Probing singly and multiply charged atomic and molecular ion species within helium nanodroplets

Lisa Ganner,[1] Stefan Bergmeister,[1] Florian Foitzik,[1] Ianessa Stromberg,[1] Fabio Zappa,[1] Paul Scheier,[1] **Elisabeth Gruber[1]**

[1]*Institute for Ion Physics and Applied Physics, University of Innsbruck, Austria*

Helium nanodroplets are an exciting and versatile matrix, facilitating the efficient trapping and cooling of dopants from the gaseous phase. These nanodroplets enable the investigation of the spectroscopic properties of cold atoms, molecules, and clusters—both neutral and charged—at temperatures below 1K. Moreover, the unique properties of helium nanodroplets allow for the stabilization and examination of transient and metastable species, typically inaccessible in conventional experimental setups due to their short-lived nature.

In this contribution, we demonstrate that multiply charged helium nanodroplets can be used to efficiently form helium tagged molecular ions, which allows to perform messenger-type spectroscopy. Upon photoabsorption, the loosely bound helium tag is evaporated, and the resulting photofragment is detected using a time-of-flight mass-spectrometer. This method yields a practically background-free signal, ensuring a high signal-to-noise ratio and producing high-quality spectra even for weak absorption lines at reduced data acquisition times [1,2].

Furthermore, we will discuss the capability of multiply charged helium nanodroplets to generate multiply charged dopant ions of low stability. The presence of multiple charge centres within a single helium nanodroplet, located near the surface, makes them accessible to subsequent interaction with metastable helium atoms. This process leads to the post-ionization of singly charged ions and the formation of multiply charged atomic, molecular or cluster ions [3-5]. This novel methodology paves the way for exploring the formation, stability, and spectroscopy of highly charged metastable species.

References:

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Contact Information: Elisabeth Gruber, Institute for Ion Physics and Applied Physics, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria, Email: e.gruber@uibk.ac.at