NuSTAR + *XMM* Observations of NGC 1365: A Constant Inner Disc

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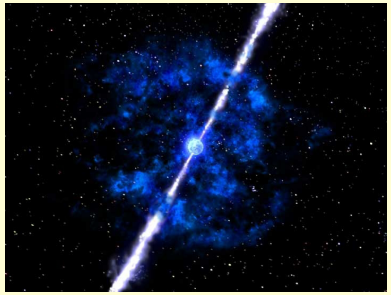
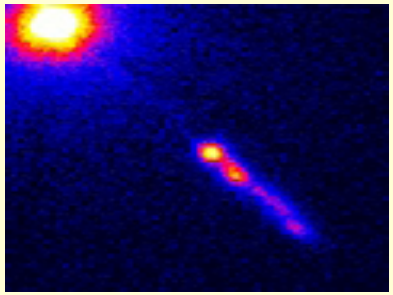
on behalf of the *NuSTAR* active galaxy working groups

Black Hole Spin



Supernova & gamma-ray bursts (stellar black hole binaries)



Relativistic jets (both stellar black hole binaries and active galaxies)

Galaxy evolution and supermassive black hole formation (active galaxies)

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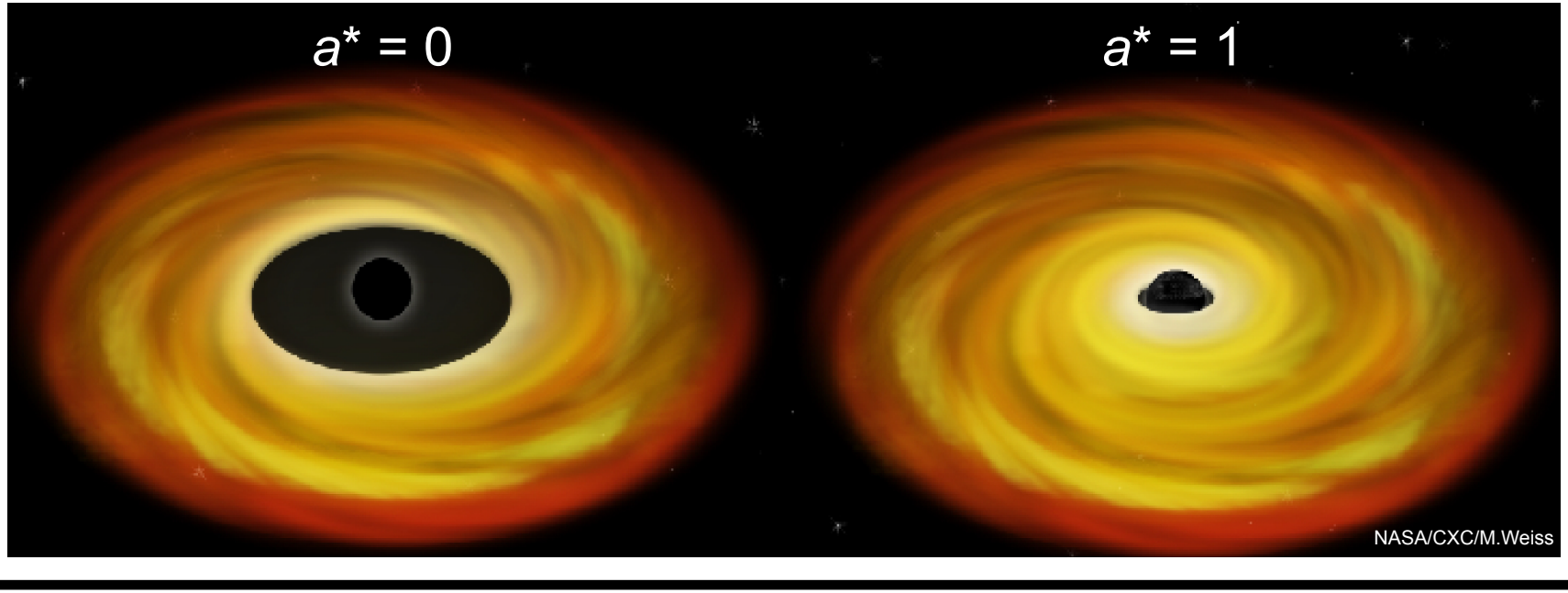
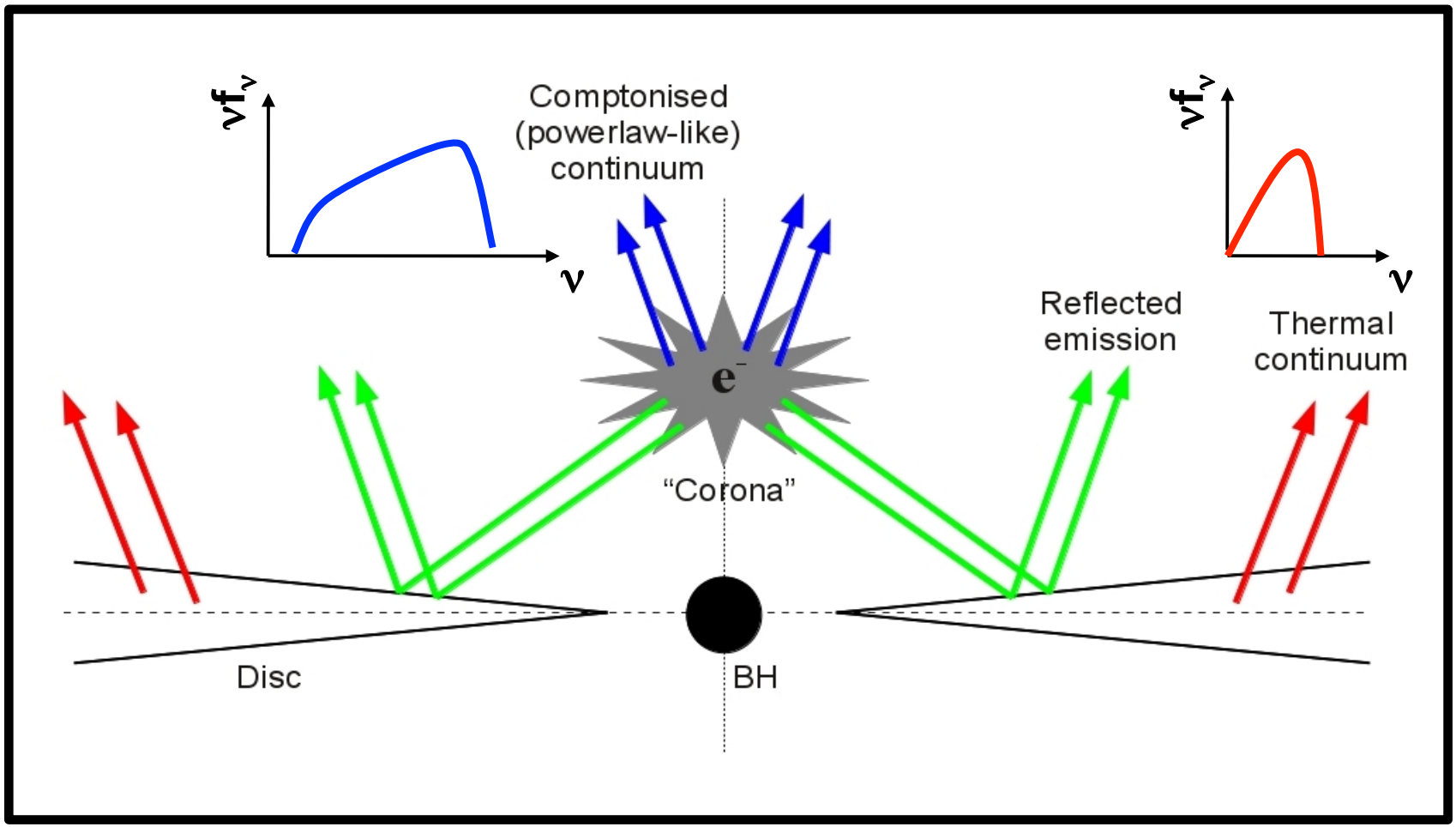
Measuring Black Hole Spin

