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PRELIMINARY SPECTROPHOTOMETRIC INVESTIGATION OF THE NUCLEUS OF GALAXY NGC 5929

I. M. Yankoulova, G. T. Petrov, V. K. Golev

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The study of non-Syfert galaxies with emission lines has begun to increasingly attract spectrophotometricians. An object of this type is the galaxy NGC 5929. It is a member of the double system NGC 5929/5930. The two objects are at a distance of 0'.5 from each other. They figure under No. 90 in the A r ρ Catalogue [1] of Peculiar Galaxies, and Zwicky mentioned them as compact objects (I Zw 112). Karachentsev included them under No. 466 in his catalogue of isolated double galaxies. A photography of that galaxy was adduced in I[1]. The summary mass of the two objects, determined by Page [2], is $1.25x1 O^{1O} M_{\odot}$. He also determined the radial velocity of NGC 5929 V_0 = 2696km. sec-^{1} (corrected for the Sun's movement) and noted the presence of hydrogen and nitrogen emission lines in the spectra of the two galaxies. At dimensions of 0'.7x0'.7 and a photographic magnitude of· I3^m.O, the surface brightness of NGC 5929 is 22^m.6 per arcsec^2. According to A r a k e l i a n ' s criterion [3J, this galaxy has a low surface brightness, which impedes its detailed investigation.

NGC 5929 has been included in our program for spectrophotometric investigation of galaxies of a non-Syfert type with emission lines [4]. For the present study we have four spectra, two of which were obtained by G.T. Petrov on a 125-cm telescope of the Southern Station of the Sternberg Institute at Moscow State University in the Crimea by means of an A-spectrograph + single-stage image tube in the region H_α, while the other two were obtained on a 6-m telescope in SAO of the Academy of Sciences of USSR by using the UAGS spectrograph-+-three-stage image intensifiers mounted in the primary focus of the telescope. The last two spectra were centered on H_α and H_β respectively. Their records are shown in densities on the Figure. The dispersion of all spectra is about 100A.mm-^{1}, which with a spatial resolution of the screen of the image tube ~ 20 —25-mm-^{1} gives a spectral resolution of~4 —5 A. The Crimean spectra were processed on a G III photometer, which records directly in intensity, of the Crimean Observatory of the Academy of Sciences of USSR, and the other two —on a high-speed microphotometer of the Dept. of Astronomy of the Bulgarian Academy of Sciences by the standard method. The special sensitivity of the apparatus was determined by the standard star of Stone BD + 25°3941, and the photometric calibration was made with a lab spectrograph ISP-51 and a nine-stage photometric wedge.

On the spectra processed by us the following lines (Fig.) were identified: the hydrogen H_α and H_β ,[0 I] $\lambda\lambda$ 6300 + 63, [0 III] $\lambda\lambda$ 4959, 5007, [SII]. $\lambda\lambda$ 6717 + 31, [NII] $\lambda\lambda$ 65484-84 and probably [S III] λ 6312. The line [N I] λ 5199, as well as the Frauenhofer absorption *b* of the neutral magnesium MgI λ5175 are barely visible.

