SPP 1929 – Seminar

16. Januar 2018, 14:30 Uhr

Max-Planck-Institut für Quantenoptik
New Lecture Hall, Room B 0.32
Hans-Kopfermann-Str. 1, 85748 Garching

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Experimental many-body physics using arrays of individual Rydberg atoms

This talk will present our on-going effort to control the dipole-dipole interaction between cold Rydberg atoms in order to implement spin Hamiltonians that may be useful for quantum simulation of condensed matter problems.

In our experiment, we trap individual atoms in two-dimensional arrays of optical tweezers, [Nogrette, Phys. Rev. X 4, 021034 (2014)] separated by few micrometers and excite them to Rydberg states using lasers. The arrays are produced by a spatial light modulator, which shapes the dipole trap beam. We can create almost arbitrary, two-dimensional geometries of the arrays with near unit filling [Barredo, Science 354, 1021 (2016)].

The talk will present our demonstration of the coherent energy exchange in small chains of Rydberg atoms resulting from their dipole-dipole interaction [Barredo, Phys. Rev. Lett. 114, 113002 (2015)]. This exchange can be controlled by addressable lasers [de Léséleuc, arXiv:1705.03293]. This interaction realizes the XY spin model. We have also implemented the quantum Ising model [Labuhn, Nature 534, 667 (2016)]. The spin ½ Hamiltonian is mapped onto a system of Rydberg atoms excited by lasers and interacting by the van der Waals Rydberg interaction. We study various configurations such as one-dimensional chains of atoms with periodic boundary conditions, rings, or two-dimensional arrays containing up to 49 atoms. We measure the dynamics of the excitation for various strengths of the interactions between atoms. We compare the data with numerical simulations of this many-body system and found excellent agreement.

This good control of an ensemble of interacting Rydberg atoms thus demonstrates a new promising platform for quantum simulation using neutral atoms, which is complementary to the other platforms based on ions, magnetic atoms or dipolar molecules.

A live stream of the talk will be available on the following website:
https://post.rzg.mpg.de/mailman/listinfo/mpq-colloquium-stream
Prior registration on the website is required.