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High resolution IRAS maps of spiral galaxies

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Abstract. High resolution maps of nine spiral galaxies have been generated in the four IRAS bands using the HIRES routine. These are used in conjunction with maps in Hα, CO, HI, radio continuum etc. to study spatial correlations and the regions of high mass star formation. Some examples are given in this short paper.

Key words : far-infrared—galaxies—high resolution—IRAS

1. Introduction

Regions of star formation, especially those of high mass stars, are generally embedded in dust and hence observations in the far-infrared (far-IR) are especially useful. In recent times high resolution maps in several other indicators of star formation (like the lines of Hα, CO, HI etc.) are becoming available. In order to make a correlative study of spatial structures in the far-IR and other indicators, we have generated high resolution far-IR maps of nine spiral galaxies. The data are obtained in each of the four IRAS bands viz. 12, 25, 60 and 100 μm. The major aim of the investigation is to study the relationship between Hα and the far-IR emissions and also between the far-IR and molecular and atomic hydrogen cloud complexes. By comparing the maps at 12 μm with those at longer wavelengths, we also hope to get information on the contribution of very small grains vs normal grains to the infrared emission in spiral galaxies.

2. The sample and the maps

Table 1 lists the galaxies studied and some relevant properties. These galaxies were selected because of the availability of data in other windows like Hα, CO, HI etc. The HIRES routine developed at the Infrared Processing and Analysis Centre uses all the IRAS data available on a galaxy, models the response of the various detectors and through an iterative procedure generates maps at a resolution much better than the field of view. With this technique the spatial resolution obtainable are : (cross scan × scan direction) 37 × 23, 35 × 23, 62 × 41 and 98 × 80 arcseconds in the 12, 25, 60 and 100 μm bands respectively. As an example we present in figures 1(a)-(c), the intensity maps of NGC 6946 at 12, 25 and 60 μm and in figure 2, the 25 μm map of NGC 4321. In both these face-on galaxies, spiral structures can be discerned.

Table 1. Sample of galaxies studied

Galaxy	θ (opt) arc sec	IRAS PSC flux density (Jy)				Other maps
		12 μm	25 μm	60 μm	100 μm	
N1569	198	0.7	6.8	46.7	52	HI, RAD
N1808	240	4.1	15.8	97.0	136	CO, RAD
N3079	522	1.2	2.0	42.9	89	CO
N3198	600	0.25	0.46	3.7	4	Hα
N3628	930	2.6	4.7	48.0	102	CO
N4321	540	0.79	1.3	18.2	58	Hα
N6240	132	0.57	3.5	23.5	27	Hα
N6946	840	2.2	6.6	52.0	126	Hα, CO, HI, RAD
N7552	270	3.0	12.0	73.0	101	OPT

