A photometric study of the MIPSGAL and Hi-GAL l=30° field

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Hi-GAL: the Herschel infrared Galactic Plane Survey

ABSTRACT.
A procedure adopted for deriving a photometric catalogue for MIPSGAL maps is described and the results for the l=30° field are presented. With the advent of recent Herschel observations, the Spitzer 24 µm data turn out to be crucial to ascertain the protostellar/starless nature of the FIR Herschel compact sources. In particular the MIPSGAL and the Hi-GAL surveys observe largely overlapping sky areas and cover complementary spectral ranges. Therefore it is fundamental to obtain reliable catalogues of MIPSGAL fluxes to extend the spectral energy distribution of Hi-GAL compact sources and then better constrain their models. The detection and extraction of point sources is performed by using both the MOPEX/APEX code and the DAOPHOT package across the l=30° field. Because the brightest objects show a "ring" of ghost sources, specific procedures are developed to detect and remove these artifacts. A comparison between the two methods is shown. The DAOPHOT photometry is also extended to consider the five Hi-GAL wavelenghts obtaining a catalog of the corresponding fluxes. Finally, MIPSGAL, Hi-GAL, and 1.1 mm Bolocam fluxes are merged to discuss some preliminary SEDs.

MOPEX DATA ANALYSIS.
The input image for the source detection and extraction is a MIPSGAL map at 24 µm, with the corresponding uncertainty and coverage maps, available from the Spitzer Science Center (SSC) site. Each Galactic longitude corresponds to two different maps, the positive (p) and the negative (n) longitude one, with a small overlap around the zero latitude. The l=30° field is analysed using the Astronomical Point source Extraction (APEX) module, a part of the MOsaicking and Point source EXtraction (MOPEX) package [1]. After subtracting the complex background by using a small-width median filter (window size of ~14"), detections are performed with a high and low threshold set to 20σ and 5σ, respectively. The brightest objects appear associated to "ghost sources" often located at the first (and sometimes at the second) Airy ring. These ghosts are rejected from the detection lists obtaining a final "cleaned" detection catalogue. Before obtaining the final photometry, the PRF (Point Response Function) is determined by selecting a "postage stamp" of 35x35 pixels (see e.g. [1], [2],[3]) around bright and isolated sources. Finally the PRF fit is done by using a background-subtracted image estimated with a larger median filter window. To verify the quality of the resulting photometry the source-subtracted image is examined, a part of which is shown in Figure 1 for the l=30°p map. As a further check, aperture photometry on both the background-filtered, source-subtracted image and the noise image ([3]) is carried out and compared. In Figure 3 the ratio of these two photometries is reported as an histogram appearing simmetrical around unity.

DAOPHOT PROCEDURE.
A parallel photometry is carried out by using the DAOPHOT package [4]. After the detection step, carried out on a background-subtracted image with a threshold of 5σ, false detections associated to bright sources are recognized and eliminated. Also in this case a set of bright and isolated point sources is chosen to estimate the PRF, that is subsequently used to derive the source fluxes. A comparison of this photometry with the APEX results is shown in Figure 4.

