Доклады Болгарской академии наук
Comptes rendus de l'Académie bulgare des Sciences
Tome 36, N° 6, 1983

ASTRONOMIE
Astrophysique

ROTATION, MASS AND PHYSICAL CONDITIONS IN NUCLEUS OF SPIRAL GALAXY NGC 7537

G. T. Petrov, V. A. Mineva, B. J. Kovachev, G. A. Kyazoumov

(Submitted by Corresponding Member K. Serafimov on February 28, 1983)

Galaxy NGC 7537 is actually a member of the double system NGC 7537 +NGC 7541=H_{σ}805. b,a≡K 578 [1]. The distance between them is about 3′ (2.7 according to Vaucouleurs [2] SRCBG and 3.05 according to Karachentsev [1]). NGC 7537 is referred to type Sbc; a bright nucleus and relatively faint spiral are clearly visible on photographies [3].

Observation data on galaxy NGC 7537≡U 12443 are as follows:

$$\alpha_{1950}: 23^{h}12^{m},0 \qquad \delta_{1950}: +23°24'$$

$$D \times d: 2',1 \times 0',5 \qquad m_p = 13,8 \qquad V_r = 2682 \text{ km/s}$$

From the dependence $m_{nuc} = 0.53\, m_{gal} + 8.40$ obtained by us for galaxies Sb/Sbc a stellar magnitude of its nucleus $m_{nuc} = 15.71$ was derived.

The observation material on which our investigation was based comprised two spectrograms of galaxy NGC 7537, obtained on a 125-cm telescope ZTE of the Southern Station of the Sternberg Institute of Astronomy in the Crimea. The spectra were obtained on an A-spectrograph with a contact IIS. The dispersion was ~90 Å/mm, corresponding to a spectral resolution of ~3 Å. The size of the slit was 360″×4″, and the image scale of the IIS screen ~140″/mm. The slit of the spectrograph was oriented along the axis (PA=75°) and along the small axis (PA=165°). The exposures in the region of λλ 6000—6900 Å were of the order of 60 min on a Kodak 103a0 photoplates.

The rotation curve required for the determination of the galaxy mass was determined by the lines H_{α} and [NII]6584 by the spectrum obtained at PA=75°. It sharply changes its slope (Fig.) at a distance of ~2 kpc from the centre. The big gradient of the radial velocity in the central region is an indication of the great density of the matter in the galaxy nucleus. After the 'refraction' of the rotation curve at ca. 2 kpc from the centre, the velocity remained almost constant up to 9 kpc. With the slope angle of ca. 15° adopted for NGC 7537, the maximal rotation velocity was 150 km/s. It should be noted that no velocity gradient was observed by means of the spectra obtained at PA=175° (small axis).

As all galaxies of a late type, NGC 7537 has a noticeable nucleus and a well-developed disk. The distribution of the mass was studied on the basis of a one-component model (a thin flat disk) by the Balabh method [5]. The gravitational effect of the disk's external regions beyond the confines of the

investigated rotation curve is not taken into account in this case. The integral stellar magnitude of galaxy $B_{T_0}=13.08$ and the diameter enclosing half of the integral luminosity $\lg A_e=0.70$ were adduced in [2]. With these data the following were determined: galaxy mass up to $R=9$ kpc $M=5.73\times10^{10}M_0$, the

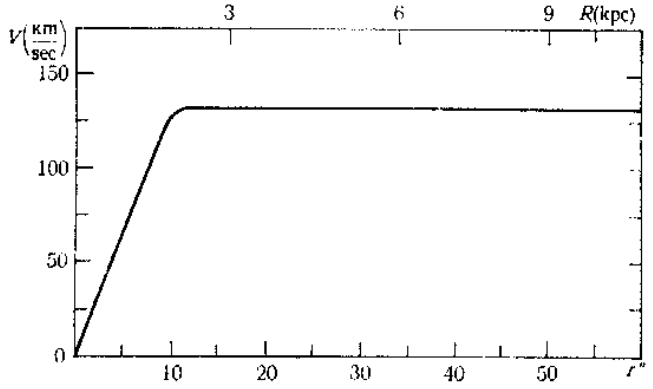

Fig. Rotation curve of galaxy NGC 7537

part of the mass enclosed in the radius $R_e=A_e/2$ comprising half of the integral luminosity $M_e/M=0{,}23$; mass: luminosity ratio for $R=9$kpc $M/L_B=4.2$ and the same ratio for $R=R_e$ $(M/L_B)_e=1.9$.

The relative intensities of the emission lines are shown in the Table.