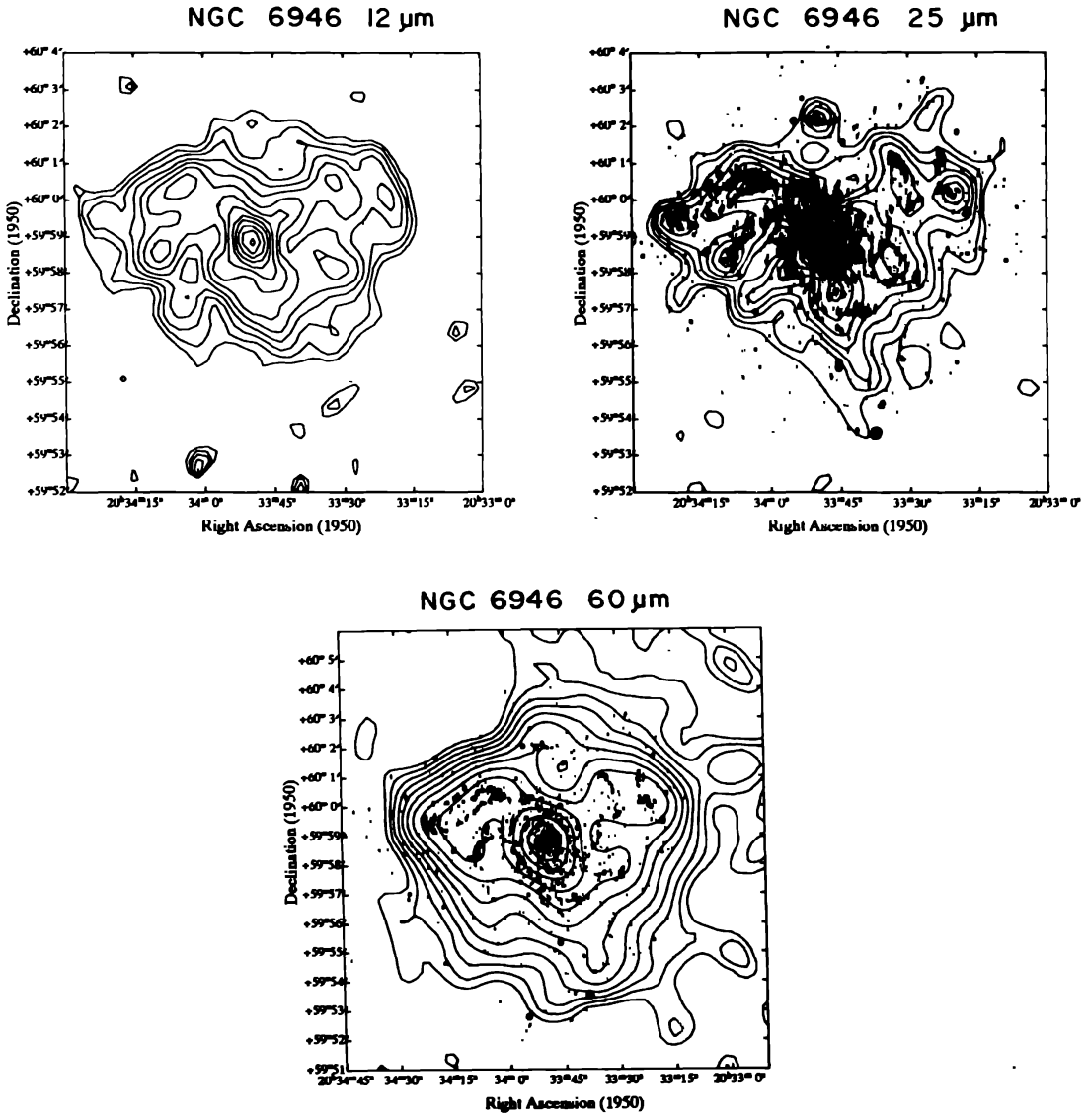

Figure 1(a-c). HIRES maps of NGC 6940 at 12, 25 and 60 μm respectively. The innermost contour is 90% of the peak and subsequent ones less by a geometric factor *p*. Values of the peak value in MJy/Sr and *p* are (a) 33, 2; (b) 720, 1.6; (c) 738, 1.8. In (b) and (c), the Hα photograph of Bonnarel *et al.* (1986) is superposed.

There has been disagreement amongst various workers about the relative contribution of cool dust in the ISM to the 60 and 100 μm IRAS emissions. Some authors are of the opinion that the cool dust plays a very important role. Future large scale mapping at wavelengths of 150 μm and above will give a definitive answer. However, even with the presently available IRAS observations, one can quantitatively estimate the contribution of young stars to the far-IR emission by a comparison with the Hα maps since the Hα emission arises from the ionised regions around the high mass stars and a good fraction of the bolometric luminosity of these stars is reradiated in the far-IR. Maps of Hα emission are available for NGC 6946 (Bonnarel *et al.* 1986) and NGC 4321 (Arsenault *et al.* 1990). We have shown these maps superposed on the far-IR maps in figures 1 and 2. It is seen that there is a striking correlation between the structures in the Hα and the far-IR maps, implying that a significant fraction of the far-IR emission is from high mass star regions. Quantitative studies will be presented later.

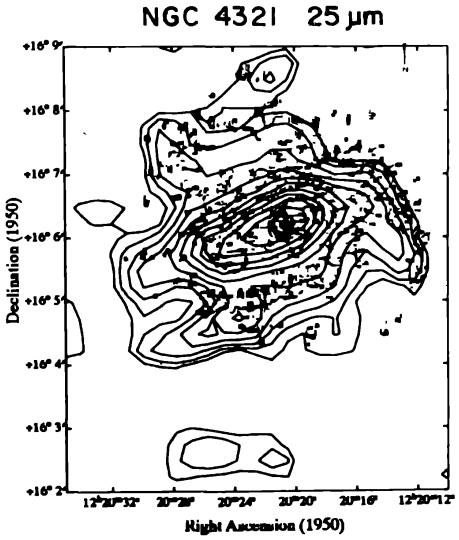

Figure 2. HIRES map of NGC 4321 at 25 μm. Peak value is 16.5 MJy/Sr. Innermost contour is 96% of the peak and subsequent ones decrease by a factor of 2. Superposed on the map are the Hα contours from Arsenault *et al.* (1990).

The 25 μm flux densities are generally much lower than the 60 μm flux densities. However, it is seen in both these galaxies as well as in others (maps not shown) that the increased resolution of 25 μm maps makes them extremely useful for high resolution studies. There is more to be learnt from a good study of IRAS 25 μm maps. Further, in conjunction with the 12 μm maps having similar resolution, they can be used to study the relative contribution of star forming complexes and the ISM to the far-IR emission. Future studies will include these aspects and also correlations with the CO and radio continuum maps.

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