Soft Condensed Matter & Biophysics

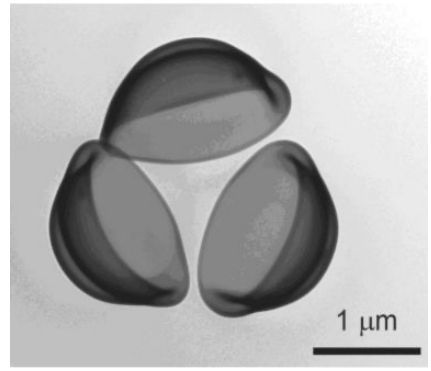
literally just means that it's soft

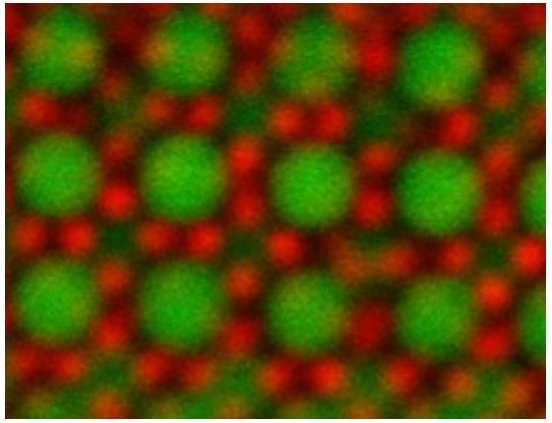
Fancy word for solids and liquids

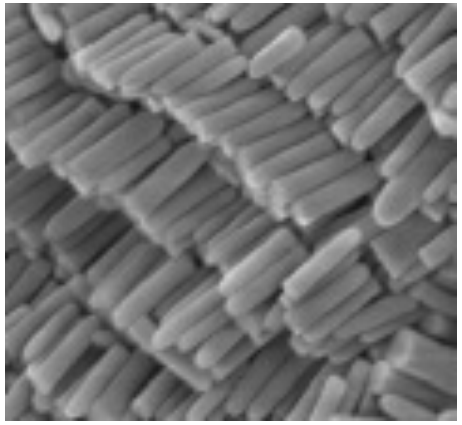
Department of Physics

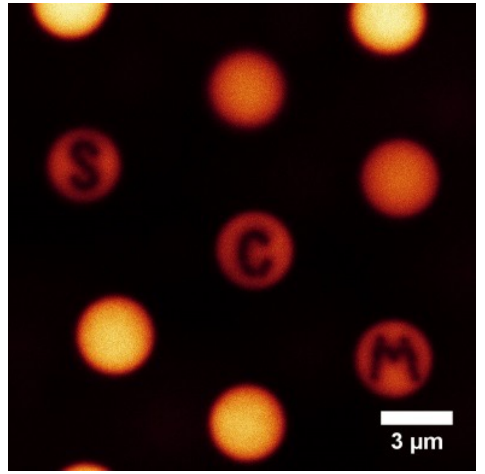
Don't be afraid of this!

Physics meets biology



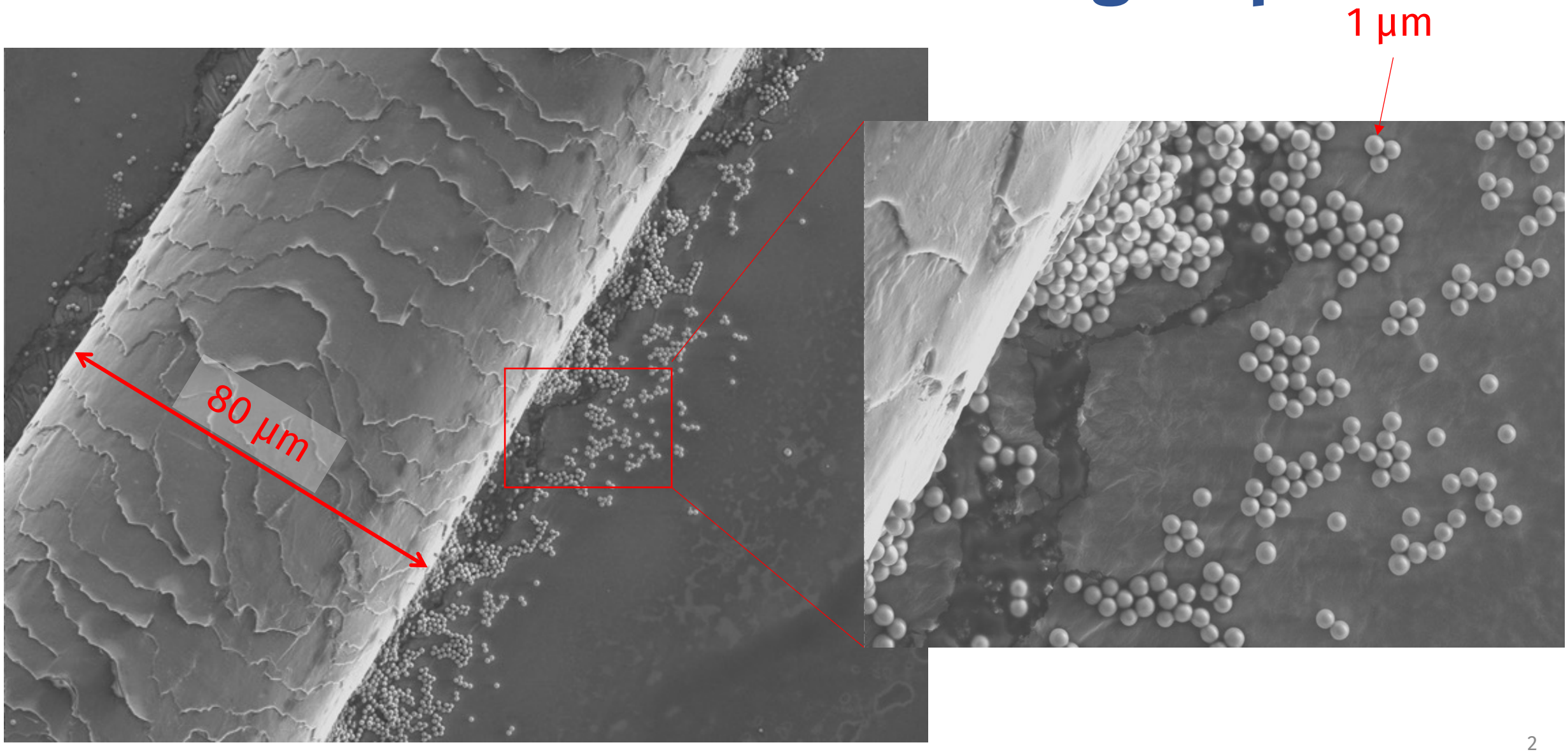




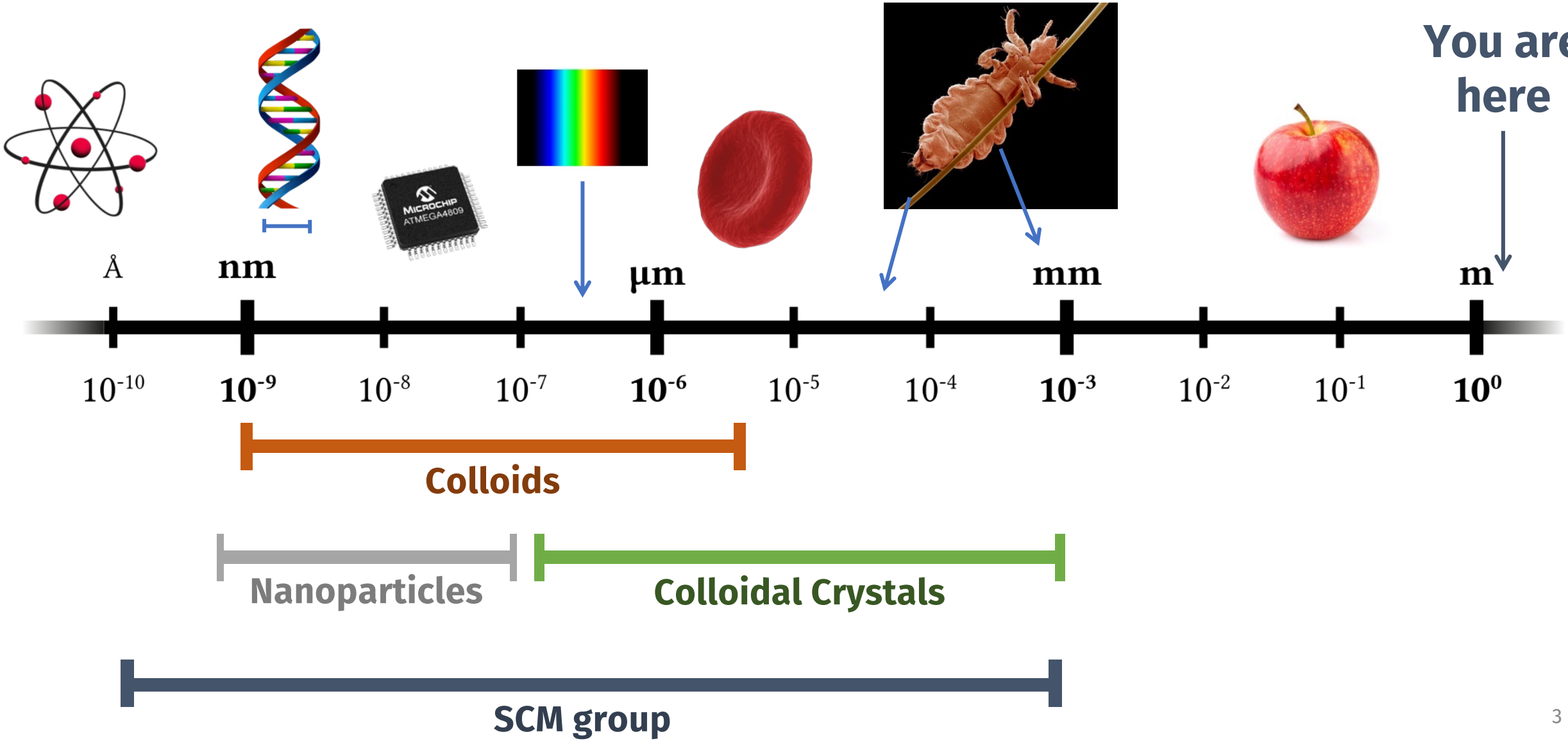


Tjom Arens| t.arens@uu.nl | www.colloid.nl

Colloids: the workhorses of our group



Orders of magnitude

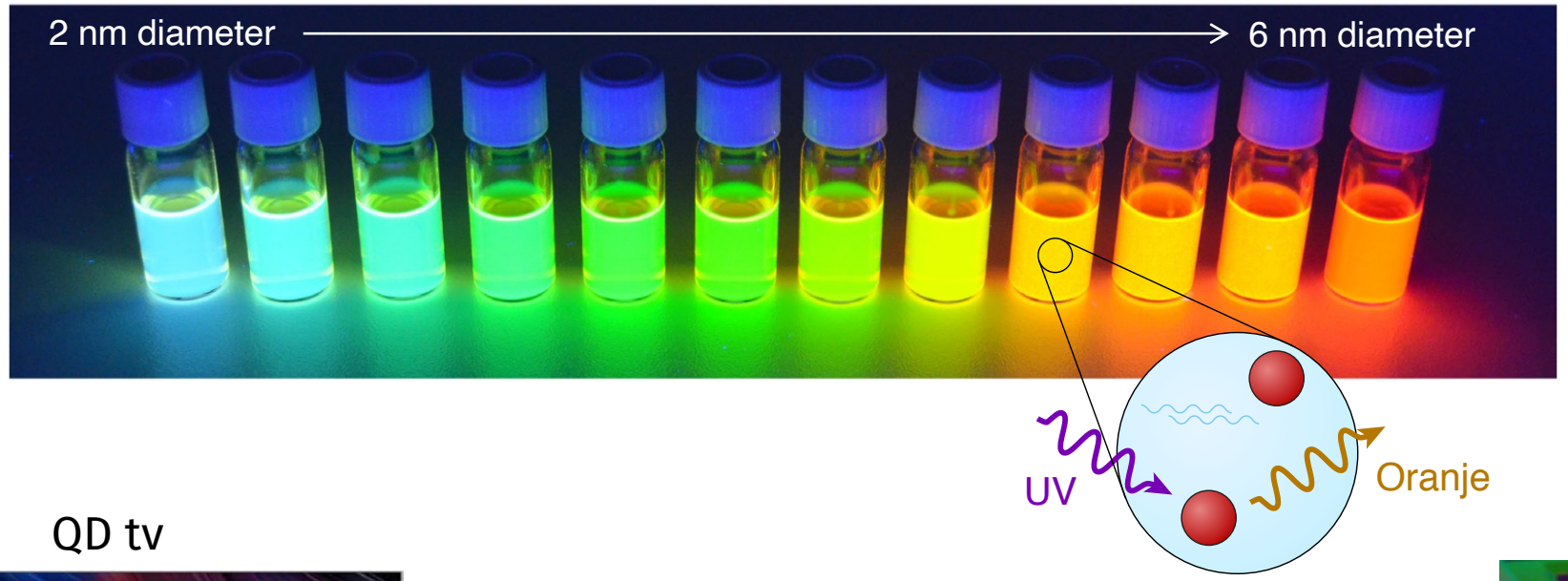


Colloidal crystals

What makes these colloids interesting?

