Dust in photodissociation regions with JWST

Elyajouri M [1], PDRs4All team, GTO "Physics & Chemistry of PDR fronts"
[1] Institut d'Astrophysique Spatiale (IAS), Université Paris Saclay, CNRS, Orsay, France

Abstract

Using JWST spectro-imaging, we conducted a quantitative analysis of the observations from two photon-dominated regions (PDRs) with different physical conditions: The Orion Bar (ERS PDRs4All [1]) and Horsehead Nebula (GTO 1192[2]).

Our analysis with the THEMIS dust model[3] and the SOC radiative transfer model[4] resolved, for the first time, the very strong density gradient and revealed unprecedented constraints on the properties of dust grains: depletion of nano-grains in the atomic region and variations in the hydrogenation of nano-grains in different regions of the PDRs[5].

These constraints truly challenge our understanding of the physics and chemistry of PDRs, given that nano-grains are responsible for the majority of UV radiation attenuation, gas heating via the photoelectric effect, and the formation of H2 on their surface. In conclusion, we showed that it is not possible to reproduce the observations in the PDRs using grains from the diffuse interstellar medium. Therefore, it is necessary to evolve the grains by altering their properties to understand the observations in PDRs.

[1] Berné et al PASP 134 054301 (2022)
[2] Abergel et al. accepted in A&A (2024)
[3] Jones, A. P., Fanciullo, L., Köhler, M., et al., A&A, 558, A62 (2013)
[4] Juvela M., Astronomy and Astrophysics, 622, A79 (2019)
[5] Elyajouri et al., A&A, Forthcoming article (2023)