Characterising the ISM of low metallicity galaxies: Quantifying the CO-dark gas reservoir

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While CO is the usual tracer of the H_2 reservoir in galaxies, it is challenging to detect in metal-poor galaxies, inspite of the rigorous star formation often taking place. The reduced dust abundance and hard UV radiation act together resulting in deeper photodissociation of the CO core leaving a large photo-dissociation region where the FIR fine structure lines are emitting. . In this zone the H_2 can be self-shielded from photo-dissociation. The MIR and FIR fine structure lines along with photodissociation and photoionisation models can be used to trace this reservoir of CO-dark molecular hydrogen.

To quantify this reservoir, we model the multi-phase ISM of the *Spitzer* and *Herschel* Dwarf Galaxy Survey with the goal of pinning down the total H_2 in a wide range of low metallicity environments. We also uncover the structure of the ISM of dwarf galaxies, notably the filling factor of the photodissociation and ionised gas components.

We find an important reservoir of molecular gas, not detected by CO, but residing in the C+ - emitting reservoir, which may be the dominant molecular hydrogen component of low-metallicity star-forming galaxies. We suggest a general recipe to quantify the total mass of H_2 in galaxies, taking into account the CO and [CII] line intensity.

By exploiting the full suite of valuable MIR and FIR lines obtained from *Herschel* and *Spitzer* spectroscopy we are able to characterise the properties of the evolving ionized and neutral gas phases of galaxies, determine robust star formation rate tracers, ISM porosity and photoelectric heating efficiencies - some of the processes that shape a galaxy. With the future JWST, SPICA, and OST missions, we will be able apply the same methodology to the multiphase analyses of high-z galaxies.