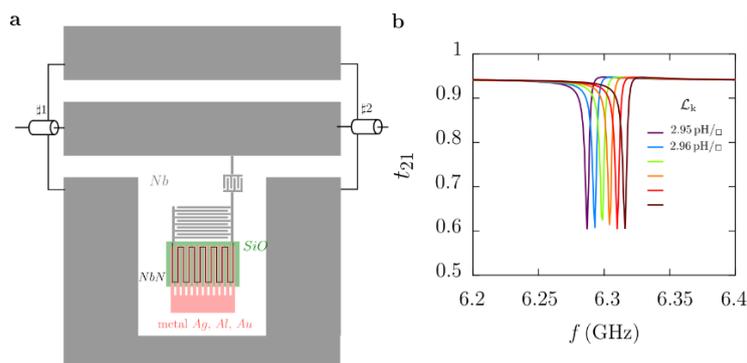


Inelastic tunneling and light emission

Light emission by inelastic tunneling in a metallic tunnel junction have recently emerged as plasmonic alternative to integrated photonics combining the advantages of photonics (high speed and large bandwidth) with those of electronics (extreme miniaturization and integration). Our recent work¹ allows us to understanding the interplay between quantum electronic transport (quantum description of electromagnetic coupling) and photon emission processes (elastic vs inelastic tunneling). For the time being, this source is not an efficient light emitter and it is difficult to characterize the generated photon state. Indeed, due to its low brightness, it is difficult to perform correlation measurements. The source is a biased metal-insulator-metal tunnel junction. Such structure has been known to emit radiations for a long time, but has been neglected because of its low electron-to-photons conversion efficiency (about 10^{-5} ph/e). However, a carefully designed plasmonic nano-antenna may allowed us to increase the conversion efficiency by two orders of magnitude² by focusing on surface plasmons (about 10^{-3} pl/e) in a nano-antenna. SPP are still detected through their photons leakage in a Kretschmann configuration³ where the plasmon-to-photon conversion rate is limited by the Joule dissipation. It would therefore be better to directly detect surface plasmons emitted by the junction in order to deal with a full "plasmonic platform". The realization of an integrated "plasmonic platform" involving source and detector of plasmons would therefore be a very useful tool involved in the development of new quantum sensors.

The internship will be devoted to the development of a kinetic inductance surface plasmon polariton detector (KISPPD). It involves nano-fabrication (electronic lithography, thin film deposition to realize an LC circuit, see figure), microwave measurement at low temperature and optical excitation of surface plasmon polaritons. In parallel with the work on the development of the KISPPD, we plan to continue the work already begun on the correlation electron-plasmons. The candidate will use samples already made and will have to improve the detection system already used.



Schematic of the detecting board. The NbN inductor is isolated from the metallic layer with a thin layer of SiO and allows a local detection of propagating SPP in a metallic film (red). b- Simulated transmission of the LC resonator in a hanger configuration.

1. Février, P. & Gabelli, J. Tunneling time probed by quantum shot noise. *Nat. Commun.* **9**, 4940 (2018).
2. Zhang, C. Excitation électrique de plasmons polaritons de surface par effet tunnel inélastique avec des nanoantennes résonnantes. <http://www.theses.fr> (2019).
3. Kretschmann, E. & Raether, H. *Radiative Decay of Non Radiative Surface Plasmons Excited by Light.* *Z. Naturforsch.* **23a**, (1968).