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PHYSICAL CONDITIONS IN THE GALAXY NUCLEI WITH EMISSION LINES. MARKARIAN 558

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The galaxy Mark 558 is included in the sixth list of galaxies with a U. V. continuum [1]. Its exact coordinates, determined by Dressel a. Condon [2], are respectively

$$\alpha_{1950}=00^h\,49^m\,35.^s9 \text{ and } \delta_{1950}=-02^\circ\,29'\,24''.$$

Its radial velocity, determined by Kopilov et al. [3], is $V_r=4155$ km/sec, i. e. $z=0.014$. The latter also noted unresolved blends of the lines H_α and [NII] of mean intensity and weak forbidden lines of the ionized sulfur.

The morphological type of the galaxy is SO. Markarian 558 is also known as NGC 279, UGCG 532, MCG 00-03-19a. Data on it are scant, although it is included in all the big catalogs. Its photographic magnitude, $m_p=14.0$ is adduced in the Catalog of Galaxies and Galactic Clusters, and the size of its nucleus (0.′5×0.′45) and its external size (1.′1×0.′8) figure in the Morphological Catalog of Galaxies. This is all that is known about Markarian 558.

In the autumn of 1980 two spectra of Mark 558 were obtained on the 2.6-m telescope of the Crimean Astrophysical Observatory by means of a three-cascade image tube intensifier UM-92. An inverse dispersion of ca. 100 Å/mm, corresponding to a spectral resolution of 4–5 Å, was used. Obtained on Kodak 103 aG emulsion, the spectra were calibrated by printing on a tube photometer.

Table

λ[Å]	6548	6563	6584	6717	6731	6717/6731	6584/6724	6724/H_α
W_λ [Å]	1.2	2.0	2.8	1.0	1.0			
I_λ/I_{H_α}	0.58	1	1.45	0.50	0.46	1.10	1.5	0.96

The results of the spectrophotometric investigation of Mark 558 are shown on the Table. Its results permit to determine all the parameters characterizing the galaxy's nucleus. The flux in a given line is determined by the magnitude of the nucleus and the equivalent width. For instance

$$F_{H_\alpha} = W_{H_\alpha} \times 10^{0.4(m_\lambda - m^*_{st})} \times F_* \ \text{erg} \cdot \text{cm}^{-2} \cdot \text{sec}^{-1}.$$

From the dependence $m_{nuc} = 1.26\, m_{gal} - 1.50$ for the SO type of galaxies it follows that the magnitude of its nucleus is $m_{nuc} - 16.1$ and hence the flux in

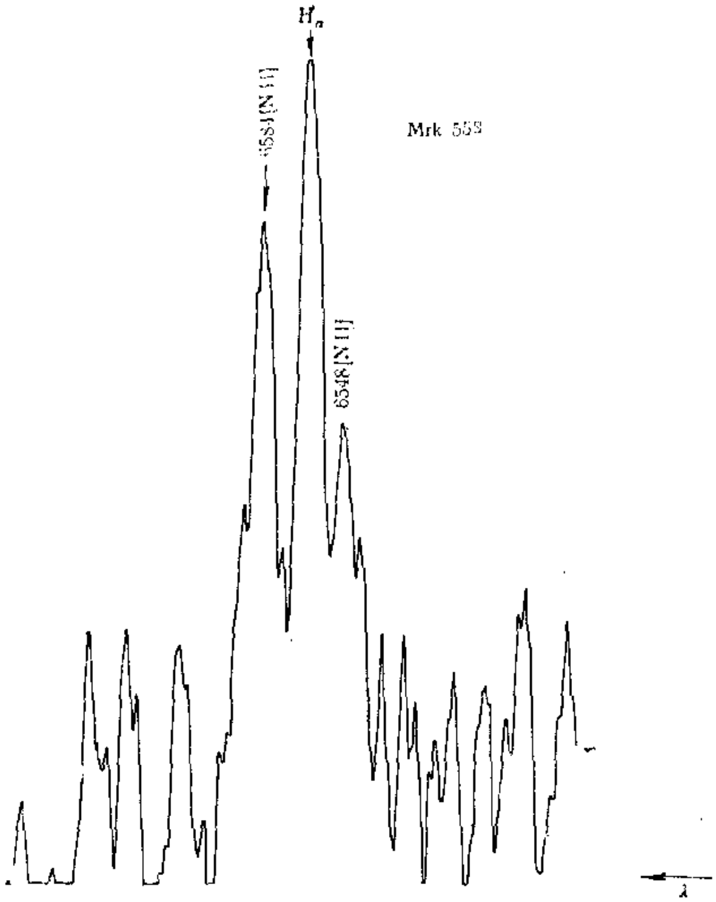

Fig. 1. Registrogram of spectrum of Makarian 558 nucleus. Original dispersion 100 A/mm,×50, the recording is blackened

the line $H_\alpha - F_{H_\alpha} = 2.9 \times 10^{-14}$ erg. cm^{-2}. sec^{-1}. We then used the corresponding sizes referred to the line H_β according to the relation $F_{H_\alpha} = 2.88\, F_{H_\beta}$, corresponding to the free-bound transitions in an optically dense layer.