They’re really at the interface of atoms and the macroscopic world

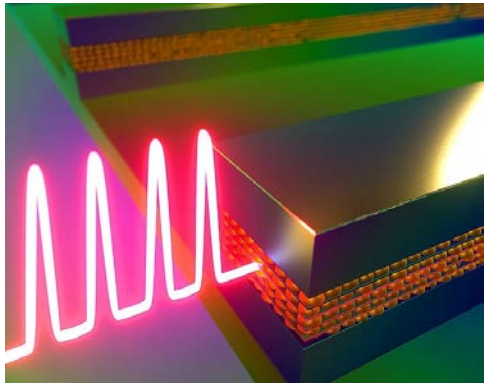
“Atom like” colloidal quantum dots



QD tv

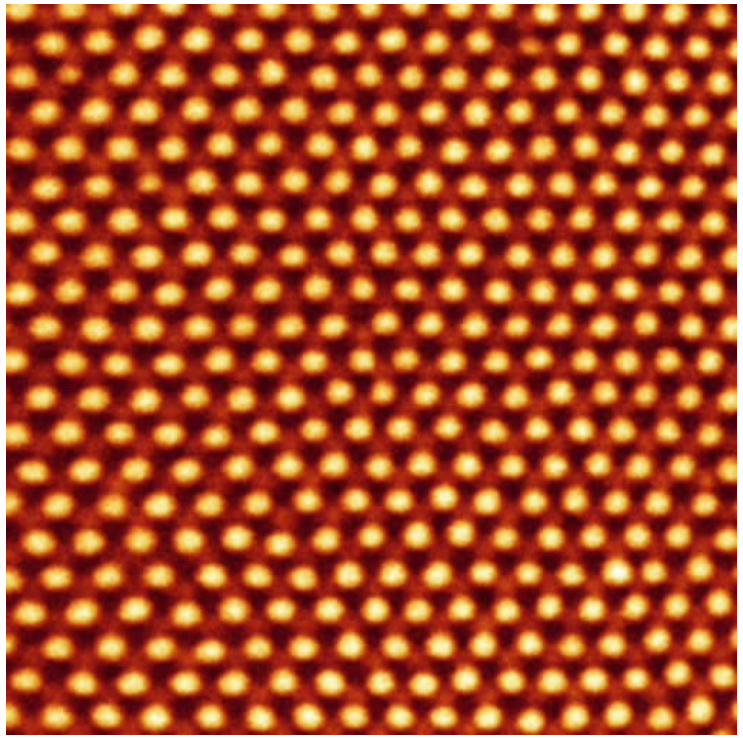
QD solar cells

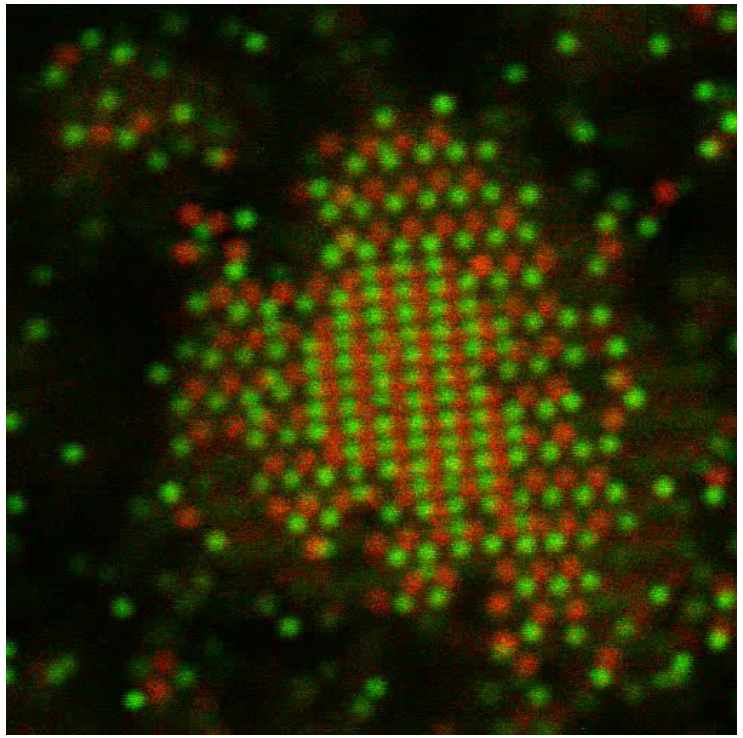
QD lasers

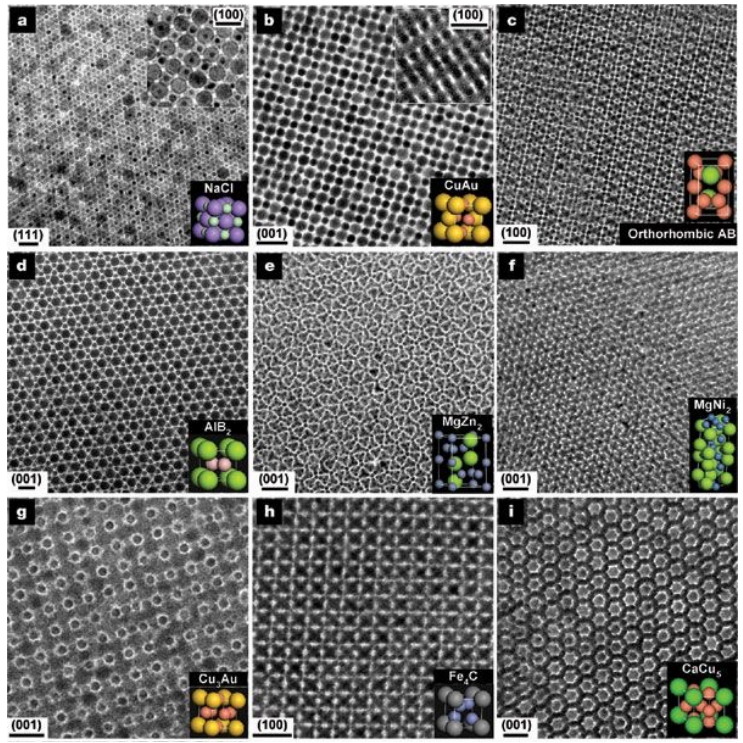


Colloidal crystals

Self Assembly: spontaneous organisation of particles into an ordered structure

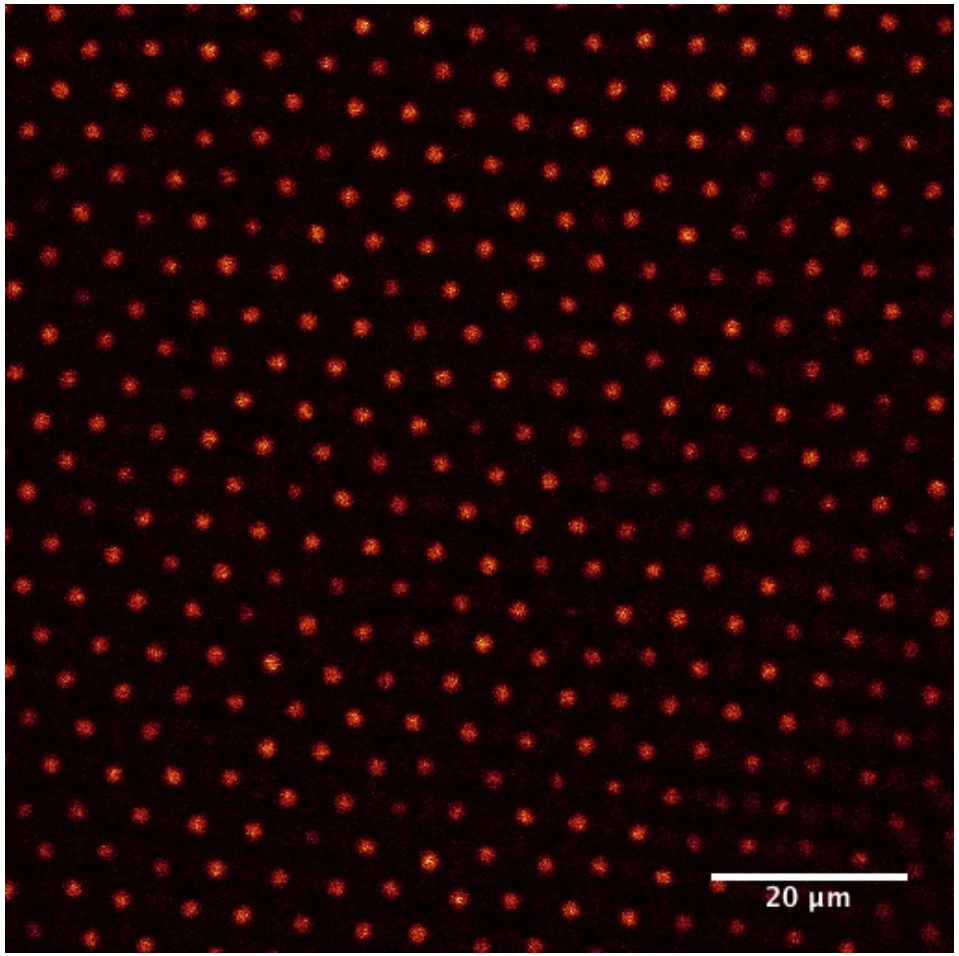


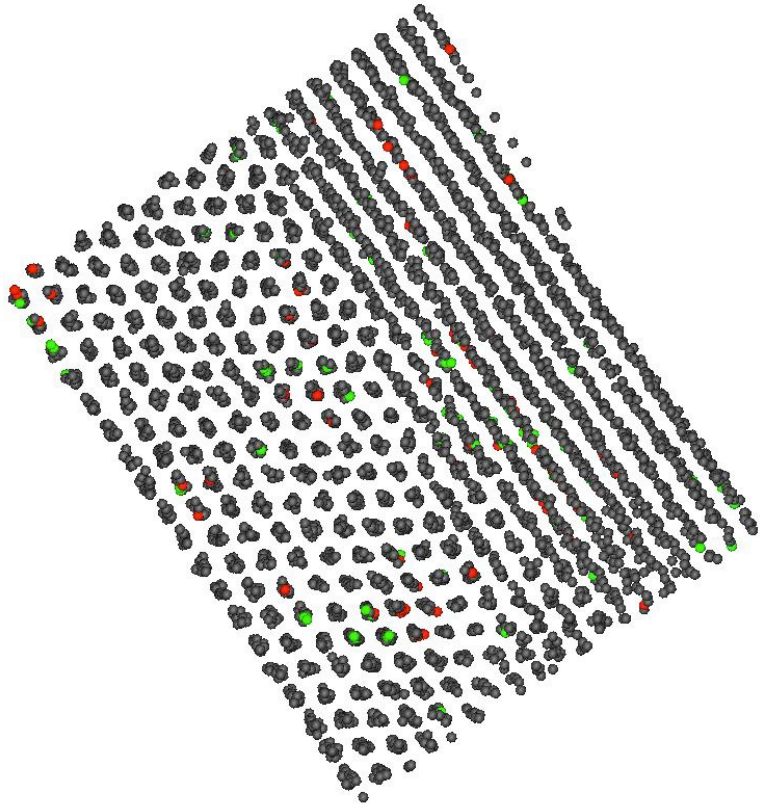




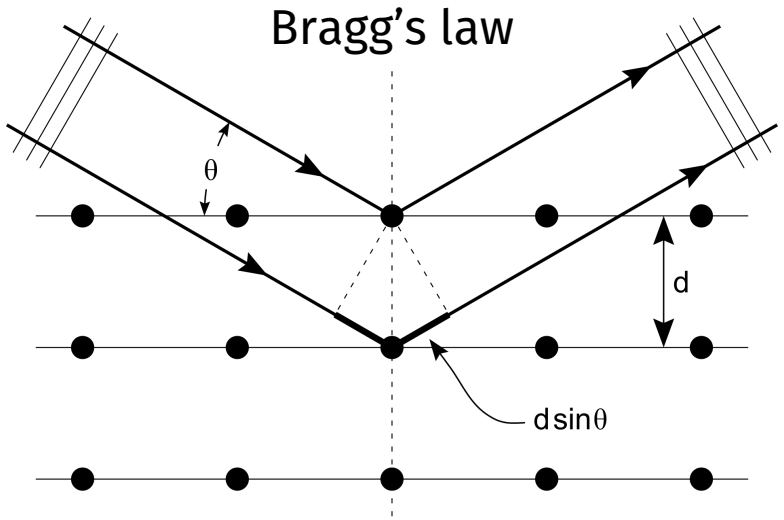
As these particles are much larger than atoms, we can see their 3D structure using microscopy

Imaging in 3D

