A PRELIMINARY CLASSIFICATION OF THE FORMS OF GALAXIES ACCORDING TO THEIR STELLAR POPULATION. II.

W. W. MORGAN
Yerkes Observatory, University of Chicago

I

A recent paper has given an outline of a revised system of classification of the forms of galaxies, together with types for 608 systems.[1] That investigation will be designated Paper I, and the present one Paper II.

The galaxies classified on the revised Yerkes system in Paper I include a large fraction of the northern entries in the Shapley-Ames Catalogue. It seemed advisable to make the classification approximately complete to some limiting apparent magnitude; a program was therefore devised to classify a number of additional galaxies. Through the kindness of Dr. I. S. Bowen and the Committee of the Mount Wilson and Palomar Observatories, I was permitted to make use of the original negatives of the National Geographic Society–Palomar Observatory Sky Survey for the purpose.

The present paper completes the classification of all galaxies brighter than magnitude 13.1 in the Shapley-Ames Catalogue and north of $\delta = -25°$, with two exceptions: the object NGC 2149 has been omitted from the catalogue, since it appears to be a diffuse nebulosity, rather than a galaxy; NGC 2798 was omitted inadvertently.

The galaxies included in the present paper were classified on the 48-inch Sky Survey plates during a period as guest investigator at Pasadena in the autumn of 1958. A large number of galaxies in Paper I were reclassified without knowledge as to the earlier type assigned; this overlap furnishes material for an accurate determination of the systematic characteristics of the two series.

II

The 48-inch Sky Survey plates are ideally suited to the classification of the forms of the brighter galaxies; the uniform quality

of the plates makes feasible the use of somewhat finer subdivisions than in the case of Paper I. In many cases, much more detail is visible on photographs made with the great reflectors; however, the uniformity of contrast and resolution on the Sky Survey negatives permits intercomparison of different galaxies to be made with high precision.

As a result of this, certain minor modifications were made in the system of Paper I; these are:

1. The definition of Ep has been broadened to include peculiar elliptical-like systems in addition to those showing dust absorption.
2. Certain highly irregular, disorganized systems have been classified in the category a?Ip; these would have been included among the aI systems in Paper I; the distinction between the aI and the a?Ip groups is shown by a comparison of the galaxies NGC 4490 and NGC 3991, both of which are illustrated in Paper I.
3. Intermediate stages in the form families have been expanded in number; for example, galaxies having an appearance intermediate between classes E and D are classified as ED or DE, depending on whether the E or the D characteristic is more apparent.

In cases where the same galaxy has been classified in Paper I and the present paper, the later type is to be preferred.

A catalogue of 642 galaxies is given in Table I. The types were determined on the blue plates of the Palomar Sky Survey, except in the case of one field where the blue plate was not available. The galaxies classified on the red plate are noted in the remarks to the table. The latter are referred to by an asterisk following the NGC number.

A few galaxies inadvertently omitted from the survey were classified on the glass copies of the Sky Atlas at the Lick Observatory; in addition, one system was classified from the paper print at the Yerkes Observatory.

III

With the addition of the galaxies listed in Table I, an extensive body of material becomes available on the system described in Paper I. At this stage, therefore, the question can be asked: How closely do galaxies classified in the various subdivisions conform to the definitions outlined in Paper I?

TABLE I

CATALOGUE OF TYPES

NGC	Y	NGC	Y
45*	fS3	681*	kDS(7)
147	L	701	(a?) IS5p
151*	fgS5	741*	kE3
157*	aS3	750	kDE2
175	gB1	772	gS4
178	a?Ip	777	kE2
185	gkDE3	821*	kE6(S?)
205	gD4–5	864	afS3
210	gkS3p–gkSD3	877	afS3–afI
221*	kE3	891	g?S7
224	gkS5	895	fS3
245	a?Ip	925	afBS5
255	gS3(B)	936	kB3
274–5	kD1 + Ip	949	k?DE6
278*	fSI	958	fB?6
309	fS2	976	(k??S3)
337*	a?S3	991	afS1
357*	k?B3	1022	gS2p
New 1*	fS3(B)	1023*	kD6p
428	afS3p	1035*	f?S6?
450	fSD3	1048	fS2
470	(afS4–afI)	1052	kE4
474*	(k?(S)2–k?E2)	1055*	gS6
488	gkS3	1058*	fD2
520	(k??) Ip	1068	gS2p
521	fS1(B)	1073	fB1
524	kD2	1084*	a?S4
533	kE4	1087	aI4–aS4
584	kE4	1090	fS4
596	kED2	1140*	I?p
598	fS4	1179*	fS1
615	gS5–gD5	1187	afS3
636	kE3	1199*	kE3
670	kE7?	1209*	kES
672	afB?5	1232	fS2

TABLE I (*Continued*)

NGC	Y	NGC	Y
1241*	fS4(B)	1726	kE3
1275*	kE2p	1784	fgSB4
1297	gk?D2	1832	fS3
1300	gB3	1964	gS5
1309	gDS1	2139*	a?I3
1325	fSD5	2146	k?Ip
1332	kDE7	2179	gD4
1337*	afS6	2196	kS3
1353	fgS5	2207*	fS4
1357	gkS3	2223	fS2
1359*	a?S:3	2336	fgS4(B)
I 1953	fS1(B)	2339	(afS2)
1376*	afS1	2347	kE2
1385*	a?Sp	2403	fS4
1395	kE3	2525	a?S3p
1400	kE2	2545*	(fg?S3p)
1407	kE1(D)	2633*	fgB3p
1415	gk?D5(S)	2639*	kE6p(S?)
1417	fgS4(B)	2642*	fS1(B?)
1421	aS6	2654	gkDS7
1426	kE4	I 520	gkSD2
1439	kE1	2672*	kE2
1440*	kB3	2685*	kD7p
1452	kB3	2742	afS4–5
1453	kE3	2763	afS1
1461	kD6–7(S?)	2768	kD6
1507	a?I7?	2781*	kD5
1518*	aI	2784	kD5
1521	kE3(D)	2787	kB4
1600*	kD4(E)	2793*	a?Ip
1637*	fS3	2811	gkSD6
1640	gB2	2815	gS5
1659	fS3–fD3	2832*	kE3(D)
1667	afS3–4	2835	aS3
1700	kE4	2848	afS3

TABLE I (*Continued*)

NGC	Y	NGC	Y
2855*	kD3	3227*	g?S4p
2865*	kED4	3245	gkD5
2889	fS3	3254	gS6
2907*	kE?6p–kD?6p	3274	I?p?
2935	gB1(S)	3277*	Pec.
2964	fS5	3287	a?I5
2967*	fS1	3294*	afS4
2968*	gk?D5?p	3301	gkDS6p
2974*	kDS4	3310	S1p
2983	kB4	3348	kE2
2985	gkS3	3351*	gB3
2986	kED2	3353	a?Ip
2992	g?Sp	3367	afS1
2993	g??Sp	3368*	gS4p
3031	gkS4	3377	kE5
3032	g?SD3N?	3379	kED1
3034*	E7p–Ip	3384	kD5
3044*	f?S?7	3389	aS4–aI
3052*	aS3	3395, 3396	aI + aI
3065	kD1		
3077*	ED3p	3403*	g?SD5
3081*	gk?D4	3412*	gkD5p
3091*	kDE3	3414*	kBp
3124*	fS1	3430	aS4
3145	(fS4)	3432*	a?S7?
3147	gkS2	3433	fS1
3158*	kE3	3445*	a?Ip
3162	fS2	3448*	a?Ip
3177	S3p	3458	kD3:
3184	fS1	3486	gS4
3185*	fgBD3	3489	kSD5
3190*	kSD6p	3504*	g?B1?p
3193	kE2	3510	fg?S?7
3200	fS6N?	3512	fg?S3p
3226*	k?E3	3516	kB?D4

TABLE I (*Continued*)