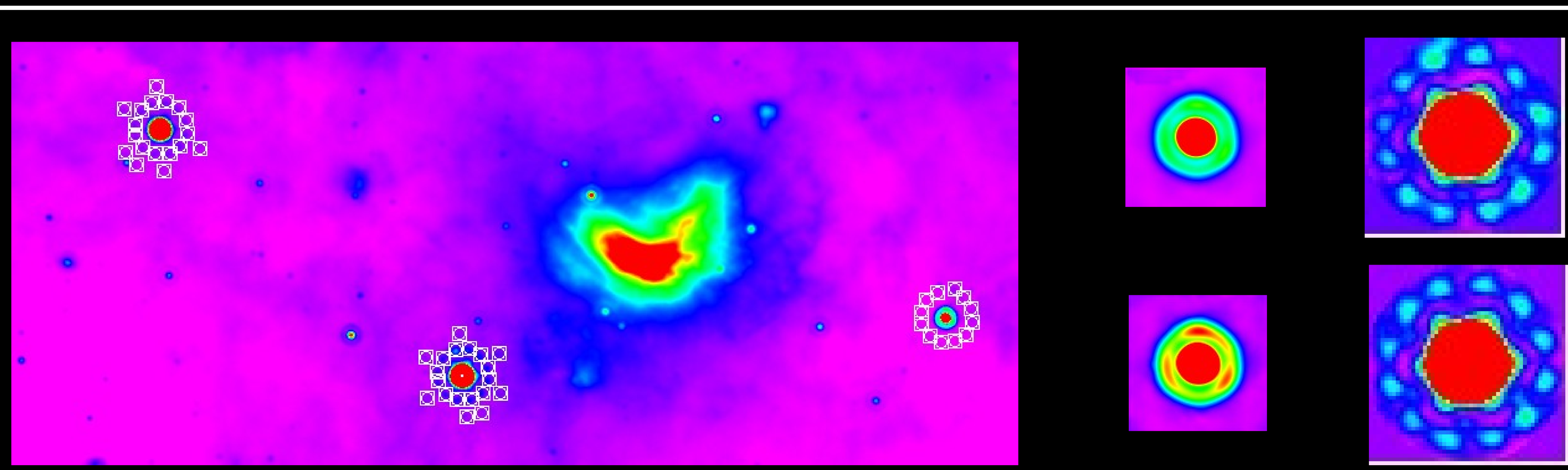

FIG. 1 – *On the left panel an example of false detections ("ghost sources") arond bright objects. On the right panels the PRFs for n map (top) and p map (bottom) obtained in APEX (left, 35x35 pix) and DAOPHOT (right, 51x51 pix) photometric procedure, respectively.*

