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

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Changing-look quasars

Rapid (~10 yrs) change:
- AGN types
- Continuum fluxes

The origin of CLQs is not known yet

(Credit: Macleod et al. 2019)
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

Hardness-Intensity Diagram

NICER Observation

Credit: Sobolewska et al. 2011

Credit: Steiner, J. & NICER team
X-ray binaries in outbursts

For black hole X-ray binaries

RXTE Observation

1. Fading, spectra hardening
2. Fading, spectra softening

“V” shape

Credit: Sobolewska et al. 2011
From X-ray binaries to AGN

RXTE Observation

Simulated AGN

Scaling all the emissions to AGN

Credit: Sobolewska et al. 2011

Adapted from Sobolewska et al. 2011
Data selection

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

To measure $\alpha_{\text{ox}}$, 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: $\alpha_{\text{ox}} - \lambda_{\text{Edd}}$

$\alpha_{\text{ox}}$ and $\lambda_{\text{Edd}}$ at $\lambda_{\text{Edd}} \lesssim 1\%$ show an anti-correlation consistent with simulated results (Sobolewska+ 2011)

(Jin et al. in preparation)
Bright/Faint States

Single Gaussian distribution for both bright and faint states

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

(Jin et al. in preparation)
Conclusion

We measured $\alpha_{\text{ox}}$ and $\lambda_{\text{Edd}}$ of 9 changing-look quasars

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

- $\alpha_{\text{ox}}$ and $\lambda_{\text{Edd}}$ 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 $\sim 1\%$, which seems to be crucial for the disappearance/appearance of the broad emission lines.
Thank you!