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Long and short-term variability of the emission lines in the nuclear spectrum of the Seyfert galaxy NGC 7469

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Abstract. 23 spectrograms of the nucleus of the Seyfert galaxy NGC 7469 in the optical region have been obtained at the prime focus of the 6-m telescope during 1977 January 13–15, while the nucleus was at minimum brightness. Spectral dispersion was $\sim$ 95 Å/mm, spectral resolution $\sim$ 8 Å. Equivalent widths, relative intensities and profiles of the emission lines H_γ, H_β, [OIII]$\lambda\lambda$ 4959, 5007ÅÅ, (H_α+[NII]) and [SII]$\lambda\lambda$ 6717, 6731ÅÅ were studied to reveal their night–to–night variability. The variations were found of profiles of Balmer lines, of relative intensities (H_α+[NII])/H_β, and of [OIII](4959+5007)/H_β. We suppose that this variability is produced by gas flares, with durations of several days. We have compared the obtained spectral properties of the nucleus with published colours and spectral properties observed by other authors during 1943–1986. The relation and character of variability of the line ratios (H_α + [NII])/H_β and [OIII]/H_β on neighbouring nights are the same as for monthly and annual observations. Profiles of the Balmer lines contain variable components keeping their positions during 20 years. These can be understood as reflecting the ingredients in the gaseous structure of the NGC 7469 nucleus, which change their brightness with time without changing their velocities.

Key words: galaxies: NGC 7469 – Seyfert – lines: profiles

1. Introduction

NGC 7469 is a well-known Seyfert 1 galaxy having a huge circumnuclear zone of recent star formation. One of the latest reviews of its characteristics is given by Doroshenko et al. (1994). The nucleus shows remarkable similarity with other active galactic nuclei (AGN) in short-term variability of the optical continuum. Dibaj and Lyuty (1984) found that there are flares in the nuclear optical continuum of NGC 7469 on a time scale of 17±4 days. Later observations revealed variability on shorter time scales. Aslanov et al. (1989) observed quasi – periodic ($2\overset{d}{.}281$) and chaotic ($10^m - 15^m$) variations. Doroshenko et al. (1989) found variations within one night. Variability on a time scale of 5 – 7 days was observed by Dultzin–Hacyan et al. (1992). Through a $5''$ diaphragm in the photometric system V, the typical amplitude was about $0\overset{m}{.}4$. X–ray variability on time scales of days and hours was observed by Marshall et al. (1981), Baar (1986), Walter and Fink (1993), Brandt et al. (1993). This variability can produce the short-time variability of the emission lines. It was shown that the time scale of Balmer decrement variation of the nucleus in question is not more than 20 days (Pronik 1975). In this paper, we discuss the results of three nights of spectral observations of the nucleus of NGC 7469 with the purpose to reveal night–to–night variations of the emission lines and to compare their characteristics with those of long-term variability found in the literature.

2. Observations

23 spectra of the nucleus of NGC 7469 within the range 3700–7300 ÅÅ were obtained on 1977 January 13–15 at the prime focus of the 6-m telescope using the high speed spectrograph UAGS equipped with the threestage image–tube UM–92 having a multialkali photocathode. The grating had 650 lines/mm. The detector at the image–tube was an A–600 film. The resulting linear dispersion on the film in the spectral range 3700–7500 Å was $\sim$ 95 Å/mm, spectral resolution (full width at half maximum – FWHM of the night sky line at 6300 Å) $\sim$ 8 Å. The scale on the film perpendicular to the spectral dispersion was $17\overset{''}{.}5$ per mm. Using the same setup as for the nucleus of NGC 7469, we observed spectra of the star i Per, to derive the spectral sensitivity of the equipment. Spectra of the planetary nebula IC 351 and of the night sky were taken to estimate the photometric errors. The Journal of the spectral observations is given in Table 1. Its columns contain: 1 – date, 2 – middle time of the observations (UT), 3 – spectral range, 4 – exposure time, 5 – seeing estimate.

The spectra were taken, calibrated, reduced and measured following essentially the same procedure described by Afanas'ev and Pimonov (1981), by Merkulova and Pronik (1983), by Metik and Pronik (1988). Films were calibrated using a step attenuator and developed using a fine–grain developer. Spectra and background were scanned using the micropho-

