A 11: Ultra-cold plasmas and Rydberg systems (joint session A/Q)

Time: Tuesday 16:30–18:30 Location: P

A 11.1 Tue 16:30 P

Probing Ion-Rydberg hybrid systems using a high-resolution pulsed ion microscope — •Viraatt Anasuri, Nicolas Zuber, Moritz Berngruber, Yiquan Zou, Florian Meinert, Robert Löw, and Tilman Pfau — 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Stuttgart, Germany

Here, we present our recent studies on Rydberg atom-Ion interactions and the spatial imaging of a novel type of molecular ion using a high-resolution ion microscope. The ion microscope provides an exceptional spatial and temporal resolution on a single atom level, where a highly tuneable magnification ranging from 200 to over 1500, a resolution better than 200nm and a depth of field of more than 70*m were demonstrated. A pulsed operation mode of the microscope combined with the excellent electric field compensation enables the study of highly excited Rydberg atoms and ion-Rydberg atom hybrid systems. Using the ion microscope, we observed a novel molecular ion, where the bonding mechanism is based on the interaction between the ionic charge and an induced flipping dipole of a Rydberg atom [1]. Furthermore, we could measure the vibrational spectrum and spatially resolve the bond length and the angular alignment of the molecule. The excellent time resolution of the microscope enables probing of the interaction dynamics between the Rydberg atom and the ion. [1] N. Zuber, V. S. V. Anasuri, M. Berngruber, Y.-Q. Zou, F. Meinert, R. Löw, T. Pfau, Spatial imaging of a novel type of molecular ions, arXiv preprint arXiv:2111.02680 (2021).

A 11.2 Tue 16:30 P

Creating spin spirals with tunable wavelength in a disordered Heisenberg spin system — •Eduard Jürgen Braun[1], Titus Franz[1], Lorenz Luger[1], Maximilian Müllenbach[1], André Salzinger[1], Sebastian Geier[1], Clément Hainaut[2], Gerhard Zürn[1], and Matthias Weimüller[1] — [1]Physikalisches Instut, Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany — [2]Université de Lille, CNRS, UMR 8523, France - PhLAM - Physique des Lasers, Atomes et Molécules

We present a novel method to create a spin spiral in a Heisenberg spin system composed of Rydberg atoms. We have designed a protocol that allows to create a spin spiral of a fixed wavevector q for an interacting spin system composed of two different angular momentum Rydberg states of Rubidium. By creating a constant electric gradient field around a fixed offset electric field one can achieve a linear detuning between the two Rydberg levels as function of position. As a consequence, after applying a $\frac{\pi}{2}$-pulse the wavelength can be tuned by the duration for which the gradient field is applied. We investigate numerically how the disorder in our system and the interaction can disturb the spiralization as well as how fast the electric fields can be ramped in order to still adiabatically follow the Rydberg states in the Stark map. The subsequent relaxation dynamics of the spirals for varying wavefector q gives insight into the mode of transport in the Heisenberg spin system. First numerical simulations with few atoms in 1D suggest that we might find a localized regime for sufficiently strong disorder in the system.

A 11.3 Tue 16:30 P

Towards an optogalvanic flux sensor for nitric oxide based on Rydberg excitations — •Fabian Munkes[1,5], Patrick Kaspar[1,5], Yannick Schellander[2,5], Lars Baumgärtner[3,5], Philipp Neufeld[1,5], Lea Ebel[1,5], Jens Anders[3,5], Edward Grant[4], Robert Löw[1,5], Tilman Pfau[1,5], and Harald Kübler[1,5] — [1]5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart — [2]Institut für Intelligente Sensorik und Theoretische Elektrotechnik, Universität Stuttgart, Pfaffenwaldring 47, 70569 Stuttgart — [3]Institut für Großflächige Mikroelektronik, Universität Stuttgart, Allmandring 3b, 70569 Stuttgart — [4]Department of Chemistry, The University of British Columbia, 2036 Main Mall, Vancouver, BC Canada V6T 1Z1 — [5]Center for Integrated Quantum Science and Technology, Universität Stuttgart

We demonstrate the applicability of a new kind of gas sensor based on Rydberg excitations. From a gas mixture the molecule in question is excited to a Rydberg state. By succeeding collisions with all other gas components this molecule becomes ionized and the emerging electrons can be measured as a current. We investigate the excitation efficiency dependent on the used laser powers, the applied charge-extraction voltage as well as the overall gas pressure.

A 11.4 Tue 16:30 P

Self-organization of facilitated Rydberg excitations — •Jana Bender, Patrick Mischke, Tanita Klas, Thomas Niederprüm, and Herwig Ott — Department of Physics and research center OPTIMAS, Technische Universität Kaiserslautern, Germany

We investigate the facilitation dynamics in a Rydberg system and the expected phase transition resulting from the interplay between driving strength and excitation decay.

In an off-resonantly driven cloud of atoms, the strong dipole-dipole interactions between two Rydberg states will compensate the laser detuning for a specific interatomic distance. For high enough driving strength, this results in a spreading of correlated excitations. We investigate the predicted non-equilibrium steady state phase transition between this active phase and the absorbing phase in which the spread of excitations is suppressed. The influence of disorder in our system might introduce additional, more complex phases dominated by excitation avalanches. Due to a loss of excited atoms, the system self-organizes from the acive phase towards the phase transition.

Our results show a persistant algebraic distribution of excitation cluster sizes independent of starting parameters when the system approaches the phase transition. We observe varying exponents which hint towards the influence of disorder in our system.