SPECIAL SEMINAR/SONDERSEMINAR
MPQ/LMU

Date/Time:	**Tuesday, November 22, 2016** **10:00 a.m**
Speaker:	**Dr. Dietrich L E I B F R I E D**
Affiliation:	**National Institute of Standards & Technology/NIST,** **Boulder CO 80305, USA**
Presentation Title:	**Preparation and Coherent Manipulation** **of Pure Quantum States of a Single Molecular Ion**
Location:	**Chair Professor Theodor W. Hänsch** **Schellingstr. 4/3rd Floor,** **Discussion Room H 311, D-80799 München**
Chair:	**Professor Theodor W. Hänsch**

ABSTRACT

An amazing level of control is routinely reached in modern experiments with atoms, but similar control over molecules has been an elusive goal. We recently proposed a method based on quantum logic spectroscopy [1] to address this problem for a wide class of molecular ions [2]. We have now realized the basic elements of this proposal.

In our demonstration, we trap a calcium ion together with a calcium hydride ion (CaH^+) that is a convenient stand-in for more general molecular ions. We cool the two-ion crystal to its motional ground state and then drive the motional sidebands of Raman transitions in the molecular ion. A transition of the molecule is indicated by a single quantum of excitation in the secular motion of the crystal. We can efficiently detect this single quantum with the calcium ion to project the molecule into the final state of the attempted sideband transition, leaving the molecule in a known, pure quantum state.

The molecule can be coherently manipulated after the projection, and its final state read out by another quantum logic state detection. We demonstrate this by driving Rabi oscillations between rotational states. A single, far off-resonant continuous-wave laser drives all Raman transitions in the molecule. This makes our approach applicable to control and precision measurement of a vast class of molecular ions.

[1] P.O. Schmidt, et al. Science **309**, 749 (2005)
[2] D. Leibfried, New J. Phys. **14**, 023029 (2012)