The dust population in PDRs: impact on PDR structure and observable gas tracers

Raphaël Meshaka[1,2], Emeric Bron[1], Franck Le Petit[1], Laurent Verstraete[2]

[1]LERMA, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université; [2]Université Paris-Saclay, CNRS, Institut d'Astrophysique Spatiale, Orsay

Dust grains play a key role in the physics and chemistry of the Interstellar Medium. They heat the gas through the photo-electric effect, and therefore influence the thermal structure of the ISM. They absorb the UV radiation of stars that dissociate molecules. They also act as catalysts of the formation of molecules like H_2. All these processes depend on the dust population: chemical composition (carboneous, silicates etc.) and size distribution. Multiple dust population models have been proposed (Mathis et al. 1977, Zubko et al. 2004, Draine & Li 2007, Compiegne et al. 2011, Jones et al. 2013). These dust population models propose a various range of grain compositions and size distributions. They have been constrained by dust IR-emission and UV-extinction in the diffuse ISM but, up to now, the impact of these new distributions on the chemistry and the excitation of the gas has never been tested. Our goal is to find a comprehensive model of both, able to explain consistently the gas and grain tracers in various environments.

Our goal is to study the link between the dust population and the thermal and chemical structure of PDRs, traced by gas emission lines. We have updated the treatment of dust physics in the Meudon PDR Code (Le Petit et al. 2006) to allow a wide range of possible dust populations to be used in the model, and refined the treatment of photoelectric effect to account for the effect of grain composition. The Meudon PDR code simulates the physics and chemistry of PDRs, solving the chemistry of hundreds of species, the radiative transfer, the thermal balance and the excitation of main species. With this new version of the code, we compare the THEMIS dust population model (Jones et al 2017) with former models (Mathis et al. 1977, Draine & Li 2007), and its impact on the chemical and thermal structure of various environments : diffuse ISM, dense and highly illuminated PDRs such as the Orion Bar, and less excited PDRs such as the Horsehead Nebula. In particular, for PDRs like the Orion Bar, our models show that gas tracers like CO are highly sensitive to the small grains abundance and to their evolution through the PDR.