INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: LOA
CNRS identification code:
Internship director'surname: Hamed Merdji
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Internship location: Ecole Polytechnique

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

Attosecond control of quantum states of light

High-harmonic generation is a light up-conversion process occurring in a strong laser field, leading to coherent attosecond bursts of extreme broadband radiation. As a new paradigm, attosecond electronic or photonic processes such as high-harmonic generation (HHG) can potentially generate non-classical states of light well before the decoherence of the system occurs. This could address fundamental challenges in quantum technology such as scalability, decoherence or the generation of massively entangled states with ultrafast processing. We recently reported experimental evidence of the non-classical nature of the harmonic emission in several semiconductors excited by a femtosecond infrared laser (Theidel et al, submitted to Nature, in review, pdf on demand). By investigating single- and double beam intensity cross-correlation, we observe two-mode squeezing in the generated harmonic radiation, which depends on the laser intensity that governs the transition from Super-Poissonian to Poissonian photon statistics. The measured violation of the Cauchy-Schwarz inequality realizes a direct test of multipartite entanglement in high-harmonic generation. These pioneer experiments were realized with a train of attosecond pulses but without the control of the intra-optical cylcle of the light. The internship will consist in realizing a platform that will allow controlling the carrier to envelope phase (CEP) of the laser that drives the semiconductor HHG emission. The CEP of the laser will allow controlling the non-classical state of the single photon emission, in connection with our recent finding in the intensity control of the HHG light states.
In conclusion, HHG is a new quantum bosonic platform that intrinsically produces non-classical states of light with unique features such as multipartite broadband entanglement or multimode squeezing. The source operates at room temperature using standard semiconductors and a standard commercial fiber laser, opening new routes for the quantum industry, such as optical quantum computing, communication and imaging. The attosecond control of light states open the vision of quantum processing on unprecedented timescales, an evident perspective for future quantum optical computers.
For M2 students: only candidates motivated to follow with a PhD in this topic will be considered. L3 and M1 students are welcome.

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