Pushing IXO to the Extreme

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Black hole power: key questions

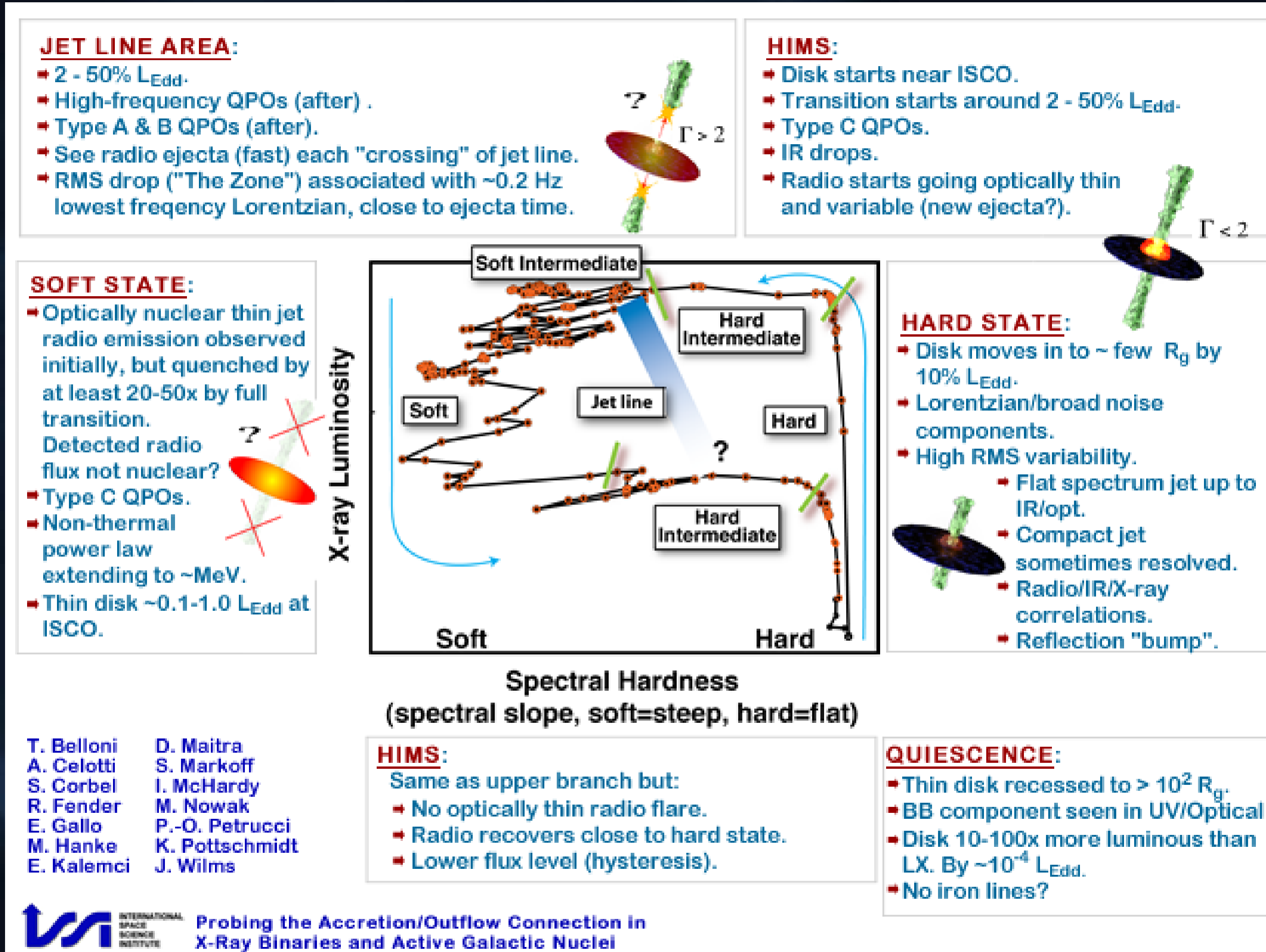
- What is the structure of the central engine of accreting black hole systems?
- What is the link between disk, jet and corona?
- Need to to study bright X-ray binaries to do this science (high-throughput - needs HTRS)

Why X-ray binaries?

