A versatile ion source for cold ions using superfluid helium nanodroplets

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Superfluid helium nanodroplets (HNDs) can be used as a nano laboratory to study atoms, molecules and clusters at cryogenic temperatures [1]. Recently, it was shown that it is possible to highly charge these HNDs without breaking them [2]. Furthermore, it was shown that these charges efficiently ionize almost every atom or molecule, picked up by the HNDs, acting also as nucleation centers for the formation of small ionic clusters [3,4]. Based on these results we constructed a new experimental setup, which can be used as an intense ion source for both, positively and negatively charged ions.

HNDs are produced by supersonic expansion of precooled (below 10K) and pressurized (about 20 bar) He 6.0 in ultra-high vacuum. These droplets are then ionized by electron bombardment, in a crossed beam electron impact ion source forming highly charged droplets. In the pick-up region, these HNDs can pick up almost any atom or molecule by individual collisions. To liberate the low-mass ions from the HNDs a movable and isolated target is place in the path of the droplets. A splashing like behaviour during the collision with the surface allows the extraction of the majority of the ions embedded in the HNDs. These ions are then guided to a conventional high-resolution time of flight mass spectrometer (QTOF-premier, Waters) with which the resulting cluster size distributions can be analysed. In addition, a quadrupole mass filter allows us to select a specific ion and further investigate it specific properties by additional collisions with atoms or electrons or perform helium tagged action spectroscopy measurements. Furthermore, a high ion yield would allow us also to store these in the double electrostatic ion ring experiment (DESIREE) and perform various experiments.

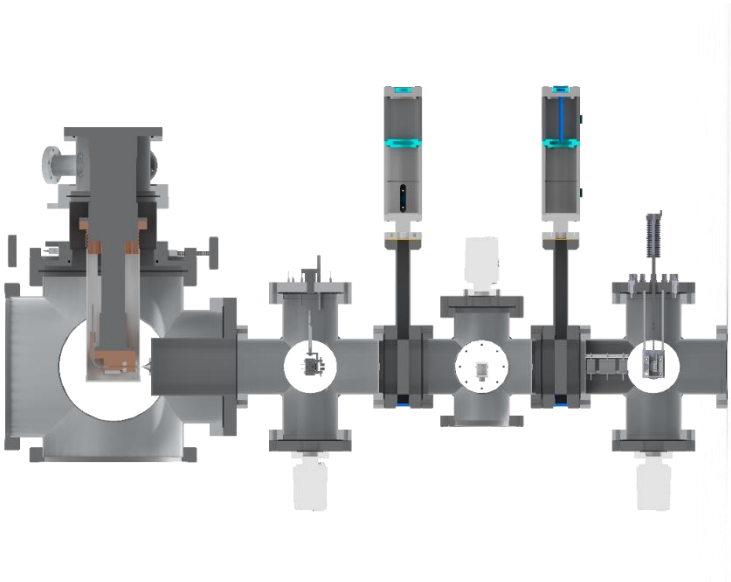

Figure 1 Rendering of the newly developed experimental setup consisting of several differentially pumped sections. Starting from the left with the helium cluster source, which if followed by an electron impact ion source to highly charge the HNDs. The pick-up chamber is used to pick up almost any atom or molecule. On the right a special designed polished stainless-steel target is placed in the path of the HNDs and is used to extract low mass ions from the HNDs and guide them towards the conventional time of flight mass spectrometer (not shown here).

References

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