Master Internship / PhD Position

Laser trapping of circular Rydberg atoms for quantum simulation

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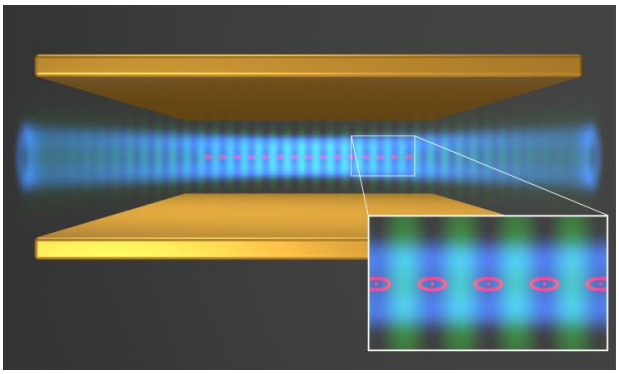

Circular Rydberg atoms are trapped in a blue-detuned dipole trap inside a spontaneous-emission inhibiting structure. We aim at the realisation of quantum simulations with tens of atoms during several tens of seconds.

Summary:
The dynamics of a quantum system, particularly in condensed matter, can be utterly complex, due to the huge size of its Hilbert space. Quantum simulation aims at emulating this dynamics with a simpler system, of which all parameters are under control and on which all relevant observables can be measured. Quantum simulation is the focus of an intense activity, particularly with cold atoms or trapped ions. We propose to explore an alternate, promising route, based on cold atomic ensembles in highly-excited Rydberg levels, strongly coupled by van der Waals dipole-dipole interaction. The final goal is to realize a vacancy-free chain of high-angular-momentum (circular) Rydberg atoms trapped in an optical lattice. The atoms are placed inside a spontaneous-emission-inhibiting structure, thereby making the trapping of tens of atoms during several seconds possible. This will enable unprecedented capabilities for a quantum simulator, with the observation of the dynamics of the system over several hundred thousands of interaction cycles.

During the internship, the first key enabling steps of the realization of the circular Rydberg atom quantum simulator will be achieved. The laser trapping of one or several circular Rydberg atoms in a doughnut-shape Laguerre-Gaussian beam will be realized. After the inhibition structure has been added into the existing experimental setup, we will be able to demonstrate the trapping of circular Rydberg atoms over durations much longer than their lifetime.