The most massive gas clumps in the Milky Way

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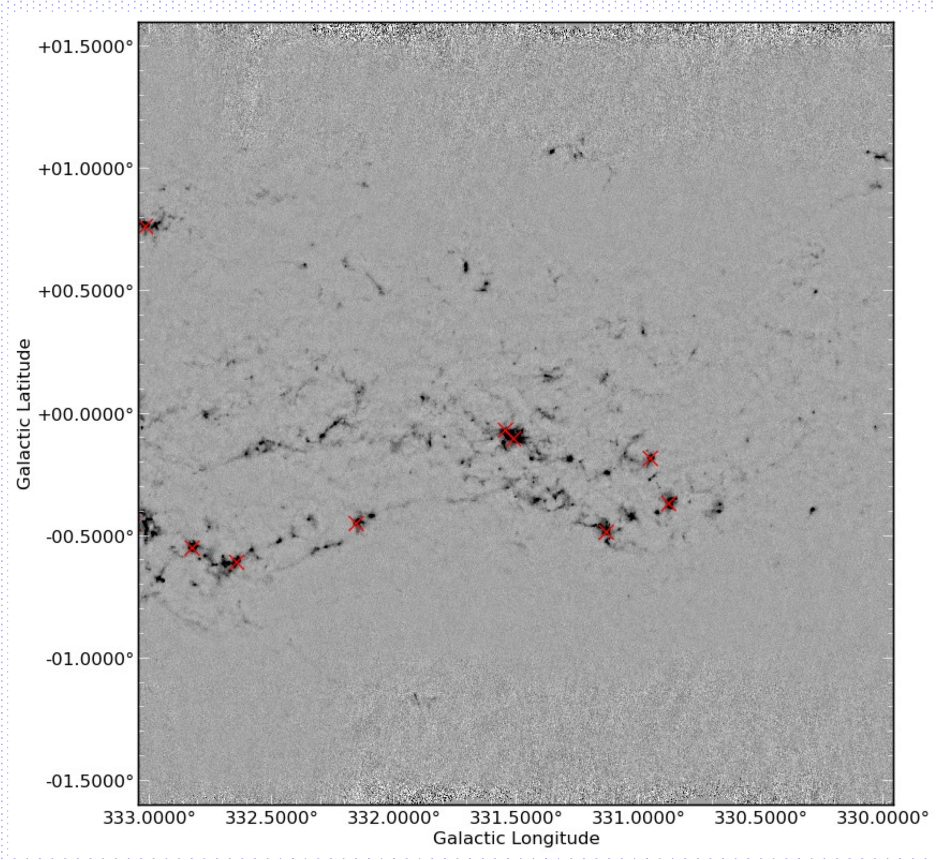
High mass stars play an important role during their whole lifetime. They influence the physical properties of the interstellar medium, the evolution of stellar clusters and of entire galaxies. In the recent years significant progress has been made in the understanding of high-mass star formation, although there are still open questions. Only a systematic survey can provide statistical data for unbiased studies.
Our aim was to select and characterize the most massive gas clumps in the Milky Way. We studied their morphologies, distances, galactic distributions, temperatures, luminostites and masses.

