(a thin, flat disk), using the method proposed by Ballabh[4] as well as an algorithm worked out by A. V. Barabanov (private communication).

Table I gives the resulting estimates for the mass of each galaxy within the region covered by the observed rotation curve, the fraction of the mass within the radius encompassing half the integrated luminosity ($A_e/2$ according to the de Vaucouleurs' catalog[5]), and the corresponding M/L_B ratio. We have adopted the catalog values[5] for the magnitude of each galaxy, corrected for interstellar extinction. The gravitational influence of the outer parts of the disk, beyond the region for which the rotation curve has been obtained, is neglected.

Conclusions. 1. The rotation curves of these two galaxies are similar in form and have long plateaus. No evidence has been found for appreciable noncircular gas motions in the galaxies.

2. The mass/luminosity is small in each galaxy; on the average it is less than the value $M/L_B = 7$ obtained (as converted to $H = 75\ \mathrm{km \cdot sec^{-1} \cdot Mpc^{-1}}$) for type Sbc–Sc galaxies within their Holmberg radius.[6] Curiously enough, M/L_B is lower for the inner than for the outer regions, suggesting that the star composition (the stellar mass function) varies along the radius of the galaxy.

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Physical conditions in the nucleus of the galaxy Markaryan 534

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A spectrophotometric analysis of the nucleus of the peculiar galaxy MrK 534 (NGC 7679) has been carried out, using spectra taken with the 6-m telescope. The following estimates are obtained: $n_e \simeq 1.4 \times 10^3\ \mathrm{cm^{-3}}$, electron temperature of radiating gas $T_e \simeq 8000\,°\mathrm{K}$, flux density $F_{H\beta} \simeq 1.62 \times 10^{-14}\ \mathrm{erg\ cm^{-2}\ sec^{-1}}$, luminosity $L_{H\beta} \simeq 1.1 \times 10^{40}$ erg/sec. The relative abundance of several ions is determined. About 2000 type O5 V stars would be required to ionize the gas, suggesting that the most likely ionization source is the ultraviolet emission of hot stars.

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1. When the Markaryan galaxies are studied in detail they prove to comprise a highly diversified group. About 10% of them are Seyfert galaxies, which now have been studied rather thoroughly. The same cannot however, be said of the other Markaryan objects: for most of them the information available is quite scanty.

In this letter we shall discuss the physical conditions in the nuclear region of a particularly interesting peculiar galaxy, Mrk 534 (NGC 7679), which has been attracting attention among investigators for some time. It is included in the sixth list of galaxies with an ultraviolet continuum,[1] and Arp assigns it No. 216 in his Atlas of Peculiar Galaxies.[2] NGC 7679 is paired with NGC 7682; Vorontsov-Vel'yaminov regards the pair as an interacting system, numbered VV 329. In the Revised NGC it is described as round, brighter toward the center, with an irregular diffuse halo and a faint diffuse lane near the nucleus.

Mrk 534 is a lenticular galaxy of Hubble morphological type S0 and apparent photographic magnitude[3] $m_{pg} = 13^m.2$. Humason et al.[4] recorded λ3727 [O II] emission and measured the redshift; the Burbidges[5] also found the redshift, determined an intensity ratio Hα/[N II] = 2, and mentioned strong emission in the λλ 4959, 5007 [O III], Hβ, and λλ 6717, 6731 [S II] lines. Gisler[6] quotes a redshift z = −0.018 which, for $H = 75\ \mathrm{km \cdot sec^{-1} \cdot Mpc^{-1}}$, corresponds to an absolute magnitude $M_{pg} = -21^m.2$. The galaxy has been studied spectrophotometrically by Peimbert and Spinrad,[7] who have determined relative intensities for several emission lines and the relative helium abundance, assuming $T_e = 8000\,°\mathrm{K}$.

With the 6-m telescope of the Special Astrophysical Observatory, USSR Academy of Sciences, two short-exposure spectra have been obtained for the nucleus of Mrk 534 (one in the blue, the other in the red region). The UAGS spectrograph was used at the prime focus of the telescope, with a three-stage multialkali image tube. The spectra were recorded on A-600 emulsion and were calibrated by impressing a multi-step wedge. The spectral sensitivity of the equipment was determined with re-

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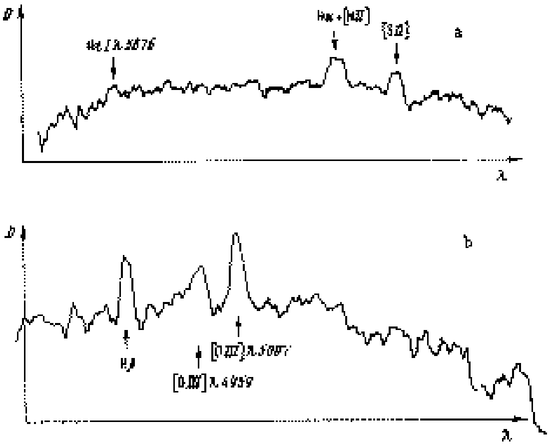

FIG. 1. Tracings of 6-m telescope spectra of the nucleus of the galaxy Mrk 534 (NGC 7679) in the vicinity of: a) the Hα line; b) the Hβ line.

spect to the spectrum of the standard star[8] BD + 25°3941. The spectrograms have a dispersion of 100 Å/mm, so that the resolving power is ≈5 Å. Figure 1 shows tracings of the spectra, recorded with a type G III microphotometer.

