Master thesis proposal

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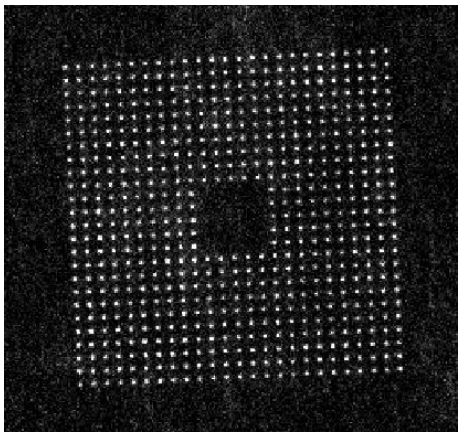
Experimental study of the Ising and XY models in large Rydberg atom arrays

Keywords: Quantum simulation, Rydberg arrays, spin models



Over the last 15 years, our group has been one of the pioneers in the **use of atom tweezers arrays for studying quantum many-body physics**. The atoms are held in optical tweezers arranged in controllable, almost arbitrary geometries, and are made to interact by exciting them to highly-excited states called Rydberg levels. With this platform, we have, overt the last few years, **realized an extensive series of experiments** [1-5] using the interactions arising between atoms in two Rydberg states, and studying the so-called **Ising** and **dipolar XY models**, some iconic spin models used to describe quantum magnetism. More recently, we have expanded the types of Hamiltonians we can study, to include situations encountered in condensed-matter physics when dealing with doped magnets, by using now three different Rydberg levels to **implement a *t-J* model** [6].

However, in these experiments, we were limited to systems of 200 atoms at most, due to technical limitations of our aging experimental setup, that was built starting in 2011. This is why our team started building an up-to-date experimental apparatus in late 2023; **this new setup is now up and running and we routinely create 600-atom defect-free arrays** (see the figure below, showing the progressive assembly of such an array of 87Rb atoms). In this new setup, we will revisit our studies of the Ising and XY models, with an emphasis on studying the effect of finite system sizes, and understanding better the phase diagram of the system. The intern will take part in data taking and analysis on this setup; the work should naturally lead to a PhD on the study of quantum spin models in these large Rydberg atom arrays.

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References

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