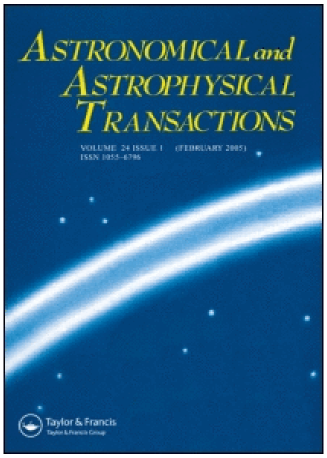

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V. V. Prokof'eva [a]; L. M. Sharipova [a]
[a] Crimean Astrophysical Observatory, Crimea, Nauchny, Ukraine

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SPECTROPHOTOMETRY OF THE NUCLEUS OF THE GALAXY NGC 4151 IN 1988

V. V. PROKOF'EVA and L. M. SHARIPOVA

Crimean Astrophysical Observatory, 334413, Crimea, Nauchny, Ukraine

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Spectrophotometric observations of the nucleus of the galaxy NGC 4151, the reference star and spectrophotometric standards were carried out at the Crimean Astrophysical Observatory during 13 nights in 1988 (January 23 – June 10). The slitless spectrograph and the digital TV complex of the 0.5-m meniscus telescope were used. The spectral resolution was 60Å under the condition of good seeing. Energeticaly calibrated monochromatic fluxes with steps of 50Å were obtained for the nucleus in the spectral region of 4500–7000Å. Fluxes in the continuum (5200–5700Å), in the blend 1 (H_β 4861Å + O[III] 4959+5007Å) and the blend 2 (H_α 6563Å + N[II] 6548+6584Å) were calculated.

KEY WORDS Seyfert galaxies, spectrophotometry

There are many aspects to research in the active nuclei of galaxies. The investigation of the peculiarities of the spectral radiation is one of the main problems.

The Seyfert galaxy NGC 4151 is very popular for monitoring. Several components of the light variations with different time scales are known (Lyuty and Oknyanskij, 1987). In 1984–1988 the nucleus of the galaxy NGC 4151 was at a brightness minimum. The colour indexes correspond to a Sy2 galaxy, while it classified as Syl–Sy1.5 as usual. The value of the ratio $W(H_\beta)/W(N_2)$ was decreased to 0.3 instead of about 1 in the "high" state of the nucleus (Lyuty *et al.*, 1984; Oknyanskij *et al.*, 1994; Solomos, 1994). The investigation of the rapid optical variability of the nucleus in 1987–88 was carried out by Lyuty *et al.* (1989). The variability with amplitude of 0.1 magnitude and time scale of 15–30 min has been found. Spectrophotometric observations of NGC 4151 were carried out in 1988 at the Wise observatory by Maoz *et al.* (1991).

A goal of our observations was to obtain the energetic calibrated spectra of the nucleus of the Seyfert galaxy NGC 4151.

Spectrophotometric observations of the nucleus of NGC 4151 were carried out with the original slitless afocal spectrograph (Pronik and Sharipova, 1993). The spectrograph was displaced in the convergence beam before the focal plane of the 0.5-metre telescope. The transparent diffractional grating had 100 grooves per mm and 70% efficiency. A TV device with an image-isocon tube having a multialkali photocathode was used as the detector (Abramenko *et al.*, 1982, 1988). Tie video-signal

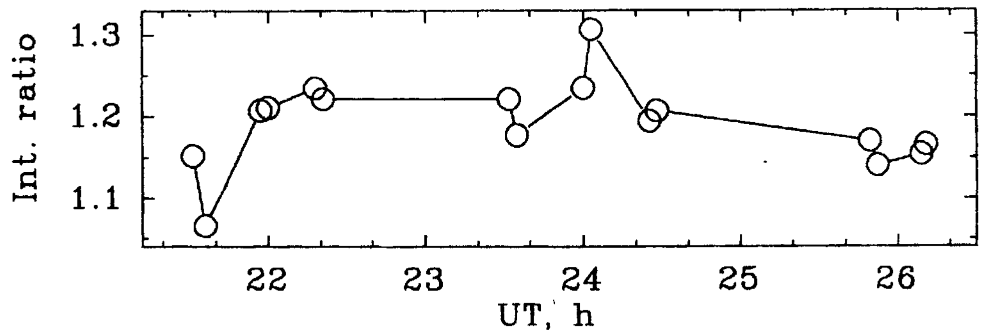

Figure 1 The ratio of intensities of star C3 at wavelength 5525Å (width 50 Å) to artificial standard intensities recorded on February 17 in 1988 versus time.

from the "strob" (width 20 arc sec) with spectrum inside was digitized and integrated in the memory of a computer. The exposure time was 3–6 min (Prokof'eva and Sharipova, 1996). The spectral resolution depends on the atmospheric seeing. Under conditions of good seeing, spectral resolution was about 60 Å but it was 100–120Å under moderate and bad seeing. All spectrophotometric observations had absolute energetic calibration. For this purpose the intensity of the special artificial energetically calibrated standard was registrated during each recording of the spectrum.

