6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Lattice Boltzmann modelling of particle dynamics in cross-slot flows at intermediate Reynolds numbers

Timm Krüger[1]

[1] School of Engineering, University of Edinburgh,
King's Buildings, Edinburgh EH9 3FB, UK, timm.krueger@ed.ac.uk

Keywords: *Inertial Microfluidics, Particle Dynamics, Cross-Slot Flow, Lattice Boltzmann Method, Immersed Boundary Method*

Cancer and bacterial infections are projected to kill 18 million people worldwide annually by 2050. Fast and reliable diagnostics are essential for early and targeted treatments. Microfluidics is at the heart of the miniaturisation of diagnostics, enabling novel portable and low-cost point-of-care devices. Inertial particle microfluidics (IPMF) is a novel and competitive method with applications in cell separation and characterisation [1].

One particular application is cell cytometry in cross-slot devices [2]. Cells reaching the stagnation region at the centre of the cross-slot are deformed and stationary for a short time. This allows for optical characterisation of the cell shape and response to the ambient shear field. The required high flow rates lead to a large throughput of $\mathcal{O}(1000)$ cells per second, which makes it possible to study large cell populations.

Recently it has been shown that the flow field in cross-slot geometries can become asymmetric for certain ranges of Reynolds number and channel aspect ratio [3]. This can lead to unexpected cell trajectories, affecting the interpretation of the experimental results.

I will present simulations of the dynamics and trajectories of single rigid beads in a cross-slot device for different Reynolds numbers and channel aspect ratios. The numerical model is based on the lattice Boltzmann and immersed boundary methods [4]. It is found that the bead dynamics depends strongly on the control parameters. The results could be useful for advanced designs of cell cytometry devices by retaining the advantage of inertial effects and minimising undesired particle dynamics.

REFERENCES

[1] H. Amini, W. Lee and D. Di Carlo, Inertial microfluidic physics. *Lab Chip*, Vol. **14**, pp. 2739–2761, 2014.

[2] D.R. Gossett *et al.*, Hydrodynamic stretching of single cells for large population mechanical phenotyping. *P. Natl. Acad. Sci.*, Vol. **109**, pp. 7630–7635, 2012.

[3] S.J. Haward *et al.*, Tricritical spiral vortex instability in cross-slot flow. *Phys. Rev. E*, Vol. **93**, p. 031101, 2016.

[4] T. Krüger *et al.*, *The lattice Boltzmann method.* 1st Edition, Springer, 2017.