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ASTRONOMIE

NGC 6503 — ROTATION, MASS AND PHYSICAL CONDITIONS IN GALAXY NUCLEUS

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This work is a continuation of our comparative study of the physical conditions in the nuclei of galaxies with emission lines. Galaxy NGC 6503 figures in our programme as a standard in the study of similar objects. Just as in the Seyfert galaxies, in its spectrum strong emission lines are observed, which facilitate its detailed study (rotation curve, mass, nucleus parameters). On the other hand, it is a typical normal galaxy of the M 51 and M 81 type. The known observation data on the galaxy NGC 6503 are as follows: the exact optical coordinates, according to [1], are $\alpha_{1950}=17^h49^m58^s,7$ and $\delta_{1950}=70^o09'26''$. Morphologically the galaxy is referred to the Hubble type Sc — i. e. with a powerful disc and a comparatively small and bright nucleus. It is included in Karachenzeva's Catalogue of Isolated Galaxies [2]. The radial velocity, determined by the emission lines [3, 4], is $V_r\sim300$ km. s^{-1}, resp. the distance to the galaxy is 4 Mps ($H=75$ km.s^{-1}. Mpc^{-1}). Electrophotometrically, the galaxy was investigated by Vaucouleurs [5]. The integral magnitude and the colours about the telescope aperture ratio/photographic diameter of galaxy $A/D_0=0.52$ are resp.: $V=10.70$, $B-V=0.72$ and $U-B=0.08$.

At an integral magnitude $m_p=10.9$ and dimensions $a\times b=5'.6\times1'.7$, the surface brightness in the Arakalian system

$B=m_p-0.25\operatorname{cosec}|b''|+2.5\lg\left(\frac{\Pi}{4}ab\right)+0.22\frac{a}{b}+0.73$ is $B=23.04$ mag. arc sec^{-2}. Kyazoumov [3] traced the galaxy up to dimensions $8'.0\times2'.6$. at which its surface brightness was $B=23.84$ mag. arc sec^{-2} and then for the mean luminosity density in NGC 6503 at these dimensions one gets

$$\lg\varrho(L)=-0.4B-\lg D+8.20,\quad \text{i. e. } 0.017\ L_\odot/pc^3,$$

where D is the linear size of the galaxy's large axis in parsecs. The mean luminosity density obtained is close to the mean $\bar{\varrho}(L)=0.01\ L_\odot/pc^3$, determined Holmberg [6] for about 120 spiral galaxies differing in type.

Four spectra in the region of the H_α and H_β lines were obtained by us for the determination of the main parameters characterizing the galaxy. The spectrograms were obtained with a 125-cm telescope of the Crimean Station of Sternberg, Institute of Astronomy. Use was made of an A-spectrograph attached to a telescope with a contact image tube FKT-1. Its slit was 360×4 arcsec and the scale perpendicular to the dispersion — 140″/mm and dispersion — a.100 A/mm. The spectra obtained on May 9/10, 1978 were oriented

by right acseption and comprised mainly the nucleus of the galaxy. The spectrum of June 9/10, 1980 was oriented along the galaxy's big axis (positional angle PA = 125°).

The latter spectrum was used in order to plot the rotation curve of the galaxy NGC 6503 (Fig. 1) along the H_α and [N II] lines. The curve was traced confi-

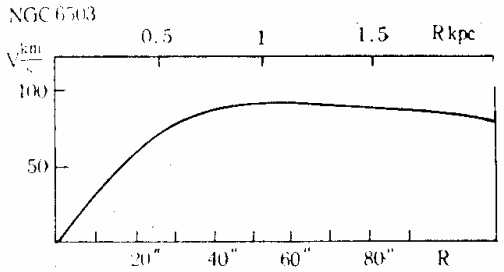

Fig. 1

dently up to $r = 90$ arcsec from the galaxy centre. The previous study of the NGC 6503 rotation, made by Burbidge et al. [7], did not include the regions $r > 50''$. It should be noted that even with a 60-min exposure in the galaxy's outermost parts the emission was not pronounced. At a distance of 40" (about 750 pc) from the centre, the rotation curve was refracted and up to $r = 80''$ (about 1,500 pc) the velocity remained almost constant. Recording the slope $i = 75^0$ adduced in the Nilson Catalogue (UGC), we obtained for the maximal rotation velocity $V_{max} = 90$ km. sec^{-1}. From the curve's smoothness it follows that the distribution of the mass in NGC 6503 can be studied on the assumption of a single-component model — a case of a thin and flat exponential disk with $\sigma = \sigma_0 \exp(-\alpha r)$, where σ is the surface density of the material in $M_\odot, pc^{-2}$ units. Within the framework of such a model (see [3]) certain galaxy parameters are assessed:

