all observations were made at the Cassegrain focus of the 125-cm reflector with a grating spectrograph and a type FKT-1 contact electronic image converter. Most of the spectrograms were obtained at ≈230 Å/mm dispersion but a few have a dispersion of ≈100 Å/mm. The spectrograph slit was 4" wide and was usually oriented along right ascension.

We present below our radial-velocity determinations for 29 interacting and peculiar galaxies. The Hα, [N II], and [S II] emission lines have been measured. Night-sky emission lines were used as wavelength standards.

Table I lists the galaxies we have investigated. Successive columns give the α, δ coordinates for epoch 1950.0, the type of peculiarity (whether interacting or compact), the number of the object in the Catalog of Interacting Galaxies,[2,3] and the designations in the NGC, IC, and Zwicky's Catalog of Compact and Post-Eruptive Galaxies. The measured radial velocity, corrected for solar motion ($\Delta V_{\odot}$ = 300 sin l cos b), is followed by the emission lines used to determine the radial velocity. Other determinations of V_r are collected in the last column; these are taken mainly from the new edition of the de Vaucouleurs' catalog,[4] or are based on private communications from I. D. Karachentsev (designated K77). Radial velocities have been measured for VV 90 and I Zw 23 by Sargent.[5] According to our 230-Å/mm spectrograms the internal error of the radial-velocity measurements (the consistency of the V_r values derived from different emission lines) is ≈60 km/sec. For most galaxies, V_r has been measured on a single spectrogram.

The small scale of our spectrograms (≈140"/mm) prevents us from measuring the radial velocities of the individual structural features of interacting galaxies, except for several large systems. Hence the measured radial velocity refers either to the primary component of the system, if it is an object of the M51 type (such as VV 472, 426, 442), or, as in the case of nest-type systems, to the component exhibiting the emission lines in the spectrum. This component will sometimes be hard to identify unless photographs that are not overexposed are available. Most of the interacting galaxies we have investigated are of the nest type, as VV 533-686, IC 214.

For interacting systems composed of two or more detached galaxies, the spectroscopic observations have usually been made for each component separately. The fact that the table contains the radial velocity of just one component means that the spectrum of the other does not exhibit sufficiently strong emission lines in the red region. This is the case, for instance, for the object VV 458 = MCG 1-37-34, 35, 36, consisting of three components; the Hα emission line is visible only in the component MCG 1-37-35.

Some clarifications of the measured radial velocities are given in the notes to the table.

We wish to acknowledge comments contributed by a referee.

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Physical conditions in the nuclei of emission-line galaxies

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Equivalent widths and relative intensities of emission lines in the red spectral region have been determined for 49 galaxies exhibiting emission, on the basis of spectrograms obtained with the 125-cm reflector of the Crimean station, Shternberg Astronomical Institute. The electron density and the abundance of several ions are estimated.

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1. A considerable number of Seyfert galaxies, radio galaxies, and quasars have now been investigated spectrophotometrically. For normal galaxies, however, the situation is quite different. Only a few papers have been published thus far on the spectrophotometry of normal galaxies.[1-8] These report studies of the galaxies M51, M64, M81, M82, NGC 1052, 2903, 3351, 4569, 5506, 7496, and 7552, as well as several galaxies listed by Markaryan which are not of Seyfert type. In several earlier analyses the λ6584 [N II]/Hα intensity ratio was determined, or emission lines were found to be present in the course of radial-velocity measurements of galaxies. The nuclei of normal galaxies are thought to have physical conditions similar to those in H II zones, which have been investigated rather thoroughly, both in our own Galaxy and in other systems. However, the occurrence of highly peculiar physical conditions in Seyfert-galaxy nuclei occasions a more detailed spectrophotometric examination of the nuclei of

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TABLE I. Equivalent Width of Hα Emission

Object	$W_{H\alpha}$	Object	$W_{H\alpha}$	Object	$W_{H\alpha}$
NGC 2903	215:	Mrk 190	35	Mrk 369	42
3504	40	198	38	370	55
3656	6.5	203	58	373	45
4258	5.0	223	60	Mrk 408	90
4618	36	237	70	Ark 147	25
4631	56	248	28	211	17
5194	10	262	45	215	40
5665	46	281	35	229	13
5929	16	286	50	257	30
NGC 6503	16	289	120	258	55
Mrk 86	50	308	140	283	12
97	21	318	40	286	?
109	72	326	30	296	?
171a	56	334	60	312	?
171b	92	341	66	337	27
Mrk 186	35	353	50	533	40

Note. As the spectrum of NGC 2903 is much underexposed, the equivalent width of Hα might be overestimated by several times. Alloin[3] quotes a value of 35 Å.

normal galaxies and of galaxies having less pronounced types of peculiarity.

