Formation and spectroscopic investigations of He-tagged molecular ions by using helium nanodroplets

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Helium nanodroplets (HNDs) provide an inert matrix with outstanding properties to isolate diverse molecular ions and to grow complexes and clusters at sub-Kelvin temperature. The conditions inside HNDs are ideal to study chemical reactions and to perform spectroscopic studies of the dopant ions.
In this contribution we will present the development of novel experimental techniques and methods, and recent results they enabled.
One crucial technique for our setups is the charging of the HNDs by electron impact before doping, which leads to the formation of highly charged droplets [1]. In dependence of the electron energy, positively or negatively charged HNDs are formed. The charges are distributed across the droplet, attract the dopants, which are then ionized by charge transfer processes [2]. The formation of several nucleation sites in a single HND enables the production of intense beams of cold ions.
Another important developed method is the shrinking of the He-matrix to obtain dopant ions decorated with a few He-atoms, suitable for messenger spectroscopy. This is achieved by 'splashing' the doped HNDs onto a surface [3] or by gentle evaporation of the helium matrix due to collisions with helium gas at room temperature [4].
We will demonstrate that the new developed techniques allow the stabilization and investigation of transient molecular ions like SF_6^+ [5] and phenanthrene anions [6,7]. Moreover, a new setup which enables spectroscopic studies of mass-selected, helium-tagged molecular ions, and first test measurements are presented.

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