGGRAVITY
EU FP7-SPACE research project 312789 2013 - 2017

Plan of the talk

- ***Primary emission***
  - ***Coronal parameters***
  - ***Soft excess***
- ***Reprocessed emission***
  - ***Relativistic reflection***
  - ***Time lags***
- ***Obscuration and outflows***
  - ***X-ray eclipses***
  - ***BALs: absorption or X-ray weakness?***
  - ***The NGC 5548 campaign***



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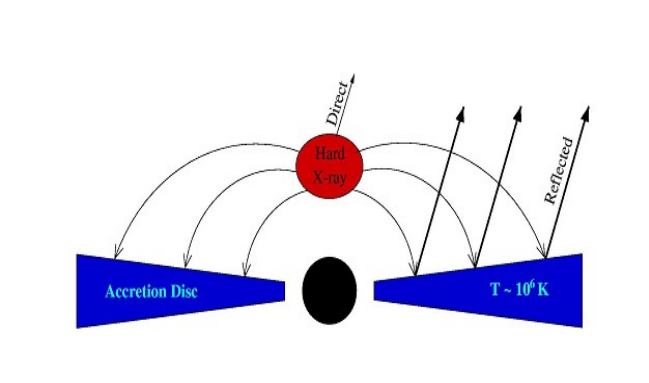

- ***Reprocessed emission***
  - ***Relativistic reflection***
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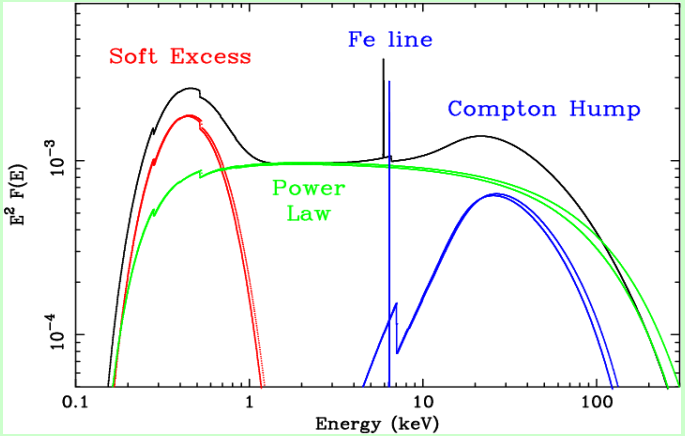

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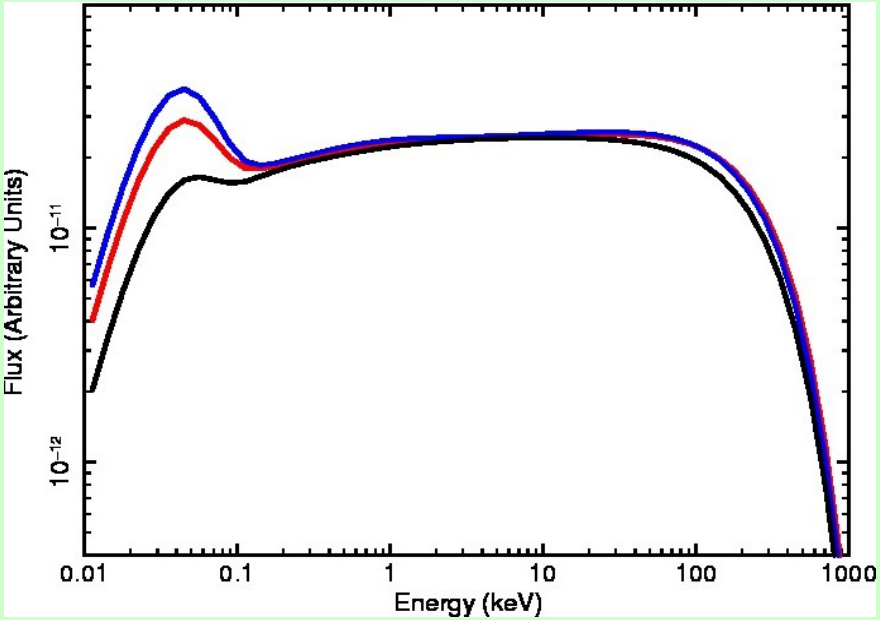
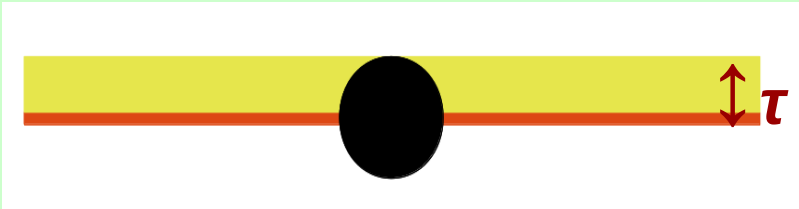
Coronal parameters

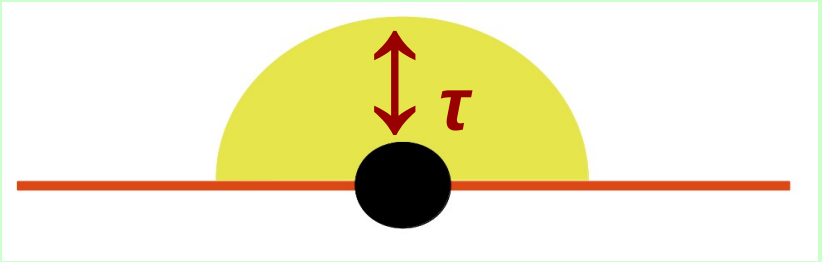
Primary hard X-ray emission likely due to Comptonization in a hot corona → quasi-exponential high energy cutoffs expected

Evidence for high energy cutoffs in BeppoSAX and XMM - INTEGRAL samples

NuSTAR is providing for the first time source-dominated obs above 10 keV → coronal parameters (much more in Andrea Marinucci's talk tomorrow; results on radiogalaxies in Anne Lohfink's poster)







Coronal parameters

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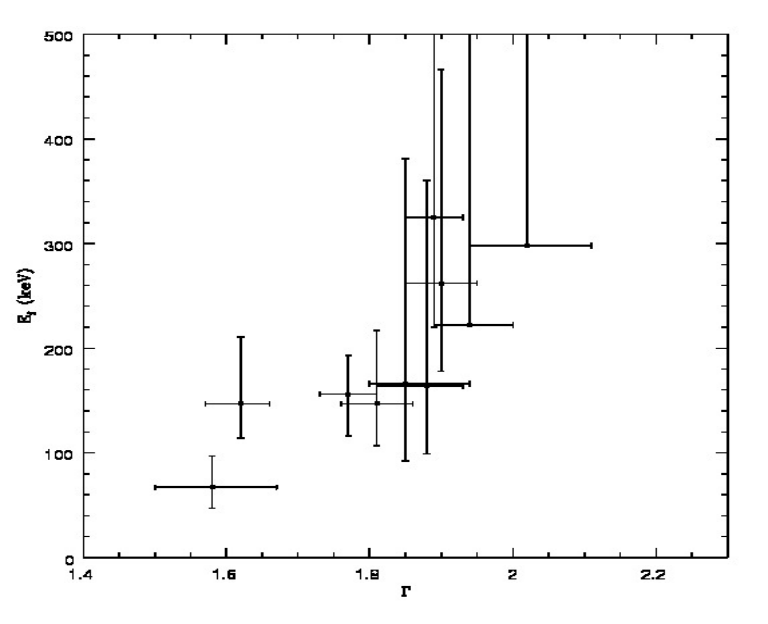
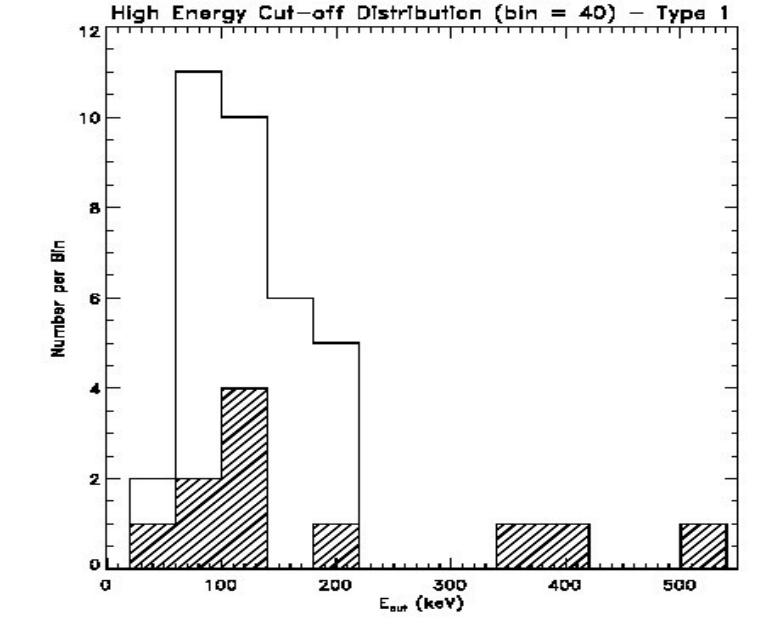


(Perola et al. 2002)



(Malizia et al. 2014)

