PAUL SCHERRER INSTITUT

PHOTON SCIENCE - SEMINAR

Research Opportunities Provided by Superfluid Droplets of Helium

J. Peter Toennies

Max Plank-Institute for Dynamics and Self-Organization,
Göttingen, Germany

DATE:	Tuesday, 19 March 2019
COFFEE:	11:00 h
SEMINAR:	11:15 h
PLACE:	WBGB/019

Abstract

Helium is an element of many superlatives. It is, on the one hand, the smallest and most inert of all atoms and, on the other, the second most abundant element (after hydrogen) in the universe. The bosonic nature, small mass and weak intermolecular forces explain why it is the only substance that remains liquid down to zero Kelvin and the only naturally occurring superfluid.

Droplets with $10 - 10^{12}$ are also readily produced in cryogenic free jet expansions and have been characterized via the spectroscopy of embedded closed-shell *heliophilic* molecules. In the infra-red small molecules (e.g. OCS, SF_6) have extraordinary sharp rotational lines indicating that the molecules rotate freely inside the droplets. This made it possible to determine their temperature which is only 0.37 K (~ 0.1 K in ^{3}He). Several subsequent experiments confirm that the droplets show many of the hallmarks of bulk superfluidity. These experiments have established that finite-sized ^{4}He droplets are superfluid making them the coldest and gentlest of all matrices for spectroscopic studies [1].

Present day experiments are directed at extending the spectroscopies to large organic and biomolecules[2], to exploring the unique structures of clusters self-organised in the interior of droplets. The recent demonstration of laser alignment in the cold droplets and femto-second pulse-probe experiments open up new avenues for dynamical studies [3]. The first successful electron diffraction experiments on single embedded molecules and X-ray diffraction experiments carried out at SLAC on *individual* pure and doped droplets [4] point the way towards many new exciting areas of research in physics, chemical physics and chemistry.

References

[1] J. P. Toennies and A. F. Vilesov, Angew. Chem. Int. Edit. 43, 2622 (2004). [2] A.I.Gonzales Florez et al. Angew. Chem. Int. Ed. 55,3295 (2016). [3] D. Pentlehner et al. Phys. Rev. Lett. 110, 093002 (2013). [4] L. F. Gomez et al. Science 345,906 (2014).

Contact: Yasin Ekinci (2824)