Temperature fluctuations and surface processes : a statistical modeling approach

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Abstract

The surface of interstellar dust grains hosts crucial physico-chemical processes, from the formation of H2, initial step of all interstellar chemistry, to the formation of complex organic molecules in ice mantles inside dark clouds. Most of these processes are very sensitive to the grain temperatures (Pauly & Garrod 2016) and are controlled by binding energies or reaction barriers which are often poorly known. These grain temperatures are subject to wide fluctuations in most environments, from stochastic UV heating of small grains in exposed environments such as PDRs, to cosmic-ray-induced fluctuations affecting much bigger grain deeper inside clouds (Kalvans 2016).

I will present a statistical modeling approach of this problem and its application to two of the simplest surface processes (H2 formation and ortho-para conversion) in UV-rich environments (PDRs) where small grains are subject to large temperature fluctuations, successfully explaining ISO and Spitzer observations (Bron et al. 2014, 2016). These results exhibit two general effects of temperature fluctuations : smoothing out threshold effects thought to sharply limit certain processes to a limited range of conditions, and reducing the impact of incertitudes on binding energies and other microphysical parameters. Finally, I will discuss the implications of these results for, and their extension to, surface chemistry in dark clouds.

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