AIP Conference Proceedings

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Citation: AIP Conference Proceedings **938**, 104 (2007); doi: 10.1063/1.2800112
View online: http://dx.doi.org/10.1063/1.2800112
View Table of Contents: http://scitation.aip.org/content/aip/proceeding/aipcp/938?ver=pdfcov
Published by the AIP Publishing

Asymmetry of the C IV λ 1549 Å and [O III] λλ 4959, 5007 Å Lines in a Sample of RQ and RL AGN

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Abstract. Here we investigate the asymmetry of the C IV λ 1549 Å line in a sample of Radio Quiet (RQ) and Radio Loud (RL) Active Galactic Nuclei (AGN), in order to find signature of an outflow in C IV λ 1549 Å emission region. We apply two-component Gaussian analysis to fit the lines. We consider the parameters of the components (emission and absorption), separately in Radio Loud and Radio Quiet AGN, and we compared those parameters with parameters of the fits of [O III] λλ 4959, 5007 Å lines, trying to see if there is any kinematical correlation between the emission regions (HIL BLR and NLR) where C IV λ 1549 Å and [O III] λλ 4959, 5007 Å lines are formed.

Keywords: Active Galactic Nuclei, Broad Line Region, Narrow Line Region, kinematical properties, line asymmetry
PACS: 98.54.Aj; 98.54.Cm; 98.58.Fd

INTRODUCTION

The broad C IV λ 1549 Å line is one of the strongest high-ionization UV lines and it arise in the Broad Line Region (BLR) of Active Galactic Nuclei. It is a doublet with components C IV λλ 1548, 1551 Å and equivalent velocity separation of 500 km/s. The peak of the line is broader than the intrinsic width of each of line doublet components [1]. Often, C IV λ 1549 Å shows a blueshifted profile, possibly indicating an outflow from an accretion disk [2].

On the other hand, the forbidden [O III] λλ 4959, 5007 Å emission lines are very prominent and typical for AGN spectra. They originate from the ionized Narrow Line Region (NLR) gas and they are often used for the NLR plasma diagnostics [3]. They usually show a complex structure which implies that multiple clouds in the NLR contribute to the emission. The medium that the observed [O III] emission comes from is composed of the same mixture of individual clouds [3], so the shapes of the emission lines are affected by the NLR kinematics [4]. The blue asymmetry in line shapes could be explained by an outflow in NLR caused by the interaction with radio jet [5]. The most of the [O III] lines in AGN spectra have a blue asymmetry but several examples of red asymmetry are found [6], which is not in a good agreement with outflow models. The line intensity ratio of 5007 and 4959 is 2.98 [7, 8].

CP938, *Spectral Line Shapes in Astrophysics—VI Serbian Conference (VI SCSLSA)*
edited by L. Č. Popović and M. S. Dimitrijević

There are some indications that inclination also affects the shape of profiles (asymmetries) and blueshifts of the CIV λ 1549 Å and [O III] λλ 4959, 5007 Å lines [9, 10], which makes kinematics analysis more complicate. Also, comparing RL and RQ line profiles and blueshifts, one can conclude that RQ and RL objects have different geometrical and kinematics properties.

Zamanov et al. [4] identify seven RQ objects showing large C IV λ 1549 Å and [O III] λλ 4959, 5007 Å blueshifts relative to the H_β, which could indicate kinematic linkage between Broad and Narrow Line Regions.

It seems that both, the C IV and the [O III] lines are affected by wind or/and outflow. One can expect that some characteristics seen in line profiles of C IV and [O III] lines could be caused by outflow/wind. Therefore, in this paper we compare asymmetries and blueshifts of the [O III] λλ 4959, 5007 Å lines and C IV λ 1549 Å line, in order to find any correlation which could imply a possible influence of the jet outflow on kinematical properties of regions where those lines arise.

THE SAMPLE AND ANALYSIS

Based on the S/N quality, we selected 28 AGN spectra from the atlas of Marziani et al [11]. To analyze the UV C IV λ 1549 Å lines, we used UV spectra from the HST archive. We subtracted the continuum and contaminating N IV λ 1486 Å , HeII λ 1640 Å and O III λ 1663 Å lines. Then we applied χ^2 minimalization routine [12] and fitted the C IV lines with two Gaussian functions. Most of the C IV lines can be well fitted with two Gaussians. Narrow Gaussian fit the core of the line and broader one the wings of the C IV line. Some of the C IV lines have absorption in the core. From the fits we found the widths and shifts of narrow and broad Gaussians in emission, where the shift difference between the two Gaussians correlates with the C IV asymmetry.

