Ministry of Human Resources and Social Security

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

2020 Helmholtz – OCPC – Program
for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project: Deformation of biological cells in microfluidic flow

Helmholtz Centre and institute: Forschungszentrum Juelich, Institute of Complex Systems, Theoretical Soft Matter and Biophysics (ICS-2)

Project leader: Dr. Dmitry Fedosov

Web-address: https://www.fz-juelich.de/ics/ics-2/EN/Home/home_node.html
https://iffwww.iff.kfa-juelich.de/~fedosov/D_Fedosov.html

Description of the project:
Cell deformability can serve as a natural biomarker for the state of a cell, since it can change in a diseased state or under stress conditions. Microfluidic technologies have been projected to enable fast label-free analyses of heterogeneous cell suspensions (e.g., liquid biopsy), because they operate at length scales similar to the size of cells. Recently, several deformability-based flow cytometers have been suggested to measure the deformability of cells and their properties. Even though such techniques are certainly very promising, the quantification of experimental measurements remains very difficult and limited. The main reason for this serious shortcoming is the complexity of fluid flow, cell structure and deformation, which does not permit the usage of such devices as precise true sensors of intrinsic cell properties.

At present, we have an insufficient understanding of cell behavior in complex microfluidic flows. High-fidelity hydrodynamic simulations with realistic cell-mechanics models have a great potential for the establishment of a theoretical basis for the interpretation of cell deformation in fluid flow. In this project, the deformation of biological cells in microfluidic flow will be investigated using mesoscopic hydrodynamics approaches. New multicomponent cell models, which realistically represent cellular mechanical properties, will be developed. Using such models, we will explore how different cell properties (e.g., shape, elasticity, viscosity, bending rigidity) and flow and suspension characteristics (e.g., microfluidic device geometry, flow rate, fluid viscosity, cell concentration) affect cell deformation in microfluidics and whether we can identify the different contributions to the deformation. Therefore, we will critically assess different contributions to overall cell deformability and their connection to the distinct physical properties of cells. This knowledge will advance the design of efficient device configurations and flow conditions for precise analysis of cellular suspensions.

Description of existing or sought Chinese collaboration partner institute:
With this project, we are seeking to establish a collaboration in the areas of cell mechanics and microfluidic flow. In particular, the laboratory of Prof. Xuejin Li (https://person.zju.edu.cn/en/xli#0) at the Department of Aeronautics and Astronautics, Zhejiang University (http://www.zju.edu.cn/english/main.htm) is of interest, following several of our previous interactions. Prof. Li has extensive expertise in modelling cell mechanics and membranes, which will have a synergistic effect with our group's research on modelling microfluidic and microvascular flow. Applications from other groups working on cell mechanics and microfluidics will also be considered.

Required qualification of the post-doc:

- PhD in physics, biophysics, applied mathematics, or a relevant engineering discipline.
- Experience with numerical modelling.
- Good programming skills.
- Good knowledge of English (speaking and writing).

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team