THE SIGNATURE OF THE GAS OUTFLOW IN THE ACTIVE GALACTIC NUCLEI TYPE 2 SPECTRA

Kovačević-Dojčinović J., Lakićević M. and Popović L. Č.

Astronomical Observatory, Volgina 7, 11160 Belgrade, Serbia

Abstract

We analyse a large sample of the Active Galactic Nuclei (AGNs) Type 2 spectra which have a specific spectral characteristic that beside expected narrow emission lines, only one broad emission line, Hα, is observed, which is not expected for the Type 2 AGNs. We focus on the fraction of these objects for which some authors (Eun at al. 2017) proposed that observed 'broad Hα' is actually the sum of the wing components of the close narrow emission lines Hα and [N II] doublet, which is misinterpreted as the 'broad Hα'. They propose that wing components of the Hα+NII arise in a gas outflow. In order to check these claims, we search for the outflow signature in the other strong, narrow emission lines in the spectra (Hβ, [O III] and [S II]). We found the significant correlations between the widths and shifts of wing components of all considered emission lines (Hα+[N II], Hβ, [O III] and [S II]) which implies their same origin from the Narrow Line Region outflow, and supports the claims of Eun at al. 2017.

1. Introduction

The most simple scheme of the Active Galactic Nuclei (AGN) structure assumes that in the center of an AGN there is a super-massive black hole surrounded by the high velocity gas of the Broad Line Region (BLR), where broad emission lines arise (with Full Width at Half Maximum - FWHM ~ 4000 km s−1). Around BLR there is a torus of the dust, and out of the dusty torus, there is the Narrow Line Region (NLR), where the narrow emission lines arise (FWHM ~ 400 km s−1). According to the Standard Unified model (Antonucci 1993, Urry & Padovani 1995), the difference in spectral properties between the AGN Type 1 and Type 2, is caused only by the orientation effect (see Fig 1). The AGNs Type 2 are observed through dusty torus (edge-on), which covers the broad emission lines from BLR, so only the narrow emission lines can be observed in their spectra. On the other hand, in the spectra of the AGNs Type 1, which are observed with higher inclination angle (~ 45 degrees), both the narrow and the broad emission lines can be observed. However, some exceptions are found in some spectra of the AGNs type 2, which challenge the classical Unified Model of the AGNs. In these objects, beside the expected narrow emission lines, the broad emission Hα line is observed. Some authors proposed that these objects are Hidden Type 1 AGNs (Greene & Ho 2005, Oh et al. 2015), while Eun et al. 2017 showed that in one fraction of these objects the broad Hα can be explained as the sum of the wing components of the narrow Hα and nearby [N II]λλ 6548, 6583 A doublet. They supposed that these wing components arise in the gas kinematically connected with an AGN outflow (Woo et al. 2016).

In this work, we focus to this fraction of the AGNs Type 2 in which the broad Hα is observed in order to check is it really 'quasi-broad Hα', i.e. the sum of the wing components of the narrow lines, which arise in the gas outflows.

