

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: | Hétet | Prénom/ first name : | Gabriel |
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| Courriel / mail: | gabriel.hetet@lpa.ens.fr | | |
| Nom du Laboratoire / laboratory name: Laboratoire Pierre Aigrain | | | |
| Code d'identification : | UMR 8551 | Organisme : | ENS |
| Site Internet / web site: | http://www.lpa.ens.fr/spip.php?rubrique32 | | |
| Adresse / address: | 24, rue Lhomond 75005 Paris | | |
| Lieu du stage / internship place: | ENS, nano-optics team | | |

Titre du stage / internship title: **Quantum optics with single atoms in diamonds**

Résumé / summary

The team « Nano-optics » at the Laboratoire Pierre Aigrain has been studying artificial atoms isolated in a solid state system and mastering the use of their quantum properties for decades. One activity in the group is on defects in diamonds, composed of one atom coupled to a vacancy in the crystalline structure. The whole system behaves as a quasi-ideal single atom (NV or SiV center) that is detectable optically via confocal microscopy.

The project will consist in setting-up the optics around the defect in diamond to control its coupling to vacuum fluctuations. A so-called « half cavity » set-up will be built for which the local density of the vacuum fluctuations around the focal point is strongly modified even if the distance between the atom and the mirror is several centimeters. The goal is to measure with precision QED effects that have been observed with single atoms, such as the modification of the Lamb shift and the rate of spontaneous emission of a single colored center. It has been predicted that the vacuum fluctuations can be cancelled when the half-cavity that has a numerical aperture close to unity even with a distant mirror lying in the far field. For a thesis, with the new set-up, the team will have the opportunity to get close to this regime and to completely control the electromagnetic environment of the coloured center. The quality of the optical system, together with the zero-phonon line linewidth will be characterised at low temperatures and the use of the defect, not only for fundamental quantum optics, but also for quantum communication and metrology will be investigated.

The objective of the internship will be to couple atoms in a diamond nano-pyramid [1] to their image in a mirror, following the work presented in [2] performed in ion traps.

[1] Diamond nano-pyramids with narrow linewidth SiV centers for quantum technologies

L Nicolas *et al.* AIP Advances 8 (6), 065102 (2018)

[2] Eschner J. *et al.* Light interference from single atoms and their mirror image

Nature 413, pages 495–498 (2001)

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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: Yes

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|--------------------------------|------------|--------------------------|------------|
| Lumière, Matière, Interactions | Yes | Lasers, Optique, Matière | Yes |
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