ATOMIC-SCALE PHYSICS OF INTERACTING SINGLE-MOLECULE PHOTON-SOURCES

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Chromophores constitute a specific class of molecules that are capable of absorbing and re-emitting visible light. Whereas the colour of the absorbed and emitted photons is intimately linked to the chemical structure of these molecules, it also depends crucially on their close environment. In this framework, the interactions between the electrical dipoles of chromophores play a central role. In photosynthesis, for example, the energy harvested from the sunlight by one molecule is transferred via dipole-dipole interactions to another that converts it into chemical energy. They are also responsible for fascinating quantum effects such as entanglement between the states of chromophores separated in space by several nanometers[1]. Many fundamental questions related to these interactions are to be explored:

How do the nanometer-scale distance or the orientation between two (or more) chromophores affect their emission properties? Does coherence emerge from the proximity between these sources? Do these structures behave as single-photons sources or do they lead to the emission of entangled photons-pairs? How can we then control the degree of entanglement between the sources? Can we remotely excite the emission of these sources by using molecular chains as charge carrying wires?

Answering these questions requires probing, manipulating and exciting chromophores with an atomic-scale precision. This is beyond what is attainable with an all-optical method. Following recent approaches[2,3] we propose to use electrons, which can be confined to atomic-scale pathways, rather than photons to excite the chromophores. To this end, the recruted PhD student will used a scanning probe microscope that provides simultaneous spatial, chemical, spectral, and temporal resolutions.

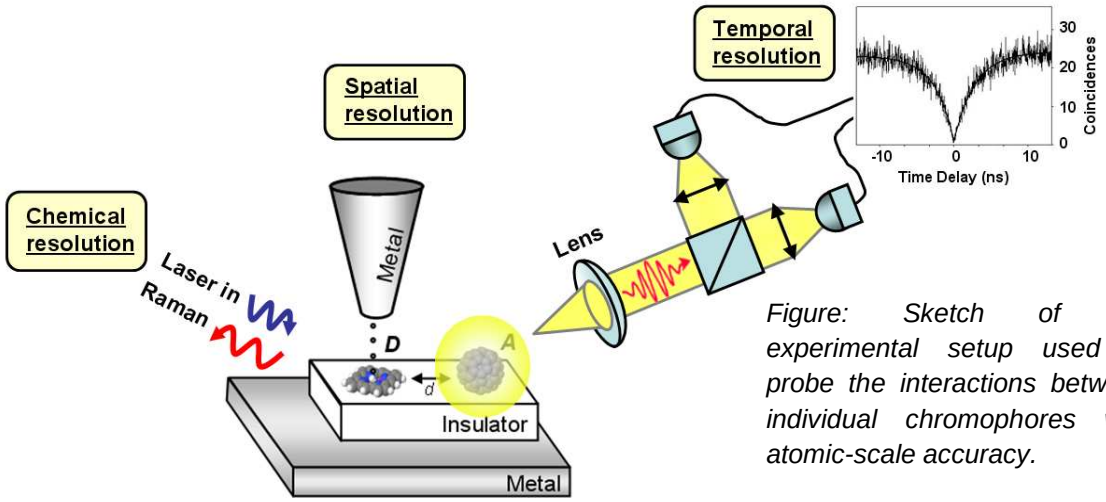

Figure: Sketch of the experimental setup used to probe the interactions between individual chromophores with atomic-scale accuracy.

[1] C. Hettich *et al.,* Nature **298**, 385 (2002).
[2] M. C. Chong *et al.,* Phys. Rev. Lett. **116**, 036802 (2016).
[3] Y. Zhang *et al.,* Nature **531**, 623 (2016).