Доклади на Българската академия на науките
Comptes rendus de l'Academie bulgare des Sciences
Tome 44, N° 4, 1991

ASTRONOMIE

MARKARIAN GALAXIES IN THE FAR INFRARED - AN ANALYSIS OF THE IRAS DATA

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(Submitted by Academician K· Serafimov on September 19, 1990)

Markarian galaxies are a sample of galaxies with strong UV continuum selected by low dispersion spectra. Recently Mazzarella and Balzano *[1]* published a full catalogue of all 1500 Markarian galaxies. There are IR fluxes in 12, 25, 60 and 100 microns from IRAS for 640 of them. More than 300 amongst Mrk G are active galactic nuclei (115 Sy 1, 43 Sy 2, 103 SBG, 34 H1I G, 5 LINERs, 5 QSOs, 3 BL Lac, 3 NELG) and for about 58% of them there are IR fluxes. Here we examine the behaviour of active and "nonactive" Markarian galaxies depending on the morphological type or of the type of activity. The main problems are to check the validity of the two component model of de Jong et al. [2] for active and "nonactive" galaxies and to make some qualitative evaluations for the star burst activity in the nuclei of Markarian and high surface brightness galaxies in comparison with normal galaxies.

Fig. *1a* represents a dependence of far infrared index $CI_{FIR} = F_{F1R}/F_B$ from colour temperature index $S = S_{100}/S_{60}$ for the active (".") and "nonactive" (" + ") Markarian galaxies. The bars are standard arrors. Here $F_{F!R} = 1.26xl0^{-14}(2.58x S_{6o}+S_{100})$ W/m^2 according to [3]. All data satisfy one relation $Lg\ S = 0.4\text{-}0.44\ Lg\ CI$ with very high correlation coefficient r=-.87. This conforms the hypothesis that the nature of the IR radiation is the same for the active and "nonactive" galaxies.

Table 1 contains the average far infrared CI_{Fm} and colour temperature S indices and their deviations defined by standard way for galaxies of different types of activity. "Normal" means galaxies studied by de Jong et al. [2] from the Revised Shapley-Ames Caralog of Bright Galaxies [3] Akn —Arakelian galaxies from his original list of HSBG p], Pet —HSBG from the list of Petrov [6], Mrk — "nonactive" Markarian galaxies and Sy 1.5, 1.8 and 1.9 — Osterbrock's subtypes of Sy 1 galaxies. Because of only two LINERs with IR data in Mrk G, "all LIN" means all LINERs with IR data from the Catalogue of QSOs and AGN [7].

Fig. *1b* sbows the changing of CI_{FIR} with the morphological type for the active (".") and "nonactive" ("+") Markarian galaxies. The vertical bars are standard errors. The number of objects in each type is marked. We can conclude that compact galaxies contain only warm components (this is the same for the galaxies without morphological classification, most of which probably are compact) and practically defined the upper limit of IR excess and temperatures of "nonactive" galaxies and in most of AGN. In some types AGN — Pec, SBO, S, SB and E, there is an additional source of heating of the dust.

The deviation of Irr and SO types active galaxies from the general relation can be explained with the lack of cold component in the Irr galaxies (see also Soifer et al. [8]) and with the lower IR luminosities of SO galaxies.