- The brightest, most rapidly variable X-ray sources (high information content)
- The most extreme environments: space-time curvature, energy densities (photon, thermal, bulk kinetic, magnetic field)
- Accretion laboratories: can see ***all*** components of accretion flow and what their life-cycles are (clear links to AGN)

Life-cycles of accretion

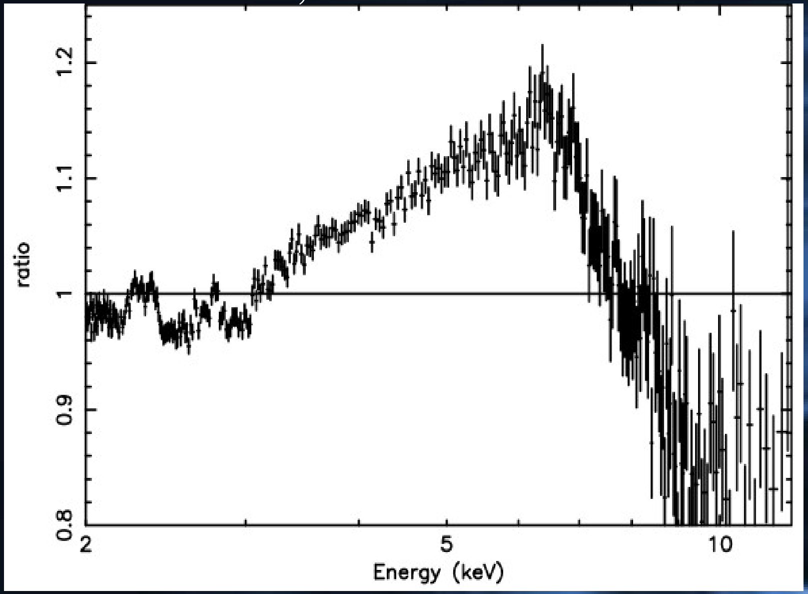
(Courtesy of ISSI International team on Accretion-Outflow Connection in XRBs and AGN)



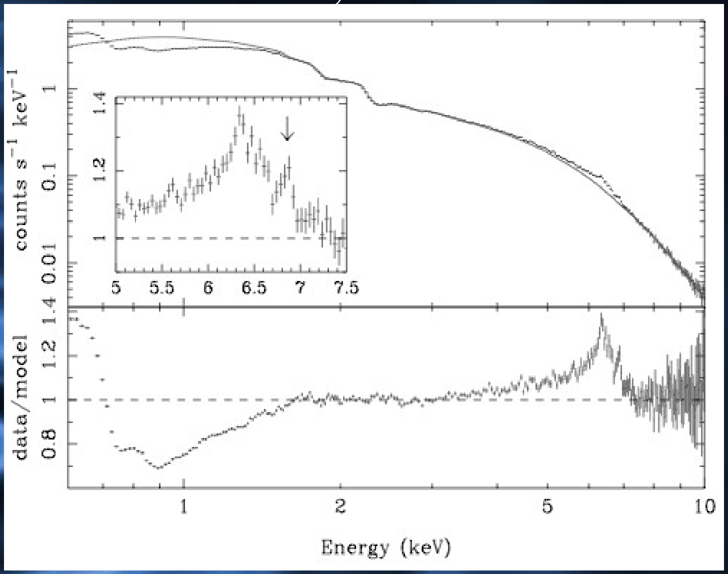
Key idea: states, jet formation determined by interplay of ‘cold’ (disk) and ‘hot’ (corona) components

