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PHYSICAL CONDITIONS IN NUCLEI OF GALAXIES WITH EMISSION LINES ROTATION, MASS AND PARAMETERS OF NUCLEUS OF GALAXY NGC 1084

G. T. Petrov, V. A. Mineva, G. A. Kyazoumov

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The galaxy NGC 1084 belongs to the Hubble type S c. Its angular dimensions are, according to MCC [1], 2.6×1.3 min, and its integral stellar magnitude is, according to Vaucouleurs et al. [2], $B_T^0 = 10.73$. This galaxy is also known as a weak radio source. The initial observation data adduced in [2] are:

$\alpha_{1975}: 2^h 43^m 53$ type: SAS5 . . . or S c
$\delta_{1975}: -7°47',1$ Bjurakan class 2
$m_H = 11{,}2\ B_T + 11.22\,(B-V)_T = 0.62$
$\lg D_{25} = 1{,}46\ \lg R_{25} = 0.25\ \lg D(0) = 1.40$
$\lg S_R = 1{,}58$ (1400 MHz) $V_r = 1410$

The spectral class of its nucleus is F5.

Investigated as early as 1963 by Burbidge et al. [3], the galaxy has recently again attracted the attention of astronomers. It has been included in the surveys of Stauffer [4] and Keel [5]. This paper is devoted to an analysis of the galaxy's optical spectrum with the aim of determining its basic physical parameters.

The galaxy was observed in the summer of 1980 through the 125-cm tecope ZTE of the southern observatory of Sternberg State Institute of Astronomy in the Crimea. An A-spectrograph attached to the telescope with an FKT-1 type of image tube system was used. The spectra were taken on a Kodac 103 al enyksuib. The spectrogram dispersion was about 100 A/mm, and the slit had dimensions of 240×4 sec. The spectrograms were measured on an 'Ascorecord', and the registrograms were obtained on a G-III recording microphotometer. Three spectrograms were obtained; their positional angles were PA=25° and 30° (along NGC' s 1084 big axis) and 120° (along its small axis).

The spectrograms used in determining the galaxy's rotational curve and mass were obtained at PA=25° and 30°. On the spectrogram obtained at PA=120° the nitrogen lines and H_α were traced not too far and no speed gradient was observed.

The earlier investigations of Burbridge et al. [3] do not permit to unequivocally determine the type rotational curve, owing to the great dispersion of the points measured by them. According to our data (Fig. 1), a maximum in that curve is observed at $r \sim 2.2$ kpc (H=75 km. c^{-1}. Mpc^{-1})— at 30″ from the centre,

after which the speed of rotation gradually drops to 70″ — to 6 kpc. The curve followed the course shown in [3], but it was traced further away from the centre. It should be mentioned that the curve shown in Fig. 1 was corrected for the galaxy's incline.

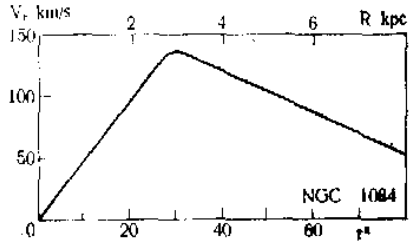

Fig. 1

The mass distribution was studied within the framework of a single-component model, the density distribution following the law

$$\sigma = \sigma_0 \exp(-\alpha r)$$

where σ_0 is the central surface density and α^{-1} is the effective radius. In other words, the case of a thin and flat exponential disk was examined. The main results were as follows:

effective radius	$\alpha^{-1} = 1{,}47$ kpc
central surface density	$\sigma_0 = 1144\ M_\odot/pc^2$
integral mass	$M = 1{,}55 \cdot 10^{10} M_\odot$
complete mass in $\rho = 70''$	$M_{tot} = 1{,}47 \cdot 10^{10} M_\odot$
total luminosity [2]	$L = 3{,}18 \cdot 10^{10} L_\odot$
mass: luminosity ratio	$M/L = 0.49$

The low mass: luminosity ratio, quite untypical of such galaxies, is noteworthy. Burbidge et al. [3] likewise obtained a ratio $M/L < 1$. Using the data on the surface photometry in the colours U, B, V and R (Blackman [6]), for $H = 75$ km/c. Mpc $L = 5.04 \cdot 10^{10} L_\odot$ was obtained for total luminosity. With these data we obtained $M/L = 0.50$ for $\rho = 47''$, in which 50 % of the galaxy's luminosity is included. It is remarkable that no increase of the M/L ratio was observed toward the periphery of MGC 1084, in contrast to NGC 7339, where it stood out clearly. The spectrophotometric data shown in the Table refer to PA = 30°. Some other data [4,5] are adduced for the sake of comparison.

Part of the spectrum's recordogram is shown in Fig. 2. As can be seen from the Table, there is good agreement in the determination of the equivalent widths of the lines.

