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The Size of Narrow Line Region and [OIII] Luminosity Analyzed from SDSS DR7 Quasar Catalogue

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Abstract. In this work, we constructed a sample of 4002 quasars from SDSS DR7 quasar catalogue to calculate the electron density and size of narrow line region. We find that the electron densities are $\sim 10^3/\mathrm{cm}^3$, and the sizes are between 27 and 775 pc. We also find that, in the ionization cone, the sizes are tightly correlated with the luminosities of [OIII]λ5007.

Key words. Methods: statistical—galaxies: active—galaxy: fundamental parameters.

1. Introduction

The narrow line region (NLR) in AGNs is very important to study the central region. A great advantage over broad line region is that the NLR is the only AGN component which is spatially resolved optically (Peterson 1997). However, the NLR is also affected by various parameters, e.g., star formation, torus, radio jets and the central region energy. In this work, we investigate the relationship between [OIII]λ5007 luminosities and sizes of NLR, which may be affected by starlight.

2. Sample

Our parent sample is the catalogue of quasar properties analyzed from SDSS DR7 (Shen *et al.* 2010). The catalogue consists of 105,783 quasars with luminosity brighter than $M_i = -22.0$ and with at least one broad emission line with full width at half-maximum (FWHM) larger than 1000 km/s or with interesting/complex absorption features. Shen *et al.* (2010) have measured various properties from the spectrums and have tabulated all these measured quantities. We selected sources which contained narrow emission lines [SII]λλ6716,6731. This gave rise to a sample of 4002 quasars.

3. Result

3.1 *Electron density of NLR*

The electron density of NLR is determined by measuring the intensity ratio of [SII]λλ6716,6731 (Osterbrock 1978). The intensities of [SII]λλ6716,6731 are

directly taken from Shen *et al.* (2010). The distribution of electron densities of NLR is shown in Fig. 1.

3.2 *Size of the NLR*

We calculate the size of the NLR using (Peterson 1997)

$$L(H\beta) = \frac{4\pi\varepsilon n_{\rm e}^2}{3} \times 1.24 \times 10^{-25}\ {\rm r}^3\ {\rm erg/s}, \quad (1)$$

where ε is the filling factor (we adopt $\varepsilon = 0.01$), $n_{\rm e}$ is the electron density and $L(H\beta)$ is the total luminosity of $H\beta$. The distribution of the sizes of the NLR is shown in Fig. 2. The sizes are in the range $r = 27$–775 pc.

3.3 *The relation between [OIII] luminosities and sizes of the NLR*

Recently, the relation between [OIII]5007 luminosities and NLR sizes have been discovered from HST narrow-band images of 7 PG QSOs (Bennert *et al.* 2002).

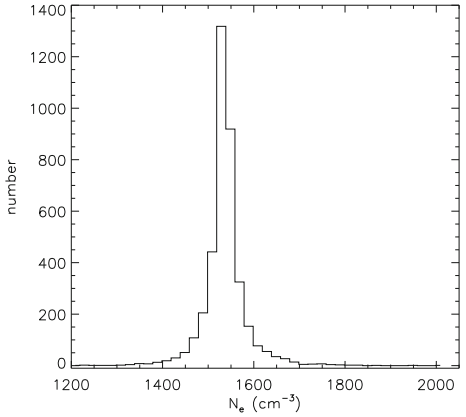

Figure 1. The distribution of electron densities of narrow line region.

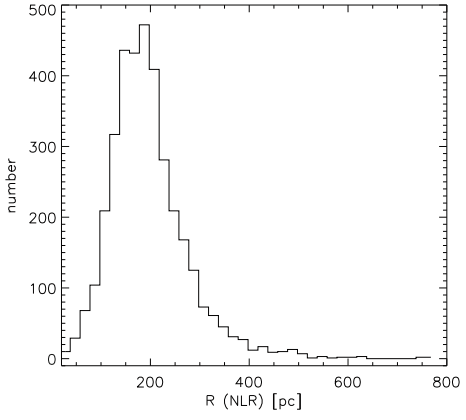

Figure 2. The distribution of sizes of narrow line region.

