Доклады Болгарской академии наук
Comptes rendus de l'Académie bulgare des Sciences
Tome 43, N° 3, 1990

ASTRONOMIE
Astrophysique

MASSES AND ROTATIONAL MOMENTA OF 47 SEYFERT AND X-RAY GALAXIES

V. A. Mineva, G. T. Petrov

(Submitted by Academician K. Serafimov on September 20, 1989)

The determination of the masses, the mass-to-luminosity ratios and the internal :otational momenta of Seyfert galaxies is a problem of present interest, having in mind :hat some dynamic characteristics have been determined by some authors only for in- lividual objects without using unified methods. This complicates the statistical analysis ›f these galaxies, the comparison and the generalization of the results.

Here a unified system of methods for the determination of the above-mentioned quantities is proposed, their mean values are calculated and compared to those obtained by other authors, and some important features typical of Seyfert galaxies are given.

The mass of the galaxies is determined on the assumption of a spherical model ›f distribution of the matter by the formula [1] $\mathfrak{M}_{25}=\gamma^{-1}\cdot V_m^2\cdot A_{25}/2$ where $\mathfrak{M}_{25}$ is the mass :nclosed in the isophote $25^m/\square''$, V_m is the galactic maximum rotational velocity, A_{25} is the galactic linear parameter up to the indicated isophote and γ is the gravity :onstant. It is worth noting that when a spherical model is applied, the mass of S_c and S galaxies is increased by 25% [2]. To determine the linear parameters and the abso- u magnitudes, the reduction scheme proposed by Karachentsev et al. [3] is ap- ›lied. If V_m is not known from optical observations, it can be determined when he value of W_{20} is known (the 21-cm radiolinewidth of HI at a level of 20% of the naximum intensity) by the calibrated dependence of Fisher and Tully [4]).5 $W_{20}/\sin i=1.2\ V_m$ where i is the inclination of the galaxy toward the line of sight. 'he total internal rotational moment of the galaxy K is calculated by the formula [5]. $K=\frac{2}{5}\cdot\varepsilon_T\cdot\mathfrak{M}_{25}(\gamma\cdot\mathfrak{M}_{25}\cdot A_{25}/2)$ where ε_T is a dimensionless coefficient measuring what 'art of the galactic mass is involved in the rotation. Depending on the morphological ype, ε_T acquires values from 0.10 to 1.00 [6]. Respectively, to find the relative internal noment k, the formula $k=K/\mathfrak{M}$ is used. According to this system of methods, we have etermined the masses, the mass-to-luminosity ratios and the internal rotational momenta f 47 Seyfert galaxies (13 X-ray and 34 non-X-ray sources). The results of the calcula- ions of the X-ray Seyfert galaxies are presented in Table 1. The columns of the Table st the following data: 1 — the number of the Seyfert galaxy according to various atalogs (NGC, Mrk); 2 — the galactic type of activity; 3 — the morphological type; — the linewidth at 20% of the maximum intensity of λ 21 cm. As a source of the adiodata, Huthmeiers catalog was used. The mean values of W_{20} are given in the case 'hen more values are published for a given galaxy. When the catalog contains data n W at levels of 20%, 25% and 50%, preference was given to the magnitudes W_{20} and W_{25} which are assumed to be equal. If for some galaxy only W_{50} was deter- nined, then W_{20} was calculated by the empirical correlation [1] $\langle W_{20}\rangle=1.38\langle W_{50}\rangle$; 5 — e galactic radial velocity corrected for the motion of the Sun [8]; 6 — the linear alactic diameter in kpc. The morphological type of the galaxy T, its linear diameter A_{25} and the visible flatness e_{25} (the latter are not shown in the Table) are determined by using various data sources, such as de Vauculeur's catalog, Nilson's catalog and Vorontsov-Veliaminov's catalog. The data sources are preferred in the above-mentioned sequence. For galaxies with diameters available only in Vorontsov-Veliam-

