Connecting Changing-look quasars optical/X-ray spectral shapes with Eddington ratios

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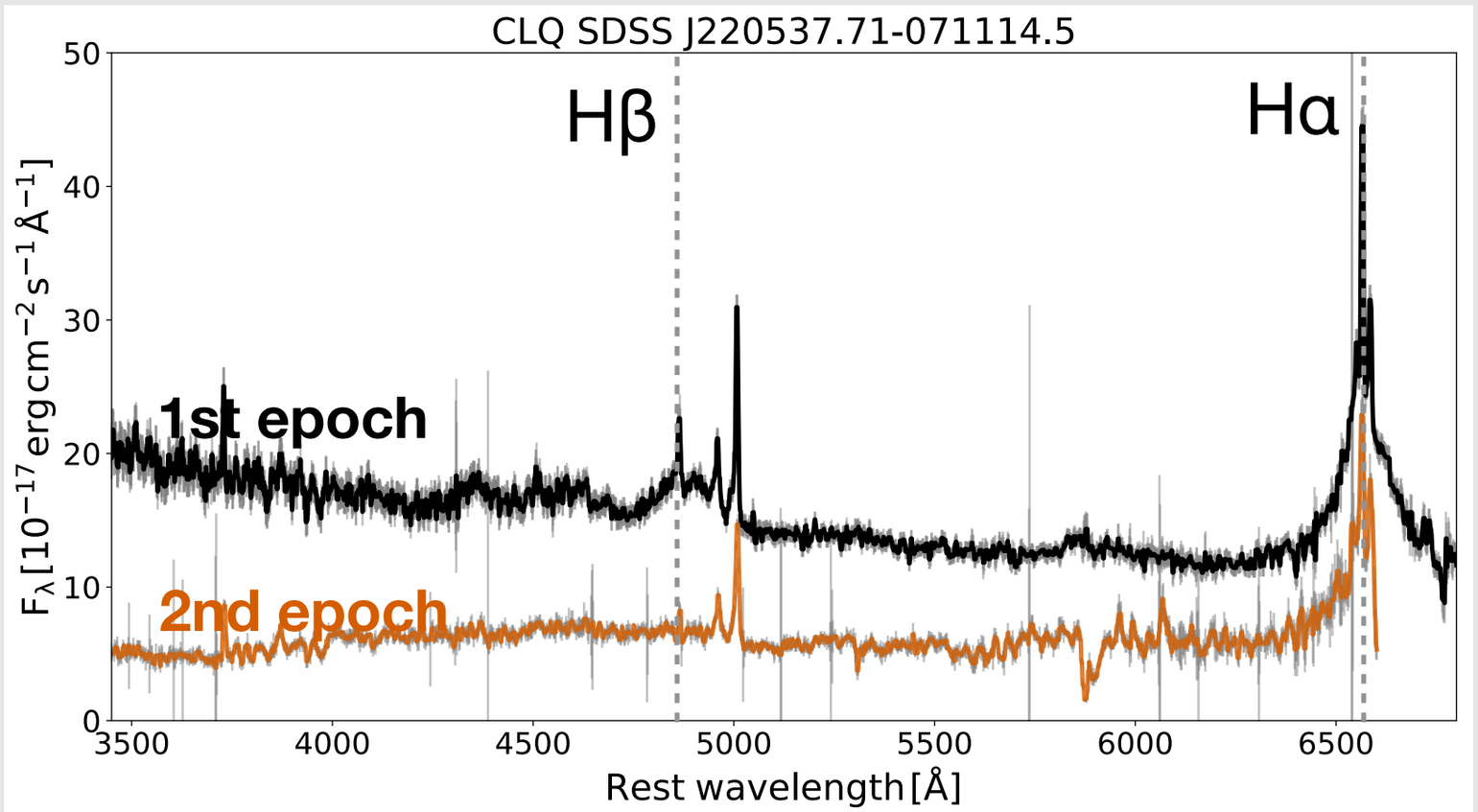
Changing-look quasars



(Credit: Macleod et al. 2019)

Rapid (~10 yrs) change:

