

Institutsseminar

Experiments with atoms, molecules and ions in supercritical, liquid and superfluid helium

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The interactions of molecules in fluids determine chemical reactions and biological processes. In the condensed phases of most ordinary liquids, the interactions between the molecules is usually so strong that it overshadows the subtle features of rotations. Liquid helium is an exception. Also, helium exhibits outstanding purity at cryogenic temperatures. It is therefore well-suited for benchmark experiments.

I will present experiments with helium in the liquid and supercritical phases and contrast them with experiments on clusters and droplets of helium in molecular beams. Rotationally resolved fluorescence spectra show that with increasing pressure helium excimers cool within liquid helium, eventually occupying the lowest rotational quantum level only. This observation is important for the probing of 'molecular' superfluidity.¹ Mobility measurements of positive ions in supercritical helium show the nucleation and subsequent growth of clusters with increasing pressure. The pressure dependence of the measured cluster radius reveals exceptionally high compressibility, exceeding that of liquid helium and indicating that the ion clusters are liquid-like. At very high pressures the compressibility falls below that of solid helium, indicating that the clusters solidify.²

¹ L. G. Mendoza-Luna, N. M. K. Shiltagh, M. J. Watkins, N. Bonifaci, F. Aitken, and K. von Haeften, J. Phys. Chem. Lett. 2016, 7, 4666.

² H. Gharbi Tarchouna, N. Bonifaci, F. Aitken, L. G. Mendoza-Luna, and K. von Haeften, J. Phys. Chem. Lett. 2015, 6, 3036.