Attraction and Repulsion: switching the optical force for plasmonic nanoparticles

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The plasmon resonance of metal nanoparticles has been subject to extensive study aiming to understand and tailor the resulting strong local field enhancements. In addition to inducing wavelength dependent scattering and absorption, the plasmon resonance strongly affects the optical forces exerted by laser light [1]. These play an important role for freely diffusing nanoparticles not attached to a substrate. Optical manipulation and trapping of metal nanoparticles provide an excellent tool to investigate these interaction processes between light and nanoparticles.

We experimentally demonstrate the wavelength dependence of the applied optical force (Fig. 1). By employing different beam shapes and laser wavelengths we are able to induce repulsive as well as attractive forces [2,3]. The induced optical forces also affect the interaction between individual nanoparticles (Fig. 2). We discuss the interplay of scattering and gradient forces and the limits of the dipole approximation for the force decomposition model.

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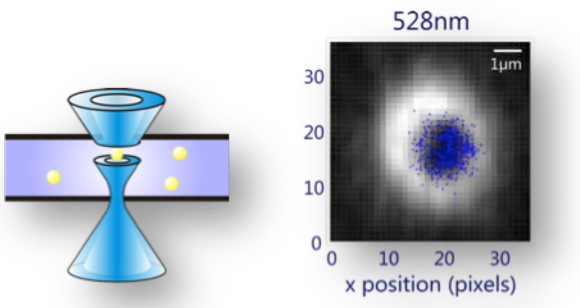

***Fig. 1:** Blue-detuned trap where a 100nm gold particle experiences a repulsive optical force out of the high intensity region on a laser beam*

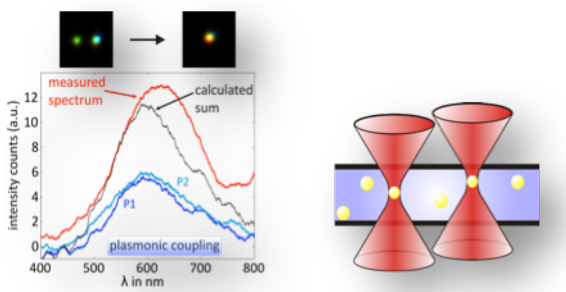

***Fig. 2:** Red-detuned optical traps attract 100nm gold particles to the high intensity focus and allow close positioning and plasmonic coupling of two nanoparticles.*

[1] M. Dienerowitz, M. Mazilu and K. Dholakia, Journal of Nanophotonics 2 (2008) 021875
[2] M. Dienerowitz et al., Optics Express 16 (2008) 4991
[3] M. Dienerowitz et al., Journal of Optics 14 (2012) 045003