Experimental and theoretical needs for the JWST Early Release Science Program PDRs4All: radiative feedback from massive stars: I. an astronomical perspective

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Massive stars disrupt their natal molecular clouds by dissociating molecules, ionizing atoms and molecules, and heating the gas and dust. These processes drive the evolution of interstellar matter in our Galaxy and throughout the Universe, from the era of vigorous star formation at z=1-3 to the present day. Much of this interaction occurs in Photo-Dissociation Regions (PDRs) where far-ultraviolet photons from these stars create a largely neutral, but warm region of gas and dust. PDR emission dominates the IR spectra of star-forming galaxies and provides a unique tool to study the physical and chemical processes that are relevant for inter- and circumstellar media, including diffuse clouds, molecular cloud and protoplanetary disk surfaces, and starburst galaxies.

The ERS program ID1288 is dedicated to provide template data and data processing and analysis tools for studying PDRs. To this end, it has observed the Orion Bar, the proto-typical PDR situated in the nearby Orion Nebula, using NIRSpec IFU, MIRI IFU (TBD), and NIRCAM and MIRI imaging. These observations, for the first time, spatially resolve and perform a tomography of the PDR, revealing the individual IR spectral signatures from the key zones and sub-regions within the ionized gas, the PDR, and the molecular cloud.

In this talk, we will present this ERS program in terms of the observed data, the science questions they address, and the science-enabling products that will be provided to the community. Subsequently, we will narrow our focus on the photochemical evolution of carbonaceous species in PDRs. We will discuss the laboratory needs to support the astronomical modeling required for interpreting the astronomical data and highlight recent advances in quantum chemistry computations supporting these. We will encourage a strong interdisciplinary collaboration (covering observations, experiments, theory) in order to fully leverage the ground-breaking astronomical observations provided by JWST.