NuSTAR

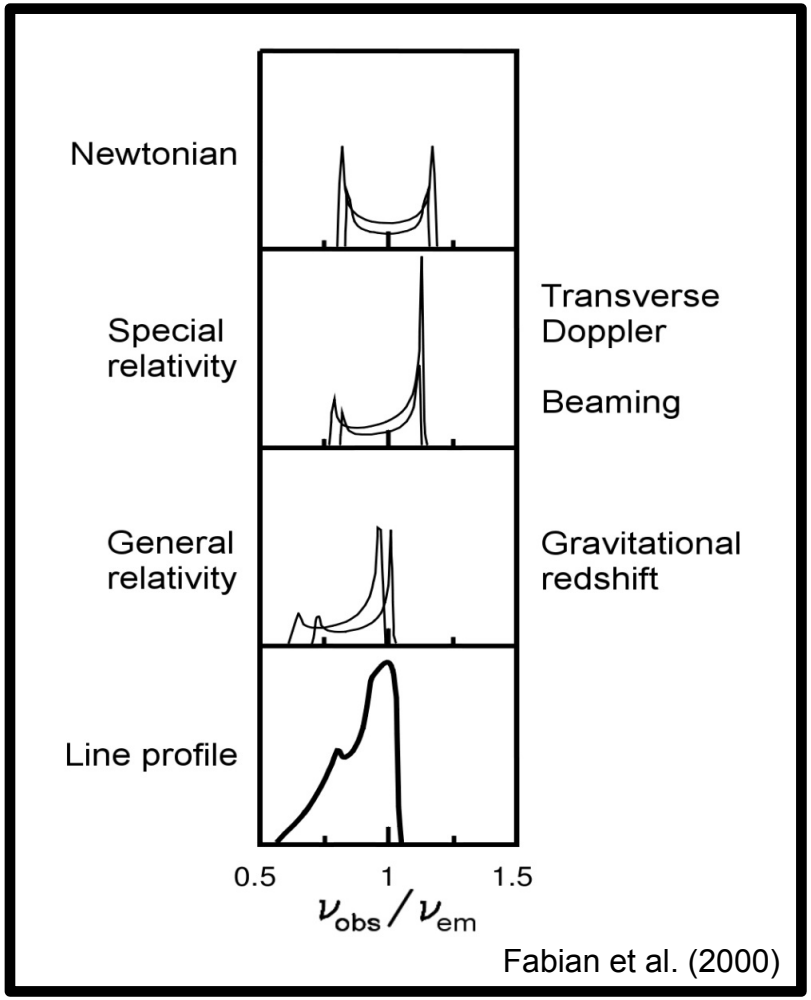


The radius of the innermost stable circular orbit depends on the spin (Bardeen et al. 1972).

Relativistic Disk Reflection

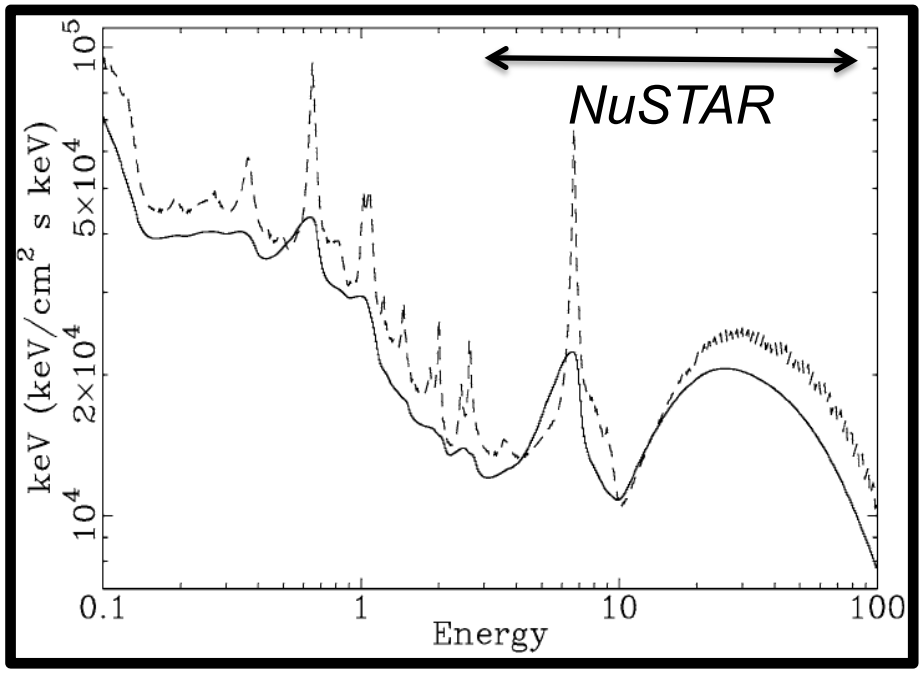


Relativistic Disk Reflection



Fabian et al. (2000)

Characterising the disc reflection component is one way in which we can measure black hole spin ***for both binaries and active galaxies***