Coronal parameters

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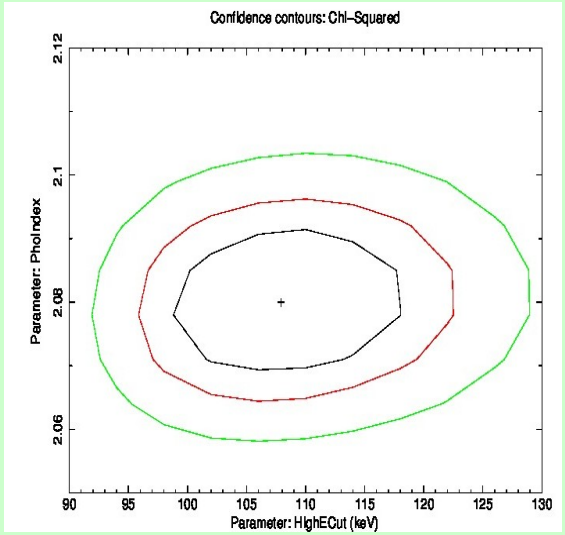
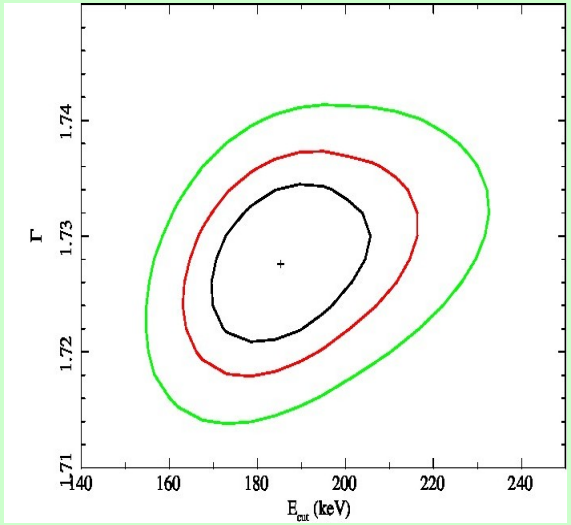


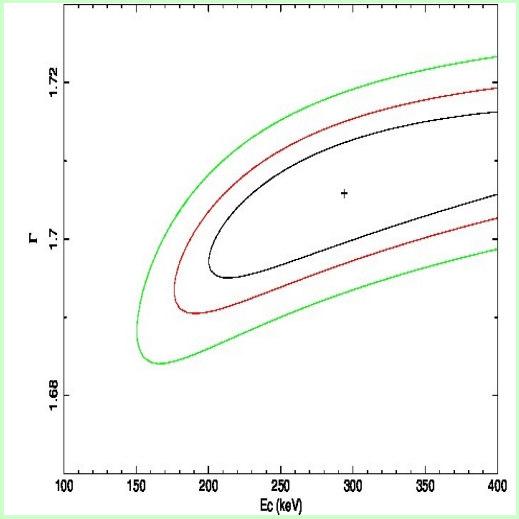
Swift J2127.4+5654 (Marinucci et al. 2014)

kT~68/53 keV τ~0.35/1.35 (slab/sphere)



IC4329A (Brenneman et al. 2014)

kT~61/50 keV τ~0.7/2.35 (slab/sphere)



Ark 120 (Matt et al. 2014)

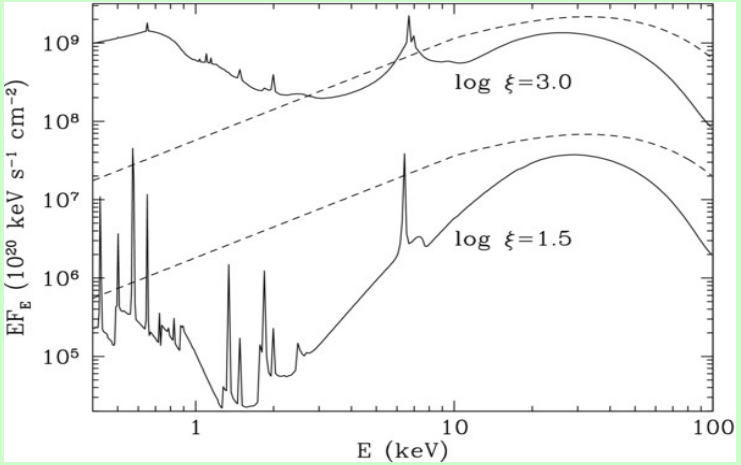
Soft excess

Most AGN show soft X-ray emission in excess of the extrapolation of the hard primary emission

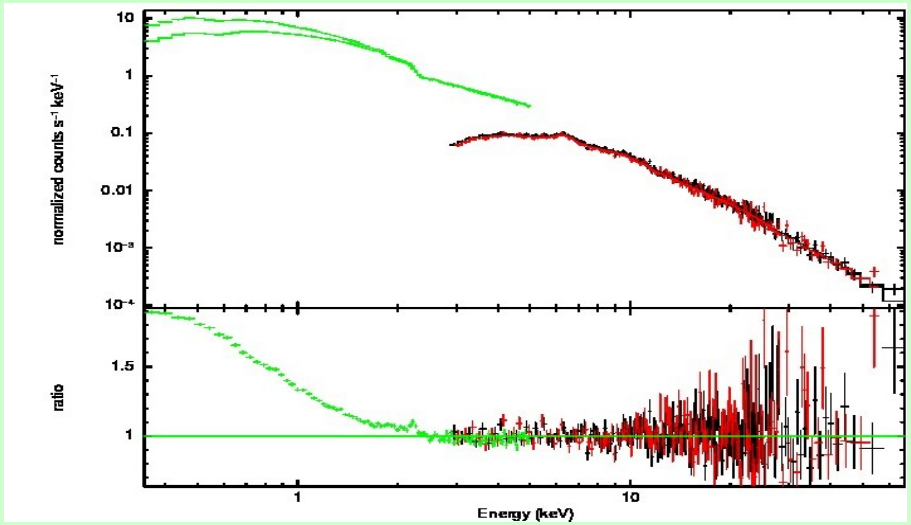
In many sources the soft excess is well explained by ionized reflection (e.g Walton et al. 2013)

However, there are sources in which another component is required (Patrick et al. 2012, Lohfink et al. 2012, Petrucci et al. 2013)

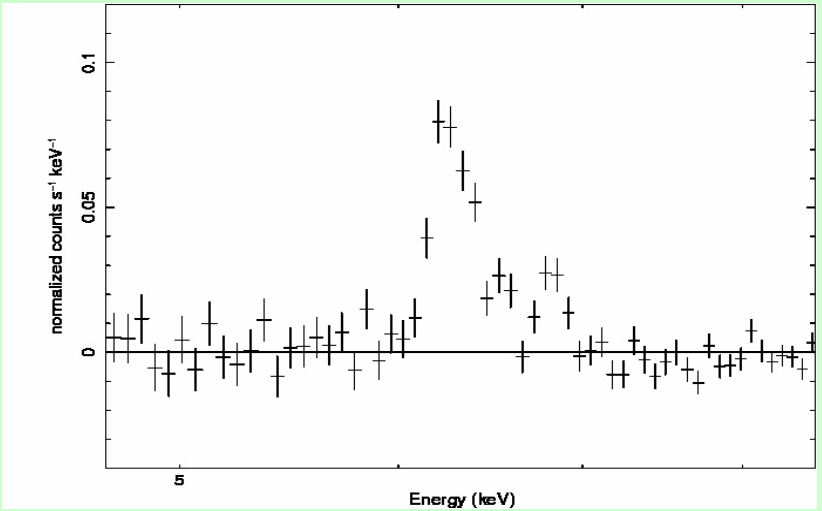
Ark 120 is one of them (Matt et al. 2014)



(Ross & Fabian 2005)



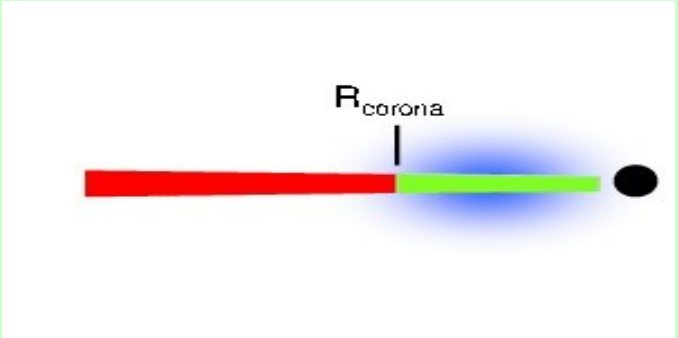
Ark 120 XMM+NuSTAR (Matt et al. 2014)

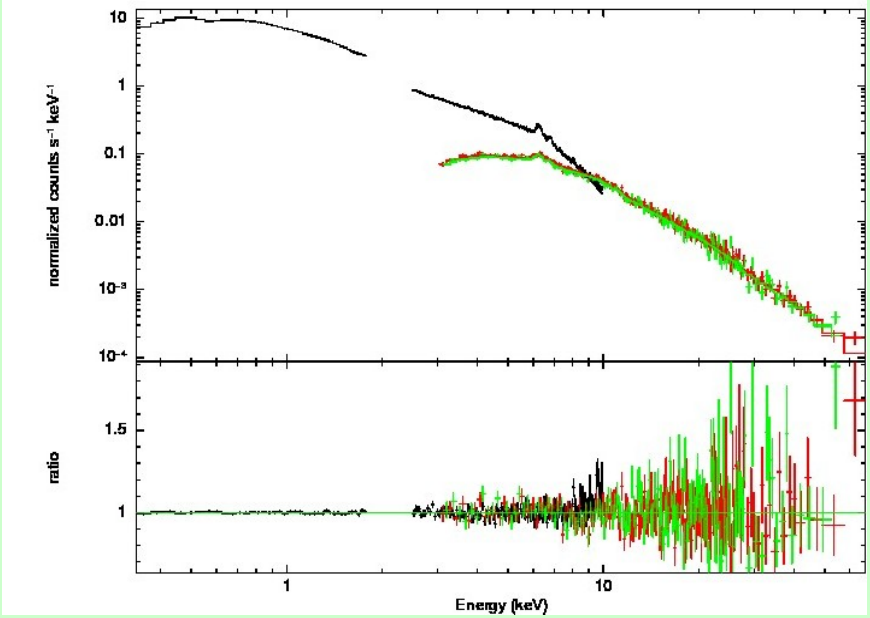


No obvious evidence for a relativistic iron line (differently from a previous Suzaku obs, Nardini et al. 2011)

Soft excess

The broad-band best fit is with a Comptonization model for the soft excess. A cutoff p.l., compTT, nthcomp or optxagnf provide fits of comparable quality.Optxagnf (Done et al. 2012) is a disk/corona emission model which assumes a thermal disk emission outside the coronal radius, and soft and hard Comptonization inside.





