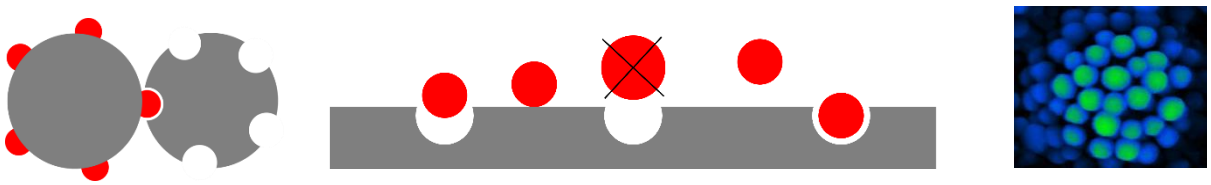
Master thesis project: Colloidal Locks and Keys



BACKGROUND

Lock and Key (L-K) interactions, well-known from enzyme-substrate interactions in biology, were recently introduced in the colloidal domain[1, 2]. The required 'tight fit' makes the L-K bond highly selective, making L-K colloids an interesting candidate for mimicking nature or making novel reconfigurable materials. Only few studies have addressed colloidal L-K bonding so far. Thermodynamically, the bond strength (compared to k_BT) is crucial for the reversibility of the bond. The driving force for bonding could be Van der Waals, electrostatic or depletion forces. Kinetically, bond formation is enabled by translational and rotational diffusion to align the locks and keys with each other.

RESEARCH OBJECTIVE

To address the question: how controllable are colloidal lock-and-key bonds? you will participate in various research activities. Depending on the stage of the research, and in consultation with you, this can include:

i) synthesizing colloidal 'locks' on a substrate, via a colloidal monolayer with sacrificial spheres.
ii) exposing the lock-substrates to suspensions of spherical colloidal 'keys' that fit in the holes.
iii) using 3D confocal microscopy to study the strength of the lock-key bond via the binding probability
iv) exploring the influences of the tightness of fit, electrostatic and depletion interactions.

Each of these activities involves experiments with colloids. Microscopic visualization and associated image analysis will play a central role in characterizing and quantifying the kinetics and thermodynamics of the L-K assembly. An impression of the type of work can also be found in a recent PhD thesis[3].

LEARNING OBJECTIVES

In addition to the standard learning objectives for a Master's project (research planning, academic writing, data presenting, how to work in a lab environment, etc.), you will:

- Learn or expand the fundamentals of colloid science
- Acquire lab experience in the preparation of colloids and their assemblies
- Learn how to work with a (dual wavelength) confocal scanning laser microscope
- Use (and write) analysis code in Python or Matlab

CONTACT INFORMATION

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REFERENCES

1. Sacanna, S.; Irvine, W. T. M.; Chaikin, P. M.; Pine, D. J., Lock and key colloids. Nature 2010, 464 (7288), 575-8.
2.Colon-Melendez, L.; Beltran-Villegas, D. J.; van Anders, G.; Liu, J.; Spellings, M.; Sacanna, S.; Pine, D. J.; Glotzer, S. C.; Larson, R. G.; Solomon, M. J., Binding kinetics of lock and key colloids. *Journal of Chemical Physics* **2015,** *142* (17).
3. PhD thesis B. Ilhan: 10.3990/1.9789036553087