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ARM CLASSIFICATIONS FOR SPIRAL GALAXIES

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ABSTRACT

The spiral arm classes of 762 galaxies are tabulated; 636 galaxies with low inclinations ($i < 60°$) and radii larger than 1′ were selected from the *Second Reference Catalogue of Bright Galaxies* and were classified on the basis of their blue images on the Palomar Observatory Sky Survey (POSS), 76 SA galaxies in the group catalog of Geller and Huchra were also classified from the POSS, and 253 galaxies in high-resolution atlases were classified from their atlas photographs. This spiral arm classification system was previously shown to correlate with the presence of density waves, and galaxies with such waves were shown to occur primarily in the densest galactic groups. The present sample indicates, in addition, that grand design galaxies (i.e., those which tend to contain prominent density wave modes) are physically larger than flocculent galaxies (which do not contain such prominent modes) by a factor of ~ 1.5. A larger group sample confirms the previous result that grand design galaxies are preferentially in dense groups.

Subject headings: galaxies: clustering — galaxies: general — galaxies: structure

I. INTRODUCTION

The symmetry and continuity of spiral arms in galaxies often reveal the presence of density waves. A classification system designed to emphasize such arm structure was introduced by Elmegreen and Elmegreen (1982; hereafter Paper I). This system described 12 distinct arm classes (AC), corresponding to a systematic variation in the orderliness of spiral arms. The flocculent galaxies lack bimodal symmetry and have a spiral-like structure, composed only of small pieces. The grand design galaxies have a two-arm symmetry, at least over part of the galaxy, and the arms are longer and more continuous than in flocculent galaxies. Intermediate arm classes show characteristics of both the flocculent and grand design types. Table 1 summarizes the characteristics for each arm class as presented in Paper I. Galaxies with AC 1–4 are considered flocculent, and those with AC 5–12 are grand design.

Azimuthal intensity profiles of galaxies in blue and near-infrared passbands illustrate the correspondence between spiral arm class and the presence or lack of stellar density waves (Elmegreen and Elmegreen 1984, 1985). Most of the grand design galaxies in our previous sample of 50 galaxies contain prominent infrared spirals, which probably result from density waves in the old and intermediate-age stellar disks. Most of the structure in flocculent galaxies originates in blue patches of star formation, which often have a pattern resembling simulations of stochastic self-propagating star formation (Seiden and Gerola 1982).

The correlation between arm class and density waves suggests that many of the predicted properties of density waves and star formation can be tested by comparing these properties in grand design and flocculent galaxies. For example, Romanishin (1985) found that grand design galaxies were slightly bluer than flocculent galaxies. Hodge (1985) found that H II regions in grand design galaxies are more clumped than those in flocculent galaxies. McCall and Schmidt (1986) found that the supernova rate was independent of arm class, and Elmegreen and Elmegreen (1986) found that the star formation rate per unit area was independent of arm class. Other galaxy properties, such as rotation curves, radial light profiles, atomic or molecular gas densities, the presence of small galaxy companions, and so on, should also be examined for possible correlations with arm class, to determine all of the physical processes that may stimulate density wave modes, or allow these modes to become prominent in galaxies, and to determine the influence of density waves on interstellar gas and star formation.

The purpose of this paper is to present the best possible sample of arm classifications for spiral galaxies. All spiral galaxies larger than 1′ in the *Second Reference Catalogue of Galaxies* (de Vaucouleurs, de Vaucouleurs, and Corwin 1976) were classified from glass copies of the Palomar Observatory Sky Survey (POSS), all galaxies that appear in high-resolution photographic atlases were classified from these atlas images, and all SA galaxies in the most recent compilation of galaxy groups were classified from the POSS.

