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CORRELATIONS BETWEEN SPECTRAL PROPERTIES IN AGN TYPE 1: INFLUENCE OF STARBURSTS

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Abstract. The possible influence of starbursts to AGN (Active Galactic Nucleus) spectra is investigated in the case of a sample of AGNs Type 1. We divided the AGN sample into two subsamples according to dominant source of ionization. It is assumed that objects with R=log([O III]/Hβ NLR) $<$ 0.5 have a predominant starburst contribution in narrow emission lines, and objects with R=log([O III]/Hβ NLR) $>$ 0.5 are pure AGNs. We performed correlations between different spectral properties within these two subsamples and found some significant differences: the correlations between FWHM broad Hβ vs. FWHM [O III], and FWHM broad Hβ vs. L_{5100}, as well as EW Hβ broad vs. L_{5100}, are seen only for the starburst subsample. The possible influence of starbursts on the emission of the broad lines in AGN spectra is discussed.

1. INTRODUCTION

In some cases, the kinematical or physical characteristics of AGNs may be reflected in the correlations between different AGN spectral properties. Many authors investigated these correlations, trying to find and explain their physical background (see Popović and Kovačević 2011 and references therein).

On the other hand, there are some indications that evolution of AGNs is probably related with starburst regions (see Lípari and Terlevich 2006; Mao et al. 2009; Sani et al. 2010). Namely, it is possible that AGNs in an earlier phase of their evolution are composed of starburst (star-forming) regions and the cental engine, that is AGN, and, during evolution, the starburst contribution becomes weaker and/or negligible (Wang and Wei 2006, 2008; Mao et al. 2009).

In this paper we analyse how the presence/absence of the starburst contribution to the AGN spectra influences to the correlations between different spectral properties.

2. THE SAMPLE AND ANALYSIS

For this investigation we use the sample of 302 AGNs Type 1, selected with criteria described in paper Kovačević et al. (2010).

The sample has approximately an uniform redshift distribution in the range of z=0–0.7 and negligible host galaxy contribution.

As it is described in Kovačević et al. (2010), the emission lines within the 4400 – 5500 Å range are fitted with multiple Gaussians, where each Gaussian represent contribution from different emission region. For spectra with z<0.4, we also fitted the Hα and forbidden [N II] lines. The Balmer lines are fitted with three components: a narrow, an intermediate and a very broad component (Hβ NLR, ILR and VBLR, respectively). We assume that all narrow lines originate from the same emission region, and consequently they have the same width and shift. The Hβ broad component is taken as the sum of the Hβ ILR and Hβ VBLR components, and FWHM (Full Width Half Maximum) of Hβ line is measured only for the Hβ broad line. The iron lines within 4400 – 5500 Å range are fitted with template given in Kovačević et al. (2010).

In order to estimate in which objects there is a significant contribution of starbursts, we plot "BPT diagram" (Baldwin, Phillips and Terlevich 1981), which use the ratio of the narrow lines for diagnostic of starburst contribution. Since we have line measurements of the Hα and [N II] lines only for objects with z<0.4, the BPT diagram is performed for the 137 objects from our sample, as shown in Fig 1. As it can be seen from Fig. 1, a number of AGNs from the sample show a significant starburst contribution in narrow lines. It is interesting that these AGNs are mostly with the FWHM Hβ broad < 3000 km s^{-1} (open circles), while in the AGN part of the BPT diagram, both fractions (with FWHM Hβ broad < 3000 km s^{-1} and FWHM Hβ broad > 3000 km s^{-1}), are present. the objects with the FWHM Hβ broad $>$ 3000 km s^{-1} are denoted with full circles.

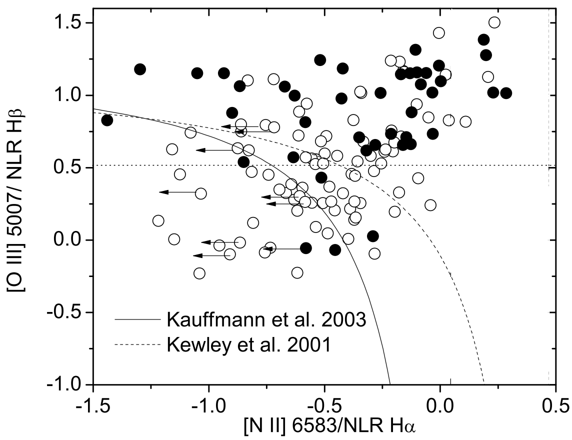

Figure 1: The BPT diagram for 137 objects from the sample. Open circles: objects with FWHM Hβ broad < 3000 km s^{-1}, full circles: with FWHM Hβ broad > 3000 km s^{-1}. Dashed line: R=log([O III]/Hβ NLR) = 0.5 (Popović and Kovačević, 2011).

