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THE EMISSION LINE SHAPES OF THE SEYFERT 1 GALAXY MRK817

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Abstract. The analysis of emission line region of Seyfert 1 galaxy Mrk817 is presented. We found that emission line region in Mrk 817 is very complex. Moreover, the Narrow Line Region shows complex structure. The spectral line shapes of Mrk 817 indicates at least three kinematically separated regions, one (or more) which emits the broad line component ($V \sim$ 5000 km/s), one which emits narrow components ($V \sim$ 450 km/s) and one extensive which emits also narrow component ($V \sim$ 150 km/s).

1. INTRODUCTION

Seyfert galaxies have very complex emission-line shapes (see e.g. Sulentic et al., 2000 and references therein). These lines are coming from two different emission regions; Narrow Line Region (NLR) and Broad Line Region (BLR) that are spatially and kinematically separated, as well as physically different (see e.g. Osterbrock, 1989). Active galaxy Mrk 817 is a Seyfert 1.5 galaxy with red-shift 0.03145 (Strauss and Huchra, 1988). The recent investigation by Kaspi (2000) shows that Broad Line Radius of Mrk 817 is very compact (around 15 light days). The spectral lines shapes indicate that the emission line region of Mrk 817 is very complex (Popović and Mediavilla, 1997). In order to find the composition of the emitting line region we have used spectral line observations with different telescopes performed with different spectral resolution.

The aim of this work is to find the kinematical parameters of BLR and NLR of Mrk 817 by analyzing the Balmer and [OIII] spectral line shapes as well as the variability of Hβ line flux. Here we will present the Gaussian analysis of the H_β, H_α and [OIII] lines.

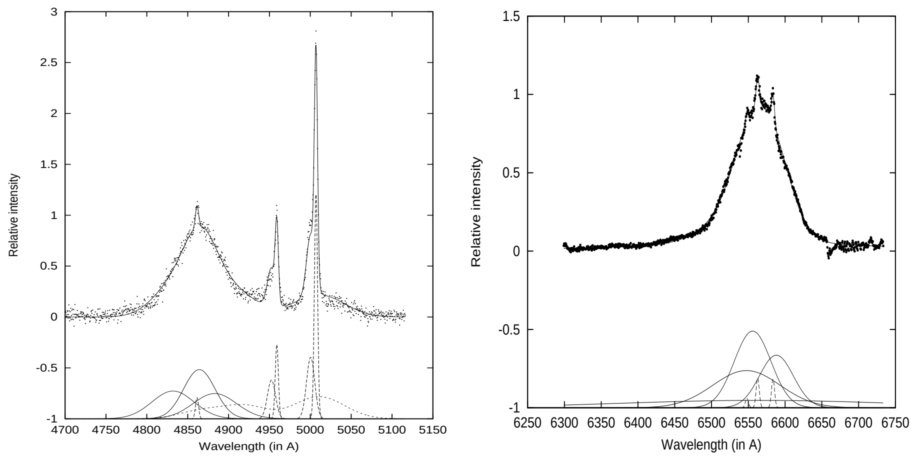

Fig. 1: **Left**: Decomposition of Hβ line of Mrk 817. The dots represent the observation and solid line is the best fit. The Gaussian components are shown at the bottom. The dashed lines at bottom represent the Fe II template, [OIII] and Hβ narrow lines. **Right**: The same as in Left, but for H_α. The Gaussian components are shown at the bottom. The dashed line at the bottom represent satellite N II lines and a narrow Hα component.

2. OBSERVATION AND DATA REDUCTION

We have used here three different sets of spectral observations of Mrk 817 wavelength line regions:

i) Observations with 2.5m Isaac Newton Telescope in La Palma Islands. The observations were performed in the period from 21th to 25th of January 2002. We used the Intermediate Dispersion Spectrograph (IDS) and the 235 camera in combination with the R1200Y grating. Two exposures of 550 and 500 s, included three Hβ and three Hα spectrum. The seeing was $1''.1$ and the slit width $1''$. The spectral resolution was around 1.0 Å . Standard reduction procedures including flat-fielding, wavelength calibration, spectral response, and sky subtraction were performed with the help of the IRAF software package.