The classification system in Paper I was changed slightly for the present study. Galaxies that were given arm classifications 10 or 11 in Paper I were distinguished by their obvious stellar

TABLE 1

DESCRIPTION OF ARM CLASSES FOR SPIRAL GALAXIES

Arm Class	Description
1.....	Chaotic, fragmented, unsymmetric arms
2.....	Fragmented spiral arm pieces with no regular pattern
3.....	Fragmented arms uniformly distributed around the galactic center
4.....	Only one prominent arm; otherwise fragmented arms
5.....	Two symmetric, short arms in the inner regions; irregular outer arms
6.....	Two symmetric inner arms; feathery ringlike outer structure
7.....	Two symmetric, long outer arms; feathery or irregular inner arms
8.....	Tightly wrapped ringlike arms
9.....	Two symmetric inner arms; multiple long and continuous outer arms
10.....	No longer used; previously denoted barred galaxies
11.....	No longer used; previously denoted galaxies with close companions
12.....	Two long symmetric arms dominating the optical disk

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TABLE 2

ARM CLASSES FOR SPIRAL GALAXIES IN THE DE VAUCOULEURS SAMPLE

NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC
23	4	906	12	2139	2	2942	9	3447	1	4030	9	4490	1	4904	2	5619	5	6412	9
26	6	908	9	2146	1	2964	12	3450	9	4037	4	4492	4	4921	2	5633	6	6467	n
36	12	918	12	2196	6	2967	9	3455	7	4038	1	4496A	2	4939	12	5635	4	6500	n
45	1	925	1	2206	5	2976	3	3456	2	4039	1	4498	4	4941	3	5641	8	6555	2
132	12	926	i	2207	5	2985	3	3464	9	4041	9	4501	9	4965	2	5645	1	6632	5
150	12	941	1	2223	9	2997	9	3471	2	4045	4	4504	5	4981	4	5656	n	6643	5
151	9	945	12	2227	i	2998	9	3485	2	4050	5	4517A	2	4995	6	5660	9	6667	i
157	12	949	n	2268	3	3001	9	3486	9	4051	5	4519	5	4999	8	5665	4	6674	2
173	9	959	2	2273B	5	3020	2	3504	8	4079	12	4523	1	5005	3	5668	2	6699	9
175	6	988	i	2276	2	3023	5	3507	9	4102	12	4525	1	5012	9	5669	5	6753	8
180	5	991	2	2280	9	3027	4	3513	12	4116	1	4531	n	5033	9	5676	3	6754	i
182	4	1022	6	2336	9	3031	12	3521	3	4123	9	4534	1	5042	4	5678	i	6764	5
192	i	1042	9	2339	5	3038	4	3583	12	4127	2	4535	9	5054	5	5691	n	6814	9
200	5	1058	3	2344	5	3041	4	3596	5	4136	9	4545	9	5055	3	5705	1	6824	2
201	4	1068	3	2347	4	3052	9	3611	2	4142	1	4548	5	5068	2	5713	4	6907	12
210	6	1073	5	2377	9	3054	9	3614	5	4145	4	4567	1	5078	5	5728	2	6923	5
214	9	1084	5	2389	2	3055	4	3621	3	4151	5	4571	3	5085	2	5740	5	6926	5
255	2	1087	2	2397	3	3057	1	3627	7	4152	9	4579	9	5112	5	5756	5	6943	i
257	9	1097	12	2403	4	3059	5	3629	2	4158	3	4580	12	5134	6	5757	5	6946	9
266	12	1169	3	2441	12	3061	2	3631	9	4162	2	4593	5	5172	9	5772	3	6951	12
271	12	1179	3	2442	7	3074	9	3642	9	4189	2	4597	1	5194	12	5774	2	6956	12
289	12	1187	9	2460	12	3095	4	3660	2	4193	2	4606	n	5204	1	5783	2	6962	12
300	5	1232	9	2487	6	3124	9	3664	2	4204	2	4618	4	5218	5	5806	5	7015	9
309	9	1241	4	2500	1	3145	2	3672	2	4210	9	4625	4	5230	9	5832	5	7042	9
337	2	1249	i	2523	6	3147	3	3673	5	4212	3	4635	2	5236	9	5850	8	7080	6
337A	2	1253	i	2525	5	3162	4	3675	3	4237	2	4639	2	5247	9	5861	12	7171	5
418	9	1255	5	2532	2	3169	2	3681	5	4242	1	4647	3	5248	12	5866B	2	7172	i
428	1	1288	9	2535	12	3182	n	3683A	9	4246	12	4651	9	5254	5	5874	12	7177	3
447	n	1292	3	2541	1	3183	12	3684	5	4254	9	4653	5	5260	12	5875	5	7217	3
450	2	1300	12	2543	12	3184	9	3686	5	4260	i	4654	4	5300	2	5876	6	7218	i
470	3	1309	3	2545	4	3185	6	3687	4	4273	4	4662	9	5320	4	5885	5	7300	5
488	3	1313	5	2552	1	3206	4	3718	i	4288	1	4682	2	5324	5	5905	12	7309	9
514	9	1325A	n	2566	n	3227	7	3726	5	4290	6	4688	2	5334	2	5921	8	7314	2
521	9	1343	5	2575	3	3259	2	3729	5	4298	2	4689	3	5350	9	5923	9	7320	2
536	12	1357	12	2595	5	3274	2	3756	9	4303	9	4698	3	5351	9	5949	i	7392	5
570	5	1365	12	2599	6	3281	i	3780	9	4304	9	4699	3	5364	9	5953	1	7424	9
578	9	1371	4	2608	12	3285	2	3786	8	4314	12	4701	5	5371	9	5957	6	7428	6
598	5	1376	2	2614	9	3287	1	3804	2	4319	8	4707	1	5375	9	5962	2	7440	5
600	2	1385	4	2633	12	3294	9	3810	2	4321	12	4713	1	5377	6	5963	2	7479	9
613	9	1398	6	2642	9	3299	1	3811	5	4332	12	4725	6	5378	6	5964	2	7495	2
622	12	1417	12	2701	4	3310	1	3813	4	4378	6	4731	5	5383	12	5968	3	7496	12
628	9	1425	2	2708	i	3319	5	3850	1	4380	2	4736	3	5395	4	5970	9	7513	5
658	i	1437	3	2712	5	3320	1	3865	5	4389	5	4750	2	5406	9	5985	9	7610	9
668	2	1493	5	2718	12	3338	9	3887	2	4393	1	4772	8	5426	2	6012	3	7678	5
673	12	1530	12	2742	9	3344	9	3893	12	4394	6	4775	9	5427	9	6060	i	7685	9
681	2	1566	12	2750	2	3346	9	3897	12	4395	1	4777	3	5430	12	6070	9	7714	1
691	3	1617	3	2763	9	3347	12	3898	3	4411A	1	4779	9	5457	9	6106	5	7716	9
701	i	1637	5	2775	3	3351	6	3913	2	4411B	3	4780	5	5468	9	6140	2	7723	5
706	n	1640	9	2776	9	3359	5	3930	4	4413	3	4781	i	5474	2	6154	8	7727	1
718	12	1642	9	2782	2	3367	9	3938	9	4414	3	4793	1	5494	5	6181	12	7741	5
753	9	1672	5	2805	5	3368	8	3949	1	4420	1	4814	9	5533	3	6215	12	7738	12
772	4	1744	1	2835	9	3370	5	3953	9	4424	i	4826	6	5556	1	6217	5	7742	n
828	1	1784	2	2848	2	3377	1	3963	12	4430	4	4877	i	5584	5	6236	5	7753	12
840	5	1792	3	2857	12	3381	12	3968	9	4450	12	4891	9	5585	1	6246A	2	7755	4
841	12	1832	5	2889	9	3389	2	3982	2	4475	9	4899	4	5595	4	6300	6	7757	9
864	5	1954	7	2903	7	3423	2	3992	9	4480	9	4900	3	5597	5	6384	9	7782	6
877	2	1961	4	2916	4	3430	5	4025	2	4487	5	4902	9	5614	6	6389	9	7793	2
895	9	2090	i	2935	8	3433	9	4027	4									7819	12

