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Spectral and photometric study of the Seyfert galaxy Mrk 1095 (Ark 120)

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Spectral observations of Seyfert galaxies at the Fesenkov Astrophysical Institute (FAI) have been carried out for about 50 years, and photometric observations in *BVR* filters have been performed over the past 10 years. The telescope $AZT-8$ and two 1-meter reflectors located at the high-mountain Tyan-Shan Observatory (TShAO) are used for observations. In addition, archival spectral data obtained in 1970–1990 with an image tube and astronomical film are used to reveal the long-term changes in selected Sy. Digitization of these archival materials is currently being carried out at FAI. In this paper, we present the results of the long-term observations of the Seyfert galaxy Mrk 1095 (Ark 120) and an analysis of its photometric and spectral variability. According to the observations of 2007 – 2021, the variability of the continuum level and radiation fluxes in the emission lines in the spectrum of Mrk 1095 was registered.

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1. Introduction

The most powerful space and ground-based telescopes are used to study deep space objects, such as quasars, Seyfert galaxies, and blazars. Seyfert galaxies (Sy) are very similar to quasars in their properties but are located much closer. Therefore, observations of Seyfert galaxies can also be carried out with telescopes of very moderate size. Such studies make a significant contribution to the solution of the most important problem of cosmology - the study of the evolution of the Universe. The galaxy Mrk 1095 = Ark 120 belongs to the Sy1 class; it was discovered by Arakelyan and then added to the Markarian catalog. Mrk 1095 is characterized by high spectral variability: changes in emission fluxes and emission line profiles are registered [1, 2]. The results of spectral monitoring were used to study the complex structure of the broad emission line region (BLR) and to determine the dynamic characteristics of its components [3]. Monitoring of Mrk 1095 in the UV and optical bands was conducted in 2017 - 2018. The light curves were obtained and the time delays in different wavelengths were determined [4]. Data obtained by different authors over a period of 40 years were collected in [5]. The V-band light curve of Mrk 1095, as well as variations of its continuum level (5100 Å) and absolute fluxes in the Hβ line, correspond to a period of about 20 years. Studies of the Hα emission line profiles revealed additional emission details created by compact ionized objects rotating in the gravitational field of the Central Body (hereafter CB) [6].

2. Photometric studies

Photometric studies of this galaxy have been carried out at FAI since 2015. The processing of observational data consists of standard operations using the Bias, Dark, and Flat service files. The light measurements are performed by differential photometry (standard software package MaximDLPro6). Stars with known brightness values in the vicinity of the object are chosen as standards. To reduce the obtained instrumental brightness estimates to the standard BVR system, a system of appropriate equations is used. The star $V1193OriS2$ with coordinates $\alpha(2000) = 05^h1^6m30^s,149; \delta(2000) = -00^o10^m36^s.827$ was used as the standard star. The star TYC4752-1081-1 with coordinates $\alpha(2000) = 05^h16^m26^s,231; \delta(2000) = -00^o09^m04^s.79$ was chosen as the check star. Images of the galaxy were measured with an 8" aperture. Table 1 shows the estimates of the brightness of Mrk 1095, obtained from FAI observations.

3. Spectral studies

Observational data were obtained with the two FAI telescopes: AZT-8 at the Kamensky Plateau Observatory and the 1-meter telescope located at TShAO. Observational results for Mrk 1095 from 2007 to 2021 are given in Table 2. The intensity of the continuum at λ=6400 Å is expressed in units of erg/cm^{2}secÅ.

4. Discussion and conclusion

Photometric observations of Mrk 1095 have been carried out at FAI since 2015. This paper presents the light curves in three filters for 2015 – 2022. The observed light variations are $0^m.6$,

Table 1: B V R MAGNITUDES OF Sy Mrk 1095 OBTAINED DURING 2015-2022.

Date	JD-2440000	B	V	R
10.09.2015	17275	14.408	14.011	13.55
25.09.2015	17290	14.364	13.897	13.536
24.11.2016	17716	14.677	14.142	13.699
28.11.2016	17720	14.725	14.173	13.729
15.12.2016	17737	14.843	14.282	13.865
17.01.2017	17770	14.707	14.184	13.813
05.01.2019	18488	14.207	13.818	13.497
25.01.2019	18508	14.236	13.824	13.488
10.09.2015	17275	14.408	14.011	13.55
25.09.2015	17290	14.364	13.897	13.536
10.12.2020	19193	14.557	14.074	13.7
15.01.2021	19229	14.458	14.004	13.65
22.01.2022	19601	14.315	13.868	13.479
04.02.2022	19614	14.311	13.856	13.468
15.02.2022	19625	14.51	14.038	13.674

Table 2: The absolute fluxes in the emission lines Hα+⌈ NII ⌉ and in the continuum at λ = 6400 Å for $Mrk1095$.

Date	JD-2440000	F_{abc} H α+⌈ NII ⌉	F_{cont} 6400 Å	FAI-telescopes
		⌈ erg/cm^{2}sec ⌉	⌈ erg/cm^{2}sec Å⌉	
02.11.2007	14406	2.0×10^{-12}	1.1×10^{-14}	AZT-8
19.01.2009	14850	3.4×10^{-12}	1.2×10^{-14}	AZT-8
19.01.2010	15215	3.6×10^{-12}	1.2×10^{-14}	AZT-8
21.02.2014	16709	3.2×10^{-12}	9.2×10^{-15}	AZT-8
15.12.2014	17006	2.5×10^{-12}	9.4×10^{-15}	AZT-8
04.12.2018	18456	2.8×10^{-12}	9.4×10^{-15}	TShAO
05.01.2019	18488	2.6×10^{-12}	6.6×10^{-15}	TShAO
24.11.2020	19177	1.6×10^{-12}	3.1×10^{-15}	TShAO
11.01.2021	19225	1.6×10^{-12}	5.9×10^{-15}	AZT-8
14.02.2021	19259	3.0×10^{-12}	8.3×10^{-15}	AZT-8

$0^m.4$, and $0^m.5$ in the $BVRc$ filters, respectively. Previous spectral studies of this galaxy were carried out mainly in the "blue" wavelength region. Our observations were performed in the "red" wavelengths region, containing the emission lines Hα, ⌈NII⌉, ⌈SII⌉, ⌈OI⌉. Photometric and spectral variability of Mrk 1095 is recorded over a wide range of wavelengths. The source of the variability is probably an accretion disk. The universal model of AGN assumes the presence in the center of a supermassive (possibly double) central body (SMCB), surrounded by an accretion disk and corona, which are the sources of the initial X-ray radiation. The results obtained from space and ground-

based observations, in particular for Mrk 1095, show the complexity of the physical processes occurring in the central regions of active galactic nuclei. Therefore, further studies using optical and space telescopes are highly desirable.

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