# Q 62: Cold Molecules III

Time: Friday 10:30–12:00 Location: V38.03

**Invited Talk** Q 62.1 Fri 10:30 V38.03

**A homonuclear polar molecule** — •Hossein Sadeghpour — ITAMP- harvard-smithsonian center for astrophysics, cambridge, ma 02138

Manipulating Rydberg interactions in ultracold ensemble is currently in vogue due to the long-range nature of forces and large dipole moments. Interactions between ultracold Rydberg and ground state atoms lead for formation of exotic classes of Rydberg molecules with peculiar properties. A particular class of such molecules was recently observed in Stuttgart and was found to sport significant permanent electric dipole moment, even though that the molecules themselves were homonuclear. In this presentation, I will describe the physics of the formation of permanent dipole moments in homonuclear species, arising from symmetry breaking. The work has appeared in Science Vol. 334 no. pp. 1110-1114, 2011, in collaboration with MPIPKS and Univ. of Stuttgart.

Q 62.2 Fri 11:00 V38.03

**Non-local state-swapping of polar molecules in bilayers** — •A. Pikovski[1], M. Klawunn[2], A. Recati[2], and L. Santos[1] — [1]Institut f. Theoretische Physik, Leibniz Universität Hannover, Appelstr. 2, 30169, Hannover, Germany — [2]INO-CNR BEC Center and Dipartimento di Fisica, Universita di Trento, 38123 Povo, Italy

The observation of significant dipolar effects in gases of ultra-cold polar molecules typically demands a strong external electric field to polarize the molecules. We show that even in the absence of a strong polarization, dipolar effects may play a crucial role in the physics of polar molecules in bilayers, provided that the molecules in each layer are initially prepared in a different rotational state. Collisions due to dipolar interactions result in an exchange of the rotational state between molecules in different layers, even for weak applied electric fields. This swapping rate has a non-trivial dependence on density, temperature, inter-layer spacing, and population imbalance. For reactive molecules such as KRb, chemical recombination immediately follows a non-local swap and dominates the losses even for temperatures well above quantum degeneracy, and hence could be observed under current experimental conditions. [ arXiv:1108.5642 ]

Q 62.3 Fri 11:15 V38.03

**Vibrational excitation of polar molecules trapped on a chip** — •Silvio Marx, Mark Abel, Gabriele Santambrogio, and Gerard Meijer — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Over the last decade Stark decelerators have proven to be an important tool for the manipulation of external degrees of freedom of neutral polar molecules. In addition, the simultaneous manipulation of internal degrees of freedom like vibrational quantum states of neutral polar molecules is necessary to gain full control over molecular motion. Here, CO molecules are trapped over the surface of a microchip and then vibrationally excited using a narrow band infrared laser. Combined with time of flight measurements, excitation of trapped molecules allows the study of quantum-state-dependent trap strength. The ability to optically address trapped molecules shows the versatility of the chip decelerator approach. It is anticipated that future chip-based experiments, for example on chemical reactions, will greatly benefit from the ability to probe the product final state.

Q 62.4 Fri 11:30 V38.03

**Depletion Stark Spectroscopy of Cold Polar Molecules in a Homogeneous Field Electric Trap** — •Rosa Glöckner, Barbara G.U. Englert, Martin Zeppenfeld, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

Cold molecules are expected to substantially increase the resolution in high-precision molecular spectroscopy with applications ranging from tests of quantum electrodynamics to the search for an electron electric dipole moment. For many applications, long interrogation times are essential which suggests trapping of cold polar molecules. However, broadening due to the trapping fields seems to contradict the desire to observe narrow spectral features.

Here, we present depletion spectroscopy in a novel microstructured electric trap which exhibits tunable homogeneous fields over a large fraction of the trap volume [1]. Using either infrared or mm-wave radiation allows depletion of individual rotational states with a Stark broadening of only a few percent of the trap depth, much less than the molecular temperature. A 1/e storage time of over 10 s in the trap provides for long interrogation times enabling spectroscopy of weak transitions. Future improvements will allow spectroscopy with kHz resolution establishing our experiment as a novel platform for precision spectroscopy.

[1] B.G.U. Englert *et al.*, Phys. Rev. Lett, in press (arXiv:1107.2821).

Q 62.5 Fri 11:45 V38.03

**Using cold molecules to detect molecular parity violation** — •Joost van den Berg, Klaus Jungmann, Corine Meinema, Aernout van der Poel, and Steven Hoekstra — KVI, University of Groningen, The Netherlands

We combine novel experimental techniques to decelerate and cool heavy diatomic molecules, in order to detect and study molecular parity violation. Parity violation has so far never been observed in molecules. Parity-violating effects, originating from the weak interaction, are most pronounced in heavy molecules, and most accurately measured in cold samples of trapped molecules. Stark-deceleration and trapping of heavy molecules is more demanding compared to light molecules such as NH and OH. Using recent advances in Starkdeceleration we set out to decelerate and trap heavy alkaline-earth halide molecules. Initially we focus on the SrF molecule. We are currently working on a supersonic beam of SrF molecules, constructing a Starkdecelerator based on ring electrodes, and exploring the opportunities for molecular lasercooling. Possibilities to use RaF molecules are also being investigated. A new generation of precision measurements to probe fundamental interactions and symmetries is possible once such samples of sufficiently cold molecules are available.