Spatial Analysis of IRAS Observations of Nearby Spirals

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The unbiased survey of the infrared sky carried out by the IRAS satellite has greatly accelerated advances in understanding the dust component of our own and external galaxies. However, most extragalactic studies to date have been based on the IRAS Point Source Catalog (PSC), which has two serious limitations. First, in sources where a significant fraction of the flux is extended, significant errors may result from using PSC fluxes in comparative studies, and these errors could be systematic if the tendency to be non-pointlike depends on physical properties of the galaxy. Additionally, use of PSC fluxes rules out any direct investigation of the spatial distribution of the IRAS emission from disks in external galaxies. Since work on the Galactic IRAS results has shown that very different physical processes (star formation, quiescent cold dust emission, and AGN processes) can make varying contributions to the observed flux, it is important to look at a wide sample of galaxies with some spatial resolution to study the relative dominance of these processes under a variety of conditions. We report on work we are doing to carry out this program for many nearby spirals, using an analysis package that we have developed for this purpose.

We have used detailed models of the point spread functions of the individual IRAS focal plane detectors to investigate the spatial distribution of the fluxes measured for a sample of nearby spiral galaxies. These objects are selected to have large enough angular diameters to be resolvable, in principle, by IRAS at 60 μm. The detector maps have kindly been provided by M. Moshir of IPAC. Our method works with single survey scans in the ADDSCAN format also provided by IPAC. The several such scans in each band over an object of interest give several independent measurements of the convolved galaxy and instrumental profiles, so that the results can be checked for consistency. As a first step in our analysis, we use a nonlinear least squares technique to make a best fit of the detector profile to the observed scan, in order to overcome the errors in the nominal pointing of the satellite and hence center our profile analysis accurately on the galaxy nucleus, empirically defined as the most pointlike object near the nominal galaxy position. We then determine the fluxes of the galaxy's pointlike and extended components. Here we will confine our attention to the question of what fraction of the 60 μm flux is contained in a pointlike nucleus, as seen by IRAS (i.e., FWHM about 1.5 arc minutes).

We have carried out this analysis for a sample of 121 nearby spirals. The fraction of the flux contained in a point source varies from 0 to 1 across the sample, all of which are well resolved at their nominal optical diameters. There is no evidence that the galaxies of smaller angular size are less likely to be resolved by IRAS at this level. Our program gives results which are quite repeatable from scan to scan; the fraction f (point source flux over total flux) at 60 μm has typical errors of 0.03 when different scans are combined.

Approximately two-thirds of the sample have more flux in the extended than in the nuclear component. There is a tendency for earlier-type spirals to be less centrally concentrated, but this effect is slight and the degree of variation is large for all types. Barred spirals are also found across the spectrum of f, but are much more likely to have little or no nuclear emission. More detail on individual unusual objects will be presented in the poster.