Internship 1st semester 2026 (5/6 months)

Characterization of superparamagnetic nanoparticles magnetophoresis in passive microfluidics

Context

Our G2Elab & LMGP teams collaborate on the magnetophoresis of superparamagnetic nanoparticles (SNP) as a promising tool for the integration of biochemical analysis steps into Lab-on-Chip (LOC) devices. SNPs can be functionalized on their surface to target and manipulate specific biomolecules. This research runs in collaboration with *MagIA diagnostics*, a startup company developing an innovative tool for point-of-care testing of infectious diseases, implemented as fast and portable immunoassays. The technology combines a substrate containing embedded micro-magnets, functionalized SNPs and a localized fluorescence detection allowing direct quantification of the targeted biomolecules, without mixing nor washing steps [1].

Project

The present project focuses on SNP magnetophoresis [2], which refers to SNP transport using magnetic fields and gradients. Due to their sub-micrometric size and superparamagnetic behavior, SNPs present low magnetic content and are thus challenging to manipulate. We exploit the benefits of the size reduction of magnets, which leads to the generation of high magnetic field gradients (~ 1000 T/m) [3] necessary for efficient SNP attraction. In our configuration, a µ-magnet array combined to an external rotating magnetic field to displace SNPs on the surface of the µ-magnetic substrate (Figure 1).

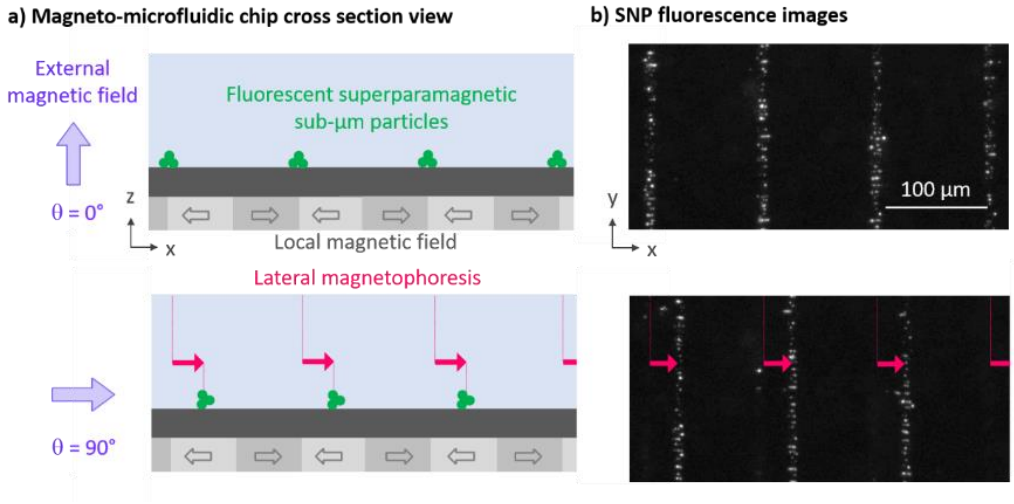

Figure 1

Project objectives

The objective is to characterize and optimize magnetophoresis to transport SNPs within a microfluidic chamber. This innovative technological development aims for fast biomolecule transport and detection in passive microfluidics, which do not require complex microfluidic actuation instrumentation.

In previous work we demonstrated the use of magnetophoresis for effective SNP transport over the µ-magnetic substrate. However, several significant challenges remain on the reproducibility and efficiency of SNP transport on the surface of the microfluidic chamber. These performances depends on multiple parameters, which include:

- magnetophoresis parameters depending on: SNP type, size and concentration, magnetophoresis velocity, micro-magnet array periodicity, magnetic field & gradient pattern;
- surface hydrophilicity and solution composition.

The objective of the internship is to experimentally investigate these parameters, and characterize SNP magnetophoresis on the surface in different conditions. Together, we will explore, imagine and implement solutions to face potential issues. Experimental results will help in the understanding and optimization of SNP magnetophoresis to progress one-step closer to practical implementation into LOC devices.

Scientific & Technical environment

The candidate will work within a small G2Elab team on the CIME/Nanotech interdisciplinary platform, in collaboration with LMGP. We are located in the heart of an exceptional scientific environment @MINATEC with various research labs & teams. The work will be realized in the framework of an existing collaboration with local startup company *MagIA diagnostics*.

This project presents a high level of interdisciplinarity between magnetism, microfluidics and biochemistry. The following experimental techniques will be used for investigations:

- Microfluidic chip design and fabrication: simple CAD, laser cutting
- Hydrophilic surface treatment and characterization: UV-Ozone treatment, water contact angle (WCA) analysis, Fourier transform infrared spectroscopy (FTIR)
- SNP magnetophoresis and interface characterization: fluorescence microscopy

Profile & required skills

M1 or M2 student with engineering or academic training in physics and/or micro-nanotechnologies. The candidate will be motivated, curious and autonomous, with experimental and basic practical lab skills. A background in microfluidics, physical chemistry or magnetism will be an additional asset. The student should exhibit creative thinking and teamwork capabilities.

Subject could be continued with a PhD thesis

To be discussed according to progress, motivation and skills.

Allowance

Internship allowance will be provided (4 to 6 months, approx. 580 €/month)

Contact

To apply, please send a CV and motivation letter to elise.bou@grenoble-inp.fr and orphee.cugat@grenoble-inp.fr.

References

1. Fratzl, M. *et al.* Magnetically localized and wash-free fluorescent immuno-assay: From a research platform (MLFIA) to a multiplexed POC system (MagIA). *SLAS Technology* **29**, 100119 (2024).
2. Lim, J. *et al.* Magnetophoresis of Nanoparticles. *ACS Nano* **5**, 217–226 (2011).
3. Cugat, O., Delamare, J. & Reyne, G. Magnetic micro-actuators and systems (MAGMAS). *IEEE Trans. Magn.* **39**, 3607–3612 (2003).