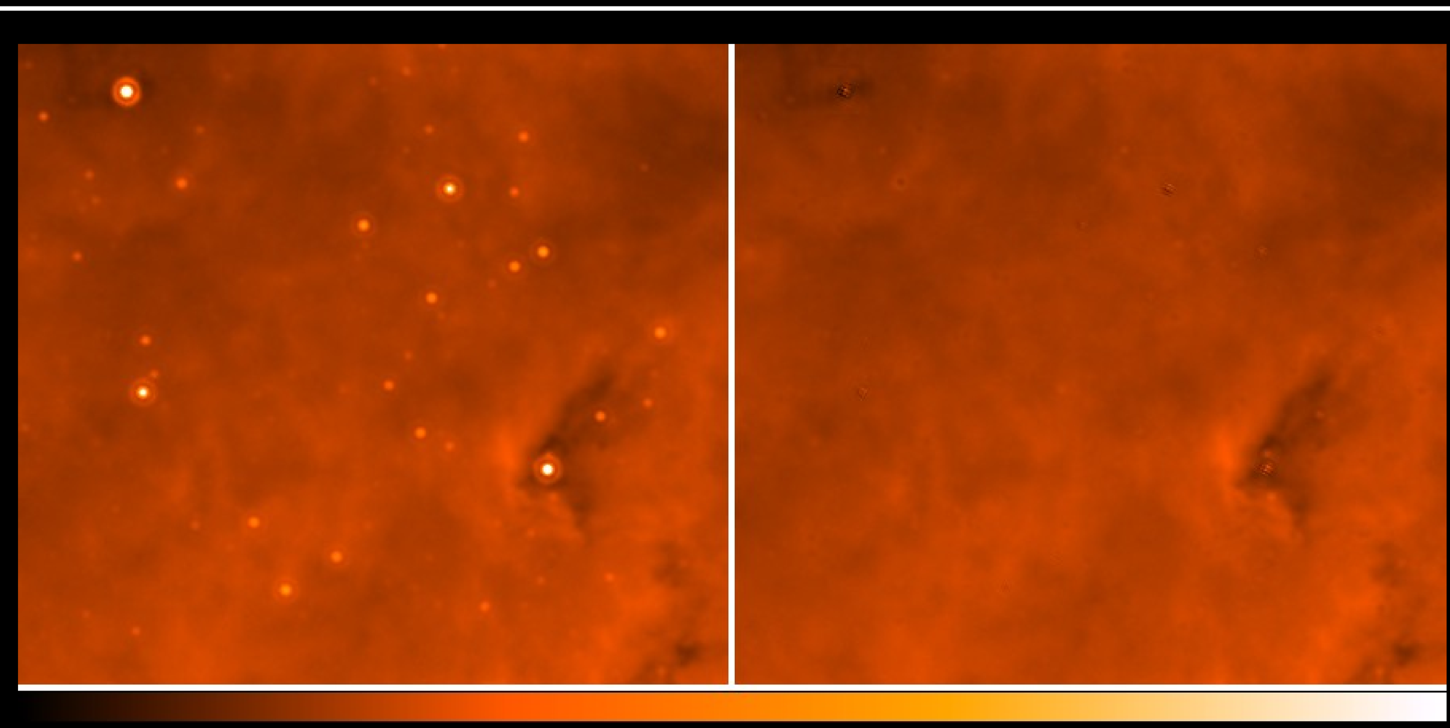

FIG. 2 – *Example of the point source subtraction obtained with the APEX procedure. On the left panel, a part of the original l=30°p map. On the right panel the same region is shown after subtraction of the point sources.*

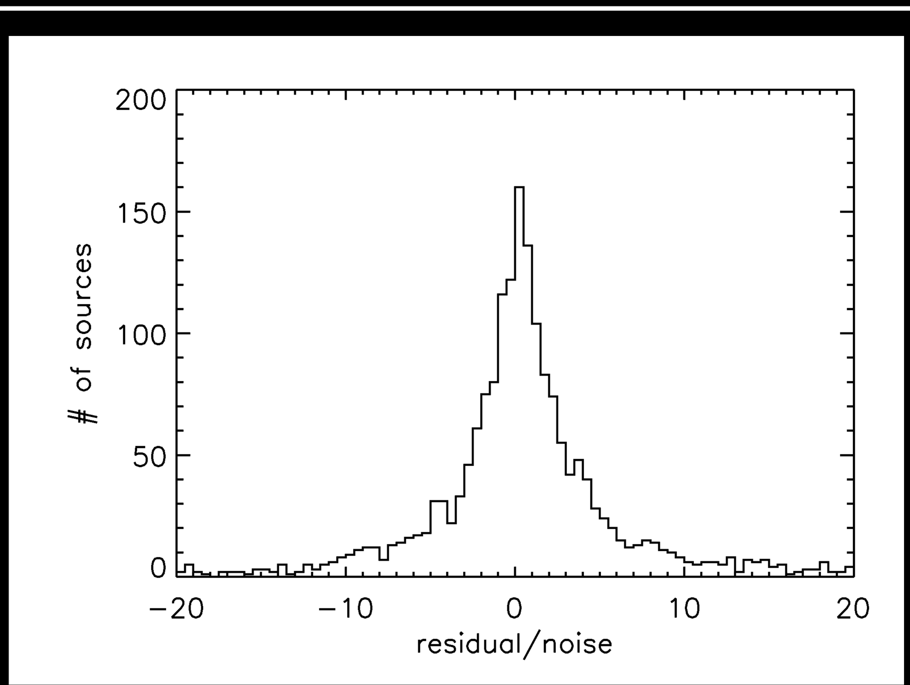

FIG. 3 – *APEX photometry: distribution of the ratio between the source residuals and the Poisson noise. Outliers are produced by the presence of extended sources .*

