INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: LOA
CNRS identification code:
Internship director'surname: Hamed Merdji
e-mail: Phone number: 0662711472
Web page:
Internship location: Ecole Polytechnique

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding:
Concours or research contract grant

Quantum imaging using high harmonic states of light

Quantum imaging (QI) is a rapidly developing field of research with stunning progresses and emerging societal applications. Quantum-enhanced imaging schemes harness the beneficial properties of entangled photon pairs allowing transferring amplitude and phase information from one photon state to the other. The technique is however still in its infancy and we propose to go beyond the state of the art. The main goal is to develop advanced QI protocols that exploits photon pairs at extreme wavelengths from near infrared to the visible down to the deep UV using a non-classical source based on high harmonic generation (HHG). The main objective of the internship will consist in using a pair of non-degenerated entangled photons at 2 harmonics from the HHG frequency comb to perform a quantum imaging experiment in the far field regime. We will study the possibility of transferring the sensing and resolution benefit from one spectral range to another one. Indeed, an intriguing question is about the spatial resolution achievable in the QI scheme, especially in the case of non-degenerate photon pairs. Interestingly, recent theoretical studies [Li17,Asb19] predict that, in the quantum diffractive imaging regime, radiation damage-free coherent diffraction can be achieved with spatial resolution limited by the shortest wavelength by using entangled photons from near infrared to deep-UV.
The quantum correlations between the two photons from the same harmonic generation process will be used to transfer amplitude and phase information between the two photons. In the diffractive regime, and in a "ghost diffractive imaging" configuration based on the coincident detection of the two entangled photons, it is a priori possible to obtain a resolution related to the UV photon, i.e. in the sub-µm range. Ultimately, the candidate will investigate novel protocols to create high-resolution label-free images of complex structures (e.g. cells) embedded inside biological tissues [Zhang23].

References:
[Asb19] Asban, S. et al., PNAS 116, (24) 11673 (2019)
[Li17] Li, Z. et al., J. Phys.B: AMOP 51 (2) 025503 (2017)
[Zhang23] Zhang, Y., et al., arXiv:2303.05643 (2023)

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

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