NGC	Y	NGC	Y
3547	Ip5	3718	fgSp
I 2627	fS1	3720*	S?1p:+fS3
3549	afS5	3726	fS3
3556*	aI	3729*	fgD4
3583	fg?S4p	3732*	Ip?
3593*	gkD5	3735	g?S?7
3596	fS2	3738	Ip?
3607	kE3	3756	afS4
3608	kDE3	3769*	fgS6
3610*	kE5	3773*	k?D?3
3611	gkDS4	3780	afS2
3613	kE6	3782*	aI?
3614	fS4	3813*	a?S5
3619*	gk?DS3pN	3818*	kB
3623	gkS5	3865	fS3
3626*	kDS5	3872	kE4
3627	gS4	3877	afS6
3628	g?S?7	3888	f?S3p
3630*	kD7	3892	kB3
3631*	fgS1	3893	fgS4
3637	kB2	3898	kS5
3640*	kE3(SD)	3900*	gSD5
3642	gkS2	3912	Ip?
3646*	fS4p	3917	afS6
3655*	Sp–Ip	3938	fS1
3659	Ip5	3941	kD4p
3664*	a?I	3949*	f?S4?
3666	f?B6?	3952	a?Ip
3672	afS5	3953	fgS4
3681	gD1–gS1	3955*	S6?p–Ip
3684	fgS4	3956	fS5
3686	afS3	3957*	k:S7:
3687	gS1	3962	kE3
3690*	a?Ip + a?Ip	3981	fS6
3705*	gS5D	3982	g?S1p

TABLE I (*Continued*)

NGC	Y	NGC	Y
3985	Ip–S3p	4151	gDS4p
3995*	a?Ip	4152	fgSD3
3998	kD3	4157	f?S6
4008	kD5	4162	afS4
4013	gk:S7:	4168	kE2
4024*	k?D	4178	afB5
I 750	Ip?	4183	f:S7:
4026	kD7	4189	afS2
4027*	afS3	4192	gS6
4032*	g?Ip	4203	gkD2
4033	kD6	4212	fS4
4037	fS1	4214	aI
4038–9	a?Ip	4215*	(k?D7?)
4047	S?p	4217	gk:S7
4050*	fS3	4220*	fgS6p
4051	fS2	4224*	(kD6(S))
4062	afS5	4233*	(kD7)
4064	afS7?	4234*	(aS2)
4085*	aI	4235*	(kD7)
4088	a?S4p	4236	aBS5–6
4094	afS5	4237	fgSD4
4096	afS5	4242	fS2?–fD2?
4100	fg:S5p	4244	af?S?7
4102	k?DS4p	4245	kB3
4111	kD7	4251	kD7
4116*	(fB5)	4254	fgS1
4123*	(fB4)	4258	gS5
4124	gD5	4260	gB5
4129*	I7?	4261	kDE2
4136	fS1	4262	kB
4138*	kD4	4267	gkD1
4143	kDE5	4270	kD6
4144	fg:S7?	4273	fgSD4
4145	fS3	4274*	gkDS5
4150	gkD4	4278	kDE1

TABLE I (*Continued*)

NGC	Y	NGC	Y
4281	kE6	4419	gkSD6
4283	kE1	4420	f?S5
4291	kE4	4424	gIS
4293	g:SD4p	4429	kD5
4294	aSB5	4433	fS4
4298	afSD4	4435	kDE6
4303	fS1	4438	gkI
4307	g:SD7	4442	kD6
4314	kB1	4448	kSD6
4321	fgS1	4449	aI
4324*	gD5	4450	gS3
4339	kD1	4454*	gD:1
4340	gkB4	4455	aI7
4342*	gkSD6	4457*	kSD1p
4346	kD7	4459	kE3
4365	kE4	4460*	gkDE7p
4369*	gD1	4461	kD6
4371	kB(4)	4462	(g?S?5)
4374*	kE1	4469	gD7
4377	kD2	4472	kE2
4378	kS2	4473	kE5
4379	kD3	4474	kD7
4380	fgSD4	4477	kBD1
4382	gkD4	4478*	kE2
4383	k:Ip	4485*	a?I
4385	gBS4	4486	kE1
4386	gkD6	4487	fS3
4388	gk:SD6	4490	aI
4389	a?Ip	4494	kE2
4394	gB2	4496*	aBS1
4395*	aS2	4501	gS4
4406	kE2	4503	kD5
4412	afIS1	4504	fS4
4414*	fSD4	4517*	f:S:7
4417	kD7	R 80	afS3