NuSTAR Spin Program

NuSTAR is performing observations of both Galactic black hole binaries and active galaxies with the purpose of constraining their spin, including (among others):

Active galaxies:

Source	Coordination
NGC 1365	***XMM* (x4)**
MCG-6-30-15	*XMM*
Mrk 335	*Suzaku*
Swift J2127	*XMM*
NGC 4151	*Suzaku*
3C 120	*XMM*
Fairall 9	*XMM*

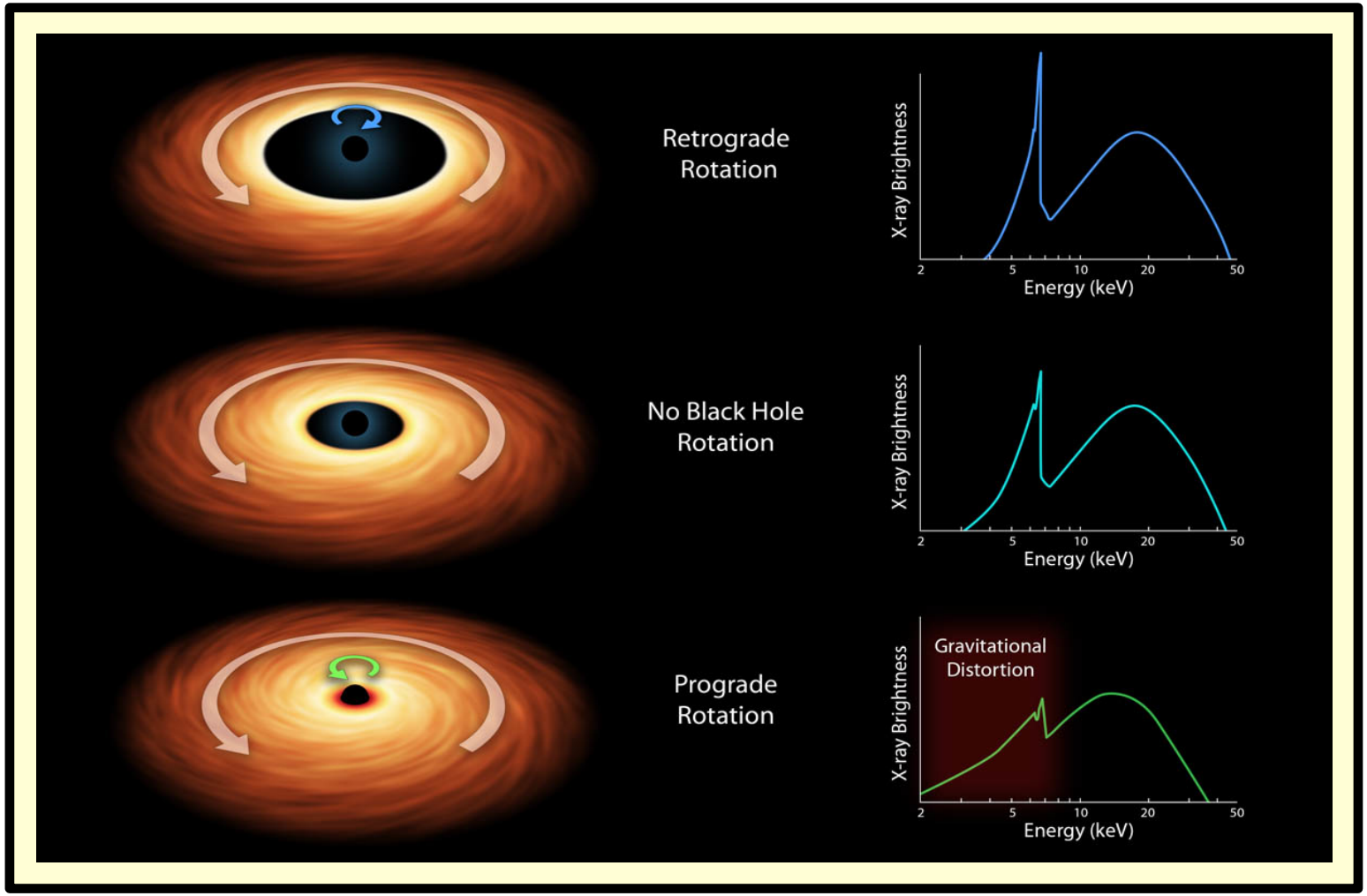
(see also talk by G. Matt tomorrow)

Galactic binaries:

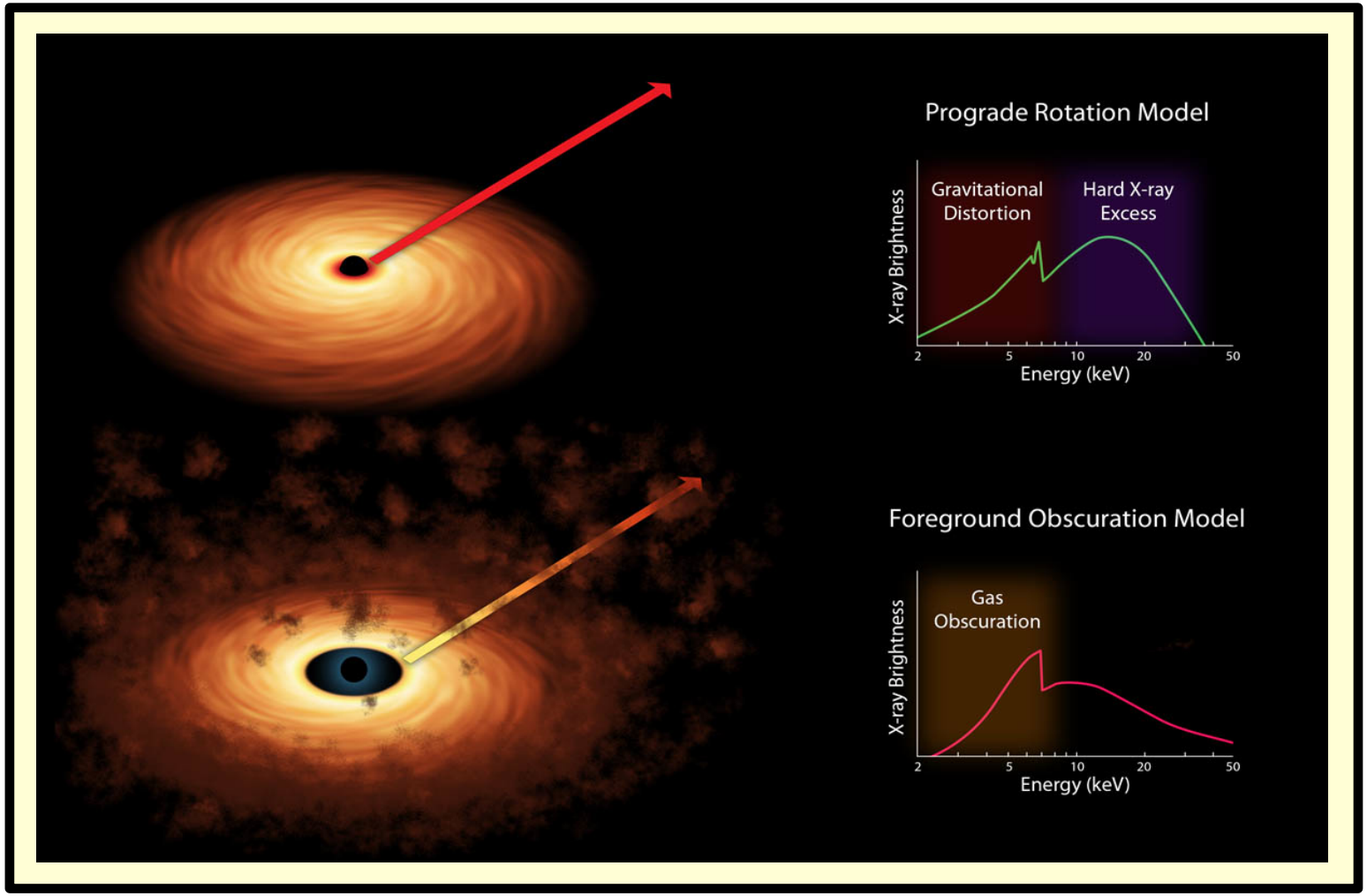
Source	Coordination
Cygnus X-1	*Suzaku*
GRS 1915+105	-
4U 1630-47	-
4U 1957+11	*XMM*
IC 10 X-1*	*Chandra*