Table 1

N	TS	T	W_{20}	V_0 (km/s)	A_{25}^{knc}	$\mathfrak{M}$ ($10^{10}\mathfrak{M}_\odot$)	$M_{H_0}^c$	f ($f_\odot$)	lg K_t	lg k
Mrk 348	Sy 2	S_a	145	4689	29.11	10.62	—19.72	9.48	—0 30	—0.14
N 262										
Mrk 506	Sy 1	S_a	414	13059	62.32	38.21	—21.77	5.16	0.70	0.31
Mrk 1376	Sy 2	S_a	336	1842	20.58	5.35	—19.46	6.08	—0.82	—0.36
N 1365	Sy 1	S_b	409	1527	57.88	3.58	—19.08	5.77	—0.80	—0.17
N 2992	Sy 1	S_a	444	2071	32.70	14.83	—18.86	29.19	—0.06	—0.03
N 3227	Sy 1	S_a	294	1058	23.07	8.12	—19.16	12.12	—0.52	—0.25
N 4051	Sy 1	S_c	333	735	17.11	12.31	—18.95	22.38	—0.21	—0.11
N 4151	Sy 1	S_b	200	993	26.97	8.36	—19.90	6.33	—0.42	—0.15
N 4388	Sy 2	S_b	431	2418	56.17	22.72	—21.48	4.04	0.39	0.22
N 5033	Sy 1	S_c	430	929	41.45	9.84	—20.23	5.53	—0.17	0.03
N 5548	Sy 1	S_a	160	5113	33.72	7.73	—21.47	1.37	—0.47	—0,18
N 7469	Sy 1	S_a	885	5043	31.31	94.51	—21.84	11.96	1.14	0.37
N 7582	Sy 2	S_b	330	1524	23.00	5.91	—18.16	22.22	—0,68	—0.26
n=13								10.89 ±2 36	—0.17 ±0.16	—0.06 ±0.06

inov's catalog, a transition to Nilson's system of diameters was performed depending on the morphological type of the galaxy. This procedure was applied to the galaxy N7582; 7 — the galactic mass in units of $10^{10}\mathfrak{M}_\odot$; 8 — the absolute stellar magnitude of the galaxy; 9 — the mass-to-luminosity ratio in units of $f_\odot$; 10 — the logarithm of the total galactic rotational moment in k_g; 11 — the logarithm of the relative galactic internal moment in k_g. The last line of Table 1 lists the mean values and the errors in the magnitudes in columns 9, 10 and 11.

Table 2 contains the results of the calculations of non-X-ray Seyfert galaxies. The denominations are analogous to those in Table 1. Some data are added and amendments are made in the columns of Table 2 as compared to Table 1. Column 1 lists the Seyfert galaxy number according to other catalogs (NGC, UGC, Mrk, Akn). In column 6 for the Markarian galaxies Nos 358, 700 and 1261, a transition to Nilson's system of diameters is performed.

For the galaxies listed in Tables 1 and 2, the variation of the mean values of the magnitudes f, K and k according to Hubble's sequence is followed and compared with data by other authors.

Our results for the $\langle f \rangle$ values are as follows: 10.45±1.48 for SO; 9.57±1.88 for S_a; 9.02±1.64 for S_b and 15.20±5.13 for S_c. The mean f value for SO is uncertain because of the unsatisfactory statistics (only 4 objects). Though, our result is in good agreement with the data by other authors: 9.1±1.1 according to Mineva and 9.3±1.7 and 11.7±2.0 according to Faber and Galacher for two samples of galaxies. The $\langle f \rangle$ value for the S_a type is very close to that obtained by Rubin et al. by using rotational curves — 9.9±1.3. The same refers to the Sb type for which Efstatiou et al. give the mean value 7.9±0.5 of the mass-to-luminosity ratio for the same morphological type. The $\langle f \rangle$ value for the S_c type is an exception for which Efstatiou et al. obtain analogous mean value which is two times lower than ours, i. e. 7.1±0.4, while, according to a study of double galaxies, Schweizer gives $\langle f \rangle = 21+5$ which is two times higher than ours.

For the K_i and k_i values of the studied galaxies, we present the following data: 14.10±11.3 for SO; 2.33±0.84 for S_a; 2.44±0.92 for S_b; 6.08±5.48 for S_c and 1.60±0.87 for SO; 1.00±0.14 for S_a; 1.05±0.19 for S_b; 2.05±0.84 for S_c.

