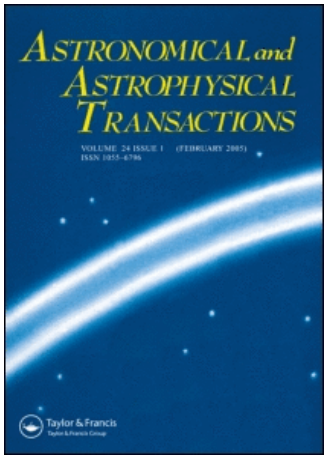

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Night-to-night variation in the emission lines of the nucleus spectrum of the Seyfert galaxy NGC 3227

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Night-to-night variation in the emission lines of the nucleus spectrum of the Seyfert galaxy NGC 3227

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The results of the emission line study of the optical spectrum of the Seyfert galaxy NGC 3227 nucleus are presented. 53 spectra obtained during the maximum nucleus brightness on 12–15 January 1977 with the 6 m telescope were the basis of the investigations. It was shown that the profiles of the hydrogen lines broadened during 3 days. The amounts of broadening at the 0.5 intensity level of the Hα, Hβ and Hγ line profile peaks were 12, 35 and 44%, respectively. The Hβ line profile broadening was accompanied by a decrease in its equivalent width EW_β. The increase in the eqiuvalent width $EW_{[O\ III]}$ of the [O III] line during 3 days was more than 3σ. It was assumed that a 3 day flare is observed in the galaxy nucleus, which could be caused by shock in long-lived flows from the galaxy nucleus.

Keywords: Seyfert galaxies; Variability in the emission lines; Nucleus spectrum

1. Introduction

NGC 3227 is the bright member of the NGC 3226–NGC 3227 pair of galaxies. The variability of the continuum flux and the changes in the Seyfert type of the nucleus have been observed by many researchers. The *UBV* observations compiled for 1967–1979 by Quisbert *et al.* [1] showed an essential increase in the nucleus brightness magnitude ($\Delta U \approx 1$) in 1975. The high brightness maximum lasted during 1975–1979. A 2 day flare of brightness magnitude $\Delta U = 0.5$ was recorded by Lyuty [2] in April 1976. Variations in the Hβ flux emission and the continuum flux emission by 70 and 200%, respectively over 2 years in 1980–1982 were obtained by Rosenblatt *et al.* [3].

2. Observations

The spectra of the NGC 3227 nucleus during the extreme maximum brightness were observed on 12–15 January 1977. 53 spectrograms in the spectral region 3700–7300 Å were obtained

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by V.L. Afanas'ev with the 6 m telescope. The entrance slit width was about 1″. The linear dispersion was 93 Å mm^{-1}. The spectral resolution (full width at half-maximum of the 6300 Å line in the night sky) was about 8 Å. The observational seeing was 1–3″. The profiles of the hydrogen emission lines and the equivalent widths EW$_\lambda$ of the $H\delta$ + [S II] (4068 + 4076 Å), Hγ + [O III] (4363 Å), Hβ, [O III] (4959 + 5007 Å), Hα + [N II] (6548 + 6584 Å) and [S II] (6717 + 6731 Å) emission lines and blends were obtained by this treatment.

3. Observational data based on two papers

The main results of the first paper published by Pronik and Metik [4] are the following.

(i) The profiles obtained for the Hα, Hβ and Hγ lines have different shapes. They provide evidence of the highly self-absorbed gas that emits these lines.
(ii) Profiles of the Balmer lines contain narrow emission components which keep their position over 25 years. It was assumed that they can be caused by long-lived gas flows or streams.
(iii) Data on the Hα, Hβ and Hγ line profiles and their EW$_\lambda$ variability allow us to assume that a 3 day flare is observed in the galaxy nucleus.
(iv) The variable profiles of the emission hydrogen lines have the inverse Balmer decrement.

The basis of the first part of the work on the 3 day flare was only the extreme shape of the Hα, Hβ and Hγ line profiles which were narrower on 12 January 1977 than on 14 January 1977. Also the EW$_\lambda$ values of these lines were higher on 12 January 1977 than on 14 January 1977. The aim of our investigation is to support the results obtained in [4] using all the observational data.

4. Results obtained on the basis of all observational data from 12–15 January 1977

4.1 *Profiles of the emission Balmer lines and their width changes*

The series of Hα, Hβ and Hγ line profiles are presented. The profile widths of these lines were measured at the 0.25 and 0.50 intensity levels with respect to the peak intensity. The profiles obtained showed two width groups. The line profiles of the first group on 13 and 14 January 1977 were broader than those of the second group on 12 and 15 January 1977 (figure 1). The amounts of broadening of the Hα, Hβ and Hγ line profiles at the 0.5 intensity level were 12, 35 and 44%, respectively. It can be assumed that the velocity of the gas for the Balmer emission lines was higher for 13 and 14 January 1977 than for 12 and 15 January 1977.