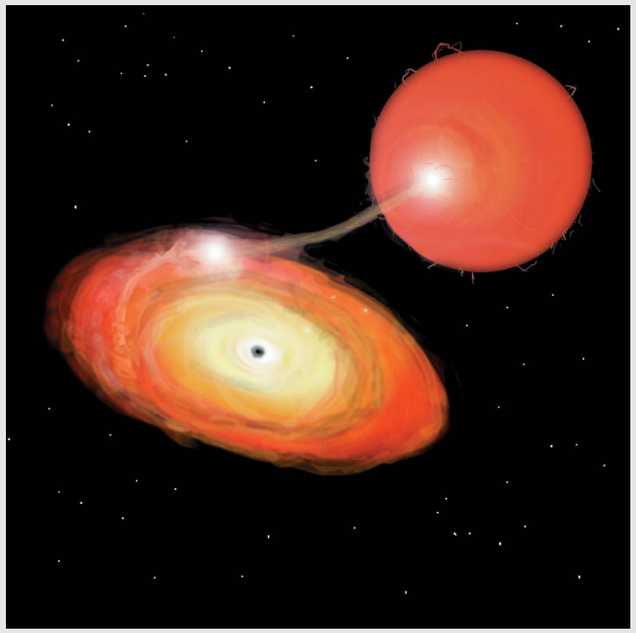
- AGN types
- Continuum fluxes

The origin of CLQs is not known yet

Test XRB/AGN analogy

X-ray binaries undergoing accretion state transition

Transition timescale: ~ **100 days**



Credit: NASA

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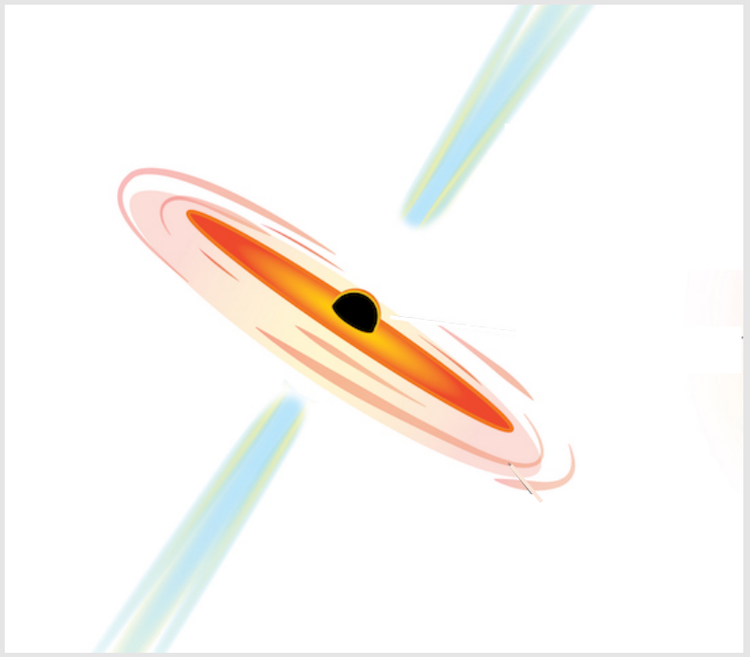
Changing-look quasar phenomenon

Expected Transition timescale: ~ **10^5 years**

Observed timescale: ~ **10 years**



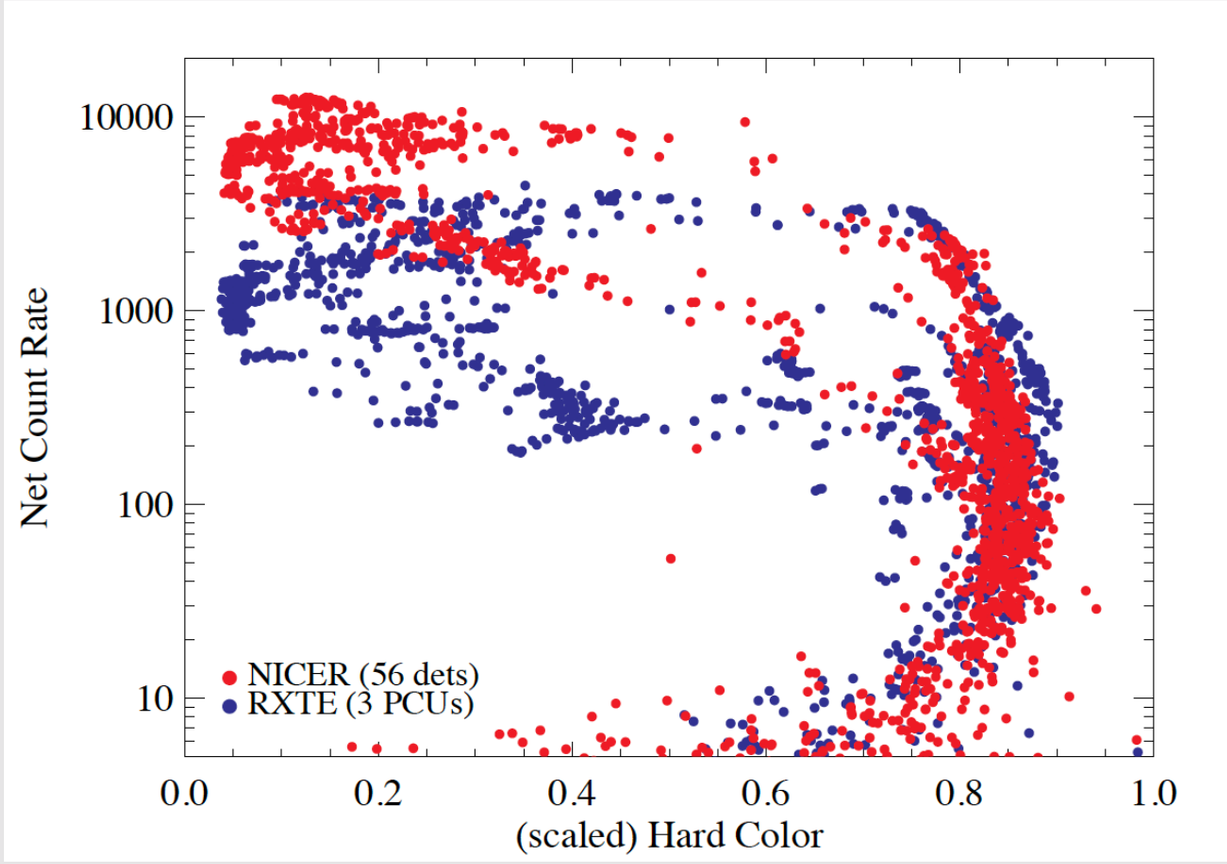
Credit: Sophia Dagnello, NRAO/AUI/NSF

We thereby aim to test whether there is any **observable** connection between changing-look quasars and X-ray binaries undergoing accretion state transitions.

