Proc. IV Serbian-Bulgarian Astronomical Conference,
Belgrade 21–24 April 2004,
eds. M. S. Dimitrijević, V. Golev, L. Č. Popović, M. Tsvetkov,
Publ. Astron. Soc. "Rudjer Bošković" No 5, 2005, 247 - 250 *Contributed paper*

THE FLUX RATIO OF [OIII]$\lambda\lambda$4959,5007 LINES IN Sy2: COMPARISON WITH THEORETICAL CALCULATIONS

L. Č. POPOVIĆ[1,2], M. S. DIMITRIJEVIĆ[1], E. BON[1] and M. DAČIĆ[1]
[1] *Astronomical Observatory, Volgina 7, 11160 Belgrade 74, Serbia*

[2] *Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany*

Abstract. Here we present the measurements of the [OIII]$\lambda\lambda$4959,5007 line flux ratios for a sample of 10 Sy 2 galaxies. Our measurements are compared with sophisticed calculation given by Storey and Zeippen (2000) and measurements given by Iye et al. (1987) and Leisy and Dennefeld (1996). We found that the ratio of the [OIII] line flux for Sy 2 is slightly smaller and in better agreement with theoretical one, than previous meausrement from emission nebulae.

1. INTRODUCTION

The forbidden [O III] 4958.911 Å ($2s^2 2p^2\ ^1D_2 - 2s^2 2p^2\ ^3P_1$) and 5006.843 Å ($2s^2 2p^2\ ^1D_2$ – $2s^2 2p^2\ ^3P_2$) spectral lines are among the most prominent not only in the spectra of photoionized nebulae but also in the spectra of photoionized gas around AGN's due to relatively high abundance of doubly charged oxygen ions in such objects. It should be underlined also their position in the centre of the visible spectral range. These two spectral lines are first of all the consequence of magnetic dipole transitions with a small contribution of electric quadrupole radiation. The elaborate theoretical work of Galavís et al. (1997) gives an 5006.843/4958.911 intensity ratio of 2.89. From astronomical spectra, Rosa (1985) deduced an intensity ratio of 3.03 ± 0.03, while measurements of Iye et al. (1987) provide a value of 3.17 ± 0.04, and of Leisy and Dennefeld (1996) 3.00 ± 0.08. Storey and Zeippen (2000) underline that in spite of the fact that the difference between experiment and theory is between 4 and 9 per cent, it must be considered as well-established because these lines can be observed with very high signal-to noise ratio in the spectra of gaseous nebulae. They demonstrated, taking into account relativistic corrections to the magnetic dipole operator introduced by Eissner and Zeippen in the context of a line-intensity ratio in [O III], that the probabilities for 5006.843 Å and 4958.911 Å transitions are affected by small relativistic corrections to the magnetic dipole operator. They obtained the A-value ratio of 3.01, implying a line intensity ratio of 2.98, which is only two percent or less different from the values of Rosa (1985) and Leisy and Dennefeld (1996) obtained from astronomical spectra, and the difference with the value of Iye et al. (1997) is 6 per cent.

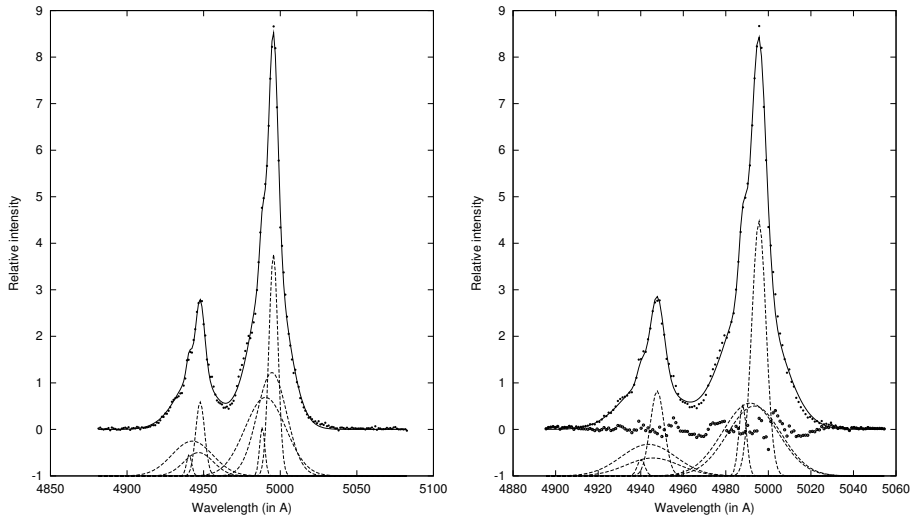

Figure 1: The [OIII] 4959, 5007 lines of NGC 1068 fitted with multi-Gaussian fit. The spectra of the slit position 1 is left and the slit postioin 2 is right (see Cecil et al., 2002).

