

# NPM1G–10.0586: an emission-line companion of the Seyfert galaxy Mrk 509

Lyuba Slavcheva-Mihova, Boyko Mihov  
Institute of Astronomy and NAO, Bulgarian Academy of Sciences,  
72 Tsarigradsko Chaussee Blvd., BG - 1784 Sofia  
lslav@astro.bas.bg

(Submitted on 15.01.2012; Accepted on 20.02.2012)

**Abstract.** We report spectral observations of the galaxy NPM1G–10.0586, the main candidate-companion of Mrk 509. Mrk 509 is a Seyfert galaxy showing no evidence of morphological perturbations of the potential. The spectrum of NPM1G–10.0586 obtained by us is emission-line. The derived weighted mean heliocentric redshift is  $0.03312 \pm 0.00023$ , which makes NPM1G–10.0586 a physical companion of Mrk 509.

**Key words:** galaxies: active – galaxies: individual (NPM1G–10.0586) – techniques: spectroscopic

## Introduction

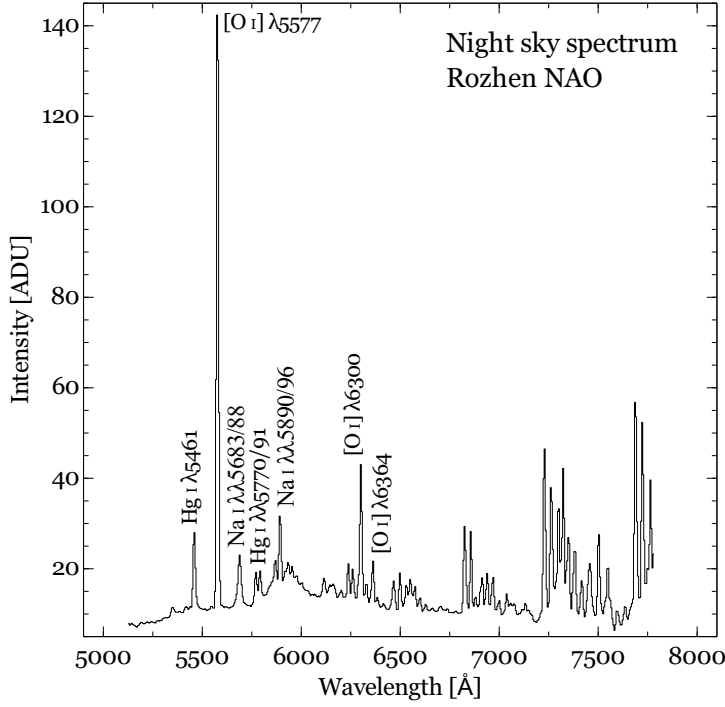
Simulations show that interactions could induce tails, bridges, and asymmetries. The relation between galaxy interactions and the onset of nuclear activity is founded upon the key studies of Toomre & Toomre (1972) and Gunn (1979). Tidal interactions could lead to gas inflow (Byrd et al. 1986; Noguchi 1988) and thus to circumnuclear star formation or even fueling the active nucleus.

With an absolute magnitude of  $M_B = -22^m5$  (Véron-Cetty & Véron 2010), Mrk 509 lies close to the boundary in luminosity between Seyfert 1 nuclei and quasars. It is classified as SA0 (Slavcheva-Mihova & Mihov 2011a) with a global ellipticity of 0.16 (Slavcheva-Mihova & Mihov 2011b). The former paper analyses the presence of bars, rings, light asymmetries, and companions in a sample of 35 Seyfert galaxies and in a control sample of inactive galaxies. Mrk 509 is among the three Seyfert galaxies with none of the above features present. Although there is no direct evidence of a companion, such a possibility was hinted by Rafanelli et al. (1993) and Boris et al. (2002).

With the aim to clarify the local environment of Mrk 509, we obtained spectra of the galaxy NPM1G–10.0586, the main candidate-companion of Mrk 509.

## 1 Spectroscopy

The spectral observations of the galaxy NPM1G–10.0586 were performed on August 7<sup>th</sup>, 2011 with the 2-m telescope of the Rozhen National Astronomical Observatory, equipped with a two-channel focal reducer. We used a grism with 300 grooves/mm and 512×512 Princeton Instruments VersArray:512B CCD detector with a square pixel size of  $24 \mu\text{m}$  (a scale of  $0''.884/\text{px}$ ). This observational setup gives a spectral resolution of  $5.15 \text{ \AA}/\text{px}$  in the range 4800–7500  $\text{\AA}$ . Several spectra of the target were acquired with an exposure time of 600 sec each. Bias and flat field frames were taken after the target frames; a quartz lamp was used as a flat field source. No spectrophotometric standard



**Fig. 1.** Night sky spectrum at a mean zenith distance of  $65^\circ$ .

was observed due to the high airmass of the target, which varied from 1.89 to 2.93 during the observations. The weighted mean full width at half maximum of the stellar images is  $1''.39$ .

