Star Formation in the Magellanic Clouds: Herschel spectroscopy first results

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As the nearest gas-rich galaxies, the Large and Small Magellanic Clouds (LMC and SMC) offer the exciting opportunity to bridge the gap between star formation processes on large galactic-wide scales and on the small scales of individual young stellar objects (YSOs). These metal-deficient galaxies ($Z \sim 0.2\text{-}0.4\ Z_{\odot}$) also provide an invaluable window into a region of parameter space hitherto observationally unexplored. Metallicity reveals itself in at least two ways: abundances of gas-phase carbon and oxygen (and their molecular products), and abundance and properties of dust grains. The most efficient cooling mechanisms during the early collapse stages are via radiation through fine structure lines of C and O, as well as rotational transitions in abundant molecules such as CO and H_2O. Furthermore, dust grains are crucial in driving molecular cloud chemistry, as dust opacity shields cores from radiation, and icy mantles on grain surfaces enable chemical reactions to occur that would not happen in the gas phase.

We present the first results of an ambitious programme using spectroscopy obtained with PACS and SPIRE onboard the Herschel Space Observatory. The sample of massive SMC and LMC YSOs is well characterised at near- and mid-IR wavelengths, and includes both deeply embedded sources and compact HII regions. We measure the strengths of key gas-phase cooling species ([OI], [OIII], [CII], H_2O, CO, OH), in order to estimate temperature, density, ionisation state and abundances. This analysis directly probes the potential metallicity effect, since it quantifies the relative luminosities of the species that promote envelope cooling and thus constrain the cooling budget of the YSO envelopes. Preliminary results indicate that while [OI], [CII] and CO are easily and widely detected, H_2O and OH may be weak or absent in most YSOs. Does this re-enforce the sparsity of H_2O hypothesized by Oliveira et al. (2011,2013), now in the gas-phase?