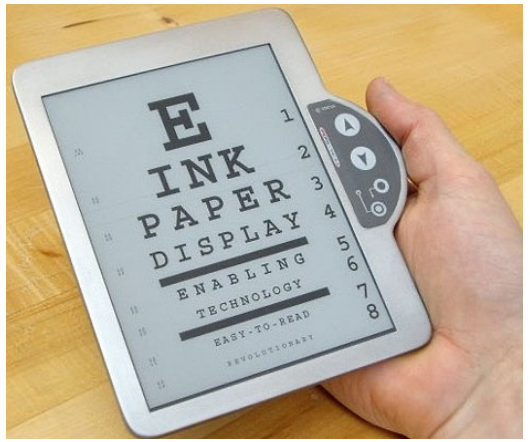


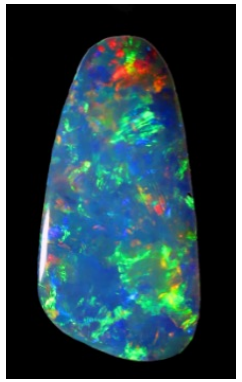


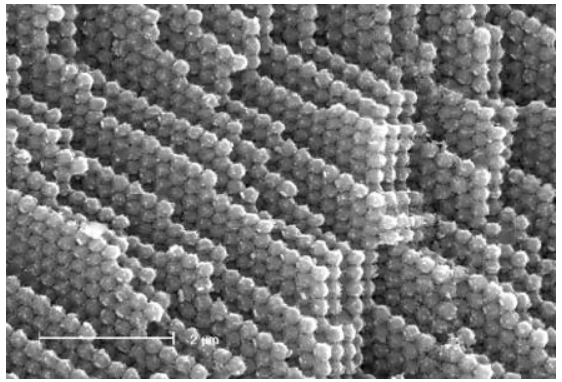
Applications: Structural colour

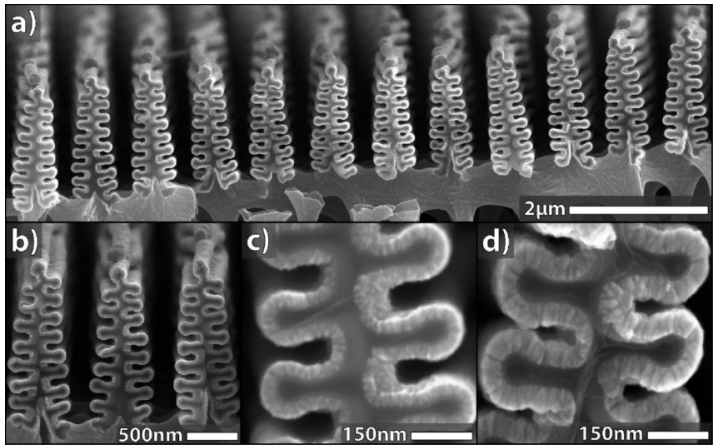


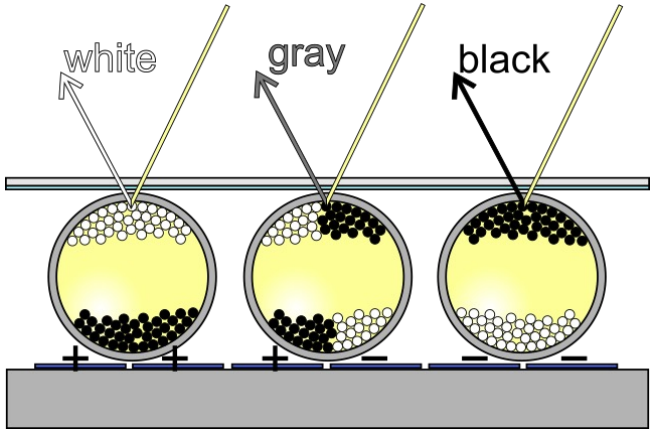
E-ink





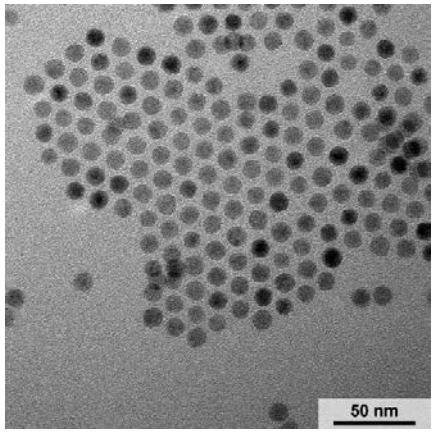




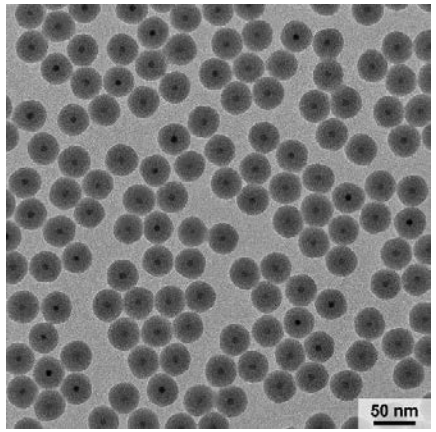


Research topics

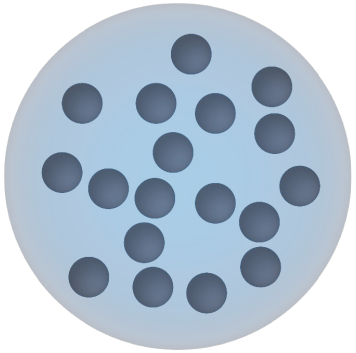
Self-assembly (for catalysis)

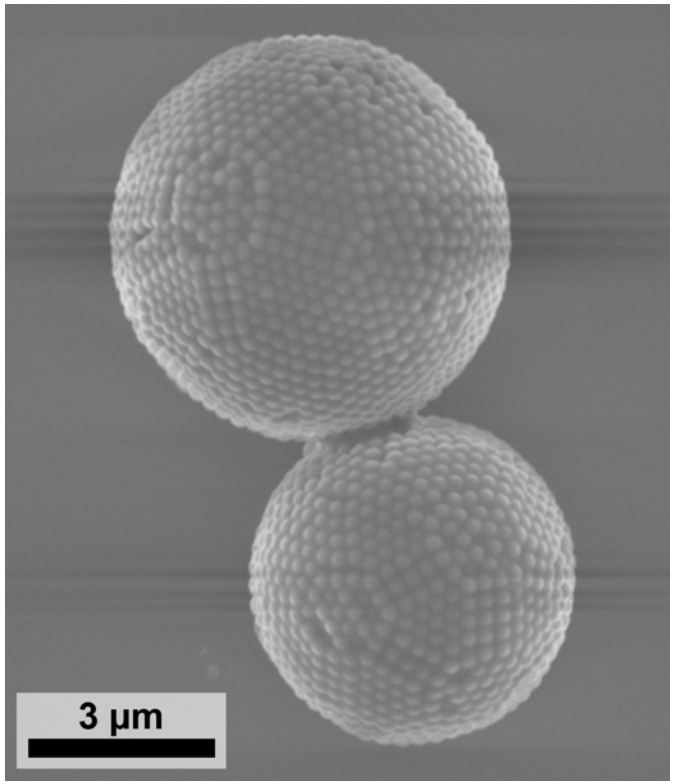


Fe_xO_y 11 nm ± 6%



Silica 38 nm ± 4%





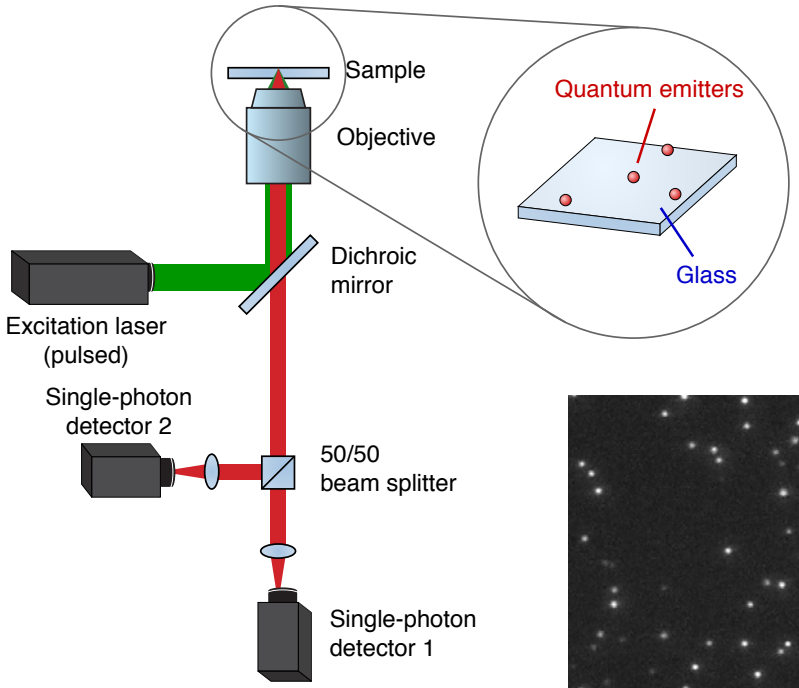
Studying different methodologies for silica growth on core nanoparticles for use in self-assembled catalysts

