Optical microscopy and spectroscopy of single molecules and single plasmonic gold nanoparticles

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Optical signals provide unique insights into the dynamics of nano-objects and their surroundings [1]. I shall present some of our experiments of the last few years.

i) We study single gold nanoparticles by photothermal and pump-probe microscopy. We recently studied the dynamics of vapor nanobubbles created in the liquid surrounding a single immobilized gold nanosphere [2].

ii) Photothermal microscopy opens the study of non-fluorescent absorbers, down to single-molecule sensitivity [3]. Combining this contrast with photoluminescence, we can measure the luminescence quantum yield on a single-particle basis. The high signal-to-noise ratio of this technique enables uses of individual gold nanoparticles for local plasmonic and chemical probing [4].

iii) Gold nanorods generate strong field enhancements near their tips. Matching the rods' plasmon to a dye's spectra, we observe enhancements in excess of thousand-fold for the fluorescence of single Crystal Violet molecules [5]. This method generalizes single-molecule fluorescence to a broad range of weak emitters.

[1] F. Kulzer et al., *Angew. Chem. Int. Ed.,* **49** (2010) 854.
[2] L. Hou et al., *New J. Phys*. **17** (2015) 013050
[3] A. Gaiduk et al. *Science* **330** (2010) 353
[4] P. Zijlstra et al., *Nature Nanotech.* **7** (2012) 379.
[5] H. Yuan et al., *Angew. Chem. Int. Ed.* **52** (2013) 1217-1221.