X-ray binaries in outbursts

For black hole X-ray binaries

Hardness-Intensity Diagram
NICER Observation

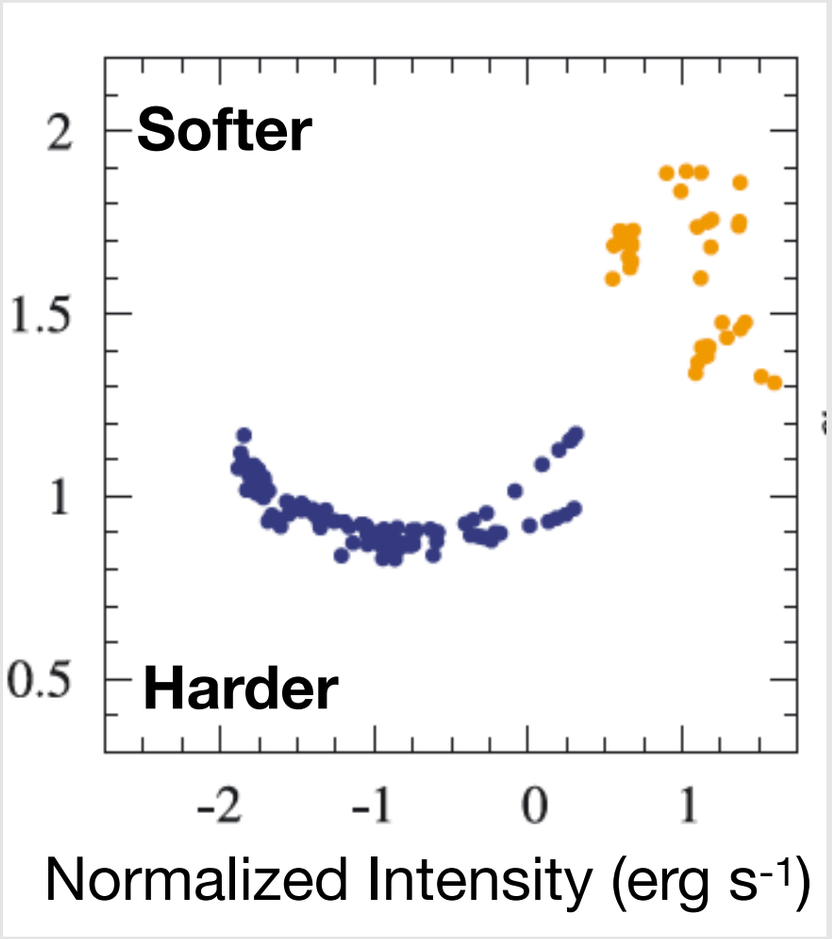


Credit: Steiner, J. & NICER team

X-ray binaries in outbursts

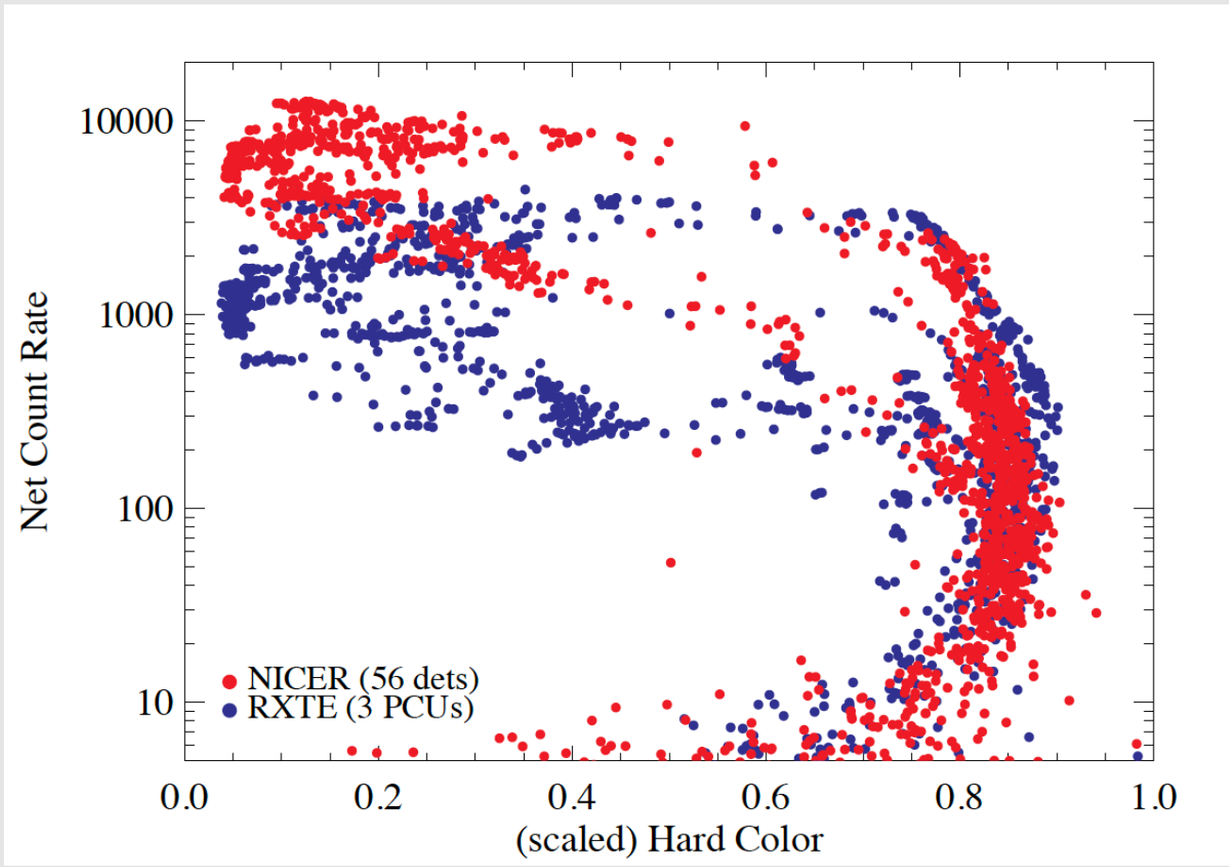
