Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*:

Nom / *name*:	Gleyzes	Prénom/ *first name* :	Sébastien
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Nom du Laboratoire / *laboratory name*: Laboratoire Kastler Brossel

Code d'identification UMR 8552 — Organisme : Collège de France, ENS, Paris 6, CNRS

Site Internet / *web site*: www.cqed.org

Adresse / *address:* 11 Place Marcelin Berthelot

Lieu du stage / *internship place*: Collège de France

Titre du stage / *internship title*: Quantum metrology with circular Rydberg states at room temperature

Résumé / *summary*

Rydberg atoms are energy levels with gigantic properties that make them a promising system for quantum technology [1]. Their huge electric dipole, their large angular momentum makes them of great interest to measure electric and magnetic fields [2]. Using quantum control methods, it should be possible to observe Ramsey fringes between levels with 100 μB difference in magnetic moment. This is two orders of magnitude larger than other single particle sensors, like NV centre or trapped ion.

However, the ultimate sensitivity of a quantum sensor also depends on the interrogation time of the Ramsey sequence, which is limited by the coherence time of the probe system. To that end, circular Rydberg levels are particularly interesting, as they have very long lifetime. Unfortunately, as these sates are very sensitive to thermal background, their use has been mostly limited so far to cryogenic environment.

Nevertheless, the lifetime of an atomic level depends on the density of mode of the electromagnetic field to which the atom is coupled. By engineering the electromagnetic environment of the atom, it should be possible to limit the effect of the atomic decay induced by the thermal photons and observe long coherence time of circular Rydberg atom at room temperature.

The main decay channel for a circular Rydberg atom of principal quantum number n is to emit or absorb a photon at the frequency of the transition between the circular state n and the circular state of principal quantum number $n \pm 1$. The purpose of the internship will be to design an electrode structure that suppresses the mode density of the electromagnetic field around those frequencies. We will then send across that structure a beam of laser-cooled atom, from which we will prepare circular Rydberg atoms, in order to measure its lifetime, at room temperature, when it is between the electrodes.

[1] A. Signoles, E.K. Dietsche, A. Facon, D. Grosso, S. Haroche, J.-M. Raimond, M. Brune et S. Gleyzes, Coherent transfer between low-angular momentum and circular Rydberg states, Phys. Rev. Lett. 118, 253603 (2017).

[2] A. Facon, E. K. Dietsche, D. Grosso, S. Haroche, J.-M. Raimond, M. Brune et S. Gleyzes, A sensitive electrometer based on a Rydberg atom in a Schrödinger cat state, Nature, 532, 262 (2016)

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : yes**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: Ecole Doctorale**

Lumière, Matière, Interactions	**x**	Lasers, Optique, Matière	**x**

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