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CONTRIBUTION OF STARBURST REGIONS IN AGN SPECTRA

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Abstract. We discuss the contribution of the starburst regions in AGN (Active Galactic Nuclei) spectra. We select a sample of 302 AGN spectra and we divide it into two subsamples concerning the narrow line [O III]/Hβ NLR ratio, since we expect more starburst (H II) region contribution for R = log([O III]/Hβ NLR) < 0.5. We find significant differences in correlations between spectral properties of objects with R < 0.5 and R > 0.5. The most interesting is the correlation between the continuum luminosity and FWHM Hβ for R< 0.5 subsample (starburst dominant) that indicates connection between the Broad Line Region (BLR) kinematics and continuum source.

1. INTRODUCTION

Properties of Active Galactic Nuclei (AGNs) spectra depend on physical conditions and geometry of emission regions which are changing during AGN evolution. The evolution of AGN is probably related with starburst regions (Lípari and Terlevich 2006, Sani et al. 2010). Namely, it is possible that AGNs in an earlier phase of their evolution are composite objects, which consist of starbursts (starforming regions) and central engine (AGN). Than, during evolution, starburst contribution become weaker or negligible (Wang and Wei 2006).

To understand the complex nature of AGN, many authors investigated the correlations between different spectral properties, trying to find and explain their physical background (see e.g. Boroson and Green 1992, Grupe 2004, Wang et al. 2006, Kovačević et al. 2010). Boroson and Green 1992 (BG92) applied Principal Component Analysis for a number of AGN spectral properties and they found that as x-slope and EW Fe II increases, the EW [O III] decreases, as well as FWHM Hβ. These correlations are related to Eigenvector 1 (EV1) in BG92 analysis, and their underlying physics is still not completely understood. Also, very interesting correlations are between equivalent width (EW) of emission lines and continuum luminosity. Namely, EW of majority of emission lines decreases as continuum luminosity increases (so called Baldwin effect, Baldwin 1977). The origin of Baldwin effect is still open question.

In this paper, we investigate the influence of starburst regions on these correlations, by analysis of the differences in correlations for subsamples with stronger and weaker starburst contribution in AGN spectra.

2. THE SAMPLE

The sample of 302 AGNs used in this paper is the same as one in Kovačević et al. 2010, where detailed description of the sample selection is given, and here will not be repeated. The sample has been chosen from the Sloan Digital Sky Survey (SDSS), Release 7. The sample contains the broad line AGNs within approximately uniform redshift range z = 0 - 0.7. As it was already described in Kovačević et al. 2010, we fitted the Fe II lines with a new template which enables precise estimation of the Fe II emission within the 4400-5500 Å wavelength range. The Hβ was fitted with three components: the Narrow, Intermediate and Very Broad component (Hβ NLR, ILR and VBLR, respectively). The example of the fit decomposition is shown in Fig. 1.

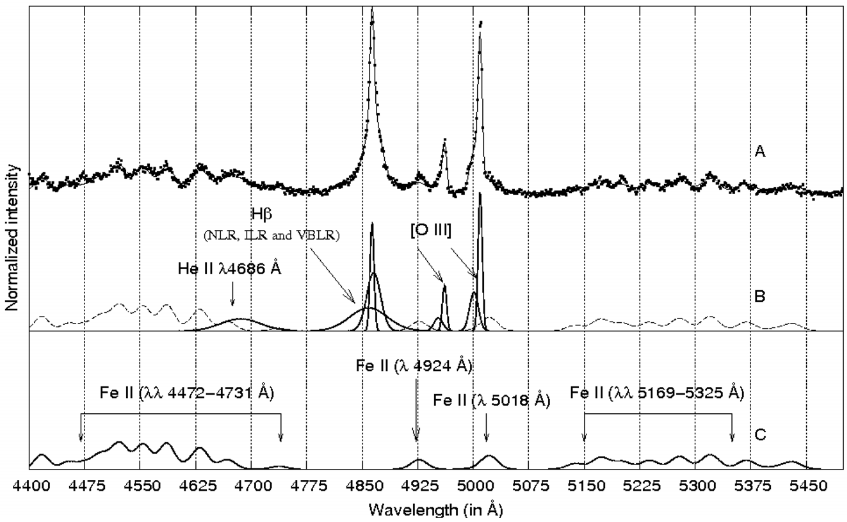

Figure 1: The example of fit in λλ 4400-5500 Å range.

Here we use the Narrow Hβ component (Hβ NLR) and the Hβ broad as a sum of the Hβ ILR and Hβ VBLR components. FWHM Hβ (as well as Full Width Zero Intensity, FWZI) is measured for the Hβ broad component.

Since we have complete measurements of line parameters only for the narrow Hβ and [O III]λλ 4959, 5007 Å lines in the whole sample (302 AGNs), we accepted a criteria of R = log([O III]5007/Hβ NLR) = 0.5 as an indicator of predominant starburst emission contribution to the narrow emission lines. So, we divided our sample into two subsamples: R < 0.5 (91 AGNs, hereafter starburst dominant) and R > 0.5 (210 AGNs, hereafter AGN dominant).