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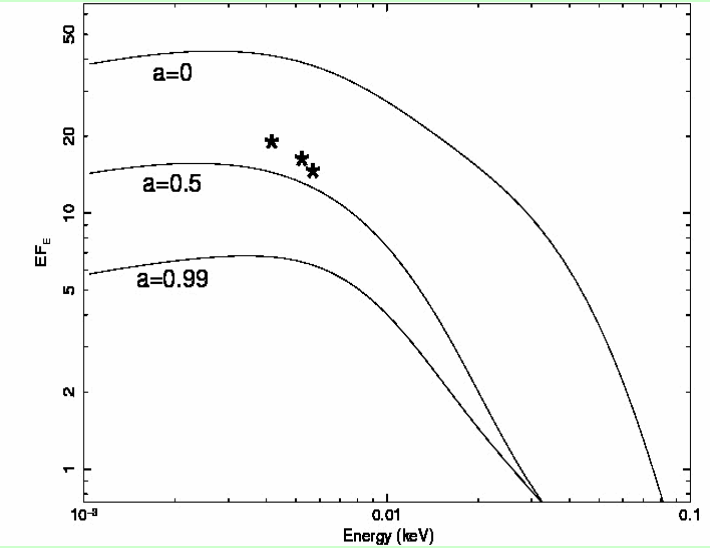

Extrapolating the best fit X-ray model to the OM UV data, an estimate of the black hole spin is possible

Plan of the talk

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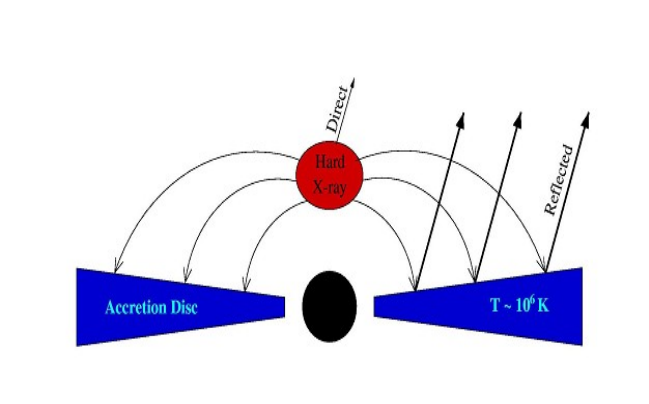
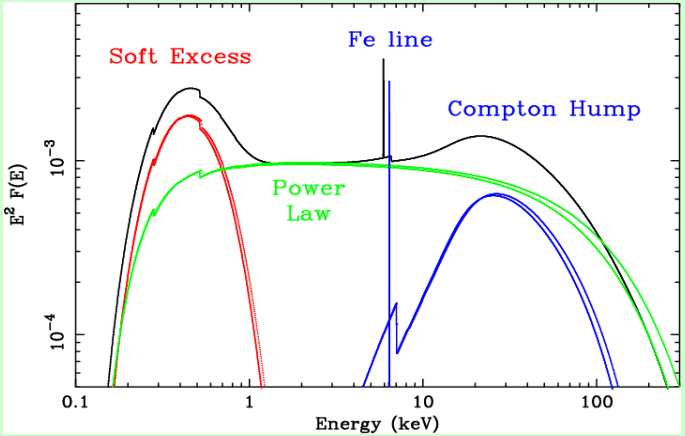
  - ***Coronal parameters***
  - ***Soft excess***

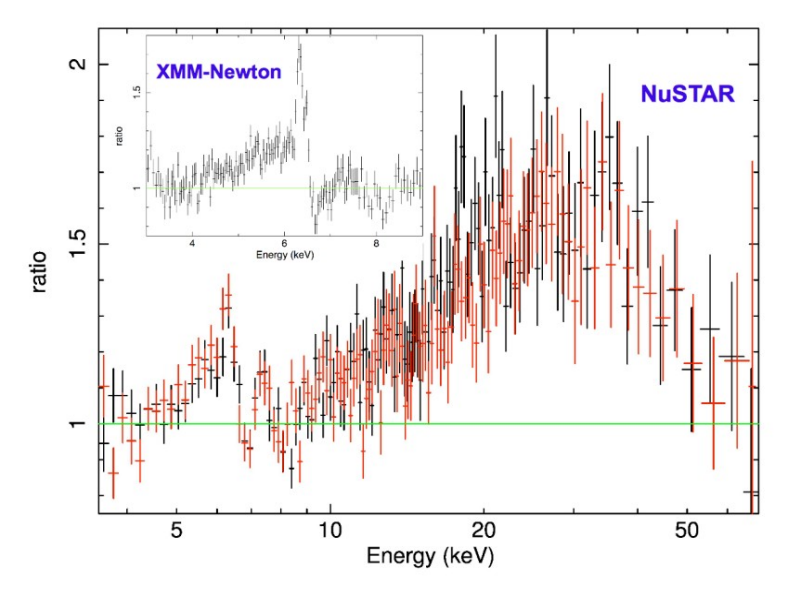


- ***Reprocessed emission***
  - ***Relativistic reflection***
  - ***Time lags***



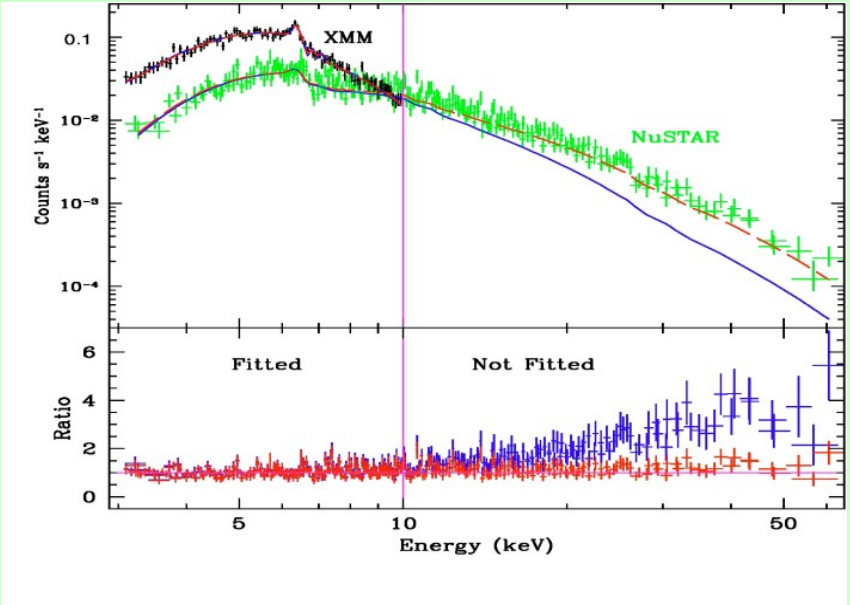
- ***Obscuration and outflows***
  - ***X-ray eclipses***
  - ***BALs: absorption or X-ray weakness?***
  - ***The NGC 5548 campaign***

