Clump mass estimate in the $l=30^\circ$ Hi-GAL field

B.M.T. Maiolo$^1$, Y. Maruccia$^1$, F. Strafella$^1$, D. Elia$^2$

$^1$Physics Department, University of Salento, Lecce; maiolo@le.infn.it
$^2$IFIC-IFAS, Roma

Abstract. One of the most important features characterizing a star forming region is the mass spectrum of clumps and cores. Here, we analyze the $30^\circ$ field observed in the framework of the Herschel key project Hi-GAL. In this region, we derive clump positions and sizes by using SExtractor (Bertin & Arnouts, 1996), which detects and classifies extended objects in an image. To this aim, we exploit the emission maps obtained in two different bands (250 and 500 $\mu$m) by the SPIRE instrument. The two images are used to derive a color temperature map that is related to the ratio of the brightness at the two different wavelengths. Once the temperature map is obtained, the optical depth, and then the column density, can be calculated pixel by pixel, allowing us to estimate the total masses for the sources whose distances are available (Russeil et al., 2011). Separating the clumps by distance intervals, for the Bar and the Sgr/Per Arm regions we select a significant number of objects allowing us to evaluate the clump mass spectra in these two regions of the Galaxy along the line of sight $l=30^\circ$. 

Observations and clump definition. The observations were carried out in the framework of the Hi-GAL key project of the European Space Agency’s Herschel Space Observatory (Molinari et al., 2010). In particular, we used the data of the Spectral and Photometric Imaging Receiver (SPIRE, Griffin et al., 2009), which is one of three scientific instruments onboard Herschel. For our aims, we analyzed the infrared emission map at 250 $\mu$m to find and characterize extended sources. This work is supplementary to other Hi-GAL papers aimed to study compact sources (e.g. Elia et al., 2010; Olmi et al., 2011). For clump identification, we used SExtractor, for its ability to deblend different objects (Hatchell et al., 2007). To avoid point sources, we rejected clumps smaller than 120$''$ of the spatial resolution of the image, causing the loss of the more compact objects. As size indicators we adopted the Kron radius whose property is to enclose a large fraction (~94%) of the source flux (Kron, 1980; Bertin & Arnouts, 1996).

The Clump Mass Function (CMF). Once the optical depth is derived, we can obtain the mass of those objects detected by SExtractor (~1000 objects) whose distances are known (~160). We use distance estimates provided by Russeil et al. (2011) who adopt a multi-wavelength approach combining extinction maps, optical and near infrared images, and velocity information from HI, CO, and HI data. Given the distances, we converted angular sizes in physical sizes for a subset of ~160 clumps. For these, we estimated the masses by summing their contributions in each pixel within the ellipse area corresponding to the Kron radius and the geometrical characteristics provided by SExtractor:

$$M = \sum A_{ij}/\kappa_{ij} \mu M_{\odot}$$

where the sum covers the clump area and $\kappa$ is the dust opacity (Draine & Lee, 1984). A is the physical area projected by a post-processed clump and $\mu$ is the geometrical characteristic. At this point, we can estimate the clump mass spectrum, depending on our ability to separate the different Galactic structures encountered along the $30^\circ$ line of sight (red line in Fig.6). In a first approximation, we adopt a power law of the form $dN/dM \propto M^{-\Gamma}$ to describe the mass spectrum, with $\Gamma$ varying among both galaxies (e.g. Williams & McKee, 1997) and clouds, and cores. In the case of the stars, in our Galaxy, the canonical value is $\Gamma=3.35$ (Salpeter, 1955), while for clumps $\Gamma=0.6-0.8$ (Kramer et al., 1998). More recent Herschel observations have shown that stellar mass cores this exponent can reach $\Gamma=1.5$ in the high mass end (see e.g. Konyves et al., 2010; Andre et al., 2010).

The fraction of objects for which the distances are available, allowed us to reasonably estimate the clump mass spectrum only for the Bar edge and the Sgr/Per Arm region. In these cases, we find $\Gamma=3.0 \pm 0.4$ and $\Gamma=1.3 \pm 0.3$, respectively (see Tab.1; errors are bootstrap estimates).

Conclusions. We used the Herschel Hi-GAL field $30^\circ$ to obtain a first estimate of the clump mass function, separating different Galactic regions encountered along the line of sight. This first attempt to estimate the CMF can be improved by:

- more accurate $T_d$ determination via gray-body fitting of the whole set of Hi-GAL fluxes;
- more distance determinations from more useful clouds for CMF;
- more accurate modeling of the clump edges (beyond Kron-radius);
- considering clump detection at 350 $\mu$m and 500 $\mu$m.

Bibliography
- Olmi, L., et al. 2011, Hi-GAL paper 8, A151