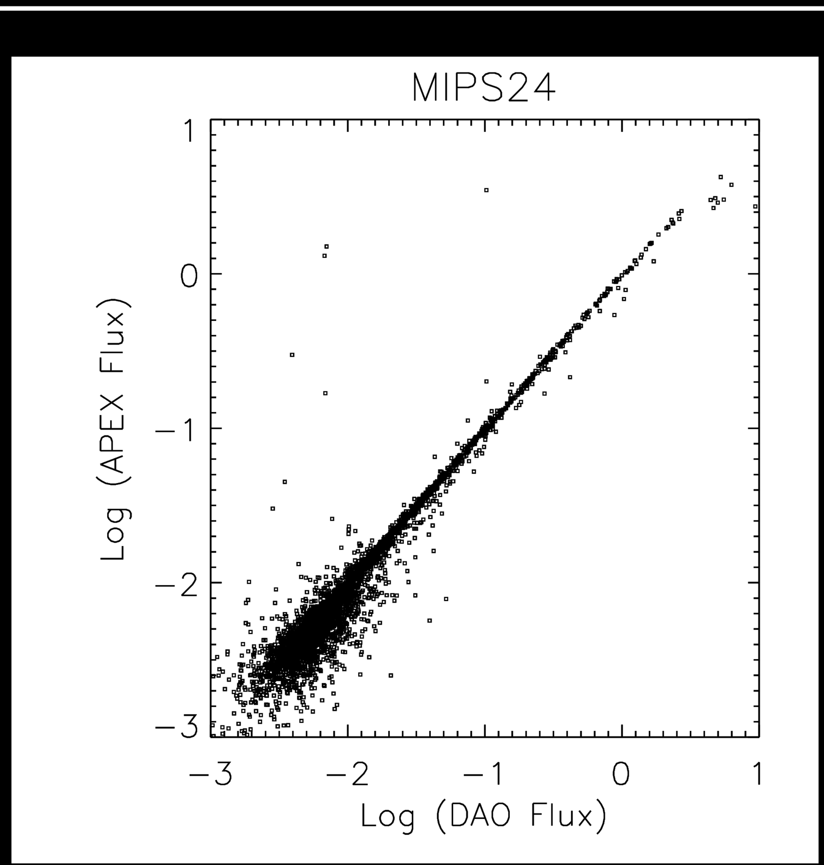

FIG. 4 – *The fluxes estimated for the same sources by means of both DAOPHOT (x axis) and APEX (y axis) are reported in a Log-Log Diagram. Units are Jy for both axis. The scatter plot shows a good agreement between the two photometries.*

MERGING OF DIFFERENT SURVEYS.
The field l=30° is covered by many complementary surveys obtained at different wavelengths. Here the first approach is to merge fluxes coming from MIPSGAL, Hi-GAL and BOLOCAM surveys covering the field of interest. This allows to use up to seven wavelenghts (24, 70, 160, 250, 350, 500, 1100 µm) that are crucial to ascertain the nature of the FIR compact sources. To this aim DAOPHOT is used to obtain source fluxes on the five Hi-GAL l=30° tiles. Because the point sources are more difficult to pick-up at the longest wavelenghts, the PRFs obtained are of decreasing quality with increasing wavelength.

BUILDING THE SEDs.
Once the multiwavelength photometry is available, the extracted sources can be spatially associated and their fluxes arranged in a final catalog. In this way it is possible to obtain the SEDs for sources of interest. The fluxes at different wavelengths are associated through the definition of an association radius that takes into account the different spatial resolutions. Here the values adopted are 3.5", 4.0", 7.0", 11.0", 15.0", 21.0", and 25.0", for 24, 70, 160, 250, 350, 500, and 1100 µm, respectively, approximately corresponding to ~0.6 times the nominal diffraction limit. Here, as an example, sources detected at all wavelengths are selected and a subsample of six objects is shown in Figure 5. In this figure the continuous blue line represents the Black Body spectrum that has been fitted to the λ ≥ 160 µm data to highlight the excess at 24 and 70 µm, probably due to a protostellar counterpart. When the short wavelength fluxes are much larger than the BB line it is possible in principle to invoke the presence of another BB emitter at higher temperature.

