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# ROTATION, MASS AND PHYSICAL PARAMETERS OF NUCLEUS OF NGC 7339 GALAXY (KARACHENTSEV 570 b)

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*(Submitted by Corresponding Member K. Serafimov on September 6, 1984)*

The NGC 7339 galaxy is a relatively close yet insufficiently studied system. A component of the NGC 7332 — NGC 7339 double system, it figures in the Karachentsev [1] catalog under the number 570 b. It is also included in all the larger catalogs of the extragalactic objects: NGC 7339 = UGC 12122 = MCG 4 — 53 — 9. Vaucouleurs et al. [2] list the following major parameters of this galaxy:

| | | |
|---|---|---|
| $\alpha 1950: 22^h 35^m, 4$ | Type SAS4.s | or Sbc by Hubble |
| $\delta 1950: +23°31', 5$ | $\lg D_{25} = 1.48$ | $\lg R_{25} = 0.52$ |
| | $B_T = 12{\cdot}5$ | $(B-V)_T = 0.85$ $(V-B)_T = 0.18$ |
| | $V_r = 1215$ km/s and | $V_r^\circ = 1495$ km/s |

The size of its external parts is $2.8 \times 0.8$ angular minutes, and the integral photographic magnitude according to CGCG is $m_p = 13.1$. Morgan determined the spectral class of its nucleus as *f*S7.

The galaxy was observed in the autumn of 1979 through the AZT-5 telescope of the Crimean station of the Shternberg Institute of Astronomy, a photography in *B* colour being obtained. No clear signs of an interaction with the other galaxy of the system (angular distance between the two galaxies = 5.2 min) were noticeable on it. The galaxy's nuclear region was indented in structure. Six spectrograms with a dispersion of ca. 90 A/mm were also obtained through a ZTE-125 cm telescope of the Crimean Station. An A-spectrograph with a one-stage image tube system, type FKT-1, as well as Kodak 103 a0 type emulsion, were used. The size of the slit was 240'x4'. The $\lambda\lambda$ 6000 — 6900 A region was investigated. The spectral resolution was assessed at 3-5 A. The apparatus used has been detailed by Essipov [3].

The spectrophotometric data on the galaxy (Table 1) refer to positional angles PA = 90° (coinciding with the galaxy's big axis) and PA = 80°. The subsequently used equivalent width of the line $H_\alpha - W_{H_\alpha} = 12.5$ A was close to the middle one of the six spectrograms. Adduced in sequence in the different columns were: 1 — positional angle, 2 — [0 I] $\lambda$ 6300 is present '+' or is not observed '—'; the equivalent width and relative intensity of the lines [N II] $\lambda$ 6548 — 3; $H_\alpha$ — 4; [N II] $\lambda$ 6584 — 5; [SII] $\lambda$ 6717 — 6; [SII] $\lambda$ 6731 — 7; 8 — the relation I $\lambda$ 6717/I $\lambda$ 6731; and 9 — the relation I $\lambda$ (6717 + 6731)/I $\lambda$6584.

Table 1

Spectrophotometric data on nucleus of NGC 7339 galaxy

| PA | [OI] λ 6300 | | [NII] λ 6548 | | $H_\alpha$ | [NII] λ 6584 | | [SII] λ 6717 | | [SII] λ 6731 | | $I\lambda$ 6717 | $I\lambda$ 6724 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $W\lambda$ | $I\lambda/IH_\alpha$ | $W\lambda$ | $I\lambda/IH_\alpha$ | $W\lambda$ | $W\lambda$ | $I\lambda/IH_\alpha$ | $W\lambda$ | $I\lambda/IH_\alpha$ | $W\lambda$ | $I\lambda/IH_\alpha$ | $I\lambda$ 6731 | $I\lambda$ 6584 |
| 90° | + | + | 2.5 | 0.12 | 12.5 | 6.5 | 0.35 | 3 | 0.11 | 3 | 0.095 | 1.14 | 0.59 |
| 80° | — | — | 3.5 | 0.3 | 11.5 | 6 | 0.5 | — | — | — | — | — | |
| 80° | — | 9 | 5 | 0.16 | 25 | 12 | 0.30 | — | — | — | — | — | |

The output data on the determination of the nuclear parameters were the equivalent width of the line $H_\alpha$/or $H_\beta$/[A], radial velocity $V_r$ of the galaxy [km/s], magnitude of the nucleus $m_{nucl}$ and electron density of the gas $N_e$ cm$^{-3}$. According to the dependences adduced in [4] for galaxies of the Sb/Sbc type the magnitudes of the galaxy and its nucleus are connected with the dependence

$$m_{nucl} = 0.53\, m_{gal} + 8.40$$

According to this connection, $m_{nuc} = 15.34$ was obtained for NGC 7339. As regards the relation I λ 6717/I λ 6731 = 1.14 for $T_e = 10{,}000$ K, using the Nossov tabulation [5], $N_e = 300$ cm$^{-3}$ was determined. Following the Dibay-Pronik method with the specifications adduced in [6], the basic parameters characterizing the nucleus of NGC 7339 were determined. The flow in the $H_\alpha$ line was given by the dependence

$$F_{H_\alpha} = W_{H_\alpha}\, 10^{-0{,}4(m_{nucl} - m_{st})} . F^* \text{ standard [erg. cm}^{-2}\text{. sec}^{-1}\text{]} .$$