We apply the same method for analyzing the [O III] λλ 4959, 5007 Å lines (see [8]). After we substracted the continuum and contaminating Fe II and H_β lines, we fit the peak of [O III] λλ 4959, 5007 Å lines with narrow and the wings with broad Gaussian. The most of [O III] lines show blue asymmetry.

Examples of fits of C IV λ 1549 Å and [OIII] λλ 4959, 5007 Å lines are shown in Figs 1 and 2.

THE RESULTS

We found the asymmetry of C IV λ 1549 Å and [O III] λλ 4959, 5007 Å lines for each object, by subtracting the shifts of the broad and narrow Gaussian. We compared C IV and [O III] asymmetries in order to find any correlation which could imply possible influence of the jet outflow. The asymmetry is considered separately for RQ and RL objects. We did not find a clear correlation between C IV and [O III] asymmetries. The distribution of those asymmetries is shown on histograms (Figs 3 and 4) separately for RL and RQ objects. We find that RQ objects have larger blue asymmetries in the C IV and [O III] lines, than RL objects. Also, we compared shifts of broad and narrow Gaussians of the C IV λ 1549 Å and [O III] λλ 4959, 5007 Å lines. We find correlation

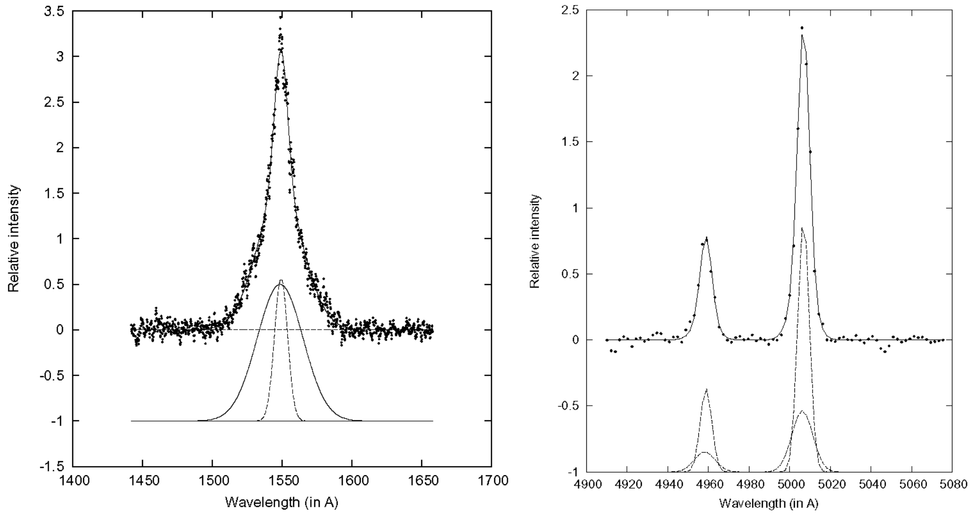

FIGURE 1. Example of fits of 4C 73.18 object: C IV λ 1549 Å (left) and [O III] λλ 4959, 5007 Å (right). The asymmetry of lines is weak.

