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BVRcIc MONITORING OF THE SEYFERT GALAXY OF THE FIRST TYPE NGC 7469

Z. F. Binnatova [a*], ***B. I. Abdullayev*** [a], ***N. A. Huseynov*** [a]

[a] *N.Tusi Shamakhy Astrophysical Observatory of Azerbaijan National Academy of Sciences, Shamakhy, Azerbaijan*

Here are the results of the observations of the nuclei of the Seyfert galaxy of the first type NGC 7469 carried out in the period 2016-2019 BVRI. Observations were carried out on the telescope "SEİSS 600" of the Shamakhy Astrophysical Observatory named after N.Tusi. It is reported that discovered from observations of 2016-2019 in the core of the active galaxy NGC 7469 there were 3 flares. The first flare was the most powerful, and the amplitudes of change in brightness was in the BVRcIc filters approximately:$\Delta B = 0.272$; $\Delta V = 0.181$; $\Delta Rc = 0.173$; $\Delta Ic = 0.125$ magnitudes. The second flare of average power and brightness changes was in the BVRcIc filters respectively: $\Delta B = 0.098$; $\Delta V = 0.047$; $\Delta Rc = 0.093$; $\Delta Ic = 0.036$ magnitudes. And the third flash is comparable to the first flash and the change in brightness was in the BVRcIc filters, respectively: $\Delta B = 0.207$; $\Delta V = 0.168$; $\Delta Rc = 0.119$; $\Delta Ic = 0.065$ magnitudes.

We believe that this may be the result of active star formation in the Seyfert galaxy of the first type NGC 7469, as well as the reason for this may be the interaction with the IC 5283 galaxy. The amount of free gas in this galaxy should be greater for this reason. As a result, this leads to a change in the rate of accretions to the core of the galaxy.

Keywords: Seyfert galaxies – nuclei of active galaxies – BVRI photometry – NGC 7469 – black holes

1. INTRODUCTION

Seyfert galaxies (SG) being as a separate class of galaxies, were first identified by the American astronomer Seyfert C. in 1943 [1]. He discovered wide lines of hydrogen, helium and ionized iron in the spectra of 12 galaxies. The half-width of

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* E-mail: zumrudbinntova@gmail.com

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these lines, in accordance with the Doppler effect, corresponded to speeds of up to several thousand km/s. Thousands of such objects are now known and in some of them the emission spectral lines have widths corresponding to the speed of about 30,000 km /s (0.1 the speed of light!). SGs are giant spiral galaxies. Among them, the proportion of crossed spirals is especially high (about 70%). Seyfert showed the unusual structure and emission spectra of these galaxies. Seyfert galaxies emit in a wide range of wavelengths from the X-ray to the radio region. Basically, the radiation of these galaxies is variable [2]. Knowing the nature of the variability of radiation in different ranges can in principle clarify the mechanisms of variability in different spectral regions. According to the most common modern point of view, radiation in the optical and UV range of the nuclei of active galaxies (NAG) is of non thermal origin (synchrotron radiation) and occurs in the accretion disk surrounding the supermassive black hole. X-rays come from the central regions that eat the closest regions of the black hole (BH). Much of the X-ray radiation falling on the disk is absorbed by the disc and heats it. The other part of the radiation is reflected from the accretion disk of the black hole, located in the core of each active galaxy. The heated disk creates additional radiation in the main optical region of the spectral range. The spectrum of a galaxy consists of electromagnetic radiation from all its constituent objects. The spectrum of an active galaxy has two local maxima. The source of radiation from galaxies is mainly stars, the maximum intensity of the radiation of most of them is in the optical range (the first maximum). As usual, there is a lot of dust in galaxies, which absorbs radiation in the optical range and re-emits it in the infrared range. The second maximum because of this falls into the IR region of the spectrum. The study of photometric and spectral variability is an effective method for diagnosing physical processes occurring in accreting compact supermassive objects, such as most YAGs. The characteristic time of this variability indicates the extremely small size of the regions emitting the optical continuum and wide emission lines. The study of photometric and spectral variability is necessary to elucidate the structure of active nuclei, without understanding which it is impossible to approach the solution of the problem of the central energy source [3]. It is very important to have information about the nature of their variability. In the supermassive black hole model, with an accretion disk, one can expect both periodic and chaotic variability in the brightness of galaxy nuclei. Knowledge of the properties of optical variability can significantly limit the possible types of models. There are two most popular models of a central energy source: an accreting black hole and a non-collapsing magnetoplasmic body. Observations of the strict periodic variability of the brightness of galaxies persisting for several cycles or the absence of a strict periodicity can be a strong argument in favor of one of the two above concepts [4].