The main parameters characterising the emitting gas — luminosity in the line $H_\beta-L_{H_\beta}$, electron density n_e, gas volume and mass, as well as content of some ions — were determined by the unified method detailed in [6]. The ratio of the ionizing sulfur lines $I\lambda6717/I\lambda6731$ [SII], according to data in [7], was determined at that electron density.

The luminosity in H_β was determined by the ratio $L_{H_\beta}=1.9074\times10^{57}Z^2W_{H_\beta}\cdot3.64\times10^{-9}/e^{0.921(0.47\ mp+9.27)}$ erg/s, while the emission capacity necessary to maintain the gas in an ionization-recombination equilibrium was given by the expression

$$L_{tot}=11.2\frac{L_{H_\beta}}{h\nu_{H_\beta}}(\bar{\varepsilon}+2.18\times10^{-11})\ \text{erg/s},$$

where $\bar{\varepsilon}$ is the energy of the free electrons obtained during ionization. The number of 07 V stars, whose u. v. emission would suffice to maintain gas in an ionization-recombination equilibrium, was estimated on the basis of this capacity. For electron temperatures of $T_e=10^4$K, $n_e=2000$ cm^{-3} was obtained. The luminosity of the line $H_\beta L_{H_\beta}=2.00\times10^{39}$ erg/s, and resp. $L_{tot}=1.2\times10^{41}$

Table

	[OI] 6300	[NII] 6548	H_α 6563	[NII] 6584	[SII] 6717	[SII] 6731	$\frac{6584}{6724}$	$\frac{6724}{I_{H_\alpha}}$	$\frac{6584}{6548}$	$\frac{6717}{6731}$
W_α [Å]	1	4.5	25	14	4	5				
$\frac{I_\alpha}{I_{H_\alpha}}$	0.03	0.15	1	0.6	0.1	0.13	2.5	0.23	3.1	0.77

erg/s. The volume occupied by the emitted gas was $V_{ef}=4\times10^{57}$ cm^3, i. e effective radius ~5 ps. The gas mass was estimated at m_{gas}~6650 m., and the number of stars 07 V required for gas ionization was ~670.

Applying the Peimbert method for the determining of the abundance of ion of sulfur and nitrogen at lgH=12.00, we obtained: $lgN^+=7.46$ $lgS^+=6.48$.

All the data suggest that:

1. The long plateau of the rotation curve indicates that considerable non-circular movements of the gas are not observed.

2. The mass:luminosity ratio of $M/L_B=4.2$ is less than the average for galaxies Sbc/Sc $M/L_B=7$ [9]. At that, it is lower for the internal $[(M/L_B)_c<M/L_B]$ than for the external regions, suggesting that the stellar composition changes along the galaxy radius.

3. As can be seen from the rotation curve and direct photographies, the nucleus radius far exceeds the 5 pc obtained from the effective volume occupied by the gas. This suggest strong nonhomogeneties in the gas distribution, i. e. the fill coefficient $\varepsilon=0.01-0.001$. This magnitude is comparable with analogous one obtained for some Seyfert galaxies.

4. Galaxy NGC 7537 is located far from the regions in which collision ionization (say, remains of supernovas) was observed and which are well delineated on the dependence ($I\lambda6717/I\lambda6731$ [SII]/$I\lambda6584$ [NII]/I_{H_α}). The emissions capacity L_{tot} necessary for gas ionization and the corresponding number of early stars, as well as the absence of radio-emission would seem to suggest that the u. v. emission of hot stars is the most probable source of gas heating in this galaxy.

The data obtained by us jully justify the inclusion of galaxy NGC 7537 into the group of normal galaxies with emission lines which, as regards the capacity of the processes occurring in them, come close to the faintest Seyfert galaxies of type 2.

Shabat Section of Shemakha
Astrophysical Observatory
AN of Azerbaijan, USSR

Department of Astronomy
Bulgarian Academy of Sciences
Sofia, Bulgaria

REFERENCES

[1] И. Д. Караченцев. Сообщ. САО **8**, 1972, 3. [2] G. de Vaucouleurs, A. de Vaucouleurs, H. G. Corwin. Second Reference Catalogue of Bright Galaxies, Austin and London, 1976, [3] Н. Арп. Astrophisika **4**, 1968, 59. [4] G. de Vaucouleurs, A. de Vaucouleurs. A. J. **72**, 1967, 730. [5] G. M. Ballabh. Ap. § Spa. Sci. **24**, 1973, 535. [6] В. К. Голев, В. И. Цветанов, Г. Т. Петров. Астрофизические исследования БАН (в печати), 1983. [7] И. В. Носов. АЦ, 1970, 1050. [8] M. Peimbert. Ap. J. **154**, 1968, 33. [9] S. M. Faber, J. S. Gallagher. Ann. Rev. A § Ap. **16**, 1679, 135.