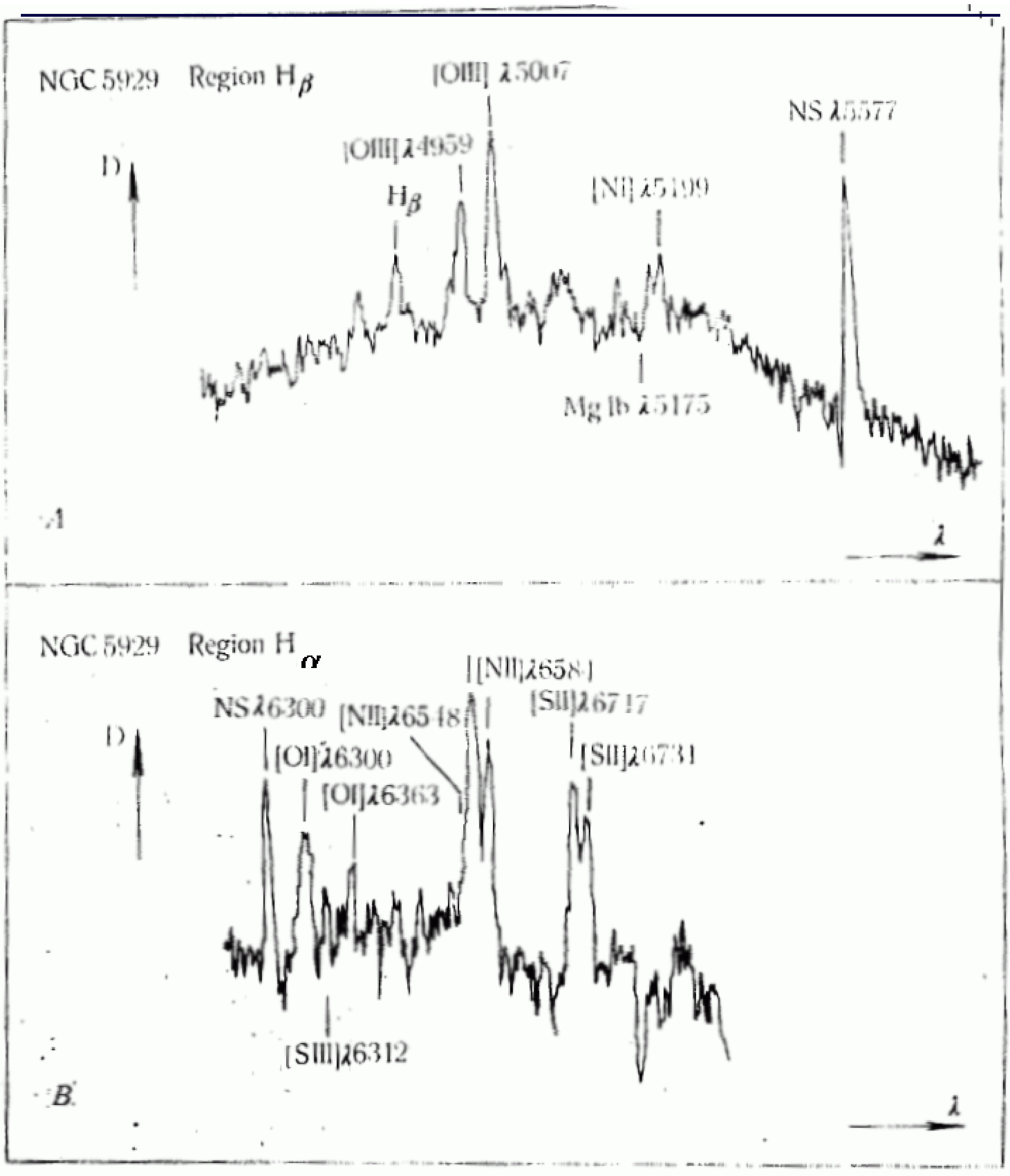

Fig.1

The emission lines exceed in width the instrumental profile (see the night sky lines denoted by NS). The components can be noticed on them, shifted towards the blue and the red parts of every line at about 5 – 6A, which corresponds to a velocity of 250 – 300km.sec^{-1}. The presence of such components has not been noticed by other authors investigating this galaxy [2,5]. The spectra obtained by Page have a dispersion of ~400 A. mm^{-1} and served only to determine the galaxy's radial velocity, while T u r n e r [5] obtained spectra with a dispersion of ~140 A.mm^{-1}, which were automatically processed according to a special program also for the determination of radial velocities and served no other purposes.