The possible contribution of starbursts in AGN Type 1 spectra has been also reported (using the BPT diagnostic) in some other investigations: Popović et al. (2009) found that in the case of NLSy1 galaxy Mrk 493, the narrow-line ratios correspond to starbursts rather than to an AGN origin. Similar result is found in paper of Mao et al. 2009 for the three AGN Type 1, which are mainly excited from starburst in narrow lines, since they belong to the H II part of BPT diagram.

Since we have complete measurements of line parameters only for the narrow Hβ and [O III] lines in the whole sample (302 AGNs), we accepted a criteria of R=log([O III]/Hβ NLR) = 0.5 (horizontal dashed line in Fig. 1) as an indicator of the predominant starburst emission contribution to the narrow emission lines. We divided our sample into two subsamples: R $<$ 0.5 (91 AGNs, hereafter starburst dominant) and R $>$ 0.5 (210 AGNs, hereafter AGN dominant). Then, we perform correlations between measured spectral properties for two subsamples, in order to check if there are some significant differences in correlation coefficients, which may be signature of different physical properties of emission regions.

3. RESULTS

Since our division of sample according to the dominant source of ionization (in narrow lines) into the AGN dominant and starburst dominant subsamples is very approximate (we use only the ratio of R=log([O III]/Hβ NLR), we need some additional tests, in order to check its accuracy. We perform correlation between FWHM [O III] and continuum luminosity (at 5100 Å) for which one may expect to be significant for the subsample with starburst contribution (Brungardt 1988). Indeed, as it can be seen in Fig 2., there is a significant correlation between these parameters for the starburst dominant subsample, but no correlation is seen for the AGN dominant one.

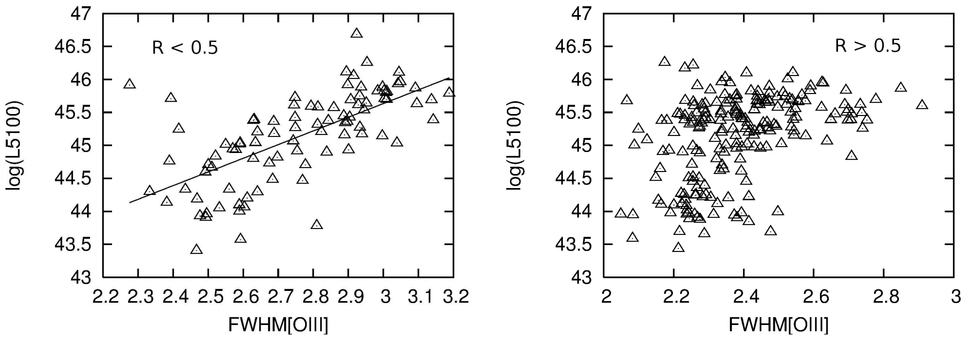

Figure 2: The correlation between FWHM [O III] and continuum luminosity (at 5100 Å) is significant for starburst dominant (R $<$ 0.5) subsample, while for AGN dominant (R $>$ 0.5), no correlation is seen (Popović and Kovačević, 2011).

We performed correlations between spectral properties (continuum luminosity, broad and narrow line widths, equivalent widths of lines) for two subsamples and found significant differences in some correlations. We found that the width of the broad Hβ is in a significant correlation with the FWHM of narrow [O III] lines and with the continuum luminosity (L_{5100}) for the starburst dominant subsample, while there are no any correlations between these parameters for the AGN dominant subsample. Correlations are shown in Fig 3 and 4. Also, we found correlation between the EW (equivalent width) of Hβ broad and L_{5100} for the starburst dominant subsample (r=0.56, P=9E-9), while there is no correlation for the AGN dominant subsample (r=- 0.03, P=0.67). This correlation is very interesting since anticorrelations between EWs of the emission lines and continuum luminosity are commonly called the Baldwin effect (see Baldwin 1977), and their physical cause is still unclear, because they can not be explained by simple photoionization model. Additionaly, in this case there is opposite trend, e.i. EW of the broad Hβ increases, as continuum luminosity increases (Inverse Baldwin effect).

