The 884th IMS colloquium

Implementation of the quantum Ising model in large arrays of individual Rydberg atoms

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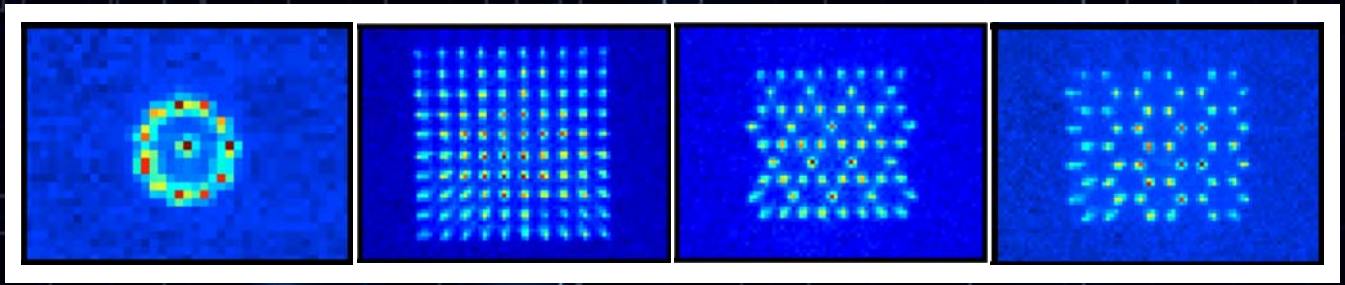
Date&Time: 2016/3/1 (Tue.) 16:00-
Place: IMS Research Building Room 201

This talk will present our on-going effort to control the dipole-dipole interaction between cold Rydberg atoms. 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 geometries of the arrays. The talk will present our measurement of the van der Waals interaction between two individual atoms [Béguin, Phys. Rev. Lett. 110, 263201 (2013)], as well as the demonstration of the coherent energy exchange between two atoms resulting from their dipole-dipole interaction [Barredo, Phys. Rev. Lett. 114, 113002 (2015)].

Recently, we have implemented the quantum Ising model in our system [Labuhn, arXiv:1509.04543]. 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 30 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 for some of the configurations. This good control of an ensemble of interacting Rydberg atoms thus demonstrates a new promising platform for quantum simulation using neutral atoms.



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Shigeyuki Masaoka & Ryota Iino (IMS colloquium FY2015 committee)