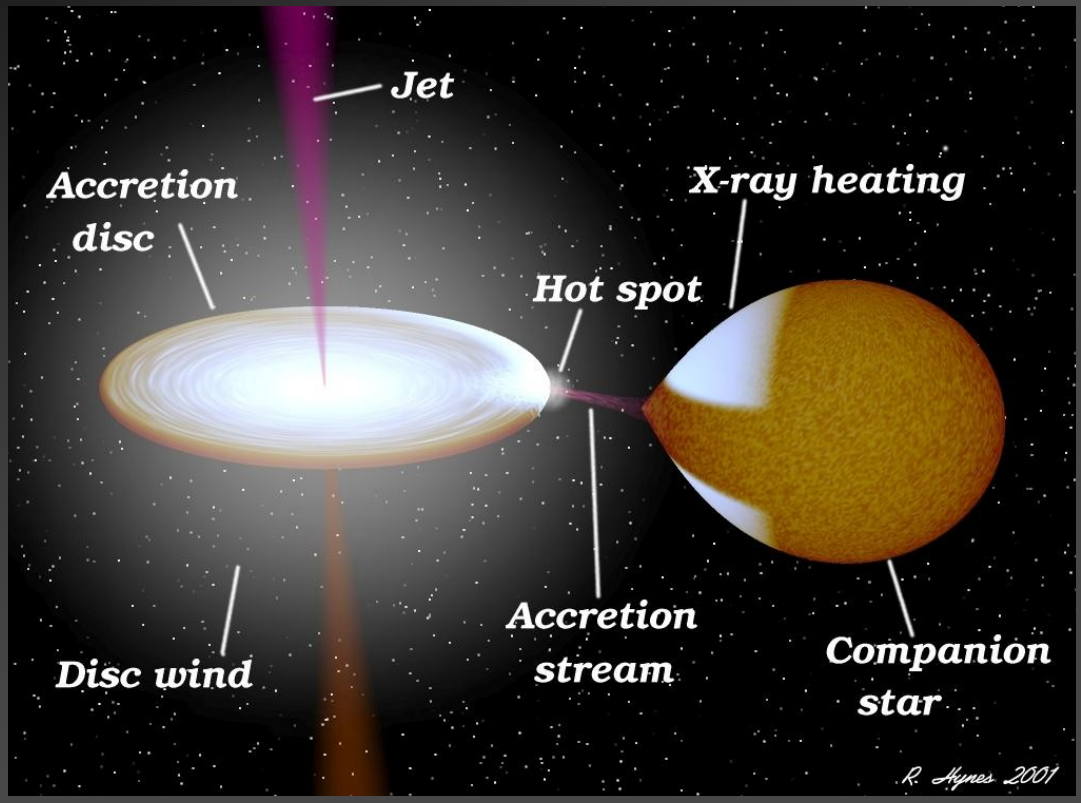
Prospects of Arcus for Galactic Black-Hole XRBs