ii) Observations with 4.2m William Herschel Telescope, at La Palma islands. The observation ware performed on 12/13 March 2001. The long-slit spectrograph (ISIS) was used, in combination with CCD cameras TEK4 (grating R158R). The spectral resolution was 2.9 Å . Also, the standard reduction procedures including flat-fielding, wavelength calibration, spectral response, and sky subtraction were performed with the help of the IRAF software package.

ii) Third set was observed at the Crimean Astrophysical Observatory by K.K.Chuvaev on 2.6m Shain telescope during the period of 1977-1991, and only Hβ line was observed. The spectral resolution was $\sim$ 8 Å. The spectrograph slit and the seeing were in the $1.8'' - 2.0''$, and $2'' - 3''$ ranges, respectively. The spectra of Hβ, were scanned with a two-coordinate CrAO microphotometer (as in the case of Akn 120, see e.g. Stanić et al. 2000, Popović et al., 2001). The reduction procedure includes

Table 1: The parameters of the Gaussian components (width, shift and intensity) of the Hα, Hβ and [OIII] λ4959,5007 lines.

$Gaussian$	H_α	H_β	Gaussian	$OIII$
W_B	2950	2250	W_{4959n}	165
z_B	-700	-1810	z_{4959n}	0
I_B	0.24	0.27	I_{4959n}	0.73
W_C	1610	1680	W_{4952b}	430
z_C	-320	180	z_{4959b}	-390
I_C	0.49	0.48	I_{4959b}	0.38
W_R	1500	2310	W_{5007n}	0.00055179
z_R	+1160	1350	z_{5007n}	0
I_R	0.34	0.25	I_{5007n}	2.20
W_{NLR}	140	160	W_{5007b}	430
z_{NLR}	0	0	z_{5007b}	-390
I_{NLR}	0.19	0.21	I_{5007b}	0.60

corrections for the film sensitivity, sky background, and instrumental spectral sensitivity. The wavelength and flux calibration were made using the SPE data reduction package, developed by S.G. Sergeev. The wavelength calibration was based on the night sky lines and narrow emission lines of the galaxy.

The spectra have been normalized to the [OIII]λ 5007 emission line.

The software package DIPSO was used for reducing the level of local continuum, by subtracting the N order polynomial, fitted through the dots taken to be on the local continuum in spectral range 4700 – 5100 Å for the Hβ . The same was done for the Hα local continuum in 6350- 6750 Å .

The red-shift of Mrk 817 was taken to be z=0.03145 (Straus and Huchra 1988, Véron-Cetty and Véron, 2000).

3. RESULTS

We fitted each line with a sum of Gaussian components using a χ^2 minimalization routine to obtain the best fit parameters. The fitting procedure has been described several times (see e.g. Popović et al., 2001, 2002; Popović 2003), but in this case we have assumed that the narrow emission lines can be composed by more Gaussian components. In the fitting procedure, we look for the minimal number of Gaussian components needed to fit the lines, taking into account the intensity ratio of [OIII] lines (the atomic value 1:3.03) and the fit of Fe II template (Korista, 1992) for the Hβ. For the two [NII] lines we assume their intensity ratio is 1:2.96 (Popović, 2003). It was found that three broad Gaussian and one narrow components could fit well the profiles of the Hα and Hβ lines.

The results of our analyses are presented in Figs. 1 and 2, and in Table 1. In Figs. 1 and 2 we can recognize clear evidence of substructure in these emission lines, not only in the broad component of the line, but also in the narrow emission lines. As one can see from the Figures, the line profiles of Hα and Hβ Mrk 817 lines are very complex. The emission line region of Mrk 817 is composed at least from three kinematically separated emission line regions:

1) The BLR which also can be more complex (two or three kinematically different emission region);

2) The NLR1, which has internal random velocity around 450 km/s, and a systemic velocity toward the blue of 390 km/s. That indicates presence outflow of emitting gas in NLR1.

3) The NLR2 has the internal random velocity around 150 km/s.

The detailed discussion will be given elsewhere (Ilić et al. 2003).

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