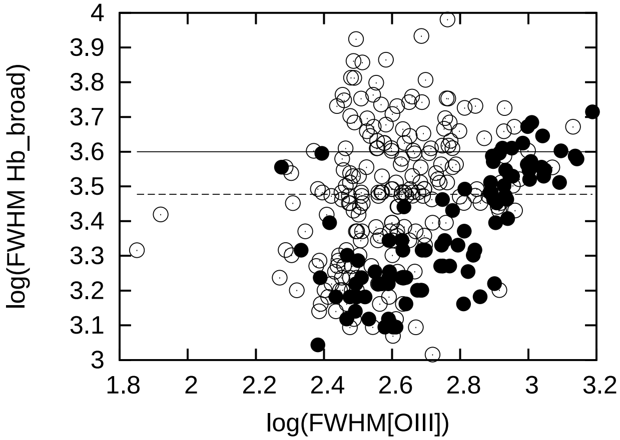

Figure 3: FWHMs of the broad Hβ vs. the narrow [O III] lines (which corresponds to the narrow Hβ). Filled circles denote the sample with R < 0.5, and open circles, sample with R > 0.5. The solid line denotes a border of FWHM Hβ = 4000 km/s, while the dashed line denotes FWHM Hβ = 3000 km/s (Popović and Kovačević, 2011).

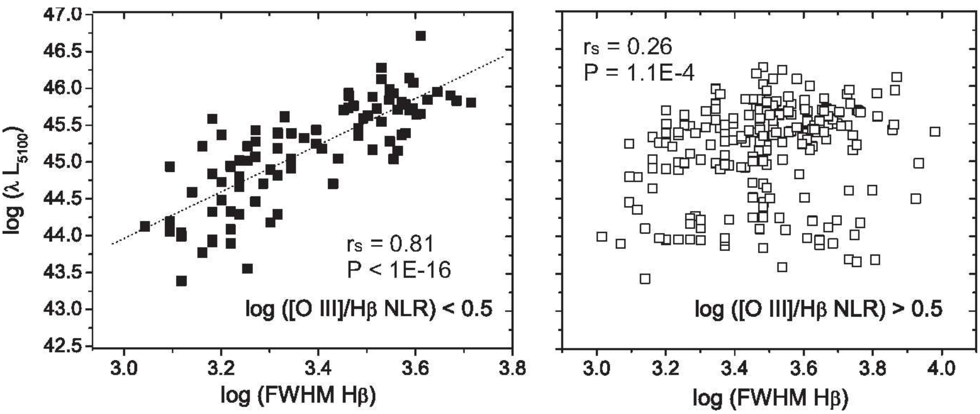

Figure 4: Correlations between continuum luminosity and FWHM Hβ for starburst dominant (left) and AGN dominant subasmple (right).

Since we found significant correlations of some spectral parameters and the broad component (ILR+VBLR) of Hβ only for starburst dominant subsample, one may ask interesting question: is it possible that starbursts may have contribution, not only in emission of narrow lines, but also partly in the emission of the broad lines in AGN spectra? In that case, 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 SN events (see Izotov et al. 2007, and references therein) and emission gas could be randomly accelerated in several bursts.

References

Baldwin, J. A.: 1977, *Astrophysical Journal*, **214**, 679.
Baldwin, J. A., Phillips, M. M., Terlevich, R.: 1981, *Astronomical Society of the Pacific, Publications*, **93**, 5.
Brungardt, C. L.: 1988, *Astrophysical Journal Letters*, **327**, 51.
Izotov, Y. I., Thuan, T. X., Guseva, N.G.: 2007, *Astrophysical Journal*, **671**, 1297.
Kovačević, J., Popović, L. Č., Dimitrijević, M. S.: 2010, *Astrophysical Journal Supplement*, **189**, 15.
Lípari, S. L., Terlevich, R. J.: 2006, *Monthly Notices of the Royal Astronomical Society*, **368**, 1001.
Mao, Y-F. Wang, J., Wei, J.-Y.: 2009, *Astronomy and Astrophysics*, **9**, 529.
Popović, L. Č., Smirnova, A., Kovačević, J., Moiseev, A., Afanasiev, V.: 2009, *Astronomical Journal*, **137**, 3548.
Popović, L. Č., Kovačević, J.: 2011, *Astrophysical Journal*, **738**, 68.
Sani, E., Lutz, D., Risaliti, G., Netzer, H., Gallo, L. C., Trakhtenbrot, B., Sturm, E., Boller, T.: 2010, *Monthly Notices of the Royal Astronomical Society*, **403**, 1246.
Wang, J., Wei, J.: 2006, *Astrophysical Journal*, **648**, 158.
Wang, J., Wei, J.: 2008, *Astrophysical Journal*, **679**, 86.