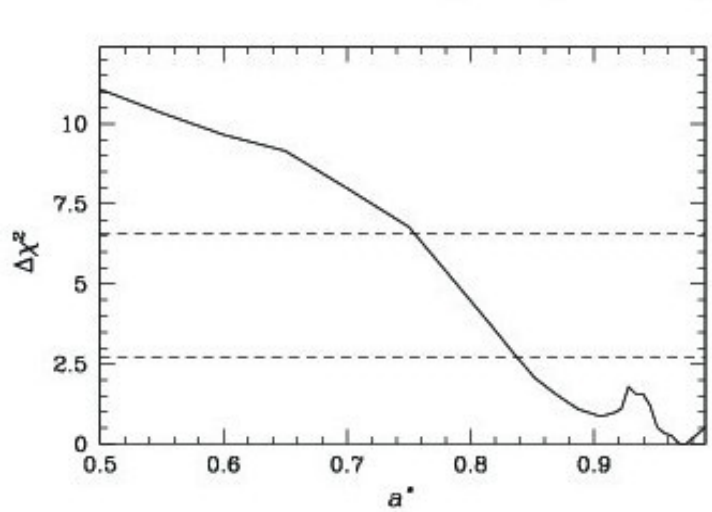
Relativistic reflection



NGC 1365: a source with BOTH absorption and relativistic reflection

Risaliti et al. 2013

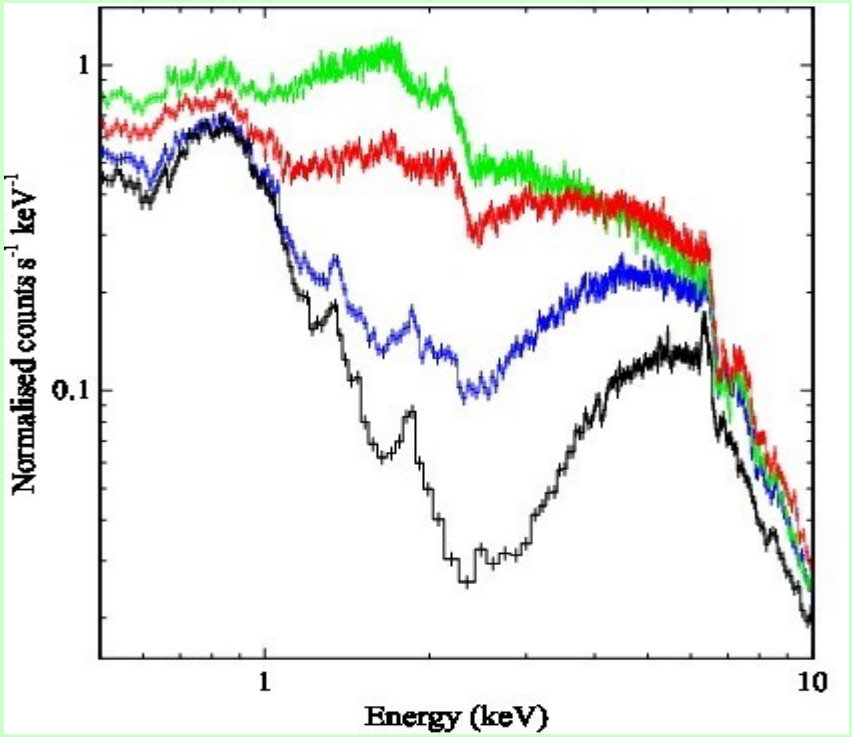


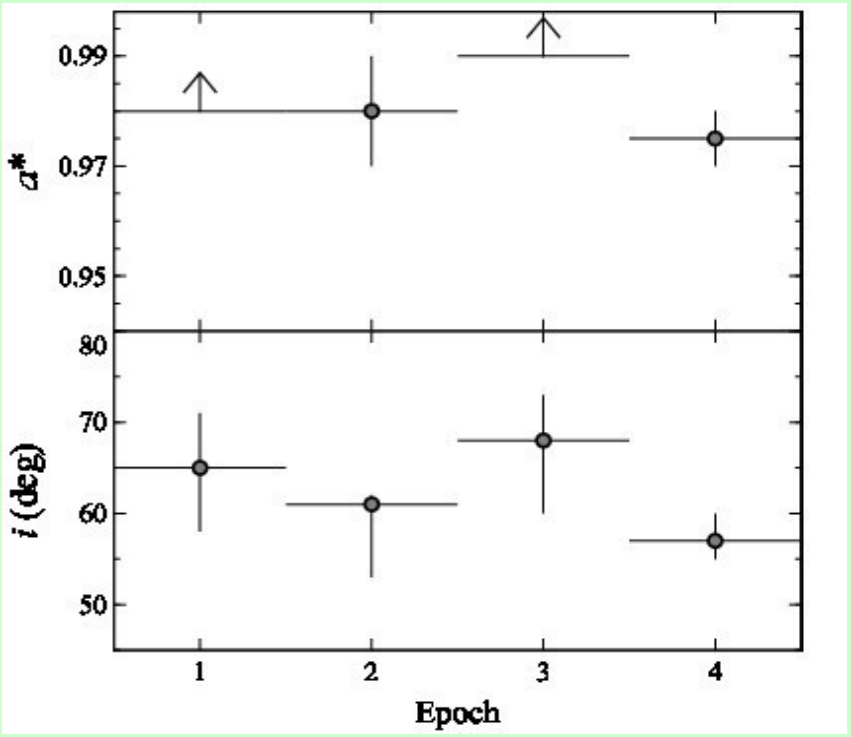


Consistent with a maximally rotating BH

Relativistic reflection

NGC 1365 was observed by XMM-Newton and NuSTAR four times. Despite large variations in the absorbers, no variations in the spin and inclination are found, demonstrating the robustness of the result.

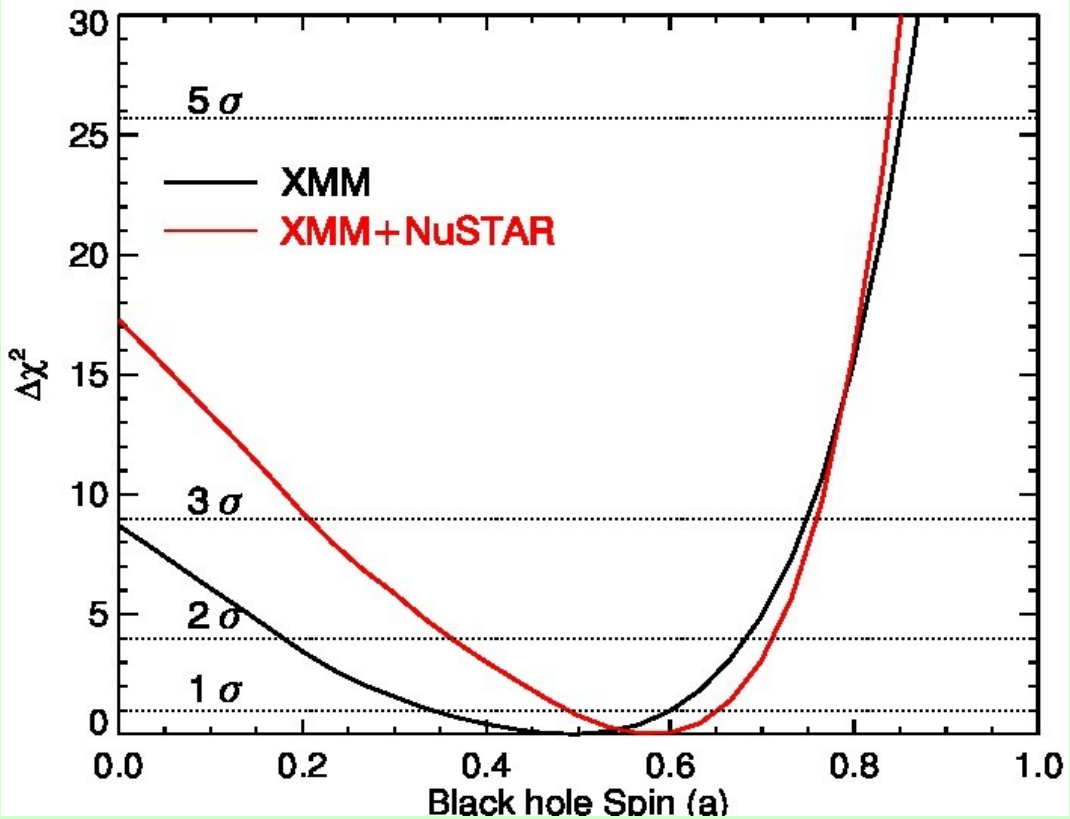




(Walton et al. 2014; Dom Walton's talk)

Relativistic reflection

Other high quality XMM-NuSTAR observations provide robust measurements of the spin which is e.g. confirmed to be consistent with extreme Kerr in MCG-6-30-15 (Marinucci et al. 2014a)

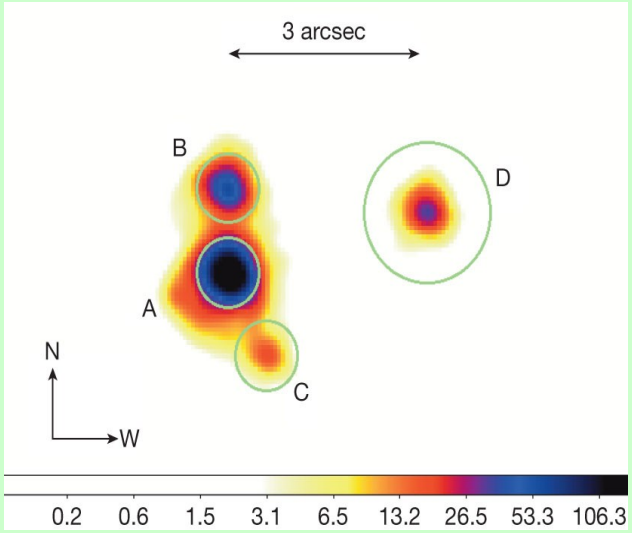


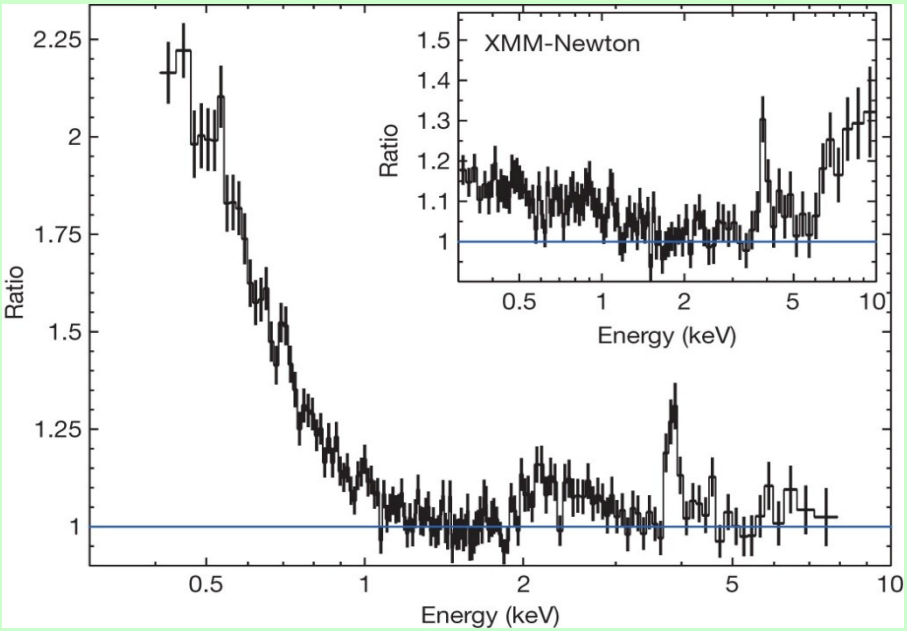
Intermediate spin confirmed in the NLSy1 Swift J2127.4+5654 (Miniutti et al. 2009, Marinucci et al. 2014b)