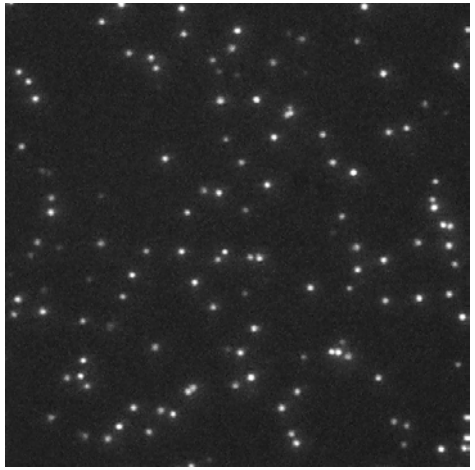
Alfons van Blaaderen

Arnout Imhof

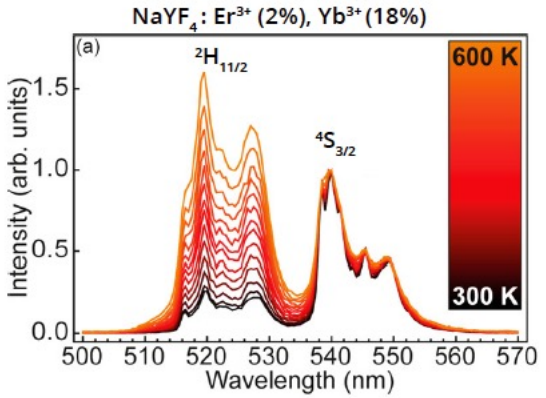
Single-particle spectroscopy

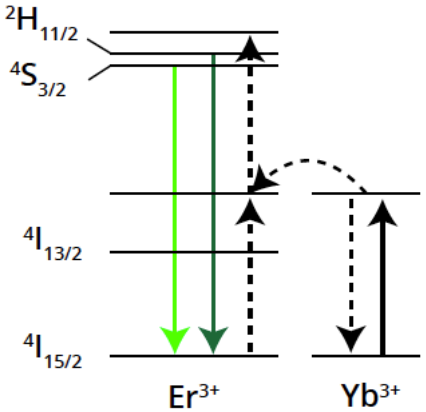
Single Quantum dots



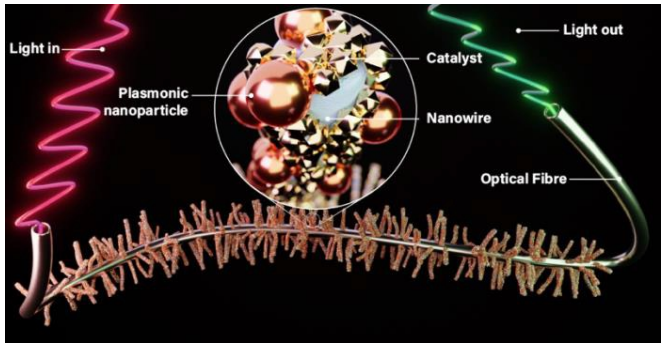


Nanothermometry



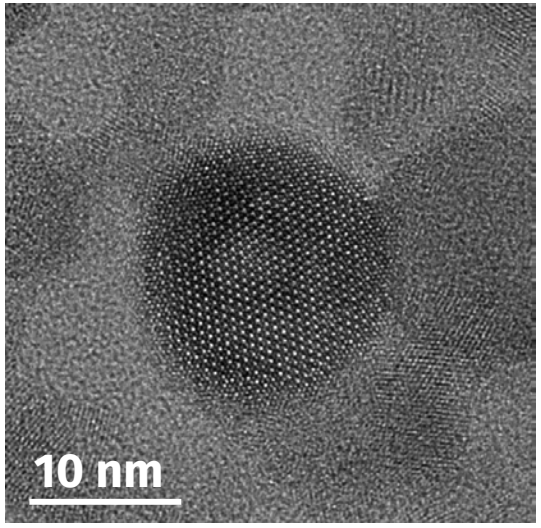


Nano catalytic reactors

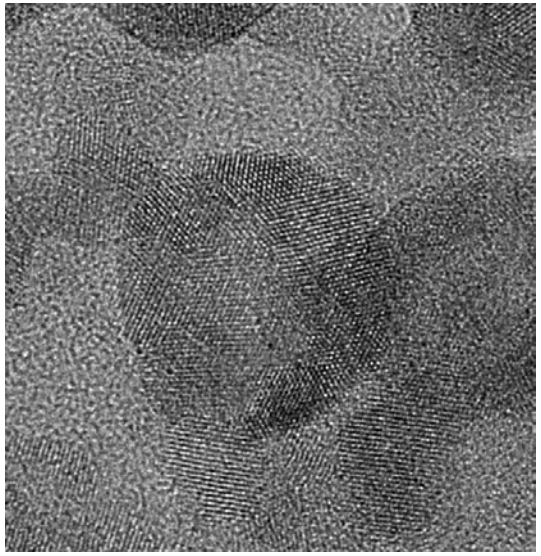


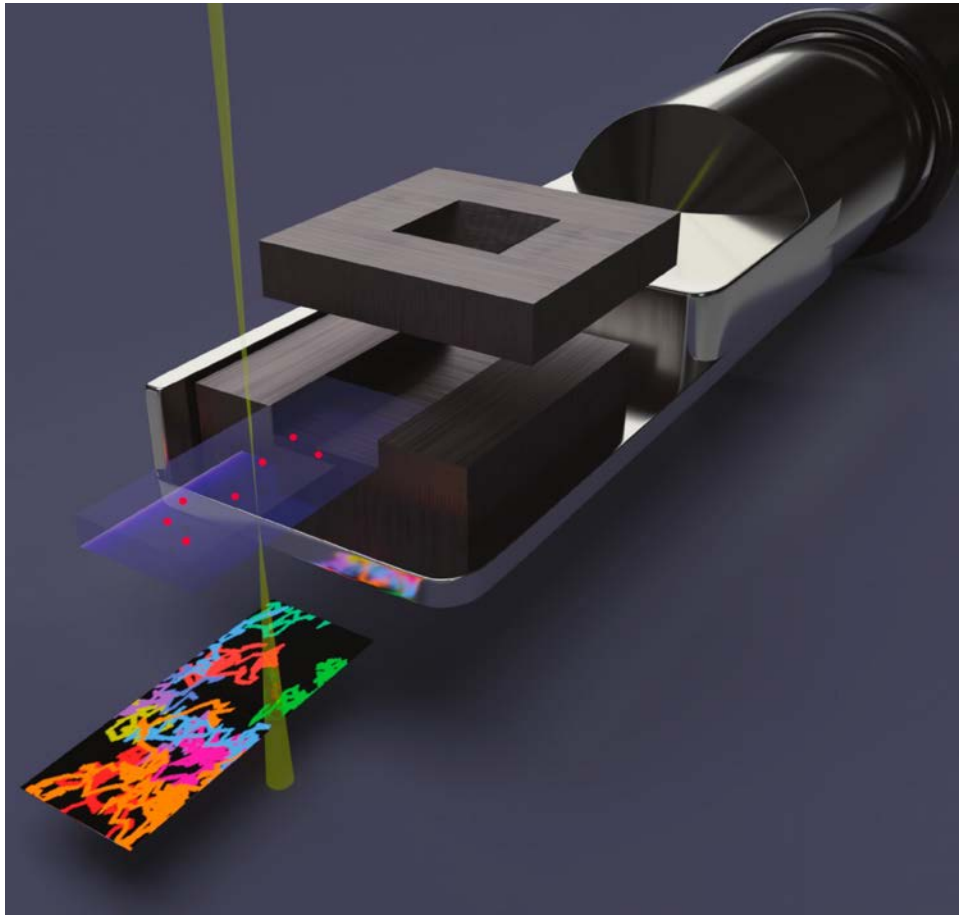
Freddy Rabouw

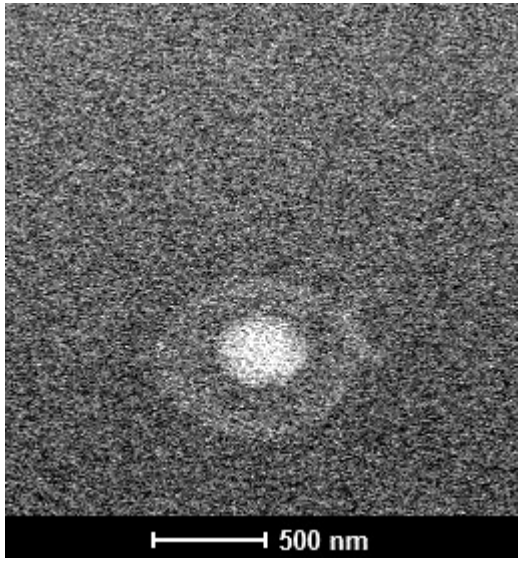
In situ electron microscopy

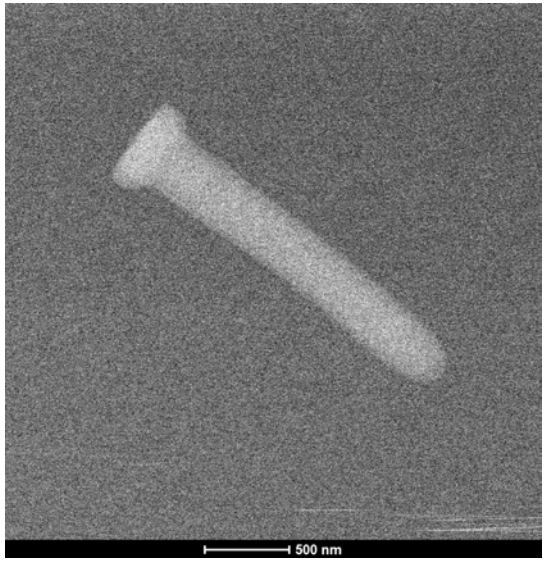


heat





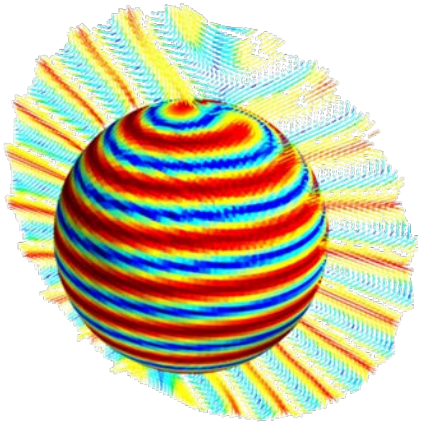




Marijn
van Huis

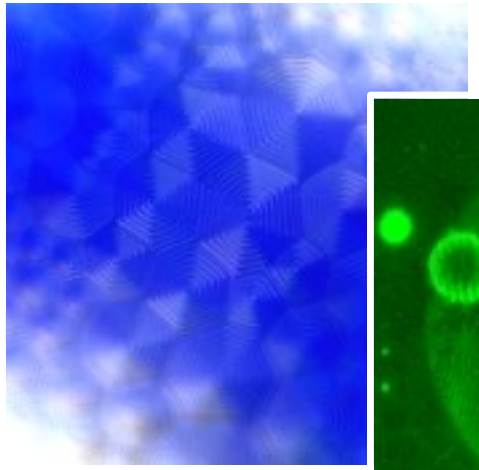
Bio-inspired materials

Uncover the fundamental organizing principles of soft and biological materials, with a special focus on liquid crystals.

