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ASTRONOMIE

SURFACE BRIGHTNESS AND STAR FORMATION IN ARAKELIAN GALAXIES

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1. Introduction. The infrared sky survey carried out by the IRAS in the far infrared spectral region identified about 25 000 galaxies and quasars with powerful infrared fluxes at 12, 25, 60 or 100 mkm. From the whole variety of objects of different types, degree of activity and morphology, we focused our study on galaxies with high surface brightness (further referred to as Akn G) identified as a class in 1975 by Arakelian [1]. From 591 objects, the Catalogue of Extragalactic Infrared Sources [2] contains 182 Akn G, or 32%. Thirty six galaxies from them are with well-defined fluxes in all the above-mentioned ranges, while for the rest of the objects in some of the ranges (usually 12 and 25 mkm), only the upper limits of the infrared fluxes are given. The radial velocities are determined for 148 of the objects under discussion.

This study is dedicated to the explanation of the nature of the high surface brightness of these galaxies and its possible relationship with the star-formation process.

2. Explanation of the high surface brightness. The surface brightness is a function of the sizes and luminosity of the object. To define it, Arakelian [1] employed the system of diameters of Vorontsov-Veliaminov et al. and the stellar magnitudes of Zwicky et al. [4].

Now we are able to reduce the Arakelian system of surface brightnesses (close that of Holmberg) to a standard system referred to isophote 25 stellar magnitude/square second [5]. For the purpose, the system of diameters and magnitudes used by Arakelian is transformed into a system of diameters D_{25} — diameters to the isophote 25 and magnitudes m_{Ho} — stellar magnitudes in Holmberg's System by the correlations found by Paturel, 1979 [6]. At this stage the transformation is carried out only for the objects with defined radial velocities. The method is described in detail in [5, 7].

Table 1 lists the standardized surface brightness B_{25} for all Akn G with known redshifts z. For 89 Akn G included in the Catalogue of Vaucouleurs et al. [8], no additional reductions have been made.

Fig. 1 shows the dependence $B_{25} - B_{Akn}$ for all the objects. To our opinion, no significant systematic changes could be observed there. The observed dispersion is real and reflects the difference in the methods for determination of galactic angular diameters.

Fig. 2*a* shows the distribution of the linear diameters in kpc for the studied sample and Fig. 2*b* — the absolute magnitudes. In this figure the analogous distribution for Seyfert galaxies according to [7] is also shown. The statistically high luminosity of the Arakelian galaxies compared to that of the Seyfert galaxies can be seen. The cited authors have come to analogous conclusion by studying the luminosity function of galaxies with surface brightness. Contrary to their conclusion that the high surface brightness reflects only the small linear.