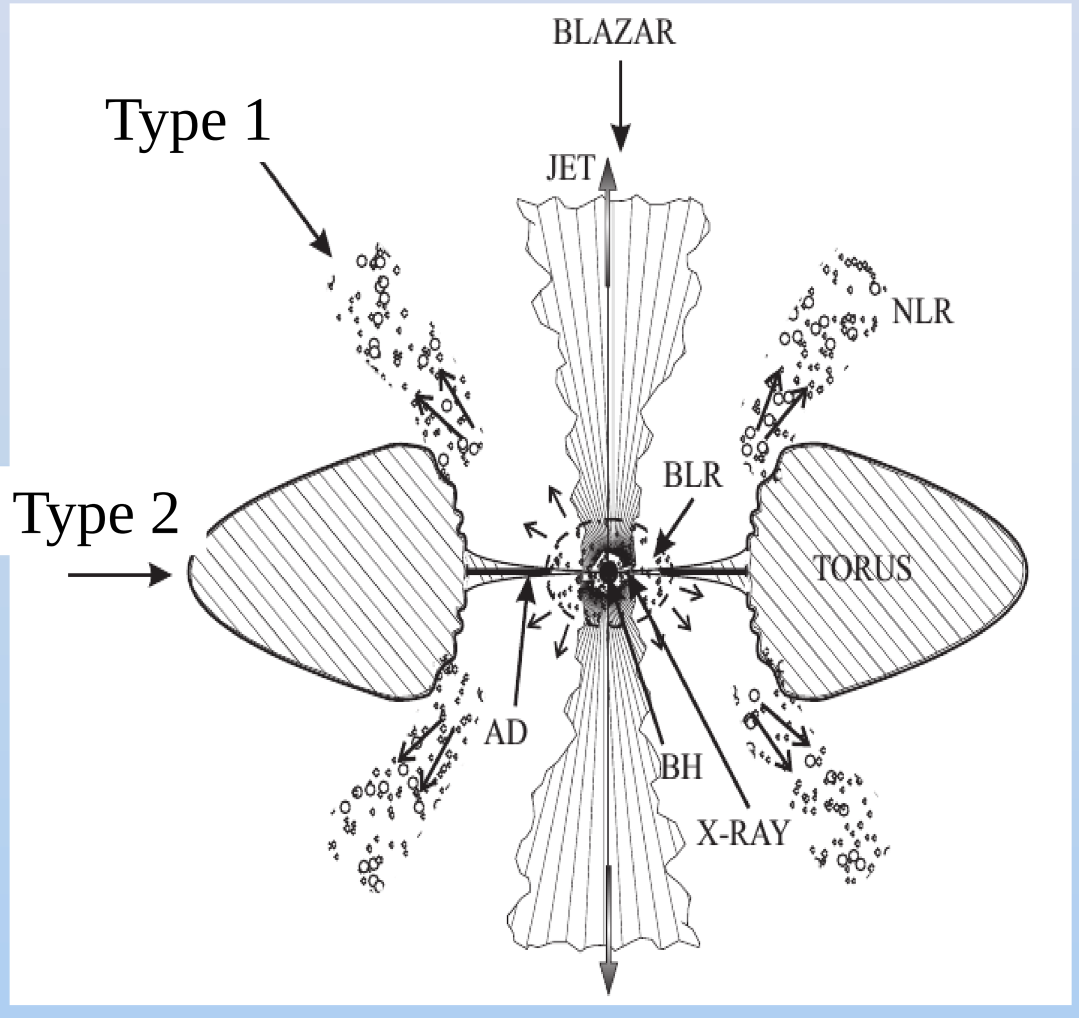

Figure 1. Unified Model of AGN (Jovanović & Popović, 2009)

2. The sample and analysis

We searched the Sloan Digital Sky Survey database (SDSS) DR 14, and found the 314 high quality (signal-to-noise > 20) AGN Type 2 spectra which have 'broad Hα'. Since narrow lines in these spectra have complex shapes and can not be fitted with only one Gaussian, we adopted the fitting model of two Gaussians (narrow core and slightly broader wing component). In this way, we fit successfully 258 spectra, in which 'broad Hα' is fitted well with sum of the Hα and [N II] wing components.