**Thermal continuum method to be utilized*

Black Hole Spin: Recap



Complex Absorption



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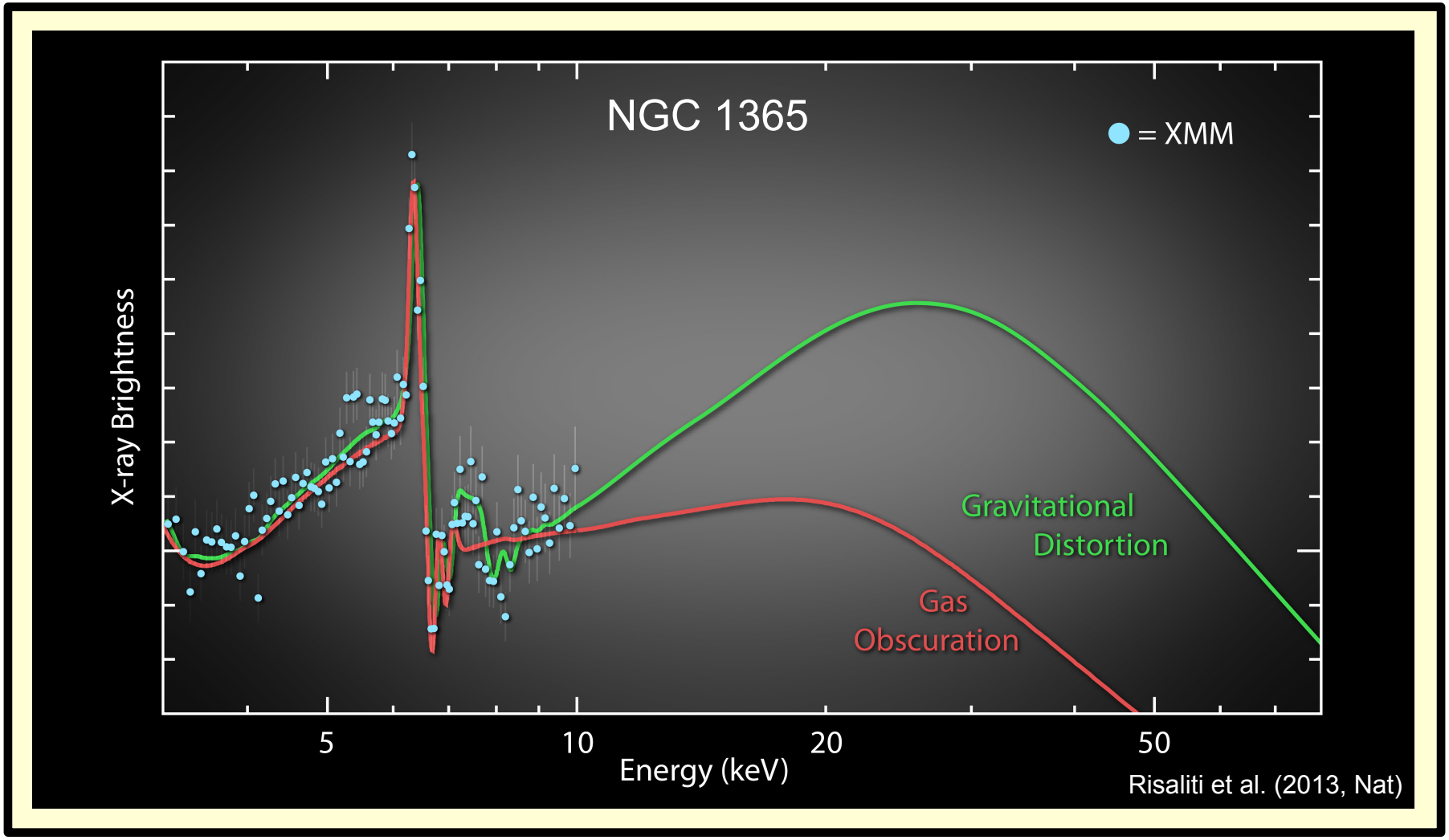
NGC 1365

