

Master 2 Internship

Title: Theory of protein thermophoresis

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Project:

Thermoosmosis and thermophoresis have become standard tools for creating microflows at laser-heated gold nanostructures and self-propelling active particles, and for analyzing the binding state of proteins. If the underlying physical mechanisms are well understood for colloidal particles and DNA, this is not the case for protein thermophoresis and its intricate dependencies on temperature, salinity, and surface properties.

This theory project aims at a better understanding of the motion of proteins along a temperature gradient. As a part of the ERC project HiPhore [1], it will be done in close collaboration with the experimental group of Guillaume Baffou at Institut Fresnel, Marseille.

Contrary to spherical particles and linear DNA, proteins have an irregular shape with non-uniform surface properties (positive and negative charges, hydrophilic and hydrophobic end-groups). They also show strong ion-specific interactions with salt (Hofmeister effect) and are sensitive to pH. The “surface” of a protein in a given conformation, consists of the amino acid groups of its constituents, which determine its thermophoretic mobility. Experiments indicate pH and thermoelectric effects, and charge regulation could play a role.

A recent experiment pointed out that thermo-osmosis at charged surfaces is significantly smaller than at uncharged materials [2]. At first sight one would expect the opposite behavior, since at charged surfaces both van der Waals and electrostatic forces contribute. In this internship we intend to study possible causes for this observation.

The project relies on non-equilibrium thermodynamics, physical chemistry of amino acids, and Stokes hydrodynamics.

[1] <http://www.fresnel.fr/spip/spip.php?article2056>

[2] A.P. Bregulla, A. Würger, K. Günther, M. Mertig, and F. Cichos, Phys. Rev. Lett. **116**, 188303 (2016)