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A Study of the Spectral Characteristics of AGN: Mrk 817 and Mrk 1040

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Abstract. We discuss the spectral characteristics of active galaxies Mrk 817 and Mrk 1040, based on observations obtained with the 2 m RCC telescope of Rozhen Observatory and the 2.5 m Isaac Newton telescope at La Palma. Analyzing and modeling their broad and narrow emission lines, as well as studying the narrow band spectrophotometric observations, we investigate the emission line region of Mrk 817 and Mrk 1040.

1 Introduction

The present model of Active Galactic Nuclei (AGN) contains a super-massive black hole, surrounded by an accretion disk, which is accreting matter from the host galaxy. More kinematically different emission regions contribute to the line profiles: the complex broad and the narrow line region (BLR and NLR, respectively) [1]. Recently, Popović *et al.* [1] showed that the BLR of some AGN could be composed of two components: (i) an accretion disk and (ii) a region with geometry different from a disk.

Here we would like to give our contribution to the general picture of the structure of the emission line regions in AGN, by analyzing and modeling broad and narrow emission lines of the two Seyfert galaxies Mrk 817 and Mrk 1040, and by studying their narrow band spectrophotometric images observed with the 2 m Ritchey-Chretien-Coude (RCC) telescope at Rozhen Observatory. These observations are a result of mutual cooperation of Serbian and Bulgarian astronomers.

2 Observations

The spectrophotometric observations have been made at the National Astronomical Observatory Rozhen with the 2 m Ritchey-Chretien-Coude (RCC) telescope.

We observed Mrk 817 and Mrk 1040 in November 2003 and in January 2004, in the narrow and broad band filters [2, 3]. The high-resolution spectral observations of Mrk 817 were made with the 2.5 m Isaac Newton Telescope at La Palma, Canarian Islands in Spain. The observations were performed in the period January 21–25, 2002 [4]. Standard reduction procedures including bias subtraction, trimming and flat-fielding have been performed with the help of the IRAF software package.

3 Mrk 817

We observed Mrk 817, which is a Seyfert 1.5 galaxy, with the 2 m RCC telescope in order to resolve the outer regions of this active galaxy. With the combination of narrow-band filters we tried to confirm the existence of the outflow in the narrow line region, previously detected with spectral analysis. On all images the presence of the spiral arms is obvious and it is clear that the observed galaxy is vertically extended (see Figure 1). We should also notice that the size of the galaxy varies in different spectral filters, being the biggest in the [OIII] filter and the smallest in HeII filter. The images taken in [OIII] filter show more intensive and wider central region of the galaxy [3]. This can be in correlation with the spectral results, where we have applied the Gaussian decomposition to the Hα and Hβ emission lines of the galaxy Mrk 817 [1, 4]. It was found that three broad Gaussian and one narrow components could fit well the profiles of the Hα and Hβ lines. 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 [4].

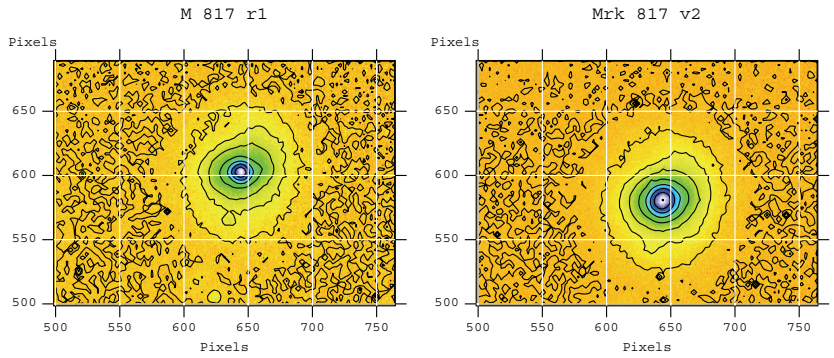

Figure 1. The galaxy Mrk 817 observed in the continuum (left) and the [OIII] (right) filter.

4 Mrk 1040 and LEDA 212995

Mrk 1040 is a Seyfert 1 galaxy with different star-forming regions in stellar ring. The close companion LEDA 212995 is also under star-formation. It is not clear if the companion is under interaction or not, and if the star-formation in it and the nuclei activity in Mrk 1040 are caused by the interaction of the two galaxies [2,5]. In order to find any evidence about interaction we have processed the spectrophotometric images as follows:

1. A surface brightness analysis over the narrow-band images has been applied assuming an elliptical isophotic model [2]. This model has been subtracted from the images (in different narrow bands). After subtraction we obtained an image where the substructures in the objects can be seen, as well as structure(s) that may indicate interaction between the objects (see Figure 2, top-left panel).
2. We have modeled Mrk 1040 using GALFIT [2]. The galaxy model has been done including three components: the nuclear point-like source, a bulge and a disk. This model has been subtracted from the images in order to detect the substructures (Figure 2, bottom-left panel).

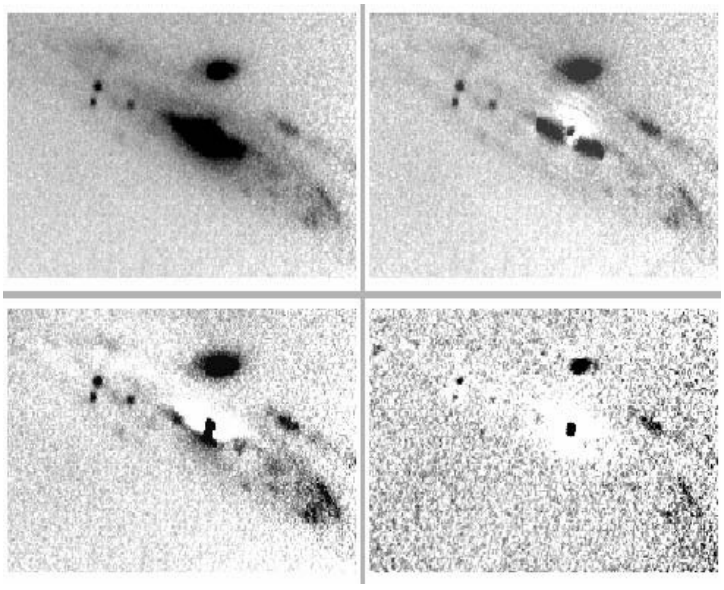

Figure 2. Original narrow-band image of Mrk 1040 and companion in [OIII] (top-left); residual image once subtracted the model obtained by the surface brightness analysis (top-right); residual image once subtracted the model obtained using GALFIT (bottom-left); residual image once subtracted the continuum scaled image (bottom-right).

3. We have scaled the continuum image to the narrow-band images, and subtracted it from them. It provides us with images of the pure HeII and [OIII] emission lines.

4. We have divided the U-band image by the I-band image, in order to get a U-I color image.

As one can see from Figure 2 the substructures seen in all images are remarkably similar, indicating that: (i) there is a very strong point-like innermost center of Mrk 1040 that is from AGN; The companion has irregular structure that is expected in the case of star-forming region; (ii) different star-forming regions in the disk of Mrk 1040 galaxy are seen in the western part of the arm; (iii) from our preliminary analysis we can conclude that there is no tidal tail of young stars in between Mrk 1040 and LEDA 212995 [2, 5].

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