MMP simulation of optical forces acting on a metallic nanoparticle within a photonic nanojet

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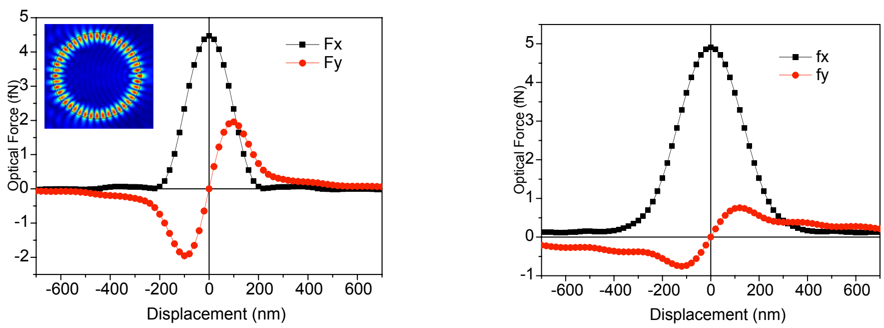
A photonic nanojet (PNJ) is a beam with a subwavelength waist that emerges from the shadow-side of a dielectric microsphere under plane wave illumination. Due to its subwavelength waist, its high intensity and low divergence features, PNJs have been proposed to provide a potential ultramicroscopy technique well suited for e.g. biosensing, particle detection, and nonlinear optics. Here, we shall investigate the possibilities of using photonic nanojets for optical trapping, with a specific focus on the optical force induced by the PNJ on a metallic nanoparticle. The simulations are performed using the Multiple Multipole (MMP) method. Optical forces at resonant and non-resonant conditions of the microcylinder/nanoparticle system are investigated. The optical forces are enhanced at resonance compared to non-resonant illuminations. We found that the optical forces acting on the nanoparticle depend strongly on the dielectric permittivity of the nanoparticle, as well as on the intensity and the beam width of the PNJ. The research also shows that the metallic nanoparticle much smaller than the incident wavelength can be efficiently trapped by the PNJ. Furthermore, the attractive force can be simply changed to a repulsive force by varying the polarization of the incident beam in the PNJ configuration. The changed sign of the force is related to both, the particle's polarizability and the generation of surface plasmons in the particle.



(a) (b)

Fig.1. Simulation of optically induced forces under resonant conditions. (a) The resonance wavelength of the microcylinder is 383nm for *E*-polarization; (b) the resonance wavelength of the nanoparticle is 350nm for *H*-polarization.