TABLE I (*Continued*)

NGC	Y	NGC	Y
4519	afS1	4635	aS3
4522	af?S6?	4636	kE1
4526	kD6	4638	kD7?
4527	gS6	4639	gS3
4532	a?I	4643	kB1
4535	afS2	4647	fD3
4536	fS5	4649	kE2
4540*	a?Ip	4654	aS3
4546	kE6	4656	aI
4548	gB(3)	4658	fg:S5
4550	kD7	4660	kE6
4552	kE1	4666	gS6
4559	fgS5	4668	a?I
4564	kD7	4670*	k?D7p?
4565	gkS7	4684	k:E7
4567	afS3	4688	afB1
4569	aS5	4689	fSD2
4570	kD7	4691*	f:B1
4571	fSD2	4694	kD6
4578	gD3	4697*	kE6
4579	kBS1	4698*	kS5
4580	fS4	4699*	kDS4
4586	gDS5	4700*	afS7
4589	kDE3	4701	gS3
4592*	af:S6	New 3	aS2
4593	gB3	4710*	k?D?7
4594	kDS6	4712	afS4
4596	kB1	4713	aS3
4597	afB4	4725	gkSB4
4602	afS5	4731	afBS
4608	kB1	4736*	gDS3
4612	gkD3	4742	kD4
4618	aS3p–a?Ip	4747*	f?S7p?
4621	kE5	4750*	gkDS3p
4632	afS5	4753*	gD5p

TABLE I (*Continued*)

NGC	Y	NGC	Y
4754	kD5	4958*	kD7
4760	kD2	4981	fgS4
4762	kD7	4984	kD2
4765*	E?4	4995	fgS4
4771	g:S:6	5005*	gkS5
4772	kS5	5018	kD4
4775	fS1	5033	gS4
4781	aS4–aI	5044*	kE1
4782*	kD1? + kD1	5054	fgS4
4783*		5068	afS1(B)
4786	kD4	5077*	kED4
4790	afS4–afI	5084*	kD7
4793	fg?S4p	5085	fS2
4800*	kD3?	5087	kE5
New 4	afS4	5112	aSI3(B)
4808	af?S5–af?I5	5134	gD4–5(S)
4818	g:B:6	5147*	aS3–aI
4825	kD4	5170*	gkS7
4845	g:S6	5194	fgS1
4856	kD6	5195	f?Ep?
4861*	a?Ip	5198	kS2
4866*	kDS6	5297	afS6
4889	kE4	5300	aS3
4891	fgS2	5301	f:S6
4899	aS4	5308	kD7
4900	afI1	5313*	afS4
4902	fB1	5322	kE4
4904	fB3	5324	afS1
4914	kE5(D)	5334	aS3(B)
4915	k:D3	5350	fB4(S)
4928*	f?S3	5353	kE7
4933*	kD4?	5371	fgS4
4939	fS4	5376	fgSD4
4941	gSD4	5377*	gkD5(S?)
4951	g:S5	5383	gB2

TABLE I (*Continued*)