2. OBSERVATIONS

NGC 7469 is a well-studied Seyfert galaxy of the first type, included in the original list of six Seyfert spiral galaxies (1943) with a high brightness of the central surface, that is, it has a star-shaped core. NGC 7469 and the nearby company galaxy IC 5283, which probably interacts with it, are at a distance of about 68 Mpc. The bright, knotty, circular nuclear ring of radiation resulting from intense star formation lies at an angular distance of 1° 5 from the core (which corresponds to about 1 kpc) [5]. This galaxy is bright and variable in the optical region of UBVRİ, which makes it attractive for studying both galaxies with active nuclei (AGN) and for studying the properties of star formation. NGC 7469 is a barred spiral galaxy (SBa). This galaxy has been studied by different authors. The work of Oknyansky et al. [6] presents the results of UBVRI monitoring of the Seyfert galaxy NGC 7469 in 1997–2005. The study showed that the nucleus is variable and there was a lag effect for different wavelengths. It should be noted that currently delays in variability in longer wavelengths relative to sporter wavelengths have been detected in a number of Seyfert nuclei. It is noted that, the nature of the effect is not yet entirely clear. Lyuty et al. [7] report the results of three-color (UBV) observations of rapid changes in the core of the Seyfert galaxy NGC 7469 conducted between 1990 and 1994. In some cases, there is a noticeable delay in variations in the U-band relative to changes in the V-band and vice versa. This delay is about 7 minutes. In the work of R. Middei et.al, a study of the Seyfert galaxy NGC 7469 is reported using space observatories. The results of spectral analysis of 7 simultaneous are reported. Sources show significant flux variability in each observation but the average flux is less variable [8]. We conducted BVRI observation of the Seyfert galaxy of the first type NGC 7469 in 2016-2019 Observations were made on the ZEISS-600 telescope of the Shamakhy Astrophysical Observatory named after N. Tusi.

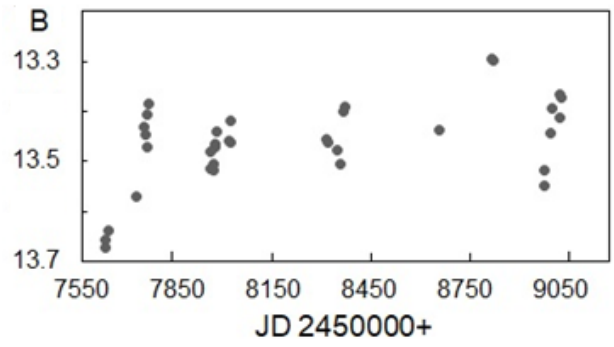

Fig. 1. The light curve in the filter B of the Seyfert galaxy NGC 7469 in 2016-2019

Details about the process of observations with the matrix, about the equipment, the method of processing and analyzing errors can be found in the work [9]. The device is installed in the Cassegrain focus of the Zeiss 600 telescope (aperture 1:12,5) and is equipped with a thermoelectrically cooled CCD matrix FLI 4096×4096. The photometer is designed to work with the telescope "ZEISS600" for fundamental and applied astronomical research by relative photometry. The resulting material was processed according to the package program MAXIM DL 4 and MAXIM DL 5. The measurement was taken with an aperture (7 pixels) of

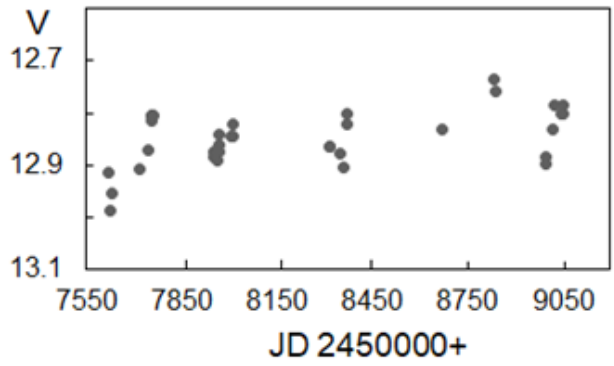

Fig. 2. The light curve in the filter V of the Seyfert galaxy NGC 7469 in 2016-2019

13.5 seconds. For reference to the International Photometric System, close comparison and reference stars were used. Stars of spectral class A0 were chosen for binding. The resulting material is unique in the sense that is was obtained in one telescope, with one photometer and the processing is performed with the same package program. The material is obtained as follows, 5 cycles are removed in each filter. Then the resulting frames are calibrated and the cleaned frames are summed up and the average value of the stellar magnitudes in each filter is taken. For each filter calculated, RMS measurement. In the optical region, the amplitude of variability decreases with increasing wavelength. In Fig. 1 shows the results of our own observations in filter B covering the period from 21 08 2016 - 19 12 2019. As can be seen from Fig. 1. during the observation period, NGC 7469 gradually became brighter. In filter B, the change in brightness was 0.359 magnitudes. Fig. 2 shows the results of observations in filter V, covering the period from 21 08 2016 - 19 12 2019. As can be seen from Fig. 2, NGC 7469 gradually became brighter during the observation period. The change in brightness was in filter $V = 0.217$ magnitudes.

