Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
Laboratorium für Physikalische Chemie

Einladung zu einem Kolloquium

Hörsaal HCI J 3
ETH Zürich, Hönggerberg

Datum/Zeit: **Dienstag, 23. Mai 2017, 16.45 Uhr**

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Thema: **High-resolution spectroscopy of Zeeman decelerated cold metastable He_2 molecules**

Translationally cold samples of molecules offer interesting perspectives for high-resolution spectroscopy. The long measurement times that are possible with such samples and the reduced Doppler widths are ideally suited for precision measurements of transition frequencies in molecules, and such measurements are beginning to be relevant in the context of tests of the standard model of particle physics and some of its extensions [1]. In particular, precision measurements in light few-electron molecules such as $H_2^{(+)}$ and $He_2^{(+)}$ are used as tests of *ab initio* quantum-chemical calculations which aim at an exact solution of the Schrödinger equation and a rigorous determination of relativistic and quantum-electrodynamics (QED) corrections.

In this talk, I will present the results of recent spectroscopic experiments on cold samples of metastable He_2 molecules in which we record transitions from the $a\ ^3\Sigma_u^+$ state to high Rydberg states belonging to series converging on the rovibrational levels of He_2^+. Extrapolation of the He_2 Rydberg series converging on different rovibrational states of the He_2^+ ion using a multichannel-quantum-defect-theory model [2] enabled the determination of the energy-level structure of He_2^+ with unprecedented accuracy [3,4]. A comparison of the experimentally obtained term values with the most recent *ab initio* calculations revealed a discrepancy that increases with the rotational quantum number N^+ of the ion core [5].

In our experiments, we generate cold metastable He_2* molecules in a supersonic beam by striking a discharge near the orifice of a pulsed valve and exploit the magnetic dipole moment of the metastable helium molecules to slow down the beam velocity with pulsed inhomogeneous magnetic fields [6,7]. The advantage of using Zeeman deceleration does not only result from the longer transit times of the decelerated molecules through the radiation field and the reduction of residual Doppler shifts, but also from the spin-rotational state selectivity of the deceleration process. This quantum-state selectivity facilitated spectral assignments and was used to generate fully magnetized samples of He_2 for studies of the fine structure of metastable He_2 in a molecular-beam magnetic-resonance-type measurement. The latter experiment was combined with high-resolution continuous-wave measurements of np Rydberg states of He_2 to obtain – for the first time – the spin-rotational structure of He_2^+.

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