Table 1. Journal of observations

Date, 1977 Jan	UT	Range of wavelenth,Å	Expos., min	Seeing
13	16^h 50^m	3700 – 4900	1.0	$1'' - 2''$
	16 55	3700 – 4900	4.0	
	17 00	4000 – 5800	1.0	
	17 08	5300 – 7300	7.0	
	17 18	5300 – 7300	5.0	
	17 25	4000 – 5800	2.0	
	17 28	4000 – 5800	1.0	
	17 34	3700 – 4900	4.0	
14	17 18	3700 – 4900	1.0	$2'' - 3''$
	17 23	3700 – 4900	7.0	
	17 27	3700 – 4900	3.0	
	17 29	4000 – 5800	1.0	
	17 30	4000 – 5800	1.5	
	17 33	4000 – 5800	2.5	
	17 35	5800 – 7300	0.75	
	17 37	5800 – 7300	1.5	
15	16 03	3700 – 4900	1.0	$1.5''$
	16 06	3700 – 4900	2.5	
	16 07	4000 – 5800	0.75	
	16 08	4000 – 5800	1.5	
	16 17	5300 – 7300	0.7	
	16 19	5300 – 7300	1.3	
	16 20	5300 – 7300	2.5	

tometer MF-2, the aperture of which projected on the film was 4Å×1.″8. Microphotometer tracings were treated with the application package by B.A. Burnasheva, utilizing only the straight line portion of the characteristic curve and automatic subtraction of the background. Equivalent widths (W_λ) and profiles of the emission lines were obtained as a result of this treatment.

The spectra of the planetary nebula IC 351 were used to estimate the uncertainty in the equivalent widths of the emission lines. In these spectra, emission lines of different intensity were selected. They were in the interval (0.03–2.0), taking as unit the equivalent width of H_β. Standard errors of W_λ were different: 5 % for bright lines, up to 33 % for weak ones.

3. Possible night–to–night emission line variability in NGC 7469 nucleus

3.1. Equivalent widths

Equivalent widths W_λ of the emission lines averaged by night are quoted in Table 2 and are shown in Fig. 1, where σ is the mean square deviation from the average W_λ. We have compared σ presented in Table 2 with the errors corresponding to the values of W_λ obtained from the spectra of IC 351. Expected values of σ are not more than 15 %. Almost all calculated values of the standard deviations, which characterize the scattering of W_λ inside one night, were found to correspond to the expected ones. Two lines exhibited a scattering in W_λ higher than expected: [OIII] λ 4959 more than 30 % for each of the three nights and (H_γ + [OIII]) more than 35 % in two nights. High scattering of W_λ ([OIII] λ 4959) can be caused by the difficulty of obtaining the "continuum" level. In addition, the line is located on the red wing of H_β, which exhibits variations from night to night. Influence of this factor cannot be calculated exactly. High scattering of W_λ of (H_γ + [OIII]) is hard to understand. We suspect variation of this line during the night, but it is necessary to have more observational data within separate nights to test this supposition.

In Fig. 1 and Table 2, one can see the systematic increase of W_λ of the emission lines H_β and [OIII]$\lambda\lambda$ 4959, 5007ÅÅ from January 13 to 15 and of (H_α+[NII]) blend from 1977 January 14 to 15. At the same time, W_λ of the H_γ and [SII] lines smoothly decreased. Confidence levels of the W_λ variations are given in the last column of Table 2 (the formalism is taken from Kron & Kron 1968). High confidence levels permit one to conclude that there was a night–to night increase of the W(H_β), W([OIII]λ 5007), W(H_α +[NII]) lines and decrease of W([SII]) lines.

We cannot explain the different direction of the W_λ variation for different emission lines in the nucleus of NGC 7469 as a result of continuum variation. Long – term UBVR observations by Doroshenko et al. (1989) show that the direction of continuum variation is the same for all photometric bands, a difference existing only in the amplitude variations. Their evidence favours the idea that during 2 days there were variations of the emission line fluxes either of H_β, [OIII] 5007 and (H_α+[NII]) or of [SII] 6717+31Å.

A generally-accepted hypothesis is that forbidden lines are not variable on short time scales. In fact, their fluxes are often used for scaling spectrophotometric data in AGN (Baribaud & Alloin 1990). Fig. 1 and Table 1 show that in this case forbidden lines behaved in different ways: W (5007) increased with the time, while W ([SII]) decreased. It is interesting that a similar night–to–night variation of these forbidden lines was observed in the nuclear spectrum of NGC 1275 (Merkulova & Pronik 1985). In the case of NGC 7469, we must conclude that at least one of the forbidden lines [OIII] or [SII] was variable. In any case, the Balmer lines showed night-to-night variation.

3.2. Profiles of the emission lines

We have compared the profiles of the Balmer lines H_γ, H_β, H_α obtained on 1977 Jan 13 after normalization to the peak intensity, Fig. 2. The profile of H_γ is the most distinguished from the others. The levels of its blue and red wings were essentially higher than those of the H_β and H_α lines. Contribution of noise to the level of the H_γ wings cannot influence this effect. The value of the noise is not more than the error of the mean profiles of this line exhibited in Fig. 3. Full width at zero intensity (FWZI) of the H_γ line is equal to about 10 000 km/s, but FWZI of H_β and H_α lines $\sim$ 8500 km/s. This effect is caused by the H_γ wings, which are longer than those of the other Balmer lines by about 1500 km/s. We call the long H_γ blue wing"extrablue". Blue wings of H_β and H_α lines fall in the limits of the errors, but the red wing of the H_β line is a little higher than the H_α one.

