Invited speaker

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Rydberg Atom – Light Interfaces

Abstract

Interfacing light and matter at the quantum level is at the heart of modern atomic and optical physics and enables new quantum technologies involving the manipulation of single photons and atoms. A prototypical atom-light interface is electromagnetically induced transparency, in which quantum interference gives rise to hybrid states of photons and atoms called dark-state polaritons.

Rydberg gases represent an ideal system to explore the interplay between coherent light excitation and dipolar interatomic interactions [1,2]. We have observed individual dark-state polaritons as they propagate through an ultracold atomic gas involving Rydberg states [3]. To further explore the dynamics of the dark-state polaritons, we have implemented a new all-optical method to in-situ image Rydberg atoms embedded in dense atomic gases [4]. Using this novel technique we show single shot images of small numbers of Rydberg atoms, allowing one to study the dynamics of strongly correlated many-body states as well as transport phenomena in Rydberg aggregates. We observe the migration of Rydberg electronic excitations, driven by quantum-state changing interactions similar to Forster processes found in complex molecules and light-harvesting complexes [5]. The many-body dynamics of the energy transport can be influenced by an dissipative environment consisting of atoms in different Rydberg states [6].

Work done in collaboration with Vladislav Gavryusev, Miguel Ferreira Cao, Adrien Signoles, Georg Günter, Stephan Helmrich, Christoph S. Hofmann, Martin Robert-de-Saint-Vincent, Hanna Schempp, Shannon Whitlock (Physics Institute, University of Heidelberg), Martin Gärttner, Jörg Evers (MPI für Kernphysik, Heidelberg).

References

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About the Author

Matthias Weidemüller is Chair Professor for Experimental Physics at the University of Heidelberg and Director of the Heidelberg Center for Quantum Dynamics. He currently also serves as the Dean of the Department for Physics and Astronomy. After having studied physics, philosophy and history in Bonn and Munich, he worked with Serge Haroche at Ecole Normale Supérieure in Paris and, under the supervision of Theodor W. Hänsch, at the Max-Planck Institute for Quantum Optics in Garching. In 1995, he received his PhD from the University of Munich. As a EU Marie-Curie fellow he then went to the University of Amsterdam and the FOM-Institute for Atomic and Molecular Physics for two years. He held a position as independent junior group leader of the "Laser Cooling" group at the Max-Planck Institute for Nuclear Physics, Heidelberg, before being appointed as Chair Professor for Experimental Physics in Freiburg in 2003, where he stayed until 2008 when he became appointed at the University of Heidelberg. Since 2013 he is also setting up a laboratory in Shanghai as professor at the University of Science and Technology of China in the framework of the 1000Talent-Plan of the Chinese Government. His group investigates interactions in atomic and molecular quantum aggregates on different levels of complexity, using modern methods of quantum control and quantum engineering.