1.1. ATLASGAL 870 μm continuum survey:

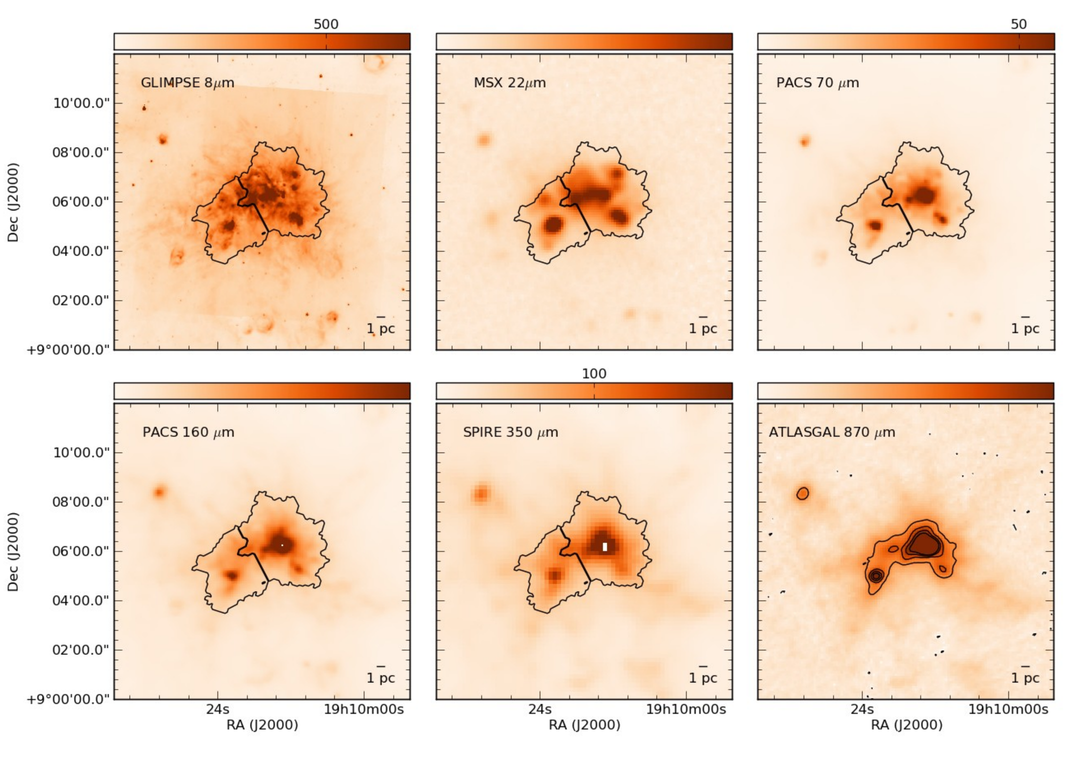
The APEX Large Area Survey of the Galaxy (ATLASGAL, Schuller et al. 2009) mapped dust thermal emission at 870 μm. It covers the full range l=-60° to 60° at 19" resolution. The 1σ rms of the maps is typically 50mJy/beam, the beam size is 19.2" and the pixel size in the maps is 6".
The survey was carried out from 2007 to 2010 using the Large APEX BOlometer CAmera (LABOCA, Siringo et al. 2009) mounted at the 12 m sub-millimetre Atacama Pathfinder EXperiment (APEX, Güsten et al. 2006) antenna.

Figure shows the ATLASGAL image for l=330-333°. Red plusses show the positions of selected sources.



1.2. Source selection:

Using the CLUMPFIND algorithm (Williams et al 1994) Beuther et al. (2012) identified 16334 clumps within the Galactic plane for longitudes between –60°and 60° and latitudes between –1.25° and 1.25°.
We applied a flux limit to select the most luminous objects. Assuming a clump at 2 kpc, with 40K temperature, 1000 $M_\odot$ mass, 10^{23} cm^{-2} column density and gas-to-dust ration of 186 (Draine et al. 2007), we selected 116 clumps.



2. Morphology

To investigate the ongoing star formation, we used the Spitzer GLIMPSE (Benjamin et al. 2003) 8 μm and MSX (Mill et al. 1994) 22 μm / MIPSGAL(Carey et al. 2009) 24 μm survey.
Herschel PACS and SPIRE observations were conducted for these regions as part of the Hi-GAL Herschel Open Time Key Project (Molinari et al. 2010).