Table 2. Equivalent widths of emission lines in the spectrum of NGC 7469 nucleus on 1977 January 13–15

line, Å	ion	January 13			January 14			January 15			CL
		n	W, Å	σ, Å	n	W, Å	σ, Å	n	W, Å	σ, Å	%
1	2	3	4	5	6	7	8	9	10	11	12
4340 + 63	H_γ + [OIII]	3	56.4	11.7	6	50.6	10.0	5	35.8	1.9	93
4570	Fe II	3	20.8	0.5	6	24.9	1,5	5	17.2	0.9	99
4686	He II	2	30.2	3.4	3	26.8	2.6	2	26.7	2.7	84
4861	H_β	3	70.3	6.1	3	96.3	8.5	2	138	4.6	99.9
4959	[OIII]	3	23.4	5.0	3	29.2	6.4	2	35.3	8.1	88
5007	[OIII]	3	63.3	3.0	3	88.3	17.9	2	105	23.5	99
brw 5007	[OIII]	3	7.4	0.8	3	8.9	1.3	2	19.9	3.3	99.9
6300	[OI]	1	15.7	–	1	3.7	–	1	9.4	–	–
6563 +49+84	H_α + [NII]	2	303	2.1	2	299	44.0	3	495	23	99.9
6717 + 31	[SII]	2	27.7	8.0	2	20.9	0.5	3	15.3	2.0	96

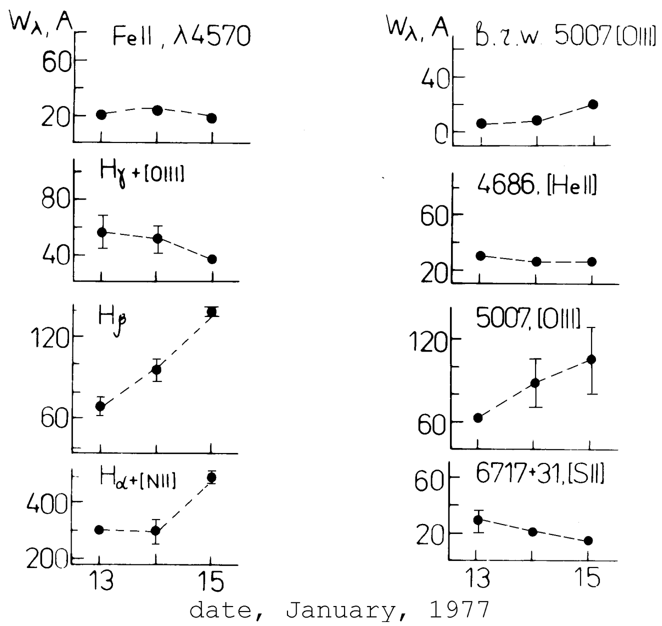

Fig. 1. Equivalent widths of the emission lines of the nuclear spectra of NGC 7469, taken on 1977 Jan 13–15 and averaged within each night of observation. Bars (σ) are mean square deviation from the average. *brw* – broad red wing

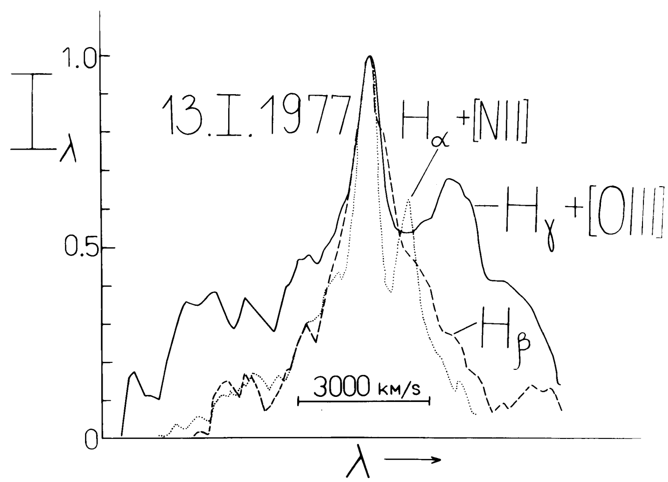

Fig. 2. Comparison of the profiles of the nuclear emission lines (H_α + [NII]), H_β and H_γ of NGC 7469, obtained on 1977 Jan 13. Intensities are normalized to the peak value

The shape of the central peak of the H_β line profile reveals duplicity. The distance between the components is 4 Å (250 km/s), or 0.5 FWHM of the line profile of the night sky. The narrow H_γ and H_β components are equal in width, but both are twice that of H_α

Fig. 3a,b show that there was evolution of the profiles of the Balmer lines from Jan 13 to 15: the H_γ profile lost its extrablue wing, [OIII] λ 4363 disappeared or strongly decreased, and the narrow component of H_β became narrower and equalized with the instrumental profile. It looks as though the narrow blue component of H_β has disappeared. Fig. 3b supports this assumption: it shows a gradual decrease of the narrow blue component and increase of the red one. From Jan 13 to 15, there were changes in the H_β and H_α broad wings, which became higher over the continuum. One can suspect variation of the relative intensities of the narrow H_α and [NII] lines. Our data do not permit to separate this effect from variation of the central part of the broad H_α component. After looking at Fig. 1 and at the lower left of Fig. 3a, one can conclude that intensities of H_β and [OIII] lines are increased by the same factor but [SII] lines are decreased.