effective radius	$\alpha^{-1} = 0.45$ kpc
central surface density	$\sigma_0 = 1560\ M_\odot pc^{-2}$
full mass	$M_t = 2.1 \times 10^9 M_\odot$
mass in $r \leq 90''$	$M_* = 1.82 \times 10^9 M_\odot$
integral mass : luminosity ratio	$M_t/L_t = 1$

The last parameter was obtained by means of the full luminosity of NGC 6503 $L_t = 2.12 \times 10^9 L_\odot$, adduced in the Second Catalog of Bright Galaxies SRCBG.

The data on the chemical composition and physical conditions in interstellar gas in the nuclei of normal galaxies are scant. Their main source are low-dispersion spectra obtained for the determination of radial velocities. By these usually noncalibrated spectrograms one can study the behaviour of the attitude of the [NII]λ 6584/H_α lines along the disk of the galaxies, which is a measure of the gas excitation. The spectra obtained with a dispersion of about 100 A/mm permit to evaluate the main parameters characterizing the state of the gas in the nuclei of the galaxies. In the spectrum of NGC 6503 the following emission lines are observed: [0 II] λ 3727; [NII] $\lambda\lambda$ 6548, 6584; [SII] $\lambda\lambda$ 6717, 6731; [0 III] λ 5007; H_α and H_β. At that the ratio I [0 III]/$I H_\beta \sim 1$. The equivalent widths W_λ and the relative intensities I_λ/IH_α of some important emission lines are shown in the Table, while the registrogram of the galaxy's spectrum in the region of the H_α line is given in Fig. 1. The main parameters of the emitted gas were determined by the known research method of gas nebula, specified with new atomic constants and detailed in [8]. The electron density $\lg n_e = 2.48 \pm 0.38$

Table

Equvialent widths and relative intensities of some emission lines in the NGC 6503 spectrum

	H_α	[NII]6548	[NII]6584	[SII]6717	[SII]6731
$I(\lambda)/I(H_\alpha)$	1	0.18	0.31	0.10	0.08
$W(\lambda)$	16	3	5	2.5	2

($n_e \sim 400$ cm^{-3}) at the electron temperature $T_e = 10^4$K was determined by the ratio $I\lambda 6717/I\lambda 6731 = 1.21$. The flux in line H_α, determined by the equivalent width of the line and the stellar magnitude of the galaxy nucleus is $F(H_\alpha) = 4.10 \times 10^{-14}$ erg. cm^{-2}.s^{-1}. For a 4-Mpc distance this corresponds to a luminosity in the same line $L(H_\alpha) = 7.80 \times 10^{37}$ erg.s^{-1}. Gas of such density and luminosity has a volume of $V_{\text{eff}} = 1.09 \times 10^{56}$ cm^3, and the corresponding effective radius is about 1 parsec. The mass of emitted gas is assessed to be $36M_\odot$.

The excitation mechanism of the emission spectrum of normal galaxies is mainly photo-ionization by UV emission of young hot stars. In the case of