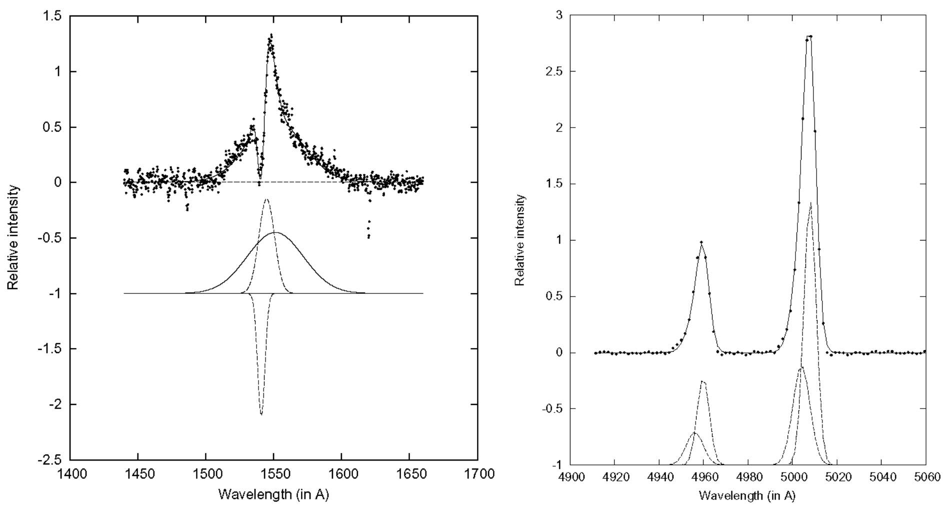

FIGURE 2. Example of fits of PG 1704+608 object: C IV λ 1549 Å (left) and [O III] λλ 4959, 5007 Å (right). The lines have a strong asymmetry

between shifts of narrow C IV Gaussians which fit the peak of the C IV line, and broad [O III] Gaussians which fit the core of [O III] line. Correlation has been seen only in RL sample (Fig 5). This could be an indication of kinematical connection between regions where core of C IVλ1549 Å and the wings of [O III]λλ 4959, 5007 Å lines arise.

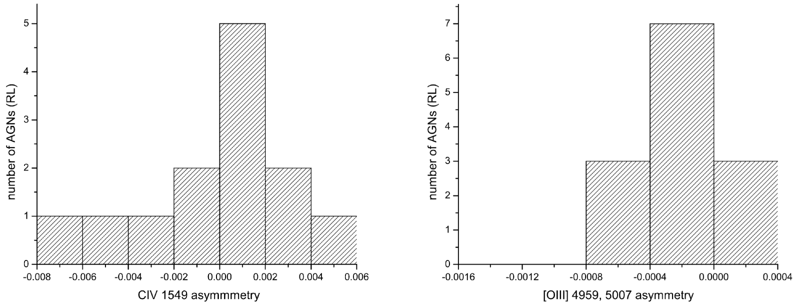

FIGURE 3. Asymmetry distribution of C IV λ 1549 Å (left) and [O III] λλ 4959, 5007 Å (right) for RL sample

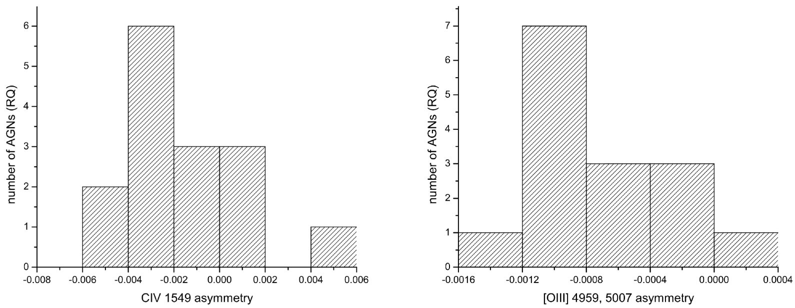

FIGURE 4. Asymmetry distribution of C IV λ 1549 Å (left) and [O III] λλ 4959, 5007 Å (right) for RQ sample

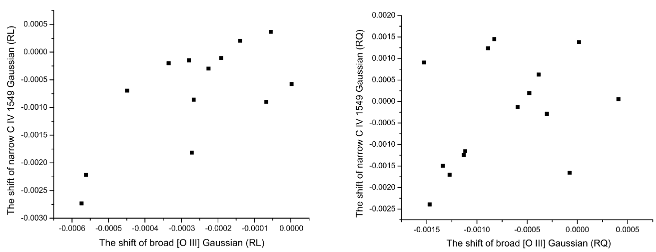

FIGURE 5. The shift of narrow C IV 1549 Gaussians as function of the shift of the broad [O III] Gaussians for RL (left) and for RQ (right) sample.

ACKNOWLEDGMENTS

This work is a part of the project 146002 "Astrophysical Spectroscopy of Extragalactic Objects" supported by the Ministry of Science of Serbia.

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