CO-dark molecular gas and the origin of [CII] emission in metal-poor galaxies

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The difficulty to detect cold H_2 in metal-poor galaxies ([1]) has led to the hypothesis that atomic gas could contribute to the star-forming gas reservoir ([2]). However, there is growing evidence that a significant fraction of the molecular gas may not be detectable in CO transitions ([3]). This is especially true in low-metallicity environments where the low dust abundance results in enhanced far-UV photon penetration and CO photodissociation within a zone where H_2 is self-shielded and where IR/sub-mm tracers such as [CI] and [CII] may emit. Therefore, the total amount of H_2 in metal-poor galaxies and the fraction that lies in a cold dense phase is largely unknown. I will present two new results that shed a new light on the tracers of the CO-dark molecular gas and on the distribution of dense clouds in low-metallicity galaxies.

First, I will present a study of the star-forming region N11 in the moderately metal-poor (1/2 $Z_\odot$) Large Magellanic Cloud. Using SOFIA/GREAT observations, we examined the velocity components of [CII], CO, HI, and H-alpha in order to isolate CO-dark and atomic gas components that are bright in [CII]. We find that most of the [CII] emission traces the CO-dark molecular gas and that most of the molecular gas toward and between CO clouds is CO-dark, either as layers around CO clumps or as interclump medium.

Second, I will describe the multi-phase and multi-sector ISM modeling of the extremely metal-poor (1/30 $Z_\odot$) nearby galaxy IZw18 [4]. We infer that the [CII] cooling line emits in an X-ray dominated region (XDR) and traces an almost purely atomic gas. We also derive stringent upper limit on the size of H_2 clumps that may be detected in the future with JWST and IRAM/NOEMA.

By drawing on these two examples and others, I will then conclude by defining a paradigm of enhanced photodissociation and prevalence of XDRs at low metallicity partly due to the low dust-to-gas mass ratio. I will also discuss the diagnostics held by [CII] and other IR tracers in different environments.

Références

[1] Cormier D., Madden S., Lebouteiller V. et al., A&A 564 , 121 (2014)
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[3] Wolfire M., Hollenbach D., and McKee C., ApJ 716, 2 (2010)
[4] Lebouteiller V. et al. A&A (2017)