Swift J2127.4-5654 XMM+NuSTAR (Marinucci et al. 2014b)

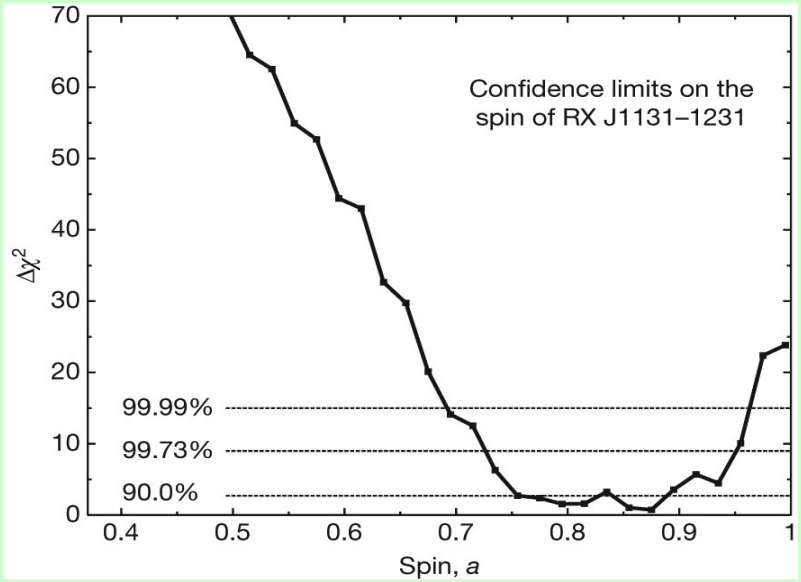
Relativistic reflection

Use of lensed quasar allows to study relativistic reflection beyond the local Universe, as in the z=0.658 quasar RXJ1131-1231 (Reis et al. 2014)





RX J1131-1231 XMM+Chandra (Reis et al. 2014)

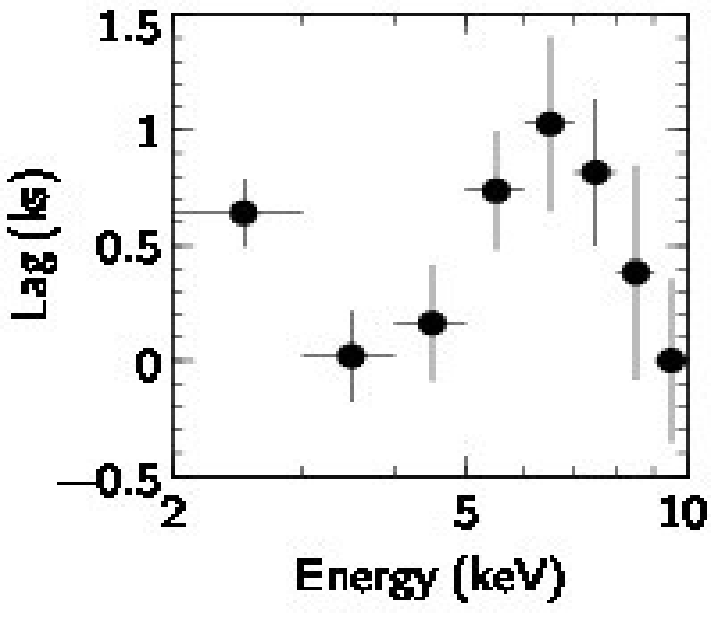


Next talk !!

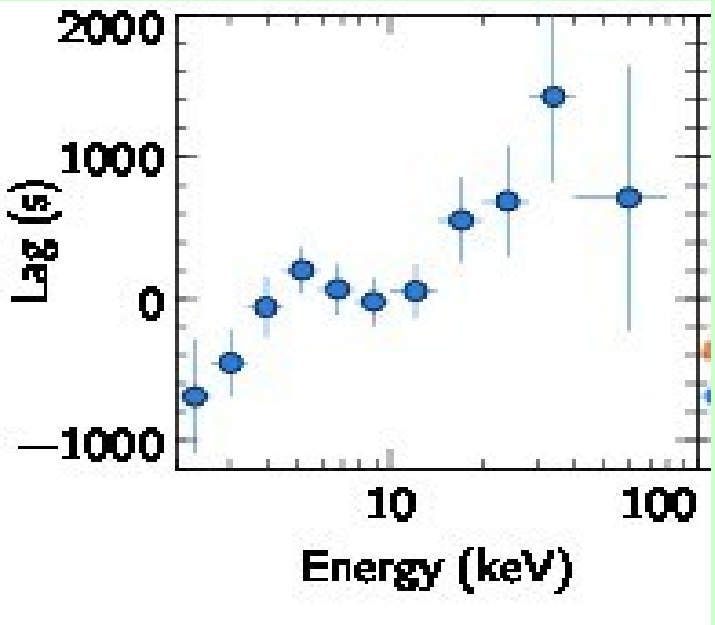
Time lags

Soft time lags observed in many AGN (e.g. Fabian et al. 2009, De Marco et al. 2013, Uttley et al. 2014 -- Phil Uttley's talk) → Reflection from inner disc

More recently, reverberation of iron lines also observed (e.g. Zoghbi et al. 2012, 2013, Kara et al. 2014) → Compton hump reverberation expected !!



MCG-5-23-16 XMM-Newton (Zoghbi et al. 2013)



MCG-5-23-16 NuSTAR (Zoghbi et al. 2014)

This and much more in Erin Kara's and Abdu Zoghbi's talks this afternoon !!!

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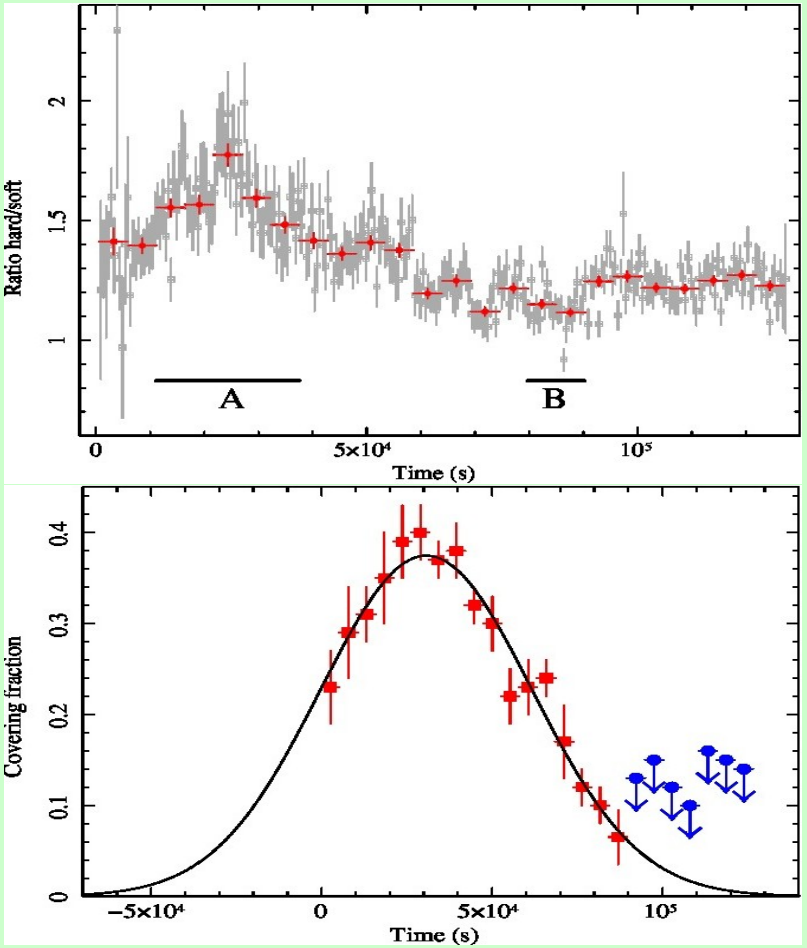
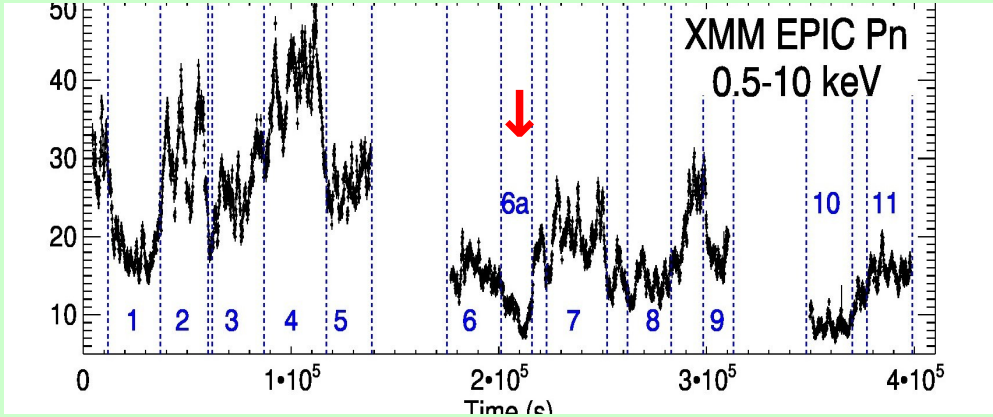
- ***Obscuration and outflows***
  - ***X-ray eclipses***
  - ***BALs: absorption or X-ray weakness?***
  - ***The NGC 5548 campaign***