4.2 *Equivalent widths*

The EW$_\lambda$ values for the Hδ + [S II] (4068 + 4076 Å), Hγ + [O III] (4363 Å), Hβ, [O III] (4959 + 5007 Å), Hα + [N II] (6548 + 6584 Å) and [S II] (6717 + 6731 Å) emission lines and blends obtained for ten observational series did not show simultaneous changes. Changes in the Hβ equivalent width EW$_\beta$ are given in figure 2. A decrease in EW$_\beta$ can be seen from 12 to 13 January 1977. During this time the Hβ peak shifted to the blue part of the profile. Figure 3 shows simultaneous decreases in EW$_\beta$ and EW$_{[O\ III]}$ from 12 to 13 January (from 1 and 2 observational days). The increase in EW$_{[O\ III]}$ from 13 to 15 January was more than 3σ

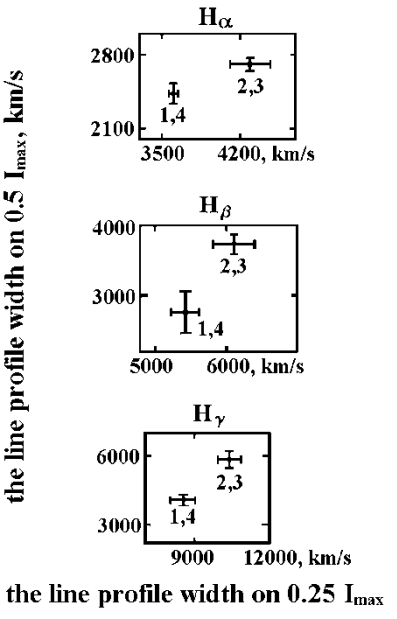

Figure 1. Changes in the width of the Hα, Hβ and Hγ line profiles at the 0.25 and 0.50 intensity levels on 13 and 14 January 1977 (2 and 3 observational days) compared with 12 and 15 January 1977 (1 and 4 observational days)

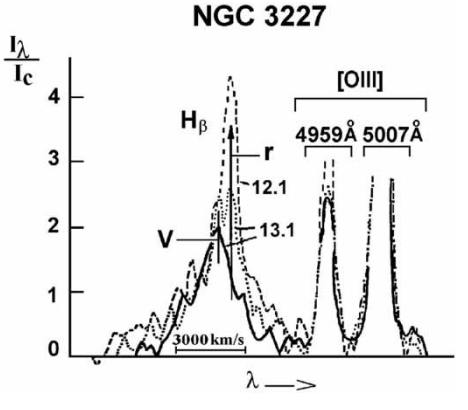

Figure 2. Decreases in the equivalent width of the Hβ line and changes in the shape of its profile between 12 and 13 January 1977.

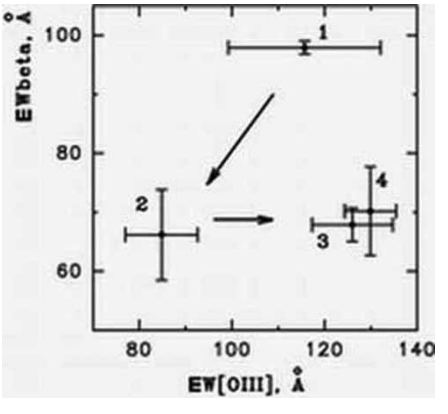

Figure 3. Variations in EW_{β} and $EW_{[O\ III]}$ from 12 to 15 January 1977: 1, 2, 3 and 4 are the same as in figure 1.

whereas EW_β was almost constant. This allows us to speculate that there was a 3 day variation in the [O III] flux.

5. Conclusions

(i) Ten series of the Hα, Hβ and Hγ emission line profiles obtained during the maximum brightness of the NGC 3227 galaxy nucleus on 12–15 January 1977 are presented.

(ii) Changes in the Hα, Hβ and Hγ line profiles were recorded from all observational data. Changes between the values for 13 and 14 January 1977 and those for 12 and 15 January 1977 were obtained.

(a) The amounts of broadening of the Hα, Hβ and Hγ line profiles at the 0.50 intensity levels of the data-averaged profile peak were 12, 35 and 44%, respectively. The amounts of broadening of the broadest profile and the narrowest profile in the whole series were 120 and 55%, respectively [4].

(b) The Hβ line profile broadening was accompanied by a decrease in its equivalent width.

(c) The absence of synchronous changes in the EW_λ values of the Hδ + [S II] (4068 + 4076 Å), Hγ + [O III] (4363 Å), Hβ, [O III] (4959 + 5007 Å), Hα + [N II] (6548 + 6584 Å) and [S II] (6717 + 6731 Å) emission lines and blends was demonstrated. This fact allows us to assume that there was no variation in the continuum flux.

(d) It was noted that EW_β and $EW_{[O\ III]}$ decreased from 12 to 13 January 1977 by factors of 1.5 and 1.4 respectively. Then, from 13 to 15 January 1977, $EW_{[O\ III]}$ increased by a factor of 1.5 or more (3σ) whereas EW_β was almost constant. This fact allows us to speculate that there was a 3 day flux variability of the [O III] lines.

The results of the emission line study on the optical spectrum of the Seyfert galaxy NGC 3227 allows us to assume that a 3 day flare on 12–15 January 1977 was observed in the galaxy nucleus. We speculate that the flare could have been caused by shock in long-lived flows from the galaxy nucleus.

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