30 Years of Photodissociation Regions:

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Revealing the chemical richness of the Orion Bar PDR

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The Orion Bar is the prototypical photodissociation region (PDR) with a far-UV radiation field of a few 10^4 times the mean interstellar field. Because of its proximity ($\sim$414 pc) and nearly edge-on orientation, the Orion Bar provides an excellent laboratory to study the chemical content and molecular formation-destruction routes in strongly UV-illuminated gas. Indeed, observations of the Orion Bar across the electromagnetic spectrum have been historically used in the development of PDR models (e.g., Tielens & Hollenbach 1985, ApJ, 291, 722) and today they are used as a template to understand the unresolved emission from sources as different as the nuclei of distant starburst galaxies or the illuminated surfaces of protoplanetary disks.

In the context of investigating the chemistry prevailing in molecular gas directly exposed to strong far-UV fields, we have performed the first complete millimeter line survey toward the edge of Orion Bar using the IRAM-30m telescope. The survey is complemented with $\sim 2' \times 2'$ maps of the 0.8 mm emission from several molecules at $7''$ angular resolution.

Our survey covers $\sim$220 GHz of bandwidth, between 80 GHz and 360 GHz, in which more than 500 lines have been detected. To the date, over 60 molecular species with up to 6 atoms have been identified, including main isotopologues (D, ^{13}C, ^{18}O, ^{17}O, ^{34}S, ^{33}S, and ^{15}N).

$\sim 40\%$ of the lines in the survey arise from small hydrocarbons (C_2H, C_4H, c-C_3H_2, c-C_3H, $C^{13}CH$, ^{13}CCH, l-C_3H and l-H_2C_3 in decreasing order of abundance (Cuadrado et al. 2015, A&A, arXiv:1412.0417). We detect new lines from l-C_3H^+ and improve its rotational spectroscopic constants. Anions or deuterated hydrocarbons are not detected but we provide accurate upper limit abundances. Despite being a very harsh environment, our observations show a relatively rich and distinctive chemistry: radicals (e.g. C_2H, CN, HCO), ions (e.g. CF^+, CO^+, HOC^+, SO^+), complex organics (e.g. HNCO, CH_3OH, CH_3CN), isotopologues and isotopomers (e.g. HCN, HNC, DCN). We have also identified tens of hydrogen, helium, and carbon recombination lines arising from the H II region/PDR interfaces.

In this contribution we summarize our ongoing work and show the perspectives for much higher sensitivity and angular resolution observations of the Orion Bar with ALMA.