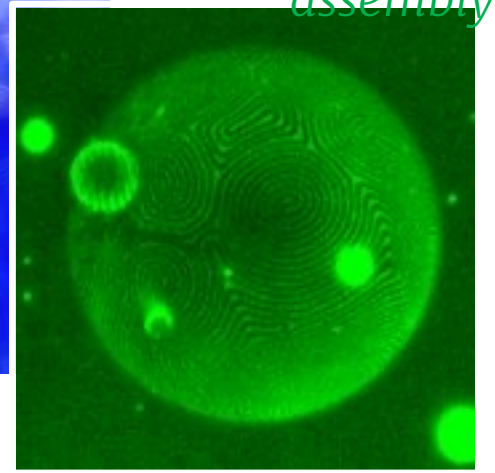


structural color in nature

liquid crystal structures



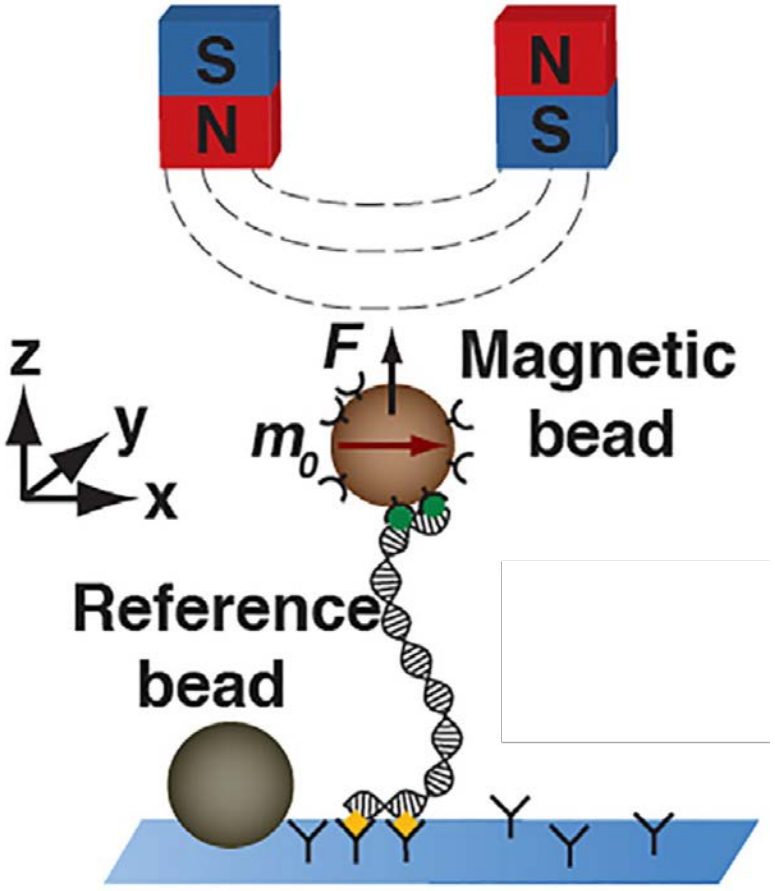
nanoparticle assembly



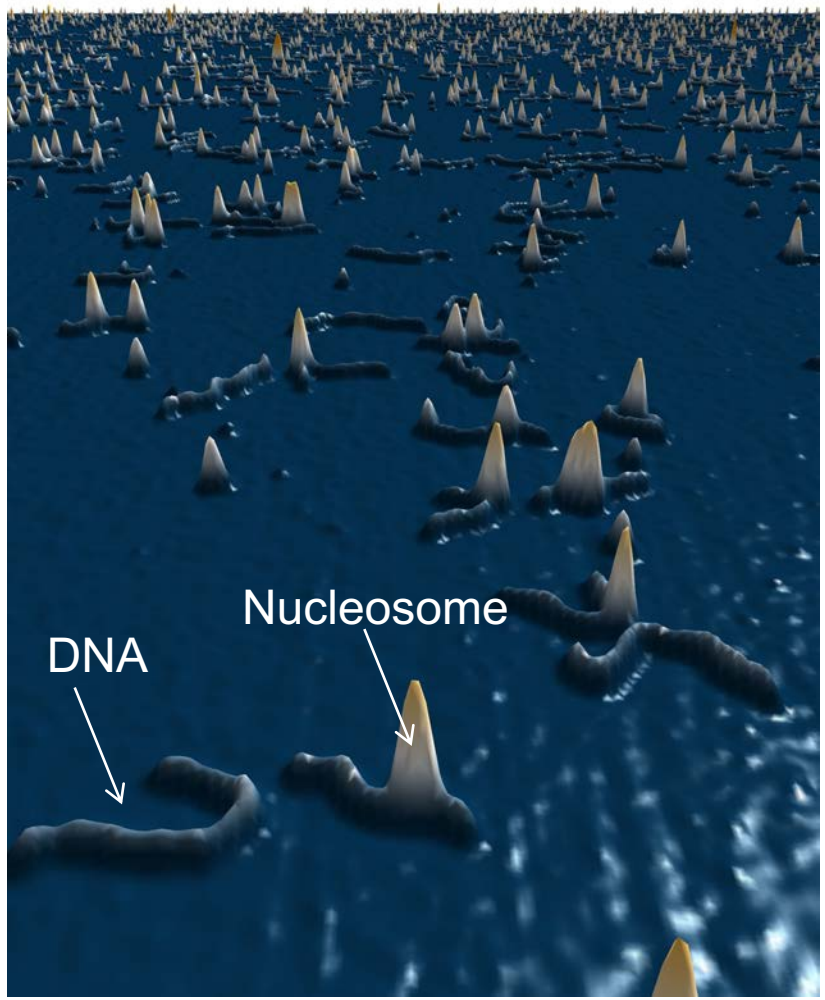
Lisa Tran

Biophysics

Investigate DNA processing using magnetic tweezers

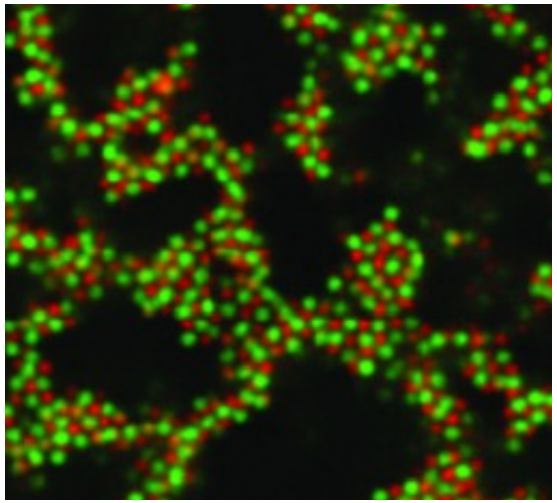


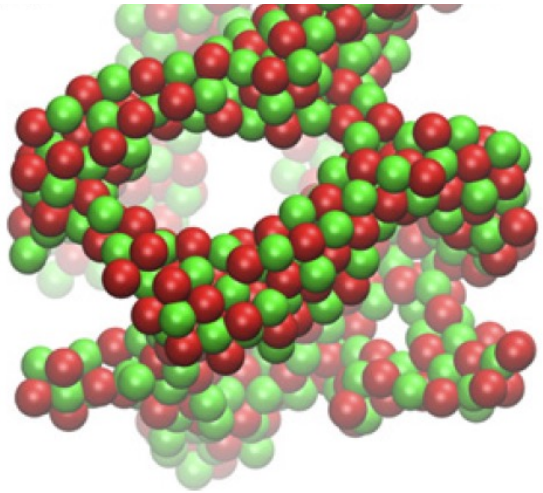
Visualize nucleosomes (the building blocks of our chromosomes) using atomic force microscopy

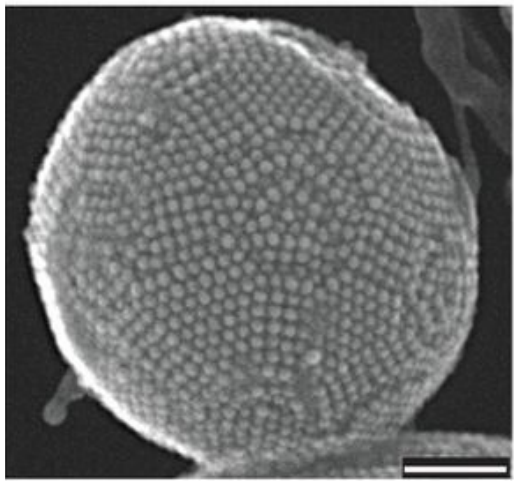


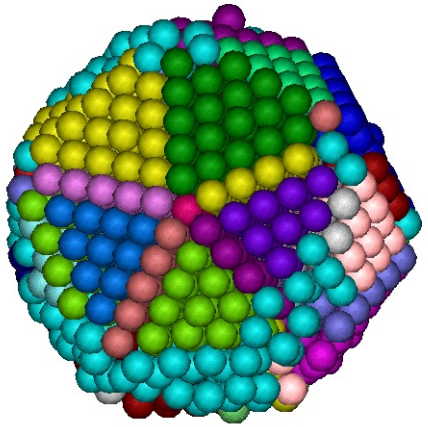
Jan Lipfert

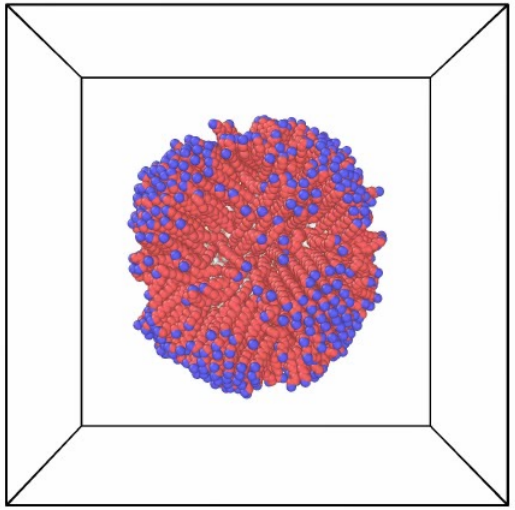
Simulations

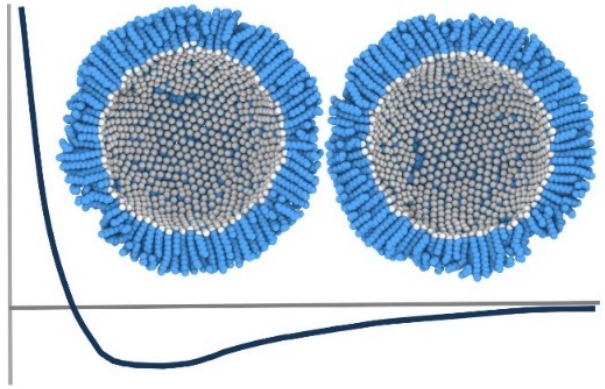












- Trying to understand self-assembly using advanced computer simulations
- Strong coupling between experiments, simulation and theory!