4. Comparison with the data of long-term variability

Spectral observations of NGC 7469 on 1977 Jan 13–15 fell exactly on a brightness minimum of the nucleus. We now compare our data with those of other phases of the nuclear brightness taken from the literature. Comparison was made for profiles and relative intensities of the emission lines calculated using the equivalent widths from Table 2 and taking into account the shape of the continuum on 1977 January 13–15. Therefore, we shall discuss the problem of continuum shape in the optical region of the NGC 7469 spectrum.

4.1. Energy distribution in the optical continuum of NGC 7469

We are interested in relative intensities of [OIII](4959+5007)/H_β and (H_α+[NII])/H_β. Neighboring positions of the first pair of lines permits one to calculate their relative intensities using their W_λ. For calculating the second ratio, we must know the relative intensities of the continuum in the regions 4800Å and 6600Å. The shape of the continuum depends on the phase of the nuclear brightness and on the aperture used for the observations. Observations of Granato et al. (1993) showed that the nucleus is much brighter than the image of host galaxy. Their CCD measurements obtained at an epoch of rather low nuclear brightness indicated that the nucleus contribution inside a 5″diaphragm is very high and corresponds to 89%, 83% and 78% of the total luminosity in the BVR bands, respectively.

Fig. 4 shows the shape of the optical continuum of the NGC 7469 nucleus compiled from the literature. Apertures during the observations were: 8″ – Anderson (1970); 7″ – Wampler (1971); 10″– de Bruyn and Sargent (1978); 25″ – Doroshenko and Terebizh (1983) (hereafter DT). All observations were photoelectric, errors of the absolute flux as given by different authors are not more than 5 %. To compare the shape of the continuum, we have normalized each of the spectra to the red part of the continuum at λ5500Å. One can see that the greatest differences were observed in the UV part of the continuum.

In Fig. 4, we brought the shape of continuum into correspondence with the colour index $(U-B)$ obtained in diaphragms 25″– 27″, using observational data by DT, Penfold (1979) and Lyuty (1972, 1977). One can see that the shapes of the continuum in Fig. 4 correspond to the colour indexes in the limits of $-0\overset{m}{.}39 > (U-B) > -0\overset{m}{.}56$. This range of colour indexes include almost all their values corresponding to phases of nucleus activity from minimum to maximum. Three continuous lines in Fig. 4 correspond to the maximum, middle phase and minimum of the nucleus brightness. For our purpose, the shape of the optical continuum is required only in the region 6600 – 4800 ÅÅ. Fig. 4 shows that it is almost constant for a wide range of colour indexes $(U-B)$ of the nucleus and diaphragm dimensions. Relative intensities of the continuum in two regions λ 4800Å and λ 6600Å do not depend on the phase of the nucleus activity or on the size of the aperture used.

DT observed the nucleus of NGC 7469 in 1976 December – 1977 December, when the nucleus was in a minimum phase as at the time of our spectroscopic observations. The same was done by Anderson (1970) and his observations agree with those of DT in the range 4800–6600Å. The corresponding colour index of the nucleus was $(U-B) = -0\overset{m}{.}39$. We can then use the continuum distribution suitable to this colour index for the dates 1977 Jan 13–15.