Jack Steiner

Harvard-Smithsonian Center for Astrophysics

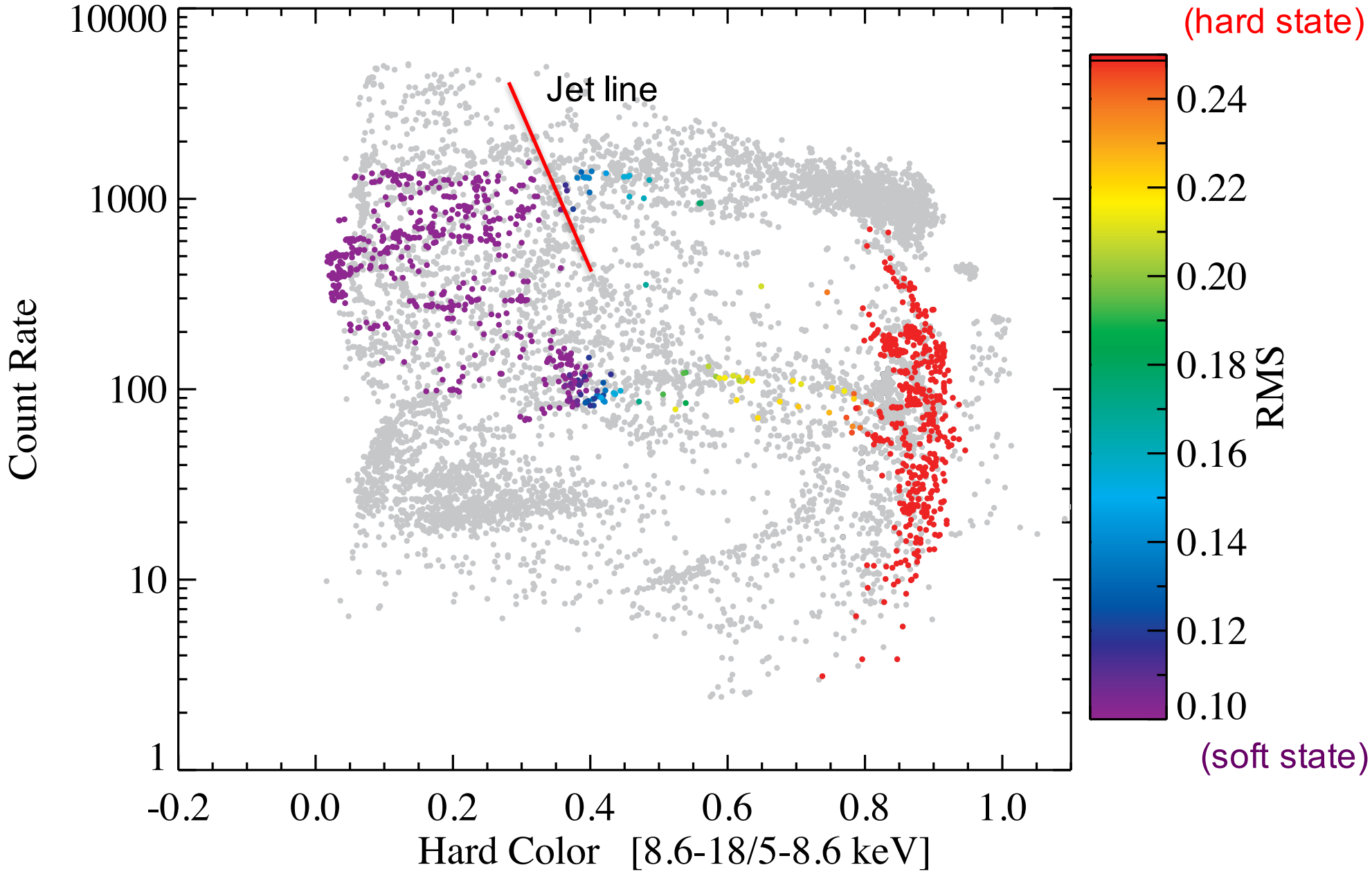
Image credit: U. Warwick

BH XRB Blueprint

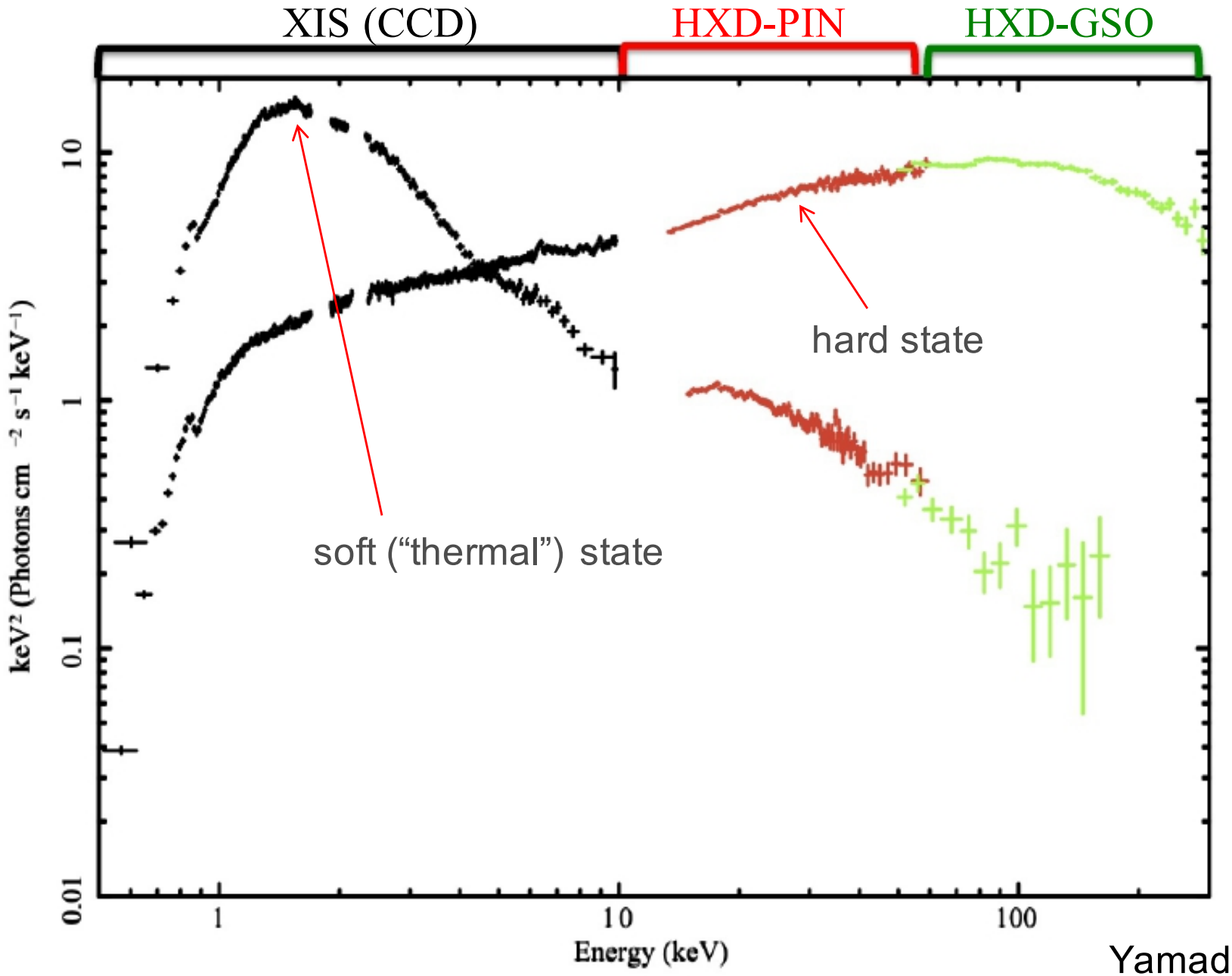