TABLE 2—*Continued*

IC	AC	IC	AC	IC	AC	IC	AC	IC	AC
43	2	302	4	749	5	1525	12	2522	5
167	12	342	9	983	2	1558	1	2537	2
211	12	356	3	1067	2	1953	4	2627	12
239	9	381	5	1158	5	1954	i	2580	9
267	12	469	i	1237	12	2075	9	3576	1
284	i	520	n	1291	5	2421	12	4182	2
								5201	i

A	AC	A	AC	A	AC	A	AC	A	AC
0001+14	1	0429+01	12	0911+16	6	1202-27	1	1522+58	2
0017+10	2	0447-29	1	0942-31	1	1222+70	2	1555+30	12
0043-11	1	0450-25	5	0949+43	5	1226+02	2	1614+47	1
0102-06	2	0505-16	2	1004+52	2	1226+37	2	1805+35	5
0118+12	i	0508-31	1	1008-25	1	1241+00	1	1906+42	12
0115+11	4	0509-14	4	1019+46	4	1241-05	1	1930+54	12
0208+06	1	0553+68	5	1020+71	1	1246-09	2	1945-18	n
0218+39A	12	0558-28	f	1021+15	1	1250+10	6	2022+05	12
0221+35	1	0608+69	i	1026+70A	1	1252+00	3	2029-02	5
0223-21	1	0609+71A	12	1026+70B	n	1301-03	2	2047+16	5
0224-24	1	0618-20	4	1033-24	1	1316+42	1	2207-22	5
0232+37	1	0704+61	9	1122+64	5	1318+10	1	2218+47	i
0235-02	12	0706+71	1	1137+46	1	1335-09	2	2231+32	3
0244+37	12	0743+59	i	1146-28	1	1338+54	4	2233-03	3
0245+03	1	0805+76	i	1149+52	1	1402+09	i	2237+37	12
0246+01	1	0814+21	9	1154+49	2	1416-26	12	2242+06	2
0249-01	f	0820+22	3	1155+38	2	1423+56	2	2327+40	1
0305-31	9	0834+51A	1	1155+51	n	1427+44	1	2334+00	3
0313+31	12	0909+35	1	1156+52	2	1442+08	2	2342+06	2
0343+70	i	0909+74	5	1200+41	12	1511-15	4	2357+47	2
								2359+23A	4

bars or companion galaxies. This distinction was made because bars and companions are thought to be associated with density waves (Kormendy and Norman 1979; Elmegreen and Elmegreen 1983). Here no galaxies are assigned to classes 10 or 11, and those classified as such in Paper I have been reclassified. Only the spiral arm features themselves are considered in the present classification of galaxies. Several galaxies in Paper I were also given multiple arm classes. Such galaxies have been reclassified here into single arm classes, with the dominant characteristics determining the arm class.

II. THE CATALOGS

a) Selection Criteria

Table 2 includes all 708 spiral galaxies listed in the *Second Reference Catalogue of Bright Galaxies* (de Vaucouleurs, de Vaucouleurs, and Corwin 1976), with declinations $\delta > -35°$, inclination-corrected radii at 25 mag arcsec^{-2}, R_{25}, greater than 1′, and inclinations less than 60°; 654 galaxies could be classified, 54 galaxies which met the criteria but were too faint, had no details (were overexposed on the POSS or were too early in Hubble type to distinguish structure) or were too inclined for reliable classification are also included in Table 2, but with designations *f*, *n*, or *i*, respectively, instead of arm classes. The galaxies were classified from their blue images on glass copies of the Palomar Observatory Sky Survey using a 10 power illuminating ocular.

Galaxies photographed at high resolution and published in atlases are listed in Table 3. These 253 galaxies were classified from the atlas photos. Sources include the *Hubble Atlas of Galaxies* (Sandage 1961), *Atlas of Peculiar Galaxies* (Arp 1966), *Atlas de Galaxias Australes* (Sersic 1968), The Bright Southern Atlas (Sandage and Brucato 1979), The Near-Infrared Atlas (Elmegreen 1981), *Revised Shapley-Ames Catalog* (Sandage and Tammann 1983), and The Virgo Atlas (Sandage, Binggeli, and Tammann 1985). Eighty-nine galaxies from these atlases were classified even though they did not meet the selection criteria used to make Table 2.

Table 4 gives arm classes for 76 galaxies (including 19 not in Table 2) with Hubble type SA from the group catalog of Geller and Huchra (1983). The list is included here because the regularity of spiral structure in nonbarred galaxies appears to be influenced by companions (Kormendy and Norman 1979; Elmegreen and Elmegreen 1983) and to be correlated with group crossing time (Elmegreen and Elmegreen 1984). The classifications were made from the POSS.

