Course:

Reading report #3

Name: Xiaozhi Lin **Date:** December 22, 2017

Paper name: Unveiling slim accretion disc in AGN through X-ray and Infrared observations

Paper authors: Nuria Castello-Mor, Shai Kaspi, Hagai Netzer, Pu Du, Chen Hu, Luis C. Ho, Jin-Ming Bai, Wei-Hao Bian, Ye-Fei Yuan, Jian-Min Wang

Paper download link: https://academic.oup.com/mnras/article-abstract/467/1/1209/2931736?redirectedFrom=PDF

Q1. What is this work all about? What is your over-all impression on the quality of this work (poor, aver- age, good, or great)? Explain briefly your assessment. [$>\sim 100$ **words required**]

This work provide a broad band spectral analysis of the AGN with high and low dimensionless accretion rate. They found that accretion rate is not correlated with α_{OX} in the system of low or median accretion rate. But for some high accreting system, the accretion rate is correlated with α_{OX}. Besides, high accreting AGN have lower α_{IO} (infrared loudness) than low accreting AGN. This is not due to difference in their covering factors, but reflects some physics in the center of high accreting sources that help to reduce the extreme-UV emission. The results in this work is acceptable, but there are many uncertainties that can influence the results, for example, the normalization of the SED during fitting, uncertainty in determining slope of the continuum, a parameterized power-law relation between the size of the broad-line region and optical luminosity $L5100\mathring{A}$, and so on. Nevertheless, this work contains a relatively large size of the AGN in the local universe with the newest X-ray and IR data, and a significant fraction of them have relatively accurate measurement of their BH mass and accretion rate through reverberation mapping (RM) method, it is still convincing and worth debate, which can give rise to future work with higher precision for a scientific comparison.

Q2. Why do the authors carry out this work (including, e.g., current research status, issues, scientific motivations)? [$>\sim$ 150 **words required**]

Beyond a critical mass accretion rate $\dot{M}_c$, energy transport by advection dominates over radiative in the inner parts of the system and the disc is thought to become geometrically thick, or slim ("slim accretion disc"). According to the basic Accretion Disc (AD) theory, slim AD systems have much higher UV and X-ray luminosities. However, in observations, the authors see no evidence for extremely luminous ionizing continua, and no unusual torus emission in those sources expected to be powered by slim ADs. Thus, it is hard to believe that the increase in the total disc luminosity expected in those AGN that are powered by slim ADs, is exactly compensated for by a changing geometry of the tours. In this paper, the authors include larger AGN samples and new X-ray and IR data to better understand the role of accretion rate in determining the physics of high Eddington ratio sources and to critically test various suggestions about the differences between thin and slim ADs. In particular, the authors want to compare the role of accretion rate on the 2 keV and 5 μm emission in low and high Eddington ratio sources.

Q3. How do the authors manage to finish this work (including, e.g., using new data, new techniques, new models)? [$>\sim$ 250 **words required**]

The authors conducted an investigation of various spectral properties in AGN samples with high and low accretion rate. More than one third of the BH masses and thus accretion rates of AGN were measured through the Reverberation Mapping (RM) method, which allows the most accurate BH mass estimates, and hence Eddington ratios. The authors implemented a Bayesian approach which enables them to infer the posterior probability density of the correlation coefficient (ρ) used to evaluate the degree of correlation between two spectral properties, α_{OX} and α_{IO} (infrared loudness), and the dimensionless accretion rate of the sources $\dot{M}$. Finally, they compute median AGN SEDs for the two groups of different accretion rates for a visualized comparison.

Q4. What are the main results and conclusions of this work? What are the differences/improvements of this work compared to previous relevant works? [$>\sim 250$ **words required**]

The authors find the optical-to-UV SED of all sources, including those with the highest mass accretion rates ($\dot{M} > 20$), can be fitted with thin AD models. The authors do not find any correlation between the X-ray loudness (α_{OX}) and the dimensionless accretion rate ($\dot{M}$), up to $\dot{M} \sim 10$. However, the highest accreting sources appear to show systematically larger values of α_{OX}. They defined a new IR-to-optical spectral index, α_{IO}, which measures the reprocessing efficiency of the central torus. They found that the distribution of α_{IO} of the highest accreting group appear to be shifted to lower values. They suggest that additional physical processes that act to reduce the extreme UV radiation in fast accreting AGN may be related to photon trapping, strong winds, and perhaps some unknown physics processes. The alternative explanation, which is related to the smaller covering factor for high $\dot{M}$ sources, is considered unlikely by the authors. The authors fail to recover the predicted differences between the SEDs of slim and thin ADs, suggesting that some additional physics occurring in the nuclear regions of high accreting AGN responsible for making SED of slim

AD consistent to thin AD must be at work. This work contains a larger AGN sample of new X-ray and IR data compared with their previous paper. They correct their claim in their previous work that α_{OX} is not correlated with accreting rate. The result in their previous work is probably due to the lack of very large $\dot{M}$ sources and an inaccurate estimation of the mass accretion rate.

Q5. What are the main contributions (i.e., scientific significances) of this work? [$>\sim 100$ **words required**]

This work provides a study of the spectral indexes (α_{OX} and α_{IO}) of the high and low accreting AGN. Their sample volume is larger than their previous work and more than 1/3 of the BH masses and accretion rates are accurately measured through the Reverberation Mapping (RM) method. Their sample contains some sources with very high accretion rate which is distinct with their previous study. Their results suggest that a non-correlation of α_{OX} and accretion rate only exists in small or median accreting AGN, and breaks down in high accreting AGN. The lower α_{IO} in the high accreting AGN suggests some unknown physics process may exist in the nuclear region, which helps to decline the extreme UV radiation of these fast accreting AGN.

Q6. Why can the authors make such contributions (e.g., using new idea, new data, new techniques, new theories)? [$>\sim 100$ **words**

required]

The survey volume of this study is significantly larger than their previous study, and contains the newest X-ray and IR data. In addition, a significant fraction of their sample have their BH mass and accretion rate accurately measured through RM method. For the other AGN, the authors derived their $\dot{M}$ through the $R_{BLR} - L_{5100}$ correlation. The objects of the high accretion rate are the best candidates to host slim ADs. While incomplete, their sample is the largest and best of its kind, in particular in terms of a better definition of the BH mass and normalized accretion rate, and more uniform distribution of sources across the ranges of interest in the $R_{BLR} - L_{5100}$ plane.

Q7. Can you think of some way to improve this work or to verify it? [$>\sim$ 100 **words required**]

The authors apply a dimensionless accretion rate in this work, which is independent of the BH spin. We can measure the EW of the [O III] emission line, which can be associated with the BH spin, to test if there is any variation of the BH spin in these fast and slow accreting AGN. We can also study the dependence of α_{OX} and α_{IO} on the BH spin. AGN activity have been long associated with the physics of galaxies. We can also make a study of the host galaxies of these high and low accreting AGN on their star-formation rate (SFR), color and morphology. AGN with high accretion rate are usually respect to quasar-mode feedback, corresponding to a short quenching time scale. AGN with low accretion rate are usually respect to jet(radio)-mode feedback, corresponding to a longer quenching time scale. After subtracting the emission of the AGN, we may study the SED of their host galaxy by assuming a parameterized star-forming history (SFH) to reproduce the SED of these host galaxies. In this way, we can explore the quenching time scale of these galaxies to test if it is correlated with the derived accretion rate of AGN in this paper.