NGC	Y	NGC	Y
5406	fgBS3	5813	gkDE3
5422	kD7	5820*	kE7
5426*	fgS?4	5831	kE3
5427*	fgS1	5838	kD5
5430	Ip–Bp	5846	kE2
5457	fS1	5850*	gB2
5468	aS1	5861*	aS4
5473	kBD4	5866*	kD7p
5474*	gS1p	5878	gSD5
5480	f?S4	F 703*	aS1
5485	kE2p	5885	aS1
5493	kE7?	5898	kDE1
5496*	afS7	5903	kDE2
5533*	k?S4	5907*	g?S7
5534	a?Ip	5908	gkS7
5557*	(kE2:)	5915*	Ip
5584	aS3	5921	fS1(B)
5595*	aS4	5936	fS1
5597*	afS2	5970	gS4
5687	kE5(D)	5984	f?BS6?
5690	f?S6	6106	(fS4)
5691*	S3p–Ip	6118	fS5
5713*	S1p–Ip	6207	fg??S5?p–Ip
5728	fgD?4N?	6482	(kE3)
5740	fS4	6503*	g?S6
5746	gkS7	6643*	afS5
5750*	gD4	6814	fgS1
5757	fB1	6822*	(f?I)
5768	afS2–afI	6835*	kD7
5775	f?S?7	6907	(fSB3)
5791	kES(D)	7171	fS4
5792*	fS5	7184*	gSD6
5796	kE2	7218	aS4
5806	g?SD4	7252*	k?pec.
5812	kE1	7371	gD1(S)

TABLE I (*Concluded*)

NGC	Y	NGC	Y
7377	kD4	7626	(kE1)
7392	gk?S4p	7721	afS5
7457	kED5	7723	fSB4
7585*	k?D3p(S?)	7727	Sp
7619	(kDE3)	7785	kD6

NOTES TO TABLE I

NGC	
45	Low surface brightness.
151	Arm tilted from plane.
157	High surface brightness.
221	Abnormally steep edge gradient.
278	From Crossley plate.
337	Strong arms; no nucleus.
357	Background, D.
New 1	Low surface brightness.
474	Exceedingly faint outer spiral arms. Limiting case between S and E systems.
681	Heavy dust lane. Total eccentricity of system (4). Edge-on system with very strong E 3–4 central part.
741	Brightest in group of k systems.
821	Very faint arms?
1023	Inner lozenge inclined to fainter, outer part. Faint, arm-like extension curving south at eastern end of elongated penumbra.
1035	Or afI.
1055	Heavy asymmetric absorption.
1058	Irregular, thready, bright features.
1084	Or Sp. Disordered S. High surface brightness.
1140	Or k??I + tail.
1179	Low surface brightness.
1199	Several small k systems nearby.
1209	Or kED6.
1241	Companion.
1275	Faint irregular bright filaments. Brightest in nest of around 12 bright k systems.
1337	Plane of system distorted.
1359	Or a?Ip. Disordered appearance.
1376	Arms building off ring.
1385	Disordered appearance; high surface brightness.
1440	Background (D).
1518	Or a?Ip.
1600	Brightest in small k cluster?

NGC	
1637	Background D.
2139	Appendage. High surface brightness. H II regions?
2207	Appendage.
2545	One-arm spiral starting from inner loop.
2633	Three hot spots in bar.
2639	Very faint thin spiral arm.
2642	Distant fragment.
2672	Companion 2673, kE1. Faint appendage, on red plate, to 2673, in direction opposite to 2672.
2685	Helix. Spiral arms around major axis.
2781	Very faint outer ring, 3 × diameter of inner system.
2793	Companion.
2832	Small companion, kE1. Brightest in nest of 8 k systems.
2855	Dust arc around nucleus.
2865	On red plate: kE4.
2907	Heavy dust lane.
2967	High surface brightness.
2968	On red plate, classified as pec.
2974	Very faint spiral arms. Superposed star.
3034	Dust streamers tending to radial direction. Faint, vein-like bright filaments extending out normal to major axis in region of minor axis.
3044	Very flat.
3052	Or afS3.
3077	Dust streamers tending to radial direction.
3081	Ring + nucleus.
3091	Or kD3. Brightest system in k group.
3124	Or fS2.
3158	Brightest in nest of around 10 bright k systems.
3185	Ring + internal bar.
3190	Heavy, inclined dust lane.
3226–7	Some similarity to 5194–5. Arm from spiral seems to join elliptical.
3277	k?E2? + faint S2 arms.
3294	Or aS4.
3351	Nuclear hot spots? Overexposed.
3368	One-arm spiral.
3403	Arms very faint.
3412	Two major axes inclined.
3414	Bar thin and weak.
3432	Or a?I7.
3445	Or aSp. I7 appendage.
3448	Faint outer extensions.
3504	Inner part g:D5.

