THE SPECTRAL PROPERTIES OF THE LARGE SAMPLE OF AGNs TYPE 2: The search for the σ* surrogate

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Abstract

M_{BH}-σ* relation is the most commonly used method for the M_{BH} (mass of the super-massive black hole) estimation in the AGNs (Active Galactic Nuclei) Type 2. Since σ* (stellar velocity dispersion, measured as width of the stellar absorption lines) is in some cases diluted by the noise in AGN Type 2 spectra, it is of interest to find appropriate surrogate for σ* in some prominent AGN Type 2 spectral characteristics. Here we used the large sample of the AGN Type 2 spectra from SDSS and try to find under what circumstances the width of the [O III]5007 Å emission lines can be used as σ* surrogate. We find that only in the case of objects with no asymmetry in the narrow emission line profiles, the width of the [O III] core can be used appropriately as σ* surrogate, since outflow kinematics do not affect significantly the [O III] profile.

1. Introduction

The commonly used method for M_{BH} estimation is M_{BH} - σ* relation (see e.g. Tremaine et al. 2002), where σ* is the velocity dispersion of the stars located in the bulge of the host galaxy, which are strongly gravitationally bounded to the M_{BH}. σ* is measured using the width of the stellar absorption lines in AGN spectra, and it is not always well measurable in Type 1 AGNs spectra due to strong luminosity of the AGN continuum, while in Type 2, it could be diluted by the noise. Taking into account that M_{BH} - σ* relation is the only method for the estimation of the M_{BH} for the Type 2 AGNs, it would be very useful to find the surrogate for the σ* in some prominent spectral property. There were numerous attempts to find the surrogate for σ* in Type 1 AGNs, using the width of the narrow emission lines (see Salviander & Shields 2013 and references therein). However, setback for larger application of this method is the large scatter between σ* and width of the narrow emission lines of Type 1 AGNs. Nelson & Whittle 1996 noticed that there is lower correlation between σ* and width of [O III] 5007 Å wings, than with width of [O III] 5007 Å core. Recently, several analysis of the complex Narrow Line Region (NLR) kinematical structure are done, using the large samples of the AGNs (see Eun et al. 2017, and references therein). They showed that the narrow emission lines can be decomposed to the two components: one is the core component of the line, which arises from gravitationally bounded gas, and the other is the non-gravitational, wing component of the line, which arises in the gas outflow. It is of the great importance to correctly separate the gravitational from non-gravitational narrow line component, in order to find the good surrogate for the σ*.

In this work we analyse the sample of the AGNs Type 2, in order to find the subsample in which the width of the narrow lines can be used as appropriate surrogate for the σ*.

2. The sample and analysis

For this research, we obtained the sample of the 525 AGNs Type 2, taken from the SDSS, DR14, with high signal-to-noise ratio S/N>20. After reddening and redshift correction, we performed spectral principal component analysis in order to subtract host galaxy contribution (see procedure in Lakićević et al. 2017). We fit [O III] 4959, 5007 Å narrow lines with two component model: one Gaussian for the core, and one for the wing (see Fig 1).

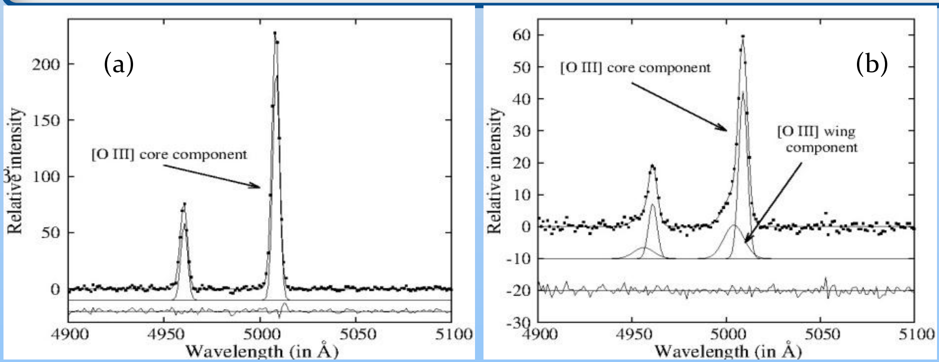

Figure 1: The example of the fit of object with no asymmetry in [O III] line profile (a), and with present asymmetry in [O III] line profile (b).

We found that in 26% of objects from the sample there is no any asymmetry in [O III] line profiles, i.e. [O III] emission lines can be fitted with only one, core Gaussian component (see Fig 1a). In the rest of the sample (~74%), the asymmetry is present in [O III] profiles, so these emission lines are fitted with two Gaussians (core + wing component, see Fig1b). Therefore, the initial sample of the 525 AGNs Type 2 is divided into two subsamples according to the strength of the outflow which is reflected in the strength (width and shift) of the wing components of the narrow emission lines. The first subsample consists of the 135 Type 2 AGN spectra, in which there are no wing components in narrow emission lines, and the other subsample consists of 391 AGN spectra, in which the wing (outflow) components are present in [O III] lines.