Iron line spectroscopy

GX 339-4, Miller et al. 2004



MCG-6-30-15, Fabian et al. 2002

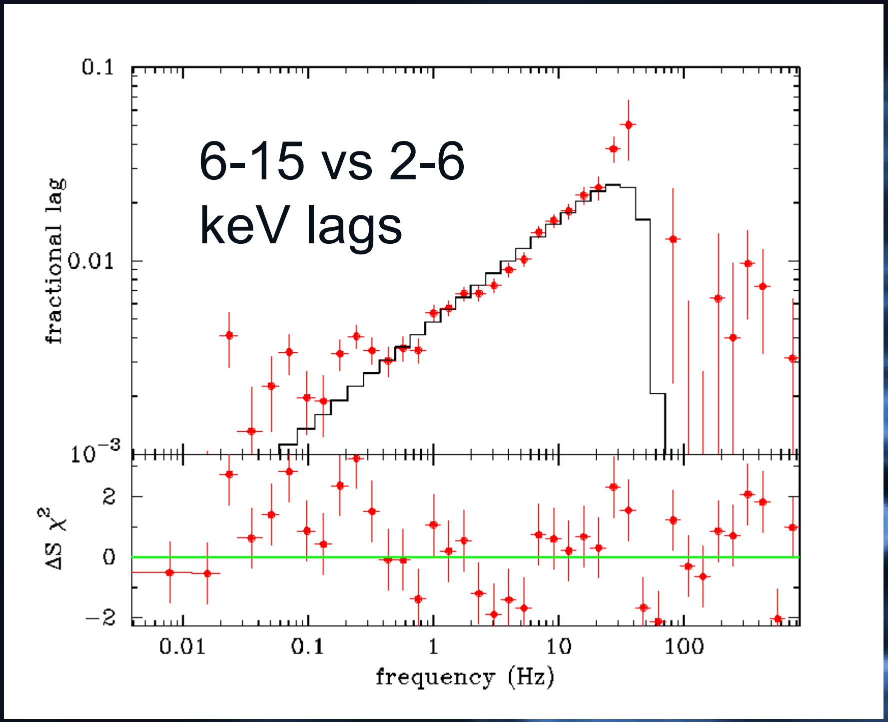


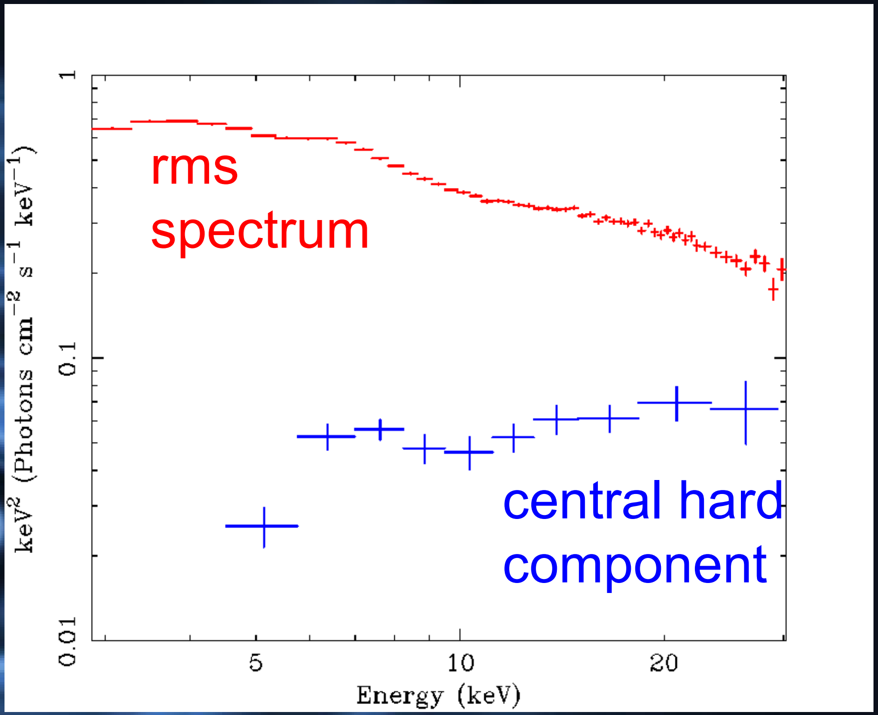
✧ Simple spectral modelling has many degeneracies

✧ Fe reverberation mapping = new paradigm with IXO

✧ Also possible in XRBs, advantage of ‘cleaner’ signal (‘warm absorbers’ are weak)