2. Our measurements of the equivalent widths W_λ of the lines and the relative intensities $I_\lambda/I_{H\beta}$ are given in Table I. For comparison the table gives the corresponding values obtained by Peimbert and Spinrad.[7] A reddening correction has been applied, using the expression

$$\log I_\lambda^0 = \log I_\lambda + c_\beta f(\lambda),$$

where I_λ^0 denotes the intensity of the line corrected for reddening, I_λ is the observed intensity, $f(\lambda)$ is the Peimberts' value[9] for the interstellar absorption, and c_β denotes the absorption in the Hβ line as determined from the Balmer decrement.

Osterbrock[10] has given a graph relating the intensity ratio of the lines in the sulfur doublet λλ 6717, 6731 [S II] to the quantity $X = 10^2 n_e T_e^{-1/2}$. Without any additional assumptions the quantity X gives the electron density n_e for $T_e = 10^4$ °K. In the case of Mrk 534 we have obtained $I_{6717}/I_{6731} = 0.99$, whence $X = 1.2 \cdot 10^3$; taking a temperature[7] $T_e = 8000$°K, we find $n_e \approx 1.4 \cdot 10^3$ cm^{-3}.

On the other hand, if we apply the method suggested by Boyarchuk et al.,[11] involving intersections of the curves $\log \theta(n_e, T_e)$ which express the ratio of the intensity of forbidden lines of particular ions to $I_{H\beta}$ as a function of the abundance of those ions and the excitation conditions, then we can use the [N II] and [S II] lines to obtain an independent estimate of n_e and T_e. For this purpose one must assume a definite chemical composition and adopt some degree of ionization. We have taken a normal composition and, in the [N II], [S II] emission regions, an ionization[12] H II/H = 0.2, N II/N = 0.4, S II/S = 0.8; as a result we obtain $n_e = 1.2 \cdot 10^4$ cm^{-3}, $T_e = 8000$°K. This value for T_e coincides with the temperature determined by Peimbert and Spinrad.[7]

The electron densities evaluated by these two methods disagree, probably because of our assumption that the gas in the nucleus of the galaxy has a normal chemical composition. There has previously been evidence (see, for example, Peimbert[13]) for an enhanced nitrogen abundance in the nuclei of certain nearby galaxies.

3. If one knows the magnitude of the nuclear region, the ratio I^0/H^0_β, and the parameters n_e, T_e, then one can apply a standard procedure[14] to estimate the flux density and luminosity in the Hβ line, and the effective volume and mass of the radiating gas. The magnitude m_n of the nuclear region of Mrk 534 has not hitherto been determined. Using data given in Soobshch. Byurakan. Obs. No. 47, 43 (1975), we have had to obtain the least-squares correlation

$$m_n = 1.26\, m_p - 1.50$$

between m_n, m_p for S0 galaxies; the correlation coefficient r=0.86. Determining from this relation the magnitude $m_n = 15^m.1$ and knowing $W_{H\beta}$, we have computed the flux density $F_{H\beta} = 1.62 \cdot 10^{-14}$ erg · cm^{-2} · sec^{-1}. The distance of the galaxy corresponding to the redshift z = 0.018 is 72 Mpc for H = 75 km · sec^{-1} · Mpc^{-1}, which yields an Hβ luminosity $L_{H\beta} = 1.1 \cdot 10^{40}$ erg/sec. The corresponding effective volume is $7.3 \cdot 10^{56}$ cm^3 and the mass of gas is $1.21 \cdot 10^{35}$ g, so that gas of mass $\approx 6 \cdot 10^3\ M_\odot$ is radiating in the nuclear region of the galaxy within an effective volume of radius ≈ 3 pc. Accordingly, the filling factor is very small.

The energy required to maintain the gas in ionization–recombination equilibrium is $8.5 \cdot 10^{41}$ erg. On the other hand, we know that a single type O5 V star radiates $4.4 \cdot 10^{38}$ erg/sec in the Lyman continuum.[14] Thus the gas could be sustained in equilibrium by the Ly_c radiation of about 2000 type O5 V stars. We may infer that the most likely ionization source for the gas in the nucleus of Mrk 534 is the ultraviolet radiation of hot stars.