This apparatus was successfully used for the creation of the regional sequence of spectrophotometric standards located near the North Pole. The absolute energy distribution was obtained with an accuracy of about 4% for stars of 12 magnitudes (Prokof'eva and Sharipova, 1997).

75 spectra of the nucleus of the NGC 4151, 114 of the reference star C3 (Lyuty, 1972) and 98 spectra of the spectrophotometric standards HZ44, Feige 92 and others were obtained during 13 nights. The spectral region 4500–7000Å was used. Each spectrum consisted of two records obtained one after another as a rule. Their comparison let us control the quality of the recording. The data of such pairs obtained in good conditions were averaged (see also Sharipova and Prokof'eva, 1998).

The spectra of the star C3 let us take control of the extinction during each night. An example of such extinction control is demonstrated in Figure 1. Such control allowed us to omit observations which were obtained when the atmosphere transparency was unstable. Spectra of the star C3 allowed us to use the differential method of observations and reduction. We used the star C3 as a regional spectrophotometric standard. The absolute distribution of energy in the C3 spectrum was found using special observations obtained during six dates. Four stars with well-known spectra (HZ 44, Feige 56, Feige 92, EG 247) were used (Barnes and Hayes, 1984). The absolute energy flux accuracy for star C3 is about 5% in the central region of the spectra and about 10% close to its edges. The obtained data were approximated by polynomials.

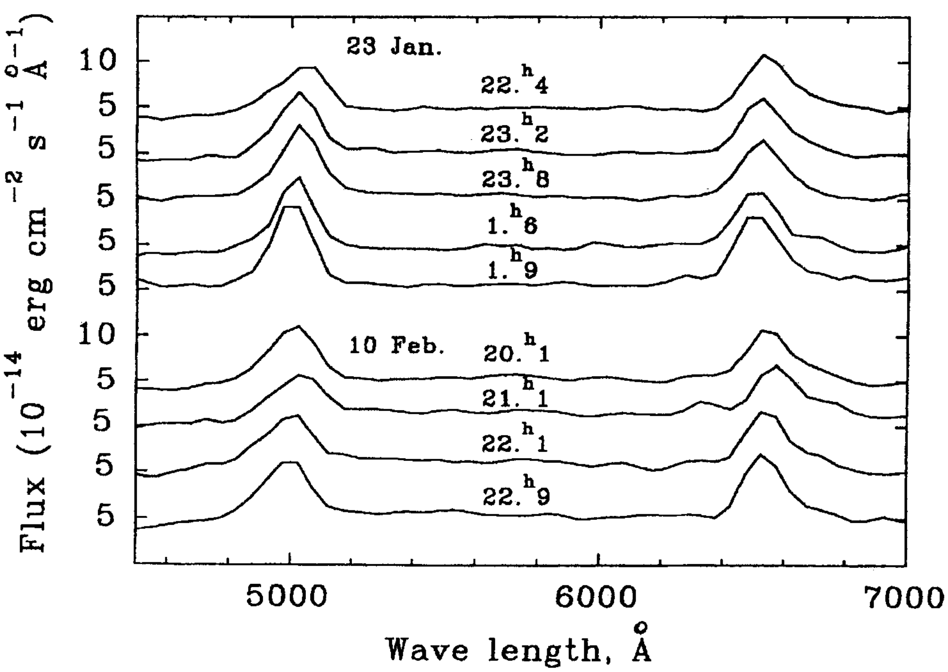

Figure 2 Monochromatic fluxes $F \times 10^{-14}$ erg cm^{-2} s^{-1} Å^{-1} in spectra of the nucleus of the galaxy NGC 4151 obtained on January 23 and February 10 1988. UT moments of observations are given over the curves. Vertical scales are shown for the first graphs for each date. Other spectra are constructed in the same scale but one digit is shown for these scales only.

Absolute energetic distributions were calculated for each NGC 4151 spectrum in relation to the spectrum of the reference star C3. Spectra of the star C3 were recorded before and after it was averaged. The moments of observations of galaxy spectra and the star C3 spectra were nearly equal and air masses were approximately the same as a rule.