NuSTAR



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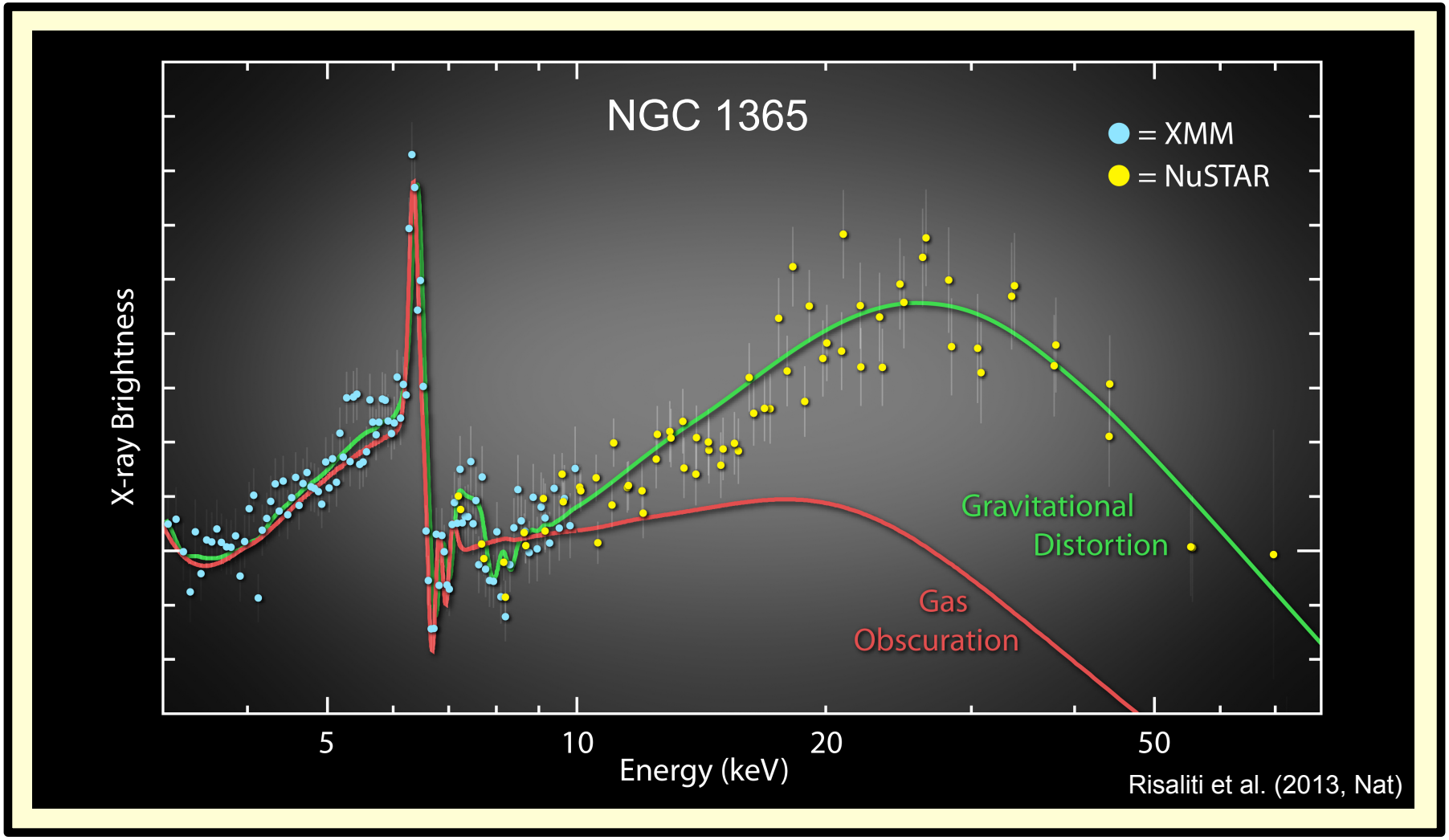
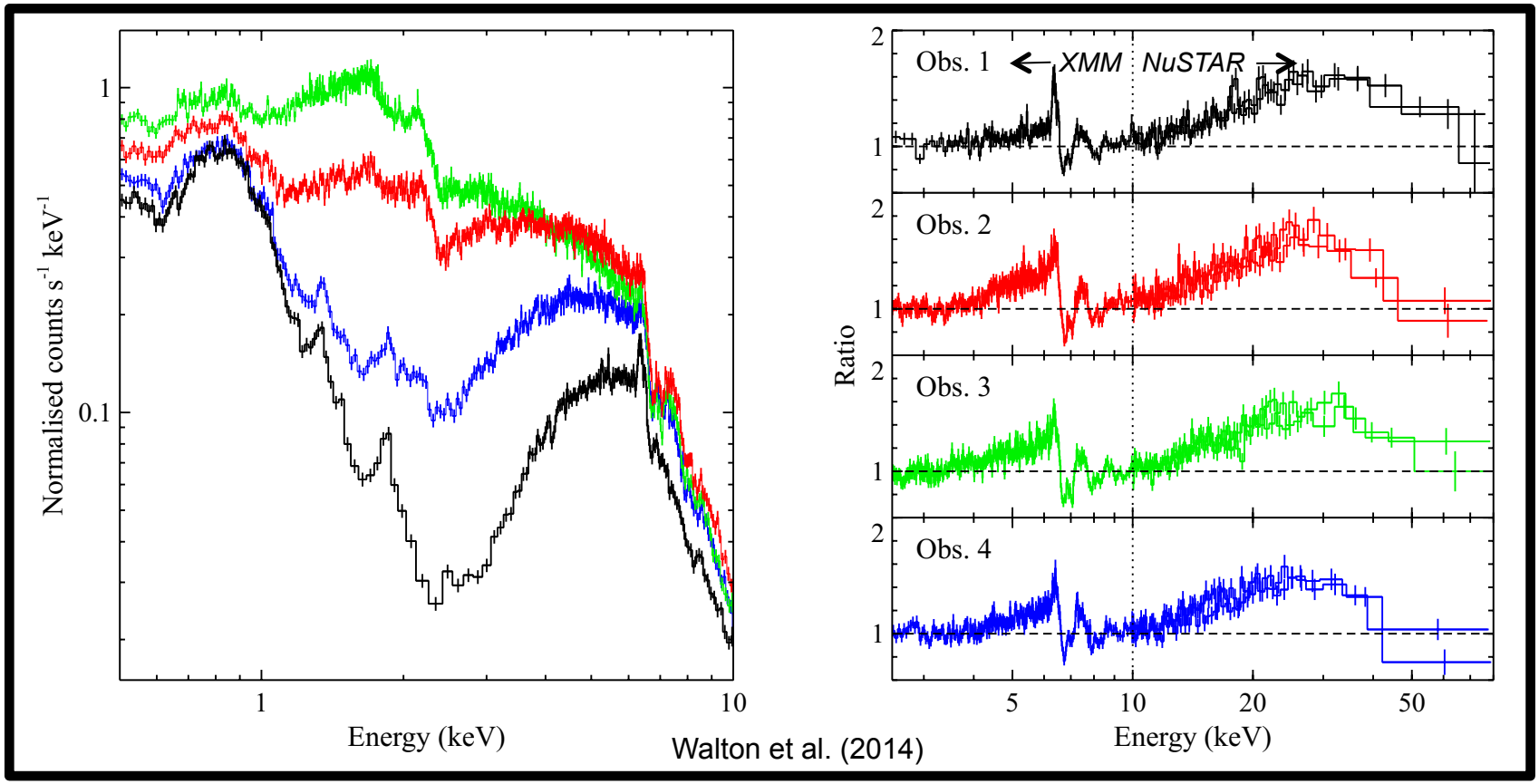
NGC 1365