2. In order to carry out spectrophotometry of normal galaxies with emission lines, we have selected about 200 galaxies not of Seyfert type whose spectrum in each case exhibits at least three emission lines. Most commonly these lines are Hα and the λλ 3726, 3729 [O II] and λλ 6548, 6584 [N II] doublets.

A total of 113 spectra have been reduced, representing 100 galaxies that satisfy the conditions above. Of these, 42 spectra have been obtained by the author; 38 spectra of Markaryan galaxies by M. A. Arakelyan, É. A. Dibai, and V. F. Esipov; and 33 spectra of galaxies on Arakelyan's list[9] by V. T. Doroshenko and V. Yu. Terebizh. About 50 of the spectra have proved to be informative from the standpoint of permitting an assessment of the physical conditions. In the remaining spectra the lines either are too faint or are blended with one another and with night-sky lines.

All spectra have been secured with the 125-cm Éngel'gardt reflector of the Crimean station, Shternberg Astronomical Institute. The spectrograph slit was oriented along right ascension. The 0.3-0.35 mm slit width corresponds to 3"-3".5. Spectra of six galaxies, NGC 2685, 2903, 3998, 4258, 4486, and Mrk 185, were recorded at ≈100 Å/mm dispersion with the UAGS spectrograph and a contact image tube. A-600 emulsion was employed, presensitized to a density of ≈0.3. The remaining spectra were obtained using the A spectrograph with a contact image tube. In this configuration Kodak 103a-O or 103a-D emulsion was employed, both with and without sensitization. The spectra taken by the author have a dispersion of ≈110 Å/mm and a spectral resolution of ≈5 Å; the other spectra have a dispersion of ≈225 Å/mm and a resolution of ≈10 Å. The spectral region photographed was in the red, centered on the Hα line. A calibration against stars with a known spectral energy distribution has been made in order to determine relative line intensities. All spectra have been recorded on an intensity scale with the microphotometer of the Crimean Astrophysical Observatory.

3. In this letter we present the results of spectrophotometry of 49 galaxies which show emission lines but are not of Seyfert type, including 27 Markaryan galaxies and 12 galaxies on Arakelyan's list.

Equivalent widths have been determined for the lines λλ 6300, 6364 [O I]; λλ 6548, 6584 [N II]; λλ 6717, 6731 [S II]; and Hα, as well as the intensity ratios for these lines and the Hα line. From these measurements one can evaluate n_e, T_e, and the ion abundance ratios N^+/H^+, N^+/S^+, so that the S^+/H^+ ratio can also be determined. To establish n_e we have used the [S II] ratio $I_{\lambda 6717}/I_{\lambda 6731}$, by analogy to the [O II] ratio $I_{\lambda 3726}/I_{\lambda 3729}$. Since the lines of the sulfur doublet are separated by ≈15 Å, they are clearly resolved in our spectrograms. Their intensity ratio has been derived in analytic form by several authors.[10-12] We have evaluated the quantity $X = 10^2 n_e T_e^{-1/2}$ by using Osterbrock's graph.[13]

If the relative number of N^+ and H^+ ions is known, then the $I_{\lambda 6584}/I_{H\alpha}$ ratio will determine[14-16] the electron temperature T_e. On the other hand, if T_e is known, this intensity ratio will yield[1] the ion abundance ratio N^+/H^+, while the $I_{\lambda 6584}/I_{\lambda 6717+\lambda 6731}$ ratio will provide us[17,18] with N^+/S^+ and accordingly S^+/H^+. Since the first ionization potentials of sulfur and nitrogen are not very different (10.36 and 14.54 eV, respectively), it is customary to regard the λλ 6548, 6584 [N II] and λλ 6717, 6731 [S II] lines as being formed within the same volume.[1)] As our spectra do not show the λ 6678 He I line, we may consider the abundance of S^{++} ions to be insignificant, for the first ionization potential of helium and the second ionization potential of sulfur are practically identical. Following Peimbert,[20] we then have $N^+/S^+ \approx N/S$, where N and S denote the total abundance of nitrogen and sulfur.

Table I gives the equivalent width of the Hα line.

In Table II we present some relative line intensities and logarithmic ion abundances computed for two temperatures, with the number of hydrogen atoms taken as 10^{12}. The data of columns 8 have been calculated by the method of Boyarchuk et al.[21] The temperatures have been chosen in accord with Peimbert's results[20] for the [O II] and [N II] lines in H II regions.