The reduction of the individual spectra was performed using IDL 7 and consists of bias subtraction, flat fielding, cosmic ray hit cleaning (L.A.COSMIC, van Dokkum 2001), sky subtraction, and one-dimensional spectrum extraction. The spectra with highest signal-to-noise ratio were then averaged. The wavelength calibration was done using the following night sky lines (Fig. 1): [O I]  $\lambda\lambda 5577.339, 6300.304, 6363.776$  (resulting from natural sky light) and Hg I  $\lambda\lambda 5460.754, 5769.598, 5790.663$  (owing to light pollution). The Hg I lines are strong because at the target position on the sky the contribution from the Pamporovo resort lighting is considerable. The accuracy of the wavelength calibration was estimated to be  $\pm 1.76 \text{ \AA}$ . No flux calibration was done.

We identified the following emission lines in the spectrum of the galaxy NPM1G−10.0586: [O III]  $\lambda 5006.843$ , [N II]  $\lambda\lambda 6548.05, 6583.45$ , H $\alpha$   $\lambda 6562.801$ , and [S II]  $\lambda\lambda 6716.44, 6730.82$ . The weighted mean heliocentric redshift, derived from these lines, is  $0.03312 \pm 0.00023$ . The final de-redshifted spectrum of the galaxy NPM1G−10.0586 is shown in Fig. 2.

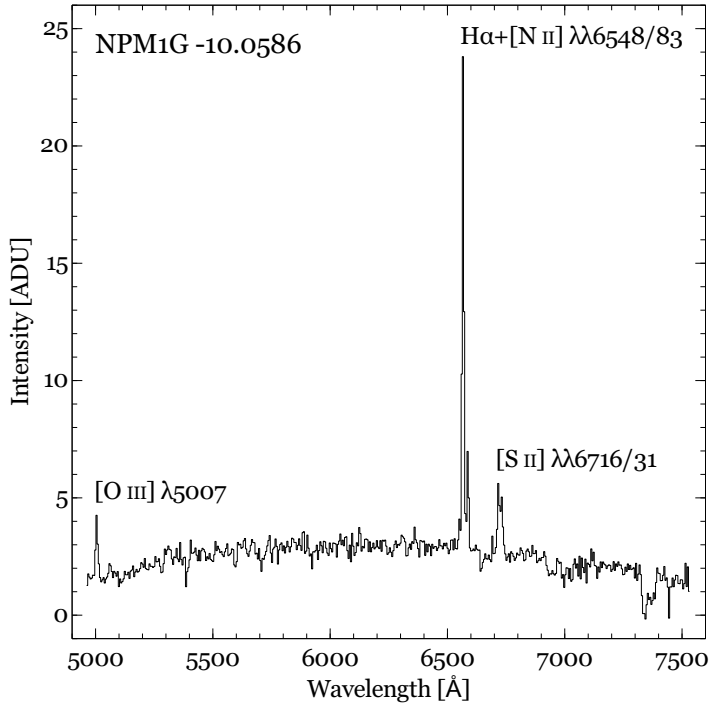


Fig. 2. De-redshifted spectrum of the galaxy NPM1G -10.0586.

## 2 Discussion

Mrk 509 ( $z = 0.034397 \pm 0.000040$ , Fisher et al. 1995) is one of the few Seyfert galaxies in the sample of Slavcheva-Mihova & Mihov (2011a) with no evidence of morphological perturbations of the potential. We performed spectral observations of NPM1G -10.0586 with the aim to find out whether it is a companion of Mrk 509. We obtained an emission-line spectrum. We identified the following emission lines: [O III]  $\lambda 5006.843$ , [N II]  $\lambda\lambda 6548.05, 6583.45$ , H $\alpha$   $\lambda 6562.801$ , and [S II]  $\lambda\lambda 6716.44, 6730.82$ . The resulting weighted mean heliocentric redshift is  $0.03312 \pm 0.00023$ . This makes NPM1G -10.0586 an *emission-line physical companion* of the Seyfert galaxy Mrk 509.

## Acknowledgements

The Two-Channel Focal Reducer was transferred to the Rozhen National Astronomical Observatory under a contract between the Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences, and the Max Planck Institute for Solar System Research.

## References

- Boris N. V., Donzelli C. J., Pastoriza M. G., Rodriguez-Ardila A., Ferreira D. L., 2002, *A&A* 384, 780
- Byrd G., Valtonen M., Sundelius B., Valtaoja L., 1986, *A&A* 166, 75
- Fisher K. B., Huchra J. P., Strauss M. A., Davis M., Yahil A., Schlegel D., 1995, *ApJS* 100, 69
- Gunn J., 1979, Active Galactic Nuclei, eds. C. Hazard & S. Mitton (Cambridge University Press, Cambridge), 213
- Noguchi M., 1988, *A&A* 203, 259
- Rafanelli P., Marziani P., Birkle K., Thiele U., 1993, *A&A* 275, 451
- Slavcheva-Mihova L., Mihov B., 2011a, *A&A* 526, A43
- Slavcheva-Mihova L., Mihov B., 2011b, *AN* 332, 191
- Toomre A., Toomre J., 1972, *ApJ* 178, 623
- van Dokkum P. G., 2001, *PASP* 113, 1420
- Véron-Cetty M.-P., Véron P., 2010, *A&A* 518, A10