Tunable Dynamics of Biological Rods and Responsive Active Colloids

L. Alvarez-Frances[1], M. A. Fernández-Rodríguez[1], E. Grelet[2], M. P. Lettinga[3], L. Isa[1]
[1] *ETH Zürich, Department of Materials, Zürich, Switzerland.* [2] *CNRS, Bordeaux, France*
[3] *ICS- Forschungszentrum Jülich, Germany.*

Biological systems possess rich dynamical and structural behavior, such as restricted motion in crowded environments [1], active self-propulsion [2] and, in particular cases, the emergence of liquid crystalline phases [3]. In order to understand the underlying physics of these processes, we try to mimic those using nano- and micron-sized particles. Our main challenges are to study the structure-dependence of passive particles on complex environments and to develop responsive active colloidal clusters, which can react to external stimuli. Inspired by lamellar and nematic structures found in nature, we study the passive Brownian diffusion of rod-like viruses through their liquid crystalline phases. Counterintuitively, we evidence that long rods diffuse faster than short rods forming smectic phases, due to commensurability effects [4]. In addition to passive particles, we also design active colloidal clusters that harvest energy from a uniform source and convert it into propulsion thanks to an asymmetry in their shape or composition [5]. However, current active particles lack the sensing capabilities and adaptive behavior of motile microorganisms found in nature [6]. Combining thermo-responsive soft materials with colloids, we produce a new generation of active clusters with an internal feedback on their propulsion in response to external temperature changes. The combination of the presented strategies, which combine elements of structural and dynamical control inspired by nature has the potential to lead to a new generation of active micro- and nanoscale systems with applications in biomedicine and material engineering.

[1] J. Dix, S. Verkman, Annual Review of Biophysics, **37**:247, 2008
[2] J. F. Reverey *et al*., Scientific Reports, **5**:11690,2015
[3] Gupta et.al Nature Communications, **6**:7525, 2015
[4] L. Alvarez, M. P. Lettinga, E. Grelet, Physical Review Letters, **118**:178002, 2017
[5] S. Ni, L. Isa, H. Wolf, Soft Matter, Accepted, 2018
[6] S.J. Ebbens, Current Opinion in Colloid & Interface Science, **21**:23, 2016