QUASAR ACCRETION DISK VARIABILITY USING MULTI-EPOCH SDSS-V UV-OPTICAL SPECTRA

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ABSTRACT

We study the evolution of the accretion disk spectrum with flux, using data from the time-domain Sloan Digital Sky Survey (SDSS-V) project for 220 quasars at z<0.8. We subtract the host contribution consistently between epochs and model the disk, BLR continua and emission lines simultaneously using the Penalized Pixel Fitting (pPXF) software. We find, even at long wavelengths, that the accretion disk itself becomes steeper when the flux increases so the Bluer-When-Brighter (BWB) is not just a matter of relative contributions of host and the Active Galactic Nuclei components.

METHODOLOGY

We selected objects with redshift z$\leq$ 0.8. For this redshift range the stellar contribution was observed to be important[2] making it difficult to distinguish between the continuum components. We use the contemporaneous Zwicky Transient Facility (ZTF) forced-photometry lightcurves[3] to compare between the SDSS-V spectrophotometry and ZTF photometry, retaining only epochs where the SDSS-V spectra match the ZTF light curves in both g and r bands.

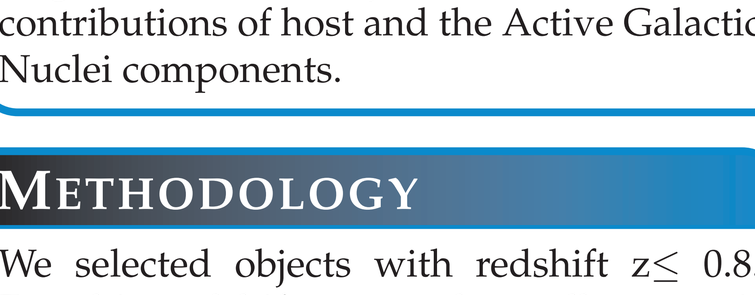

Figure 1. ZTF ligthcurves of SDSS J142735.27+363721.0 and the SDSS integrated flux (SDSS Flux) represented by the black dots plotted over the region formed by the ZTF mean Flux (solid line) and 1σ ZTF flux errors (ZTF 1σ Flux err) (filled area) for both g (left) and r (right) bands. Here three out of four SDSS epochs conform to the ZTF trend in both g and r bands, while the first epoch is out of the trend and is therefore discarded from the analysis.

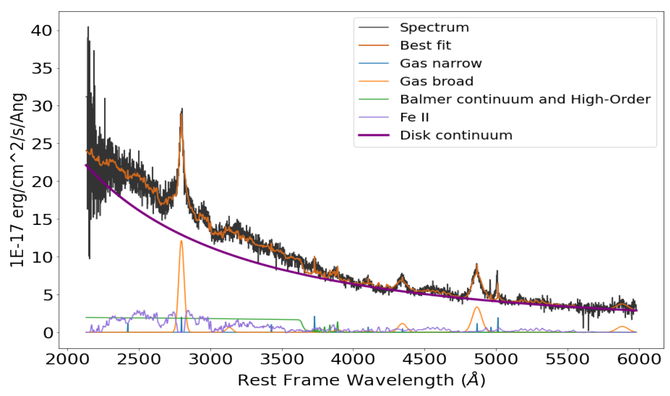

Figure 2. Best fit result of a starlight-subtracted spectrum (black) of one epoch of the object in Figure 1. Different components of the model are plotted in different colors, in particular the disk continuum emission is in purple. All the different components. i.e. broad lines, narrow lines, pseudo continua and disk continuum were allowed to vary independently.

DATA

We used the AQMES Medium quasars sample that is part of the Black Hole Mapper (BHM) program from the SDSS-V[1]. This sample consists of objects previously observed in the SDSS DR14 to DR16 and classified as Quasars or Seyfert type I, and covering ~300 deg^2 of the sky. During the first period of observations from December 2020 to July 2021 at least one spectral epoch was obtained for ~26000 objects with a redshift range that extends until $z = 5$.

RESULTS

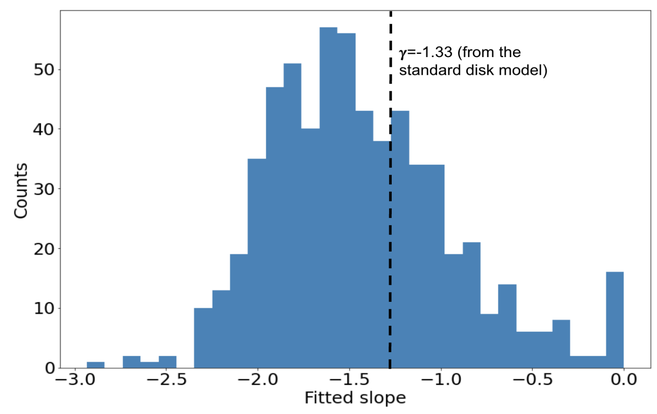

Figure 3. Distribution of accretion disk fitted slopes for individual epochs.