X-ray Eclipses

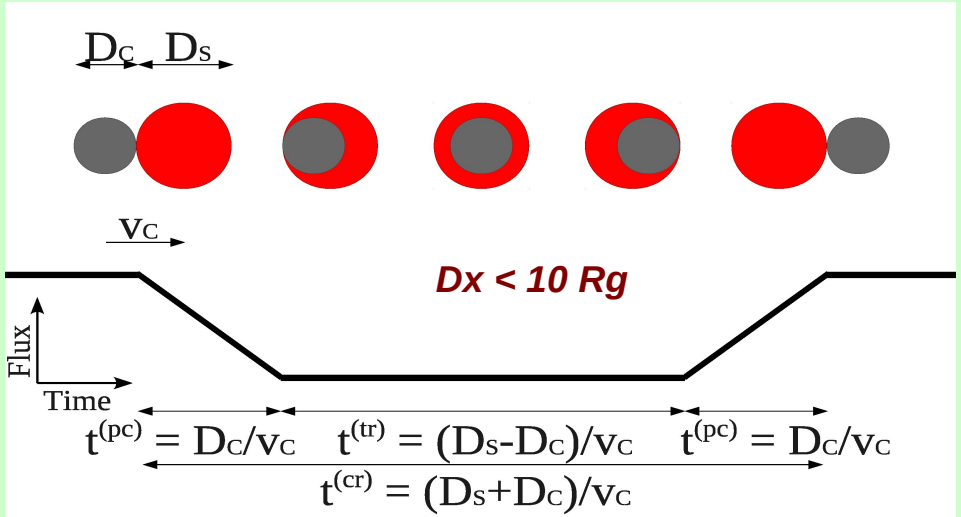
X-ray eclipses have been found in some sources (e.g. NGC1365, Risaliti et al. 2009, Maiolino et al. 2010; Mrk 766, Risaliti et al. 2011, ...) allowing to estimate the size of both absorbing clouds and X-ray emitting regions (see Giovanni Miniutti's talk this afternoon)



Swift J2127.4+5654 XMM-Newton (Sanfrutos et al. 2013)

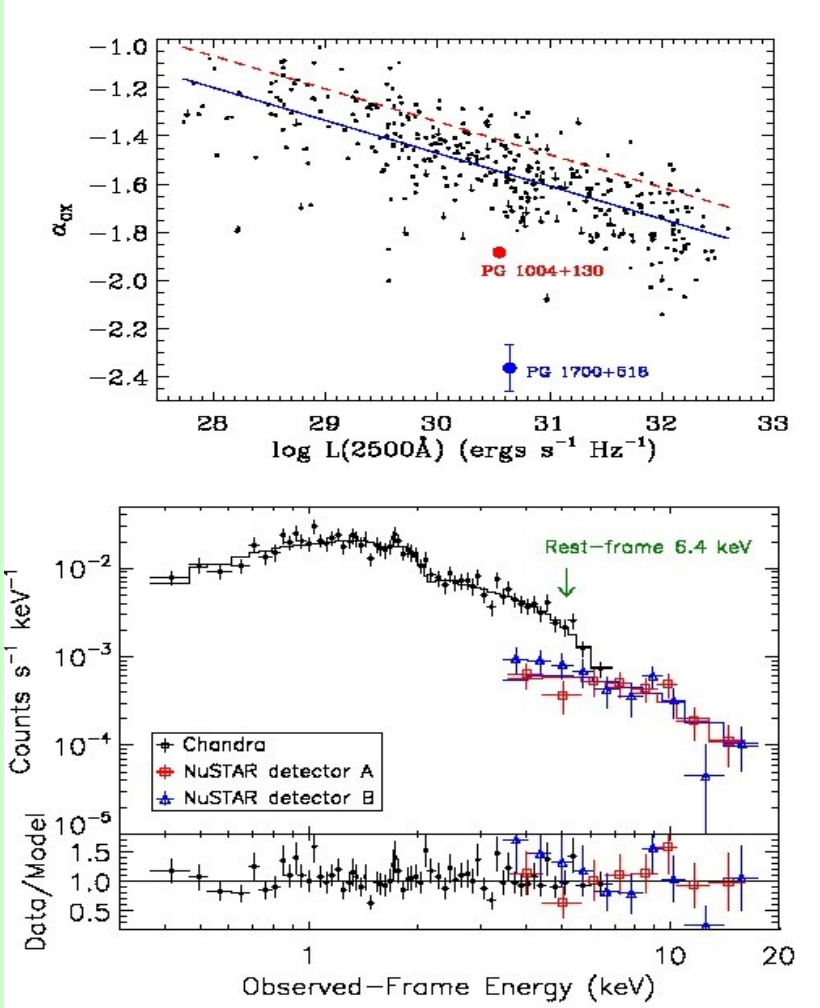


MCG-6-30-15 XMM-Newton (Marinucci et al. 2014)

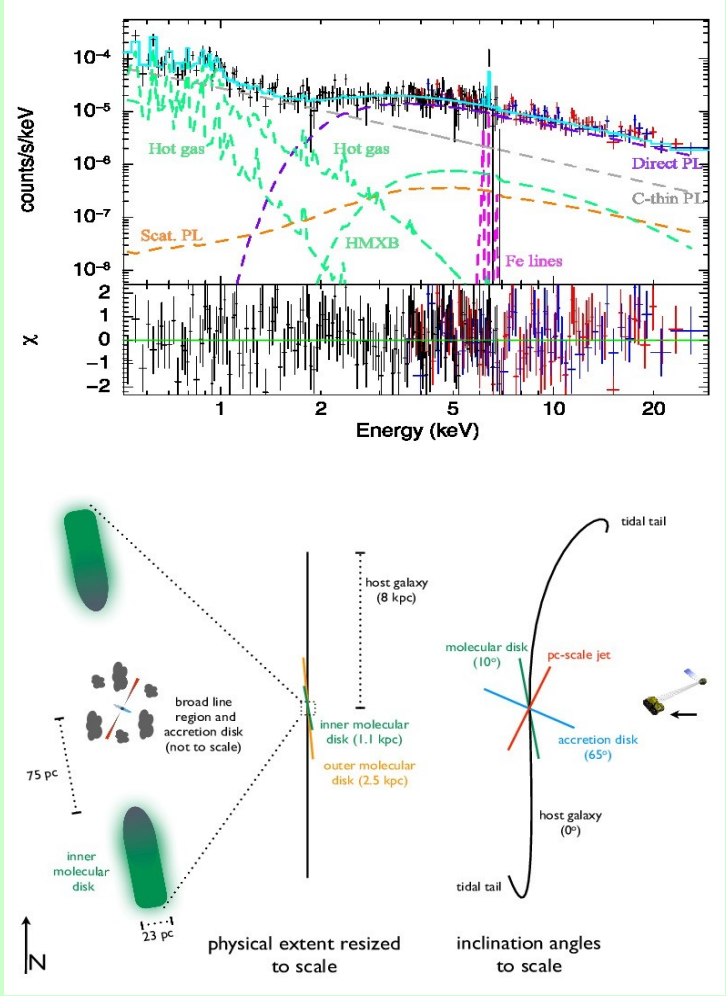


BAL: Absorption or X-ray weakness?

Broad Absorption line quasars have a low X-ray-to-optical flux ratio → Absorption or intrinsic X-ray weakness?



PG 1004+130 Chandra+NuSTAR (Luo et al. 2013)

