Black Holes from Stars to Galaxies – Across the Range of Masses
Proceedings IAU Symposium No. 238, 2006
V. Karas & G. Matt, eds.

doi:10.1017/S1743921307005492

The gravitational redshift in the broad line region of the active galactic nucleus Mrk 110

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Abstract. We used the long term spectroscopic observations of Mrk 110 (Hα and Hβ lines) to investigate the gravitational field influence on spectral line profiles. We found that effects of gravitational field can be measured and that the lines are more intense where the emission is originating close to the central black hole of Mrk 110.

Keywords. galaxies: nuclei – galaxies: active – galaxies: Seyfert

1. Introduction

Popović *et al.* (1995) showed that in a strong gravitational field broad emission lines are red-shifted and asymmetric. Müller & Wold (2006) showed that the gravitational red-shift in Mrk 110 is present. They describe shifts on larger distance from the black hole where a line is shifted as a total feature, conserving its intrinsic shape. Another mode describes the behavior of the BLR lines in strong gravity regime, where lines are strongly deformed and suppressed. Using effects of gravitational red-shift Kollatschny (2003) determined the mass of the central black hole ($M = 14 \pm 3 \times 10^7\ M_\odot$) in Mrk 110 and the projection of the accretion disc ($i = 21 \pm 5$ degrees). Here, we investigate the Hydrogen line shapes in order to detect gravitational field influence on the Mrk 110 broad line profiles.

2. Observations and analysis

Observations were performed with the 9.2 m Hobby-Early Telescope at Mc Donald Observatory and in a period between November 1999 and May 2000 were taken 26 spectra (Kollatschny 2003). The variable fraction of observed emission lines are probable created in distance of 1 to 50 light days from the super-massive black hole (Kollatschny 2003). Here we analyzed the Hα and Hβ lines from 24 spectra of Mrk 110. To measure the red-shift of the lines, first we subtract narrow lines and continuum.

3. Results and discussion

As one can see in Fig. 1, we obtained a linear dependence between the red-shift of lines and flux. It seems that the lines are more intensive with stronger gravitational influence, i.e. where red-shift of lines is higher. It may indicate that the lines stay more intensive in the part of the BLR closer to the black hole. The intensity of the Hβ line as a function of the width at tenth intensity maximum ($W_{1/10}$) is present in Fig. 2 (left). As one can see from Fig. 2, there is a correlation between the intensity and the width, i.e. the $W_{1/10}$

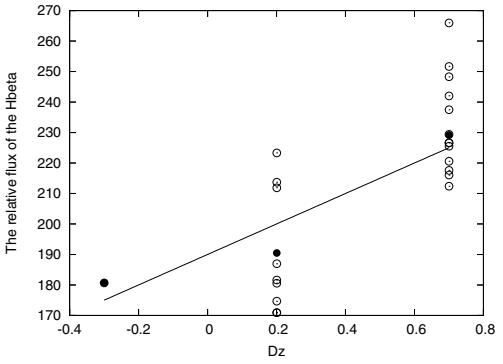

Figure 1. The relative flux of the Hβ as a function of the red-shift of the line center. White circles present measured values from each spectrum, while black circles correspond to the averaged values according to the red shift.

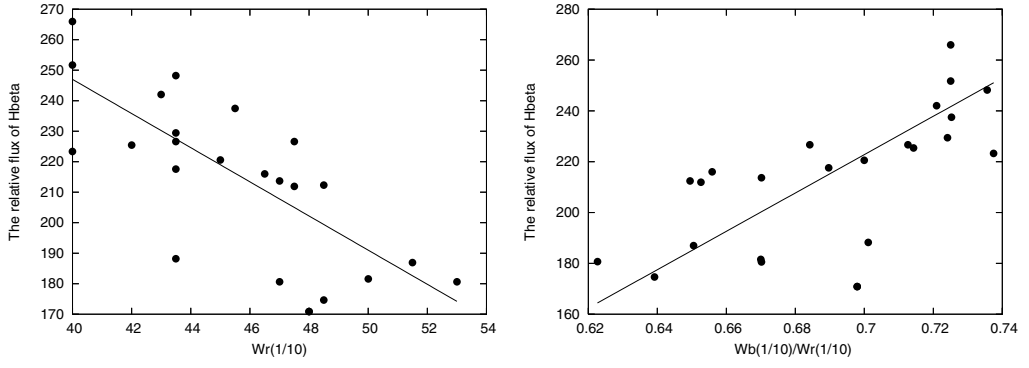

Figure 2. Left: The relative flux of the Hβ as a function of full width of the red part at tenth of intensity maximum; Right: The relative flux of the Hβ as a function of the full width ratio of blue (Wb) and red part (Wr) at tenth of intensity maximum.

is decreasing with intensity. Also, the asymmetry of the Hβ is changing (Fig. 2, right). The detailed discussion of our results will be given elsewhere (Gavrilović, *et al.* 2006).

Acknowledgements

This work was supported by the Ministry of Science and Environment Protection of Serbia through the project 146002.

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