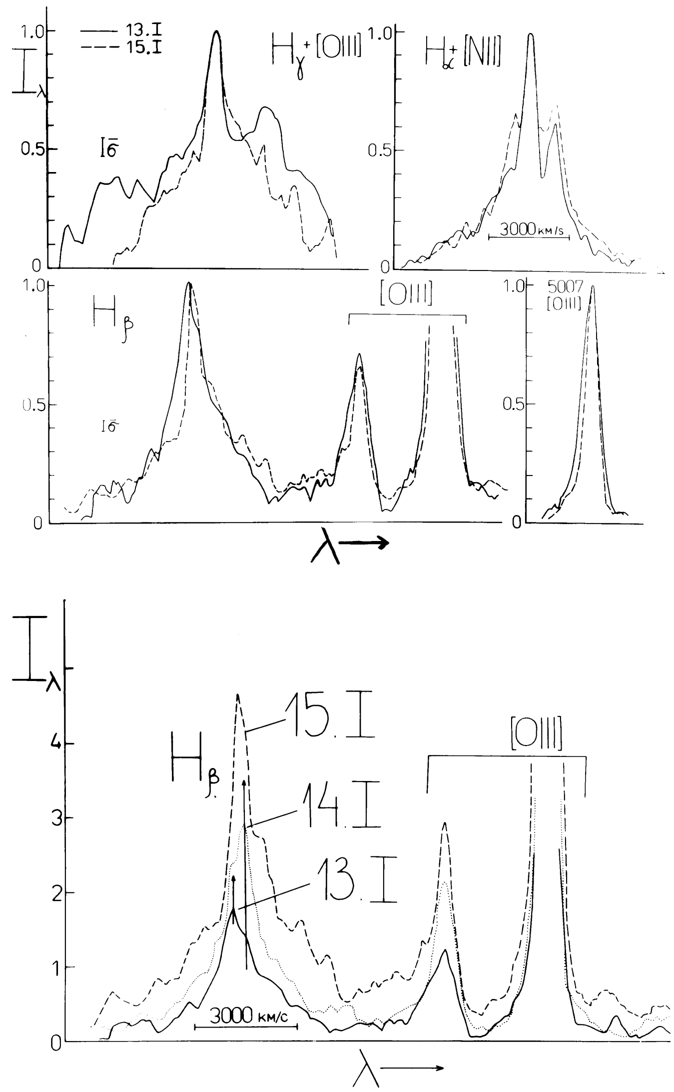

Fig. 3a and b. Profiles of emission lines in the spectrum of NGC 7469 nucleus averaged during one night: **a** (top) — calibrated in peak units; bars on the left of each plot are the average errors, **b** (bottom) — calibrated, taking as unit the intensity of the continuum $(I_\lambda)_c$

4.2. Relative intensities of emission lines

Using W_λ of emission lines from Table 2 and the continuum shape by DT and Anderson (1970), we have calculated the relative intensities of the lines [OIII](4959+5007)/H_β and (H_α + [NII])/H_β and compared them in Fig. 5 with those obtained for the NGC 7469 nucleus by other authors. Data for minima are shown by crosses, for maxima by dots. One can see that there are different relations of the ratios for minima and maxima of the NGC 7469 nucleus. Fig. 5 shows that there are five cases of observations carried out at minimum on neighboring nights: our observations on 1977 Jan 13–15 and observations by DT on 1977 Sept 21 and 22. The five pairs of ratios [OIII](4959+5007)/H_β and (H_α+[NII])/H_β fit to the relationship for the minimum phase very well.

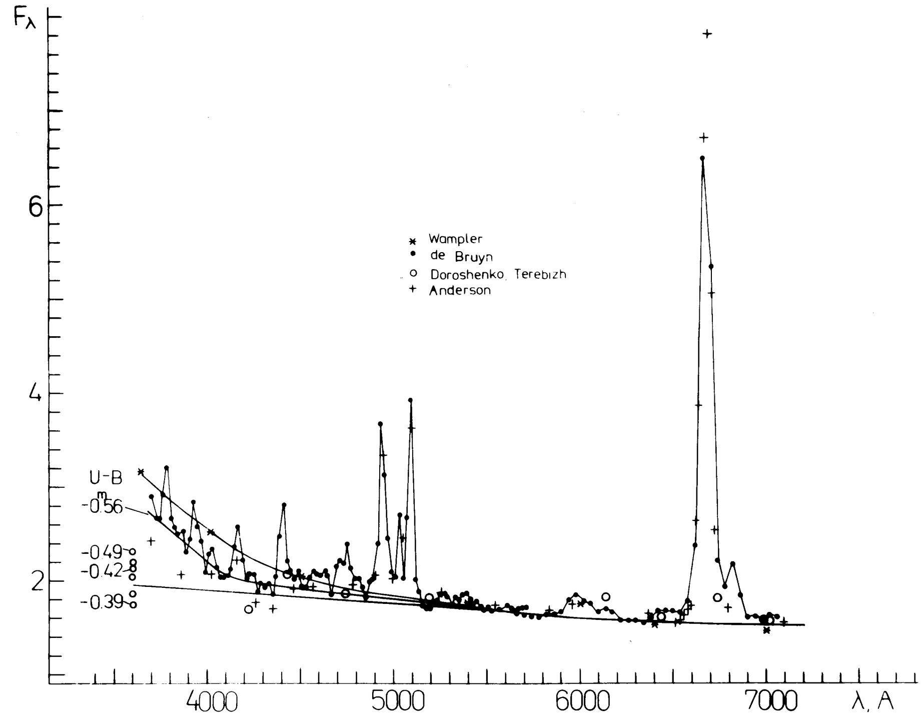

Fig. 4. Energy distribution of the nuclear continuum of NGC 7469 in arbitrary units according to data of Anderson (1970), Wampler (1971), de Bruyn and Sargent (1978), DT. Colour indexes are as obtained by DT and Penfold (1979) (see text). The three continuous lines correspond to the shape of the continuum at maximum, intermediate stage and minimum of nuclear brightness