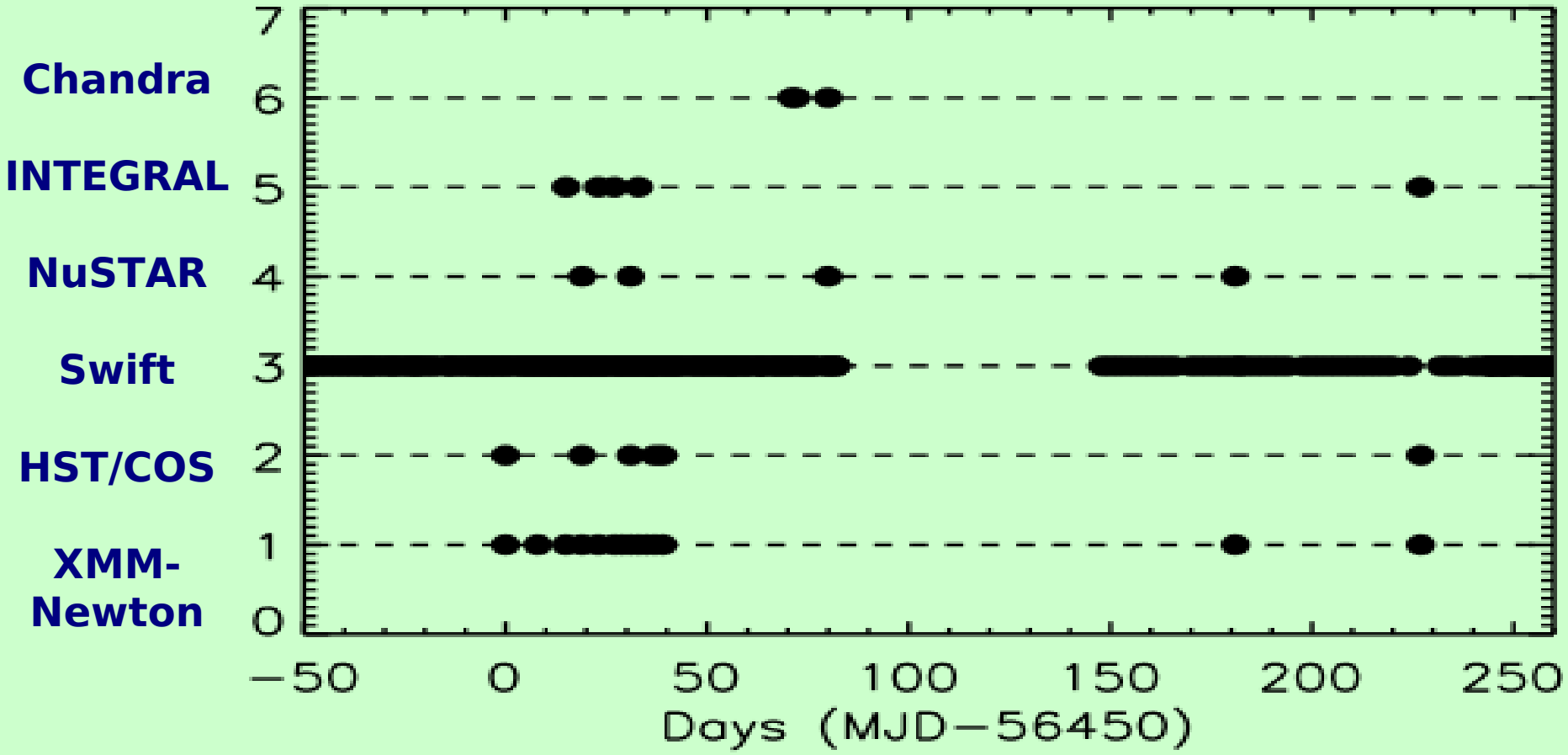


Mrk 231 Chandra+NuSTAR (Teng et al. 2014)

Anatomy of an AGN: NGC 5548

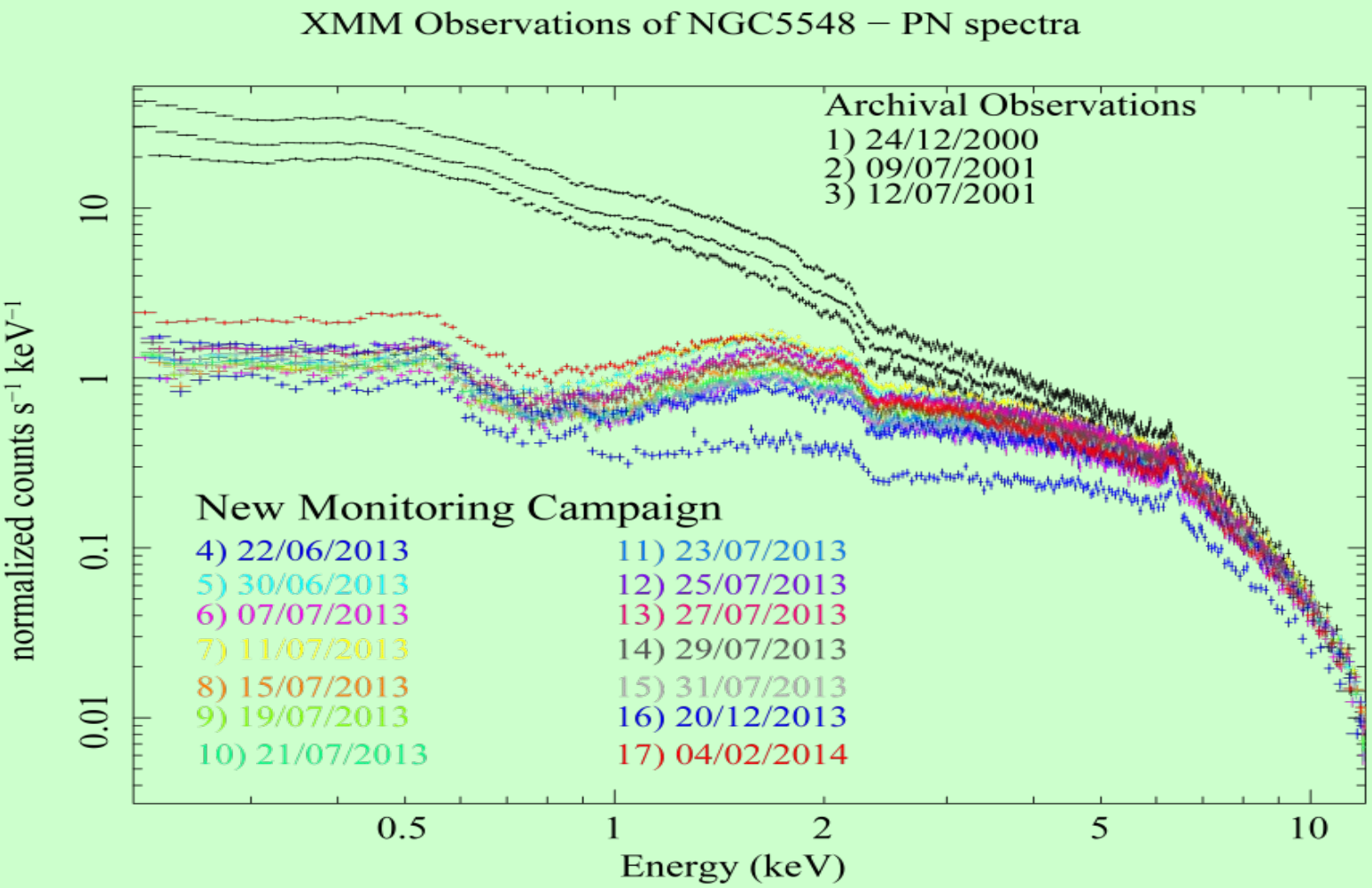
Broad band (UV to hard X-rays) monitoring campaign with six different satellites over a period of about a year.

Exceptionally rich dataset !!



Anatomy of an AGN: NGC 5548

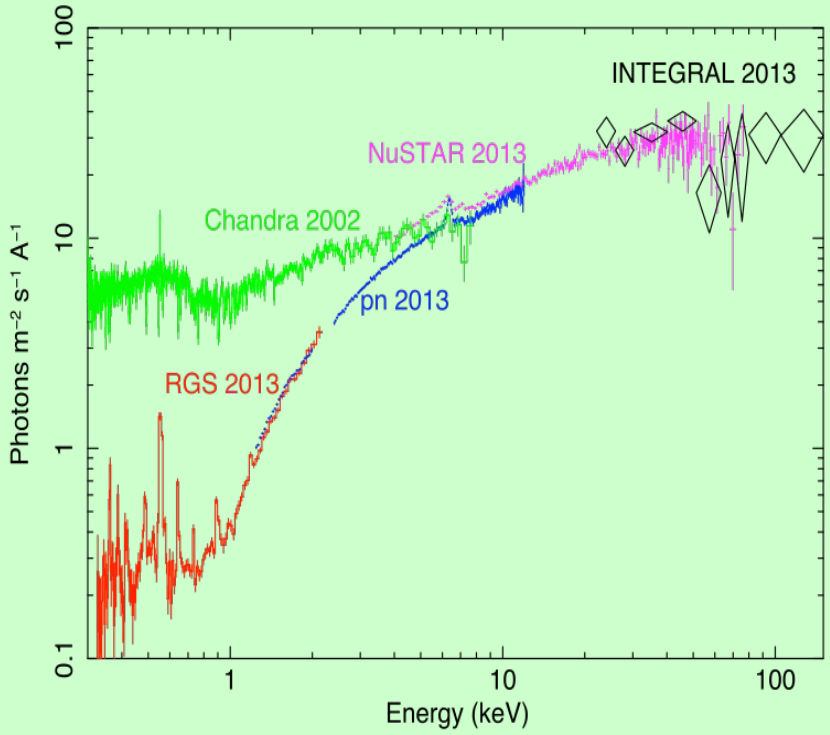
Unexpected soft X-ray dimming → obscuration !!!

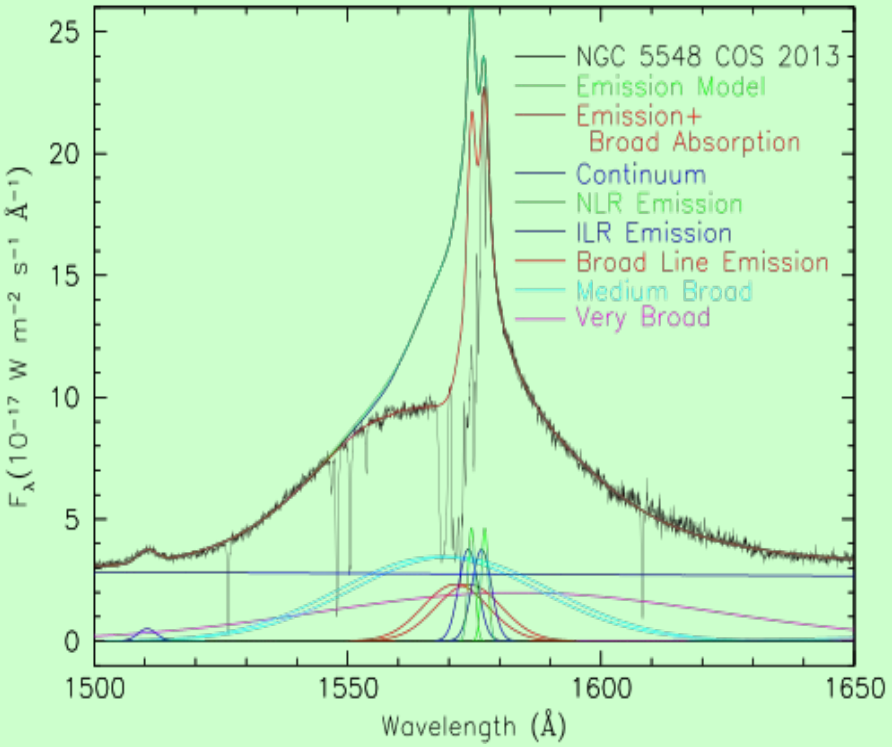


Anatomy of an AGN: NGC 5548

Unexpected soft X-ray dimming → obscuration !!!