Laura Filion

Marjolein Dijkstra

Experimental

Alfons van Blaaderen

Self-assembly

Single particle spectroscopy

Freddy Rabouw

Colloids in external fields

Arnout Imhof

Electron microscopy

Marijn van Huis

Biophysics

Measuring forces on bio-molecules

Jan Lipfert

Bio-inspired Materials

Lisa Tran

Develop new microscopy tools

Gerhard Blab

Simulations

Inverse design and link to experiments

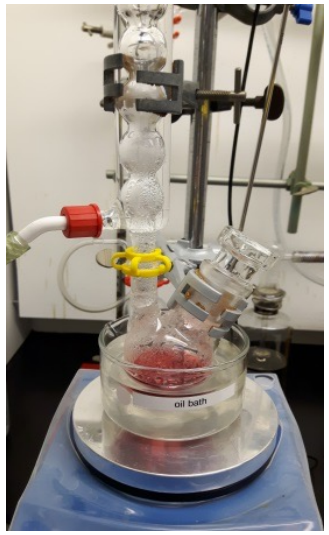
Marjolein Dijkstra

Defects, nucleation, simulations

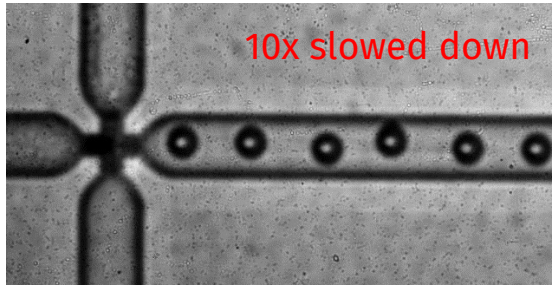
Laura Fillion

~30 PhD students, 7 postdocs
~50/50 chemistry/physics

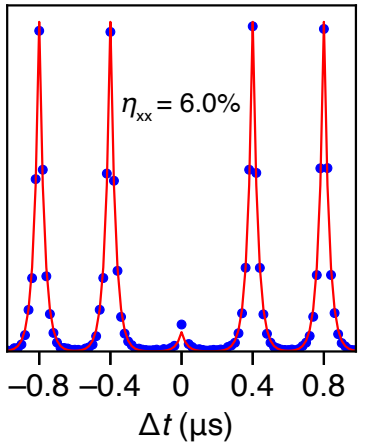
But what kind of things do you *really* do?



real chemistry!
(organic and inorganic)

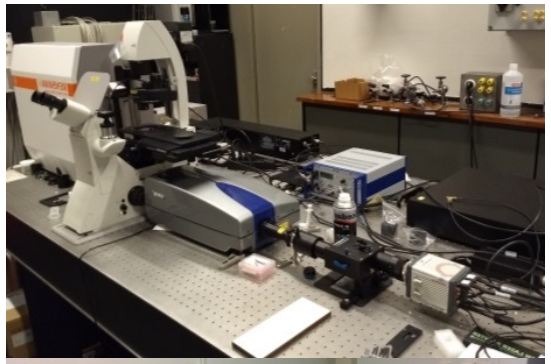


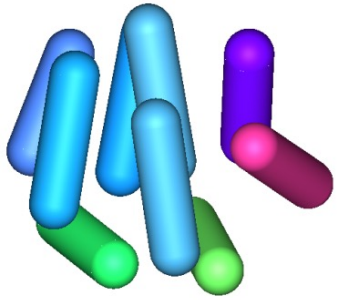
microfluidics

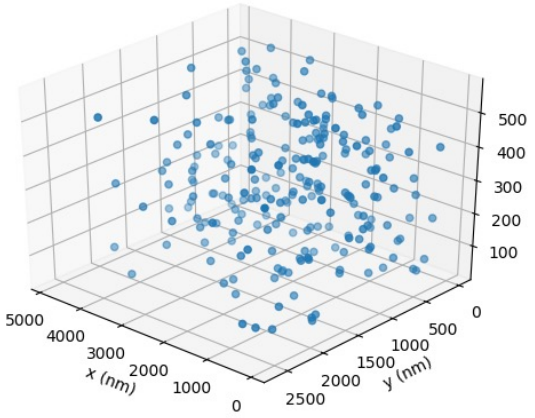


spectroscopy, light scattering,
single photon measurements

Lots of microscopy
(electron and
optical/fluorescence)





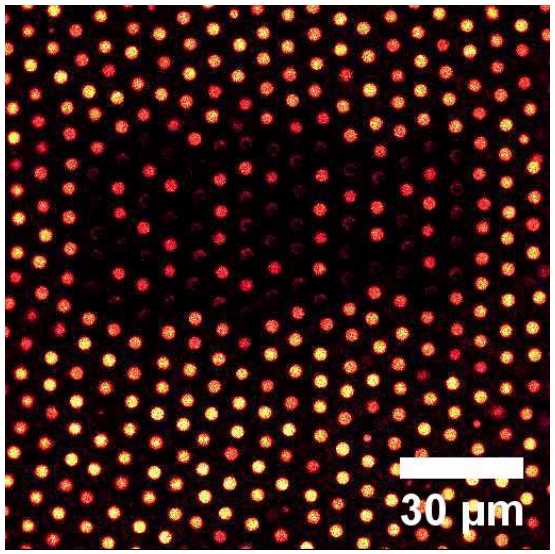


data analysis:
plotting, programming, modelling

I (might) want to do a project! What do I need to do? Where can I find information?

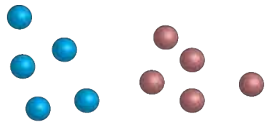
edu.nl/ffuug

- Some example projects:
  https://edu.nl/ffuug (or the QR code at top right)
- More information about the group:
  www.colloid.nl
- Contact person for experimental projects:
  Arnout Imhof: A.Imhof@uu.nl
- Contact for theoretical/simulations projects:
  Laura Filion: L.C.Filion@uu.nl
- Other questions? Not sure who to contact? Only want to remember one email?
  Email me: Tjom Arens (T.Arens@uu.nl)

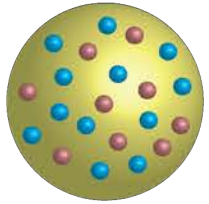


Example projects

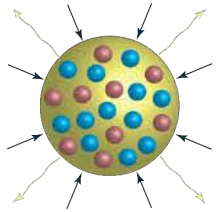
Synthesis of monodisperse nanoparticles for (binary) self-assembly



Nanoparticle building blocks

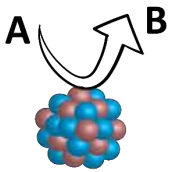


Emulsion droplet containing building blocks

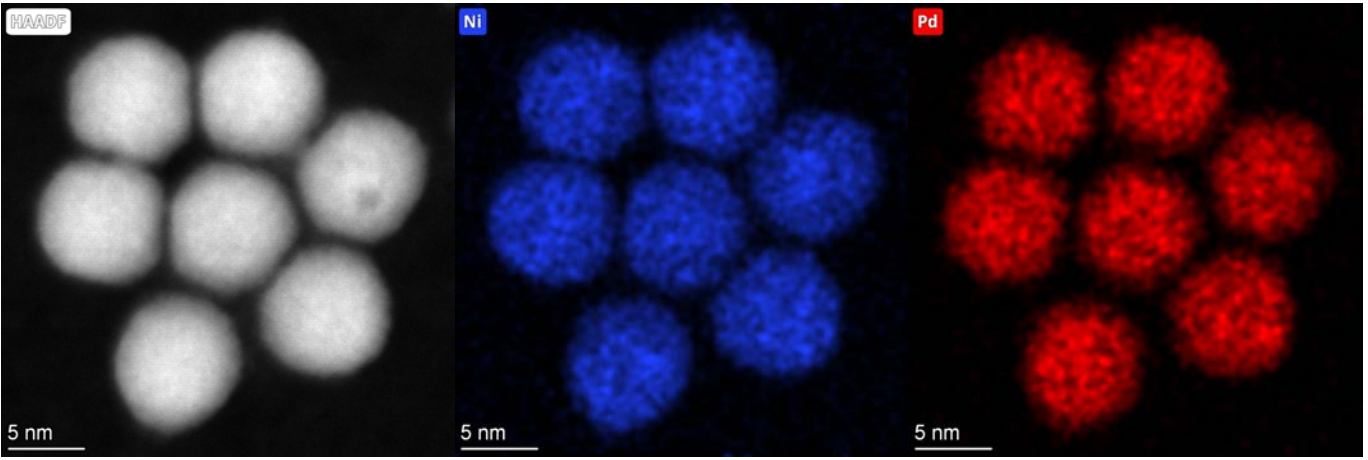


Slowly drying emulsion droplet

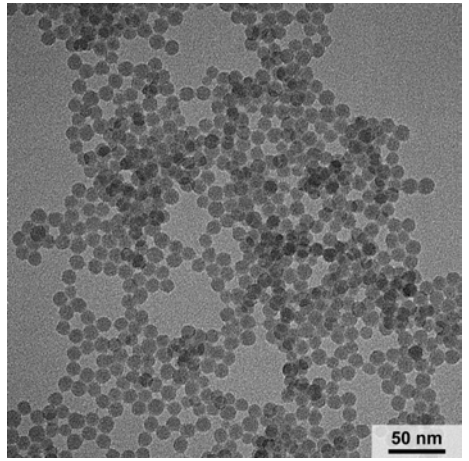
Crystallized binary supraparticle



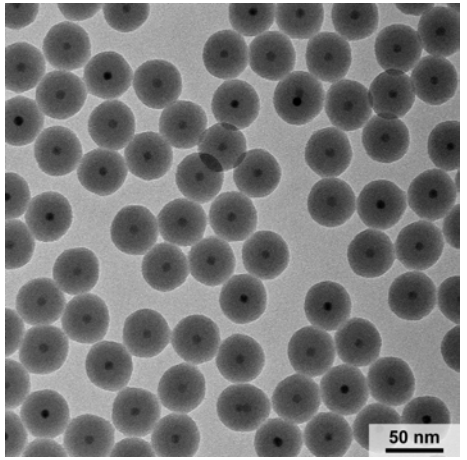
Heterogenous catalysis



Bimetallic NiPd 10 nm



SiO_2 12 nm

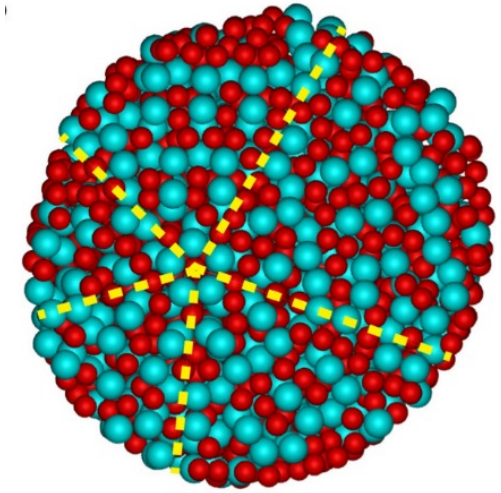


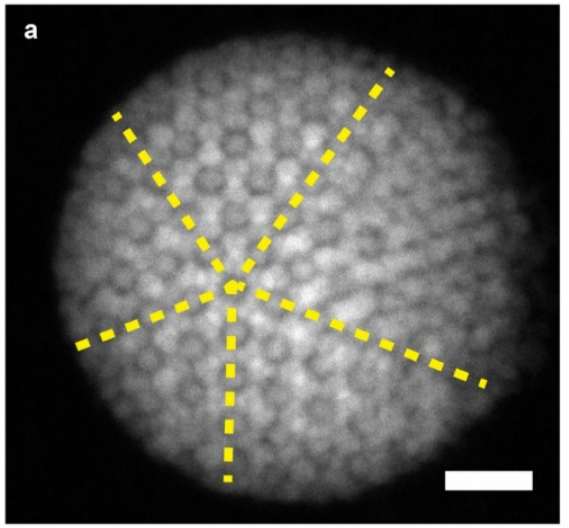
Fe_xO_y core + SiO_2 41 nm

Utrecht University

Quantitative Real-Space Analysis of Binary Nucleation and Growth of Colloidal Crystals

- **Research Question:** Classical nucleation theory (CNT) is over 100 years old but has never been tested yet experimentally on single particle level.
- **Skills and subjects to learn:**
  - Quantitative real-space analysis using confocal light nanoscopy and fluorescent core-shell colloids…
- **Keywords:** CNT, confocal microscopy, bond order analysis



