Statistical distribution and properties of molecular clouds in unresolved low-metallicity galaxies

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The study of the properties of molecular clouds in spatially unresolved galaxies has so far been limited by two main issues: (1) the lack of unambiguous tracers of molecular gas and star formation, (2) the unknown spatial distribution of molecular clouds in different environments. To tackle these challenges, statistical tools have been designed to infer the interstellar medium (ISM) properties based on representative models accounting for the mixing of multiple gas components within a beam (Lebouteiller & Ramambason 2022).

I will present an application of this multicomponent modeling to a sample of 40 unresolved dwarf galaxies (Dwarf Galaxy Survey; Madden et al. 2013), with extensive infrared spectroscopic data (*Spitzer*, *Herschel*, and ALMA). In such metal-poor galaxies, the gas reservoirs available for star formation are impacted by strong ionizing radiation, which permeates the ISM over large scales (e.g., Cormier+19, Ramambason+22) and may photodissociate CO (Madden+20). To account for this inhomogeneous ISM structure, we revise the uniform H_2 distribution assumed in Madden+20 and adopt instead a “clumpy” distribution, required to simultaneously match all the spectral signatures.

We derive the probability distribution functions (PDFs) of key physical parameters (density, ionization parameter, and visual extinction) of molecular clumps using several power-laws, constrained by tracers arising from different ISM phases. As in Madden+20, we predict that large masses of “CO-dark” H_2 may be missed in CO, while [CII] or [CI] lines correlate better with the total H_2 mass at low-metallicity. Unlike previous studies assuming simpler geometries, we find that the CO-to-H_2 conversion factors are primarily driven by the internal distribution of molecular clouds rather than by galactic parameters such as the metallicity. Our results showcase the interest of complex PDF-based models to make the most of the many spectral tracers detected by JWST, including in high-redshift galaxies.

References: Lebouteiller V. and Ramambason L., 2022, A&A, 667, A34 - Madden S. C., et al. 2013, PASP, 125, 928, 600 - Cormier D., et al. 2019, A&A, 626, A23 - Ramambason L., et al. 2022, A&A, 667, A35 - Madden S. C., et. al. 2020, A&A, 643, A141