NuSTAR



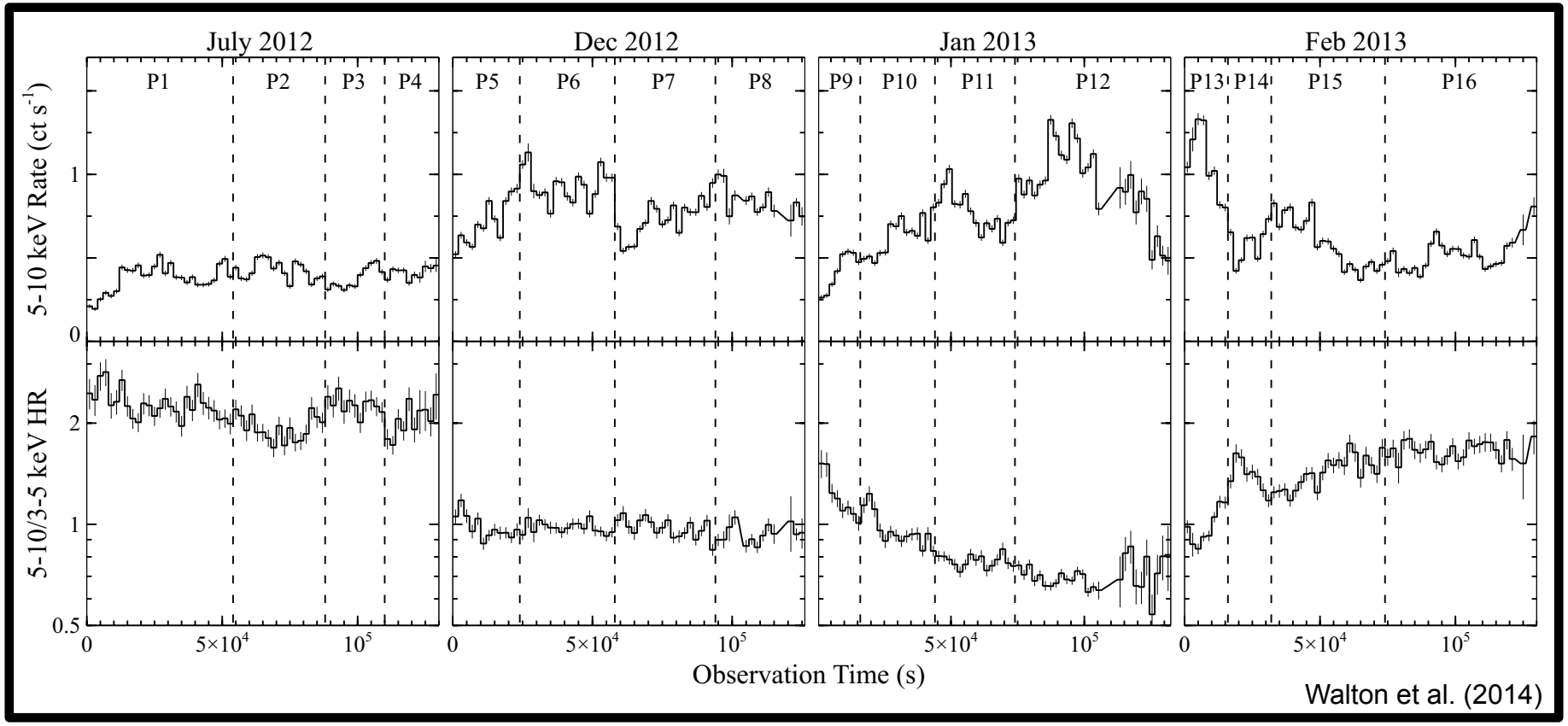
NGC 1365: NuSTAR+XMM



Walton et al. (2014)

Characteristic signatures of disc reflection present regardless of the level of line-of-sight absorption (see poster F28 by E. Rivers focusing on absorption variability)

