Publ. Astron. Obs. Belgrade No. 60 (1998), 67 – 70 *Contributed paper*

OBSERVATION OF THE GRAVITATIONAL EFFECT IN H_β OF AGNs

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Abstract. In this paper redshift difference between H_β and O III (4959,5007) lines as well as between Broad and Narrow components of H_β is discussed. We measured this difference in spectra of two Active Galactic Nuclei (AGNs): IIIZw2 and 3C120. The red asymmetry of the broad H_β as well as the redshift differences between Broad component of H_β and Narrow O III lines may be explained as the influence of a strong gravitational field in Broad Line Region of these galaxies.

1. INTRODUCTION

In spectra of many Active Galactic Nuclei (AGNs) an inner redshift difference between peak of narrow (high ionized) and broad (low ionized) lines exists (see e.g. Osterbrock *et al.* 1975, Peterson *et al.* 1985, Zheng & Sulentic 1990, Corbin 1990). Also, in spectra of some AGNs, especially in radio loud sorces, the H_β and other broad lines have strong red asymmetry (see e.g. Jackson & Browne 1989, Corbin 1995, Brotherton 1996). This asymmetry could not be explained only with contamination lines, e.g. H_β may be contamined by Fe II (4924,5018) and He I (4922,5016) lines (Jackson & Browne 1989).

In order to explain this inner redshift we have to consider that the whole Emitting Line Region (ELR) can be divided into two (see e.g. Netzer 1990, Osterbrock 1989) or three (see e.g. Bonatto & Pastoriza 1990, Brotherton 1996) physically distinct regions: Broad Line Region – BLR, Intermediate Line Region – ILR and Narrow Line Region – NLR. So, this inner shift difference can be explained as influence of effects which are different in these emitting regions. Usually, two mechanisms are considered as cause of the shift difference: 1) gravitational redshift effect, where the emitters located in BLR are in a stronger gravitational field than the emitters located in NLR and, 2) large-scale gas radial motions in the presence of electron-scattering opacity that steeply increases inward the emitting cloud (proposed by Kallman & Krolik 1986).

From our point of view both of the effects should be the cause of this shift difference, but there is a very large number of AGNs which have a redward asymmetry and, also, have a redshift difference between Broad Component (BC) and Narrow Component (NC) of a broad line, as well as between BC and Narrow Lines (NL). In these cases, we assume that the gravitational redshift causes the assymmetry as well as the redshift difference. The influence of gravitational redshift effect has been discussed by our group ((Popović *et al.* 1994, Atanacković *et al.* 1994, Popović *et al.* 1995a, 1995b) and Corbin (1995). Corbin (1995, 1997) proposed that the redshift difference as well as the redward asymmetry observed in spectra of some radio loud quasars could be explained as influence of gravitation feild on spectral line profile. From our investigation (Popović *et al.* 1995a, 1995b) we have concluded that: 1) Gravitational redshift effect should be considerd in BLR, but in NLR, this effect is negligible; 2) The red asymmetry broadening of a line increase, while reduced redshift decreases with wavelength; 3) The red asymmetry probably could not be observed as an asymmetric profile of the broad component alone, but it can be observed in a composite line; 4) The gravitational redshift influence is larger on a line created in a thin than in a thick region. Also, considering that the BLR (closer to the central mass) is opticaly thin (see e.g. Corbin 1995, Brotherton 1996), the gravitational effect may be observable only in BC of a line, and one may expect that this effect can be observed as a shift of the BC of the line.

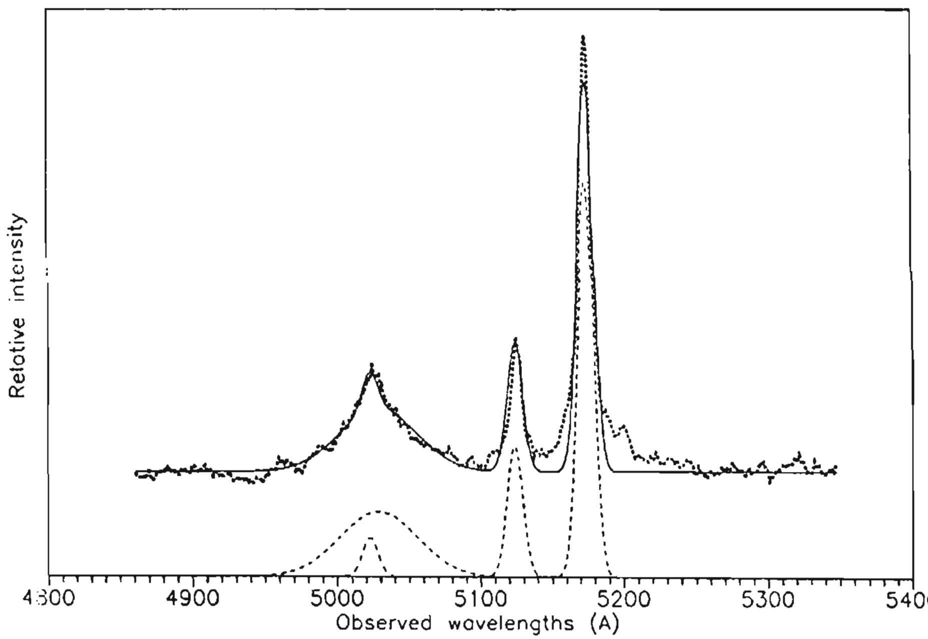

Fig. 1. An example of H_β and O III emission lines of the 3C120. The observed spectrum (dotted line) is fitted with several gaussians which are superposed (solid line). The resolved gaussians are shown at the bottom (dashed line).

