Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

Laboratory name: Institut des Nanosciences de Paris (INSP)
CNRS identification code: UMR 7588
Internship director'surname: Hugo Defienne
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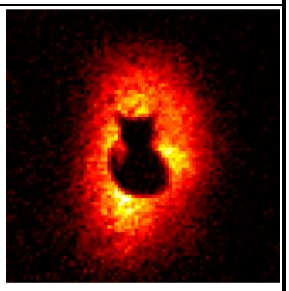
Web page: www.quantumimagingparis.fr
Internship location (main): Sorbonne Université, campus Jussieu. 4 place Jussieu 75005 Paris
Thesis possibility after internship: YES Funding: NO

Title: Hiding images in quantum correlations

Topics: Experimental quantum optics, quantum imaging, optical imaging.



Summary: Quantum imaging refers to imaging systems that exploit the non-classical properties of light to surpass the performance of classical approaches (e.g. in terms of resolution or signal-to-noise ratio) or to enable entirely new imaging modalities [1]. In this context, our team has recently developed a novel quantum imaging approach that consists of *encoding images in the correlations of entangled photon pairs* [2]. In this scheme, the images are invisible to standard intensity measurements but are revealed when measuring spatial correlations (i.e. photon coincidences) with state-of-the-art single-photon cameras. Using this method, we have recently demonstrated the transmission of images through scattering layers in conditions where classical light fails [3]. This M2 internship - ideally continued as a PhD thesis - builds on these advances. After upgrading the setup with a digital micromirror device and an event-based camera to approach real-time operation, we plan to explore new applications of this technique. For instance, (i) leveraging the intrinsic nonlinearity of quantum imaging for advanced image processing or photonic computing, inspired by recent progress in classical approaches [4], or (ii) investigating secure image transmission schemes based on entanglement-encoded information [5]. The student will play a key role not only in substantially improving the experimental performance of the system, but also in understanding the underlying physics and related literature. Together with the supervisor, they will identify promising research directions and applications, supported by both experimental work and simulations.

Candidate Profile: The ideal candidate should have strong skills in both theory and experiments, with a background in optics, quantum physics, quantum optics and potentially machine learning. Previous laboratory experience (through internships, projects, or advanced courses) will be highly valued.

Research Environment: The student will join the *Quantum Imaging Paris group*, based at the Institut des NanoSciences de Paris (INSP), Sorbonne University. The group benefits from an outstanding scientific environment. In the context of this PhD, the expertise of Prof. Gigan's team at the Laboratoire Kastler Brossel (LKB), with whom we maintain a close collaboration, will be essential. The INSP team, led by Dr. Hugo Defienne, is young, dynamic, and international, currently composed of four PhD students and two postdocs. We value a fun, inclusive, and collaborative atmosphere.

References: [1] Defienne et al., *Advances in quantum imaging*, Nat. Phot. 18, 1024-1036 (2024); [2] Vernière et al., *Hiding images in Quantum Correlations*, PRL 133, 093601 (2024) ; [3] Vernière et al., *Entanglement-enabled imaging through complex media*, arXiv:2508.14616 (2025) ; [4] Wang et al., *Large-scale photonic computing with nonlinear disordered media*, Nat. Comp. Sci. 4, 429-439 (2024) ; [5] Johnson et al., *Transmission of quantum-secured images*, Sci. Rep. 14, 11579 (2024)

Contact: hugo.defienne@insp.upmc.fr

Starting dates: Internship: between Jan and May 2026 | Phd: Between Sept and Nov 2026

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO