The Herschel Hi-GAL view of dust in molecular clumps in different Galactic environments

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High resolution molecular surveys of the Galactic plane are able to provide a census of molecular clumps in the Galaxy, and dust continuum observations provide an ideal way to explore their properties. By using recent observations of dust and gas emission, we seek to constrain the dust properties in discrete molecular clumps in the plane of the Milky Way.

We use a catalogue of molecular clumps previously identified using CO observations and perform a Galactic inversion on Herschel observation of the dust continuum. The inversion uses observations of HI and CO towards each clump, as well as photometric observations from Herschel from 70 μm to 500 μm. The radial velocity of the gas observations are used to separate the HI and C0 into on-clump and off-clump templates of the atomic and molecular phases of the ISM. A new dust spectral inversion technique is used where the observed dust emission is assumed to be a linear sum of a finite number of the on-clump and off-clump components, and where the emission from each component follows a modified blackbody emission law, enabling all Herschel bands to be solved for simultaneously.

We are able to obtain the dust properties in nearly 600 molecular clumps in the range $17° < l < 55°$, $|b| \leq 10$. The dust in the atomic medium is seen to decrease with increasing Galactic radius, showing that they are heated by the ambient interstellar radiation field. The temperature of the dust in the molecular clumps is seen to be more constant. The dust emissivity in the molecular phase is roughly three times higher than in the atomic phase, consistent with studies of individual molecular clouds and showing that the observation of the modification of dust properties in the molecular phase is a Galactic phenomenon, and not restricted to particular lines of sight. The dust in a few of the molecular clumps are found to be warmer than the dust associated with the surrounding atomic phase of the gas. These clumps are not heated solely by the interstellar radiation field, but also contain an internal heating source suggesting the onset of an initial stage of star formation.