b) Self-Consistency Checks

Most galaxies in Table 2 were classified at least 3 times, separated by intervals of several months, as a consistency check. They were classified from both paper and glass copies of the POSS. In the de Vaucouleurs sample, ~10% of the galaxies were given different arm classes during independent examinations on the paper prints. An 8% variation occurred when the glass images were subsequently examined. The most common reclassification was from an AC 2 to 3, or vice versa, since these types are similar. AC 2 or 3 was sometimes reclassified as 4 or 5 (or vice versa), indicating that one or two small arms seemed more or less prominent at different times. Another common change was an AC 9 to AC 12, or vice versa, indicating some difficulty in deciding how much weight to give to branching or nonsymmetric structures besides the dominant two-armed symmetry. Occasionally an AC 12 was reclassified to or from AC 5, indicating some confusion in deciding whether a two-armed structure was weak or dominant. A reclassification of AC 12 into 7 occasionally occurred when a galaxy examined on the POSS was then examined at higher resolution; this confusion occurs when central regions are overexposed or too small on the POSS. For the high-resolution galaxies listed in Table 3, again ~10% of the arm classes changed upon reclassification. In these cases the large amount of detail presented confusion; irregular features were given more or less weight at different times of classification.

Arm classifications become increasingly difficult for very small, faint galaxies. The cutoff of 1′ radius for the galaxies in

TABLE 3

ARM CLASSES FOR SPIRAL GALAXIES IN ATLASES

NGC	AC	NGC	AC	NGC	AC	NGC	AC	NGC	AC
23	4	1832	5	3486	9	4411A	1	5033	9
45	1	1961	4	3504	8	4411B	3	5055	3
145	5	1964	9	3511	2	4412	12	5194	12
157	12	2146	1	3521	3	4413	3	5204	1
175	6	2217	6	3576	1	4414	3	5236	9
210	6	2223	9	3627	7	4416	5	5248	12
300	5	2276	2	3631	9	4420	1	5364	9
309	9	2397	3	3646	2	4430	4	5383	12
488	3	2403	4	3672	2	4432	4	5394	5
497	9	2427	5	3756	9	4433	1	5395	4
598	5	2442	7	3783	9	4457	4	5457	9
613	9	2500	1	3810	2	4470	3	5585	1
615	3	2523	6	3898	3	4480	9	5614	6
628	9	2525	5	3992	9	4501	9	5676	3
718	12	2541	1	4017	12	4507	5	5728	2
772	4	2608	12	4027	4	4519	5	5806	5
776	1	2681	8	4062	3	4523	1	5829	12
864	5	2763	9	4088	12	4535	9	5962	2
925	1	2775	3	4152	9	4536	12	5985	9
972	1	2835	9	4189	2	4540	3	6181	12
1058	3	2841	3	4193	2	4548	5	6215	12
1068	3	2857	12	4212	3	4567	1	6300	6
1073	5	2903	7	4234	2	4568	2	6384	9
1084	5	2976	3	4237	2	4569	5	6412	9
1097	12	2997	9	4254	9	4571	3	6643	5
1156	1	3031	12	4273	4	4579	9	6699	9
1232	9	3059	5	4274	8	4580	12	6753	8
1300	12	3081	6	4276	1	4593	5	6814	9
1302	8	3145	2	4298	2	4595	2	6946	9
1313	5	3147	3	4299	2	4618	4	6951	12
1347	4	3185	6	4302	3	4630	1	7205	5
1365	12	3256	1	4303	9	4639	2	7217	3
1398	6	3259	2	4303A	4	4647	3	7314	2
1433	6	3275	4	4304	9	4654	4	7331	3
1437	3	3294	9	4314	12	4689	3	7392	5
1452	6	3310	1	4321	12	4699	3	7424	9
1493	5	3344	9	4351	5	4725	6	7479	9
1512	6	3347	12	4376	1	4736	3	7496	12
1566	12	3351	6	4378	6	4750	2	7678	5
1569	1	3359	5	4380	2	4793	1	7741	5
1617	3	3367	9	4390	9	4800	2	7743	12
1637	5	3414	1	4394	6	4814	9	7753	12
1672	5	3445	1	4395	1	4941	3	7769	2
1792	3	3464	9	4405	3	5005	3	7793	2

IC	AC	IC	AC	IC	AC	IC	AC	IC	AC
356	3	1222	12	3115	12	3268	1	3528	12
749	5	1933	4	3156	2	3476	1	3583	1
797	1	2522	5	3267	9	3517	1	4837	12

A	AC	A	AC	A	AC	A	AC	A	AC
0020-01	12	0418+02	5	0830+19	12	1240+26	12	1408+17	12
0020+22	5	0650+86	12	0849-16	12	1313+26	12	1722+62	4
0149+21	12	0700+27	2	1103+30	5	1332+31	5	2234-03	2
0206+41	12	0800+05	1	1200+09	1				