1,000,000 km

Outburst / State Landscape

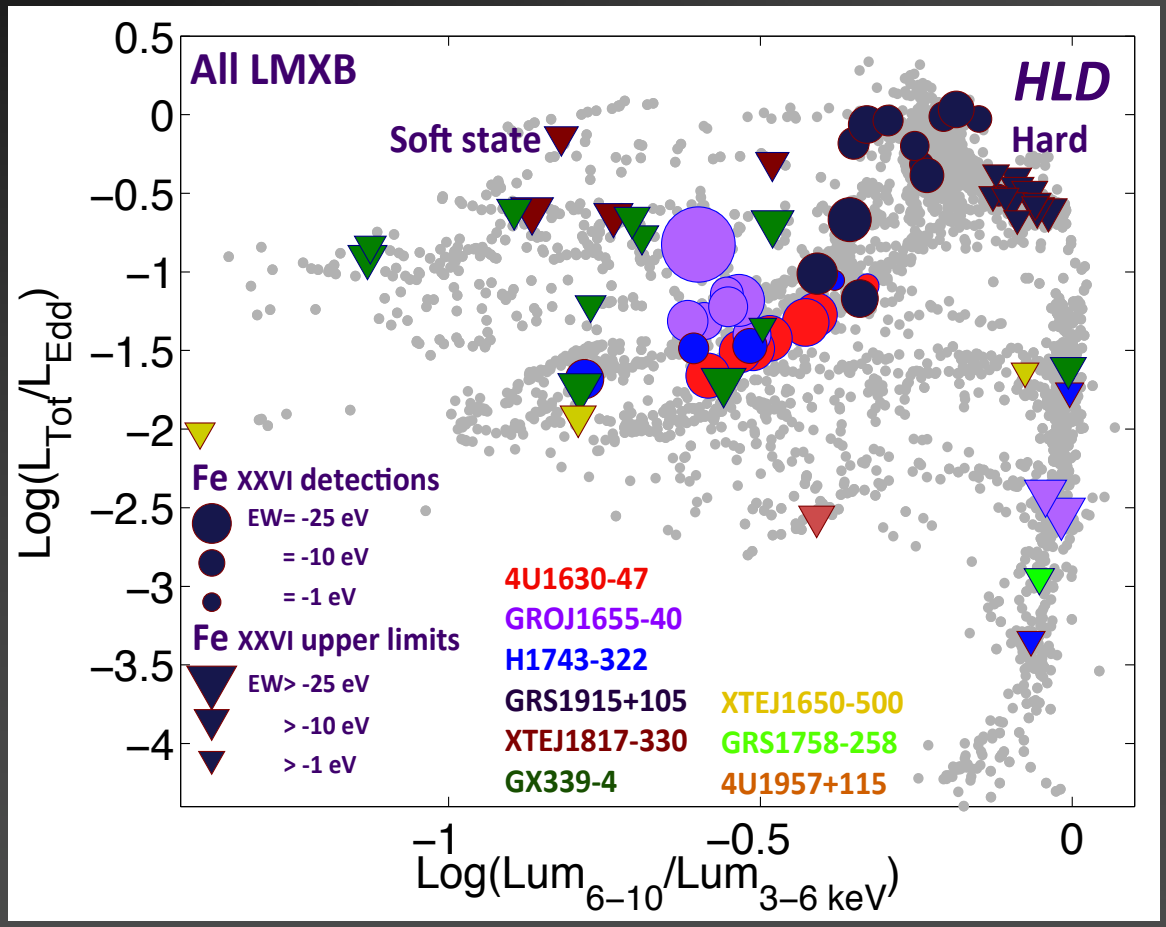


Canonical States of Cyg X-1



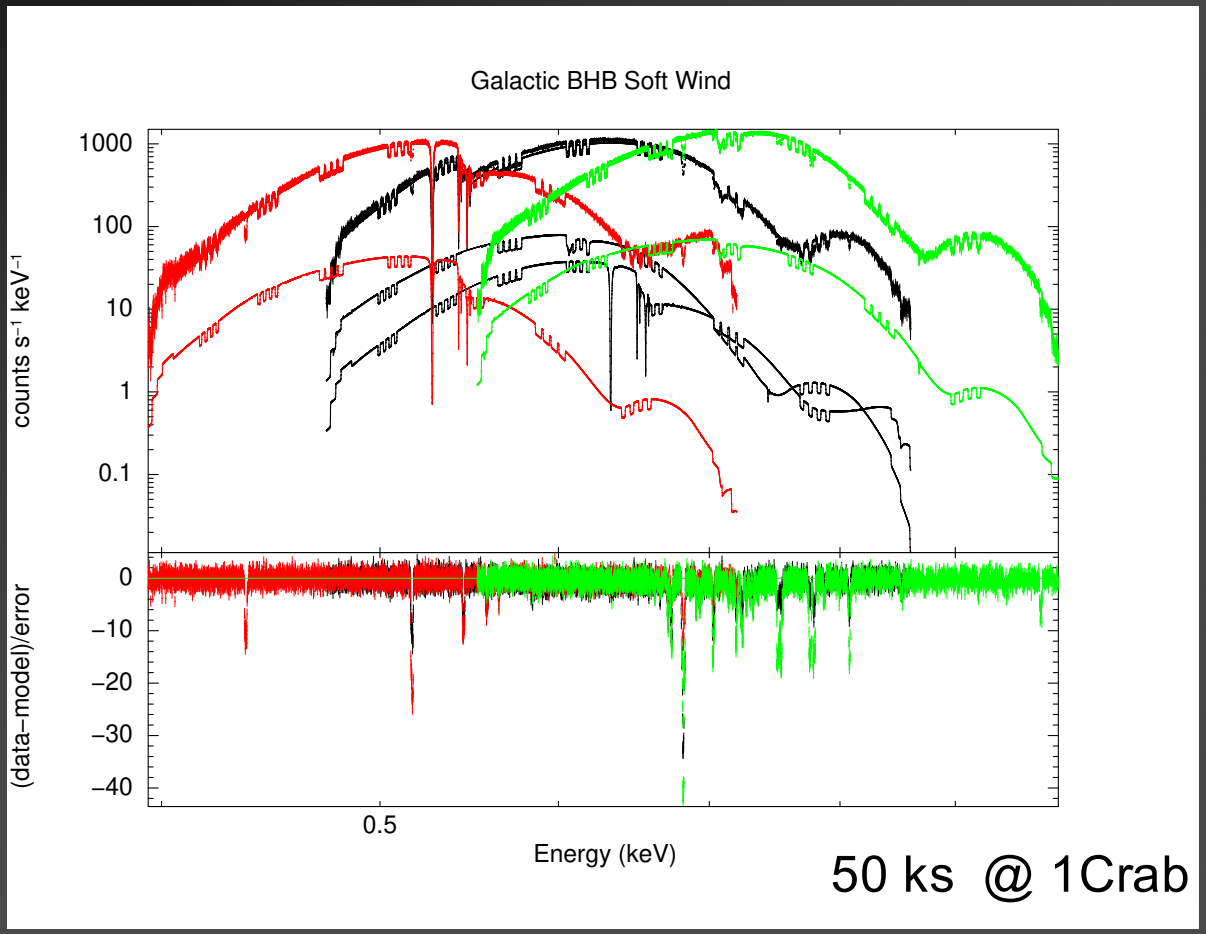
Yamada+2013

State Dependence of Winds