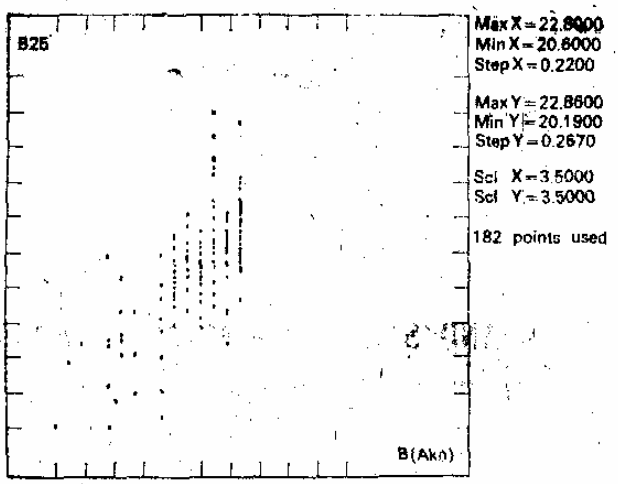

Fig. 1

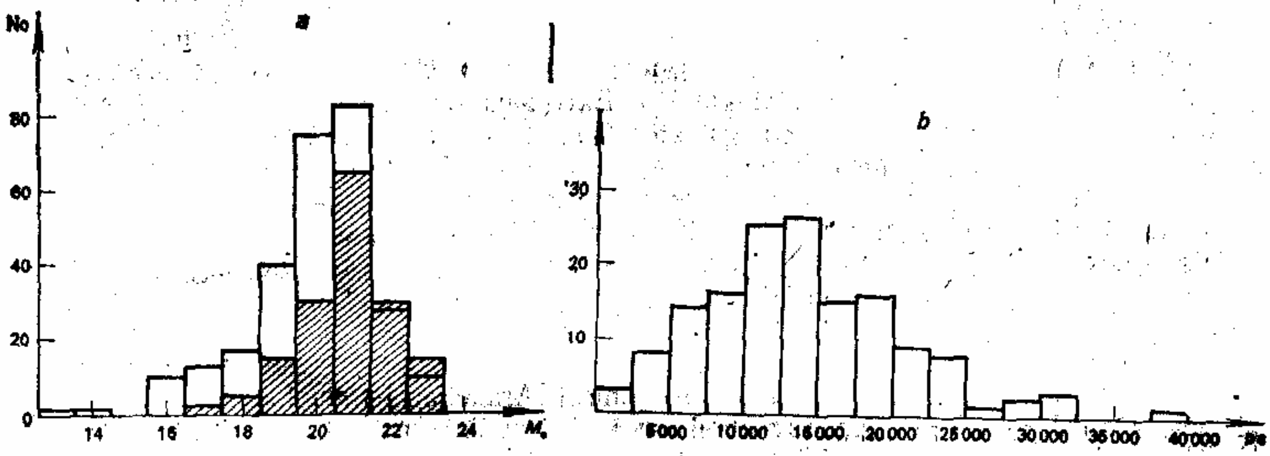

Fig. 2

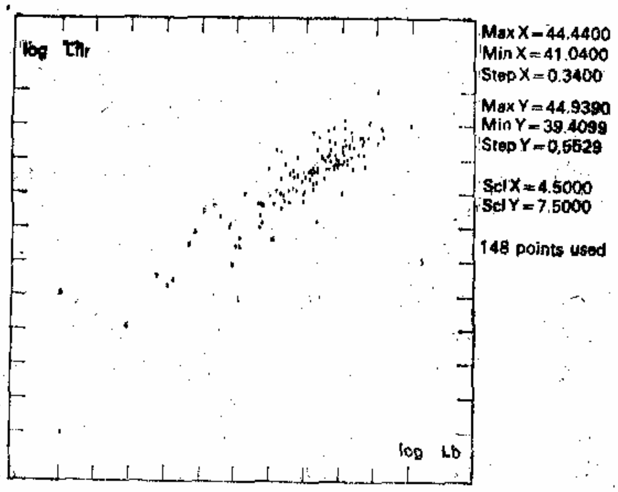

Fig. 3

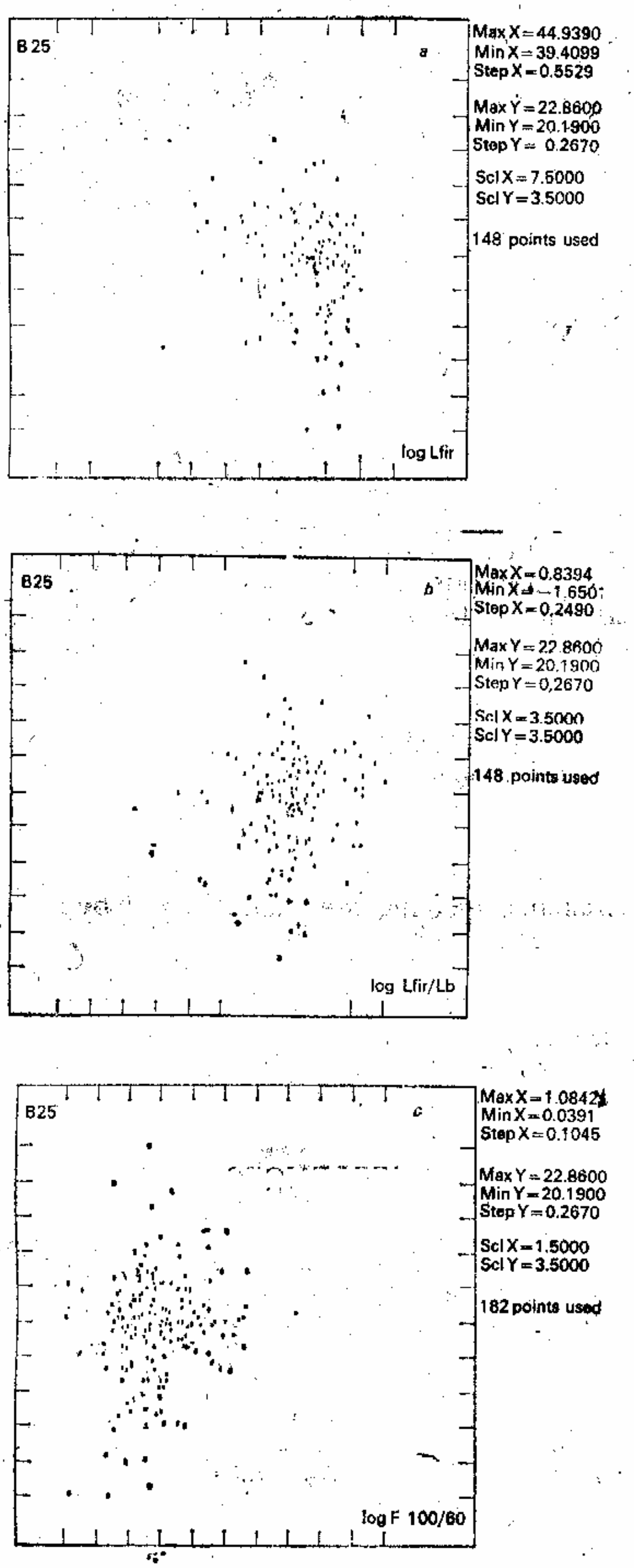

Fig. 4

galactic diameters, the new data show that it is the result of the two factors — diameters and luminosities. As far as the sizes of the objects could be viewed as something existing, we could search for some other explanation of the high luminosity. According to us, the high luminosity is the result of star formation in these galaxies.

Galagher and Hunter, 1987 [9] studied the possibility of estimating the rate of star formation by using the observed luminosities in $H_{\alpha 1}$ in the infrared spectral range. Fig. 3 shows the dependence L_{IR}-L_{Blue} for all Akn/I[RAS] galaxies with known radial velocities. In the same figure, lines *1*, *2* and *3* denote respectively the decreasing, constant and increasing rate of star formation. It can be seen that the majority of objects is located in the region of the diagram which is characterized by increasing rates of star formation. This is probably the reason for the high luminosity of these galaxies.

Following de Joung et al., 1984 [10], we can estimate the average rates of star formation in Akn G under the assumption that the infrared emission is due mainly to the heating of the dust by the ultraviolet emission of *O*-stars with masses of about 10 solar masses and luminosities L of about 10^4 solar luminosities. At a mean luminosity of Akn *G* $L_{FIR}=6\times10^{10}\ L_0$ and life-time of the *O*-stars of about 10^7 years, it follows that annually about 60 M_0-masses of gas are transformed into stars, 5 to 10 of which being massive. This is 4 to 6 times more than the normal galaxies according to [7].

Fig. 4*a* shows the dependence B_{25} — lg L_{IR} for all objects with well-determined fluxes at 60 and 100 mkm. An apparent tendency toward an increase in the surface brightness B_{25} (its value decreases!) is observed with the increase in the luminosity in the infrared region L_{IR}. The behaviour of the objects in diagram 4*b* B_{25}— lg(L_{IR}/L_B) is similar. The dashed line denotes the equal luminosities in the infrared and visible spectral region. The surface brightness also increases with the increase in the star-formation index L_{IR}/L_B.

The temperature index lg(F_{60}/F_{100}) is a measure for the dust temperature. The object distribution in the diagram B_{25} — lg(F_{60}/F_{100}), Fig. 4*c*, shows a strong concentration of the Arakelian galaxies toward temperatures of 40-50 K. Just for comparison we should note that the temperatures of the cyruses in the Galaxy are about 25 K.

3. Conclusion. The Arakelian galaxies are characterized by relatively small sizes and statistically higher luminosities.

The increased luminosity is probably due to the higher rates of star formation.

Yearly, about 10 solar gas masses are transformed into massive hot stars.

The dust temperature is higher than that of the cyruses in normal *S*-galaxies and is close to 40-50 K.

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