30 Years of Photodissociation Regions:

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Gas-ice chemical interplay in interstellar clouds

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When diffuse clouds evolve into molecular clouds, gas-phase molecules freeze out on surfaces of dust particles to form ices. On these surfaces, water is the main constituent of the icy mantle in which a complex chemistry is taking place. Our goal is to follow the evolution of a gravitationally bound diffuse cloud into a molecular cloud in various environments. We fully considered the gas-dust interplay by including the details of freeze-out, chemical and thermal desorption, and the most important photo-processes on grain surfaces. For this purpose, we used time-dependent rate equations to calculate the molecular abundances in the gas phase and on solid surfaces and perform 3-d hydrodynamical simulations with the adaptive mesh code FLASH. In non-PDR, Milky Way like conditions, our findings show that while the dust grains are still bare, water formation is enhanced by grain surface chemistry that is subsequently released into the gas phase, enriching the molecular medium (Hocuk & Cazaux 2015). The CO molecules tend to gradually freeze out on bare grains. This causes CO to be well mixed and strongly present within the first ice layer. Once one monolayer of water ice has formed a strong depletion of gas-phase water and CO molecules occurs. While hydrogenation converts solid CO into formaldehyde ($\mathrm{H_2CO}$) and methanol ($\mathrm{CH_3OH}$), water ice becomes the main constituent of the icy grains. For PDR like conditions, our initial findings show that the results are different in several ways. The differences will be presented during this conference.

REFERENCES

Hocuk, S. and Cazaux, S. (2015) Astronomy & Astrophysics, 576, 19