On the other side, the measurements of the flux ratio of [OIII]4959,5007 lines for Sy 1 galaxies given in Popović et al. (2004) indicate that it can be significantly smaller than before measured values.

Up to now, all observational checks of [OIII] 5006.843/4958.911 intensity ratio have been made for planetary nebulae spectra. The aim of this paper is to measure the considered flux ratio in Sy 2 galaxies in order to see if they are also convenient for such cheks and to compare the obtained results with theoretical ones and with results obtained for planetary nebulae.

2. USED OBSERVATION AND MEASUREMENTS

In order to measure the flux ratio for [OIII]4959,5007 lines of Sy 2 galaxies, we use HST observations obtained with the Space Telescope Imaging Spectrograph (STIS) and Faint Object Spectrograph (FOS), covering the wavelength ranges 2900-5700 Å. From very large data base of AGN spectra at HST archive we selected the objects that have spectra with needed quality. For NGC 1068, we used several spectra made by HST with different slit positions (see Cecil et al., 2002).

The spectra were reduced by the HST team. We transformed the wavelength scale to zero red-shift taking into account the cosmological red-shift of the objects (Véron-Cetty and Véron, 2000). After that we estimated and subtracted the continuum. The fluxes of the lines were measured by using the DIPSO software. To estimate the error we measured several times the fluxes, where the procedure of subtracting of continuum has been three times repeated.

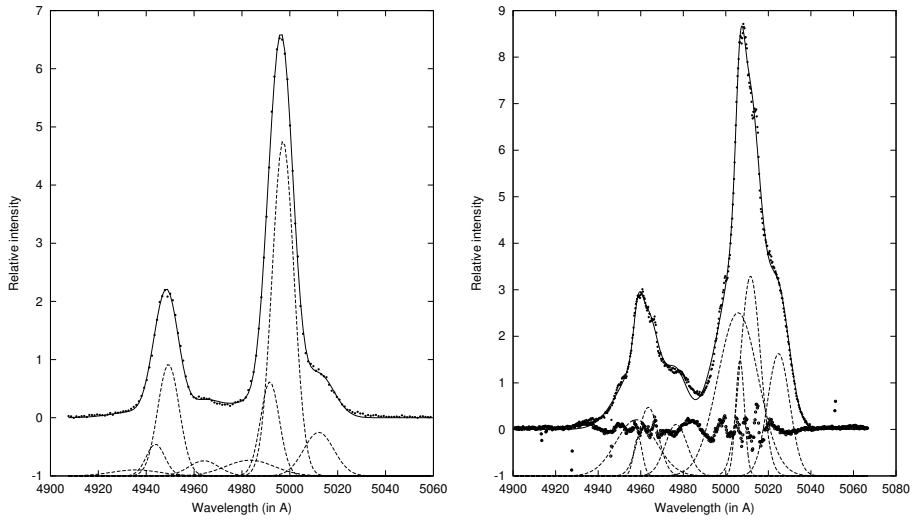

Figure 2: The same as in Fig. 1, but for the slit position 3 (left) and 4 (right).

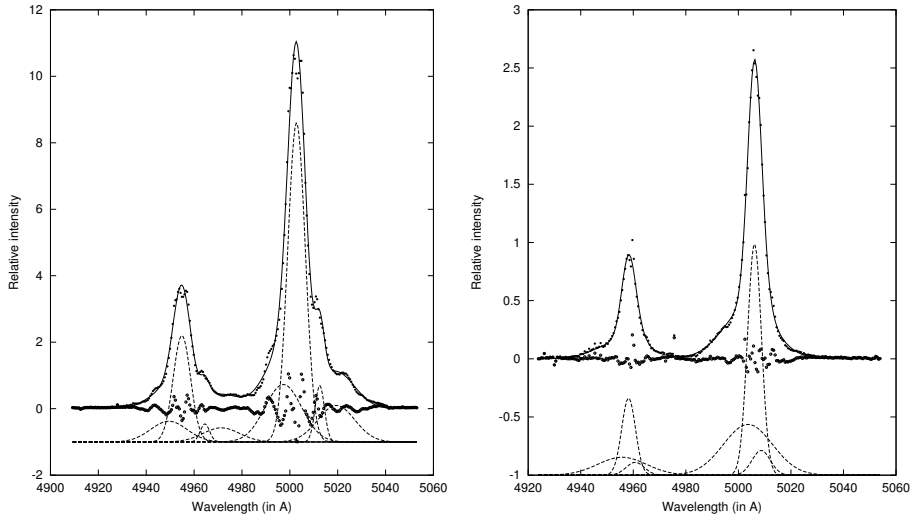

Figure 3: The same as in Fig. 1, but for the slit position 5 (left) and 6 (right).

