Antennas for Light – Exploiting the light-metal interaction for controlling optical transitions in matter

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An antenna is a device, which converts free propagating radiation into localized energy, and vice versa. The irradiation of a metal nanostructure with light leads to the excitation of localized surface plasmons, which are associated with an enhanced and localized, non-propagating secondary electromagnetic field [1]. Hence, noble metal nanoparticles and assemblies thereof, can be exploited as antennas to confine and manipulate optical processes on the nanometer scale [2,3]. As such, optical antennas can be used for high-resolution optical microscopy and spectroscopy. In this talk, I will introduce the concept of nanoparticle antennas, discuss their properties and their influence on the light emission of a coupled quantum emitter and of quantum systems governed by energy transfer mechanisms. Furthermore, applications using these antennas as probes in scanning near-field optical microscopy and spectroscopy are shown. These applications cover investigations of phosphorescent materials [4], auto-luminescent bio matter and immuno-fluorescence stained membrane-proteins [5]. For the latter, the protein distributions of isoforms of the plasma membrane bound ATPase in red blood cells can be directly correlated with the membrane topology. This study implies a scaffolding function of the cytoskeleton on the accumulation of these isoforms in destinct membrane areas.

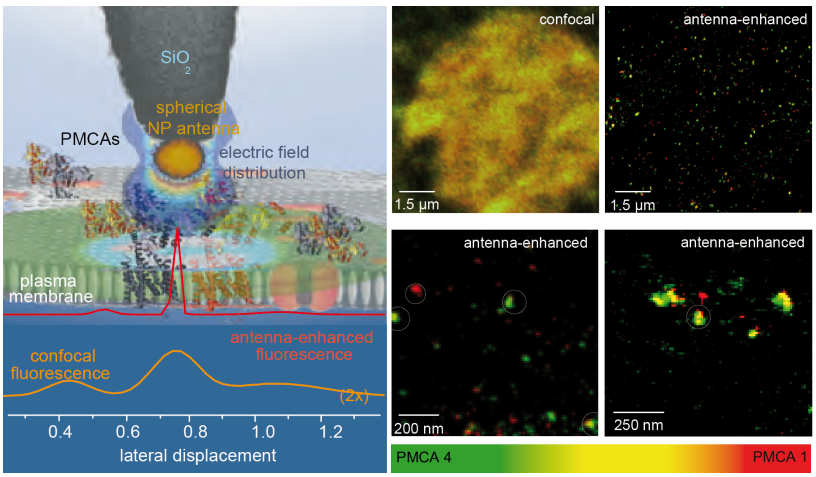

Figure 1: Confocal and antenna-enhanced colocalization of PMCA isoforms with a 40 nm AuNP antenna reveals the dimerization of PMCAs and the formation of small nanodomains.

References:

[1] C. Höppener and L. Novotny, Quarterly Reviews of Biophysics **45**, 2005 (2012)
[2] C. Höppener et al., *Phys. Rev. Lett.* **109**, 017402(1-4) (2012)
[3] P. Popp et al., Small, **12**, 1667 (2016)
[4] J. Herrmann et al., A*CS Photonics*, **3** 1897 (2016)
[5] C. Höppener et al. *Nano Letters* **9**, 903 (2009), Lapin et al. *J. Neuroimmune Pharmacol*. **7**, 539-543 (2012)