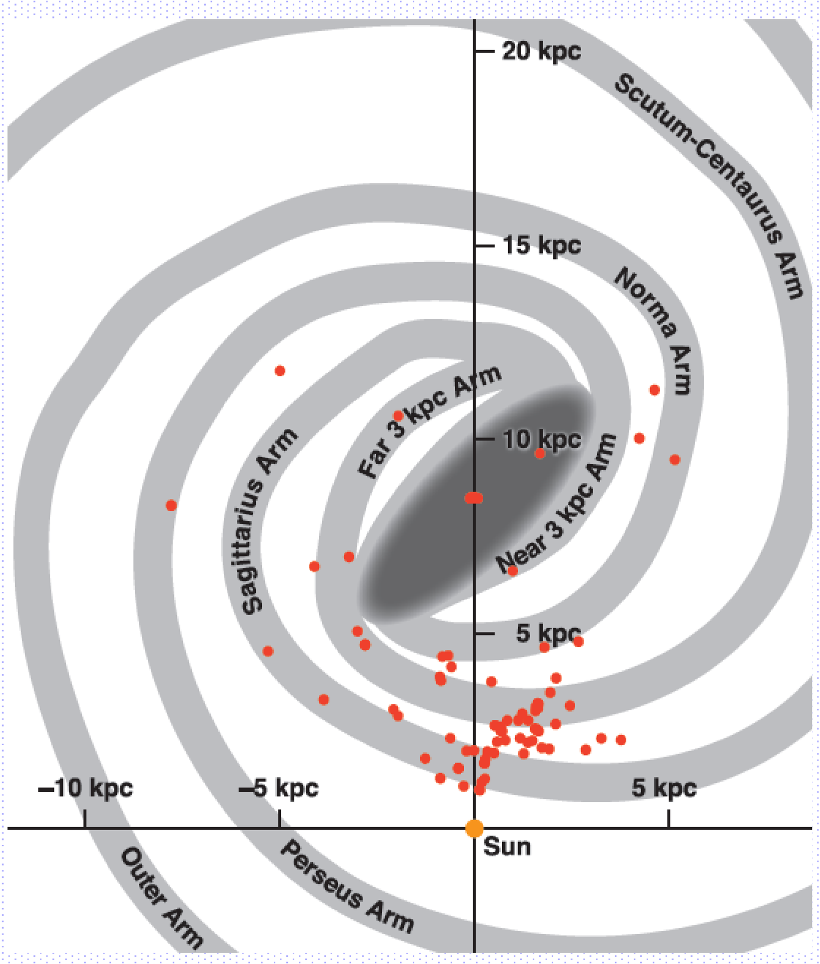
Figure shows the Spitzer GLIMPSE, MIPS; Herschel PACS, SPIRE and ATLASGAL 870 μm maps for G043.16-0.03 and G043.17+0.01. Black contours show the clumpfind masks - they define the area of our selected objects.

33% of the investigated clumps are single objects and 67% of them are located in complex systems or they compose pairs.

3. Physical properties

3.1. Distances and galactic distribution

Radial velocities are available for 85 clumps in different follow-up catalogs (Wienen et al. 2012, Urquhart et al. 2008, Bronfman et al. 1996, Purcell et al. 2012). We used the Galactic rotation curve from Reid et al. (2009) to calculate the kinematic distances. To resolve the kinematic distance ambiguity, we used the method presented by Kolpak et al. (2003) based on HI absorption. For the clumps without available v_{LSR} data, we checked the literature.

