Numerical simulations of complex flows: from mesoscopic modelling to macroscopic approaches

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Numerical high-fidelity simulations of flowing matter enable us to predict, analyze and understand the intertwined mechanisms arising at various time and event scales. However, the sheer complexity and the large range of scales of non-trivial flows quickly become challenging for classical direct numerical simulation methods, even when running on the largest of supercomputers. In this seminar, I will discuss how these problems can be tackled with novel methods using both mesoscopic and macroscopic descriptions of the flow. On the mesoscopic scale, we will discus recent advances of entropic lattice Boltzmann methods [1] as well as a novel kinetic theory, the so-called Particles-on-Demand method [2]. On the macroscopic scale, I will demonstrate efficiency and robustness of using lattice Green's functions in combination with mimetic finite volume schemes for solving incompressible flows on maximally truncated and spatially adaptive computational domains [3]. Effectiveness of these schemes will be shown for applications in turbulence, fluid-structure interaction, compressible as well as multiphase flows.

References

[1] B. Dorschner, F. Bösch, S. S. Chikatamarla, K. Boulouchos, and I. V. Karlin. "Entropic multi-relaxation time lattice Boltzmann model for complex flows". In: *Journal of Fluid Mechanics* 801 (2016), pp. 623–651.

[2] B. Dorschner, F. Bösch, and I. V. Karlin. "Particles on demand for kinetic theory". In: *Physical Review Letters* 121.13 (2018), p. 130602.

[3] B. Dorschner, K. Yu, G. Mengaldo, and T. Colonius. "A fast multi-resolution lattice Green's function method for elliptic difference equations". In: *Journal of Computational Physics* 407 (2020), p. 109270.