NGC	
3556	Or a:S:6. Dust clouds; high surface brightness.
3593	Dust arc around nucleus.
3610	Very faint outer arms?
3619	Like 4151?
3626	Spiral arms in inclined plane. Heavy dust arc around nucleus.
3630	Small.
3631	Nuclear hot spots.
3640	Inner part, E, surrounded by asymmetrical faint penumbra, with possible faint traces of spiral arms.
3646	Outer ring irregular in structure.
3655	High surface brightness.
3664	Or a?Ip.
3690	Two systems in contact; debris outside.
3705	Bright inner ring.
3720	High surface brightness; fS3 = 3719.
3729	Ring.
3732	Or k??Sp. Very bright nucleus. Faint, close arm.
3769	Or gD6. Ring. I6p companion.
3773	Or pec.
3782	Like M 82?
3813	High surface brightness.
3818	Red plate: kE6.
3900	Ring.
3949	High surface brightness.
3955	Smooth, amorphous background on which brilliant features are superposed.
3957	Or kD7: distant. Dark lane across nucleus.
3995	Or aSp.
4024	Or k?B.
4027	a?Ip.
4032	Small thready (spiral) arms. Like 1275?
4050	Or fBS3.
4085	Or aS6.
4116	From red plate.
4123	From red plate.
4129	Or gD7?–gS7?.
4138	Dust ring.
4215	From red plate.
4220	Or gD6.
4224	Heavy dust lane. From red plate.
4233	Circular nucleus. From red plate.
4234	Or aI. From red plate.
4235	From red plate.
4274	Ring.

NGC	
4324	Ring.
4342	Southernmost of group of 5.
4369	Distant, kD1. Hot spots in nucleus.
4374	Dust visible on high-resolution plates.
4395	Low surface brightness.
4414	High surface brightness.
4454	Ring.
4457	Faint outer ring.
4460	Row of hot spots near nucleus?
4478	Or kE3.
4485	Satellite and debris near 4490.
4496	Overlapping afI.
4517	Or afI.
4540	Companion.
4592	Or afI.
4670	Eccentric envelope.
4691	Row of 3 hot spots.
4697	Dust?
4698	Faint disk-arm system 3 × size of inner part.
4699	Distant: kD4.
4700	Or aI. Chain?
4710	Irregular dust clouds projected.
4736	Distant, kD3.
4747	Or I?p. Extended "tidal" arm. Central row of hot spots.
4750	Bright ring.
4753	Irregular dust.
4765	Or Ip.
4782–3	Two connected, distorted. Nuclei eccentric.
4800	Or S3p. Distant: kD3. High surface brightness.
4861	Comet. Multiple hot spots in head. Spray of bright regions in tail.
4866	Ring. Or gkD6, ring.
4928	Small; bright.
4933	2 companions.
4958	Flat, outer envelope.
5005	gD background, with S arms delineated principally by absorption lanes.
5044	Brightest member of small k cluster.
5077	Brightest of group.
5084	Very flat. Flat, large envelope 2–3 × length of main body.
5147	Projected star.
5170	Exceedingly flat.
5313	High surface brightness.
5377	Faint outer inclined ring.

NGC	
5426	Connected with 5427.
5427	Connected with 5426.
5474	Low surface brightness gS1 superposed on north edge of D1 system which seems to be smooth and featureless.
5496	Or afI.
5533	Thready, blue spiral arms.
5557	Classified on Sky Atlas print.
5595–7	Similar pair.
5691	One irregular arm from Ip? nucleus.
5713	Brilliant, mottled inner part.
5750	Or fD4(S). Nucleus + ring.
5792	Arms from ring.
5820	Very faint curving extension to SE from end of major axis.
5850	Or gB3.
5861	No nucleus on blue plate.
5866	Heavy dust lane.
F 703	Or afS2.
5907	Very flat.
5915	Or Sp. Small, bright spiral.
6503	High surface brightness.
6643	High surface brightness.
6822	Magellanic Cloud type.
6835	Or kS7.
7184	Ring.
7252	Four-petaled daisy.
7585	Faint spiral arm?