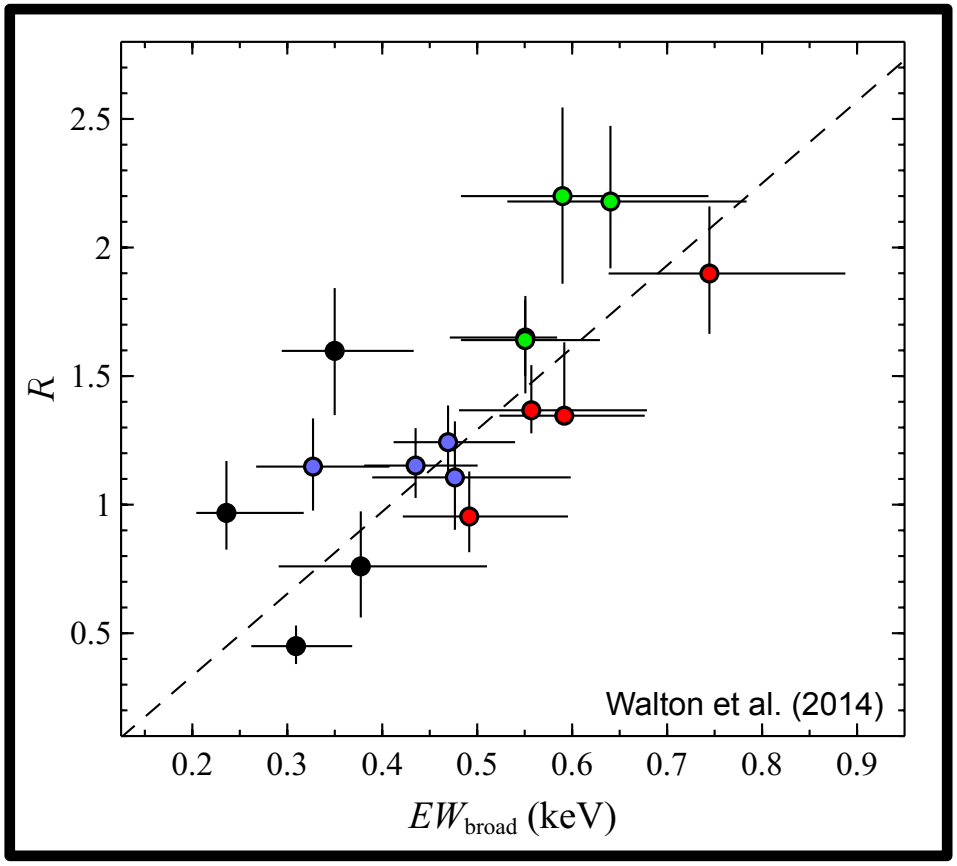
NGC 1365: Variability



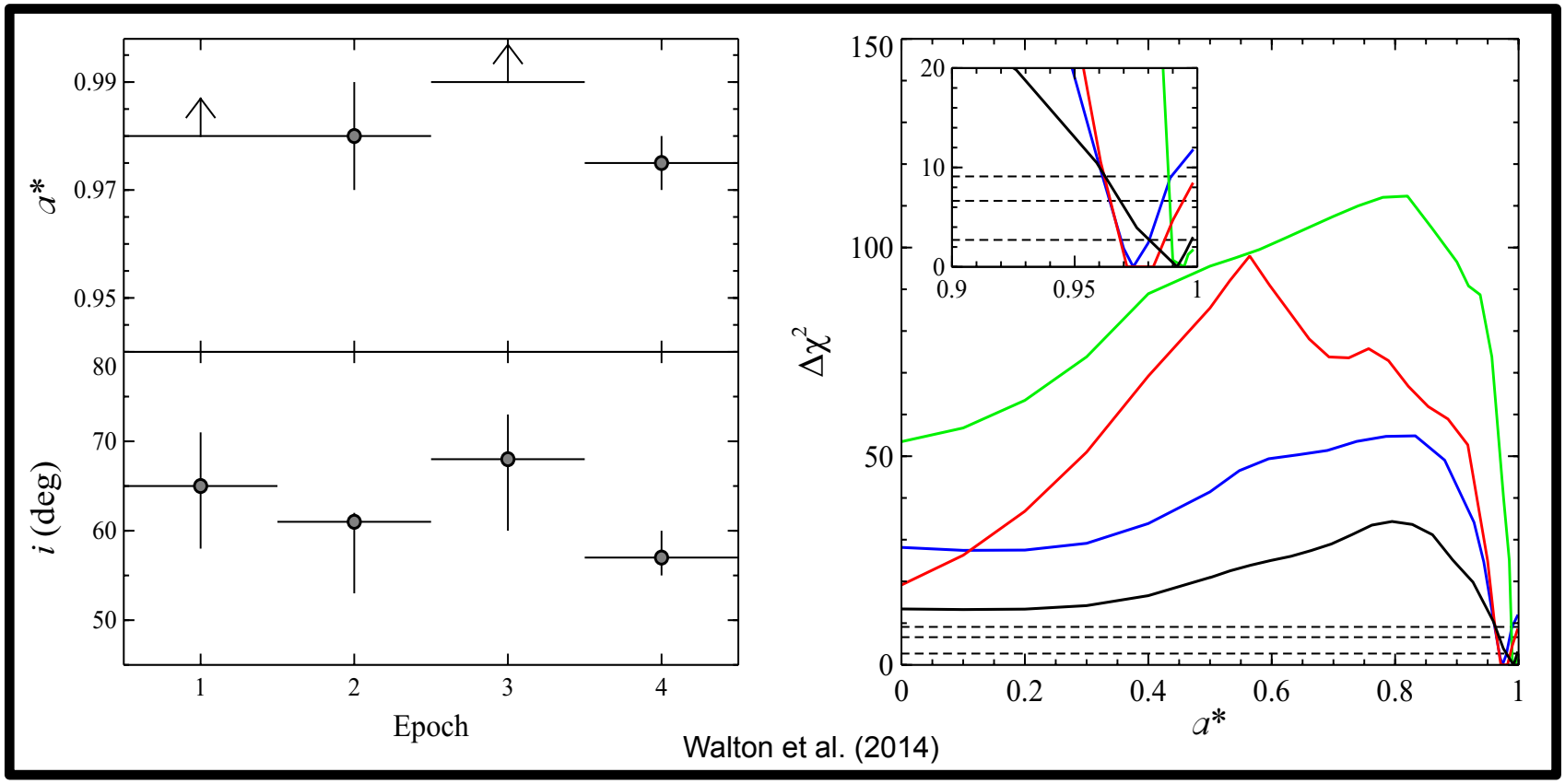
Displays both long and short timescale variability, some intrinsic, some due to variable absorption

NGC 1365: NuSTAR+XMM

- Extracted spectra from 16 time intervals
- Modelled data above and below 10 keV separately
- Below 10 keV: absorbed powerlaw and broad iron emission line
- Above 10 keV: powerlaw (same as below 10 keV) and a reflected continuum (pexrav)
- Good correlation between *EW* of the broad line and *R*



