L4H Seminar JEROME WENGER 'Photonic Antennas to Enhance the Detection of Single Fluorescent Molecules in Solution'

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June 11, 2014

Wednesday, June 11, 2014, 10:30. Seminar Room

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Sensors able to detect a speci?c type of molecules in real-time and with high sensitivity are a subject of intense research, and a major drive for the ?eld of nanophotonics. In this framework, optical antennas are receiving a large interest to interface light with molecules on dimensions much beyond the optical wavelength. Controlling the fluorescence emission from nanoscale quantum emitters such as single molecules is a key element for a wide range of applications, from efficient analytical sensing to quantum information processing. Enhancing the fluorescence intensity and narrowing the emission directivity are both essential features to achieve a full control of fluorescence.

Nanoantennas have been designed for the specific application of enhanced single molecule analysis in solutions at high concentrations, reaching detection volumes down to 58 zL (four orders of magnitude smaller that the diffraction limit) and large enhancement of the single molecule ?uorescence, up to 1100-fold. The large ?uorescence enhancement and detection volume reduction combine to make nanoantennas a highly parallel platform for studying single molecule dynamics at the biologically relevant micromolar concentration regime.

Forster fluorescence resonance energy transfer (FRET) between donor and acceptor fluorescent mole-cules is one of the most popular methods to measure distance, structure, association, and dynamics at the single molecule level. However, major challenges are limiting FRET in several fields of physical and analytical sciences: (i) a short distance range below 8 nm, (ii) a concentration range in the nanomolar regime, and (iii) generally weak detected signals. Thanks to their ability to control and manipulate optical fields down to the nanometre scale, it is appealing to use plasmonic antennas to enhance the FRET process between single quantum emitters. We report a thorough analysis of the FRET process into metallic subwavelength apertures. Both donor and acceptor emission channels are investigated simultaneously down to the single molecule regime. This approach enables to quantify independently the photonic effects on the decay rates and the plasmonic enhancement on the emission.

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Hosted by Prof. Niek van Hulst