Table 2

N	TS	T	W_{20}	V_0 (km/s)	A_{25}^{kpc}	$\mathfrak{M}$ ($10^{10}\mathfrak{M}_\odot$)	$M_{H_0}^c$	f ($f_\odot$)	lg K_i	lg k_i
Mrk 1 / N 449	Sy 2	S_a	235	5006	13.40	3.10	—19.56	3.20	—1.30	—0.57
Mrk 10 / U 4013	Sy 1	S_b	625	8827	65.07	59.46	—22.20	5.40	1.05	0.47
Mrk 176 / U 6527	Sy 2	S_a	485	7987	34.09	22.86	—21.04	6.08	0.24	0.07
Mrk 358	Sy 1	SO	511	13284	55.15	74.25	—22.13	7.28	0.93	0.25
Mrk 391 / N 2691	Sy 1	S_a	345	3945	24.49	9.76	—20.32	5.00	—0.39	—0.20
Mrk 463 / U 8850	Sy 2	S_b	160	15082	58.52	3.79	—22.32	0.31	—0.77	—0.16
Mrk 471 / U 9214	Sy 1	S_a	305	10313	36.01	9.85	—21.72	1.39	—0.30	—0.10
Mrk 533 / N 7674	Sy 2	S_b	467	8861	34.38	79.68	—22.37	6.22	1.11	0.39
Mrk 700 / U 10675	Sy 1	S_a	235	10296	33.16	7.25	—21.00	2.00	—0.52	—0.19
Mrk 1261 / Akn 253	Sy 1	S_a	745	7616	20.98	65.31	—21.72	9.30	0.81	0.19
Mrk 1291 / N 3660	Sy 2	S_c	290	13401	142.99	87.50	—22.00	9.63	1.52	0.77
N 1052	Sy 3	E	381	1467	16.39	9.17	—19.67	8.57	—1.40	1.22
N 1068	Sy 2	S_b	334	1104	38.55	41.77	—21.79	5.56	0.71	0.27
N 1566	Sy 1	S_c	226	1241	36.55	10.96	—18.29	36.65	—0.12	0.02
N 3031	Sy 1	S_b	440	85	8.57	4.73	—17.80	24.76	—1.05	—0.52
3081	Sy 2	SO	276	2142	18.20	8.14	—19,08	13.09	—0.75	—0.48
3185	Sy 1	S_a	333	1136	8.81	3.08	—18.47	8.7	—1.40	—0.67
N 3718	Sy 1	S_a	476	1099	46.91	26.91	—19.82	21.88	0.41	0.17
N 3982	Sy 2	S_b	245	1072	9.98	7.87	—19.48	8.78	—0.67	—0.38
N 4258	Sy 1	S_b	435	536	45.75	21.01	—20.38	10.25	0.30	0.16
N 4579	Sy 1	S_b	373	1695	35.32	28.85	—21.12	7.09	0.45	0.17
N 4594	Sy 1	S_a	790	973	33.64	53.77	—21.27	11,54	0.79	0.24
N 4941	Sy 2	S_b	296	621	8.91	2.34	—17.60	14.81	—1.52	—0.67
N 5005	Sy 2	S_b	190	1050	25.67	2.43	—20.61	0.95	—1.22	—0.44
N 5273	Sy 1	SO	276	1093	13.10	8.29	—19.12	12.85	—0.81	0.54
N 5347	Sy 2	S_b	144	2408	15.88	2.03	—19.63	1.97	—1.45	—0.58
N 5635	Sy 3	SO	779	12070	112.40	183.63	—22.92	8.58	1.68	0.60
N 5728	Sy 2	S_a	539	2799	30.63	26.61	—19.72	23.76	0.31	0.07
N 5929	Sy 2	S_b	220	2660	11.35	11.38	—20.02	7.74	—0.92	—0.27
N 6221	Sy 2	S_c	308	1258	15.42	6.53	—18.76	14.13	—0.66	—0.28
N 6300	Sy 2	S_b	331	992	20.67	8.10	—19.18	11.93	—0.49	—0.22
N 6500	Sy 3	S_b	545	3174	30.17	46.20	—20.61	18.19	0.72	0.24
N 7319	Sy 2	S_b	204	6901	46.59	10.00	—20.96	2.86	—0.13	0.05
N 7682	Sy 2	S_a	277	5340	22.79	10.78	—20 67	4.04	—0.34	—0.18
$n=34$								9.84 ±1.34	—0.15 ±0.16	—0.10 ±0.07

Compared to the results obtained for Turner's [5] double galaxies, for the sample of galaxies — members of systems with various degree of multiplicity and for 84 Markarian galaxies, for the Seyfert galaxies we have noted the minimum value of the magnitudes K_i and k_i in the S_a type and their growth toward the S_c type.

From the comparison between our results and those obtained by other authors it can be concluded that the mean values of f for the individual morphological types of the Seyfert galaxies are in good agreement. As far as the peculiarities of the rotational momenta of these objects are concerned, it should be pointed out that they have been observed for the first time in Seyfert galaxies and that they will be studied in detail in our next publication.

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Department of Astronomy and
National Astronomical Observatory
Bulgarian Academy of Sciences
Sofia, Bulgaria