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Asilomar, CA, USA - June 28th to July 3rd, 2015

Dust Temperature Fluctuations and Surface Processes: Impact on H_2 Emission Lines in PDRs.

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H_2 emission lines are a powerful tool to study PDRs, as they give informations about the conditions near the H/H_2 transition. However, the modeling of H_2 excitation state and the H/H_2 transition – which then controls the apparition of other species, e.g. the CO transition – requires a careful understanding of several physico-chemical processes. Two remain problematic in models : the H_2 formation process, which controls the position of the H/H_2 transition and can induce formation pumping, and the slow ortho-para conversion processes, with a competition between reactive collisions in the gas (with H^+ and H) and thermalization on dust surfaces.

ISO and Spitzer observations of H_2 emission lines provide constraints for the models, and show very efficient H_2 formation in PDRs (Habart et al., 2011). The introduction of detailed H_2 formation mechanisms in the Meudon PDR Code has led to an improved formation efficiency at the edge, in better agreement with the observations (Le Bourlot et al., 2012), but discrepancies remain in low-UV-flux PDRs, related to the ortho-para conversion processes.

Dust grains are the support of both the formation mechanism and an efficient ortho-para conversion process. Small grains are the largest contributors as they account for most of the total dust surface. But small grains undergo temperature fluctuations caused by the absorption of individual UV photons. As the surface processes are very sensitive to the dust temperature, these fluctuations need to be taken into account, but are problematic for both stationnary and time-dependent PDR models (due to the short timescales involved).

I have thus developed a statistical formalism based on master equations to compute the average efficiency of surface processes perturbed by fluctuations of the grain temperature. I present here the application of this method to H_2 formation (Bron et al., 2014) and ortho-para conversion, and show the strong impact of fluctuations in PDRs. The integration of this method with the Meudon PDR Code then allows us to directly compare to H_2 observations in PDR.

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