The relative intensities of forbidden lines may be represented by the standard expression

TABLE II. Line Intensity Ratios and Abundances

Object		$I_{\lambda\,6584}/I_{H\alpha}$	$I_{\lambda\,6724}/I_{H\alpha}$	$I_{\lambda\,6717}/I_{\lambda\,6731}$	$\lg X = \lg 10^2 \frac{n_e}{\sqrt{T_e}}$	N+ 7500 K	N+ 10000 K	S+ 7500 K	S+ 10000 K	S+ 7500 K	S+ 10000 K
1		2	3	4	5	6		7		8	
NGC	2903	0.34				7.57	7.20				
	3504	1.06	0.32	0.83	3.35	8.08	7.71	6.99	6.64	7.28	6.87
	3656	1.12				8.09	7.72				
	4258	1.54	0.75	2.21		8.22	7.86	7.35	6.99		
	4618	0.63	0.10			7.83	7.47	6.47	6.12		
	4636	0.70	0.50	0.83	3.35	7.90	7.53	7.18	6.83	7.48	7.34
	5194	2.81	0.65	1.15	2.80	8.49	8.13	7.29	6.93	7.60	7.20
	5665	0.80	0.48	1.22	2.55	7.94	7.58	7.16	6.80	7.46	7.08
	5929	1.08	0.90	1.22	2.55	8.07	7.71	7.43	7.07	7.73	7.34
NGC	6503	0.48	0.18	1.21	2.65	7.72	7.36	6.73	6.37	7.04	6.63
Mrk	86	0.36	0.24	1.12	2.72	7.60	7.23	6.86	6.50	7.15	6.76
	97	0.67				7.86	7.50				
	109	0.30	0.68	0.88	3.28	7.53	7.16	7.32	6.96	7.61	7.20
	171a	0.84	1.00	0.83	3.35	7.97	7.61	7.48	7.13	7.78	7.38
	171b	1.11	0.64	1.22	3.65	8.09	7.72	7.28	6.92	7.60	7.20
	186	0.35	0.42	1.08	2.95	7.59	7.22	7.10	6.75	7.40	7.00
	190	0.53	0.37	0.76	3.45	7.78	7.41	7.06	6.70	7.34	6.95
	198	0.50				7.74	7.37				
	203	0.50				7.74	7.37				
	223	0.35	0.20			7.58	7.22	6.77	6.42		
	237	0.98	0.32	0.56	3.90	8.08	7.71	7.02	6.67	7.28	6.89
	248	1.02	0.87	1.26	2.57	8.08	7.68	7.42	7.06	7.72	7.32
	262	0.26	0.18	1.26	2.60	7.45	7.09	6.73	6.37	7.04	6.63
	281	0.45	0.32	2.62		7.68	7.33	6.98	6.62		
	286	0.64	0.16	1.01	3.08	7.85	7.48	6.68	6.33	6.96	6.58
	289	0.43	0.33	1.10	2.92	7.68	7.31	7.00	6.64	7.30	6.90
	308	0.43				7.67	7.30				
	318	0.61	0.56	0.87	3.30	7.84	7.47	7.23	6.88	7.53	7.11
	326	0.97	0.20	1.42	1.40	7.43	7.07	6.18	5.83	7.08	6.68
	334	0.56	0.13			7.78	7.42	6.59	6.23		
	341	0.19	0.83			7.32	6.95	7.39	7.03		
	353	0.62	0.44	0.60	3.75	7.86	7.50	7.15	6.79	7.41	7.04
	356	0.42	0.51	1.54		7.66	7.30	7.18	6.82		
	369	0.48	0.55	0.97	3.12	7.73	7.36	7.22	6.86	7.52	7.11
	370	0.23	0.30	0.92	3.32	7.41	7.04	6.96	6.60	7.26	6.86
	373	0.60	0.52	0.52	4.00	7.87	7.51	7.25	6.89	7.49	7.08
Mrk	408	0.12	0.38	1.06	3.00	7.12	6.76	7.06	6.70	7.36	6.96
Ark	147	1.00	0.75	2.81		8.04	7.67	7.35	6.99		
	211	0.56	1.09			7.78	7.42	7.51	7.16		
	215	0.29				7.50	7.13				
	229	0.54				7.77	7.40				
	257			1.02	3.05						
	258	0.30	0.28	0.54	3.95	7.57	7.20	6.97	6.61	7.23	6.83
	283	0.34	0.34	1.23	2.55	7.57	7.21	7.00	6.65	7.30	6.91
	286		0.16	1.14	2.85					6.98	6.58
	296			1.10	2.92						
	312		0.17	1.20	2.70					7.00	6.61
	337	0.54	0.30	1.70		7.77	7.40	6.95	6.59		
Ark	533	0.86	0.55	0.80	3.40	7.99	7.62	7.23	6.87	7.52	7.11