At our request A. Petrossian received a direct photography of the nucleus of NGC 5929 in the main focus of a 2.6-m telescope of the Bjurakan Astrophysical Observatory. The nucleus proved to be structureless. In the spectrum of the other member of the pair, NGC 5930, no components with the same spectral resolution were observed. The components in the profiles of the emission lines can be interpreted as a radial movement of gas masses with a velocity of 200 — 300 km. sec-[1], i. e. the nucleus of NGC 5929 has an activity of the type of Syfert nuclei, but to a much smaller degree.

The spectrophotometric parameters determined by us — equivalent widths and relative intensities (non corrected and corrected for interstellar extinction) — are shown in the

Table

Ion	H+		O^0		S+				O++	
λ	4861	6563	6300	636	6717	|	6548	658	4959	5007
$W\lambda$	6.0	17	6.5	2.5	8.5	7.5	8.0	18	9.0	20
I_λ/IH_β	1	5.45	2.0:	0.6:	3.47	2.66	1.95	3.75	1.59	3.64
$(I_\lambda/IH_\beta)_0$	1	2.88	1.0:	0.3:	1.80	1.41	1.07	2.02	1.50	3.32
lg X_i/H^+ + 12.0			7.59:		7 15		7.23		8.50	

Table. The parameters of the emitting gas can be estimated by an analysis of the emission spectra, as described in [6]. O s t e r b r o c k [7] adduced the dependence of the intensity ratio as a function of $X= 10^2\ n_e T_e^{-1/2}$, where n_e can be estimated on the assumption that T_e=10^4 K. In our case $\lambda_{6717}/\lambda_{6731}$= 1.3, which at the thus assumed temperature leads to n_e = 400 cm-^{3}. Given n_e and T_e, the emission coefficient in the line H_β can be calculated

$$4\pi j_{H\beta} = h\nu_{H\beta}\ \alpha_{42}^{eff}(T_e)\ .n_e.n_p \qquad [\text{erg. cm}^{-3}.\ \text{sec}^{-1}]$$

where $\alpha_{42}^{eff}(T_e) = 4.19\times10^{-16} \times (4^2) \times b_4 (e^{x_1/kT_e} / T_e^{3/2}) \times A_{42}$

and $A_{42} = 8.37\times10^6$ sec-^{1}.

For the galaxy NGC 5929 this coefficient is $4\pi j_{H\beta}$ = 2.0x10-^{20} erg. cm-^{3}.sec^{-1}. By our estimation the magnitude of the nucleus is ~15^m and, at an equivalent width $W_{H\beta}$ =6 A we obtained that the flux in Hβ on the front of the Earth's atmosphere is $F_{H\beta}$ = 2.49x10-^{14} erg. cm-^{2}.sec-^{1}. The luminosity in H_β, for H = 75km/s. Mpc, is L_{Hb} -=3.85xl0^{39}erg. sec.-^{1}. In that case the effective volume occupied by the emitting gas is 1.76X10^{57}cm^3 and the mass enclosed in this volume — 5850 M .

The energy necessary for maintaining the gas in an ionization-recombination equilibrium is

$$E=11.2\ (L_{H\beta}/h\nu_{H\beta})(\varepsilon + 2.18 \times 10^{-11})\ \text{erg. sec}^{-1},$$

where ε is the mean energy of the free electrons obtained during ionization; it can be calculated from the total intensity of the forbidden lines. For the nucleus of NGC 5929: $E=4.27$x10^{41} erg. sec-^{1}. The number of stars of class 05 V, whose Ly_c-radiation would suffice to supply that energy, is ~ 1000, i.e. the Ly_c-radiation of the young hot stars in the nucleus of the galaxy is the most probable source of gas ionization.

Making use of the method proposed by Peimbert [8], we can estimate the relative content of the ions 0°, S+, N+ and 0++ at T_e=10^4K and at lg n(H) = 12.00. The values obtained for the relative number of ions in units lg X_i/H^++12.00 are adduced at the end of the Table.

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Dept. of Astronomy *Bulgarian Academy of Sciences* *Sofia, Bulgaria*	*Chair of Astronomy* *Sofia University* *Sofia, Bulgaria*

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