Report from the Workshop on complex organic molecules

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Complex organic molecules (COMs) have long been detected in the hot-cores of high- and low-mass star forming regions and they have been widely used as hot-core tracers. These molecules were thought to form on the icy mantles of grains during the warm-up phase of the nascent protostar, from reactions between heavy radicals (such as CH_3O) at temperatures close to 30-40 K, until they were sublimated into the gas phase at higher temperatures (typically above 90 K). The detection of COMs in prestellar cores at temperatures as low as 10 K [1] has severally challenged this scenario. Various new models have now been proposed to account for the abundances of these species in the cold gas, but it is yet unclear whether COMs form from gas phase reactions which had been ignored up to now, or whether photolytic and radiolytic processes (e.g. cosmic rays, UVs) or chemical processes (e.g. chemical desorption/explosions) can provide heavy radicals with enough grain surface mobility.

The fourth Workshop "Processus physico-chimiques d'intérêt Astrophysique" was held in St Florent, France (Haute-Corse), June 12-15, 2017. Following the success of the previous editions, the aim of this new workshop was once again to bring together experts from both the laboratory astrophysics and observational communities to discuss the current status and the new challenges of interpreting the growing amount of observational data on COMs. The scientific program has consisted of 32 invited talks and many informal discussions. The spectroscopy, collisional excitation and gas/solid-phase reactivity of COMs were discussed together with their current and future observations.

In the gas-phase, the importance of ion-neutral and radical-neutral reactions accelerating at low temperature was emphasized (see [2] for a recent review). The need for high-accuracy potential energy surfaces (PESs), i.e. at better than 1 kcal/mol, was highlighted by the theoreticians. An important step forward was also made recently with the first measurements of product branching ratios at very low temperature [3, 4, 5]. In the solid-phase, significant progress in our understanding of fundamental and competitive processes (adsorption/desorption, addition/abstraction, diffusion/reactivity, etc.) have been made thanks to various laboratory studies of interstellar ice analogues [6, 7]. New results were also presented on the nucleation and growth of large carbonaceous solids (soots and PAHs) at high temperature [8]. Many of these important gas/solid-phase processes are now modelled and even implemented, despite large uncertainties, in sophisticated (e.g. multi-phase) chemical models [9, 10]. Finally recent detections of COMs including isotopologues in high-mass star forming regions (Orion KL and Sgr B2), in Titan and in the comet 67P were presented [11, 12, 13, 14]. All these advances promise a bright future for the study of the rich organic chemistry in space. We hope to learn a lot more in the coming years, in particular with NOEMA and ALMA for the detection of new COMs in the gas-phase and with the launch of the James Webb Space Telescope next year for the robust identification of new ices.

References

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