3. The preliminary results and conclusions

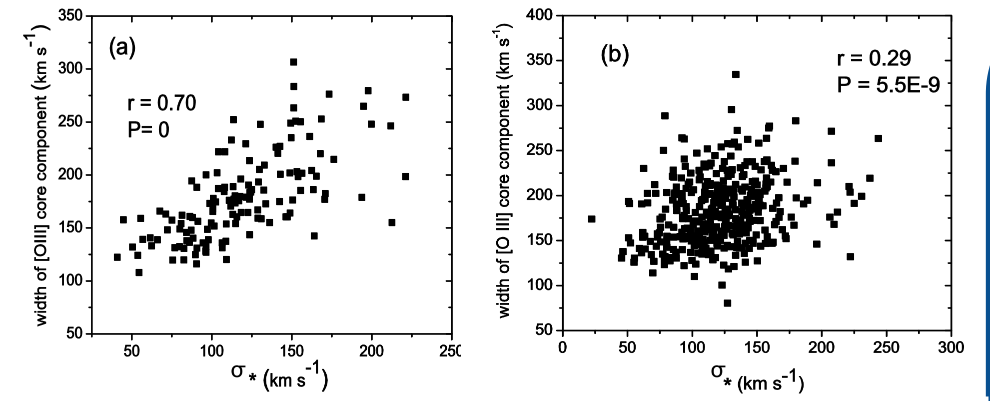

Figure 2: The correlation between σ* and width of [O III] line core component for the subsample with no asymmetry in [O III] line profile (a), and for subsample with present asymmetry in [O III] line profile (b).

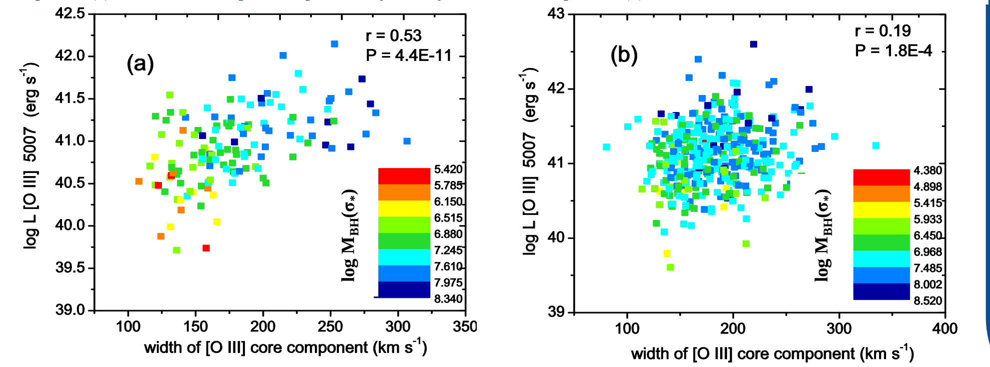

Figure 3: The correlation between L[O III] and width of [O III] line core component for the subsample with no asymmetry in [OIII] line profile (a), and for subsample with present asymmetry in [O III] line profile (b).

The recent investigations of the NLR kinematics (see Eun et al. 2017) suggest that, in order to avoid the outflow influence to the line width, wing component should be subtracted from the [O III] profile, and only the core component should be used as surrogate for the σ*. Here we investigate if there is some influence of the outflow kinematics, not only in the wings, but also in the core components as well. We compared the widths of the [O III] core components with the σ*, for both subsamles. We found that correlation between the widths of [O III] core components and σ* is significantly stronger for subsample with absent wing components (r = 0.70, P = 0), than for the subsample with strong wing components (r = 0.29, P = 1.7E-6). The correlations are shown in Fig 2 a, b.

Also, we compared the [O III] luminosity with the width of the [O III] core component for the both subsamples, and we coloured the symbols with diverse colours for different M_{BH}(σ*) bin intervals. In the subsample with absent wing components, correlation between these two parameters is stronger (r = 0.53, P = 4.4E-11), and it could be seen that L [O III] and width of [O III] core component are both indicators of the M_{BH}(σ*) (see Fig 3a). For subsample with present wing components, there is only weak trend between these two parameters, and they are not correlated with M_{BH}(σ*) (see M_{BH}(σ*) coloured bins in Fig 3b). As it can be seen from these correlations, the width of the [OIII] core component is better surrogate for σ* in the subsample with absent outflows, and consequently better M_{BH} indicator.

This implies that in the case when outflow kinematics is strong in spectra (strong wing components in narrow emission lines), there is probably some influence of the outflow to the narrow core component as well. Our results point out that M_{BH} estimation using the width of the [O III] core as surrogate for the σ* can be applied for the AGNs Type 2 with absent wing components (with no asymmetry in emission line profiles), in order to get accurate M_{BH} estimation. In the case of the AGNs Type 2 with significant emission line asymmetry, this method should be taken with the caution because of the large scatter caused by the outflow influence.

References:
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