The emission capacity of the ionization source required for maintaining the gas in an ionization-recombination equilibrium was determined by

$$L_{tot} = 11.2 \frac{L_{H\beta}}{h\nu_{H\beta}} (\bar{\varepsilon} + 2.18 \times 10^{-11}) \text{ [erg. sec}^{-1}\text{]}, \text{ where}$$

$L_{H_\alpha} = 2.88\, L_{H_\beta}$ and $\bar{\varepsilon}$ is the mean energy of the free electrons obtained during their ionization, taking into account all the forbidden lines

$$\bar{\varepsilon} = \left[0.2 \left(\frac{10^4 \text{k}}{T}\right)^{1/3} \frac{\Sigma I_\lambda}{I_{H\beta}} + 1.2 \frac{T}{10^4 \text{k}}\right] \text{ [eV]}$$

The determined in this manner parameters are adduced in Table 2.

Table 2

Parameters of the nucleus of the galaxy NGC 7339

| | |
|---|---|
| Magnitude of nucleus | $m_{nucl} = 15{,}34$ |
| Electron density of gas | $N_e = 300$ cm$^{-3}$ |
| Flux in the line H | $F_{H_\alpha} = 3.6 \times 10^{-14}$ erg/cm. c |
| Luminosity in the line H | $L_{H_\alpha} = 5{,}8 \times 10^{38}$ erg/c |
| Power of ionization source | $L_{tot} = 1{,}2 \times 10^{40}$ erg/c |
| Mass of the gas | $m_{gas} = 5000\, M_\odot$ |
| Effective volume occupied by gas | $V_{ef} = 1{,}8 \times 10^{58}$ cm$^3$ |
| Effective radius | $R_{ef} = 2{,}3 \times 20^{19}$ cm (~10 pc) |
| Number of ionizing stars type 07 V | $N^* = 80$ |
| Relative number of nitrogen ions | log N+ = 7.22 |
| Relative number of sulfur ions (for lg H = 12.00) | log S+ = 6.43 |

The relative content of the nitrogen and sulfur ions was evalued by the method proposed by Peimbert [8]. Part of the recording of the NGC 7339 spectrum comprising the region with the strongest lines obtained at PA=90° is shown in Fig. 1.

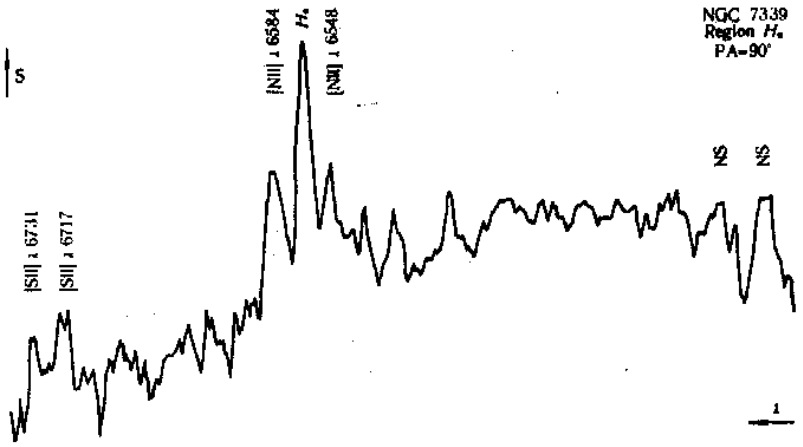


Fig. 1

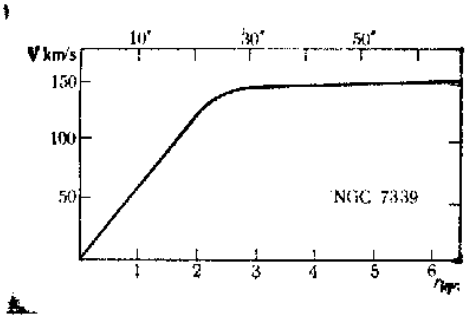


Fig. 2

The curve of radial velocities of the galaxy was plotted by the spectrograms obtained along the galaxy's big axis PA=90°. It is symmetrical in relation to the centre of the galaxy. At 2 kpc from the centre it 'breaks' sharply, and then $V_r$ gradually increased (Fig. 2) to ca. 6 kpc (~65″). A comparison of the curves obtained at PA=90° and PA=80° revealed that the galaxy's tilt angle $i=7°$. The galaxy's maximal rotation velocity was 160 km/s. It should be mentioned that at PA=180° (along the small axis) no gradient of velocities was observed.

Insofar as the NGC 7339 galaxy is of a late type, a nucleus and a well-developed disk was observed in it. The distribution of the mass was studied within the framework of a single-component model (thin flat disk) by a method proposed by Ballab [9]. At that, the gravitational effect of the disk's external parts located outside the rotation curve obtained by us were not recorded. The chief results boil down to the following:

The mass of galaxy in radius $R=6$ kpc was $M=1.95\times10^{10}$.

The Mass: Luminosity ratio was $M/L_B=2.3$.

The rotation curve was smooth and no significant noncircular gas movements were observed. The mass: luminosity ratio was lower than the average obtained for Sbc/Sc-type galaxies (according to Faber a. Gallagher [10];

for H=75 km/s. Mpc for Sbc/Sc-type galaxies $M/L_B=7$). At that, the above ratio was lower for the nuclear region. This may be due to the change of stellar composition by the galaxy radius.

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