Engineering spin Hamiltonians with 2D arrays of single Rydberg atoms

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Cold Rydberg atoms are a promising scalable platform for the quantum simulation of spin models that describe a large variety of quantum many-body phenomena in condensed matter physics.

We will present the latest results of our experiment, where we exploit van der Waals [1] and dipole-dipole interactions [2,3] between single Rydberg atoms in fully configurable 2D arrays to engineer different type of spin Hamiltonians. As proof-of-principle experiments we study the coherent dynamics of spin excitations in systems of three Rydberg atoms. We show that their dynamics are accurately described by parameter-free theoretical models and we analyze the role of the small remaining experimental imperfections [1,3]. In larger arrays of a few tens of spins (Fig. 1), either fully ordered or disordered, we measure the coherent evolution of the particles interacting under an Ising-type Hamiltonian after a quantum quench.

Our results open exciting possibilities in quantum magnetism to study, for example, the role of disorder and the emergence of geometry-induced frustration in such systems.

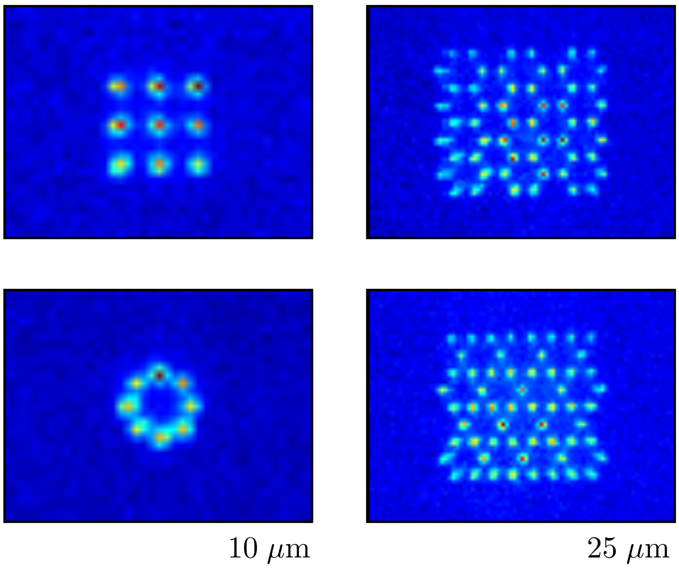

Figure 1: *Fluorescence images of single atoms trapped in microtrap arrays with different geometries [4].*

References

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