4.3. Profiles of the emission lines

In Fig. 6, we compare the profiles of the emission lines H_γ, H_β and [OIII] $\lambda\lambda$ 4959, 5007 obtained for the NGC 7469 nucleus on 1977 January 13–15 with the profiles observed by other authors in 1943–1989 for different phases of the nucleus brightness. Fig. 6a shows the data of 1977 and 1975. Barbieri et al. (1977) supposed that the profile of the H_β line in the phase of extreme high nucleus brightness consists of two components: "c"(central) and "a" with a separation of about 25 Å, or 1500 km/s. One can also see details "b" and "d" in the H_β profile, separated from the "c" component by +7Å (+500 km/s) and by – 6 Å (−350 km/s), respectively. All components are present in the H_γ profile as well: "a" and "b" as emission, "d"– as a blue asymmetry of the narrow component. The components "a – d" of the profiles at maximum (Fig. 6a) appear in the profiles of the H_γ and H_β lines on 1977 Jan 13–15 as small shoulders, or steps. The profile of H_γ on Jan 13 indicates the features of maximum profile: high level of red and blue wings and long blue wing. These features are not caused by effects of noise on the wings of the line. The level of the noise is less than the error shown in the left top picture of Fig. 3a.

Normalization of H_β profiles obtained on 1977 Jan 13–15 was made taking as reference their peak intensities. The normalized profile of 1975 Oct was multiplied by a factor 1.35 to enhance the features to be compared. It appears that the FWHM of the H_β profiles on 1977 Jan 13–15 was around half the FWHM of the maximum profile. We suppose that this could be associated with the fading of the components "a" and "d".

Fig. 6b exhibits the comparison of the profiles obtained in 1977 with those of 1973 and 1943. It shows that the H_β profile of 1977 Jan 15 is similar to that of the middle phase of the nuclear brightness obtained on 1973 Aug 24, but its profile on 1977 Jan 13 is closer to the profile obtained by Seyfert at the beginning of the 1940s. Widths of [OIII] λ 4959, 5007 Å lines are similar for all dates on 1977 Jan 13–15, 1973 Aug 24, and the 1940s.

Fig. 6c compares the profiles of 1977 with those of 1989. At the end of 1989, Chuvaev et al. (1990) observed the nucleus of NGC 7469 during 3 – 4 months in deep minimum. The broad wings typical to the profile of the H_β line were almost lost. Fig. 6c shows that this profile in 1989 became typical of a Seyfert 2 galaxy. It is interesting that it contains emission details in the region of "a" and "b" components and a little plateau in the region of the "d" component, all features revealed in the maximum phase. According to Fig. 6c, the profiles of the H_β line observed on 1977 Jan 13–15 do not repeat the profile of the deep minimum phase.

All data presented in Fig. 6 permit us to support the assumption by Pronik (1975) that the profiles of the H_γ and H_β lines in the nucleus of NGC 7469 contain components keeping their positions relative to the central peak during the last 20 years. The intensities of the components during the maximum phase are comparable to the intensity of the central peak and become one degree of magnitude fainter in deep minimum. These components appear to reflect the gaseous structure of the nuclear region of NGC 7469, where emitting gas clouds change their emissivity without changing their velocities.

Thus our data showed that spectra of the nucleus of NGC 7469 obtained on 1977 Jan 13–15 during the minimum brightness of the nucleus have features between those shown at extreme maximum and deep minimum.

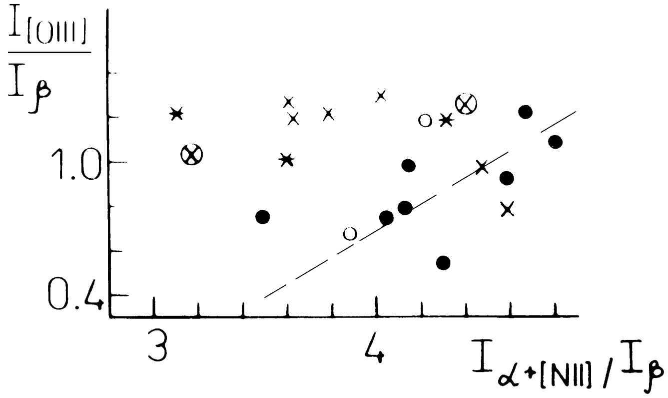

Fig. 5. Relations of the emission line ratios in the NGC 7469 nucleus spectrum during minima (crosses) and maxima (filled dots) of brightness, according to Anderson (1970), Wampler (1971), Martin (1974), Pronik (1975), Osterbrock (1977), Phillips (1978), DT, Westin (1985), Morris and Ward (1988), Fricke and Kollatschny (1989), Bonatto and Pastoriza (1990). Circles – unknown dates of observation; crosses in circles – two neighboring nights in minimum 1977; stars – 1977 Jan 13–15, this work. The broken line is the regression line for filled dots