$$\frac{I_\lambda}{I_{H\beta}} \approx \frac{n_{1r}}{n_p}\theta_i(n_e,\ T_e),$$

where n_{1r} denotes the abundance of r-fold ionized atoms on the first level and n_p is the proton abundance. Under the conditions such that forbidden lines are emitted, $n_{1r}/n_p \approx n_r/n_p$. Boyarchuk et al.[21] have given the function $\theta_i(n_e, T_e)$. For temperatures T_e = 7500°K and 10,000°K we have used the known values of $X = 10^2 n_e T_e^{-1/2}$ to determine n_e, and thereby $\theta_i(n_e, T_e)$. Adopting the observed intensity ratios $I_\lambda/I_{H\beta}$ (for T_e = 10,000°K and $n_e = 10^{14}$ cm^{-3} we have taken the $I_{H\alpha}/I_{H\beta}$ ratio from Brocklehurst[22]; the dependence on n_e is weak), we have determined the abundance of S^+ ions. It is these values that are given for comparison in columns 8 of Table II. We would point out, however, that if improved atomic constants are taken into account the values become about half again as large.[23] The results given in columns 7 and 8 will then practically coincide.

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1) One cannot exclude, of course, that these lines may be formed in different regions.[19] However, since our ultimate aim is to compare the physical parameters of normal and peculiar galaxies, the main feature of such an analysis should be a uniform approach in estimating the integral parameters that characterize both types of galaxy.

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Observations of 24 Seyfert objects from Markaryan galaxy lists VII–XI

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Spectroscopic observations are reported for 24 new Markaryan galaxies that exhibit definite or suspected Seyfert characteristics.

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Spectroscopic observations of Markaryan galaxies selected[1-4] from lists VIII–XI were carried out at the Astrophysical Institute of the Academy of Sciences of the Kazakh SSR in November 1976. The red spectral region was observed with the 70-cm AZT-8 telescope, equipped with a type UM-92 image converter. We have described the observing technique elsewhere.[5] At 140-Å/mm dispersion the spectral resolution was ≈10 Å. In addition, spectra of several objects in the blue-green range were obtained at the Special Astrophysical Observatory, USSR Academy of Sciences, using the Zeiss-600 telescope with a UAGS spectrograph and a UM-92 image tube (dispersion ≈90 Å/mm).

As a result, broad emission lines were detected, or suspected, in 24 galaxies. Table I gives preliminary data for these objects. For nine of the objects, designated by an asterisk, there is only a suspicion of broad lines. In most cases these could be Seyfert galaxies of the second type. Possibly some of them may be objects emitting narrow lines that are blended with night-sky lines, or objects with significant rotation (the spectrograph entrance slit measured 5–7"). The spectral and angular resolution available to us was inadequate to answer the question definitely. One of the objects, Markaryan 716, has previously been identified as a possible Seyfert galaxy,[6] and the new observations confirm this identification.

The catalog number and type of each galaxy are taken from lists VIII–XI, as are magnitudes given in parentheses; the other magnitudes are from Zwicky's catalog.[7] The red shifts have been corrected for solar motion.[5] Since the red shifts have often been measured using broad emission lines, the error in the determination could reach 0.001 or even more in the case of an individual Hα line of substantial width. In such cases z is quoted to three decimal places only. The absolute magnitudes assume a value H = 75 km · sec^{-1} · Mpc^{-1} and are corrected for absorption in the Galaxy. The visual estimates quoted for the full width of the Hα + [N II] lines are qualitative in character and are given only for well-exposed spectra showing unblended lines. In the last column of the table we provisionally indicate the type of Seyfert galaxy – first or second.

From the accompanying description of each object it is evident that Mrk 707, 715, 716, 720, 728, 744, 896, 926, 975, 993, 1040, 1044, 1048, 1095 are typical Seyfert galaxies. The objects Mrk 915, 917, 955, 1073 are most likely Seyfert galaxies of type 2. All the others, which might possess weak Seyfert peculiarities, need to be observed further. The most interesting objects appear to be Mrk 707 and 1095, which display considerable variability, and unquestionably Mrk 926 and 744 in view of their singular properties as described in the notes.