CFEL SCIENCE

SEMINAR

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CFEL – Building 99, seminar room I+II (ground floor)

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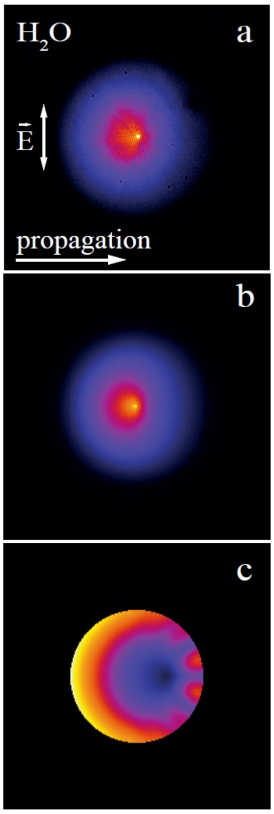
Optical cavity resonances in photoelectron imaging and photokinetics of submicron droplets



My talk addresses two fundamental processes in submicron aerosol droplets: The transport of hydrated electrons in water droplets and the size-dependent photokinetics in single optically trapped nanodroplets. For both topics, we exploit the information contained in optical cavity resonances.

The electron mean free path is the important quantity to describe electron transport in condensed matter. We use photoelectron imaging and VUV ionization to extract detailed mean free path values for slow electrons in water with kinetics energies in the region of hydrated electrons [1] (Fig. 1). This data is important for the description of slow electron damage in biological tissues and for chemical processes with solvated electrons in atmospheric water droplets.

Much of the chemistry happening in planetary atmospheres is driven by sunlight. Photochemical reactions in small aerosol droplets play a special role in this context. Sunlight is strongly focused inside these droplets which leads to a natural increase in the rates of photochemical reactions in small particles compared with the bulk. This ubiquitous phenomenon has been recognised but so far escaped direct observation and quantification. We have developed a single-droplet photoacoustics experiment, which has finally made it possible to directly observe size-dependent effects in droplet photokinetics [2].

If time allows, I will briefly present recent results on the nonmetal-to-metal transition in Na-ammonia nanodroplets probed by photoelectron imaging [3] and a new mass spectrometric experiment to study neutral gas phase nucleation at the molecular level [4].

Fig. 1:
a) Experimental photoelectron image of a 100 nm water droplet.
b) Corresponding simulated photoelectron images.
c) Calculated light intensity inside the 100 nm water droplet.

[1] R. Signorell, M. Goldmann, B.L. Yoder, A. Bodi, E. Chasovskikh, L. Lang, and D. Luckhaus „Nanofocusing, shadowing, and electron mean free path in the photoemission from aerosol droplets", Chem. Phys. Lett., Frontiers Article, (2016).
[2] J.W. Cremer, K.M. Thaler, C. Haisch, R. Signorell „Photoacoustics of single laser-trapped nanodroplets for the direct observation of nanofocusing in aerosol photokinectics" Nat. Commun., 7, 10941 (2016).
[3] S. Hartweg, A.H.C. West, B.L. Yoder, and R. Signorell„Metal Transition in Sodium-Ammonia Nanodroplets" Angew. Chem. Int. Ed. In press (2016).
[4] J.J. Ferreiro, S. Chakrabarty, B. Schlaeppi, and R. Signorell „Observation of propane cluster size distributions during nucleation and growth in a Laval expansion" J. Chem. Phys., 145, 211907 (2016).

Host: Jochen Küpper/ CFEL Molecular Physics Seminar