Laboratoire Matériaux et Phénomènes Quantiques
Séminaire Général

Many-body physics with arrays of individual Rydberg atoms

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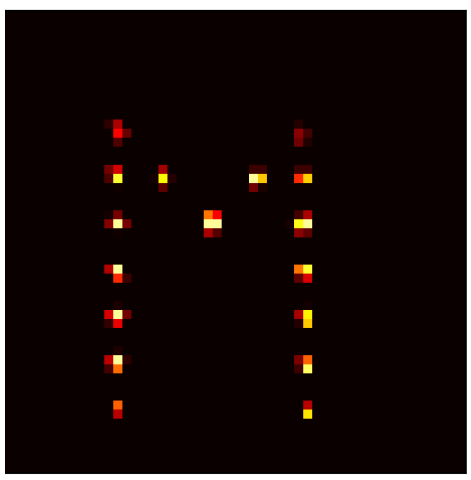
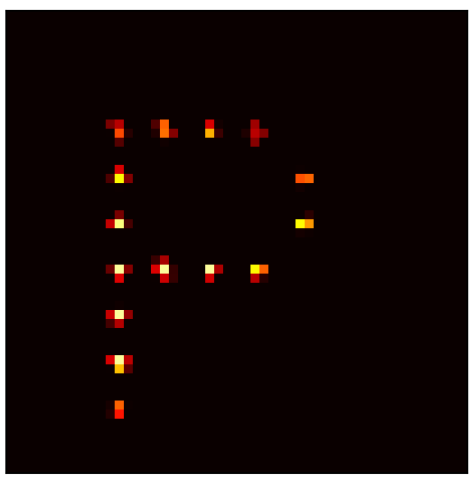
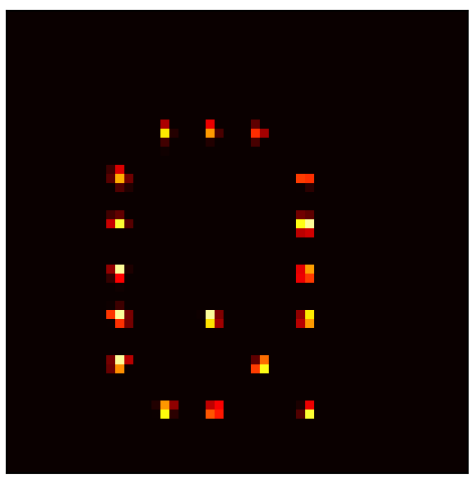
This talk will present our effort to use the dipole-dipole interactions between cold Rydberg atoms to study artificial interacting quantum system. In our experiment, we trap individual atoms in arrays of optical tweezers separated by few micrometers. The arrays are produced by a spatial light modulator, which shapes the dipole trap beam. We can create almost arbitrary geometries of the arrays with near unit filling in two and three dimensions up to about 70 atoms.

Using the van der Waals interaction between atoms, we implement the quantum Ising model in one-dimensional chains with periodic boundary conditions and two-dimensional arrays containing up to about 50 atoms. We measure the dynamics of the excitation for various strengths of the interactions and compare the data to numerical simulations of this many-body system. We also demonstrate the coherent energy exchange in chains of Rydberg atoms resulting from their resonant dipole-dipole interaction. We use it to study elementary excitations in a di-merized spin chain featuring topological properties, thus implementing the Su-Schrieffer-Heeger model. We observe the edge states in the topological condition. We explore the regime beyond the linear response by adding several excitations, which act as hard-core bosons and demonstrate a symmetry protected topological phase.

This control of an ensemble of interacting Rydberg atoms demonstrates an interesting platform for quantum simulation using neutral atoms, complementary to the other platforms based on ions, magnetic atoms or dipolar molecules.

Fluorescence images of individual atoms trapped in arrays of optical tweezers separated by a few micrometers

Resp. séminaires : Alexandre LE BOITÉ & Damien ALLOYEAU