Reflections on spectral-timing





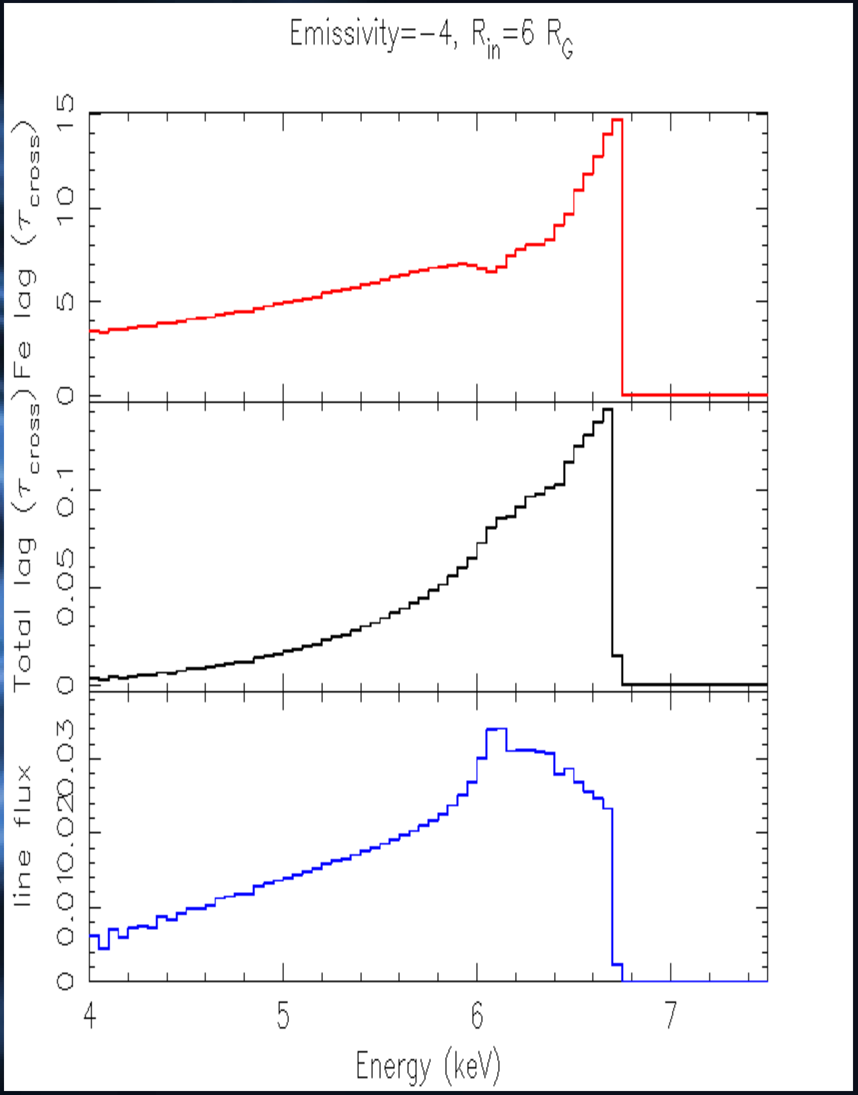
- ✧ Cyg X-1 soft state: hard lags observed with RXTE due to radial drift time from soft to hard emitting regions
- ✧ 'Time-averaged' map of emitting region
- ✧ But model-dependent - need to probe light-crossing times

The need for high count rates

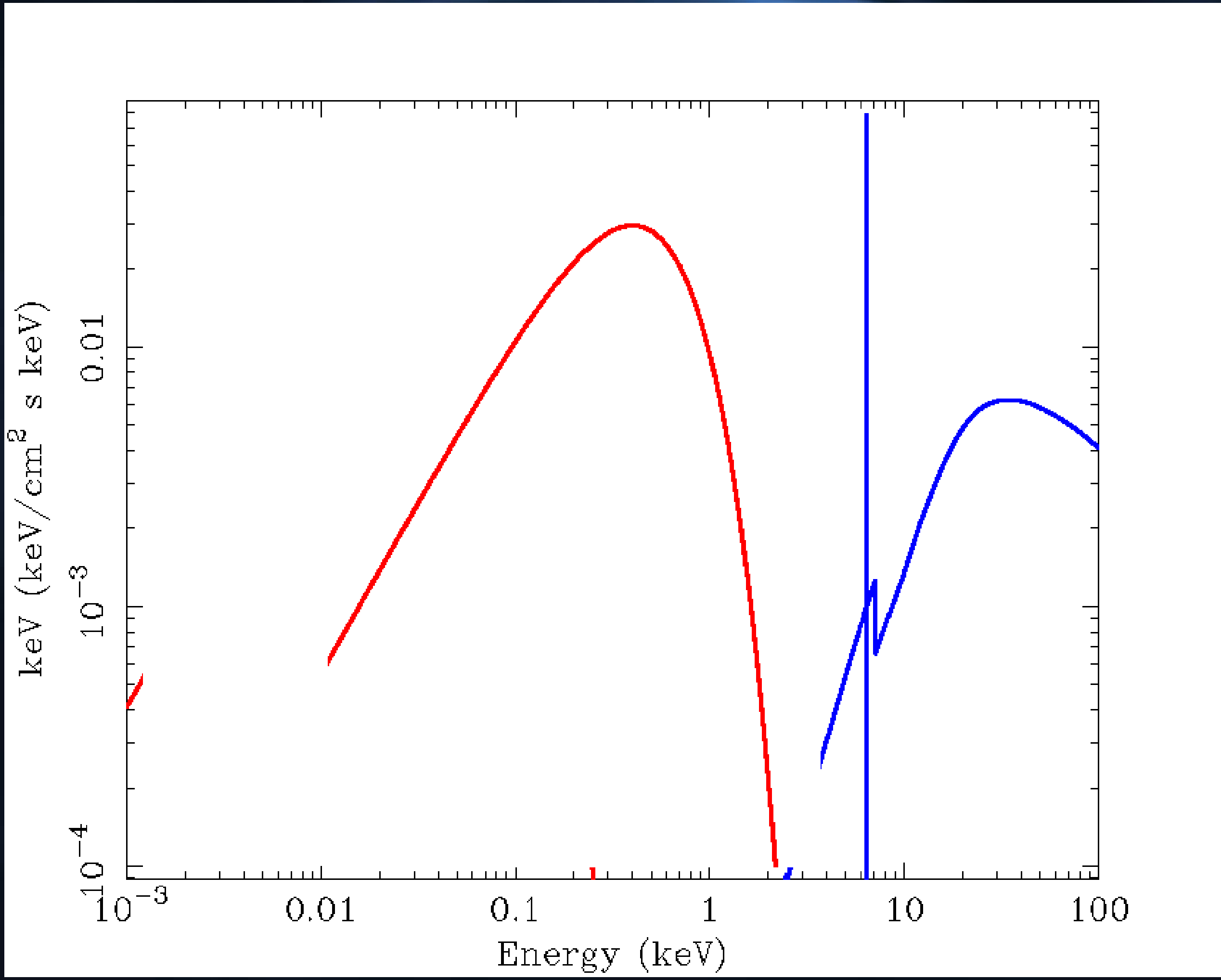
- Lag uncertainty $\propto$ **(rate1*rate2)$^{-1/2}$**