The accuracy of a single intensity measurement in a single wave length interval of 50Å relative to the reference star spectrum is about 3%. All calculated spectra of the nucleus of NGC 4151) had sets of absolute energy measurements as a function of the wavelength with a step of 50Å. Figure 2 demonstrates spectra of the galaxy NGC 4151 obtained on 23 January and 10 February as an example.

Spectrophotometric data permitted us to analyse fluxes in the continuum 5450Å (calculated as the mean flux in the interval 5200–5700Å), blend 1 (H_β 4861Å + [OIII] 4959+5007Å) and blend 2 (H_α 6563Å + N[II] 6548+6584Å). Figure 3 shows our data (open circles with bars), data obtained by Maoz *et al.* (1991) for the continuum at 4750Å (open triangles) and Sergeev's (1994) data for the continuum 6563Å (filled circles). The values of bars were estimated as standard errors calculated from several observations obtained during nights. If there was one spectrum the accuracy depended on the stability of the atmospheric transparency.

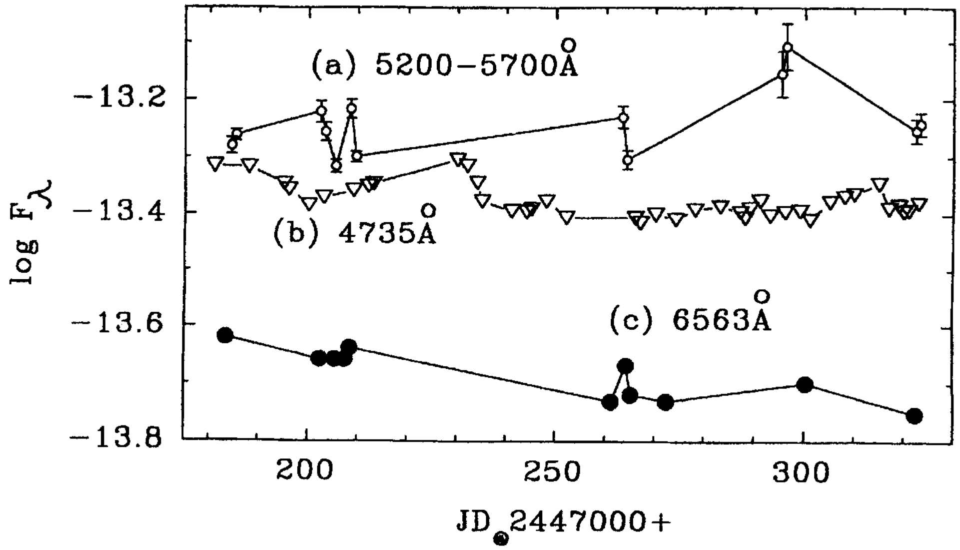

Figure 3 Light curves for fluxes in the continuum ($\log F_\lambda$) of the nucleus of the galaxy NGC 4151 obtained: (*a*) by the authors in the wavelength interval 5200–5700Å (mean 5450Å); (*b*) by Maoz *et al.* (1991) at 4735Å; (*c*) by Sergeev (1994) at 6563Å.

