

Radial Velocities of Galaxies. II.

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We present a list of radial velocities of galaxies derived from spectrograms obtained in 1971 with the Carnegie image-tube Cassegrain spectrograph attached to the KPNO 84-inch telescope. The list includes data for a $7^\circ \times 4^\circ$ region centered near R.A. = $12^{\text{h}}18^{\text{m}}$, Dec. = 29° . It contains members of the NGC 4274 group with $\langle V_0 \rangle = 882$ km/sec, the NGC 4131 group with $\langle V_0 \rangle = 3969$ km/sec, and the Coma cluster. Four galaxies in the compact VV 115 group, Seyfert's group, have radial velocities near $\langle V_0 \rangle = 4454$ km/sec, while a fifth has $V_0 = 20\,137$ km/sec. This Sc galaxy may be a background object. The distorted double galaxy, No. 98 in Arp's *Atlas*, has practically no velocity difference. It could be a tidally interacting system.

IN a recent paper (Chincarini and Rood 1972; hereafter called Paper I), radial velocities are given for galaxies based on spectrograms obtained in 1970 with the Carnegie image-tube Cassegrain spectrograph attached to the 84-inch telescope at Kitt Peak National Observatory. The present paper gives radial velocities based on spectrograms with a dispersion of 250 Å/mm obtained in 1971. The reduction procedures, error analyses, and derived accuracy are identical to those described in Paper I. The completion of the analyses shows that the mean curvature for the 1971 Hg spectra has a sagitta of -40 km/sec on a $300''$ slit length. The curvature is independent of wavelength. No correlation with the various setups used has been found. For all plates with two or more measured lines, the average internal mean error is 96 ± 12 km/sec. This compares well with the uncertainties given in Paper I derived from different spectra of the same galaxies: 50–100 km/sec for spectra with only absorption or broad and/or faint emission lines, 50 km/sec for spectra with strong emission lines, and 100–200 km/sec for spectra with wide and/or faint absorptions, or high sky background. The rest wavelength of the spectral lines has been taken from de Vaucouleurs and de Vaucouleurs (1967).

Results are given in Table I. Columns 1 and 2 identify the galaxy and its associated group or cluster. The NGC or IC number is given, when available. The relative location of each galaxy in a close double system is indicated. The designations of galaxies in the group VV 115 are those of Vorontsov-Velyaminov (1959). Columns 3–6 give standard locational coordinates. Galactic longitude and latitude are estimated with the conversion table by Torgard (1961). When a galaxy is a member of a close double galaxy or compact group, the coordinates of that system are given. Column 7

lists the spectral lines used to derive the radial velocity, and Column 8 gives the position angle of the slit of the spectrograph. Column 9 lists the radial velocity relative to the Sun, Column 10 gives the solar-motion correction, $300(\cos^I - 55)\cos b^I$, and Column 11 gives the radial velocity relative to the center of mass of the local group of galaxies. Column 12 gives notes.

I. COMA CLUSTER

Three galaxies in the study by Rood *et al.* (1972) have new redshifts given here, based on better quality spectrograms. We obtain for NGC 4735, NGC 4712, IC 4040 the values 6687, 4536, 7759 km/sec compared with the values 6110, 4350, 7528 km/sec adopted by Rood *et al.* The uncertainty of the previous velocity of NGC 4735 was given as ± 500 km/sec. Our spectrum of NGC 4712 contains strong sky contamination which gives an uncertainty of $\pm(100-200)$ km/sec. For IC 4040, the origin of the 2.4σ difference between the previous and our velocity is unclear. The differences are too small to significantly affect the statistical analyses of Rood *et al.* (1972).

Following discussions held with Zwicky, a test was undertaken to check for the presence of starlike objects in the Coma cluster. Star counts showed a weak indication, one or two standard deviations, of a blue-star concentration toward the center of the cluster. Therefore, a sample of nine blue stars with $m_{pv} \lesssim 17$ near the center was chosen to check their radial velocities. All nine have a negligible redshift and are foreground stars.