TABLE 4

ARM CLASSES FOR SA GALAXIES IN GROUPS

NGC	AC	NGC	AC	NGC	AC	NGC	AC
70	9	3389	2	4378	6	5351	9
173	9	3509	1	4380	2	5364	9
198	2	3517	2	4395	1	5395	4
245	2	3631	9	4414	3	5434	9
470	3	3642	9	4450	12	5474	2
488	3	3675	3	4492	4	5477	2
598	5	3684	5	4501	9	5480	5
628	9	3719	2	4534	1	5486	2
691	3	3780	9	4567	1	5533	3
976	5	3898	3	4571	3	5668	2
1068	3	3913	2	4651	9	5676	3
1085	3	3938	9	4689	3	5953	1
2841	3	4041	9	4698	3	5962	2
2976	3	4108	3	4701	5	7673	12
3031	12	4127	2	4736	3	7757	9
3169	2	4212	3	5033	9	7782	6
3177	6	4241	3	5055	3	I4182	2
3338	9	4254	9	5194	12	A0152+60	6
3370	5	4298	2	5230	9	A1136+58	2

Table 2 represents a minimum practical size for classification from the POSS. Although a higher proportion of small angular size galaxies may be misclassified than large angular size galaxies, no evidence for a systematic bias was actually found in the data. Figure 1 shows the angular size of the galaxies in Table 1 versus the arm classes, with large dots representing averages in each arm class bin. There is no obvious correlation between average angular size and arm class. The slight increase in the proportion of AC 9 galaxies for large angular sizes is apparently not a classification bias, because this increase also occurs for the well-resolved galaxies in Table 2.

III. TWO CORRELATIONS

As discussed in the introduction, several correlations between arm class and galaxy properties have been found. A new correlation is between arm class and galaxy size. Grand design galaxies are found to be larger than flocculent galaxies. Figure 2 shows the arm class of a galaxy plotted against its physical size, as determined from its apparent size, R_{25}, multiplied by its velocity V_0. The average size for each arm class is indicated by large dots. The average size for a grand design galaxy is ~ 1.5 times the average size for a flocculent galaxy.

This size correlation is similar to that found by Iye and Kodaira (1976) between the size of a galaxy and the van den Bergh (1960) luminosity class. (van den Bergh did not consider galaxy size, only luminosity, although the two properties are obviously related.) The arm classification differs from the luminosity classification in the sense that the arm class emphasizes symmetry and spiral arm length, whereas the luminosity class emphasizes arm prominence or brightness relative to the galactic disk. Paper I showed that each arm class contains a wide range of luminosity classes, and vice versa (see Fig. 3 in Paper I). Although there are many exceptions, long and symmetric arms tend to be visually prominent, or "well-developed," as in luminosity class I, and flocculent arms tend to be faint, as in luminosity class III, for example. Thus, the correlation in Figure 2 is not surprising, but it is also not trivial. It may eventually indicate the reason why luminosity class or arm class correlate with luminosity; namely, that large galaxies tend to develop prominent wave modes more easily than small galaxies, or, perhaps wave modes make a galaxy larger because of enhanced star formation (Elmegreen and Elmegreen 1986).

This variation of size with spiral arm class implies that the sample of galaxies in Table 2, which was selected on the basis of apparent size, is not a uniform sample with respect to distance. The average velocity of galaxies with AC 2 and 3 in Table 2 is 1818 km s^{-1}, and the average velocity of galaxies with AC 9 and 12 is 2708 km s^{-1}. Thus, grand design galaxies in Table 2 are ~ 1.5 times more distant than flocculent galaxies. This systematic variation in distance implies that the ratio of flocculent to grand design galaxies in space is much

