Photofragmentation of $C_{60}^{+}He_n$

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Recently several laboratories developed new helium tagging techniques to enable action spectroscopy for complex molecular ions [1]. One possibility to tag a molecule with helium is to use helium nanodroplets as a matrix. Even though the intensity of an ion in the mass spectrum with only one He atom attached is lower than in other methods, the high number of attachable helium atoms renders the method as an important alternative.

One molecule of interest for this method is C_{60}, which is subject of extensive research in our working group [2]. Therefore, one of our helium cluster sources was adapted to combine photofragmentation with mass spectrometry. Experimental results obtained by this setup show a remarkable linear absorption redshift of 0.07 nm per added He up to $C_{60}^{+}He_{32}$ (see Figure 2), where all faces of C_{60} are occupied with one He atom (Figure 1). Combined with MD simulations and DFT calculations the results indicate a phase transition from solid to liquid to superfluid for the solvation of C_{60}^{+} in helium. Furthermore, our results confirm that C_{60}^{+} may be the carrier of at least four diffuse interstellar bands as previously reported by John Maiers group [1].

The presently utilized method can be easily applied for various other ionic species such as polycyclic aromatic hydrocarbons or other fullerenes solvated in helium or hydrogen. It also allows fast scans through large frequency ranges searching for unknown resonances of ionic complexes that might be relevant in the interstellar medium.

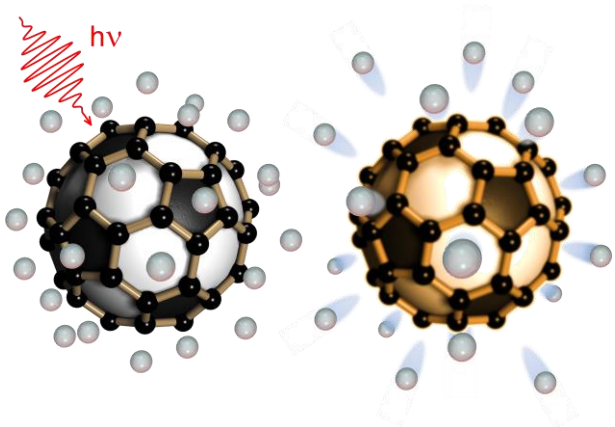

Figure 1. C_{60}^{+} He complex boils of Helium after absorption of an IR photon

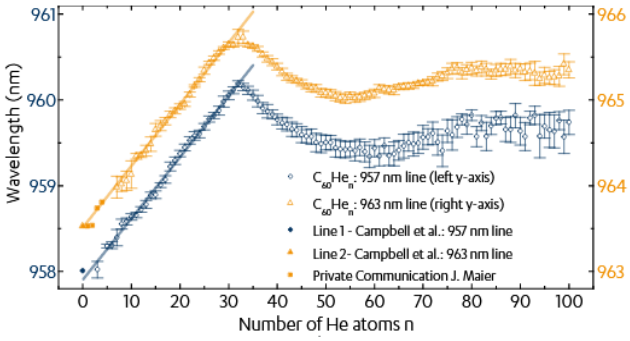

Figure 2. Center positions of the absorption spectra of $C_{60}^{+}He_n$ around 959 and 965nm

References

[1] Campbell *et al. 2015: Laboratory confirmation of C_{60}^{+} as the carrier of two diffuse interstellar bands. Nature 523, p322-323. doi:10.1038/nature14566*
[2] Kuhn *et al. 2016: Atomically resolved phase transition of fullerene cations solvated in helium droplets. Nature Communications 7.* doi:10.1038/ncomms13550

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