VIENNA COMPUTATIONAL MATERIALS LABORATORY

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USING LIGHT SCATTERING TO TRACK, CHARACTERIZE AND MANIPULATE COLLOIDS

A TALK BY DR. PETER VAN OOSTRUM,

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Colloidal particles are about as large as the wavelength of light. The scattering of light by these particles is a rich and interesting phenomenon. During my PhD I have used the scattering of light by colloids in various ways. First of all I co-developed a new method to analyze in-line holographic micrographs. Our particles are illuminated with a collimated laser beam. Part of the light is scattered and interferes with the remaining, not-scattered, light. This interference pattern is called a hologram. By combining Mie theory and the well known interference, it is possible to calculate holograms. We minimize the difference between an experimental hologram and a calculated hologram. Doing so, we can determine the particle's lateral position to within 1 nm, and, surprisingly, to within 10 nm in the axial direction, from a single snapshot. Using a fast CCD camera it is then possible to track colloids in space with unprecedented accuracy and speed. This fitting procedure also gives the radius and the refractive index of the individual particle to about 1 %.

The same scattering behaviour that we use to track and characterize the colloids can be used to exert forces on them using optical tweezers. I performed extensive calculations of the forces exerted by optical tweezers on various colloids, including colloids with a core-shell structure. We used optical traps to measure colloidal forces between PMMA particles in CHC. A more sensitive measurement can be achieved when the particles diffuse freely while they move under influence of interaction forces between them. From the statistics of many holographically measured trajectories one can measure the interaction forces between the colloids with fN accuracy. We demonstrated that this technique allows measuring the screened charge interaction between colloids in various solvents.