Inventory of experimental and theoretical resources available for NanoSpace COST Action	
Country:	Austria
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Website:	https://www.uibk.ac.at/ionen-angewandte-physik/nanobio/
Short description **(max 0.5 page)** of available techniques (experiment or theory): If appropriate, please include 1 picture/figure and caption highlighting resources.	See below
Sample/target description (e.g. gas, clusters, solid,…):	We perform gas-phase action-spectroscopy of ions (cations and anions) Targets which we can study: samples in the gas phase or of high vapor pressure; samples of low vapor pressure which can be brought into the gas phase by evaporation (we operate ohmically heated ovens in vacuum which can be heated up to about 1200°C)
How to access to experimental/computational resources (e.g. through collaboration, user facility proposal calls,….):	We developed 2 experimental setups for messenger spectroscopy (He-tagging), which can be used 24/7
References (max 5):	• M. Kuhn et al., *Atomically resolved phase transition of fullerene cations solvated in helium droplets*, Nat. Commun. **7** 13550 (2016) • P. Martini et al., *Splashing of Large Helium Nanodroplets upon Surface Collisions*, Phys. Rev. Lett. **127** 263401 (2021) • M. Meyer et al., *Electronic Spectroscopy of Anthracene Cations and Protonated Anthracene in the Search for Carriers of Diffuse Interstellar Bands*, Astrophys. J. **913** 136 (2021) • M. Kappe et al., *Electronic spectroscopy of heptacene ions in the search for carriers of diffuse interstellar bands*, Astron. and Astrophys. **672** (2023) • S. Bergmeister et al., *Spectroscopy of helium-tagged molecular ions-Development of a novel experimental setup*, under review in Rev. Sci. Instrum. (2023)

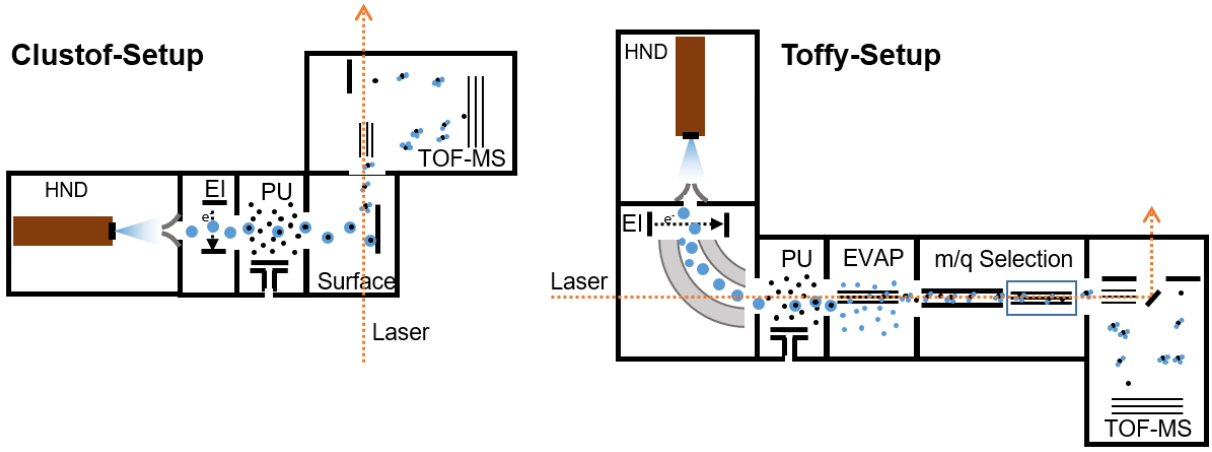
Short description of available techniques

We operate two experimental setups (Clustof and Toffy; see figure) that enable the formation of **He-tagged molecular (cluster) ions (cations as well as anions)**, which are perfectly suitable for **messenger spectroscopy**. In the first step, the sample of interest is embedded in the cryogenic environment of multiply-charged **helium nanodroplets (HNDs)**. HNDs can be used to synthesize molecular complexes as well as to stabilize reactive or metastable species. In the next step, the dopant ions are extracted from the HND matrix via collision with a

surface (Clustof-Setup) or via collisions with He gas at room temperature (Toffy-Setup), delivering He-tagged molecular ions.

In Clustof, these ions are then merged with the laser beam and detected in a time-of-flight mass-spectrometer (TOF-MS). The depletion of the precursor ions after photoabsorption is used to extract the absorption spectrum. In Toffy, the He-tagged ions are first m/q selected in a quadrupole mass filter and then merged with the laser beam. This method allows the detection of photofragments, yielding a much better signal-to-noise ratio compared to the 'depletion' method.

The TOF-MS of both systems are typically operated at a **duty cycle of 10kHz**. Several laser systems are provided by the laser facility of the institute, including several **UV/Vis and IR laser systems** (UV/Vis OPO EKSPLA NT242 (210–2600 nm), UV/Vis OPO EKSPLA NT262-SH-SF (210-2600 nm), IR OPO EKSPLA NT273 XIR (4475–12000 nm), IR OPO EKSPLA NT277 (2500–4475 nm), cw OPO Sirah Matisse TR, narrowband, (680-1020 nm)).



Schematics of the two experimental setups for messenger spectroscopy. The HNDs are first multiply-charged by electron ionization (EI) and then doped with the sample of interest in the pick-up chamber (PU), equipped with a gas inlet system and an ohmically heated oven. The dopant ions are liberated from the He matrix via collisions on a surface (Clustof) or via collisions with He gas at room temperature (Toffy) in the evaporation chamber (EVAP). The extracted ions are irradiated by the laser beam and measured in a time-of-flight mass-spectrometer (TOF-MS). In the Toffy setup, the He-tagged ions are first m/q selected before being merged with the laser beam, yielding a much better signal-to-noise ratio compared to the depletion method.