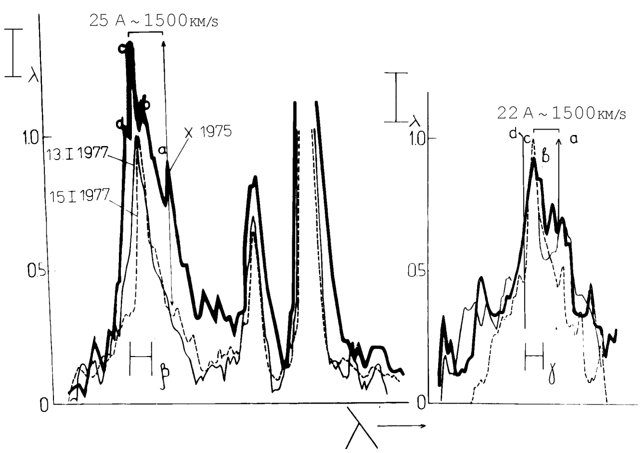

Fig. 6. Comparison of the profiles of the emission lines of NGC 7469 obtained on 1977 Jan 13–15 with those of different phases of the nuclear brightness: **a** extreme maximum on 1973 October 25 (Barbieri et al.1977)

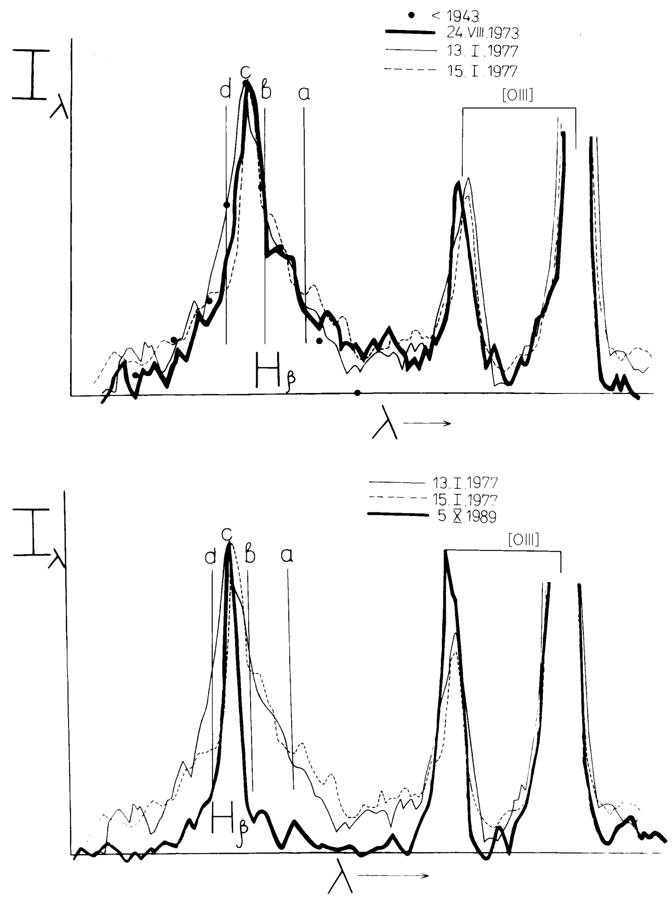

Fig. 6. b (top) phase between maximum and minimum on 1973 August 24 (Chuvaev et al. 1990), points show data obtained by Seyfert (1943), **c** (bottom) deep minimum in 1989 October (Chuvaev et al. 1990). a, b, c, d – details on the profiles are discussed in the text. All profiles are normalized to units useful for their comparison

5. Discussion

5.1. Bursts during the minimum nuclear brightness

We suppose that the emission line variability of the nucleus of NGC 7469 at minimum brightness, observed on 1977 Jan 13–15, is connected with a short optical and/or X flare, which likely occurred before those dates. Unfortunately, we do not know when it occurred, we can only speculate about its development before Jan 13. At this date, we have observed the properties of emission lines that were not typical of extreme minimum phase: high level of the H_γ broad wings (its blue broad wing is about 1500 km/s more extended than in the H_β and H_α lines), bright [OIII] λ 4363 line and bright blue component of the narrow H_β line. All of these peculiarities could be due to a flare in the nuclear gas occurring before 1977 Jan 13. On the other hand, according to Fig. 5, the line ratios [OIII](4959+5007)/H_β and (H_α + [NII])/H_β were typical of the extreme minimum phase.