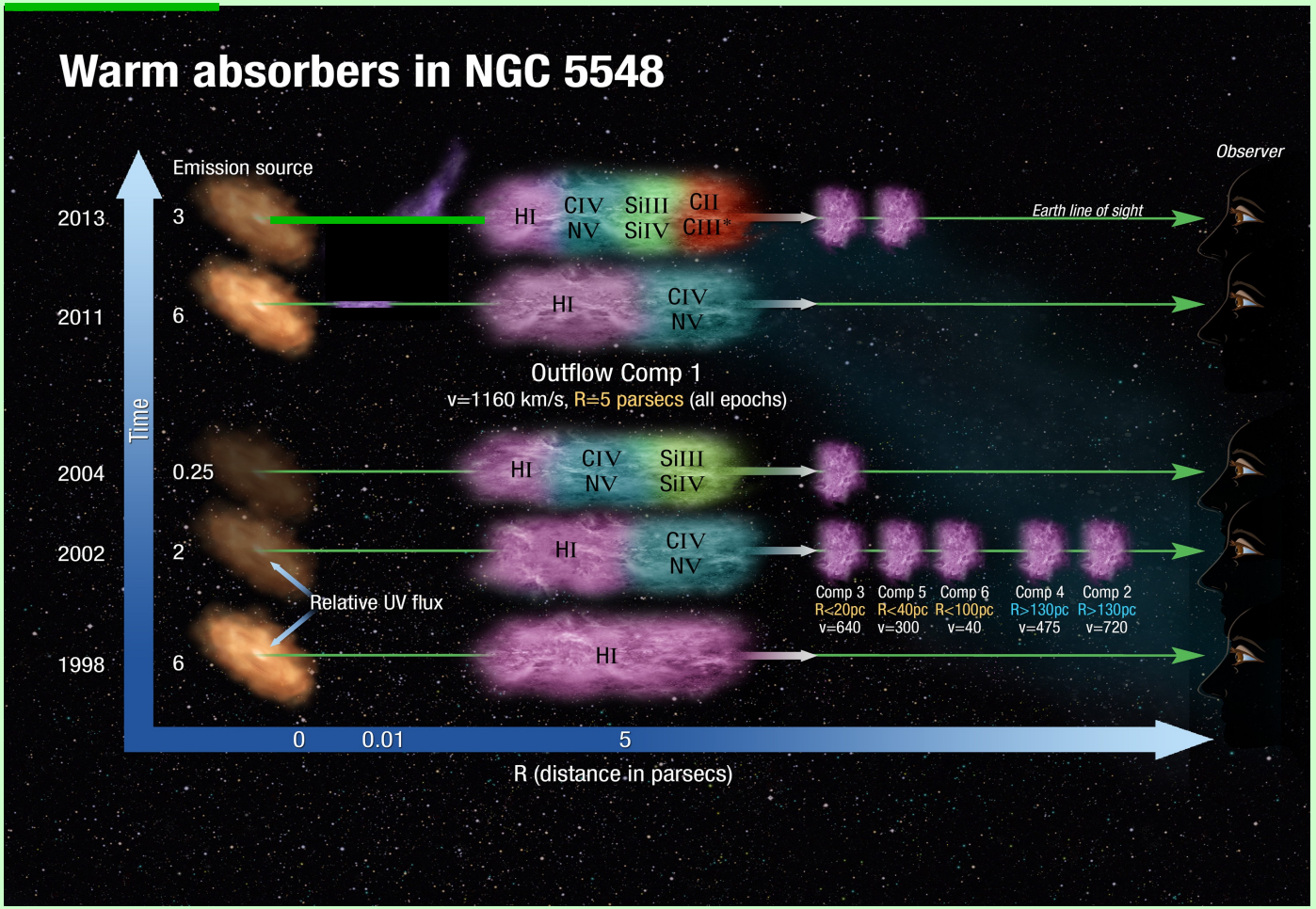
And appearance of UV Broad Absorption Lines





Anatomy of an AGN: NGC 5548

The NGC 5548 UV + X-rays campaign provide arguably the clearest ever picture of an AGN environment



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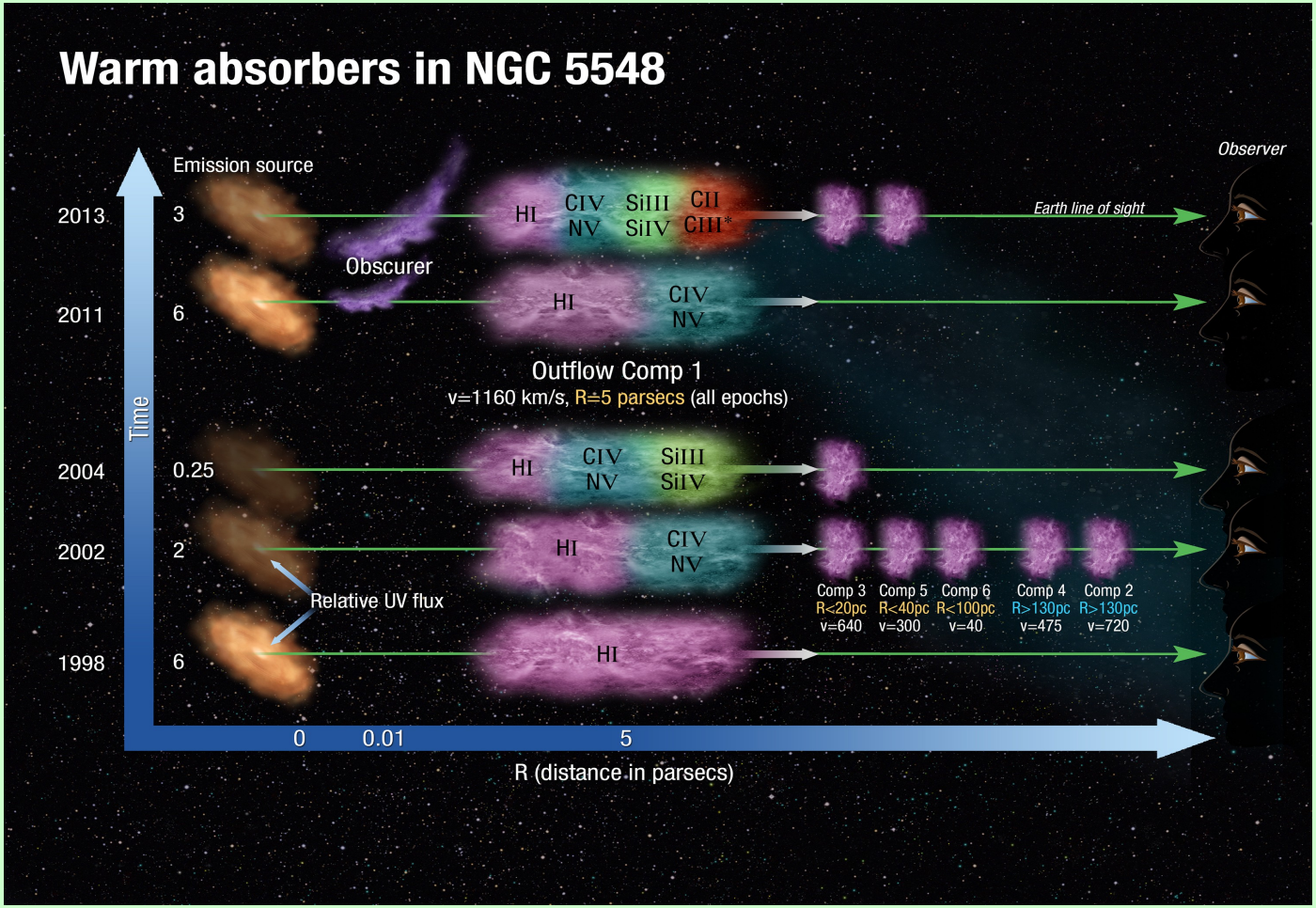

Anatomy of an AGN: NGC 5548

All you may want to know about the NGC 5548 campaign in this afternoon's AGN session

(talks by J. Kaastra

J. Ebrero

M. Mehdipour

M. Cappi

F. Ursini

K. Steenbrugge)

Wait also for a press release tomorrow (late)

Summary

- ***Primary emission***

  Coronal parameters → first measurements of T and τ

  Soft excess → Warm Comptonization (in addition to reflection)?

- ***Reprocessed emission***

  Relativistic reflection → Robust detection and spin estimate

  Time lags → Compton reflection lag observed!

- ***Obscuration and outflows***

  X-ray eclipses → Size of absorbing clouds and X-ray region

  BALs: absorption or X-ray weakness? → X-ray weakness! (at least in some cases)

  The NGC 5548 campaign → Clearest ever picture of AGN environment