- Iron line 100 cps, continuum 10^6 cps (very high states) ~ lag measured to 10μ s (0.2 R_G)

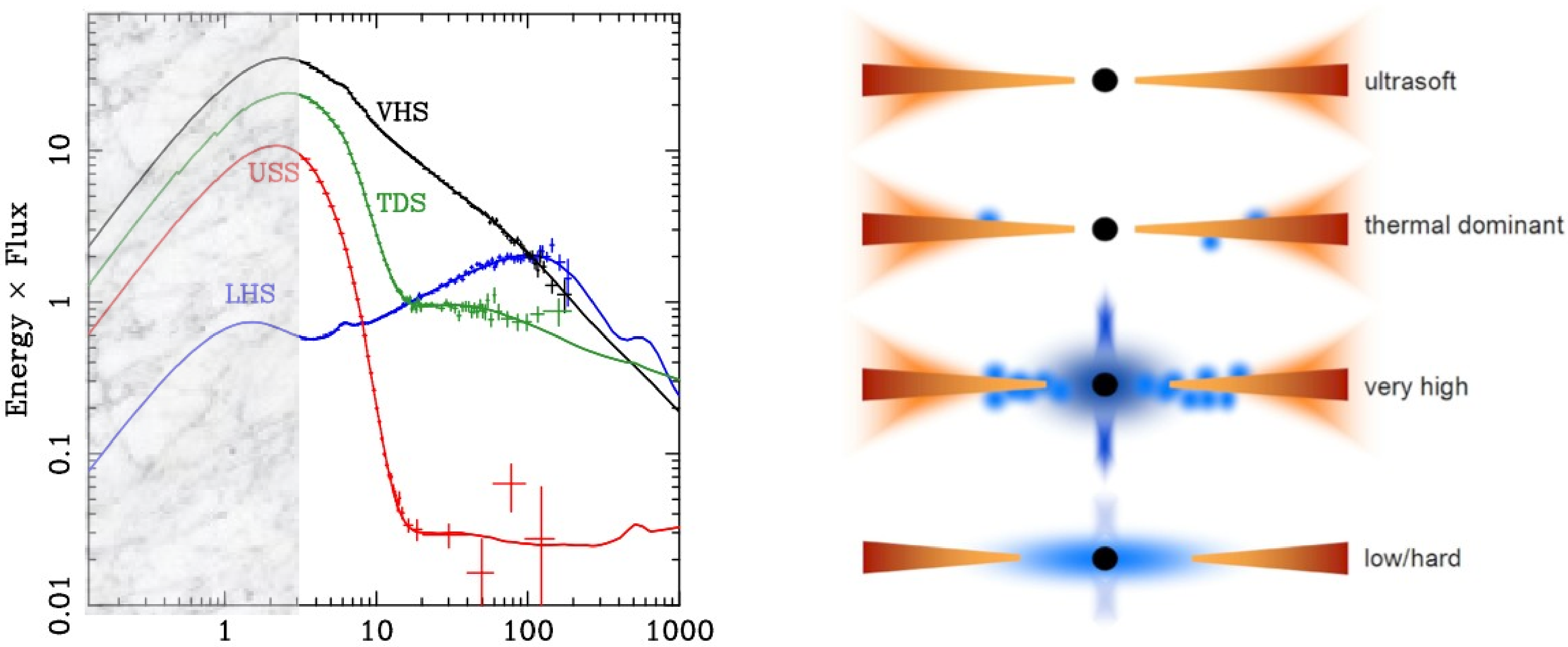
- Iron line 10 cps, continuum 10^4 cps ~ lag measured to 0.3 ms (6 R_G)