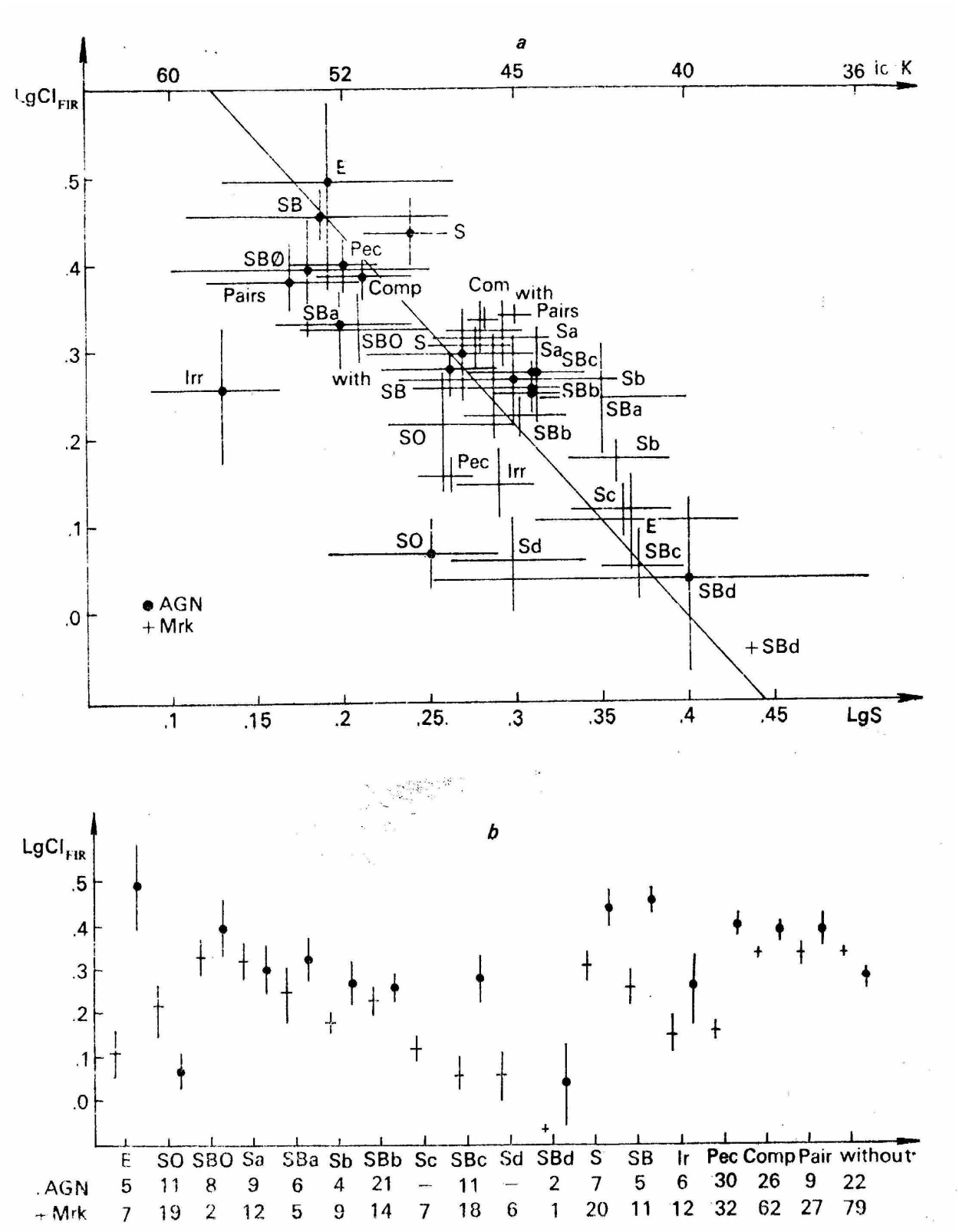

Fig. 1

Fig. 2 shows the relation between the average values of CI_{Fm} and S with their errors for galaxies of different types of activity. All objects here also satisfy a general relation Lg S = 0.33 —0.25 Lg Ci with a very high correlation coefficient r=-.82. It is

Table 1 Galaxies with a different type of activity

	Normal		Akn		Pet		Mrk		SBG		HII G		LIN		all LIN	
	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S
X	—.33	.40	.26	.36	.14	.25	.22	.31	.32	.21	.39	.26	.61	.15	.38	.36
X+	—.29	.49	.27	.37	.18	.27	.23	.33	.34	.23	.44	.31	.68	.21	.44	.43
X-	—.36	.35	.24	.35	.09	.23	.21	.30	.30	.20	.33	.21	.53	.67	.31	.28
N	88	88	148	148	24	23	332	332	76	79	17	19	2	2	7	9

	Sv2		Svl		Svl.5		Svl.8		Svl.9		Sv	
	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S	lgCI	lg S
X	.43	.21	.27	.26	.15	.25	50	.18	.43	.23	.32	.27
x+	.45	.25	.29	.32	.20	.33	55	.24	.49	.34	.38	.34
x	.41	.18	.25	.20	.10	.15	44	.10	.36	.08	.26	.19
N	32	33	48	50	6	6	3	3	4	4	6	5