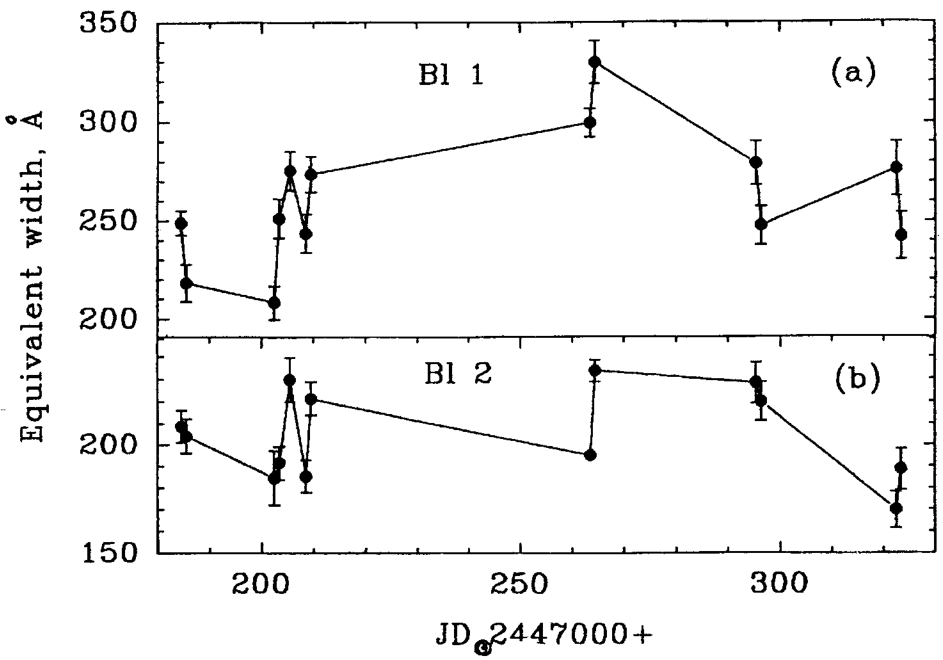

Figure 4 Light curves for fluxes of the nucleus of the galaxy NGC 4151: (*a*) in the blend 1 (H_β 4861Å + O[III] 4959+5007Å) and blend 2 (H_α 6563Å + N[II] 6548+6584Å).

The comparison of data shown in Figure 3 showed that our data have a null-point correction of about -2×10^{-14} erg sm^{-2} s^{-1} Å^{-1}. This value of the correction may appear as the result of our measurements done in the region about 20 arc second around the nucleus. Weak emission lines in the spectral region of 5200–5700Å may also increase the flux.

Light curves for fluxes in spectral blends 1 (H_β + O[III] 4959Å + 5007Å) and blend 2 (H_α + N[II] 6548Å + 6584Å) are shown in Figure 4. Bars indicate data accuracy. The amplitude of flux variations in blend 1 is more than that in blend 2. The coefficient of the correlation between them is about 0.4.

Spectrophotometric investigations showed that the nucleus of the galaxy NGC 4151 had small variations both in the continuum and in blends in the low phase of the activity. In a time scale of days-months continuum fluxes had amplitudes of variability about 15% in January–April. The brightness extension up to 30% recorded on May 13 and May 14 may be unreliable as a consequence of the variations of the atmospheric trasparency on this dates.

Our results are in sufficient agreement with data of other observers of NGC 4151 (Solomos *et al.*, 1990; Guseinov, 1988; Lyuty *et al.*, 1989; Maoz *et al.*, 1991; Sergeev, 1994).

References

Abramenko, A. N., Alexandrin, Ju. S., Prokof'eva, V. V., and Yakushin, V. N. (1982) In: C. M. Hamphries (ed.), *Instrumentation for Astronomy with Large Optical Telescopes*, Proceedings of the IAU Colloquium **67**, Reidel Publishing Company, Dordrecht, p. 175.

Abramenko, A. N., Prokof'eva, V. V., Bondar, N. I., Mayer, V. A., Pavlenko, E. P., and Sharipova, L. M. (1988) *Izv, Krim. Astrofiz. Obs.* **78**, 182.

Barnes, J. V. and Hayes, D. S. (1984) *IRS Standard Star Manual*, Kitt Peak National Observatory.

Guseinov, N. A. (1988) *Astron. Circ.*, No. 1533, 1.

Lyutv, V. M. (1972) *Astron. Zh.* **49**, 930.

Lyuty, V. M., Oknyanskij, V. L., and Chuvaev, K. K. (1984) *Sov. Astron. Lett.* **10**, 335.

Lyuty, V. M. and Oknyanskij, V. L. (1987) *Astron. Zh.* **64**, 465.

Lyuty, V. M., Aslanov, A. A., Volkov, I. M., Kolosov, D. E., and Khrusina, T. S. (1989) *Sov. Astron. Lett.* **15**, 87.

Maoz, D., Hetzer, H., Mazeh, T. *et al.* (1991) *Astrophys. J.* **367**, 493.

Oknyanskij, V. L., Lyuty, V. M., and Chuvaev, K. K. (1994) In: T. J.-L. Courvoieier and A. Blecha (eds.), *IAU Symp. 159, Multi-wave Length Continuum Emission of AGN*, Kluwer, Dordrecht, p. 401.

Pronik, V. I. and Sharipova, L. M. (1993) *Author's Certificate*, No. 1822932, Patent USSR, Moscow.

Prokof'eva, V. V. and Sharipova, L. M. (1996) *Astrofizika* **39**, 101.

Prokof'eva, V. V. and Sharipova, L. M. (1997) *Kinematics and Physics of Heavenly Bodies* **13**, 82.

Sergeev, S. G. (1994) *Astron. Rep.* **38**, 162.

Sharipova, L. M. and Prokof'eva, V. V. (1998) *Astrofizika*, in press.

Solomos, N. H. (1994) In: T. J.-L. Courvoieier and A. Blecha (eds.), *IAU Symp. 159, Multi-wave Length Continuum Emission of AGN*, Kluwer, Dordrecht, p. 405.

Solomos, N., Whitehead, M. J., Meaburn, J. *et al.* (1990) *Astron. Astrophys.* **229**, 80.