For black hole X-ray binaries

RXTE Observation



Credit: Sobolewska et al. 2011

Hardness-Intensity Diagram
NICER Observation



Credit: Steiner, J. & NICER team

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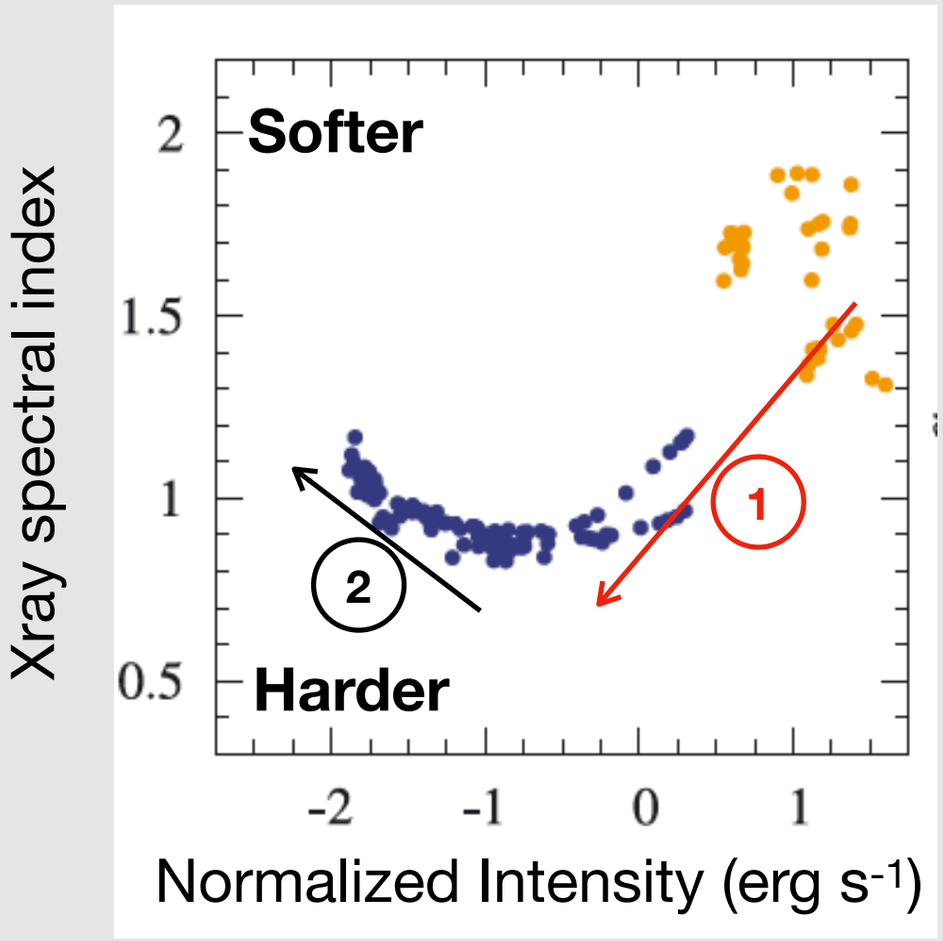


