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CLASSIFICATION SCHEMES AND PROPERTIES OF INFRARED GALAXIES

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ABSTRACT

We established a separation scheme to distinguish galaxies from stars with the aid of AKARI/FIS color-color (CC) diagrams. In all the combinations of CC diagrams we can distinguish two separate clouds. It was shown that in all cases one of them contains more than 95% of galaxies and the other one, in most cases, consists in more than 80% of stars (Pollo et al., 2010). Currently we are looking into more detailed classifications. We are especially interested in separating different morphological types of galaxies, mainly within spiral galaxies. Moreover, we study the properties of infrared galaxies.

Key words: infrared: galaxies, stars; telescope; conferences: proceedings

1. OUR SAMPLE

It is crucial for all-sky surveys, detecting tremendous amount of sources, to find a way to distinguish between different kinds of objects based on minimal amount of additional information. The best option would be to use only data which is brought by the survey itself.

The AKARI/FIS catalogue contains more than 400,000 sources. For the reason mentioned above, we are looking for various classification schemes between different types of objects within the catalogue, using photometric information only. For our purpose, we selected sources in regions of low Galactic emission at 100 μm ($I_{100} < 10$ MJy sr^{-1}) in order to increase the probability of finding a counterpart. This condition is met by 39968 sources within which 5,176 sources have complete photometric information. This sample of sources was identified in the NED and SIMBAD databases, resulting in the following identification: 68.8% of sources is extragalactic, about 6.6% is Galactic, 4% have been observed in infrared and 2.7% in radio wavelengths, and finally 16.4% of sources were unidentified.

Table 1.
Morphological Types of 9217 FIS Galaxies

Type of galaxies	Number	Percentage	
	in IR	in IR	in opt.
Spiral	7877	85%	61%
Lenticular	911	10%	22%
Irregular	161	2%	4%
Elliptical	268	3%	13%

Pollo et al. (2010) have shown, for AKARI/FIS Bright Source Catalogue Version β-1, that in all the combinations of far-infrared (FIR) color-color (CC) diagrams we can distinguish two separate clouds. Based on these scatter plots, the division line between stars and galaxies was decided. Two examples of the diagrams, for the sources with the best quality FIS fluxes, are shown in Fig. 1.

There are 27,384 galaxies in the cross-identified sample of FIS sources. Nearly 68% of these galaxies have their redshift measured and 95% of them are located at very low redshifts below 0.1. Morphology was obtained for just over one third (34%) of the galaxies. Summary of morphological counts is presented in Table 1.

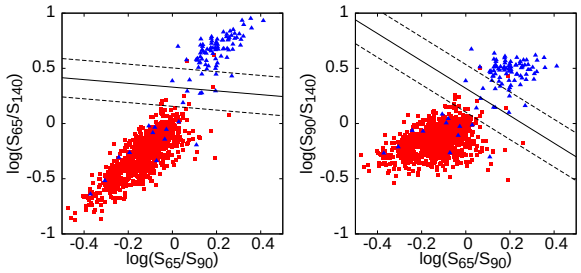

Fig. 1. The S_{65}/S_{90}–S_{65}/S_{140}, S_{65}/S_{90}–S_{90}/S_{140} CC diagrams for the sources with flux quality indicators equal to 3. Symbols represent the sources as follows: red squares - galaxies; blue triangles - Galactic stars. The solid line is a division line between the two classes of objects. The dotted lines represent the uncertainty ranges in the color determination.

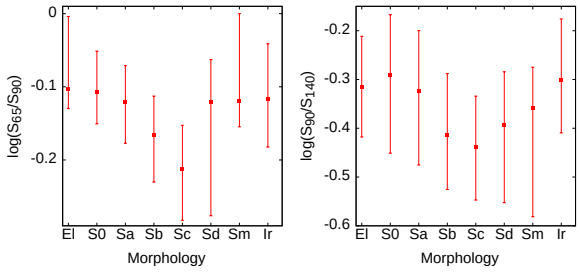

Fig. 2. *Left*: $\log(S_{65}/S_{90})$ vs morphological type; *Right*: $\log(S_{90}/S_{140})$ vs morphological type. Filled squares are medians. The lower bar is the 25th percentile; the upper is the 75th percentile.

2. HOW FIR COLORS VARY WITH HUBBLE SEQUENCE?

Trends along the Hubble sequence for two FIR colors is presented in Fig. 2 and median values of possible FIR colors for each galaxy type are listed in Table 2. Among all types of galaxies, Sc have the lowest median for each FIR color. The median of $\log(S_{140}/S_{160})$ is almost the same for all morphological types because 140 μm and 160 μm wavebands lie very close to each other and it is very possible that both are at the Rayleigh-Jeans regime of dust emission. If we neglect morphological types for which we have very low number of objects, e.g. Sm, the difference between the highest and the lowest values of medians are 0.1, 0.24, 0.27, 0.15, 0.24, 0.02; also lenticular galaxies have the highest median for almost all colors. Luminous IR galaxies and starburst galaxies have colors' median bluer than S0.

TABLE 2.
Medians of FIR Colors for Galaxies with the Best Quality Fluxes

	E	S0	Sa	Sb	Sc	Sd	Sm	Ir
$< S_{65}/S_{90} >$	-0.10	-0.11	-0.12	-0.17	-0.21	-0.12	-0.12	-0.12
No. of objects	16	104	127	157	135	10	3	24
$< S_{65}/S_{140} >$	-0.28	-0.23	-0.29	-0.38	-0.47	-0.42	-0.21	-0.26
No. of objects	12	94	118	152	131	10	3	21
$< S_{65}/S_{160} >$	-0.27	-0.20	-0.19	-0.38	-0.46	-0.34	-0.17	-0.15
No. of objects	4	44	68	102	105	6	2	13
$< S_{90}/S_{140} >$	-0.32	-0.29	-0.32	-0.41	-0.44	-0.39	-0.36	-0.30
No. of objects	59	287	384	785	796	63	13	68
$< S_{90}/S_{160} >$	-0.17	-0.08	-0.12	-0.28	-0.32	-0.24	-0.01	-0.03
No. of objects	9	54	94	199	234	15	3	15
$< S_{140}/S_{160} >$	0.02	0.04	0.04	0.04	0.02	0.03	0.05	0.08
No. of objects	9	49	89	185	224	14	3	14

3. CONCLUSIONS

The FIR CC diagrams allow for a high quality star-galaxy separation. The distribution of morphological types significantly differ from what is observed in the case of optically bright galaxies. Our galaxy sample contains small number of elliptical and irregular galaxies, overrepresentation of spiral galaxies, and noticeable number of lenticular galaxies. Rough conclusion about galaxies can be that lenticular galaxies contain more hot dust than Sc galaxies.

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