Thermal reprocessing: the other side of reflection



A direct view of disks

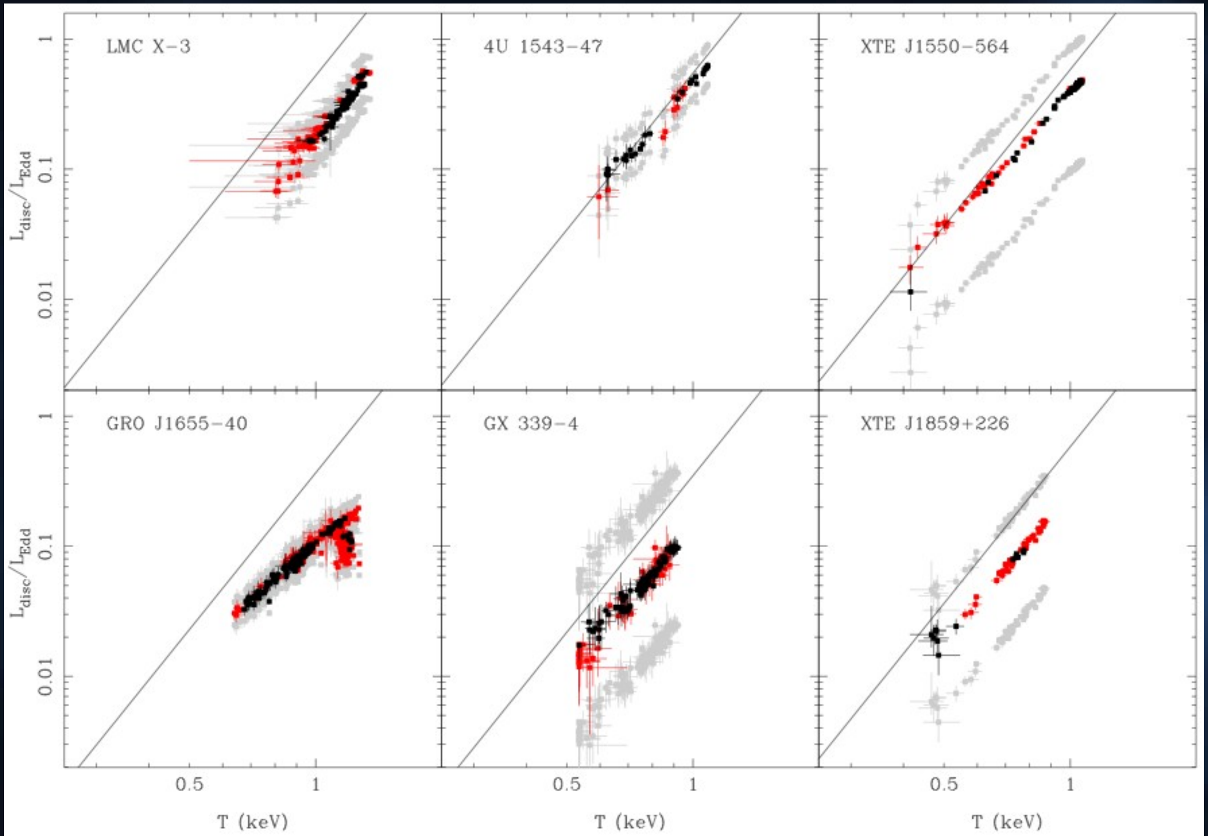


(Done & Gierlinski 2007)

- Coverage below 3 keV is limited: no RXTE, pile-up problem in XMM-Newton (even timing mode) - couple hundred count/s maximum