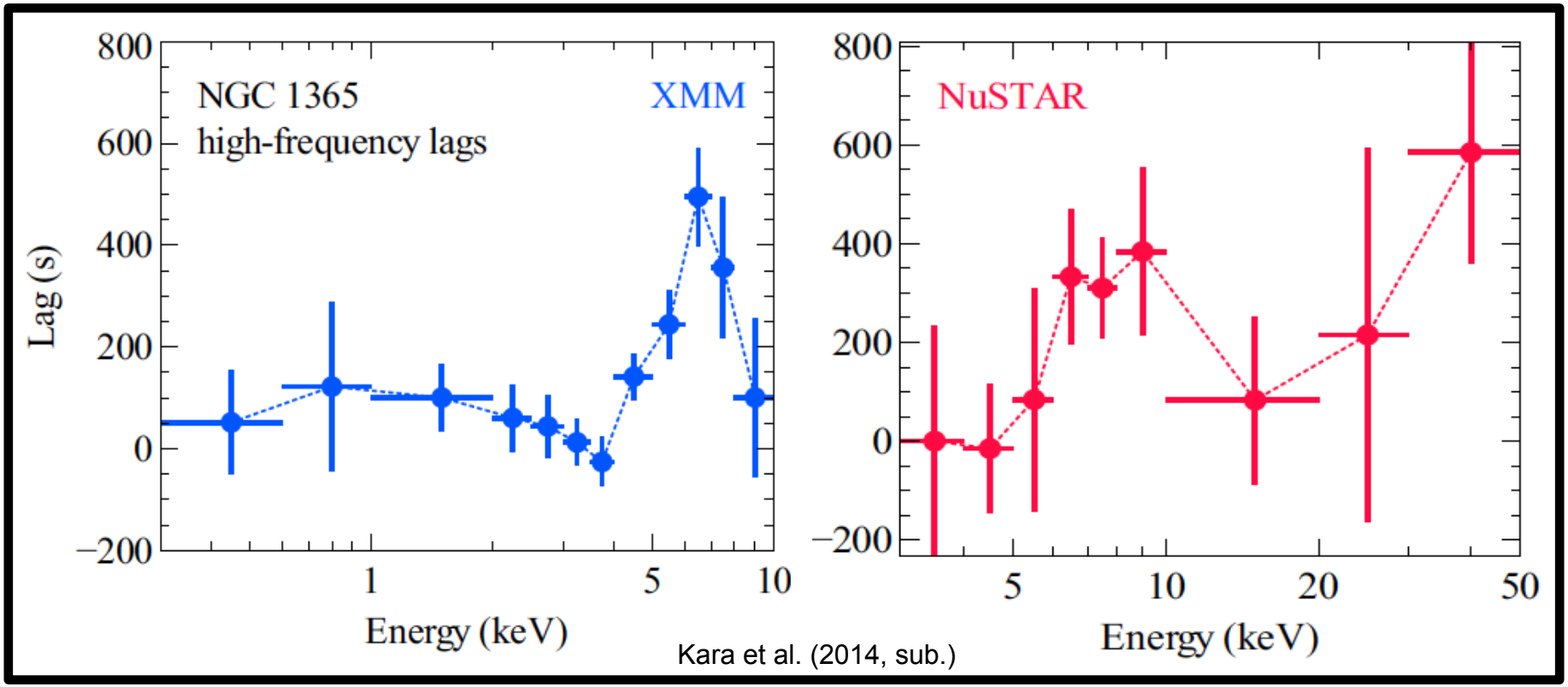
NGC 1365: NuSTAR+XMM



Walton et al. (2014)

The black hole spin and the disc inclination obtained are consistent for all four observations, even allowing for variable, partially covering absorption

NGC 1365: X-ray Reverberation



Kara et al. (2014, sub.)

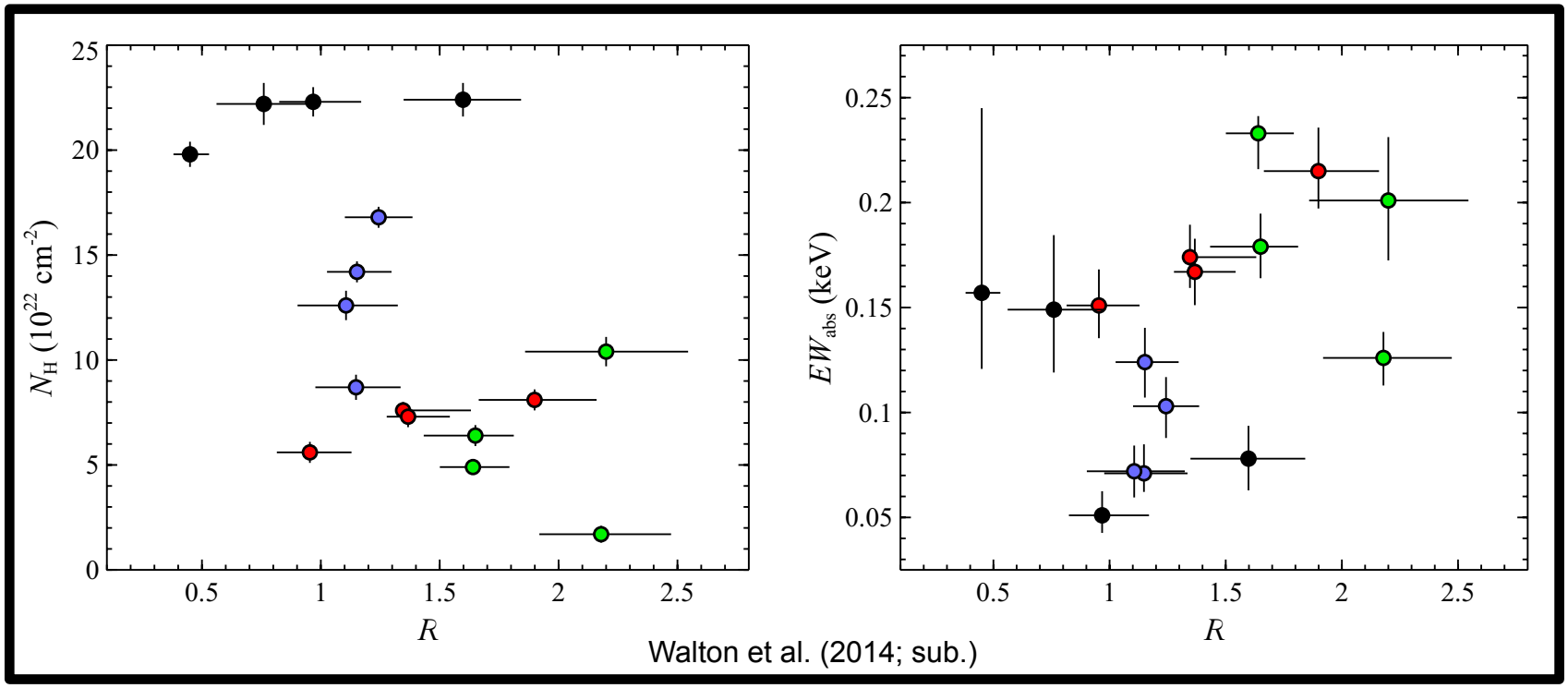
Clear reverberation (time delay) from the broad Fe K line, and marginal detection from the Compton hump, implies a compact (R <~ 10 R_G) emission region (Uttley, Kara, Zoghbi talks tomorrow)

Conclusions

NuSTAR

- Our 4 coordinated *NuSTAR* + *XMM* observations of NGC 1365 reveal an extreme level of absorption variability, yet show the same characteristic signatures of reflection from the inner accretion disc
- Broad Fe K line and the Compton hump are correlated, each observation independently returns the same BH spin and disc inclination, and X-ray reverberation now detected
- These results confirm NGC 1365 hosts a rapidly rotating BH
- The combination of *NuSTAR* and *XMM* allows us to resolve long-standing degeneracies regarding the interpretation of the spectral features observed from AGN

NGC 1365: NuSTAR+XMM



Walton et al. (2014; sub.)

Correlation between EW_{broad} and R is not simply due to parameter degeneracies associated with the simple models used