Master 2 Project in Biophysics

Molecular Rotor Nanorheology : A physical approach to red blood cell pathologies

Where : Laboratoire Matière et Systèmes Complexes (MSC), UMR7057 CNRS & Université Paris Cité
Collaborations : Laboratoire Biologie Intégrée du Globule Rouge (BIGR), UMR_S 1134 CNRS & INSERM and Necker Hospital
Supervisors : Bérengère Abou (MSC), C. Le Van Kim (BIGR)
Keywords : red blood cells, molecular rotors, nanorheology, sickle-cell anemia, spherocytosis, diagnostics

Advanced biophysics with direct clinical impact

This project investigates intracellular nanorheology using molecular rotors — fluorescent probes which quantify local viscosity at the nanoscale. Our team at MSC laboratory has developed the application of these probes to measure rheological properties within red blood cells [1-2]. This approach allows quantitative assessment of red blood cell mechanical properties and detection of pathological alterations in sickle cell anemia and spherocytosis.

Objectives

- Understanding molecular rotor dynamics in crowded cellular environments
- Enhancing quantitative fluorescence-based rheology at the single-cell level
- Applying the MR nanorheology to pathological red blood cells
- Biomarkers identification for pathology monitoring

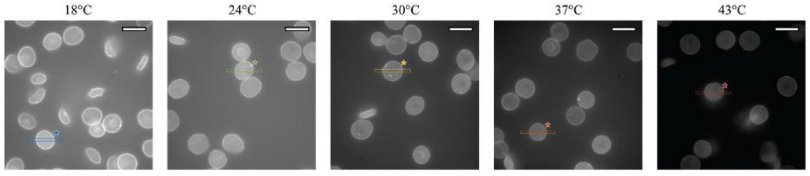
Medical motivation: Red blood cell pathologies involve altered cellular deformability that current clinical methods cannot sensitively detect. Physics measurements could directly improve patient diagnosis and monitoring.

Research environment: You'll work in Matière et Systèmes Complexes, soft matter lab with state-of-the-art microscopy and microfluidics facilities, collaborating with BIGR biologists and clinicians at Necker Hospital.

Technical skills: Advanced fluorescence microscopy, quantitative image analysis, machine learning implementation, and clinical assay development.

Candidate profile: Physics or Biological background. Programming skills (Python/MATLAB). Interest in applying rigorous physics to biological problems.

To apply: Send CV and motivation letter to Dr. Bérengère Abou: berengere.abou@gmail.com



Images of red blood cells incubated with the DASPI molecular rotor at increasing temperature (scale bar: 10 µm). The rotor fluorescence signal increases with RBC rigidity as temperature decreases.

1. A. Briole, T. Podgorski & B. Abou, Molecular rotors as intracellular probes of red blood cells rigidity, Soft Matter **17**, 4525 (2021).
2. A. Briole, M. Marin, C. Le Van Kim & B. Abou, Using molecular rotors to investigate hemoglobin concentration and heterogeneity in red blood cells, J. Rheol. **69**, 463 (2025).