Atomic-scale physics of quantum-photon sources

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Single-photon sources (SPSs) are systems capable of emitting photons one by one. These sources are of major importance for quantum-information science and applications. SPSs experiments generally rely on the optical excitation of two level systems of atomic-scale dimensions (single-molecules, vacancies in diamond…).
Many fundamental questions related to the nature of these sources and the impact of their environment remain to be explored:

Can SPSs be addressed with atomic-scale spatial accuracy? Does coherence emerge from the proximity between sources? Do coupled SPS still behave as SPSs or do they lead to the emission of correlated photons? How can we then control the degree of entanglement between the sources?

Answering these questions requires probing, manipulating and exciting SPSs with an atomic-scale precision. This is beyond what is attainable with an all-optical method. Since they can be confined to atomic-scale pathways we propose to use electrons rather than photons to excite the SPSs. This unconventional approach provides a direct access to the atomic-scale physics of SPSs and is relevant for the implementation of these sources in hybrid devices combining electronic and photonic components. To this end, a scanning probe microscope will be used that provides simultaneous spatial, and temporal resolutions [1,2,3].

The objective of this PhD project is to characterize the emission statistics of single or assembled chromophoric molecules acting as quantum-photon sources and will take place within the STM team of the IPCMS.

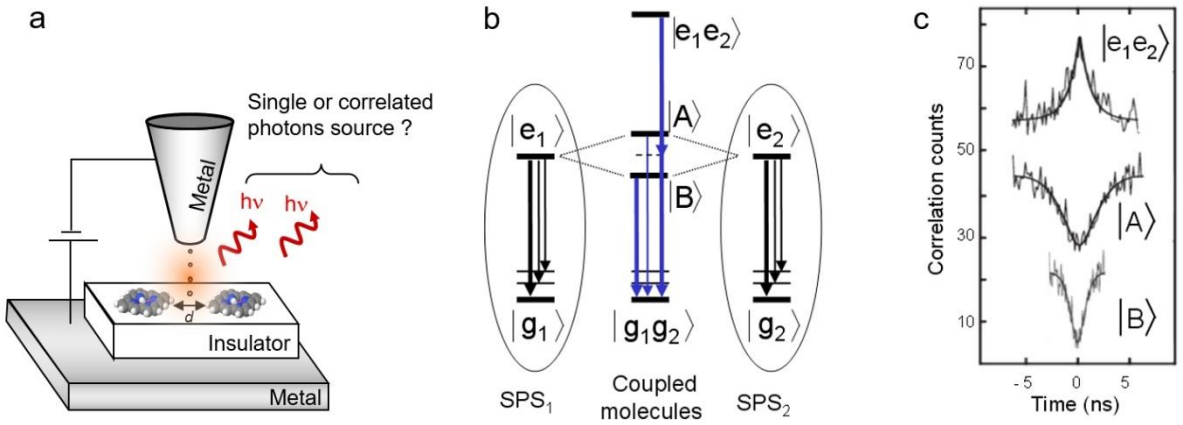

Figure : Electrically and locally driven excitation of a coherently correlated pair of molecules (a). Energy diagram of the coupled system (b). Emission statistics of the individual and coupled systems (c).

[1] Doppagne *et al.*, Nature Nano., **15**, 207 (2020)
[2] Doppagne *et al.*, Science, **361**, 6399 (2018)
[3] Doppagne *et al.*, Phys. Rev. Lett., **118**, 127401 (2017)