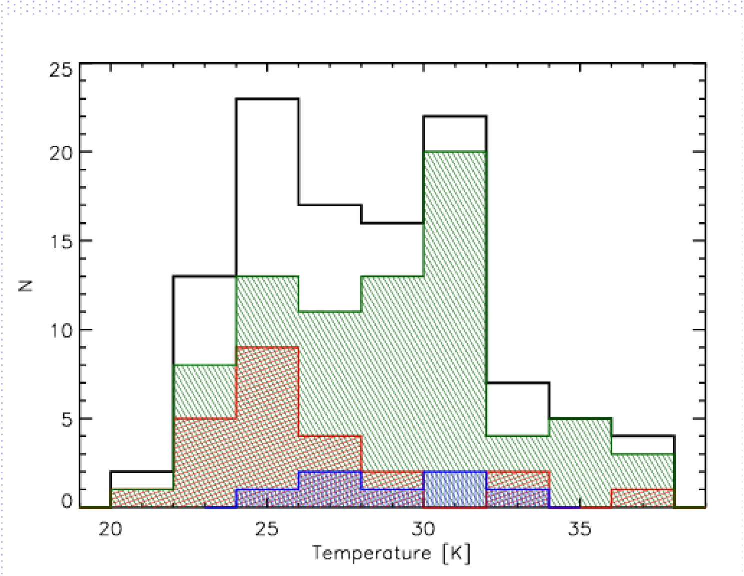


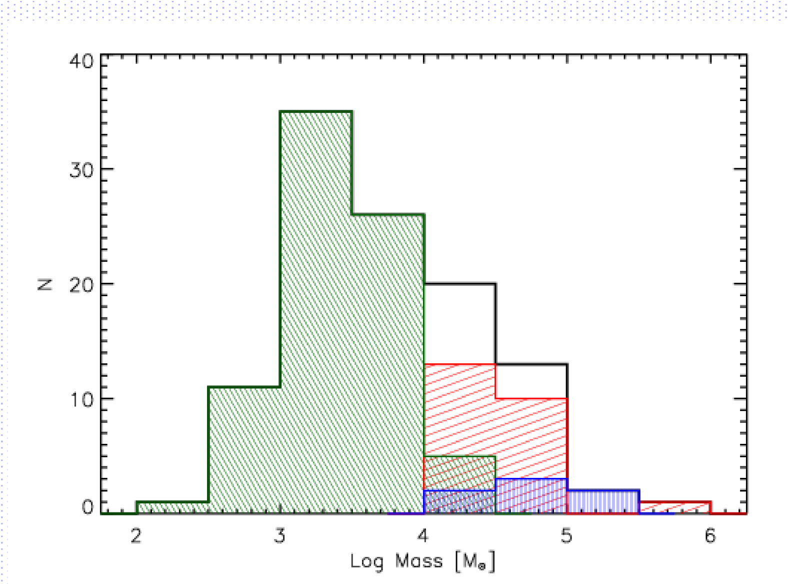
67% of the clumps located on the near side, 27% associaated with tha galactic center region and only 6% of them are on the far side.

Artist impression of face-on view of the Milky Way by R. Hurt (SSC-Caltech) / MPIA graphic. Plotted on top are the most massive clumps.

3.2 Temperatures and masses

We fit a single temperature modified Planck function to the spectral energy distribution comprised of the Herschel PACS, SPIRE and ATLASGAL integrated flux densities at 70, 160, 250, 350, 500 and 870 μm.
The average temperature of the clumps is 28 K. A small difference observable between the clumps" temperatures located at different distances: on the near side (green), on the far side (blue) and in the galactic center region (red).





Assuming optically thin dust emission we calculated the masses for the given distances and temperatures, based on the total flux density integrated over the source at 870 μm.
With a gas-to-mass ratio of 150 (Draine et al. 2009), our survey is sensitive to cores with typical masses of ~800 $M_\odot$ at 2kpc.
Color coding is the same as on the temperature distribution.
The average mass is $2x10^4$ $M_\odot$. The most massive sources located on the far side and in the galactic center region.

Acknowledgements: S.Zahorecz acknowledges the financial support of German Academic Exchange Service (DAAD) and for giving the opportunity to make a research project in Germany. This project is partially based on data acquired with the Atacama Pathfinder Experiment (APEX). APEX is a collaboration between the Max-Planck-Institut für Radioastronomie, the European Southern Observatory, and the Onsala Space Observatory. This work is based, in part, on observations made with the Spitzer Space Telescope, which is operated by the Jet Propulsion Laboratory, California Institute of Technology under a contract with NASA.

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