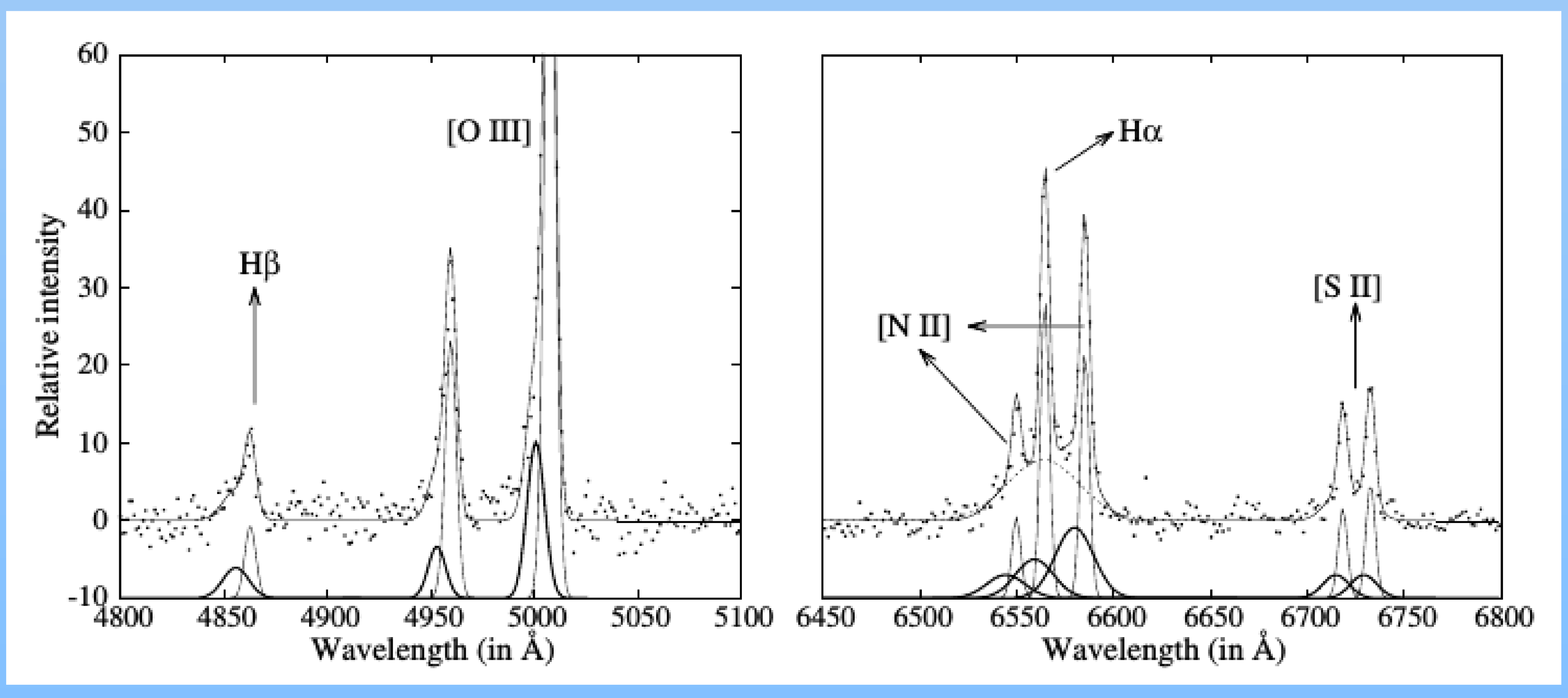

Figure 2. The example of fit of object SDSSJ112135.17+042647.1. Solid tin Gaussian – core component of narrow lines, solid thick Gaussian - wing component, dashed Gaussian - 'quasi-broad Hα' (FWHM = 2840 km−1)

The rest of the objects, with very broad Hα line, which can not be fitted with sum of the three wing components are excluded from the sample. In order to check is the broad Hα in these spectra fraction the true broad line or just the sum of the gas outflow wing components, we analysed several prominent narrow emission lines (Hβ, [O III] λλ 4959, 5007 A, Hα, [N II]λλ 6548, 6583 A and [S II]λλ6717, 6731 A). The example of the fit is shown in Fig. 2. In the case that 'broad Hα' is indeed the sum of the wing components which arise in an outflow, we expect the same signature of the gas outflow in the other emission lines as well. Therefore, we search for the correlations between the kinematical parameters (widths and shifts) of the Hα wing component and wing components of the other analysed emission lines.

3. The preliminary results and conclusions

We found the strong correlations between velocity shift of the Hα wing component and velocity shifts of the wing components of all other considered emission lines (Hβ, [OIII], [S II]), as well as between their widths. The coefficients of correlations are given in the Table 1. These results show clear kinematical connection between the wing components of the Hα and wing components of the other narrow, emission lines, [OIII], Hβ and [S II]. Since forbidden narrow [O III] and [S II] lines originate from the NLR (they cannot arise in BLR because of the high density in that region), this kinematical connection implies that observed 'broad Hα' in this AGN Type 2 fraction is not emission which originate from the BLR, but indeed the sum of the Hα+[N II] wing components, which arise in the NLR and which are affected with the gas outflow kinematics. Furthermore, we examined in more details the influence of the gas outflow kinematics to the Hα profile, by comparing it with the [O III]. We compared the distributions of shifts and widths of Hα wing components with the same of [O III] wing components (see Figure 3). We found that these distributions are similar. [O III] wing components have larger blueshifts comparing to the Hα wing components, and their widths are broader. These results imply that influence of the gas outflow to the Hα shape is slightly smaller than to the shape of the [O III] lines.

