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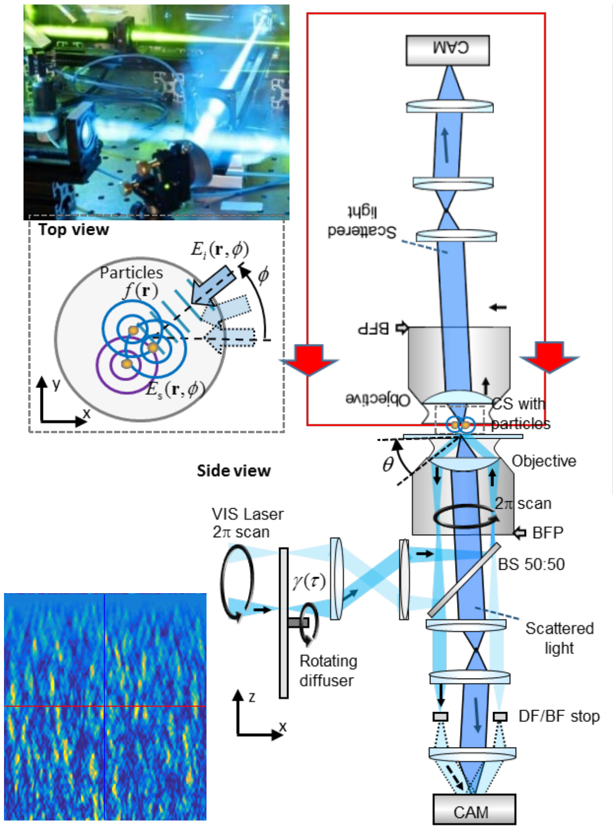
Master thesis

Coherent imaging using correlative separation in a 4pi ROCS microscope

Background: Recently, we have presented the novel super-resolution imaging technique based on rotating coherent scattering (ROCS). Here, a 2pi azimuthal scan of an obliquely incident, unfocused laser beam during the integration time of a camera generates a partially coherent image, which reveals a superior contrast and a resolution of about 150nm without any postprocessing. ROCS has enabled the image acquisition of living, highly active cells at 100 Hz - much faster than other techniques. Without requiring fluorophores, thousands of images can be monitored online without loss in image quality, opening new insights into the unexpectedly high dynamics of living cellular systems. We want to extend the image formation to 3D and further improve the resolution (see planned setup fig. right).



Open questions

a) ROCS works excellently in total internal reflection (TIR) mode, but how can 3D information be extracted from a 3D object despite multiple coherent back-scattering processes?

b) ROCS has only been used in reflection mode. How can a new transmission mode be used in combination with the reflection mode?

Research project

a) Coherent imaging a cluster of spheres embedded in the transparent gel results in the same first order scattered field independent of the illumination direction. However, every subsequent layer of spheres (section) generates a different higher order scattered field, such that a superposition of all layers results in a different 3D image. Different speckle images with decaying cross-correlation coefficients.. (see

Top secret !

b) One of the existing ROCS setups will be extended by a transmission mode unit with a second objective lens and a second camera to record multiply back scattered & forward scattered light at the same time (4pi configuration with angular scans). In a first step, incoherent image correlation will be investigated. In a further step – if time is left – a coherent image correlation (interference) needs to be dissected.

Both project parts a) and b) require experimental and construction work, as well as computer simulations and theory to work out the principles and to find the best research strategy for solving the above questions.

We are looking forward to answering your questions!