4. Peimbert[13] uses the following ratios to determine the abundance of O^+, O^{++}, and N^+ ions.

$$\frac{O^+}{H^+} = 7.2 \cdot 10^{-6}\, \frac{1 - 7.6x + 6.8x^2}{1 - 5.6x}\, T_e^{-0.375}\, \frac{I_{3727}}{I_{H\alpha}}\, e^{3.84 \cdot 10^4/T_e},$$

$$\frac{O^{++}}{H^+} = 1.65 \cdot 10^{-4} (1 + 0.01x)\, T_e^{-0.376}\, \frac{I_{5007}}{I_{H\alpha}}\, e^{2.99 \cdot 10^4/T_e},$$

$$\frac{N^+}{H^+} = 1.65 \cdot 10^{-4} (1 + 0.14x)\, T_e^{-0.576}\, \frac{I_{6584}}{I_{H\alpha}}\, e^{2.2 \cdot 10^4/T_e},$$

where $x = X/10^4$. If the oxygen were entirely in a singly or doubly ionized state, then we would have

$$\frac{O}{H} = \frac{O^+ + O^{++}}{H^+}.$$

The small I_{5007}/I_{3727} ratio (since our spectra have been obtained in the 4000–7500 Å region, we have had to adopt Pembert and Spinrad's[7] relative intensity $I^0_{3727} = 1.35$ for the λ3727 [O II] line) implies a relatively small amount of oxygen in an ionization state of at least 3. In view of the fact that nitrogen and oxygen have almost the same ionization potential, Peimbert determines

$$\frac{N}{H} = \frac{O^+ + O^{++}}{O^+}\, \frac{N^+}{H^+}.$$

TABLE I. Equivalent Width and Relative Intensity of Emission Lines

Parameter determined	Hβ	[OIII] λ4959	[OIII] λ5007	HeI λ5876	[NII] λ6548	Hα	[NII] λ6584	[SII] λ6717	[SII] λ6731
$W_λ$	5.0	2.5	6.5	1.0:	10	31	30	25	28
$I_λ/I_{Hβ}$	1.0	0.51	1.44	0.1:	1.38	4.76	4.75	2.57	2.68
$I_λ^0/I_{Hβ}^0 (c_β=0.61)$	1.0	0.48	1.38	0.1:	0.88	2.88	2.92	1.53	1.57
$I_λ/I_{Hβ}$ *	1.0	–	1.36	–	–	3.65	1.70	–	–
$I_λ^0/I_{Hβ}^0 (c_β=0.27)$ *	1.0	...	1.10	0.11	–	2.85	1.35	–	–

*Data from Peimbert and Spinrad.[7]

By considering $I_{6584}/I_{Hα}$ and $I_{(6717+31)}/I_{Hα}$ ratios for the H II regions in the galaxy M33, Benvenuti et al.[15] have established that the N^+ and S^+ abundances are of the same order and on this basis they propose the expression

$$\frac{S^+}{N^+} \approx 3.43\,(1+0.14x)\,e^{500/T_e}\,\frac{I_{(6717+31)}}{I_{6584}}\,f(x,T_e),$$

for determining the relative abundance of ionized sulfur, where $f(x, T_e) \sim 1$ for $T_e \approx 10^4$°K and $x \sim 1$.

To determine the relative abundance He^+/H^+ of helium ions, Peimbert and Spinrad[7] suggest the formula

$$\frac{He^+}{H^+} = 0.65\,T_e^{0.13}\,\frac{I_{5876}}{I_{Hα}} = 9.8\cdot10^{-2}\,T_e^{0.22}\,\frac{I_{5876}}{I_{Hβ}}.$$

For $T_e = 8000$°K and for x given by the intensity ratio I_{6717}/I_{6731} of the sulfur doublet, we have used these expressions to obtain the following values for the relative abundance of the ions of radiating gas in the nucleus of NGC 7679:

$$N^+/H^+ = 9.16\cdot10^{-6},\quad O^+/H^+ = 1.26\cdot10^{-4},$$
$$S^+/H^+ = 3.62\cdot10^{-6},\quad He^+/H^+ = 0.071,$$
$$O^{++}/H^+ = 9.94\cdot10^{-5},$$

as well as the total abundance of oxygen and nitrogen:

$$O/H = 2.25\cdot10^{-4},\ N/H = 1.64\cdot10^{-5}.$$

The convention $\log n(H) = 12.00$ is adopted throughout.

For comparison, we mention that the oxygen and nitrogen abundance in the solar atmosphere[16] is $N/H = 1.1\cdot10^{-4}$, $O/H = 6.8\cdot10^{-4}$. Evidently, then, the composition of the radiating gas in the nuclear region of Mrk 534 differs from the normal solar composition.

5. To conclude, let us compare our data with those of Peimbert and Spinrad.[7] They observed Mrk 534 with a scanner having a round diaphragm 7" in diameter centered on the nucleus of the galaxy, whereas our spectra were obtained with a 3".5 slit about 5' high. The results for $I_{5007}/I_{Hβ}$ and $I_{5876}/I_{Hβ}$ are in good agreement, but the $I_{6584}/I_{Hβ}$ ratios are quite different. Since Peimbert and Spinrad observed at the center of the nuclear region, while in our case the slit included a portion of the outer zone, this difference in the ratio probably reflects a variation in the intensity of the nitrogen lines over the disk of the galaxy. Similar variations have been reported previously for other nearby galaxies.[17] For the relative abundance of helium ions and the Hβ flux, our values are in satisfactory agreement with those of Peimbert and Spinrad.

This investigation represents a part of a more extensive program of analysis of the physical conditions in the nuclei of galaxies with emission lines. Some of the results of this program have been published in a previous letter.[18]

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