3. RESULTS

We performed some of the correlations using the Spearman rank method between the spectral properties for total sample of 302 AGN spectra, and also for subsamples with R < 0.5 and R > 0.5. One of the most interesting correlations is FWHM (FWZI) of the broad Hβ vs. continuum luminosity (L_{5100}). In Fig. 2 we plot log(L_{5100}) vs. log (FWHM Hβ) and log (FWZI Hβ). We found a strong correlation between the L_{5100} and FWHM Hβ for starburst dominant subsample (R < 0.5), with Spearman coefficient of correlation r_s = 0.81, P < 1E-16. In the subsample with dominant AGN (R > 0.5), the coefficient of correlation is much lower (r_s = 0.26, P = 1.1E-4) and not so significant. The correlation between the continuum luminosity and FWZI Hβ is present in R < 0.5 subsample (r_s = 0.70, P = 1.6E-14), but not in R > 0.5 subsample (r_s = 0.15, P = 0.03).

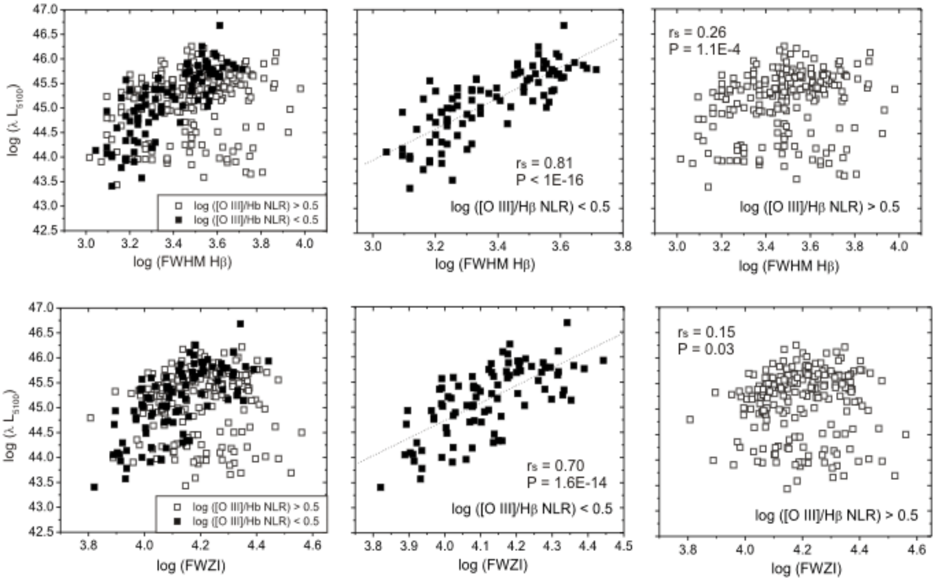

Figure 2: Correlations between continuum luminosity and FWHM (FWZI) Hβ for all AGNs (left), AGNs with R < 0.5 (middle) and R > 0.5 (right).

Some other correlations are also sample dependent, i.e. there is significant difference in coefficients of correlation for AGN dominant and starburst dominant subsamples. Baldwin effect (BEF) for [O III] and Hβ NLR is stronger in AGN dominant (r_s = -0.51, P = 3.6E-15 and r_s = -0.56, P < 1E-16, respectively), than for the starburst dominant subsample (r_s = -0.46, P = 4.2E-6 and r_s = -0.27, P = 0.01). Also, Fe II lines show significant inverse BEF in AGN dominant (r_s = 0.29, P = 2.4E-5), while in other subsample (r_s = 0.26, P = 0.01) there is no correlation. Interesting is that the broad component of Hβ shows no Baldwin effect for R > 0.5 subsample but, significant inverse BEF is present in the R < 0.5 subsample (r_s = 0.56, P = 8.7E-9). EW [O III] vs. EW Fe II anti-correlation, which is dominant in BG92 EV1, is stronger in AGN dominant subsample (r_s = -0.38, P = 8E-9 comparing to r_s = -0.27, P = 0.01).

4. DISCUSSION AND CONCLUSION

There is a significant difference in correlations between line properties of two subsamples indicating that there is a difference in the physics of emitting gas and the origin of the broad line components.

We found that in the case where starburst (H II) region emission is dominant in the narrow lines (R < 0.5 subsample), there is a high and significant correlation between the FWHM Hβ broad component and continuum luminosity. It is interesting that the correlation between continuum luminosity and FWZI Hβ is less significant than previous one. It may indicate that in this case the broad component is not primarily caused by geometry (i.e. by rotation due to the gravitational force), but rather by random motion of the gas caused by different effects (as randomly accelerated in several bursts). Namely, part of the flux of the broad Balmer emission lines may arise in the stellar envelopes of Wolf-Rayet and OB stars, associated with multiple Super Nova events (Izotov et al. 2007). Note that only in starburst dominant subsample EW Hβ broad increases as L_{5100} increases, which is not found in other subsample. This indicated that the widths of R < 0.5 subsample seem not to be connected only with predominant rotational motion, but rather by randomly distributed high velocity gas. This should be taken into account when the broad lines are used for black hole mass determination.

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