In Fig. 3 shows the results of our observations in the Ic filter covering the period from 21 08 2016 - 19 12 2019 as can be seen from Fig. 1. During the

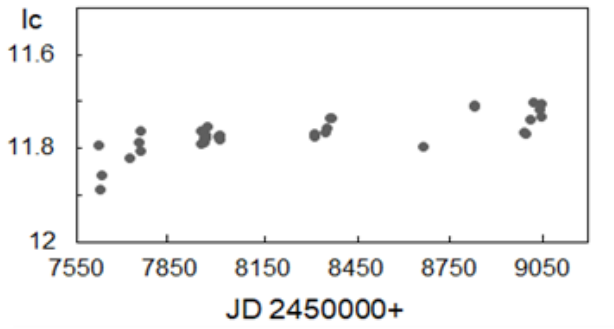

Fig. 3. The light curve in the filter Ic of the Seyfert galaxy NGC 7469 in 2016-2019

observation period, NGC 7469 gradually became brighter. In the İc filter, the change in brightness was 0.113 magnitudes.

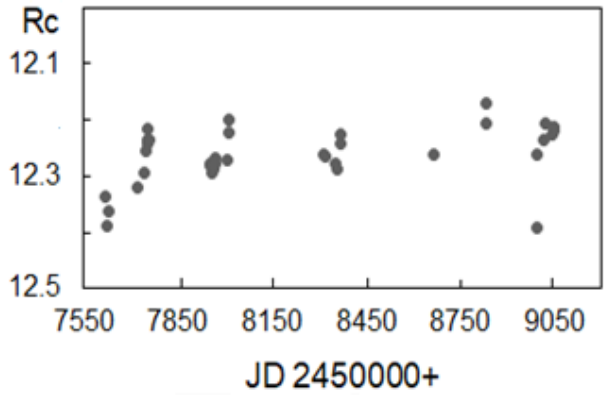

Fig. 4. The light curve in the filter Rc of the Seyfert galaxy NGC 7469 in 2016-2019

In Fig. 4 shows the results of our own observations in the Rc filter covering the period from 21 08 2016 - 19 12 2019 as can be seen from Fig. 1. During the observation period, NGC 7469 gradually became brighter. In the Rc filter, the change in brightness was 0.176 magnitudes. The amplitude of variability increases from filter I to filter B indicating a characteristic burst of brightness in the blue part of the spectrum in the active nuclei of galaxies.

3. DISCUSSION

When analyzing the light curve built on observations of 2016-2019, 3 flashes occurred in the core of the active galaxy NGC 7469. As can be seen from Fig.1,

2, 3 and from Fig. 4, the first flash was the most powerful, and the change in brightness was in the BVRcIc filters approximately: $\Delta B = 0.272$; $\Delta V = 0,181$; $\Delta Rc = 0,173$; $\Delta Ic = 0.125$ magnitudes. The second flash of average power and brightness changes was in the BVRcIc filters, respectively: $\Delta B = 0.098$; $\Delta V = 0.047$; $\Delta Rc = 0,093$; $\Delta Ic = 0.036$ magnitudes. And the third flash is comparable to the first flash and the change in brightness was in the BVRcIc filters, respectively: $\Delta B = 0.207$; $\Delta V = 0.168$; $\Delta Rc = 0.119$; $\Delta Ic = 0.065$ magnitudes. It should be noted that a third outbreak is possible and continues to this day. Unfortunately, we were not able to observe the galaxy NGC 7469 by 2020. Since astronomical observations depend on weather, seasonal conditions and as well as the distribution of observational time. The above observation conditions and interferes will accurately determine the duration of the outbreak. The coordinated observations at different latitudes are very relevant for this reason. The brightness gradient increases from filter Ic to filter B, the amplitude of variability increases from filter Ic to filter B which indicates a characteristic burst of brightness in the blue part of the spectrum in the nuclei of active galaxies.

4. RESULTS

As can be seen from Fig. 1, 2 , 3 and 4 of the constructed light curve Seyfert galaxy of the first type NGC 7469 gradually increases its brightness during the observation period. This may be the result of a gradual increase in the amount of matter in the acre ionic disk of the black hole. The increase in brightness in BVRcIc filters is approximately 0.359, 0.217, 0.113 and 0.176 magnitudes, respectively. The amplitude of variability increases from filter I to filter B, indicating a characteristic burst of brightness in the blue part of the spectrum in the active nuclei of galaxies. The brightness curve in filter B and V has a steeper gradient compared to other filters when leaving the cycle minimum and the maximum is reached much earlier than in filters Rc, Ic.

We believe that this may be the result of active star formation in the Seyfert galaxy of the first type NGC 7469, as well as the reason for this may be the interaction with the IC 5283 galaxy. The amount of free gas in this galaxy should be greater for this reason. As a result, this leads to a change in the rate of accretions to the core of the galaxy.

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