Credit: Sobolewska et al. 2011

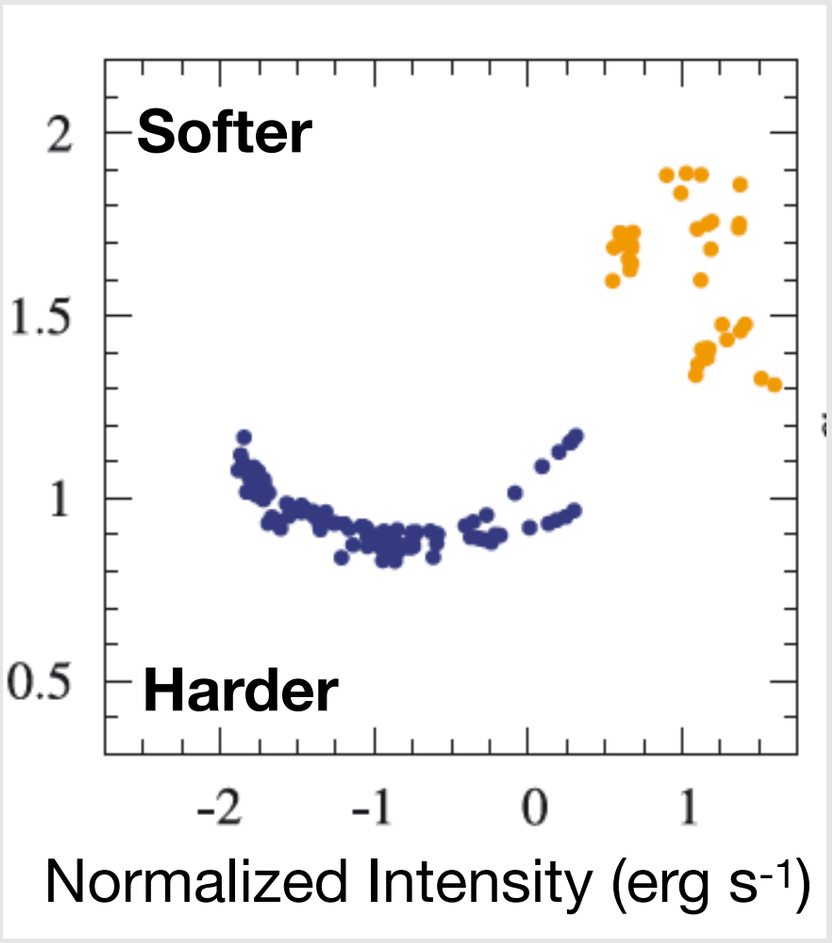
① Fading, spectra hardening

② Fading, spectra softening

“V” shape

From X-ray binaries to AGN

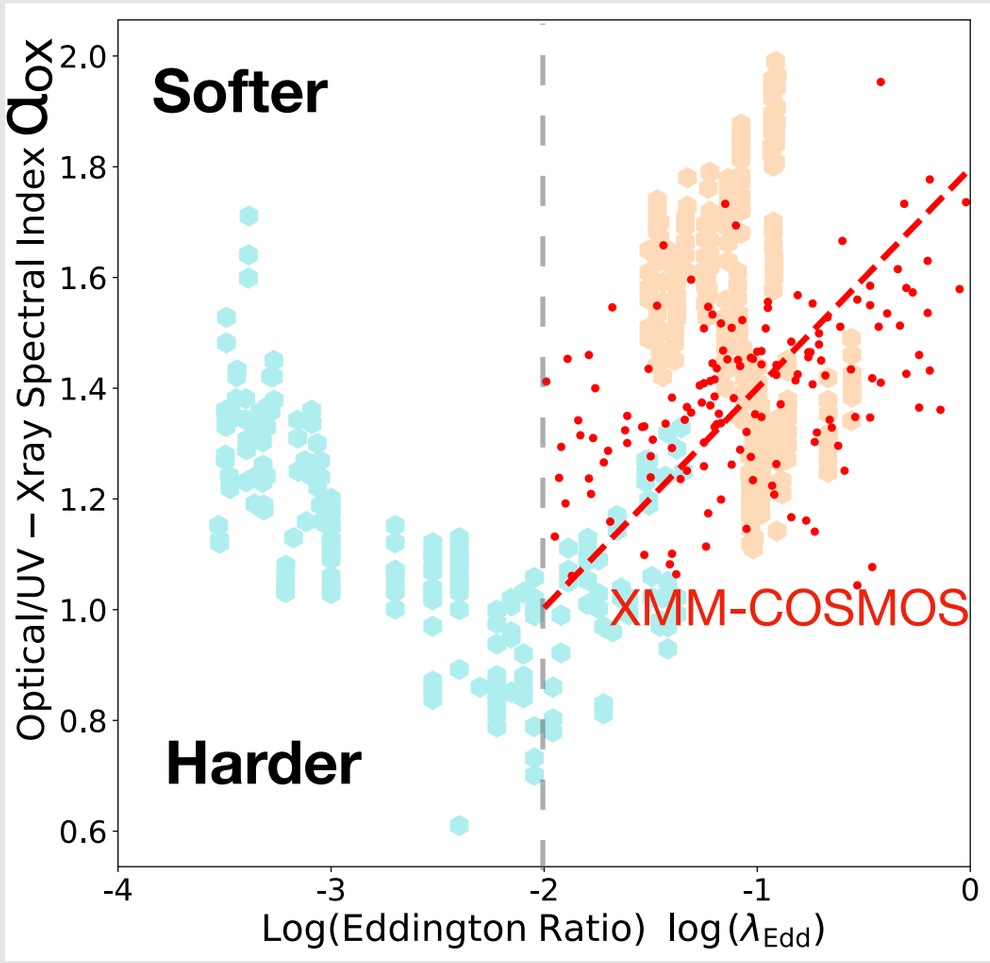
RXTE Observation



Credit: Sobolewska et al. 2011

