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The spectral decomposition of Active Galactic Nuclei with double-peaked Balmer lines from SDSS

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Abstract. For a sample of 52 double-peaked broad-lines AGNs from the Sloan Digital Sky Survey (SDSS), we do the spectral decomposition to obtain the host spectrum and the nuclei spectrum from their SDSS spectra, as well as the bulge luminosity (L_{bulge}), stellar velocity dispersion (σ_*). A strong correlation is found between the σ_* and the gaseous velocity dispersion in narrow line regions. With the $M_{\rm bh} - \sigma_*$ relation, we estimate the black hole masses, range from 1.0×10^7 to 6×10^8 $\mathrm{M}_\odot$, and the Eddington ratio from about 0.01 to about 1. It is consistent with the result from $M_{\rm bh} - L_{\rm bulge}$ relation. However, it is not consistent with the mass from the Hβ FWHM. It seems that the empirical size-luminosity relation for broad line regions dose not hold for double-peaked AGNs, otherwise the calibration factor is as small as 0.185, suggesting the non-virial dynamics of broad line regions.

Keywords. galaxies:bulges — galaxies:active — galaxies: nuclei — black hole physics

1. The model of stellar contribution in double-peaked AGNs

With the Sloan Digital Sky Survey (SDSS), more double-peaked broad Balmer emission profiles have been detected, about 3% of the $z < 0.332$ SDSS AGNs (e.g. Eracleous & Halpern 2003; Strateva *et al.* 2003). It is found that about 50% starlight contribution in optical continuum around Hα. It remains a matter as debate of the origin of the double-peaked profiles.

Here we used the sample of double-peaked AGNs at $z < 0.332$ from SDSS (Strateva *et al.* 2003) to investigate their host properties. Through the stellar population synthesis code, STARLIGHT (version 2.0, Cid Fernandes *et al.* 2001), we modelled the stellar contribution in the SDSS double-peaked spectra. We obtain 52 double-peaked AGNs with reliable σ_* measurements of stellar velocity dispersions considering the resolution of SDSS spectra and the template spectra. For more detail, please refer to Bian *et al.* (2007).

The typical uncertainty of σ_* is based upon the effective S/N at 4020Å. In our sample, the effective mean spectral S/N at 4020Å for these objects are 7.2. The typical uncertainty in σ_* should be around 20 km s^{-1}.

σ_* is measured for 48 objects with SDSS spectra not covering Ca II$\lambda\lambda$ 8498, 8542, 8662 triplet. We also use the synthesis method to the sample of Greene & Ho (2006) in two manners: one is using whole spectrum, the other is just using partial spectrum between 3200Å and 7500Å at the rest frame. And the the values of σ_* in these two manners are similar. We obtain the correction formula and do the correction of σ_* measured from the spectra not including Ca II$\lambda\lambda$ 8498, 8542, 8662 triplet for 48 double-peaked AGNs.

For these 52 double-peaked SDSS AGNs, the host luminosity in V band is calculated from optical monochromatic luminosity and the stellar fraction at 5530Å. We assume that the host luminosity in V band approximates the bulge luminosity $L_{\rm bulge}$ in V-band. We then use the following formula to calculate the bulge mass: $\log(M_{\rm bulge}/\,\mathrm{M}_{\odot}) = 1.18\log(L_{\rm bulge}/\,\mathrm{L}_{\odot}) - 1.11$ (Magorrian *et al.* 1998). For the relation between this bulge mass and the black hole mass from σ_*^c, we fit with fixed slope as 1, intercept is 2.93 ± 0.05, correlation coefficient is 0.53. The null hypothesis is less then 10^{-4}. It is suggested that the black hole mass is about 0.002 of the bulge mass. Therefore, the SMBH mass from $L_{\rm bulge}$ and the Magorrian relation agrees with that from σ_*^c. The image decomposition of double-peaked AGNs will be discussed in the future.

2. The relation between the stellar and gaseous velocity dispersions

The gaseous velocity dispersion ($\sigma_{\rm g}$) is obtained from our fitting of the core [O III]λ5007 line after correction of the SDSS spectral resolution. For the relation between $\sigma_{\rm g}$ and σ_*^c for these 52 double-peaked AGNs, the best linear fit gives: $\sigma_{\rm g} = (-29.9 \pm 28.6) + (1.17 \pm 0.17)\sigma_*^c$, the correlation coefficient is 0.7. We can use the FWHM of the core [O III] line to trace the stellar velocity dispersion. This strong correlation is consistent with those of other type AGNs (e.g. nearby Seyfert galaxies, Type II AGNs), implying that the gaseous kinematics of narrow line regions in double-peaked AGNs are similar to other type AGNs, primarily dominated by the bulge gravitational potential (e.g. Nelson & Whittle 1996).

3. The SMBHs masses and Eddington ratios in double-peaked AGNs

With the relation, $M_{\rm bh}(\sigma_*^c) = 10^{8.13}(\sigma_*^c/200\ \mathrm{km\ s^{-1}})^{4.02}\,\mathrm{M}_{\odot}$ (e.g. Tremaine *et al.* 2002 and reference therein), we calculate the SMBH mass and then the Eddington ratio. We use the monochromatic luminosity at 5100Å to estimate the bolometric luminosity, $L_{\rm bol} = 9 \times \lambda L_{\lambda}(5100\text{Å})$.

For the typical uncertainty of 20 km s^{-1} for $\sigma_* = 200$ km s^{-1}, the error of log σ_* would be about 0.05 dex, corresponding to 0.2 dex for $\log M_{\rm bh}$. The error of $\log M_{\rm bh}$ is about 0.4 considering the error of 0.3 dex form the $M_{\rm bh} - \sigma_*$ relation (Tremaine *et al.* 2002). Richards *et al.* (2006) suggested a bolometric correction factor of 10.3 ± 2.1 at 5100 Å. Therefore, the final Eddington ratio, $L_{\rm bol}/L_{\rm Edd}$, has a large uncertainty, about 0.5 dex.

The black hole masses $\log M_{\rm bh}/\,\mathrm{M}_{\odot}$ are estimated from σ_*^c, ranging from 7 to 8.7, with a mean value of 7.76 ± 0.37. The Eddington ratio is from 0.01 to 1 and the mean value is -1.13. It was suggested that the accretion disk in double-peaked AGNs is in the mode of Advection Dominated Accretion Flow (ADAF) (e.g. Eracleous & Halpern 2003). The higher Eddington ratios clearly show that these double peaked AGNs have accretion disks in the standard regime.

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References

Bian W., Chen Y., Qu Q., & Wang J. 2007, *ApJ*, in press, astro-ph/0706.2473
Cid Fernandes R., Sodre L., Schmitt H. R., & Leao J. R. S. 2001, *MNRAS* 325, 60
Eracleous M. & Halpern J. P. 2003, *ApJ*, 599, 886
Greene J. E. & Ho L. C., 2006, *ApJ*, 641, L21
Magorrian J., *et al.* 1998, *AJ*, 115, 2285
Nelson C. H. & Whittle M., 1996, *ApJ*, 465, 96
Richards G. T., *et al.* 2006, *ApJS*, 166, 470
Strateva I. V., *et al.* 2003, *AJ*, 126, 1720
Tremaine S., *et al.* 2002, *ApJ*, 574, 740