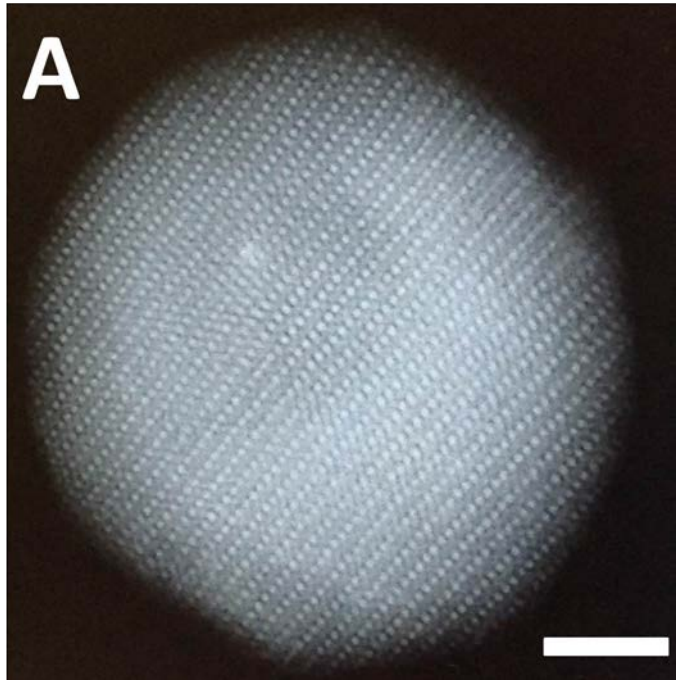


Alfons van Blaaderen

Utrecht University

Crystals of Crystals of NanoCrystals

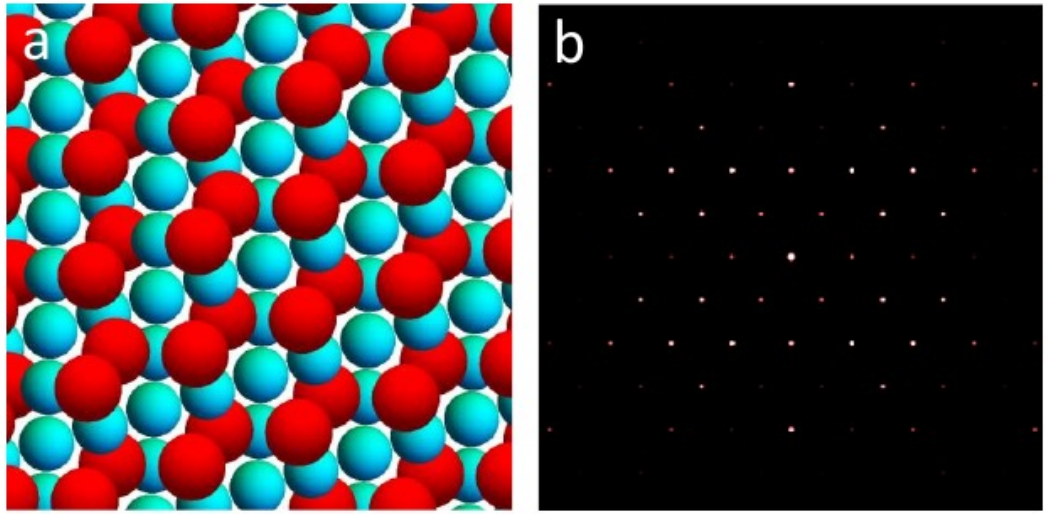
- **Research Question:** Structuring matter at multiple length scales is important to realize materials with new properties (*e.g.* negative index of refraction, photonic band gap)
- **Skills and subjects to learn:**
  - Quantitative real-space analysis using microscopy at multiple length scales…
- **Keywords:** confocal microscopy, electron tomography, microfluidics



Alfons van Blaaderen

Double BSc Projects: Chem./Phys., Phys./Math. & Exp./Theory

- **Research Question:** Research within the Soft Condensed Matter group often is helped by a multidisciplinary approach and therefore well suited for double BSc projects on wide range of topics (enquire!)
- **Skills and subjects to learn:**
  - Combining views from different disciplines in one coherent research project…
- **Keywords:** Chem./Phys., Phys./Math/, Exp./Theory,…

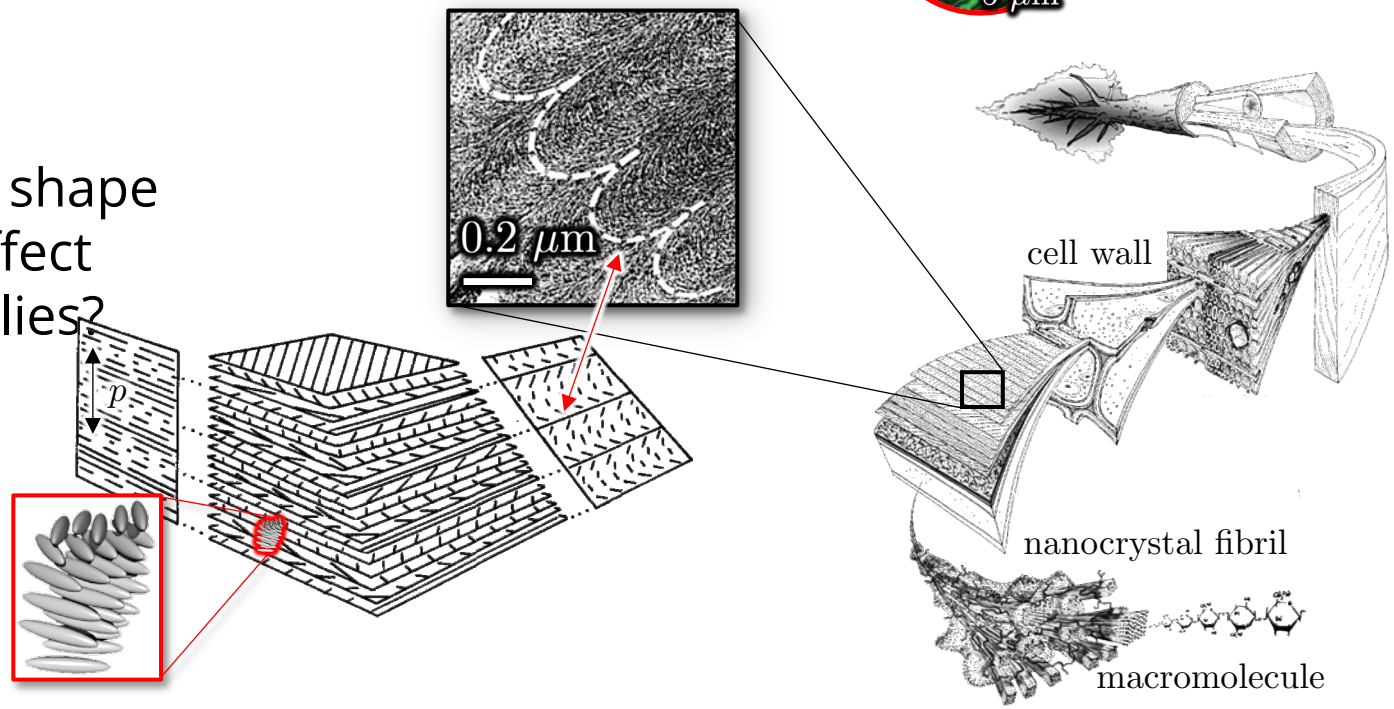


Alfons van Blaaderen

Utrecht University

Structural Color in Bio-materials

- **Research Question:** How does the shape of bio-derived, cellulose particles affect the structural color of their assemblies?
- **Skills and subjects to learn:**
  - Wet-lab work
  - Optical microscopy
  - Self-assembly
- **Keywords:** Bio-inspired materials, liquid crystals



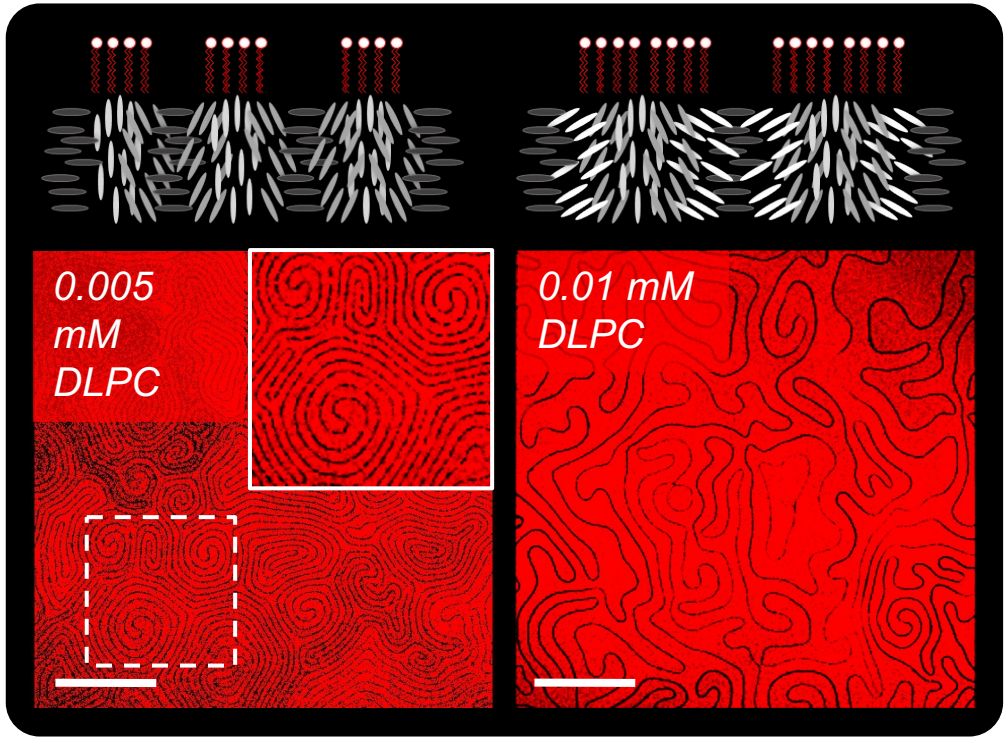
Visit
sites.google.com/view/tran-group
for more information.

Lisa Tran

Utrecht University

Lipid assembly in liquid crystals

- **Research Question:** Lipids make up cell membranes, but how does an anisotropic environment affect their assembly?
- **Skills and subjects to learn:**
  - Wet-lab work
  - Confocal microscopy
  - Self-assembly
- **Keywords:** Bio-inspired materials, liquid crystals



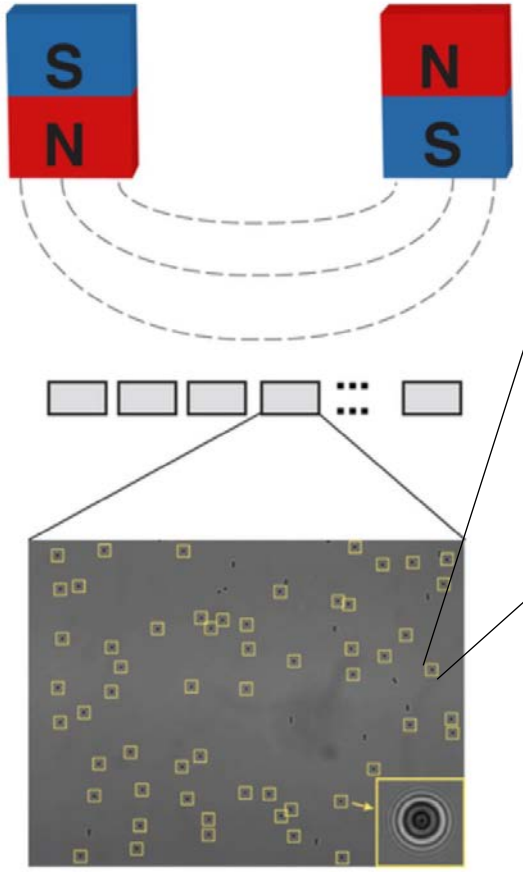
Visit sites.google.com/view/tran-group for more information.