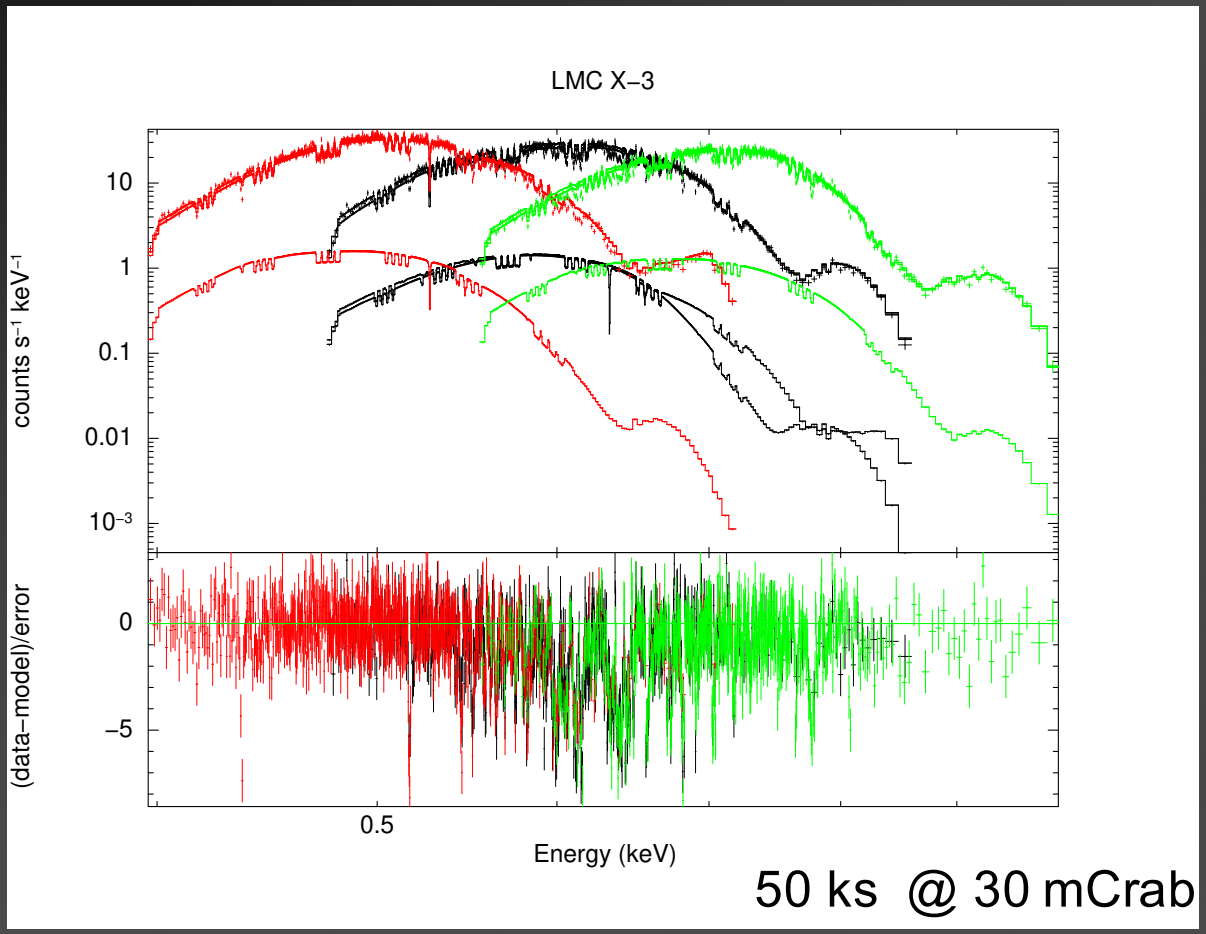


Ponti+2012

A “typical” wind from a bright BH soft state



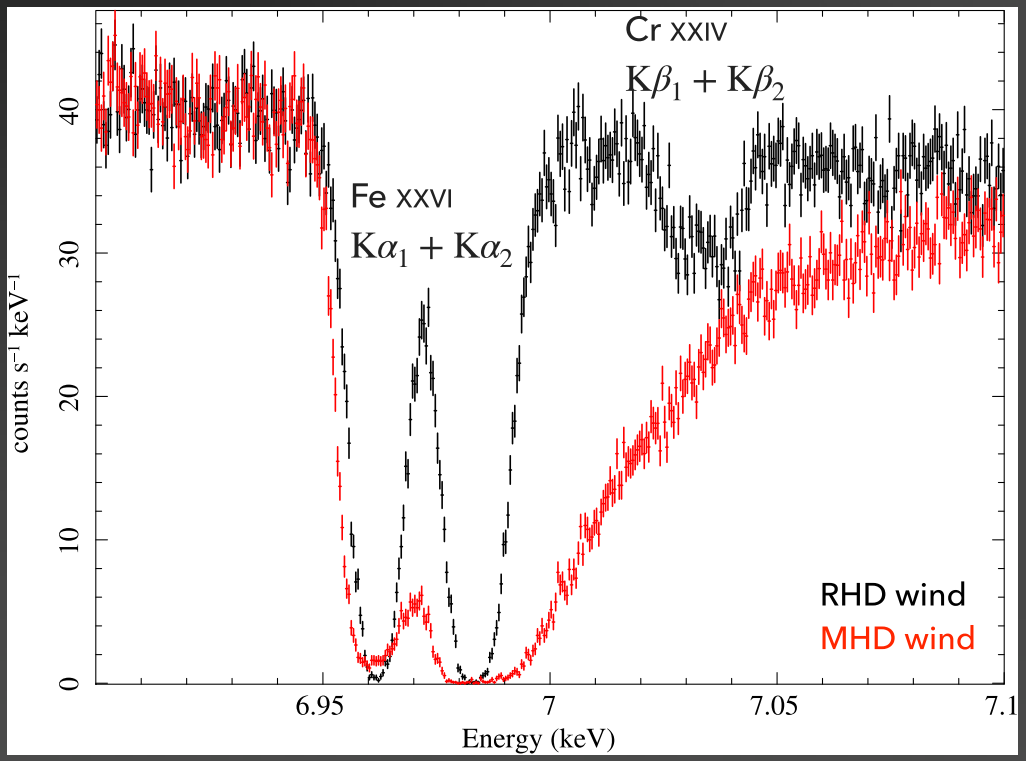
Wind from the pristine soft state of LMC X-3