Table

Spectrophotometric data on the nucleus of galaxy NGC 1084

λ	6300 [OI]	6563 H_α	6548 [NII]	6584 [NII]	6717 [SII]	6731 [SII]	$\frac{6717}{6731}$	$\frac{6724}{6584}$	source
W_λ	2.5	20.0	5.0	8.5	5.5	4.5			our
I_λ/I_{H_α}	0.09		0.27	0.47	0.20	0.15	1.37	0.81	paper
W_λ		15.1	28.3		26.2				acc.[4]
W_λ				7.40					acc.[5]

The Dibay a. Pronic [7] method with some specifications due to the new atomic parameters was used in determining the chief parameters characterizing the nucleus. Its magnitude and the relative intensities of the emission lines

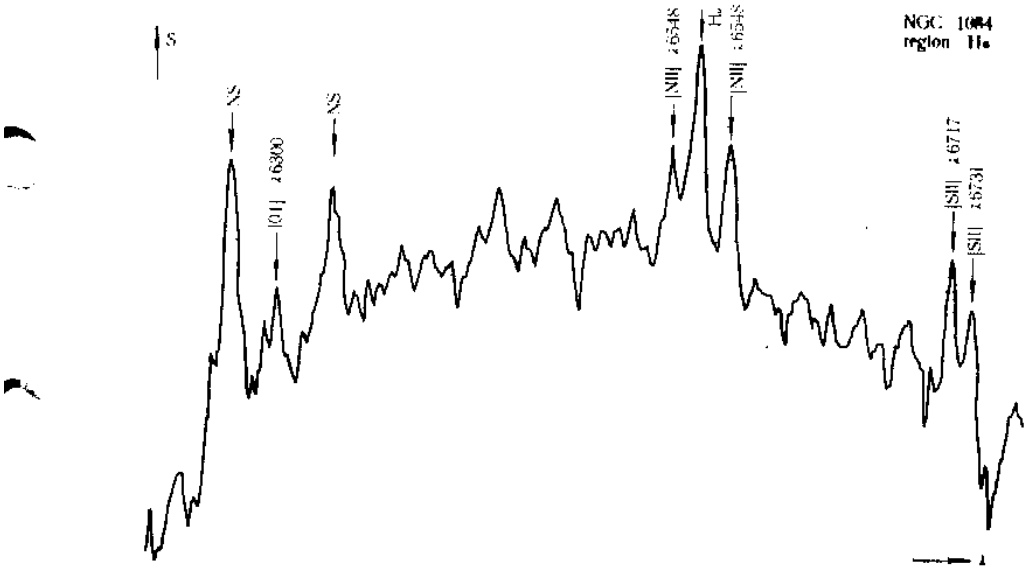

Fig. 2

were used as a basis. The assessment of this magnitude for Sc-type galaxies according to [8],

$$m_{nucl} = 0.28\, m_{gal} + 12.11$$

was $m_{nucl} = 15.2$. As to the ratio $I\lambda 6717/I\lambda 6731$ [S II] = 1,37, according to Nossov's tabulation [9], we determined the electron density of the emitted gas — $N_e = 100\ cm^{-3}$, allowing us to assess the parameters of the gas component of the nucleus:

gas mass	$M_{gas} = 15840\ M_\odot$
effective volume taken from gas	$V_{ef} = 1{,}91.10^{59}\ cm^3$
effective radius	$R_{ef} = 5{,}50.10^{19}\ cm$
flux in line H_α	$F_{H_\alpha} = 1{,}6.10^{-14}\ erg/cm^2.c$
luminosity in line H_α	$L_{H_\alpha} = 6{,}80.10^{38}\ erg/c$
total luminosity	$L_{tot} = 1{,}42.10^{40}\ erg/c$
no. of ionizing stars 0 7V	$n^* = 80$
flux in line [NII] λ6584	$\lg F = -13{,}27$ [5]
luminosity in line [NII] λ6584	$\lg L = 38{,}51$ $\lg L = 39.44$ [5]

And finally, applying the Peimbert method [10], we can evaluate the content of oxygen, nitrogen and sulfur ions, assuming that as usual $\lg H = 12.00$.

$$\frac{N^+}{H^+} = 1{,}65.10^{-4}(1+0.14x).Te^{-0,375}.\frac{I\lambda 6584}{I H_\alpha}.e^{\frac{2{,}2.10^4}{Te}}$$

$$\frac{N^+}{S^+} = f(x, Te).(1+0.14x).3.43.e^{\frac{500}{Te}}.\frac{I\lambda 6584}{I\lambda 6717 + I\lambda 6731}$$

$$\frac{O^0}{S^+} = \frac{f(x, Te)}{1.9\times 10^{-5}}.Te^{-0,82}.e^{\frac{1.4\times 10^3}{Te}}.\frac{I\lambda 6300}{I\lambda 6717 + I\lambda 6731}$$

Assuming $Te = 10^4$K, which is close to the average temperature in the emitting regions, we obtain:

$$\lg O^0 = 7{,}56 \quad \lg N^+ = 7{,}35 \quad \lg S^+ = 6{,}66$$

The fairly high content of neutral oxygen in the nucleus is noteworthy. Keel [5] referred the nucleus to the H type, as in the H II regions, but then usually I [OI] $\lambda 6300 < 0.05$ IH_α. In the case of NGC 1084 the relative intensity of this line is about 0,1 IH_α. On the other hand, there are no reasons why it should be referred to another subtype, as the gas is obviously ionized by young, hot star and the [N II]/H_α ratio is low. The gas quantity in the nucleus is impressive.

The adduced assessments permit to refer NGC 1084 to normal galaxies with a weak activity, manifest chiefly in presence of strong emission lines, similar to the M 51 and M 81 galaxies.

Section of Astronomy
National Observatory
Bulgarian Academy of Science
Sofia, Bulgaria

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