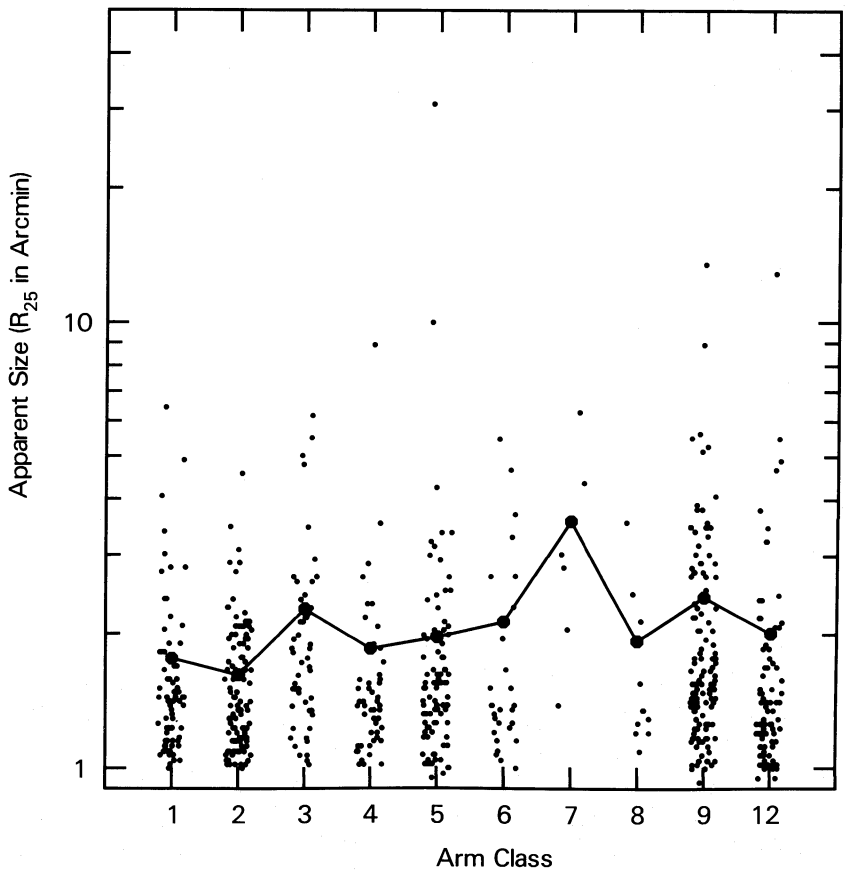

FIG. 1.—Angular sizes of the galaxies in the sample from the Second Reference Catalog are plotted against the arm classes. Large dots are the average angular sizes for each arm class. Data points for arm class were dispersed to avoid overlaps by adding random variables between −0.3 and 0.3 to the arm classes. There is no obvious correlation between average apparent size and arm class.

