NANO-ANTENNAS - TOOLS FOR LIGHT ON THE NANOSCALE

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"NanoPhotonics" is a young and active direction in the science of light, with the goal to control the generation, confinement and flow of light energy on the nanometerscale, i.e. far below the wavelength of light, for applications in high resolution optical imaging, nanosensing, nanolasing, super-compact photonic circuitry, ultra-sensitive biochemical analysis, data storage and quantum information. First, I will shortly present an overview of the key elements that facilitate nanoscale optics and particularly show examples of recent achievements, relevant methods and applications.

We present the optical monopole antenna, a novel nano-antenna positioned at the end of a metal-coated glass fiber near-field probe. Antenna resonances, excitation conditions and field localization are directly probed in the near field by single fluorescent molecules and compared to finite integration technique simulations. It is shown that the antenna is indeed equivalent to its radio frequency analogue, the monopole antenna. For the right antenna length and local excitation conditions, antenna resonances occur that lead to an enhanced localized field near the antenna apex. Direct mapping of this field with single fluorescent molecules reveals a spatial localization of 25 nm, demonstrating the importance of such antennas for nanometer resolution optical microscopy. [1, 2]

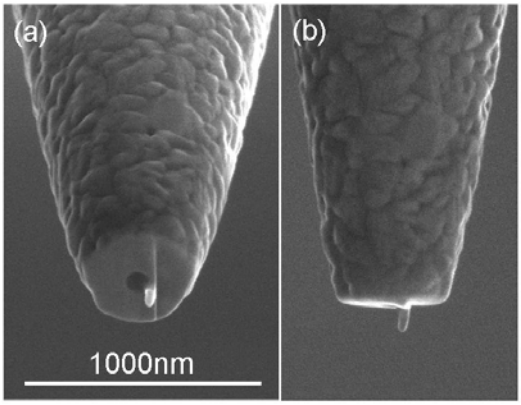

Figure.
An optical monopole antenna
(a) viewed from a 52° angle
(b) side view.

At radio frequencies metallic antennas are employed to control the emission and reception of radiation. At optical energies, where electronic transitions take place, antennas have been recently demonstrated to strongly modify the emitter excitation and lifetime. However, the main function of traditional antennas, the direction of radiation, has hardly been explored. Here we demonstrate experimentally that the angular emission of a single photon can be controlled by an optical antenna. A single fluorescent molecule is coupled to the optical monopole antenna by precisely manipulating its position. We give a simple, yet powerful, interpretation for the resulting emission; the antenna mode determines the emission. Such control of angular emission is important for all light emitting devices, including single photon sources for quantum information, light detection and harvesting. [3]

References:

[1] Tim Taminiau, Robert Moerland, Frans Segerink, L. (Kobus) Kuipers and Niek van Hulst, *NanoLetters* **7**, 28 (2007).
[2] Tim Taminiau, Frans Segerink, Robert Moerland, L. (Kobus) Kuipers and Niek van Hulst, *J.Opt.A: Pure Appl.Opt.* **9** (2007).
[3] Tim Taminiau, Fernando Stefani, Niek van Hulst, submitted.

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