There is a widely diffused opinion that the narrow components of the emission lines in the spectra of AGN are produced by streams and flows of gas, with size of several lightyears or more. Our last investigations led us to the conclusion that the narrow line region (NLR) of the AGN contains a variable part, with dimension less than one lightmonth. A month time variability of the NLR in NGC 7469 was suspected by Pronik (1975). Now we have observed two narrow H_β components, variable on a time scale of several days. We suppose that they are observational evidences of two variable streams in the nucleus of NGC 7469. In this case, the radial velocity of the stream, emitting H_β light, is about – (50 – 70) km/s compared to the recession velocity of the galaxy (Wilson et al. 1986). The difference in radial velocity of the two components is 250 km/s, comparable within the error limits to the value 180 km/s — observed by Ulrich (1972) in the profiles of H_α and [NII] λ 6584. The difference between the H_β and [OIII] λ 5007 blue shifts compared to the recession velocity of the galaxy is 180 km/s (Wilson et al. 1986). One can suppose that this difference in blue shift is caused by different contributions of different H_β narrow components during quiescent and flaring stages of the nucleus. In fact, if measurements of the shifts of the H_β and [OIII] λ 5007 lines were made in quiescent stage, the H_β blue component would be faint, and the center of the line profile would then be shifted towards the red. It is interesting that the same result was obtained for Akn 120: the velocities of the [OIII] $\lambda\lambda$ 4959, 5007 lines coincide with those of the blue component of H_β (Schulz & Rafanelli 1981).

Two variable H_β components show that two gas streams in the NGC 7469 nucleus have been acting for not less than a dozen years. Prevalence of "blue" or "red" components varies with time. Sometimes one or both are observed in H_α light, but not always simultaneously with the H_β ones, indicating that the emitting gas is opaque.

Variations in streams influence the nearby gaseous regions. As an example, brightening of the narrow blue H_β component on 1977 Jan 13 was accompanied by an increase in the intensity of the broad H_γ wings. At the same time, the extrablue wing of H_γ extended up to velocities of 3500 – 5000 km/s compared to the velocity of the stream. An extrablue component was never observed in the profiles of H_β and H_α lines during low and intermediate nuclear brightness. One could argue that the gas from which arises the extrablue H_γ wing emits radiation of inverse Balmer decrement. This gas could also be opaque and hot plasma (T_e = 25 000 K, $n_e = 10^{12} – 10^{14}$ cm^{-3}) ionized and excited mainly by collisional processes (Gershberg & Shnol 1974), produced by shock fronts connected with the burst. The presence of two subregions with very different physical conditions in the BLR of NGC 7469 was already suggested by Pronik (1975), Westin (1985) and Doroshenko et al. (1994). The last two authors found a systematical increase of the FWHM from H_α to H_γ lines.

Regions of broad H_β and H_α lines are heated several days after the beginning of the burst. What is the source of heating? We can speculate that it can be a radiative ionization and excitation by ultraviolet and/or X – ray photons emitted by the burst. Asynchronous variations of the nuclear Balmer lines H_γ, H_β and H_α evidenced that the emitting gas is opaque in the Balmer lines and that its physical conditions are inhomogeneous. High optical depths in the H_β and H_α lines arising in the nucleus of NGC 7469 are supported by the extremely low observed ratio $L_\alpha/H_\beta \sim 3.1$, (Wu et al. 1983). In the case of the optically thin gas in the Balmer lines – case B Menzel, – this ratio is $L_\alpha/H_\beta \sim 37$ (Katysheva 1983). Very likely the nucleus of NGC 7469 contains both regions ionized by radiation and by shocks. The contribution of each region to the total emission is variable in time depending on the phase of the nuclear brightness. These problems were discussed earlier by Pronik (1975), de Bruyn (1980), Wu et al. (1983), Doroshenko et al. (1994).

Effects of a flare in the nucleus of NGC 7469 observed on 1977 Jan 13–15, permitted to reveal interesting connections existing in its gaseous surroundings. During the flare, there was an almost simultaneous variability of the broad H_γ line, of the [OIII] λ 4363 line of intermediate width and of the narrow components of H_β . This can be explained only if the emitting regions are not far separated in space, namely if there is an overlap of the broad line region (BLR) and the narrow line region (NLR).

6. Summary

(a) 23 spectrograms of the nucleus of NGC 7469, obtained on 1977 Jan 13 – 15 revealed the night – to – night increase of W_λ of the H_β, [OIII] λ 5007 and (H_α + [NII]) lines and the decrease of W_λ of [SII] λ 6717+31Å. Since photoelectric UBVR and spectrophotometric observations never before showed variability in different directions of the continuum in different spectral regions in the range 3600–7000Å, we conclude that there were night–to–night variations of the line fluxes (either in the first group of the lines or in the [SII] $\lambda\lambda$ 6717+31Å lines).

(b) The profiles of the hydrogen lines in the spectrum of the NGC 7469 nucleus show four variable components keeping their positions relative to the central peak over the last 20 years. They appear to reflect the components of the gaseous structure of the nucleus of NGC 7469, which change their brightness with time without changing their velocities.

(c) Many of the considered data show that narrow and broad lines in the nuclear spectrum of NGC 7469 on Jan 13–15, 1977 changed almost simultaneously on time scales of several days. The same phenomenon was observed in the nucleus of NGC 1275 (Pronik et al. 1990). We suppose that at least the part of NLR in both active nuclei is located not far in space from the BLR. It is not excluded that the NLR and BLR are partly mixed. The physical conditions in the overlap regions are influenced from time to time by short-time flares in the gas caused by nuclear bursts.

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