However, the slope is controversial. Bennert *et al.* (2002) found $R \propto L_{[\mathrm{OIII}]}^{0.52}$, while Schmitt *et al.* (2003) reported a relation of $R \propto L_{[\mathrm{OIII}]}^{0.33}$ for their 60 Seyfert galaxies. The relation obtained from our 4002 quasars is shown in Fig. 3. In this figure, we find that the size of NLR is correlated with [OIII]λ5007 luminosity, where a significant scatter is apparent. The gas in the NLR is thought to be ionized by the luminous central engine, but it may be affected by starlight. Therefore, we investigate the relation inside the ionization cone. The result is presented in Fig. 4. It shows singificantly that the scatter is obviously smaller than that in Fig. 3. A comparison between them is shown in Fig. 5. Using the least squares fitting, we find that, inside the ionization cone, the size of NLR tightly correlates with [OIII]λ5007 luminosity with a correlation coefficient $r = 0.665$ and 0.0 for rejecting the null hypothesis of no correlation. The relationship can be expressed as:

$$\log R_{\mathrm{NLR}} = (-9.62 \pm 0.30) + (2.84 \pm 0.01) \log L_{[\mathrm{OIII}]}. \quad (2)$$

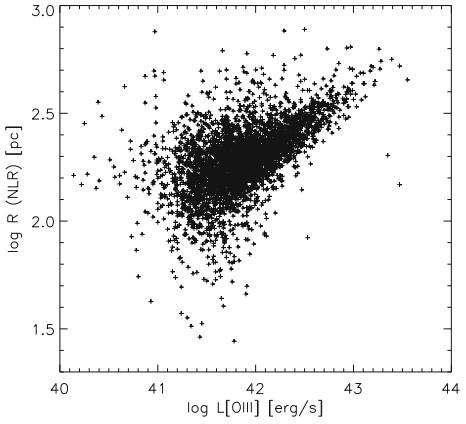

Figure 3. NLR size *versus* [OIII]λ5007 luminosity, where the gas distributes inside and outside the ionization cone.

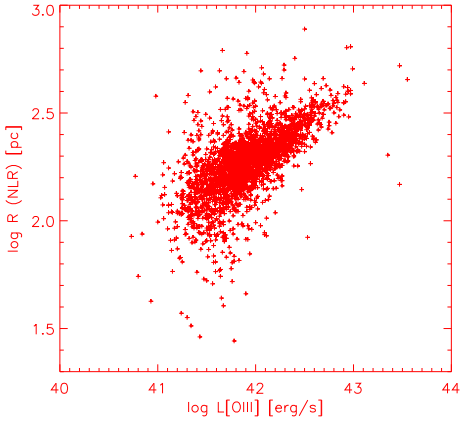

Figure 4. NLR size *versus* [OIII]λ5007 luminosity, where the gas distributes only inside the ionization cone.

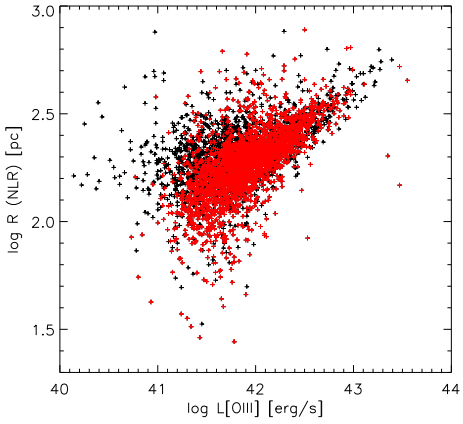

Figure 5. NLR size *versus* [OIII]λ5007 luminosity. The red points are for the sources that the gas distributes inside ionization cone, and the black points are for all sources.

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