Scaling all the emissions to AGN

Simulated AGN

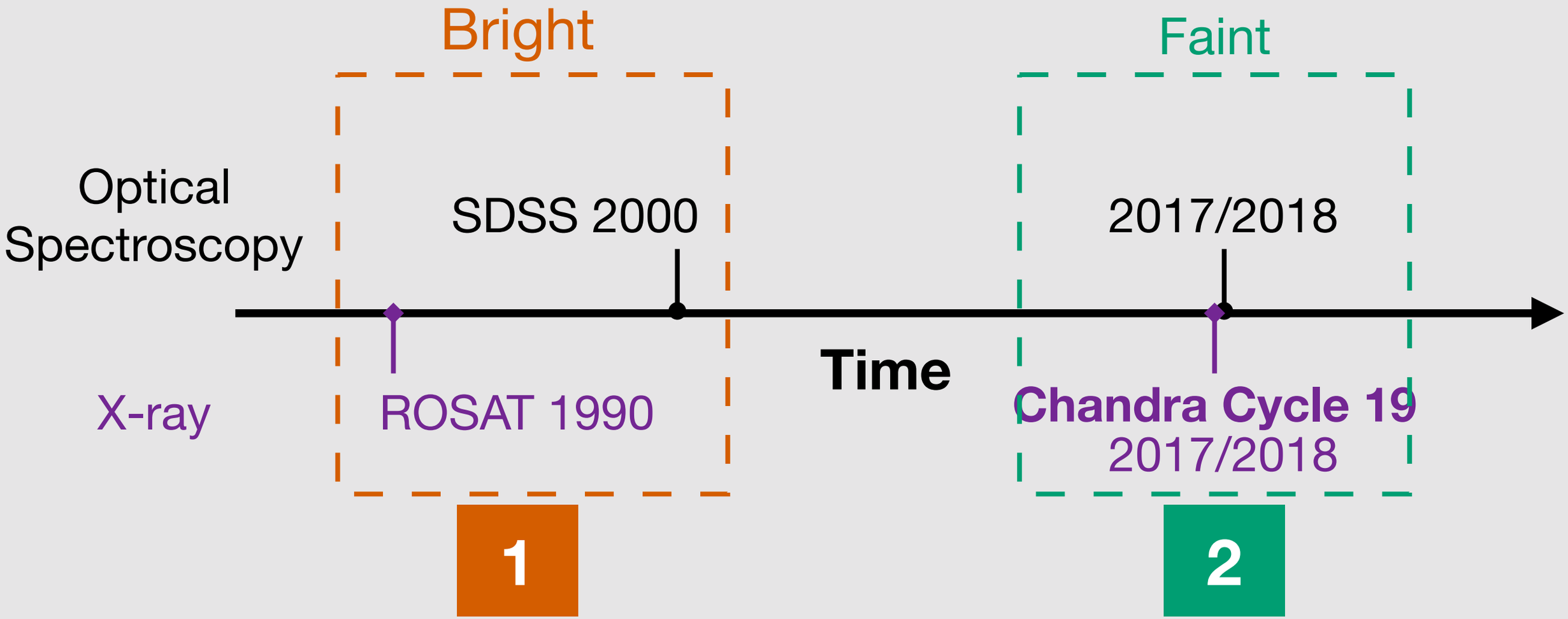


Adapted from Sobolewska et al. 2011

Data selection

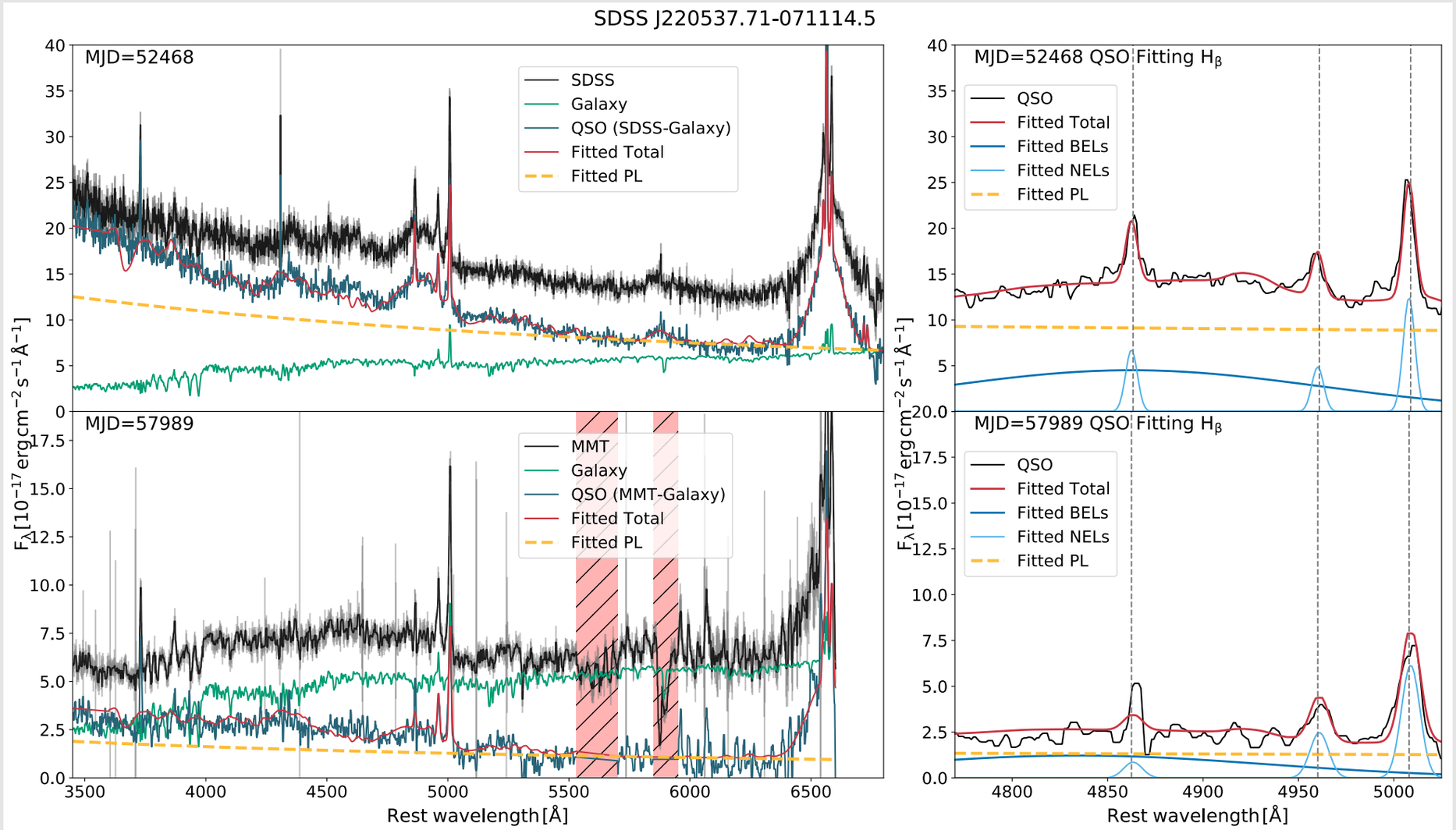
9 Changing-look quasars (identified by SDSS), all faded in optical