II. THE NGC 4274 AND NGC 4131 GROUPS

Towards the west of the Coma cluster, a $7^\circ \times 4^\circ$ region centered near R.A. = $12^{\text{h}}18^{\text{m}}$, Dec. = 29° is outlined by Zwicky and Herzog (1963) (cluster 16 in fields No. 158 and 159). Table II contains all known radial velocities of galaxies in the region with $m_p \leq 15.0$. These redshifts

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TABLE I. Radial velocities from 1971 spectra.

Identification		R.A. (1950)	Dec.	l^{II}	b^{II}	Lines	Slit P.A.	V km/sec	ΔV km/sec	V_0 km/sec	Notes
Abell 838 Cl.	W	09 34 ^m .6	-04°49'	238.2	34.1	KH	90°	15428	-215	15213	1
NGC 4274 Grp.	NGC 4062	12 01.5	32 10	185.3	78.6	KH	90	748	-4	744	1
Coma Cl.	Anon 1202	12 02.1	31 27	188.5	79.0		3727 159	7469	-7	7462	
Coma Cl. 65'' SE of	Anon 1202	12 02.1	31 26	188.5	79.0		3727 159	7996	-7	7989	
Coma Cl.	NGC 4104	12 04.1	28 27	204.3	80.0	KH	90	8493	-20	8473	
NGC 4131 Grp.	NGC 4131	12 06.2	29 35	197.4	80.3	KH	90	3710	-13	3697	
NGC 4131 Grp.	NGC 4132	12 06.5	29 31	197.7	80.4	K, 3727	90	4069	-13	4056	
Coma Cl.	Anon 1206	12 06.6	31 51	184.6	79.7	KH, 3727	90	6758	-5	6753	
NGC 4131 Grp.	NGC 4169	12 09.7	29 27	197.3	81.1	KH	136	3840	-11	3829	
NGC 4131 Grp.	Anon 1209	12 09.8	29 05	199.6	81.2	H, 3727	90	4050	-16	4034	
NGC 4131 Grp.	NGC 4174	12 09.9	29 25	197.5	81.	KH	136	4161	-11	4150	
NGC 4131 Grp.	NGC 4175	12 10.0	29 26	197.3	81.1	KH, 3727	136	4061	-11	4050	
NGC 4131 Grp.	NGC 4196	12 11.9	28 42	201.8	81.7	KH	90	3982	-16	3966	
Coma Cl.	NGC 4211 W	12 13.1	28 27	203.3	82.0	KH	145	6695	-15	6680	
Coma Cl.	NGC 4211 E	12 13.1	28 27	203.3	82.0	KH	145	6838	-15	6823	
Coma Cl.	NGC 4272	12 17.3	30 37	186.2	82.3	KH	90	8462	-2	8460	
NGC 4274 Grp.	NGC 4275	12 17.4	27 54	207.0	82.9		3727 90	2307	-15	2292	1
Comma Cl.	NGC 4295	12 18.7	28 26	202.4	83.2	KH	90	8568	-11	8557	
NGC 4274 Grp.	NGC 4308	12 19.4	30 20	186.9	82.8	KH	90	606	-4	602	
NGC 4274 Grp.	NGC 4310	12 19.9	29 29	193.2	83.2	KH	90	901	-6	895	1
Coma Cl.	NGC 4375	12 22.5	28 50	197.6	83.9	KH	90	9042	-8	9034	