50 ks @ 30 mCrab

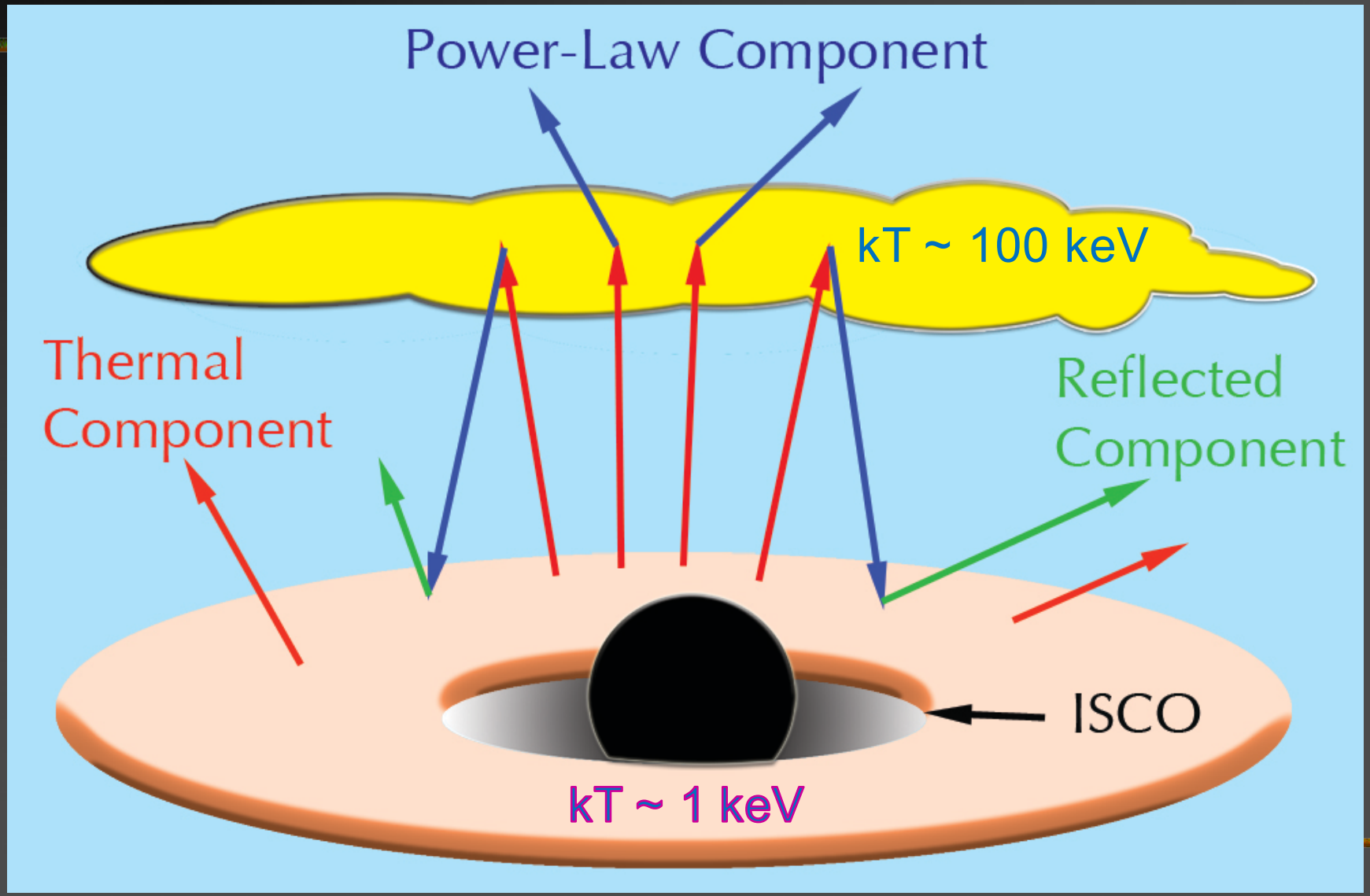
Determining the Wind Mechanism

Line profile can reveal launching mechanism



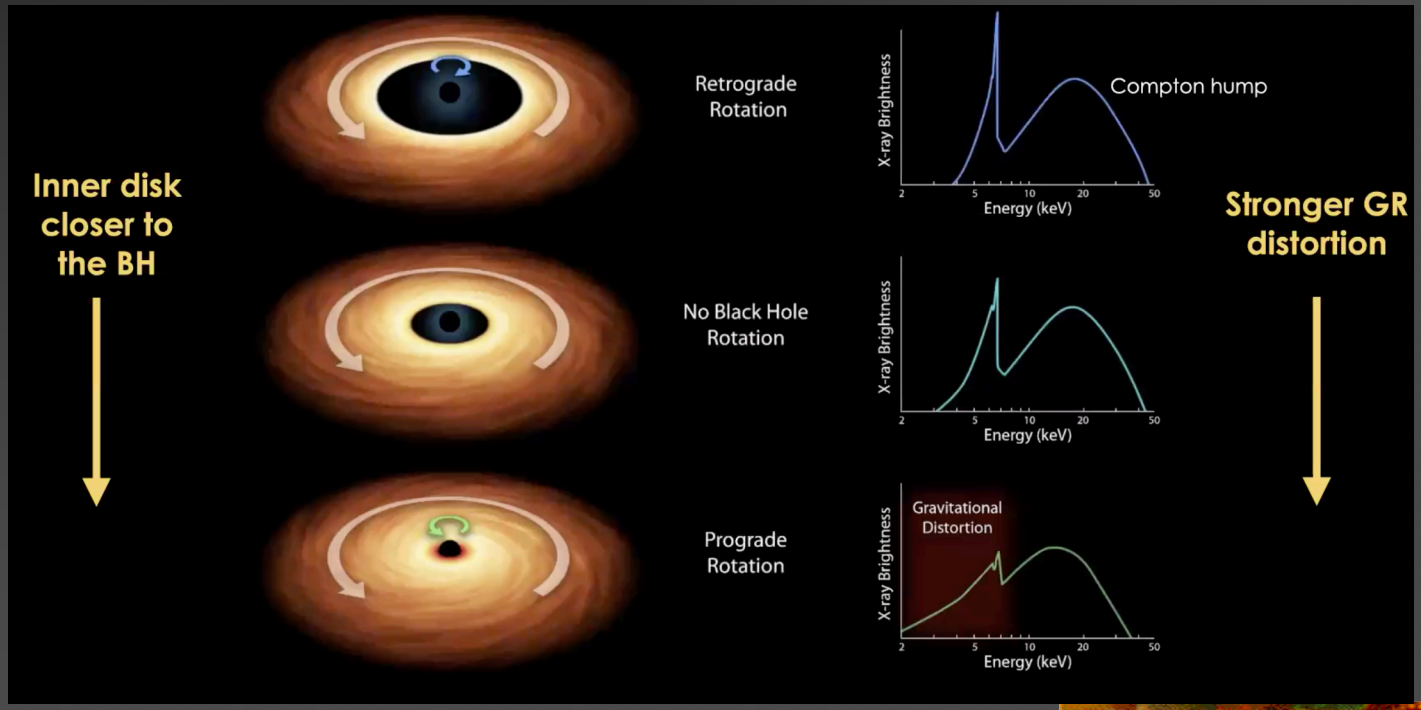
Tomaru+2023

Strong-Gravity Regime - Disk-Coronal Geometry & Reflection

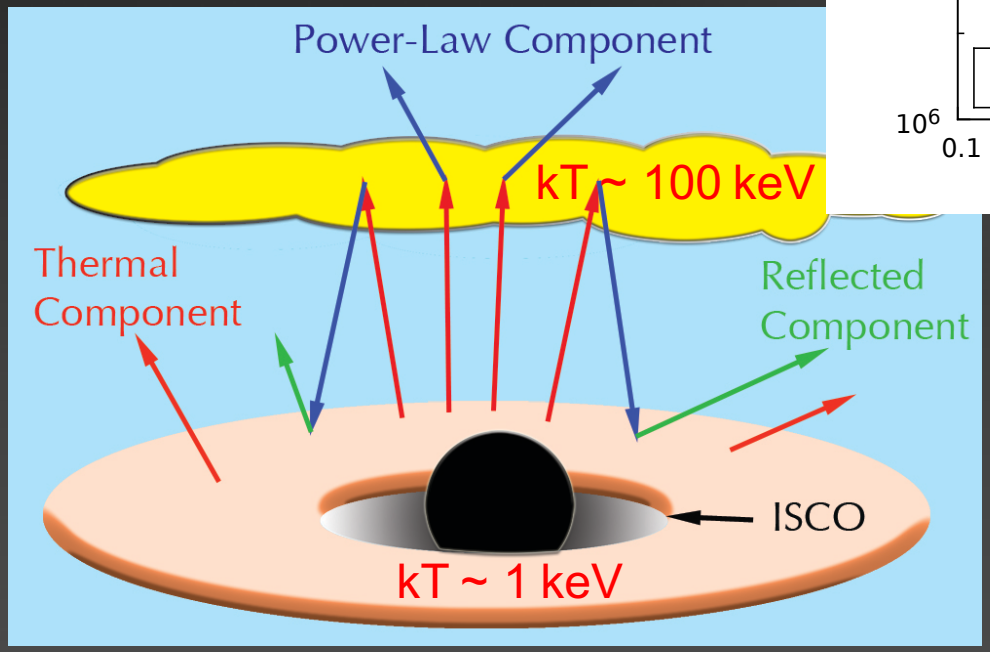


