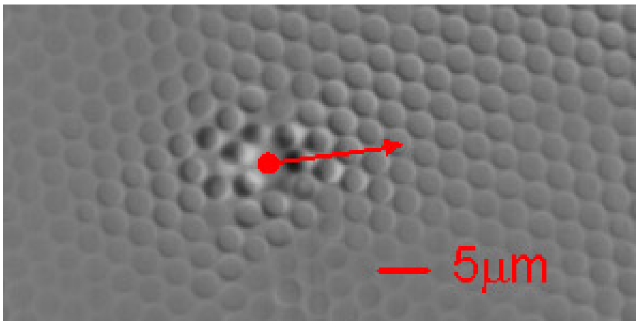
Master / Bachelor Project 2007/2008 in Soft Matter
VAN DER WAALS-ZEEMAN INSTITUTE

From atomic scale to continuum: Measuring displacement fields of model atoms

How do the macroscopic properties of a material arise from the local bonds between the individual atoms ? On a macroscopic scale, the hardness of a solid or resistance to flow of a liquid are described in a continuum picture by the material's elastic and viscous moduli, whereas on the atomic scale the individual atomic bonds are responsible for the material's mechanical stability. How do the discrete atomic displacements emerge on larger and larger scales into the displacement field described by continuum theory ?
We will address this question by studying model crystals and glasses composed of micrometer size colloidal particles. Due to their Brownian motion, these particles form phases (gas, liquid, crystal), which show many hallmark features of the corresponding atomic phase, but with the advantage that the individual particles can be easily imaged with an optical microscope. In particular, confocal microscopy allows us to precisely locate the particles in three dimensions, enabling us to use these systems as models or 'analogue computers' to study condensed matter at the atomic scale. In this project, we will apply local perturbations in colloids on the microscopic scale by pulling on magnetic particles that are incorporated in the colloidal suspension, and we will visualize the resulting distortion in three dimensions on the particle scale. By comparing the measured displacement field with that predicted by continuum theory, we will be able to determine the local elastic moduli, and we will get insight into the stability of the material on length scales from micro- to macrocopic.



Distortion of a colloidal crystal lattice
A magnetic particle embedded in a colloidal crystal is pulled to the right in a magnetic field (red arrow); gray gradients visualize the resulting displacements of particles around the magnetic particle; the particles move from black to white.

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