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MASSES AND ROTATIONAL MOMENTS OF ARAKELIAN GALAXIES

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In 1980 we initiated a complex investigation of galaxies with high surface brightness (Arakelian galaxies), identified as a class in 1975 [1]. The first stages covered spectrophotometric and spectral investigations. The present communication is dedicated to the determination of masses and rotational moments of a sample of 21 galaxies on data from radio observations. In order to compare our results to similar results obtained for other types of objects, we have used the same methods proposed by Karatchentsev et al. in 1985 [2] and Karatchentsev, 1985 [3]. All the parameters are calculated at a value of Hubble constant $H=75$ km/s mpc.

For the determination of the galactic mass, a spherical model of matter distribution was assumed. For this type of objects this simplification yields a relatively small error since they are compact and with not very well developed disks. The latter circumstance complicates the plotting of optical rotational curves extended far enough from the nucleus. On the other hand, their study within the radiowave range is facilitated by the fact that the Arakelian galaxies in the mean are more powerful radio sources [4] even from the correlation between the surface brightness and radio flux at a frequency of 408 MHz [1] noted by Arakelian.

With the above-mentioned simplifications, the mass of the galaxy contained in a radius R is given by the expression $\mathfrak{m}(R)=\gamma^{-1} V_M^2 R$, where V_M is the maximum angular velocity and γ is the gravitational constant. In the case of flat rotational curves (V =const.) the mass increases linearly with the radius and it is therefore necessary always to specify the isophote of the mass determination. To generalize the results, a standard isophote is assumed at surface brightness of 25 magnitudes of a square arc second. Thus, according to Karatchentsev [3], the mass is obtained from the expression $\mathfrak{m}_{25}=\gamma^{-1}V_M^2(A_{25}/2)$, where A_{25} is the galactic linear diameter to the indicated isophote. For galaxies with strongly developed disks, that is of the morphological type Sc and Sm, a thin-disk model is more suitable. In the sample under consideration 9 objects (about 43%) belong to this type. The approximation for a spherical mass distribution leads to a value enhanced by about 25% [5]. The angular velocities of the objects are taken from the catalogue of Huhtmeier et al. [6]. For the cases where the maximum rotational velocity is not available we have used the calibration dependence between the maximum rotational velocity and the hydrogen linewidth $\lambda 21$ at a level of 20% proposed by Fisher a. Tuly [7]: $0.5\, W_{20}/\sin i = 1.2\, V_M$ where i is the galactic inclination.

According to Zasov a. Ozernoi [8], the total internal rotational moment of a spiral galaxy with a large semi-axis R coincides with that of a uniform sphere with a radius R, rotating with the same angular velocity, as well as of the external parts of the galaxy. In their view, if the flatness of the spheroid is neglected, the rotational moment is determined by the expression $K=\frac{2}{5}\mathfrak{m}(\gamma R)^{1/2}$. Later, Karatchentsev [9] proposed the dimensionless coefficient $\varepsilon_T=(\mathfrak{m}_d/\mathfrak{m})^{3/2}=(L_d/L)^{3/2}$ to be introduced for finding the part of the galaxy involved in the rotation. In the latter expression $\mathfrak{m}_d$ and L_d are the mass and disk luminosity, respectively. For the total internal moment we

Table

Masses and rotating moments for 21 Arakelian's galaxies

Akn No	Other name		Type	W_{20}	V_0 km/s	A_{25} Kpc	m_{10} $10^{10} m_\odot$	M_{H0}	M/L $(M/L)_\odot$	$L_g \frac{K}{K_g}$	$L_g \frac{k_i}{k_g}$
1	*2*		*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
19	U	540	Sm	283	5308	14.42	3.11	—20.64	1.20	—1.15	—0.43
55	N	662	Sc	291	5855	18.17	4.53	—21.46	0.82	—0.85	—0.[illegible]
71	U	1510	Sm	238	5207	12.12	1.85	—20.29	0.98	—1.50	—[illegible]
72	N	789	Sm	254	5269	14.31	2.49	—20.77	0.85	—1.27	—0.48
77	N	834	Sb	307	4855	22.60	5.22	—21.58	0.84	—0.77	—0.29
89:	U	2105	Sa	291	5101	31.67	15.75	—21.05	4.16	—0.02	—0.03
209:	U	5151	Sb	137	450	1.40	0.20	—15.67	7.49	—3.49	—1.61
214	N	2990	Sc	352	3076	13.13	4.38	—21.32	0.90	—0.96	—0.40
257	N	3395	Sc	228	1614	12.21	2.13	—19.91	1.60	—1.40	—0.58
259:	N	3419	SO	331	2881	7.82	6.64	—20.14	4.05	—1.06	—0.70
288	N	3627	Sb	375	609	21.27	7.75	—21.43	1.44	—0.52	—0.23
294:	N	3691	Sb	173	905	3.86	0.71	—17.57	4.58	—2.44	—1.11
309	U	6637	Sb	164	2937	10.26	0.69	—18.93	1.27	—2.00	—0.90
311	U	6655	Sb	106	750	1.46	0.05	—15.77	1.70	—4.44	—1.90
317	U	6711	Sb	175	2779	8.63	0.78	—19.44	0.90	—2.00	—0.91
334	N	3985	Sm	168	900	3.84	0.37	—17.69	2.15	—2.80	—1.19
365	N	4414	Sc	418	726	13.52	8.65	—19.43	10.18	—0.49	—0.24
391	N	4765	SO	122	744	4.33	0.28	—17.72	1.59	—3.25	—1.52
393	N	4800	Sb	380	832	5.49	3.23	—18.87	6.31	—3.49	—1.61
560	N	7318	SO	200	6959	46.98	7.88	—20.97	2.23	—0.57	—0.27
562:	IC	5243	Sm	189	7411	20.13	5.57	—21.14	1.34	—0.67	—0.24
359	N	4319	E	273	—300	0.93	0.32	—14.59	32.32	—4.21	—2.58

finally obtain the expression $K=\frac{2}{5}\varepsilon_T m(\gamma m A_{25}/2)^{1/2}$, $R_i=K/m$ giving the relative internal moment expressed by the relative moment of the galaxy $K_g=3.85 . 10^{29}$ cm²/sec.

Using the above pattern, the mass, the mass-to-luminosity ratio and the rotational moment of 21 Arakelian galaxies have been determined. The data are listed in the Table which contains the following: *1* — Arakelian number [1], *2* — other designation, *3* — Hubble morphological type, *4* — linewidth λ21 cm at a level of 20% [6], *5* — radial velocity corrected for the solar motion [10], *6* — linear galactic diameter in kpc, *7* — galactic mass in units $10^{10} m_\odot$, *8* — absolute stellar magnitude in Holmberg's system, *9* — mass-to-luminosity ratio in units $M_\odot/L_\odot$, *10* — total internal rotational moment in units of rotational moment of the Galaxy and *11* — relative internal moment in the same units.

This investigation is part of a comparative study of masses and rotational moments of galaxies with various degrees of activity comprising 84 Markarian galaxies, as well. Since the latter have some parameters similar to those of the Arakelian galaxies, a statistical comparison between the two samples was carried out. We used Fisher's criterion for verifying the statement that the two samples are identical with respect to the mass-to-luminosity ratio. With a 5 to 10% degree of certainty, it was found that the two samples do not belong to one and the same totality.

A detailed consideration of the results obtained will follow in another publication.

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