(A)	shift Hβ wc	shift [O III] wc	shift [S II] wc
shift Hα wc	r = 0.53, P = 4.1E-5	r = 0.46, P = 1.1E-14	r = 0.77, P = 0
(B)	**width Hβ wc**	**width [O III] wc**	**width [S II] wc**
width Hα wc	r = 0.31, P = 0.02	r = 0.28, P = 8.0E-6	r = 0.66, P = 0

Table 1: Correlations between the shifts of the wing components (wc) of the emission lines (A); The same, just for the widths (B).

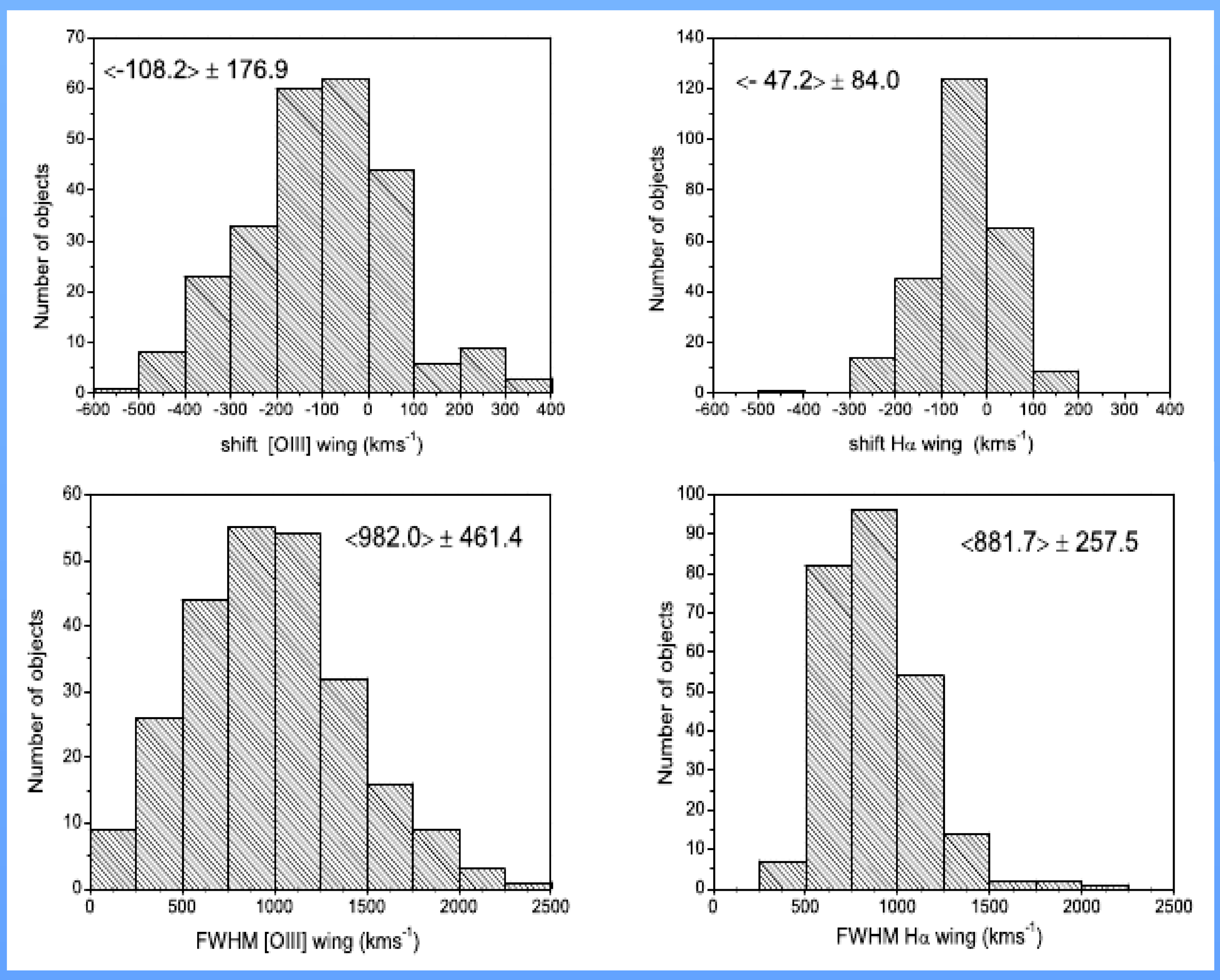

Figure 3: Distributions of the shifts and widths of the [O III] and Hα wing components. Mean values ± sigma of distribution are given in brackets.

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