NGC 4274 Grp.	NGC 4525	12 31.3	30 34	172.6	85.0		3727 90	1131	5	1136	1
Coma Cl.	NGC 4555	12 33.2	26 48	221.8	86.4	KH	90	6694	-9	6685	
Coma Cl.	NGC 4556 W	12 33.3	27 12	215.4	86.5	KH	90	7987	-7	7980	
Coma Cl.	NGC 4556 E	12 33.3	27 12	215.4	86.5	KH	90	7402	-7	7395	
Haro 32 Grp.	NGC 4566	12 33.7	54 30	127.8	62.7	KH	90	5290	108	5398	1
Coma Cl.	IC 3582	12 24.0	26 28	227.7	86.5	KH	90	7122	-9	7113	
Coma Cl.	IC 3585	12 34.1	27 07	217.0	86.6	KH	90	7412	-9	7403	
Haro 32 Grp.	Anon 1242	12 42.3	56 25	124.9	60.9	KH, 3727	90	4805	119	4924	
Haro 32 Grp.	NGC 4675	12 43.3	55 00	124.7	62.3	KH, 3727	90	4806	112	4918	1
Haro 32 Grp.	Anon 1246	12 46.0	54 18	123.9	63.0		3727 90	3383	109	3492	1
NGC 4131 Grp.	NGC 4712	12 47.1	25 44	288.6	88.2	KH, 3727	162.5	4542	-6	4536	1
Coma Cl.	NGC 4735	12 48.6	29 12	125.7	88.2		3727 90	6677	10	6687	1
Coma Cl.	Anon 1257	12 57.2	28 54	73.1	87.6	H α	90	5327	15	5342	1
Coma Cl.	IC 4040	12 58.2	28 19	57.7	87.7	H α	148	7744	15	7759	
Coma Cl.	Anon 1259.6	12 59.6	28 03	49.0	87.5	KH	90	7202	11	7213	1
Coma Cl.	Anon 1259.8	12 59.8	28 29	58.0	87.3		3727 90	8308	15	8323	
Coma Cl.	NGC 4929	13 00.3	28 18	53.4	87.3	KH	90	6338	15	6353	1
Coma Cl.	Anon 1300	13 00.8	28 50	62.5	87.0	KH	90	6914	17	6931	1
VV 115	A	15 57.0	20 54	34.9	46.8	KH	33	4392	128	4520	2
VV 115	a	15 57.0	20 54	34.9	46.8	KH, 3727	33	4285	128	4413	1, 2
VV 115	b	15 57.0	20 54	34.9	46.8	KH	104.5	4187	128	4315	1
VV 115	c	15 57.0	20 54	34.9	46.8		3727 26	4438	128	4566	1, 2
VV 115	d	15 57.0	20 54	34.9	46.8	KH	104.5	20009	128	20137	1
Hercules Cl.	NGC 6040 W	16 02.1	17 53	31.4	44.7	KH, 3727	6	12386	122	12508	1
Hercules Cl.	NGC 6040 E	16 02.1	17 53	31.4	44.7	KH, 3727	6	12618	122	12740	1
Abell 2199	Anon 1627.2	16 27.2	39 41	62.9	43.6		3727 90	8794	199	8993	1
Abell 2199	Anon 1627.3	16 27.3	39 48	63.1	43.6	KH	90	8115	200	8315	
Abell 2197	Anon 1627.7	16 27.7	40 59	64.7	43.5	KH	90	8182	203	8385	3
Abell 2197	Anon 1628.7	16 28.7	41 02	64.8	43.3		3727 90	9092	204	9296	4
Abell 2197	Anon 1628.8	16 28.8	40 50	64.5	43.3	KH	90	8900	204	9104	3
Abell 2197	Anon 1628.9	16 28.9	40 40	64.3	43.3	KH	90	9110	204	9314	