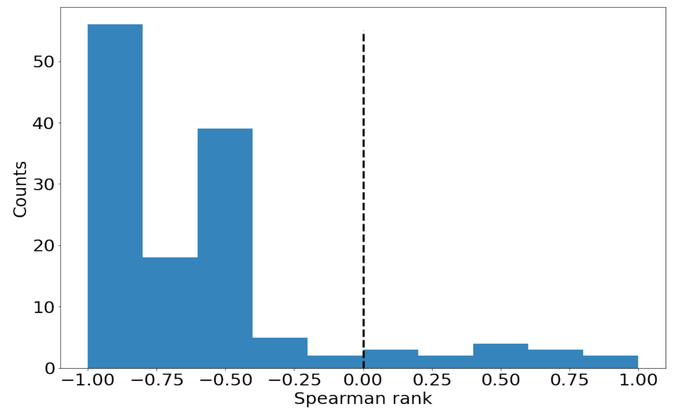

Figure 4. Correlation coefficients between changes in slope and changes in flux for individual objects at 2500Å.

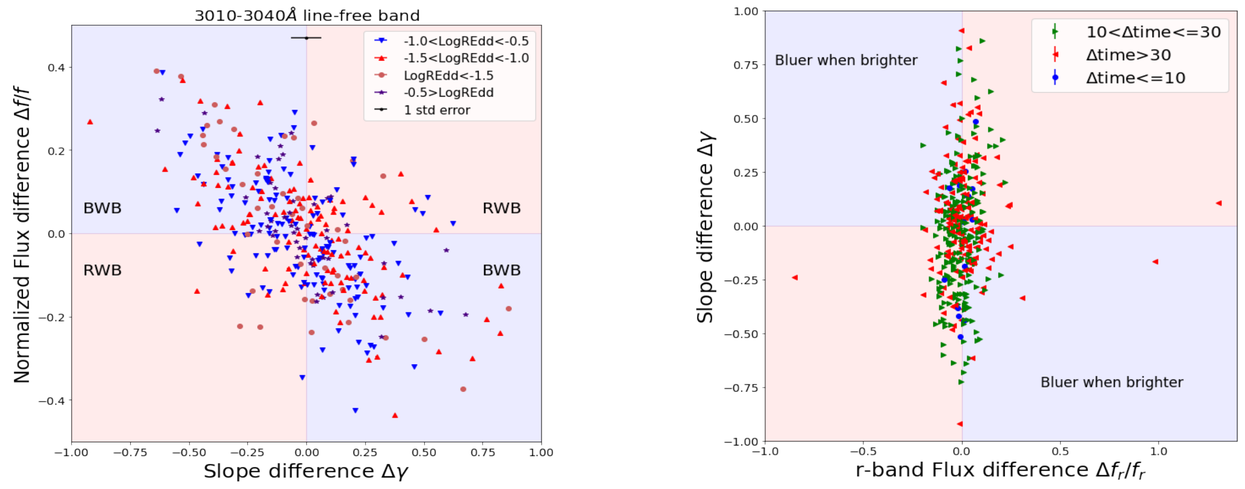

Figure 5. Comparison between differences in slope and flux for the g (left) and r-band (right).

CONCLUSIONS

We have performed spectral decomposition and systematic host galaxy subtraction of 629 individual spectra of a total of 220 quasars after confirming the flux changes via comparison with photometric data. We fit the isolated disk continuum emission component in a range from 1980 to 10000Å with a combination of power law models.
The median value of the fitted disk continuum is γ=-1.50 (standard disk model γ=-1.33[4]) with values distributed between -1.99 and -0.82 corresponding to the 10% and 90% percentiles.
The Spearman rank correlation test at the rest frame wavelength of 2500Å results in 185 (i.e. 84%) of the quasars being consistent with a negative correlation, meaning BWB.
The comparison between differences in the slopes ($\Delta\gamma$) with the normalized flux differences at bluer bands shows a clear BWB trend and disappears when the flux is measured in the r-band, where the change in flux is small.

REFERENCES

[1]Almeida A., et al., 2023, arXiv e-prints, p arXiv:2301.07688 [2]Rakshit S., Stalin C. S., Kotilainen J., 2020, ApJS, 249,17 [3]Masci F. J., et al., 2019, PASP, 131, 018001 [4]Shakura N. I., Sunyaev R. A., 1973, A&A, 24, 337

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