PhD thesis
proposal by the cluster group, LCAR (Université de Toulouse/CNRS UMR 5589)

Nucleation and melting of water clusters

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The Cluster Group is currently studying nucleation and fragmentation processes at a molecular level. Our purpose is to learn how a polyatomic system grows by successive attachment of atomic (or molecular) subunits (unimolecular nucleation). Our setup also allows addressing the thermodynamics of mass selected clusters.

Our experiments are expected to offer a new insight into the first stage of nanoparticles formation, when particles are so small (made of tens of atoms) that classical thermodynamics fails and classical nucleation theories do no longer apply. Our original experimental setup [1] already allowed measuring the attachment cross sections of single sodium atoms onto mass selected sodium clusters[2]. An original method to measure caloric curves of mass selected clusters, thus melting temperatures and latent heats, was also developed in our group [3]. Our investigations now focus on water clusters. Protonated and deprotonated water clusters already unveil unexpected attachment [4,5] and thermodynamics features [6]. We will next investigate nucleation, fragmentation and thermodynamic properties of negatively charged clusters and of species containing a few molecules of nitric and/or sulphuric acid. These species are likely to be present in stratospheric cirrus clouds for which unimolecular nucleation may be responsible for growth. We will learn how water nanodroplets properties are modified when going from pure clusters to heterogeneous ones.

The work will be mostly experimental. However, the candidate may also be required to perform computer simulations.