Notes to Table I

¹ Strong sky contamination.² Spectrogram slightly out of focus.³ Weak spectral lines.⁴ Galaxy has very low surface brightness.

are taken from Table I of the present paper and de Vaucouleurs and de Vaucouleurs (1964). The sample is 63% complete. In our observing run, we selected mainly E, S0, and SB0 galaxies. It is seen that the velocities are segregated into three groups (Fig. 1). At $\langle V_0 \rangle = 882$ km/sec lies the NGC 4274 group with a velocity dispersion, $\sigma_v = 424$ km/sec. To its west lies the NGC 4131 group with $\langle V_0 \rangle = 3969$ km/sec and $\sigma_v = 144$ km/sec. Finally, several galaxies may be

outlying members of the Coma cluster at $\langle V_0 \rangle \approx 7000$ km/sec.

III. SEYFERT'S GROUP VV 115

VV 115 is a compact group of six galaxies described by Seyfert (1951). This group has been studied independently by E. M. Burbidge and Sargent (1971) and they arrive at similar conclusions. (We thank the editor for bringing this to our attention.) A photograph with

TABLE II. Radial velocities of galaxies with $m_p \leq 15.0$ in a $7^\circ \times 4'$ region containing the NGC 4274 group, the NGC 4131 group, and part of the Coma cluster.

Identification	V_0 km/sec	Type	m_p^*
NGC 4062	744	Sa	11.9
Anon 1202	7462	E2	14.0
NGC 4104	8473	E6	13.7
NGC 4131	3697	E6	14.1
NGC 4132	4056	S0	14.6
Anon 1206	6753	E0	14.4
NGC 4136	434	Sb	12.1
NGC 4150	236	E3	12.6
NGC 4169	3829	E5	12.9
Anon 1209	4034	E5	14.8
NGC 4174	4150	S0	14.3
NGC 4175	4050	Sa	14.2
NGC 4196	3966	E2	13.7
NGC 4211	6752	...	14.4
NGC 4245	882	SB0	12.4
NGC 4251	1000	S0	11.5
NGC 4274	761	Sa	11.1
NGC 4272	8460	E1	14.2
NGC 4275	2292	...	13.4
NGC 4278	622	E1	11.2
NGC 4283	1078	E0	13.1
NGC 4295	8557	E1	15.0
NGC 4308	602	E0	14.3
NGC 4310	895	S0	13.5
NGC 4314	879	SBc	11.5
NGC 4375	9034	S0	13.9
NGC 4414	720	Sa	10.9
NGC 4448	687	Sa	11.9
NGC 4525	1136	Sb	13.0
NGC 4555	6685	E2	13.5
NGC 4556	7688	E2	14.4
NGC 4559	852	Sb	10.7
NGC 4565	1171	Sb	10.3
IC 3582	7113	E6	14.3
IC 3585	7403	E0	15.0

* Magnitude according to Zwicky and Herzog (1963).

the 200-inch telescope by Baade appears in that article. Photographs with galaxy designations (A, a, b, c, d, e) are in the atlas by Vorontsov-Velyaminov (1959). Radial velocities have been derived for five galaxies, and four (A, a, b, c) have $\langle V_0 \rangle \approx 4454$, $\sigma_v = 97$ km/sec. Galaxy d, an Sc, however, has $V = 20\ 137$ and may be a background object. If the Hubble velocity is $20\ 137$ km/sec, then $M_p = -20.3$, where $m_p = 16.8$ was taken from Vorontsov-Velyaminov (1959), and $H = 75$ km/sec/Mpc was adopted. If Galaxy d were a group member with Hubble velocity = 4454 km/sec, then $M_p = -17.1$, somewhat faint for an Sc galaxy. Also, see the discussion by Seyfert (1951).

IV. ARP 98

In Paper I, redshifts were given for the peculiar double system at $\alpha(1950) = 1^h 29^m 3$, $\delta(1950) = 31^\circ 51'$,

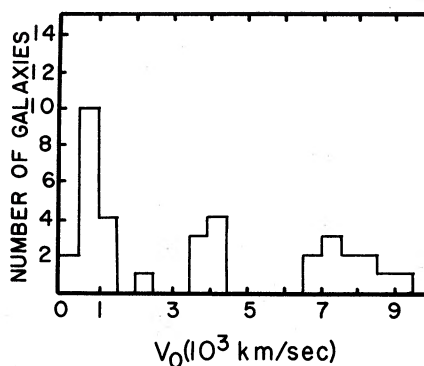


FIG. 1. Frequency distribution of velocities of galaxies in a $7^\circ \times 4'$ region toward the west of the Coma cluster.

$\delta(1950) = 31^\circ 51'$, No. 98 in Arp's *Atlas* (1966). The double system contains a spiral with one arm stretched towards an elliptical companion, an apparent result of a tidal encounter. The redshifts of the two galaxies are $12\ 723$ and $12\ 758$ km/sec, and the 35-km/sec difference is consistent with the tidal-encounter hypothesis.

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