To measure α_{ox}, we need both optical and X-ray data

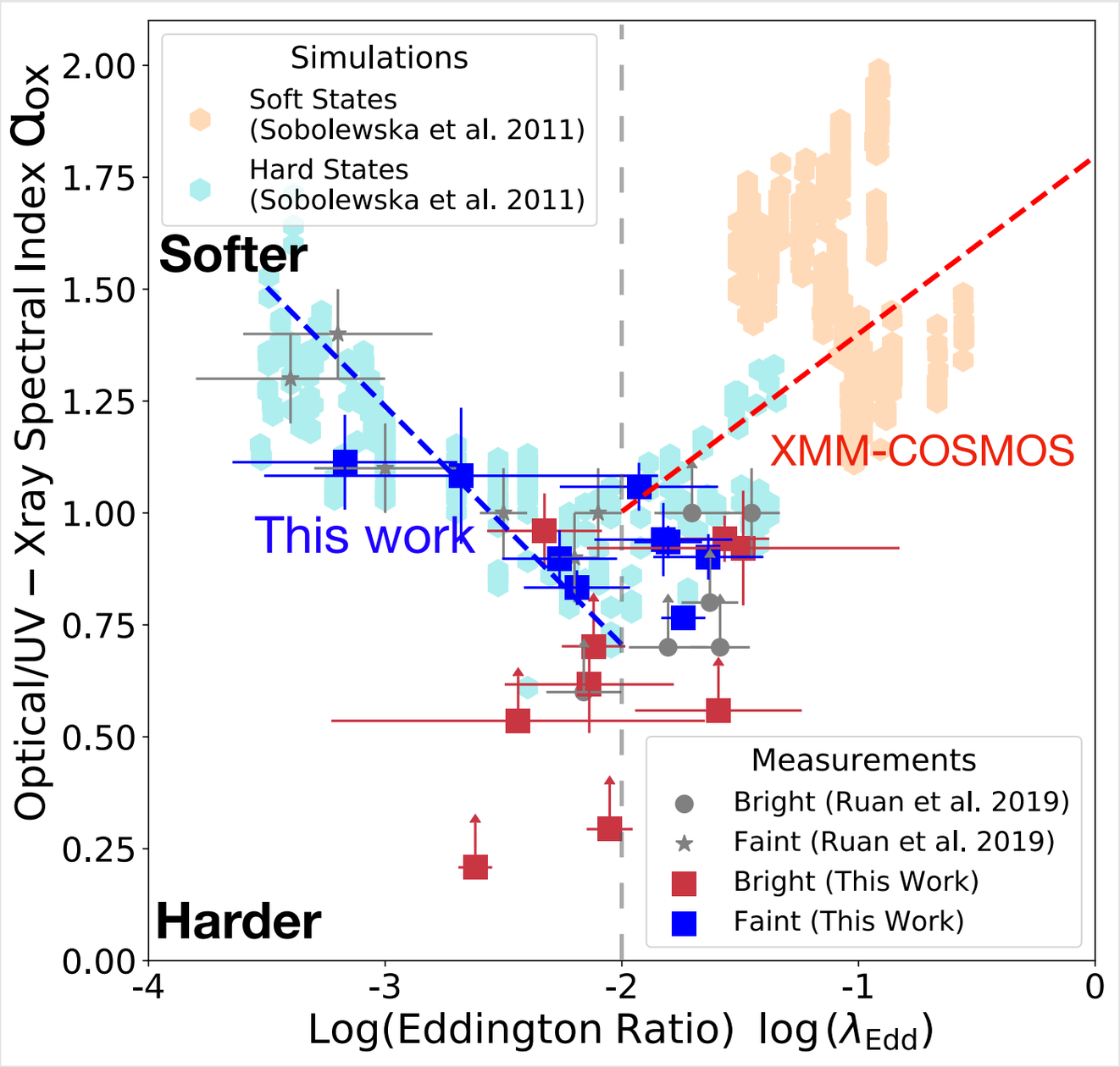


Quasar spectra fitting

Every optical spectrum is decomposed into corresponding galaxy/quasar spectrum by using MCMC. Eigen galaxy/quasar spectra are from Yip et al. 2004. The power-law continuum, broad/narrow emission lines, and high order Balmer lines etc. are fitted in the quasar spectrum.



