POST-DOCTORAL FELLOWSHIP (12 months)
ICB – CNRS/Université de Bourgogne - Dijon, France

Design and theoretical implementation of STIRAP-driven Plasmonic Arithmetic Logic Units

This project deals with the design of monolithic plasmonic Arithmetic and Logic Units (ALU). ALUs allow to realize complex computing functions (addition, boolean calculation, ...) from simple logic gates gates (OR, AND, etc.). The electronic microprocessors are made up of a cascading gates realized by transistors. Our approach is based on the realization of *monolithic optical ALUs*, by performing the desired operation using several optical in- and outputs of a plasmonic structure [1]. This limits the losses from one gate to another. Moreover, the modal confinement of plasmons permits full on-chip integration of all-optical ALUs and to take benefit of the convergence of optical fiber to photonic chip for high-speed data transfer over the entire chain (long-distance fiber transmission and on chip computer processing). We have recently investigated plasmon mediated Stimulated Raman Adiabatic Passage (STIRAP) between two emitters [2,3]. STIRAP consists of a counter intuitive sequence of two pulses: a Stokes pulse S(t) on output emitter followed by a pump pulse P(t) on input emitter.

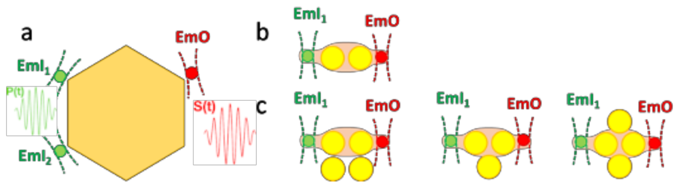

Figure : a) *STIRAP-driven plasmonic ALU. The two atoms $EmI_{1,2}$ are excited by a pump pulse P(t) and the EmO atom by a Stokes pulse S(t). (b,c) Schematics of possible arrangements of peripheral particles strongly coupled to those of the core whose effective plasmon mode is then modified.*

The post-doctoral fellow will be in charge of developing the theoretical description of the STIRAP-driven plasmonic ALU. We have developed a formalism describing the quantum emitter-plasmon coupling using an effective Hamiltonian. We will apply this formalism to investigate the capability to realize Boolean gates based on emitters coupled to plasmonic structures (see the figure). Beyond this approach, we also plan to develop a formal analogy with molecular ALUs (QHC - Quantum Hamiltonian Computing) [4]. In QHC, the Boolean function is encoded in the energetic shift of molecular levels by interaction with metallic adatoms and is described by the Molecular Hamiltonian. In our approach, the Boolean function is encoded in the pulse sequence or in the plasmon mode shift of the core pair by interaction with the peripheral particles; described by an effective Hamiltonian.

[1] *Interconnect-Free Multibit Arithmetic and Logic Unit in a Single Reconfigurable 3µm^2 Plasmonic Cavity.* Kumar *et al.* ACS Nano **15**, 13351 (2021)
[2] *Adiabatic passage mediated by plasmons: A route towards a decoherence-free quantum plasmonic platform*. B. Rousseaux *et al*, Phys. Rev. B **93**, 045422 (2016). Erratum Phys. Rev. B **94**, 199902 (2016)
[3] *Quantum plasmonics with multi-emitters: application to stimulated Raman adiabatic passage*. Castellini *et al*, Eur. Phys. J. D **72**, 233 (2018).
[4] *Quantum Hamiltonian Computing protocols for molecular electronics Boolean logic gates*. Namarvar *et al*, Quantum Sci. Technol. **4**, 035009 (2019).

To apply, please send your Curriculum Vitae, a brief research statement and arrange for two or more letters of recommendation.

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