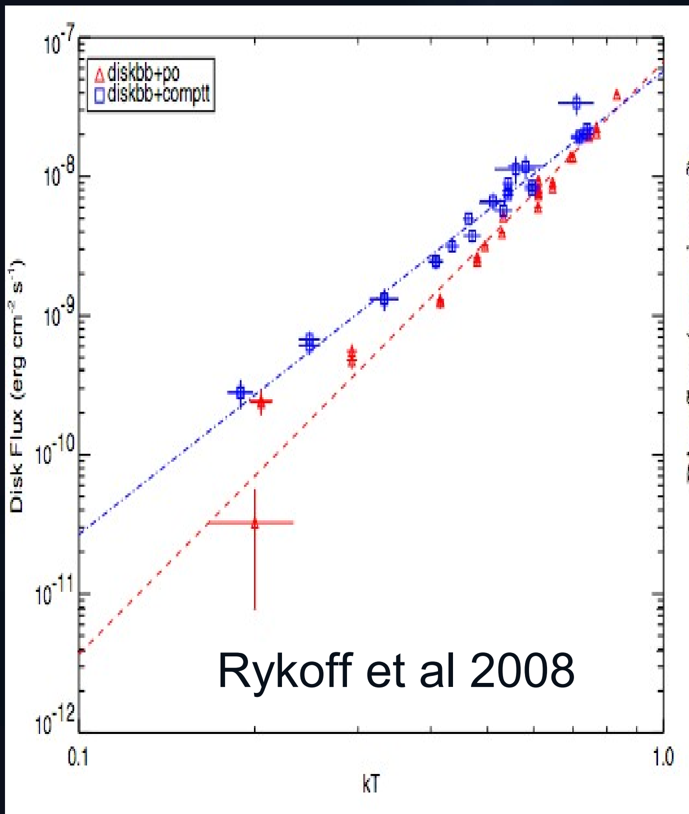
Accretion disks: the good news

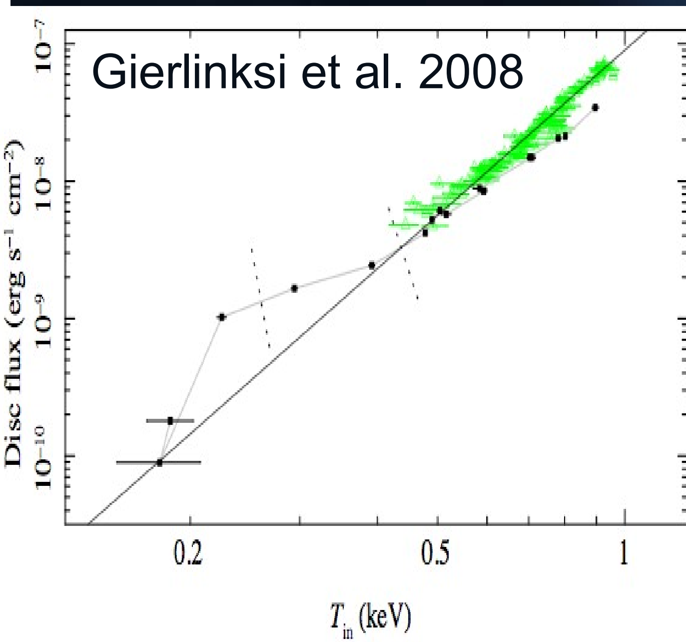
(Gierlinski & Done 2004)

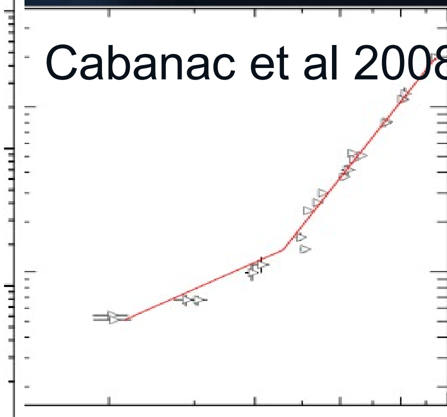


We think we understand disks… but only in states which are pretty boring (no/weak jets, no variability)