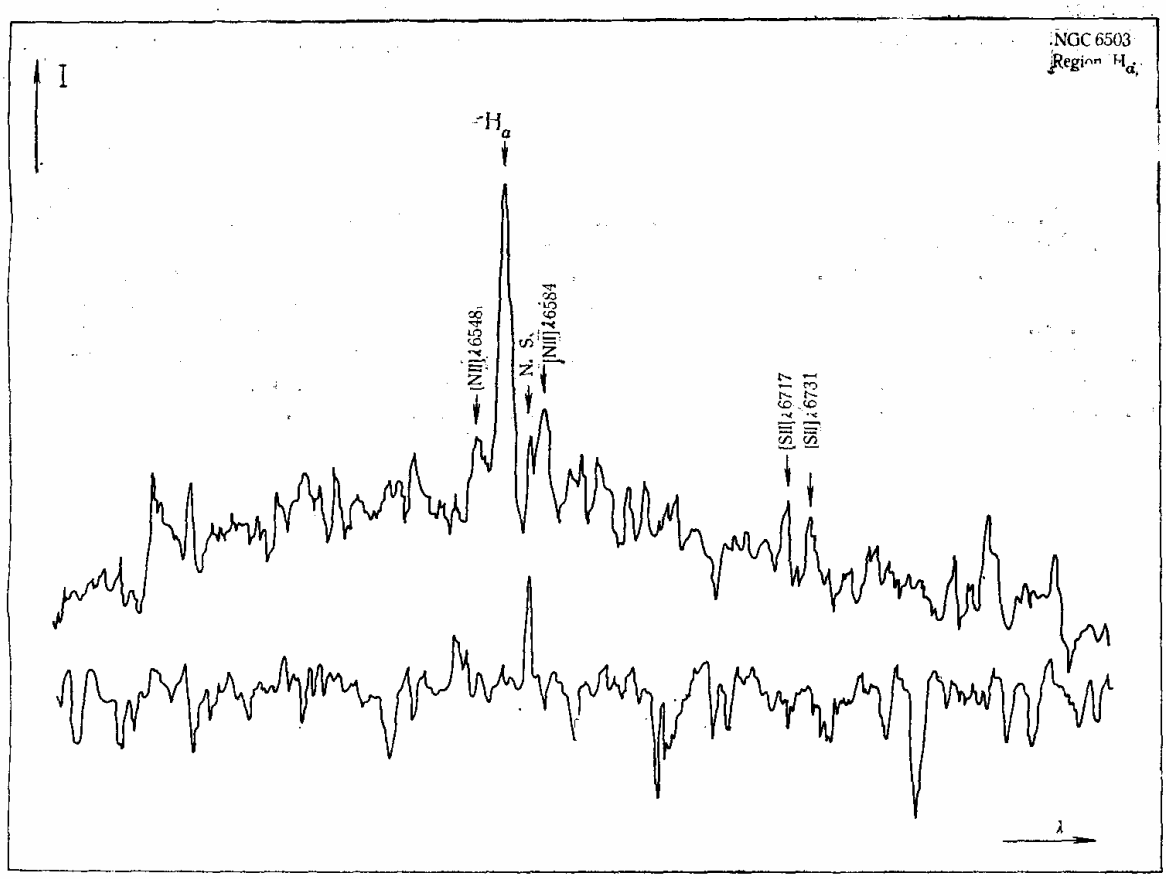

Fig. 2

NGC 6503 the ionization-recombination equilibrium of the gas can be achieved by the emission of 10 stars of the 07 V spectral class with masses about $30M_\odot$, each of which produces a flux $F(\text{Lyc}) = 6 \times 10^{48}$ ph.s^{-1} in the Layman continuum.

The abundance of the three main ions — of N^+, S^+ and O^{++} — ionized oxygen was determined by the known method detailed by Peimbert [9] (as the abundance is usually referred to $\lg H^+ = 12.00$):

$$\lg N^+ = 7.17 \quad \lg S^+ = 6.38 \quad \lg O^{++} = 7.50.$$

Let us now compare NGC 6503 with the normal galaxies M 51 and M 81, which were investigated in detail by Peimbert [10]. In its basic parameters MGC 6503 is similar to them — the electron density in M 51 and M 81 is N~ 500—1,000 cm^{-3}, while the required number of young hot stars on the same assumptions is about 40. A difference can be observed in the content of the heavy elements: while in the galaxy investigated by us the N/H ratio is close to what is typical of diffusion nebulae in our galaxy, in M 51 and M 81 it is 2—6 times as high as the normal 10^{-4}. The fluxes and luminosities of these objects are comparable. Consequently, NGC 6503 is a typical normal galaxy with emission lines, which can be used as a standard when subjecting objects of this type to a comparative study.

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