In any attempt at classification, three stages can be recognized: (1) The setting up of a system of categories that are defined in an approximate manner—according to certain preconceived ideas; (2) the classification of a body of specimens into the categories outlined; (3) the description of the categories in terms of the specimens classified in each.

In the course of the progression outlined above, developments and modifications in the original scheme result of necessity. An interesting example of this is furnished by the evolution of the Harvard system of spectral classification into the system of the *Henry Draper Catalogue*. Some categories tend to disappear; others are modified in nature; and, most important of all, the definitions of the surviving groups undergo a certain amount of systematic change.

A dogmatic insistence on the exactness of the preliminary definitions of the classification system is therefore inadvisable; a valid and precise definition of an empirical system of classification can only be in terms of the observed properties of the specimens classified in each category. As the amount of observational evidence increases, the ideas on which the new classification is based are subjected to increasingly critical tests.

The original basis for the Yerkes form system was the spectral classification of galaxies of Morgan and Mayall.[2] In the latter, groups of galaxies were classified into spectroscopic categories of A to K. The galaxies of earliest spectral type were described as "A-systems"; there was no category of "B" galaxies included in the classification. The ultraviolet region of the spectrum of these "A" galaxies generally contains strong absorption lines of hydrogen, and it was considered that the principal contributors to the violet spectral region are main sequence stars of type A.

Spectrograms of higher resolving power obtained more recently at the McDonald Observatory by Mayall and Morgan show that galaxies classified in the "A" category vary greatly among themselves: in some cases (NGC 4490) it seems that B8–A5 main sequence stars are probably responsible for the principal contribution to the light in the ultraviolet region of the spectrum; at the other extreme are galaxies similar to NGC 4214, whose spectroscopic characteristics in the ultraviolet resemble rather closely those of the inner parts of the Orion Nebula.[3] At an intermediate position are galaxies similar to NGC 4449, where the ultraviolet line of He I at λ 3820 is present.[3] In such systems as NGC 4449 it seems likely that most of the ultraviolet light originates in B1–B3 stars; in this case, there seems to be a resemblance to the population of the Large Magellanic Cloud.[4]

Now, if this wide range in spectroscopic appearance is to be taken account of in a classification system of forms, further subdivisions in the system are called for; however, at the present time, it does not appear to be practicable to distinguish the three abovementioned categories of galaxies of early spectral type from each other *by their form characteristics alone*. We therefore, in the form classification procedure, continue to describe all three categories as "a-systems." At this current stage in the classification

development, the category "a-systems" refers to galaxies whose stellar populations, as observed in the ultraviolet region, range from a situation approximately similar to that of the Orion Nebula region to a population in which the principal contribution to luminosity originates in A—or even early F—stars.

In view of the modifications outlined above—and of the fact that further modifications are almost certain to be made in the future—the justification for the carrying out of the reclassification of forms of galaxies in Papers I and II might be called into question. The present justification lies in the fact that the new classification does effect an approximate separation of galaxies according to their stellar populations; the "a" galaxies do have populations rich, by luminosity, in early type stars and gas; the "k" galaxies have a population rich, again by luminosity, in yellow-giant stars; and the galaxies of intermediate form type tend to have mixtures of the two extreme categories above mentioned. The final decision will depend on how useful the new classification proves to be in the future.

I wish to express my thanks to Dr. I. S. Bowen, Director, and to the Committee of the Mount Wilson and Palomar Observatories for the opportunity to carry out the classification of galaxies given here.

The investigation was supported by a grant from the Office of Naval Research.

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[1] W. W. Morgan, *Pub. A.S.P.*, **70**, 364, 1958.

[2] W. W. Morgan and N. U. Mayall, *Pub. A.S.P.*, **69**, 291, 1957.

[3] W. W. Morgan and N. U. Mayall, unpublished.

[4] G. and A. de Vaucouleurs, *Lowell Obs. Bull.*, **4**, 58, 1959 (No. 92), or *Pub. A.S.P.*, **71**, 83, 1959.