In the case of NGC 1068, where the [OIII] lines show very complex profiles (in difference with slit orientation) we apply multi-gaussian method to determine the flux of both lines (see Figs. 1-4). The total flux in a line is obtained as a summ of Gaussians that represent the line.

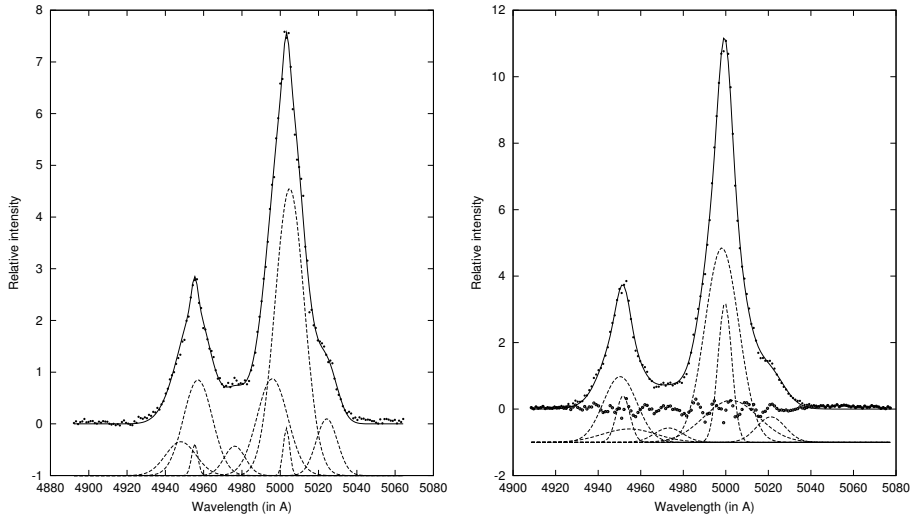

Figure 4: The same as in Fig. 1, but for the slit position 7 (left) and 8 (right).

3. PRELIMINARY RESULTS

We have analyzed the [O III] 4959,5007 intensity ratio in the spectra of 10 Sy 2 galaxies and our preliminary averaged value is 2.921 ± 0.084. which is in reasonable agreement with the theoretical value of 2.98 obtained by Storey and Zeippen (2000), better than some of the values within the 2.89-3.17 range obtained from planetary nebulae observations (Rosa, 1985 - 3.03; Iye et al., 1987 - 3.17; Leisy and Dennefeld, 1996 - 3.00; Galavías et al., 1997 - 2.89). Consequently, one can conclude that our results are in reasonable agreement with the sophysticated calculations of Storey and Zeippen (2000) and that the spectra of Sy 2 galaxies could be also used for checks of such theoretical calculations. More detailed discussion will be given elsewhere (Popović et al., 2004).

References

Cecil, G., Dopita, M.A., Groves, B., Wilson, A.S., Ferruit, P., Pcontal, E., Binette, L.: 2002, *Astrophys. J.*, **568**, 627.

Eissner, W., Zeippen, C.J.: 1981, *J. Phys. B*, **14**, 2125.

Galavís, M.E., Mendoza, C., Zeippen, C.J.: 1997, *Astron. Astrophys. Suppl. Series*, **123**, 159.

Iye, M., Ulrich, M.H., Peimbert, M.: 1987, *Astron. Astrophys.*, **186**, 84.

Leisy, P., Dennefeld, M.: 1996, *Astron. Astropphys. Suppl. Series*, **116**, 95.

Popović L.Č., Mediavilla, E., Bon, E., Ilić, D.: 2004, *Astron. Astrophys.*, accepted (astro-ph/0405447).

Popović L.Č., Dimitrijević M.S., Bon E., Dačić M.: 2004, in preparation.

Rosa, M.: 1985, *The Messenger*, **39**, 15.

Storey, P.J., Zeippen, C.J.: 2000, *Mon. Not. R. Astr. Soc.*, **312**, 813.

Véron-Cetty, M.-P., Véron, P.: 2000, A Catalogue of Quasars and Active Galactic Nuclei, Sci. Report, **19**.