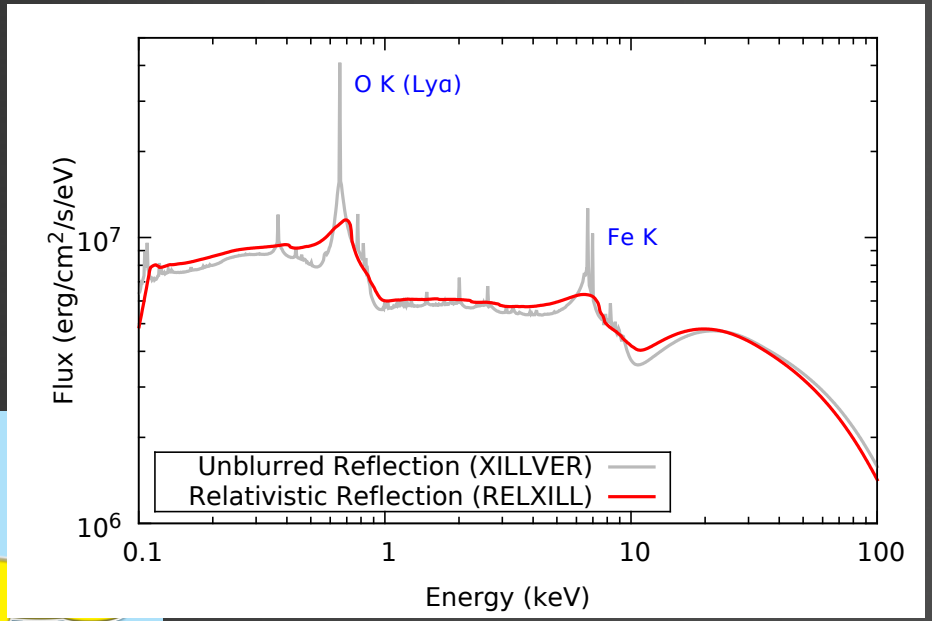
Reflection Fluorescence & Spin

- Higher spin → disk closer in → more relativistic distortion

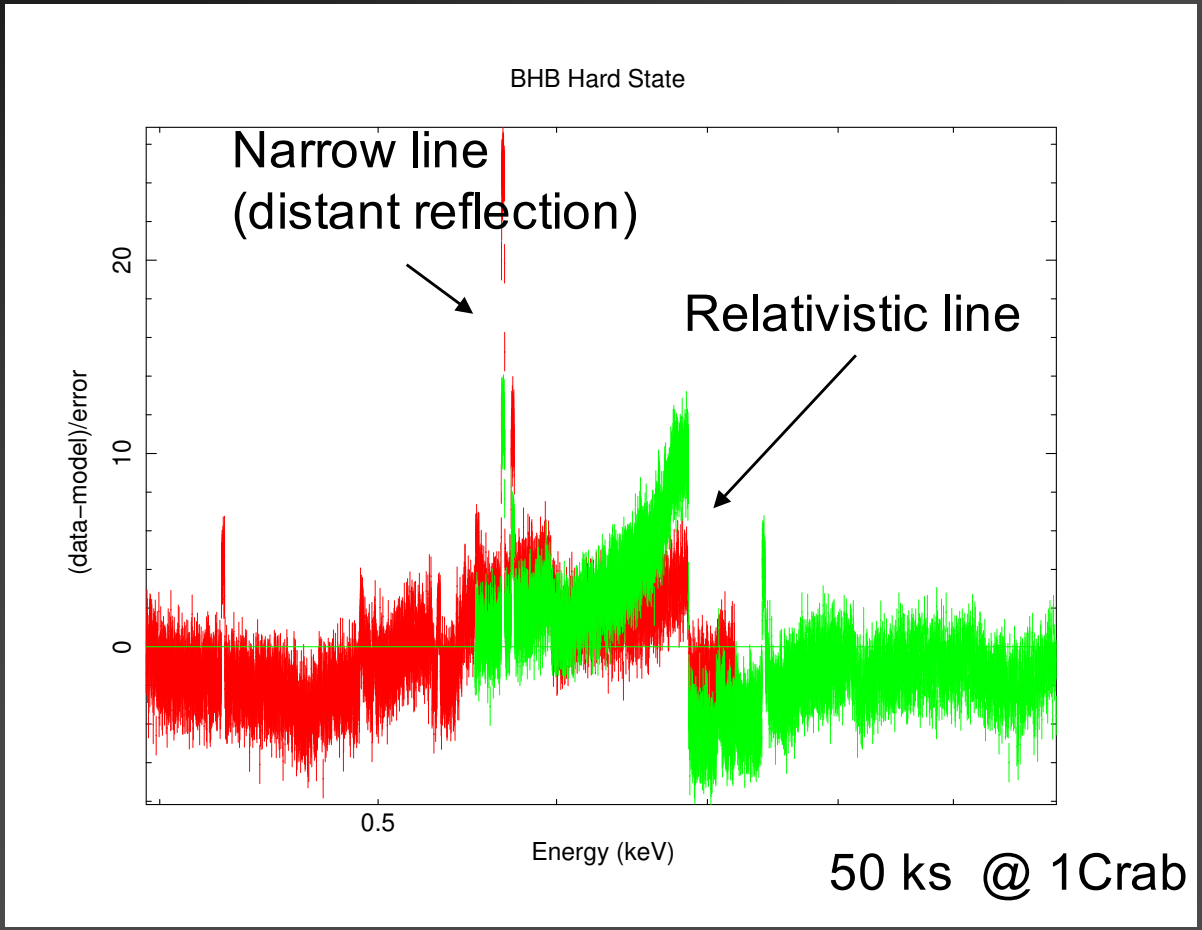


Primed for an Oxygen Renaissance





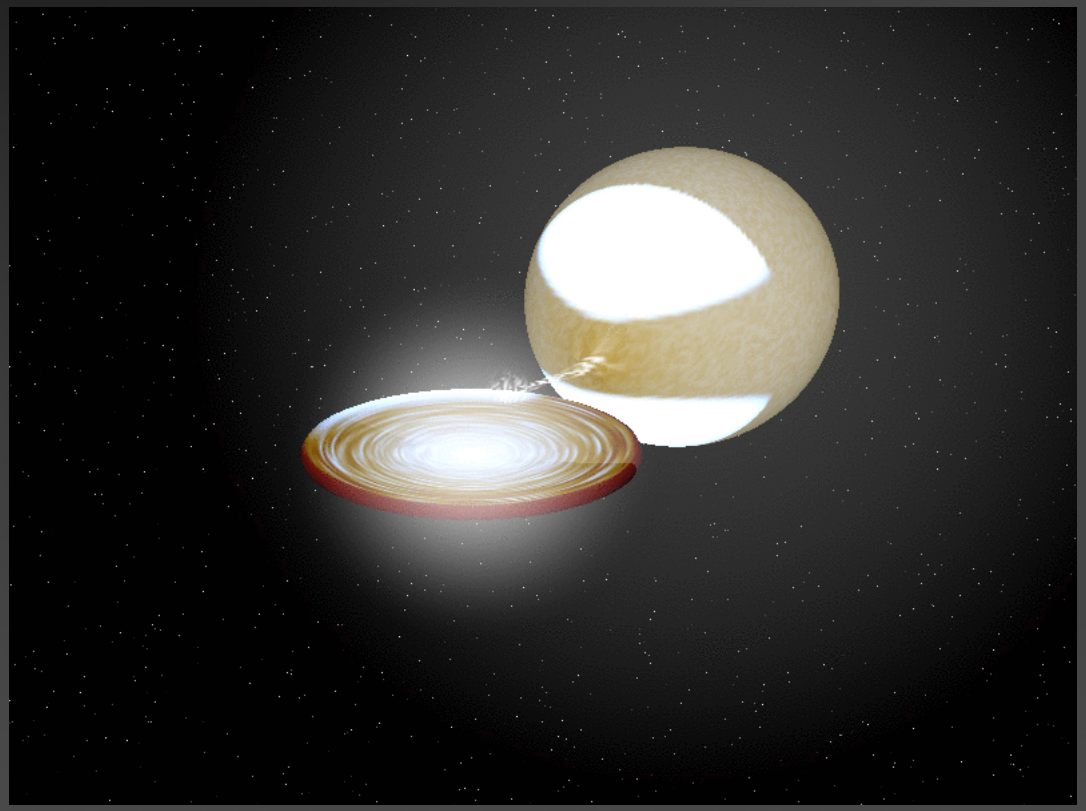
Hard-State Simulation



Applications of O-K Reflection Spectroscopy

- Determining black-hole spin
- Assessing potential disk truncation (R_{in}>R_{ISCO}) in faint hard states.
- Nearby quiescent systems – test the "ADAF" paradigm for hot accretion flows.
  - Target known / faded transients
- Measuring masses?

