MO 22: Poster – Cold Molecules (joint session MO/Q)

Time: Wednesday 17:00–19:00 Location: Philo 1. OG

MO 22.1 Wed 17:00 Philo 1. OG

Progress on Zeeman slowing CaF — •Julius Niederstucke, Timo Poll, Paul Kaebert, Sebastian Anskeit, Mirco Sierke, and Silke Ospelkaus — Leibniz Uni Hannover

Significant advancements have recently been achieved in direct laser cooling of molecules, bringing them to temperatures near absolute zero [1, 2]. However, the number of molecules that can be captured from molecular beams using conventional laser cooling methods remains a limiting factor in such experiments [3, 4]. In this work, we present strategies to enhance the yield of molecules in such experiments. To this end, we present our experimental findings on the Zeeman slower developed for directly laser-coolable molecules, as proposed by our group [5], and outline the initial steps towards creating a sub-Doppler engineered red magneto-optical trap [6,7]. [1] J. F. Barry et al. 2012 [2] Y. Wu et al. 2021 [3] S. Truppe et al. 2017 [4] L. Anderegg et al. 2017 [5] M. Petzold et al. 2018 [6] S. Xu et al. 2021 [7] S. Xu et al. 2022

MO 22.2 Wed 17:00 Philo 1. OG

Towards laser cooling of NH radical — •Ashish Mahangare, Daniel Roesch, and Edvardas Narevicius — TU Dortmund, Germany

Ultra-cold molecules open up a wide variety of applications like quantum control, ultra-cold chemical dynamics, quantum information, tests of fundamental constants and precision measurements. Laser cooling has been applied for a few diatomic molecules such as SrF, CaF and YO, YbF, AlF, BaF and a poly-atomic molecule CaOH.

Our goal is to laser cool ^{15}NH. The main transition of interest for laser cooling is $(X^3\Sigma^-)(v" = 0, N" = 1, J" = 1)$ to $A^3\Pi(v' = 0, N' = 1, J' = 0)$ at 336 nm. The excited state of this cooling transition has a lifetime of around 400 ns. This electronic transition is rotationally closed and has highly diagonal FCFs.

We performed laser-induced fluorescence (LIF) to study the hyperfine structure of laser cooling transition. I will also present Terahertz rotational spectroscopy to pump molecules from N = 0 to N =1 state. Terahertz spectroscopy is also performed to get highly precise hyperfine splitting in N = 0 and N = 1 rotational states for $X^3\Sigma^-$.

MO 22.3 Wed 17:00 Philo 1. OG

Collisions in a quantum gas of bosonic ^{23}Na^{39}K molecules — •Fritz von Gierke[1], Mara Meyer zum Alten Borgloh[1], Jule Heier[1], Philipp Gersema[1], Kai Konrad Voges[2], Baraa Shammout[1], Eberhard Tiemann[1], Leon Karpa[1], and Silke Ospelkaus[1] — [1]Institut für Quantenoptik, Leibniz Universität Hannover — [2]Centre for Cold Matter, Blackett Laboratory, Imperial College London

We present our latest experimental results on ultracold NaK quantum gases, focusing on atom-molecule and molecule-molecule collisions. In particular, we report recent advances in the electric field control of atom-molecule Feshbach resonances and shielding of collisions with implications for future quantum simulations and many-body physics.

MO 22.4 Wed 17:00 Philo 1. OG

Crystal-to-droplet melting in ultracold polar molecules — •William Freitas, Panagiotis Giannakeas, and Jan M Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Microwave-shielded polar molecules provide a novel platform for exploring dipolar matter in the strongly correlated regime, where dipole-dipole interactions naturally confine molecular ensembles to quasi-two-dimensional geometries. The competition between the long-range antidipolar attraction and the anisotropic short-range repulsion leads to a rich variety of phases, ranging from quantum droplets to crystalline structures.

In this work, we investigate the transition between the crystal and droplet phases, focusing specifically on the melting of crystalline order for finite systems. For systems of up to N = 40 molecules, we observe that the system develops droplet-ring configurations as an intermediate state between the droplet and crystal phases, characterized by a superfluid fraction below unity. Moreover, we show that the droplet-ring state retains six-fold symmetry, a fingerprint of the underlying crystal structure, as demonstrated by the pair-correlation function and structure factor.

Our simulations employ the Variational Monte Carlo method with a neural-network quantum state as the trial wave function. This approach provides a highly flexible functional form and enables stable energy minimization, yielding an accurate description of the ground state and an efficient treatment of strongly correlated finite systems.

MO 22.5 Wed 17:00 Philo 1. OG

Towards laser cooling of NH radical — •Ashish Mahangare, Daniel Roesch, and Edvardas Narevicius — TU Dortmund, Germany

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