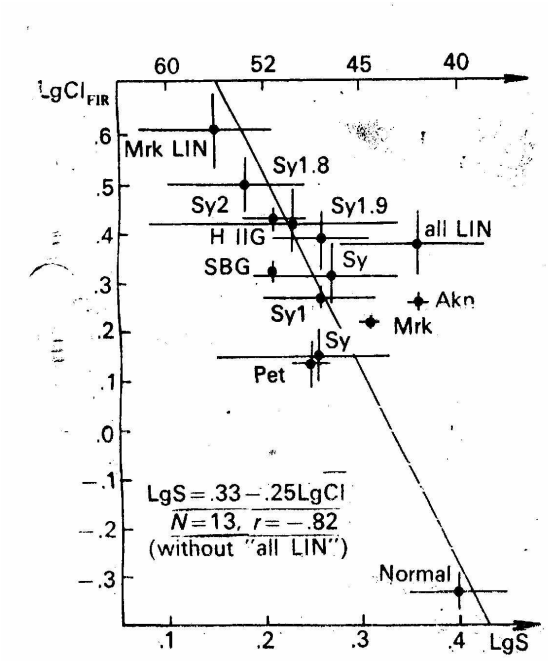

Fig. 2

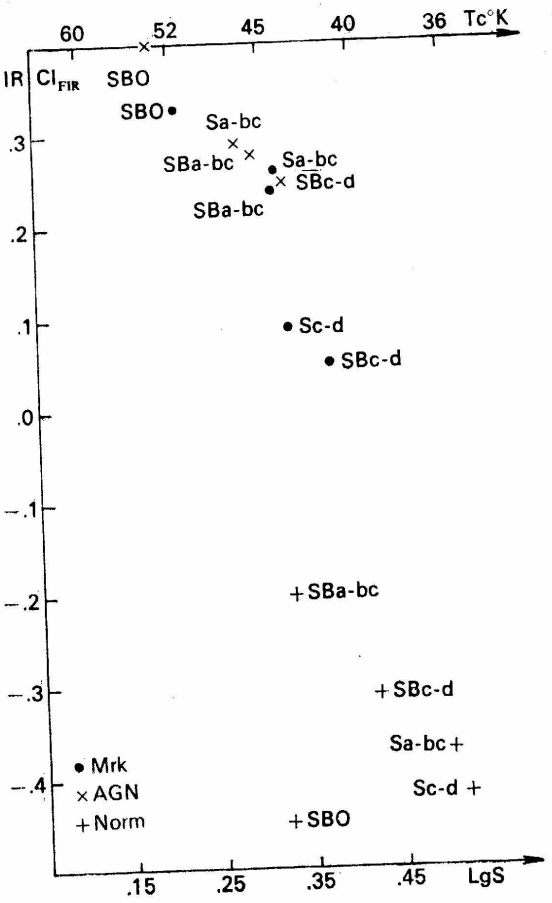

Fig. 3

Table 2 Infrared and colour temperature indices for morphological "groups" as in [2]

Type	SBO Lg CI	lg S	Sa-bc lg CI	lg S	Sc-d lg CI	lg S	SBa-bc lg CI	lg S	SBc-d lg CI	lg S
Norm	—.45	.32	-.37	.50	-.42	.52	—.20	.33	—.31	.42
Mrk	.33	.21	.26	.32	.09	.33	.24	.31	.05	.37
AGN	.40	.18	.29	.28	[1] .37	.47	.28	.29	.25	

seen that Mrk G and HSBG by their IR characteristics are more closer to the typical AGN than to the normal galaxies and the two groups demonstrate high star burst activity.

Based on the data from Table 1 and Figs 1 and 2 we can conclude that as a first step two components model of de Jong et al. [3] is good enough to explain the observable IR data either of AGN or of normal and "nonactive" galaxies.

De Jong et al. p] found that normal galaxies with bars have higher IR excesses in comparison with those without bars. We can check if this is valid for active and "nonactive" Markarian galaxies. All objects are grouped as in their original study in classes SBO, SBa-bc, SBc-d Sa-bc and Sc-d (Table 2) and are shown in Fig. 3 where with "·" are marked Markarian "nonactive" galaxies, with " + " —normal galaxies and with "X" —active galactic nuclei. It is seen that barred active and "nonactive" Markarian galaxies have not a higher IR activity. As is demonstrated in Fig. 1 this statistically is true only for SBO and SBa of active galactic nuclei and for SBO of "nonactive" Markarian galaxies.

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