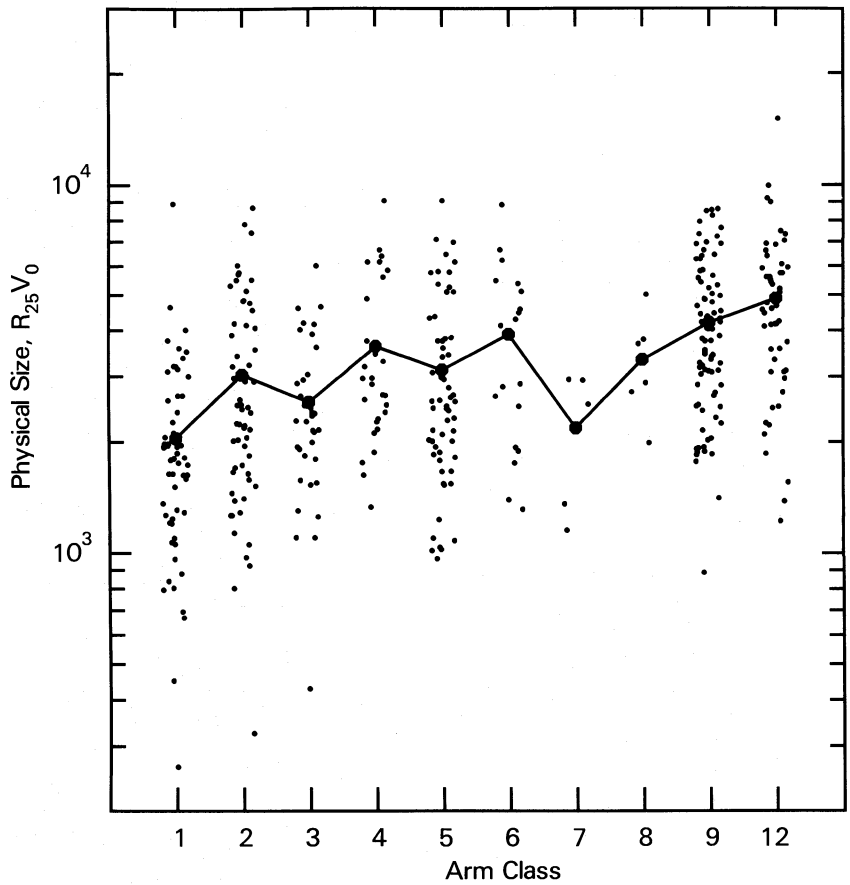

FIG. 2.—Relative physical sizes of the galaxies, determined from the product $R_{25} \times V_0$ (in arcmin km s^{-1}), are plotted vs. the arm classes. Large dots are the average physical sizes for each arm class. As in Fig. 1, the data points for the arm classes were randomly dispersed to avoid overlap. A correlation between physical size and arm class is evident.

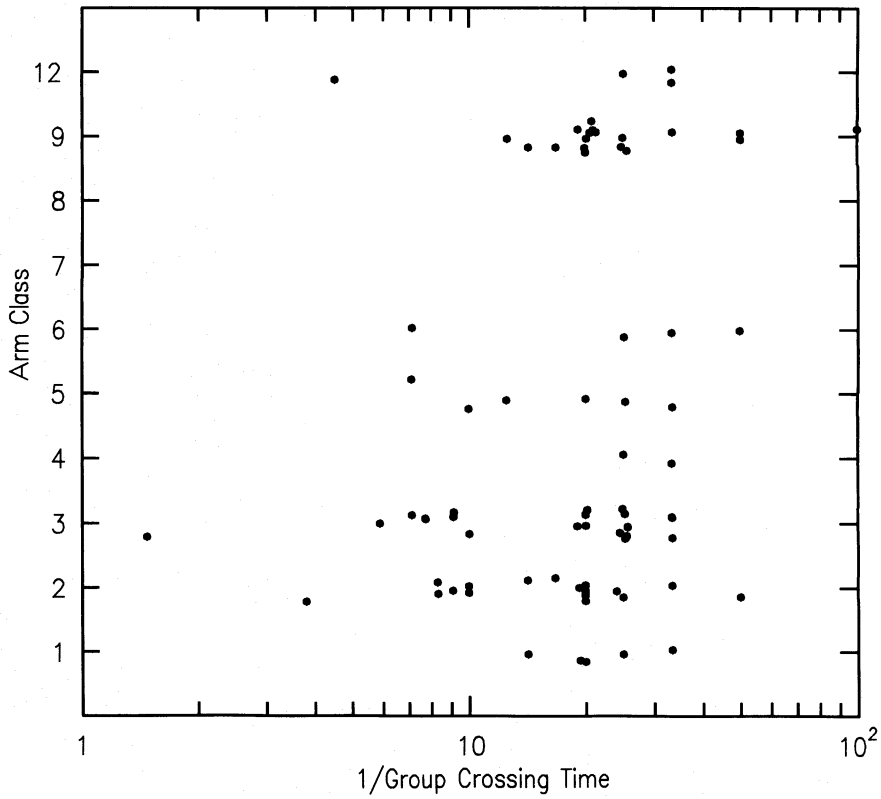

FIG. 3.—Arm class is plotted against the inverse of the group crossing time, measured in units of the Hubble time, for SA galaxies in groups listed by Geller and Huchra (1983).

larger than the ratio in Table 1, larger possibly by a factor equal to the cube of the distance ratio, which is (2708 km s^{-1}/1818 km s^{-1})^3 = 3.3. Statistical surveys of spiral arm–related properties of galaxies should be made with a velocity or distance-limited subset of Table 2.

The arm classes of SA galaxies in groups were previously found to be correlated with the group crossing rate, which is a measure of the mean group density (Elmegreen and Elmegreen 1984). That correlation was based on the Huchra and Geller (1982) nearby groups, covering the whole sky down to a limiting magnitude of 13.2 mag. Figure 3 shows the arm class versus the inverse of the crossing time for SA galaxies in the groups studied by Geller and Huchra (1983), which include groups in the northern hemisphere down to a limiting magnitude of 14.5 mag. Groups with small crossing rates (low densities) have a higher fraction of flocculent galaxies.

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