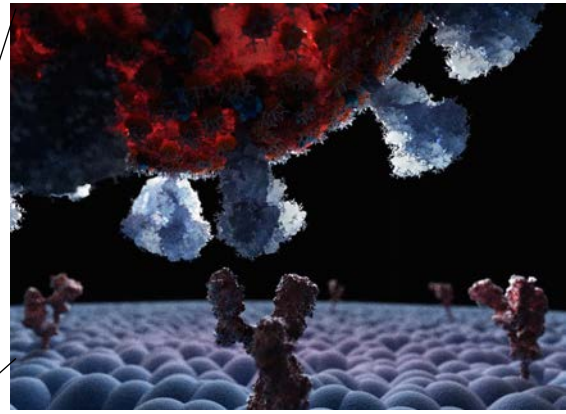
Lisa Tran

Utrecht University

Highly Parallelized Magnetic Tweezers for Single-Molecule Force Spectroscopy

- **Research Question:** Develop a high-throughput single-molecule assay to determine how proteins respond to and are regulated by mechanical forces.
- **Skills and subjects to learn:**
  - Single-molecule force measurements using magnetic tweezers
  - Image analysis, automation, and magnetic field modeling
- **Keywords:** Single-molecule force spectroscopy, magnetic tweezers, protein regulation



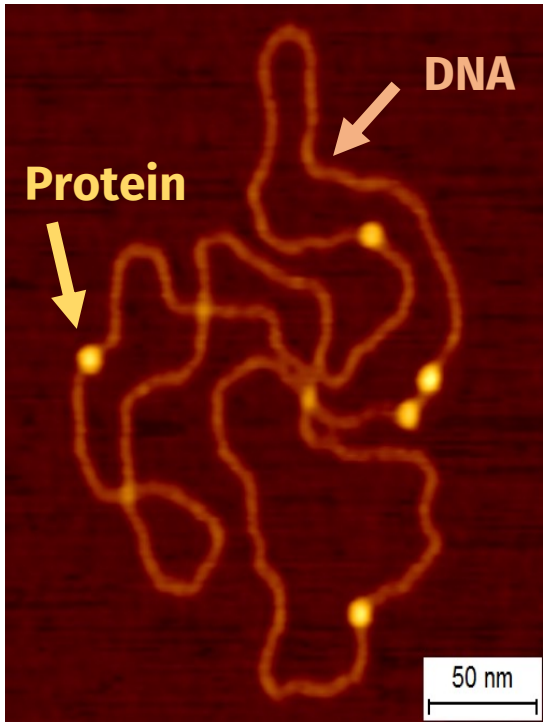


Jan Lipfert

Utrecht University

Revealing the Players of HIV Integration Using High-Resolution AFM Imaging

- **Research Question:** What is the molecular environment of HIV integration?
- **Skills and subjects to learn:**
  - Preparation of DNA and protein samples
  - AFM imaging of biomolecular complexes
  - Quantitative image analysis and modeling
- **Keywords:** Atomic force microscopy (AFM), HIV integration, quantitative image analysis

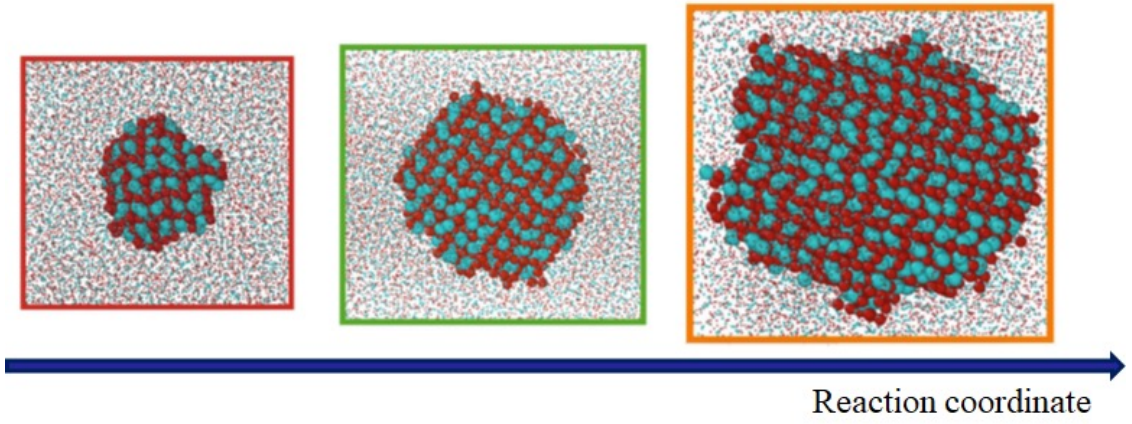


Jan Lipfert

Utrecht University

Can we machine learn colloidal liquids to nucleate?

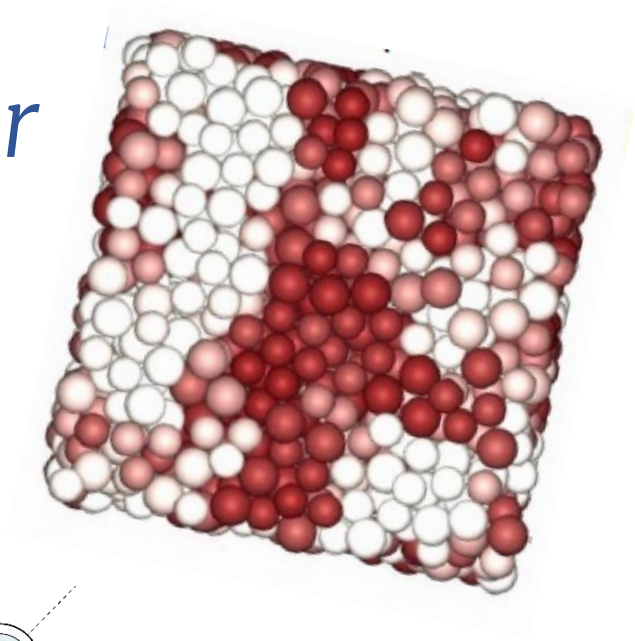
- **Research Question:** Can we use machine learning to find the best reaction coordinate to learn colloidal particles to crystallize?
- **Skills and subjects to learn:**
  - Programming skills
  - Machine Learning
- **Keywords:** Monte Carlo simulations



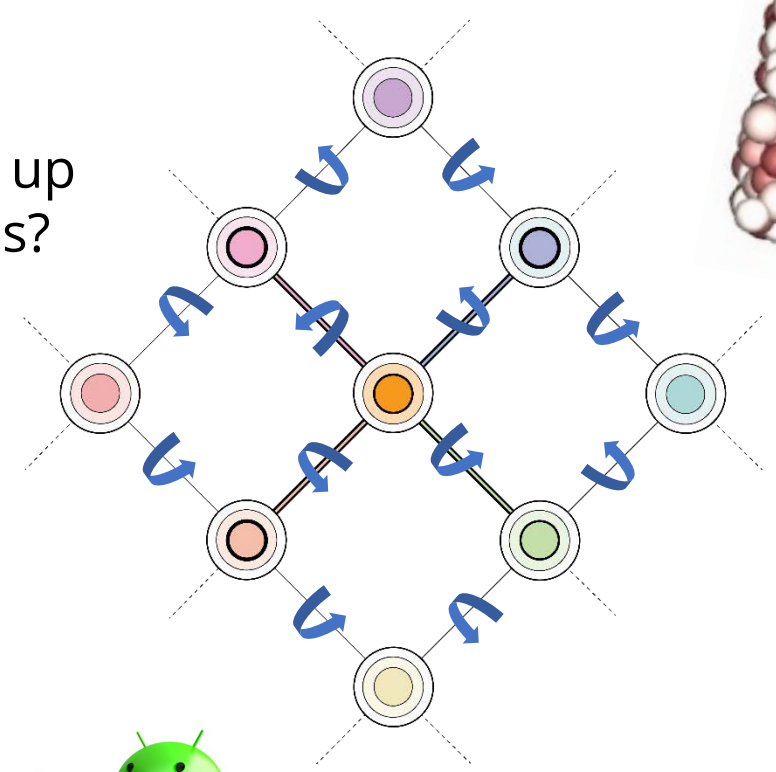
Marjolein Dijkstra

Utrecht University

Machine Learning & Soft Matter



- **Research Question:** How can we speed up simulations using advanced data analysis?
- **Skills and subjects to learn:**
  - C programming
  - Python
  - Statistical Physics
  - Machine Learning

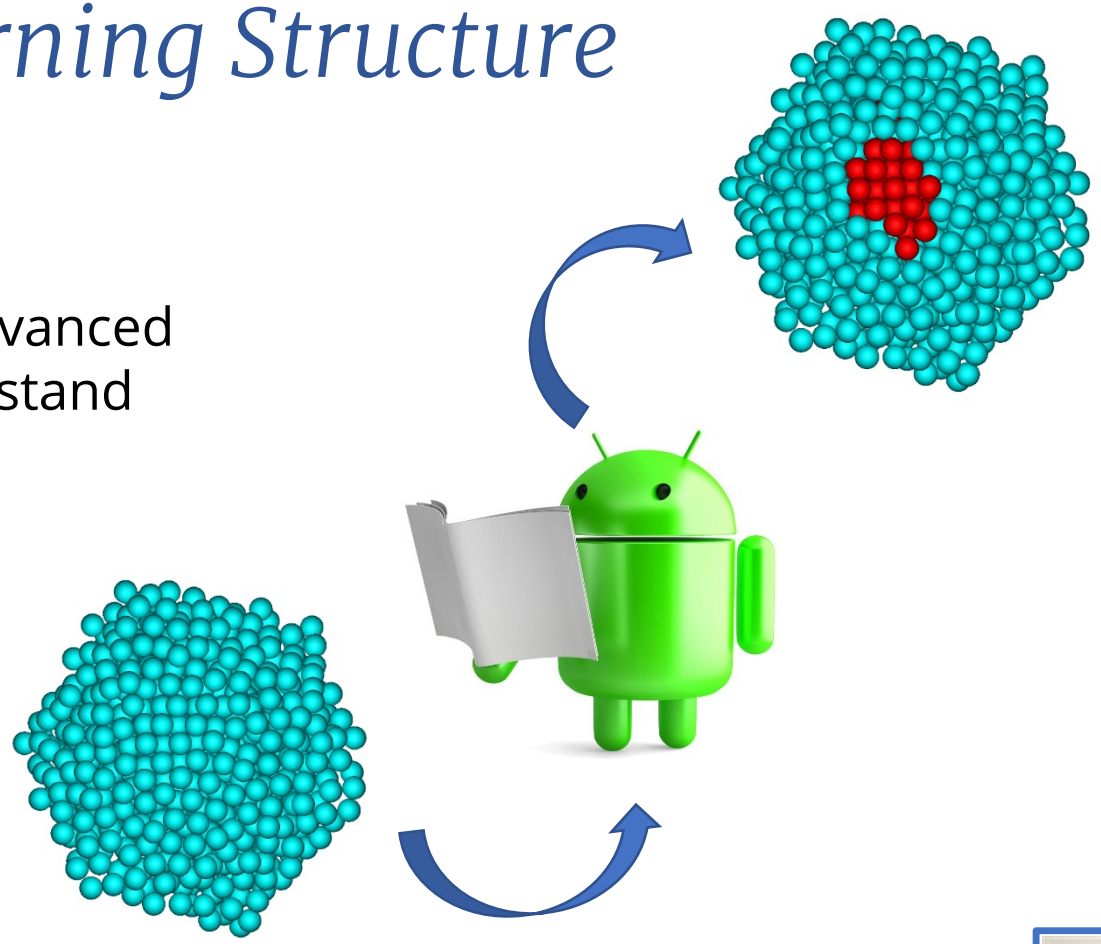


Laura Filion

Utrecht University

Machine Learning Structure

- **Research Question:** How can we use advanced data analysis techniques to better understand how systems self-assemble?
- **Skills and subjects to learn:**
  - C programming
  - Python
  - Statistical Physics
  - Machine Learning



Laura Filion