The luminosity in the line H_β is $L_{H_\beta} = 4\pi D^2 F_{H_\beta}$ and at $Z = 0.014$ $L_{H_\beta} = 3.76 \times 10^{39}$ erg . sec^{-1}.

The volume occupied by the irradiating gas is obviously $V_{ef} = L_{H_\beta} / \varepsilon_{H_\beta}$,

where $\varepsilon_{H_\beta} = h\nu_{H_\beta} \alpha^{ef}_{42}(T_e)\, n_e n_p$ erg. cm^{-3} . sec^{-1}

$$\alpha^{ef}_{42}(T_e) = 4.19 \times 10^{-16} n^2 \frac{b_4 e^{x_4/kT_e}}{T_e^{3/2}} A_{42}\, \text{cm}^3 \cdot \text{sec}^{-1}$$

and $A_{42} = 8.37 \times 10^6$ sec^{-1}.

The electron density of the gas can be determined by the relation of the forbidden lines of the ionized sulfur I_λ 6717, 6731 Å. According to Nossov's tabulation [4], to the relation I_λ 6717/I_λ 6731 = 1.10 there corresponds an electron density n_e of ca. 400 cm^{-3} at an electron temperature $T_e = 10000$°K.

The emission coefficient $\varepsilon_{H_\beta} = 1.71 \times 10^{-20}$ erg. cm.$^{-3}$ sec and the effective volume occupied by the emitting gas is $V_{ef} = 2.19 \times 10^{59}$ cm^3, i. e. the effective radius of the irradiating regions is about 20 parsecs. The mass of the irradiating gas $M_{gas} = n_e m_{pr} V_{ef} = 1.35 \times 10^{38}$ g or about 6.8×10^4 $M_\odot$.

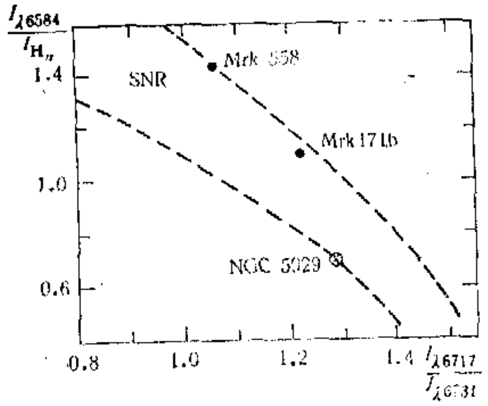

Fig. 2. Dependence $(I_\lambda 6717/I_\lambda 6731)/(I_\lambda 6584/IH_\alpha)$. The region occupied by the supernova remnants is denoted by broken lines. The position of the nuclei of the galaxies NGC 5929 and Markarian 171 b is also shown

According to Osmer et al. [5], full luminosity is about $60 L_{H_\beta}$; hence, $L_{tot} = 2.25 \times 10^{40}$ erg . sec^{-1}.

The averaged spectrum of the young hot stars of the class 05-B0 is ca. 07. Knowing the irradiation power of a star 07 V, we can determine the number of young stars whose U. V. irradiation would suffice to keep the gas in ionization-recombination equilibrium. For Mark 558, 1 250 stars of class 07 V suffice, Assuming (as usual) that a star 07 on the average occurs in ha. 10^7 stars. this would suggest a nucleus mass of about 10^{10} $M_\odot$.

The spectrophotometric data also provide information on the possible ionization source. Alloin et al. [6] calculated the location of objects excited by shock ionization (say, residues of supernovas) on the diagram $(I_\lambda 6584/I_{H_\alpha})/(I_\lambda 6717/I_\lambda 6731)$. There Mark 558 lands in the region occupied by the supernova remnants and Seyfert galaxies type 2. The young stars should therefore be viewed as only a probable source of gas ionization in the nucleus. However, no links of neutral oxygen λλ 6300, 6363, which are usually strong when there is shock-wave excitation, were observed in the spectrum of Mark 558. It should be noted that this is the second (after Mark 171 b) Markarian galaxy of a nonSeyfert type investigated by us, which in some of its parameters recalls Seyfert galaxies of type 2.

The method proposed by Peimbert [7] permits also to calculate the relative ion content of nitrogen and sulfur, whose lines are observed in the Mark 558 spectrum. At lg H = 12.00, lg $N^+ = 7.84$ and lg $S^+ = 7.10$, i. e. an increased content of sulfur ions as compared to similar objects is observed. The latter is probably due to more favourable temperature and density conditions for the emergence of sulfur's lines.

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