

PhD position in Soft Condensed Matter Physics

Assembly and mechanics of colloidal superstructures

Goal

The aim of this PhD project is to investigate the assembly and mechanics of complex colloidal structures made from patchy colloidal particles. Recent breakthroughs in synthesis allow the design of anisotropic colloidal particles that serve as building blocks in complex micron and nanoscale structures. These structures are both of fundamental scientific interest as well as important for applications in future smart materials. This project explores the physics of their assembly, and the resulting mechanical properties. It will provide fundamental insight into complex self-assembly processes and mechanical response at the micron- and nanoscale for tomorrow's materials, and elucidate principles that also underlie complex biological structures.

Project description

New micron and nano particles have the potential to act as building blocks in hierarchical structures of tomorrow's materials: the ability to design these particles with exquisite precision over their shape and surface properties promise the creation of new micron and nano-scale structures with exceptional optical and mechanical properties. While recent breakthroughs in colloidal synthesis allow making these particles routinely, the assembly of these particles into functional structures remains a grand challenge: it requires fundamental understanding of colloidal assembly, and the statistical mechanics of equilibrium and non-equilibrium structure formation.

In this project we will use patchy colloidal particles of well-defined geometry to investigate the assembly and mechanics of complex superstructures. The particles interact via hydrophobic/hydrophilic patches that can be made with exquisite precision over the patch geometry, width and wetting properties. Using novel critical Casimir forces in binary solvents, we can control the assembly of these building blocks into complex superstructures and study the physics of assembly and resulting structural and mechanical properties in three dimensions with confocal microscopy.

We will systematically investigate the assembly of structures from di-patch, tri-patch, and higher-order particles and investigate the role of local coordination in the mechanical response. In collaboration with the theory and simulation groups in Amsterdam, we will then elucidate the underlying physical principles to understand the relationship between structure and mechanics, as well as search for universal mechanical instabilities, critical behaviour and universality classes. The combination of direct observation and modelling will yield fundamental insight into principles of structure formation and mechanical response that also underlie molecular and biological structures. Furthermore, this work should elucidate new "design rules" to create complex mechanical metamaterials at the nanoscale. The work will be embedded in the lively environment of the Amsterdam Soft Matter group, as well as the local Soft Matter cluster, a focus point of the faculty, with contributing experimental, simulation and theory groups.

The successful candidate will work in an inspiring cross-disciplinary environment with diverse expertise in colloidal synthesis and assembly, rheology and nanomechanics (Soft condensed matter group), as well as take part in our national and international collaborations.

Requirements

- Master in Physics or Physical Chemistry,
- Experience in the following fields: colloidal/nanoparticle synthesis or assembly, Soft Matter, Statistical Mechanics.
- Good communication skills (English).

Further information

For more information, please contact Prof. Peter Schall, e-mail P.Schall@uva.nl

Appointment

The appointment will be on a temporary basis for a period of 4 years (initial appointment will be for a period of 18 months and after satisfactory evaluation it can be extended for a total duration of 4 years) and should lead to a dissertation (PhD thesis). An educational plan will be drafted that includes attendance of courses and (international) meetings. The PhD candidate is also expected to assist in teaching of undergraduates.

Based on a full-time appointment (38 hours per week) the gross monthly salary will range from €2,191 in the first year to €2,801 in the last year. The Collective Employment Agreement (CAO) of the Dutch Universities is applicable.