Here we preliminarily analyse the shapes of H_β and O III (4959,5007) lines from the spectra of the two low-redshift Active Galactic Nuclei: IIIZw2 and 3C120. First, we try to resolve the broad H_β line into several gaussian components, which come from different regions. After that, we analyse these gaussian components. The gravitational redshift influence on the spectral line shapes can be taken as a contributor to the redshift of the H_β BC.

2. RESULTS AND DISCUSSION

There is no rapid variability in equivalent widths and in H_β line shapes of the galaxies 3C120 (see e.g. Chuvaev, 1980) and IIIZw2 (Popović *et al.* 1998). Hence, we have averaged common relative shift parameters from the spectra in the intervals 1979-1990 (3C120) and 1978-1983 (IIIZw2).

In our explanation of H_β and O III line shapes of the observed galaxies we choose the model with gas outflows in the BLR and partly in NLR with the presence of strong gravitational redshift effect in BLR (see Popović and Mediavilla 1997). Hence, the broadest line of the emitting gas may come from the region of strong gravitation field that can cause a part of the observed shift toward the red with respect to the narrow line component. However, in 3C120 the relative shift is negligible within the errors of measurements.

This shift has been obtained as a wavelength difference of the two corresponding gaussians (a narrow and a broad one) which are superposed to fit the observed H_β profile, Fig.1 (solid line). Also, two narrow gaussians have been used to fit the OIII spectral lines.

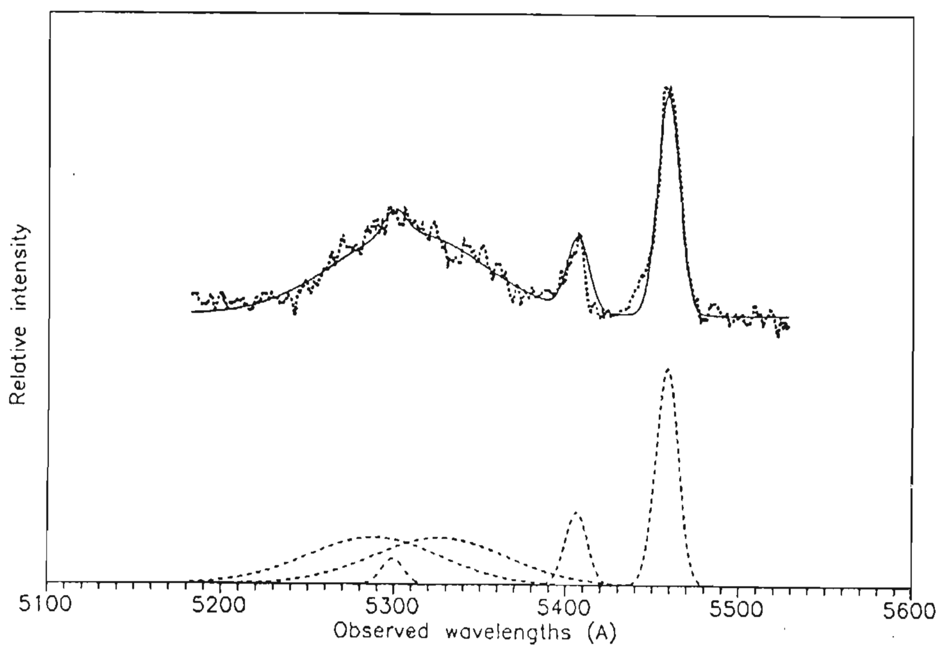

Fig. 2. One of the analyzed spectra of IIIZw2 fitted with several gaussians (solid line). Bottom: five gaussian components of the spectral line profiles (dashed line). Notice two broad gaussians fitting the BC of H_β and their mean redshift with respect to the narrow one.

In the case of the IIIZw2 the BC of H_β is double peaked (see Popović *et al.* 1998). It suggests that in this line we can see the effects of an emitting disk. It is in agreement with the observation of continuum distribution noticed by Kaastra &

de Korte (1988), where an increase of the energy density in the optical part of the spectrum was explained as radiation of a blackbody disk. Hence, we a priori suppose that the two broad gaussians (from the approaching and receding sides of the disk) have the same width and intensity. Their mean relative redshift with respect to the NC amounts to 7.94 Å, what in velocity terms corresponds to 490 km/s. The result of the fitting is shown in Fig.2. It is in agreement with our theoretical investigation (Popović *et al.* 1995a, 1995b), and they may indicate that in the case of this Sy 1 galaxy the redshift difference and the red asymmetry of the broad H_β line can be explained with the gravitational redshift effect.

Further and more detailed analysis of these and some other spectra of the two galaxies is in progress.

Acknowledgement

The authors are very grateful to Dr. Nina Polosukhina, Prof. Albert Bruch and Dr. Thomas Shimpke for their cooperation during the selection and scanning of the spectrograms. This work has been supported by Ministry for Developement, Science and Environment of Yugoslavia. Also, the work covers a theme (Research spectral line shapes in spectra of AGN) of the project "Astrometrical, Astrodinamical and Astrophysical Researchs" supported by Ministry of Science and Technology of Serbia.

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