From single-molecule fluorescence to photosynthesis with an STM

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The electric current traversing the junction of a scanning tunneling microscope (STM) may lead to a local emission of light that can be used to generate sub-molecularly resolved fluorescence maps of individual molecules. Combined with spectral selection and time-correlated measurements, this hyper-resolved fluorescence microscopy approach allowed us to scrutinize the vibronic structure of individual molecules [1] in a very similar way than in the recent TERS reports, without requiring an optical excitation. We used this approach to characterize the photonics properties of charged species [2], to track the motion of hydrogen atoms within free-based phthalocyanine molecules [3], and more recently to follow resonance energy transfers between individual pigments, exploring processes occurring in photosynthetic complexes with sub-molecular spatial resolution [4].

These results constitute an important step towards photonic measurements with atoms-scale resolution [5].

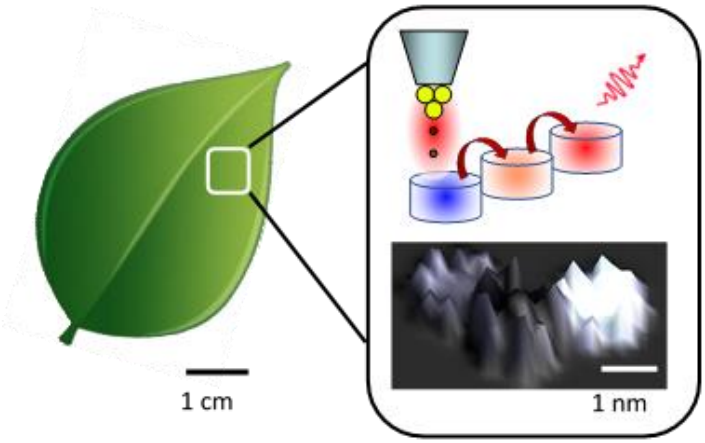

Figure 1. Exploring energy transfers occurring in leafs with a scanning tunneling microscope.

[1] B. Doppagne et al., Phys. Rev. Lett. 118, 127401 (2017)

[2] B. Doppagne et al. Science 361, 251 (2018)

[3] B. Doppagne et al. Nature Nanotechnol.15, 207 (2020).

[4] S. Cao et al. Nature Chem. 12, 766 (2021)

[5] A. Roslawska et al. Physical Review X 12, 011012 (2022)