Results: α_{ox}-λ_{Edd}



(Jin et al. in preparation)

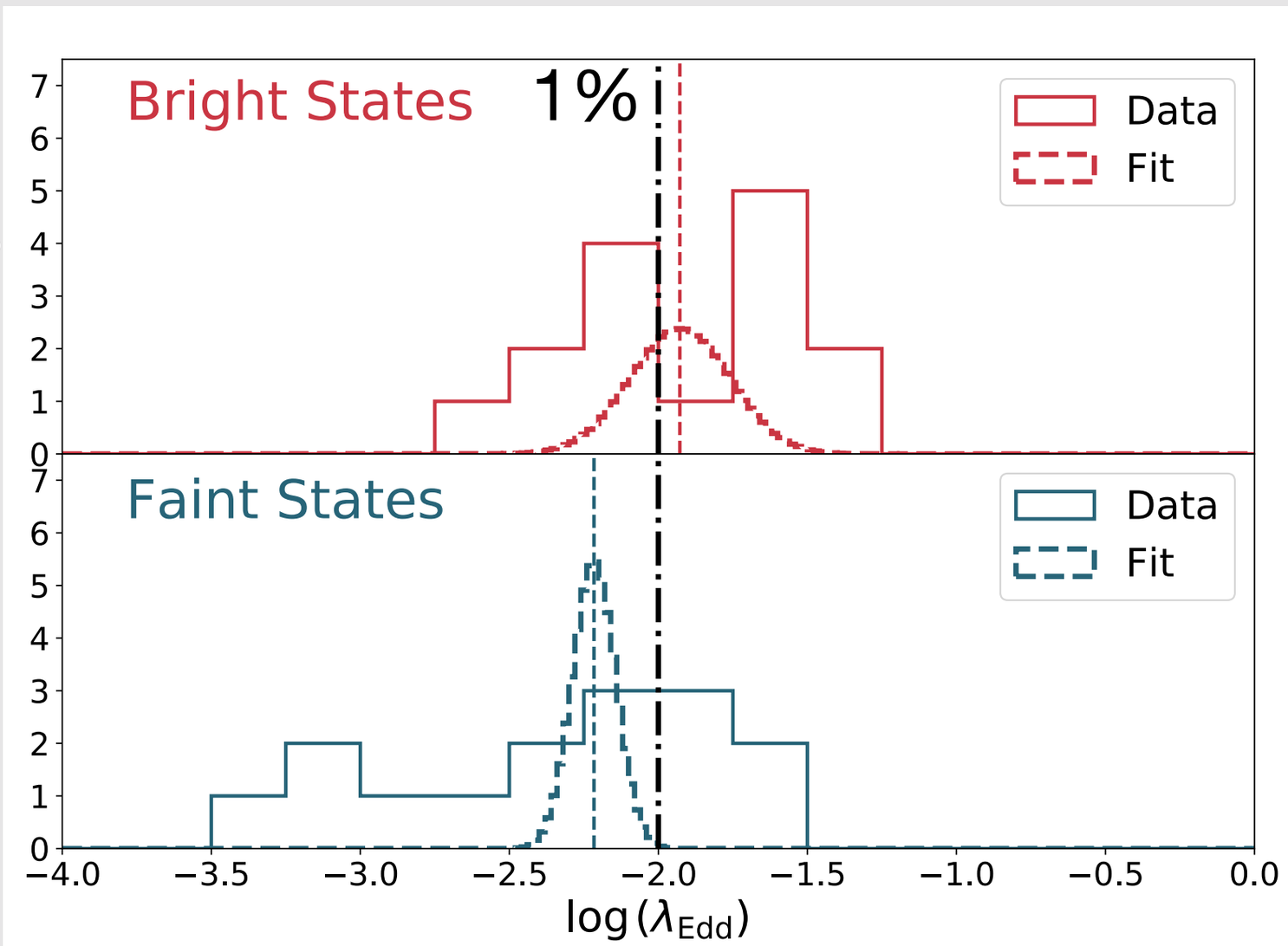
α_{ox} and λ_{Edd} at $\lambda_{Edd} \lesssim 1\%$ show an **anti-correlation**

consistent with simulated results (Sobolewska+ 2011)

Bright/Faint States

Single Gaussian distribution for both bright and faint states

Transition from bright to faint cross an Eddington ratio ~ 1% (Elitzur et al. 2014)



(Jin et al. in preparation)

Conclusion

We measured α_{ox} and λ_{Edd} of 9 changing-look quasars

- α_{ox} and λ_{Edd} of faint state CLQs at $\lambda_{Edd} \lesssim 1\%$ show an anti-correlation.

- α_{ox} and λ_{Edd} of CLQs are consistent with simulated results scaling from X-ray binaries to AGNs (Sobolewska et al. 2011).

- Eddington ratios of best-fitted bright/faint states cross ~1%, which seems to be crucial for the disappearance/appearance of the broad emission lines.

Thank you!