PARTICLE SCATTERING AND OPTICAL FORCES IN HIGHLY FOCUSED BEAMS

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The application of optical forces and especially of trapping forces in highly focused beams seems to be of still increasing significance in biophysics, colloidal physics and nano-technology although the first presentation of a single beam optical trap is nearly 20 years ago. However, theories on optical trapping forces are still under development. Especially when wave-optical effects for small particles meet boundary conditions imposed by non-ideal objective lenses, special sample-chambers or different aperture plane illuminations, a flexible but sufficiently accurate theory is required.

Such a theory must first include vectorial focusing of arbitrary field distributions in the pupil plane of the objective lens. Second, vectorial scattering of the highly focused field at different particles must be described. Third, the arising optical forces on small particles have to be evaluated mathematically as a consequence of the space dependent electro-magnetic force density (Figure). Last but not least, the interaction of the trapped particle with the local environment due to thermal collisions plays an important role for the stability of a trap and the feasibility of experiments.

In my talk all four aspects are discussed. The theory of high-NA focusing, particle scattering and optical trapping forces is explained. Calculation results are shown and are compared to new experimental data.

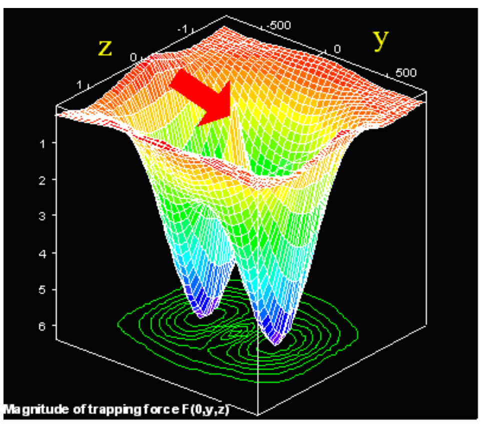

Figure 2: Magnitude of the trapping force |**F**(x,0,z)| for a small bead in a highly focused beam.

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