INTERNSHIP PROPOSAL

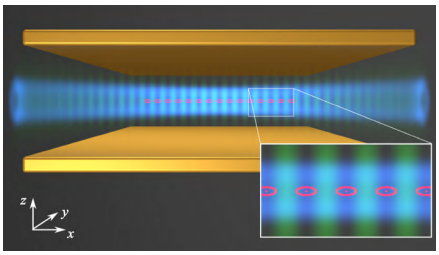
Laboratory name: Laboratoire Kastler Brossel
CNRS identification code: UMR8552
Internship director's surname: DOTSENKO Igor
e-mail: igor.dotsenko@lkb.ens.fr Phone number: 01 44 27 16 25
Web page: www.cqed.org

Internship location: Collège de France, 11 place Marcelin Berthelot, 75005 Paris
Thesis possibility after internship: YES, in TOULOUSE
Funding: YES If YES, which type of funding: requested ANR

Inhibition of spontaneous emission of trapped Rydberg atoms

Scientific context:

The current ultimate goal of the group is the realization of a novel quantum simulator platform based on a chain of circular Rydberg atoms and its benchmarking by the exploration of the phase diagram of a 1D spin chain. The corresponding proposal is presented in details in Phys. Rev. X 8, 011032 (2018). Circular Rydberg levels have a large principal and maximum orbital and magnetic quantum numbers. Despite their very long intrinsic lifetime T of several tens of milliseconds, the lifetime of a chain of N atoms scales as T/N, significantly limiting the possible use of these atoms in chains for long and sophisticated quantum simulation protocols. Thus, the realization of long (up to 40 atoms) chains ready to be efficiently used in a quantum simulator requires much longer lifetimes of individual atoms, on the order of several minutes. This demand can be fulfilled by passing two basic milestones: the realization of a Rydberg atom chain trapped at laser intensity minima by the ponderomotive energy of the atoms' nearly-free electron and the enhancement of the atom lifetime (inhibition of their spontaneous relaxation) by placing the atoms in a plane-parallel capacitor with millimeter spacing, as schematically shown in the figure.



Artist's view of a laser-trapped circular Rydberg atom chain inside a spontaneous-emission inhibiting capacitor.

Internship:

The goal of the internship is the assembling of a new experimental setup for trapping and protecting circular Rydberg atoms. During his/her internship in the group, the intern student will participate in the building and testing of different components of the experimental system. Under the guidance of senior colleagues, he/she will learn various experimental technics, like optical systems for laser control (frequency, power, polarisation, beam shape), electronics (fast control, high-current applications, superconducting elements, etc), high frequency generation (radio-frequency, microwaves), cryogenics and ultra-high vacuum.

Future thesis:

The main task of the future PhD project is to study atomic interactions in trapped chains of circular Rydberg atoms. This is a necessary and important step on the way to full-fledged quantum simulations on arrays of long-lived atomic qubits. **The PhD project will be conducted at the Laboratoire Collisions Agrégats Réactivité (LCAR, UMR 5589) in Toulouse, where the current experimental setup will be moved in July 2024.**

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: NO Macroscopic Physics and complexity: NO
Quantum Physics: YES Theoretical Physics: NO