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Probing AGN central engine and its environment based on their photometry and spectroscopy

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Abstract. In this work, we have summarized (i) common methods to probe the central part of AGN, with a particular emphasis on key parameters such as mass of Super-Massive Black Holes (SMBHs) and Eddington ratios based on reverberation scaling relation and (ii) the caveat involved in method based on pure gas dynamics, such as role of non-gravitational radiation pressure. This is highlighted based on the recent evidence of very high velocity (up to 0.15c) associated absorber close to central region which probably are accelerated due to radiation driven winds.

Keywords : quasars: absorption lines – quasars: emission line – galaxies: active – techniques: spectroscopic

1. Probing AGN central engine using reverberation technique

The radius of influence of SMBH, is about 1-100pc, which for an AGN at a distance of $\simeq$ 10 Mpc will subtend an angle of 0.1"-1" in the sky. Clearly it is not possible to resolve the central part of distant AGN. However, many indirect methods based on AGN spectroscopy and variability property can be used to infer many aspects of AGN central region (e.g, see Chand et al. 2010). For instance, a key parameter such as mass of SMBHs, can be inferred with the reverberation technique. It allows to estimate the radius of broad line region (BLR) clouds based on the time delay of variability in the flux of continuum and the broad emission lines from BLR. These BLR clouds are under the influence of SMBH, and their broad emission lines velocity width can be used to measure the mass of the SMBH (and hence Eddington ratio as well) in conjunction with the radius of BLR determined using the reverberation technique (e.g, see Bentz et al. 2009). An observationally less expensive alternative

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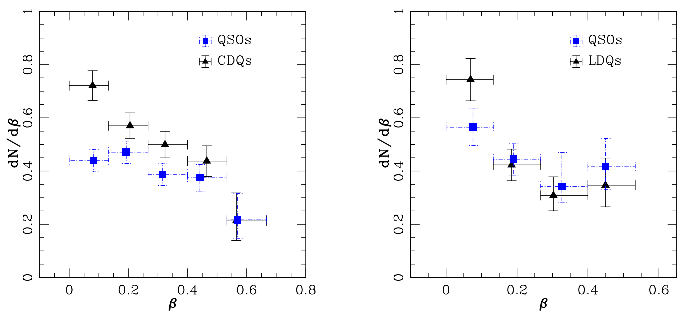

Figure 1. *Left:* The incidence of Mg ii strong absorbers verses offset velocity, $v = \beta c$, measured relative to the quasar rest-frame, for CDQs and QSOs. Here a 3.5σ excess is evident due to associated absorbers up to 0.2c. *Right:* same for lobe dominated QSOs (LDQs) and QSOs.

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is to use narrow band filter to monitor flux variation of emission line and a broad band filter to monitor the continuum flux variation.

2. AGN associated absorber: tool to probe their environment

Broad absorption line (BAL) QSOs are seen in about 10% of radio-quiet QSOs (RQQSOs), blue-shifted to velocity width of as large as 30000 – 50000km/s. Both temporal and spectral properties of these BAL outflows play crucial role in our understanding of the environment close to central engine of AGNs. Recently, in a search for the spectral variability of X-ray bright C iv BALQSOs, we find two BALQSOs, showing variation in C iv column density and spectral shift, with the highest deceleration observed till date in such outflows (e.g see Joshi et al. 2014).

Similarly, a statistical analysis of number density of MgII absorber in the spectral range of 0.4c blue ward of z_{emi}, for about 4000 core dominated quasar (CDQs) have shown that they can have cool gas outflows with velocity as large as 0.15c (e.g see Fig. 1 above and Joshi et al. 2013). Therefore, though resolving the central region of distant AGN may be beyond the capability of current observational facilities, but indirectly the combination of temporal and spectral behavior of AGNs allow us to infer many aspects of their kinematic/dynamic behavior.

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