Accretion disks: the bad news*





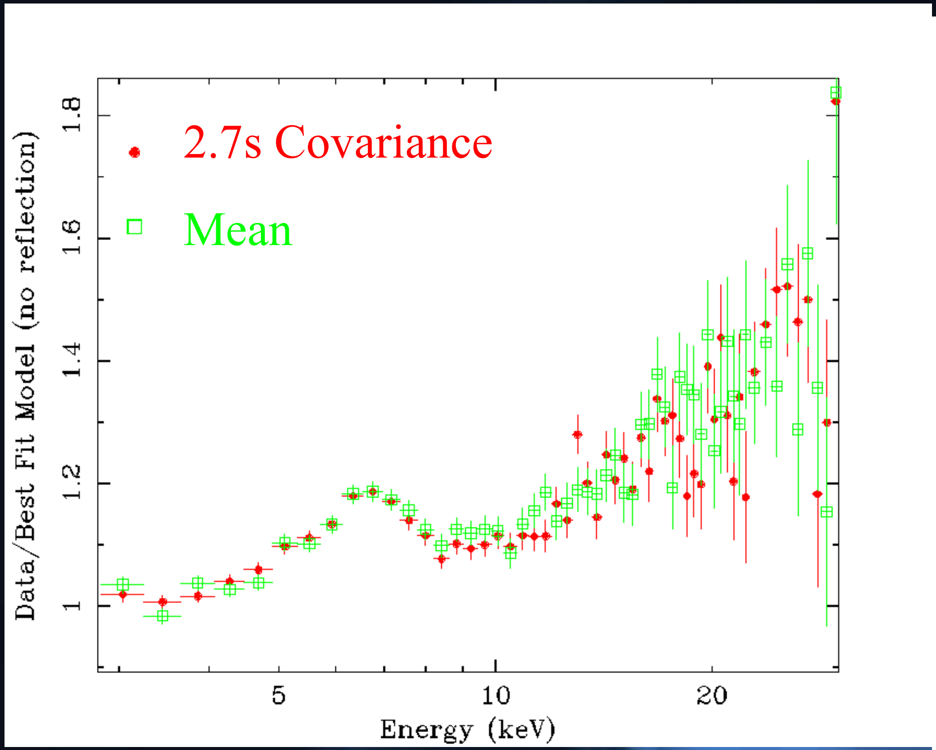


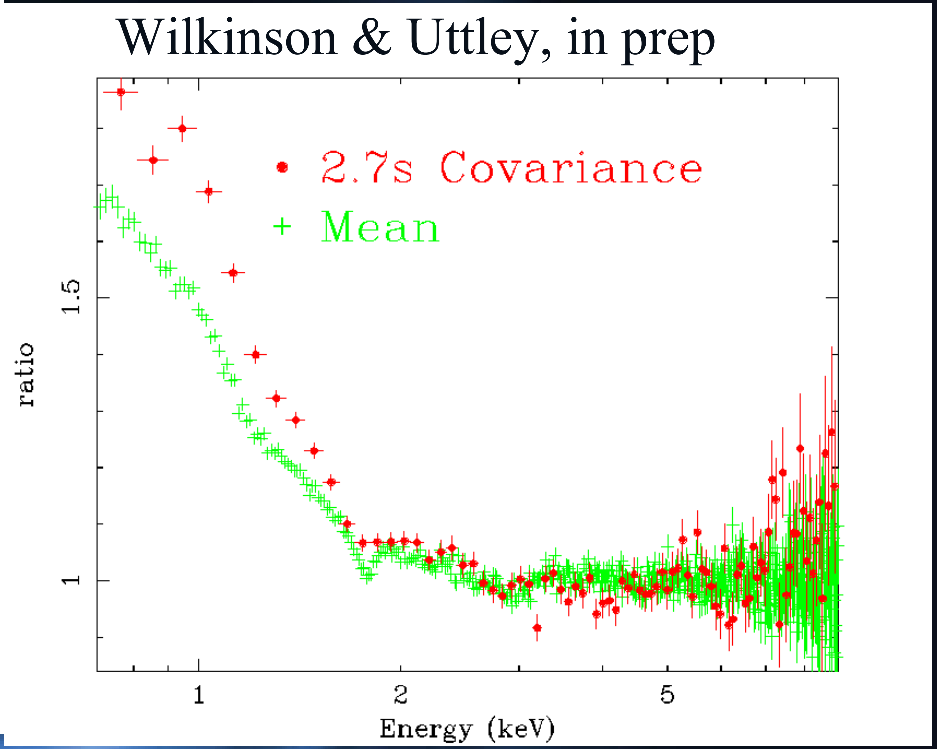
All: Swift/RXTE observations of XTE J1718-330

At lower temperatures things get interesting but also very model-dependent and messy!

* (but not for IXO-HTRS)

Disk mapping: a new territory





- GX 339 hard state: reflection varies with continuum
- But on few s time-scales, disk shows additional variation
- Could use lags to separate reprocessing from intrinsic disk variations (10^4 disk $\times$ 10^4 power-law photons = 0.2 R_G lag measurement in hard state)

Summary: the need for HTRS

- High count rates + CCD-like resolution allow sub 1 R_G iron line reverberation mapping
- Soft response of IXO-HTRS combination allows us to map the disk also to sub 1 R_G
- The only way to clearly see into the heart of the ***whole central engine*** (disk+corona) until < 1 microarcsec X-ray interferometry!