Statistical properties of light emission in current-driven single-molecule STM-junctions

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Abstract

The atomic resolution of the scanning tunnelling microscope (STM) enables fluorescence on the scale of single molecules. Recent experiments demonstrate the change from a broad plasmonic resonance to a sharp peak in the photon emission spectrum, by moving the tip laterally from the bare substrate towards the molecule [1].
These systems are of particular interest to the quantum cryptography community because they have been reported to emit non-classical light (antibunching) [2, 3].
We propose a microscopic model based on the quantum master equation approach for the reduced density matrix of the central system. In particular, we focus on the description of the emission spectrum, conductivity and photon coherence. Additionally, by using full counting statistics, we calculate the Fano factor and correlations between emission and currents. The model provides a simple framework to explain the features observed experimentally in the photon spectrum and the electronic conductance.

References

[1] B. Doppagne et al., Science (2018) 361, 251
[2] P. Merino et al., Nat. Commun. (2015) 6, 8461
[3] L. Zhang et al., Nat. Commun. (2017) 8, 580

Figures

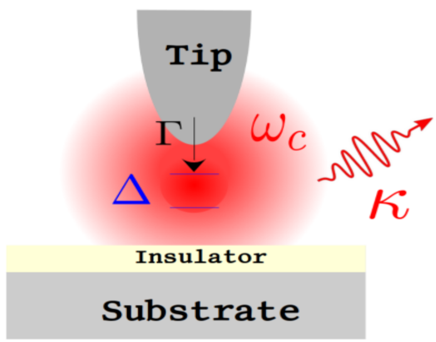

Figure 1: Schematic of two metallic electrodes forming a plasmonic nanocavity. A two-level system in the nanogap couples to the confined electromagnetic field. Electrons can tunnel from the tip to the molecule, activating the fluorescence of the molecule.