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# Rydberg atoms of Ytterbium

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Physical properties of Rydberg atoms pave the way to experimental control of the quantum state of mesoscopic ensemble of particles. Interactions between Rydberg atoms are large for interparticle distances in the micrometer range. They can be used to induce Rydberg blockade and generate entanglement between two[1,2] or even larger ensemble [3] of atoms. Nevertheless, Rydberg atoms lack some of the resources used with ground state atoms, especially optical techniques such as imaging and optical dipole traps.

In this poster I will describe the experimental scheme under development and present the status of the experiment. Ytterbium atoms have two valence electrons which should allow applying optical manipulation on the Rydberg states. The idea is first to promote one electron to a long lived Rydberg state. The system can then be approximated as a free electron orbiting around an ionic core. The latter has still a valence electron that can be used for optical manipulation (i.e. imaging or trapping).

We are currently able to have Ytterbium atoms held inside a magneto-optical trap on the intercombinaison transition between 1S0 and 3P1 around 556nm. We performed the spectroscopy of the ns and nd Rydberg states from n=35 to n=80, increasing by two orders of magnitude the precision of their energy levels. By means of a Multi-Channel Quantum Defect Theory (MQDT) analysis we are able to fit the levels and deduce a new value of the ionisation energy. The next step will be to complete the spectroscopy of the Rydberg levels (with p and f series), enabling us to compute the Stark map.

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[2] Gaëtan, A., Miroshnychenko, Y., Wilk, T., Chotia, A., Viteau, M., Comparat, D., ... & Grangier, P. (2009). Observation of collective excitation of two individual atoms in the Rydberg blockade regime. Nature Physics, 5(2), 115-118.

[3] Peter Schauß, Johannes Zeiher, Takeshi Fukuhara, Sebastian Hild, Marc Cheneau, Tommaso Macrì, Thomas Pohl, Immanuel Bloch, and Christian Gross. Dynamical crystallization in a low-dimensional rydberg gas. Science 347, 1455 (2015)

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