Dynamical Mass Determination

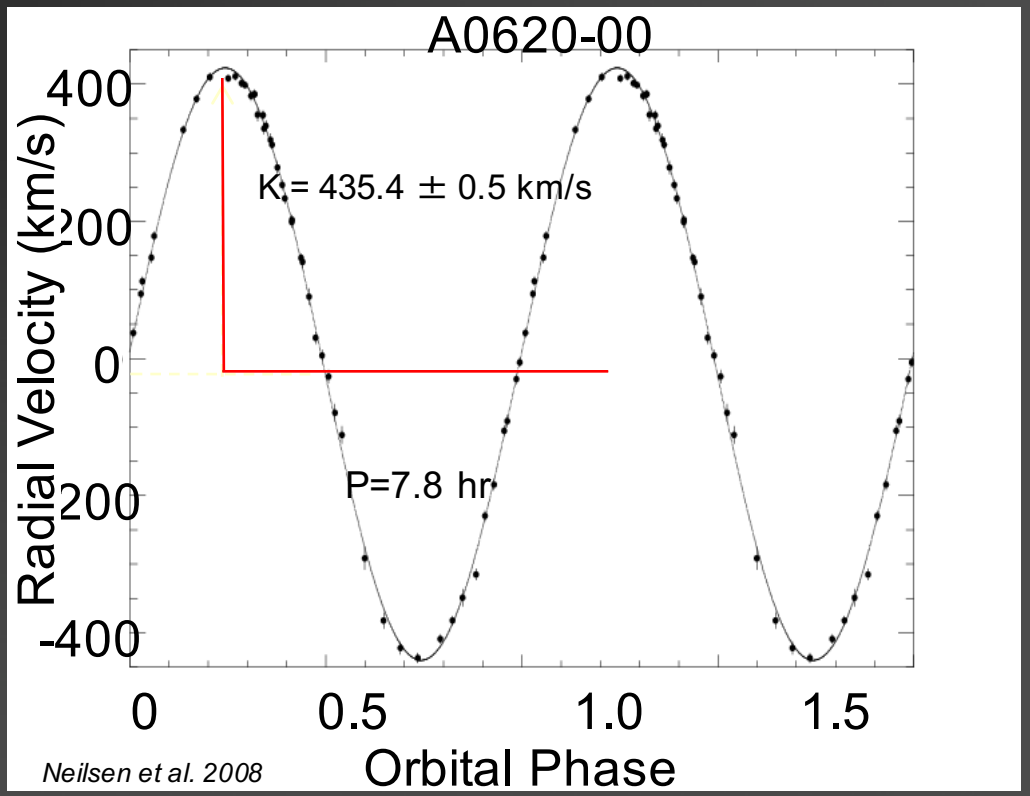


The Mass Function

$$f(M) = \frac{P_{\rm orb} K^3}{2\pi G} = \frac{M_X \sin^3 i}{(1+q)^2}$$

$M_X > f(M)$

R=λ/Δλ≥1500 required



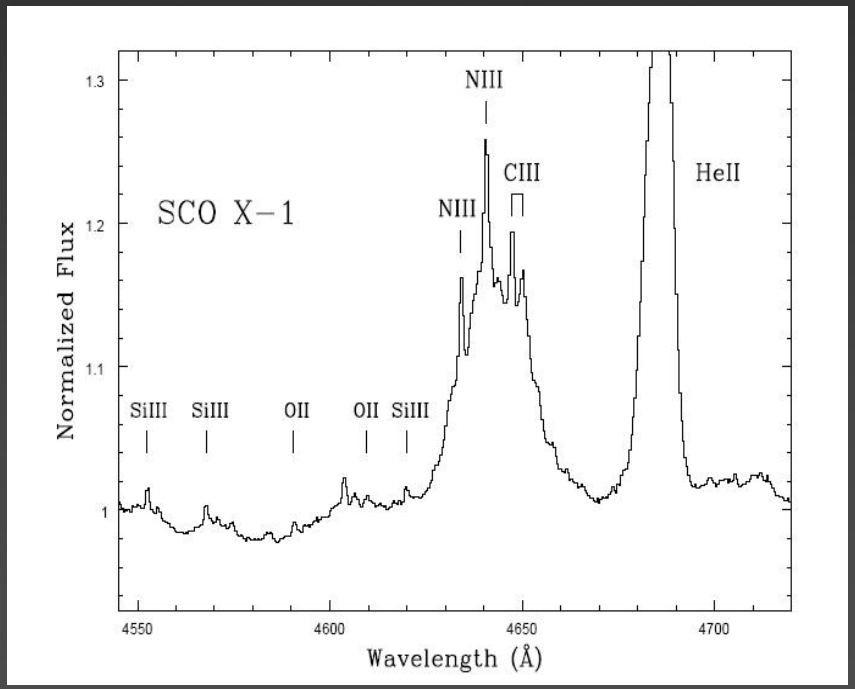
X-ray Heated Systems: Bowen-Line Emission / Fluorescence

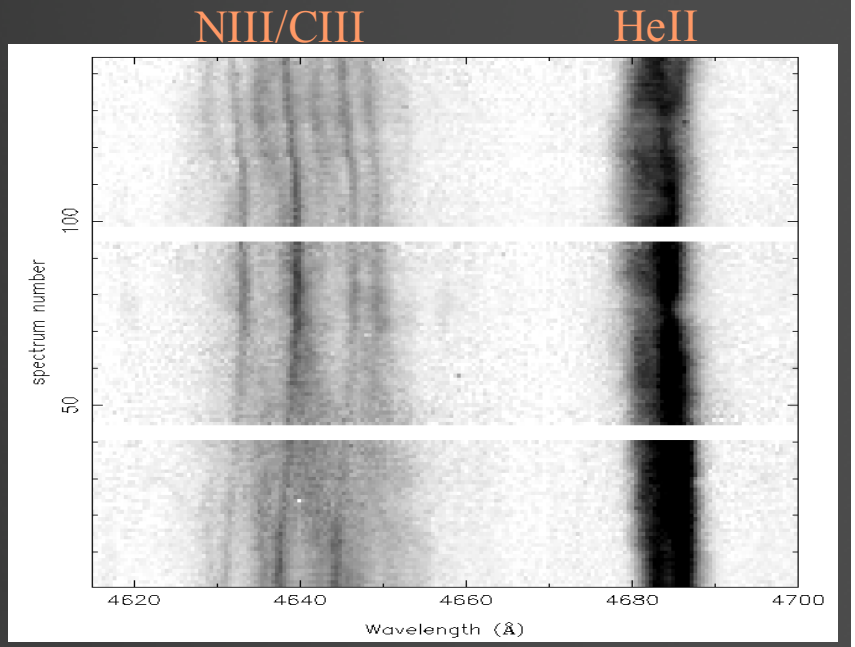
Detection of sharp high excitation emission

Most prominent are CIII/NIII at λλ4630-40

NIII powered by fluorescence

Doppler shift traces orbit of heated companion





Steeghs & Casares 2002

- *Requires R>~2000.*
- *Narrow reflection may offer analogous mass probe*
- *Mass ratio may be measured from reflex signal*

Challenges

- BH XRBs are generally in the galactic plane
  - High extinction common (low-end N_H is ~3e21cm^{-2})
- Sources are very bright!
  - 0th order could have several thousand/s rate (incident)
  - Pileup affects and potentially telemetry effects

Takeaways

- Rich BH XRB science prospects with Arcus
- Primary challenge is absorption

- Winds galore!

- New window on O-K reflection fluorescence
  - Determine BH spin and / or truncation
  - Hopefully, a new goldmine for dynamical masses!