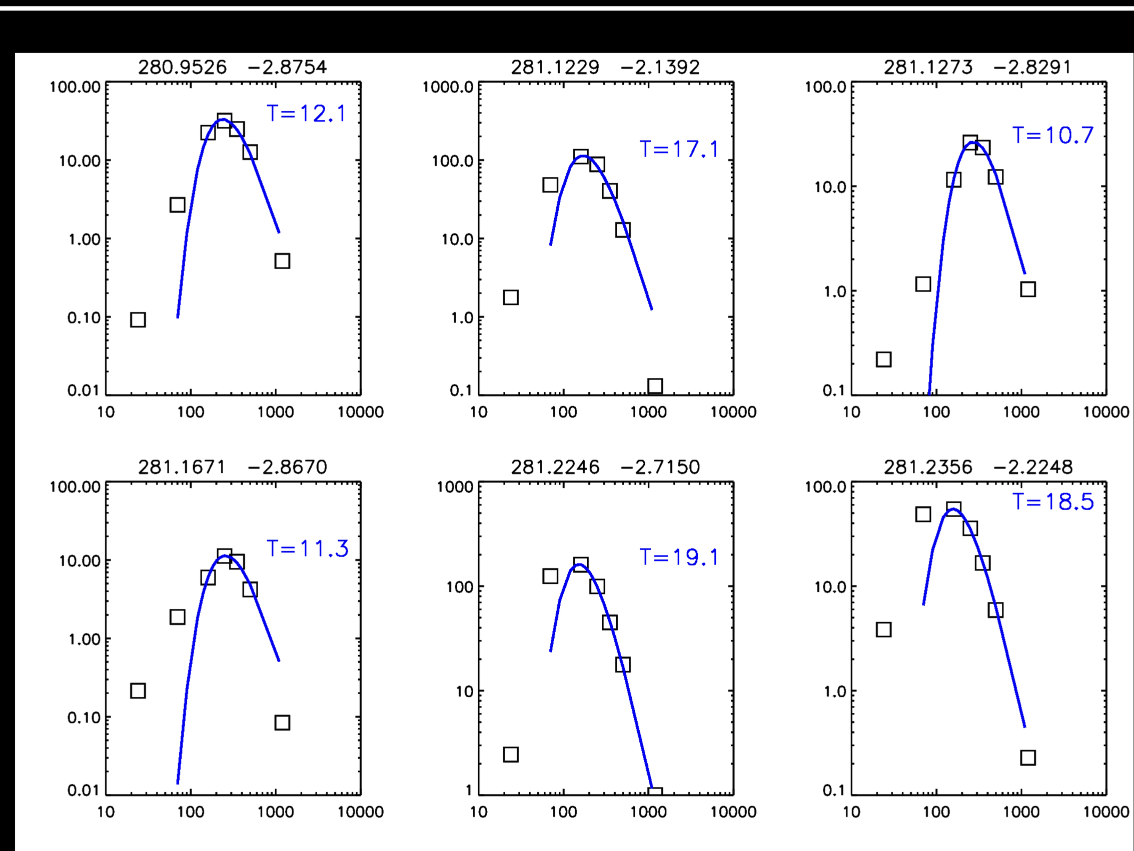

FIG. 5 – *A subsample of sources detected at all the seven wavelengths considered. In each panel the BB fit is shown as a blue line and the corresponding temperature is reported in the upper right corner. Equatorial coordinates are in the titles.*

CONCLUSIONS.

- **The MIPSGAL 24 µm point source photometry has been carried out on the field centered on l=30°, b=0° with MOPEX/APEX and DAOPHOT packages. The two photometries appears to be in good agreement.**
- **Point source photometry of the Hi-GAL l=30° tiles has been performed with DAOPHOT obtaining a preliminar evaluation of the fluxes associated to the detected sources.**
- **These fluxes have been assembled in a catalog by spatially associating the sources at the different wavelengths, also including 1.1 mm fluxes available from the BOLOCAM survey.**
- **A few cases of SEDs are shown. The BB fit to the longest wavelengths evidences that the 24 and 70 µm fluxes are in excess with respect to the BB line.**

BIBLIOGRAPHY.
[1] Makovoz D. et al. (2005), PASP, **117**, 1113-1128.
[2] Fadda D. et al. (2006), AJ, **131**, 2859-2876.
[3] Carey S.J. et al. (2009), PASP, **121**, 76-97.
[4] Stetson P. (1987), PASP, **99**, 191-222.