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 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

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

✧ 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)

GX 339-4, Miller et al. 2004

MCG-6-30-15, Fabian et al. 2002
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 $\propto (\text{rate}_1 \times \text{rate}_2)^{-1/2}$

✧ Iron line 100 cps, continuum $10^6$ cps (very high states) ~ lag measured to $10\mu$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

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

(Done & Gierlinski 2007)
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

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 ($10^4 \text{ disk } \times 10^4 \text{ power-law photons} = 0.2 R_G$ 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!