



FAKULTÄT FÜR VERFAHRENS-UND SYSTEMTECHNIK

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Evaluation of Wall Shear Stress in lattice Boltzmann solvers

The lattice Boltzmann has been widely used for a variety of flow configurations over the past decades. Most notably, given its suitability for flows in complex geometries in the incompressible regime, it has been widely applied to medical flows, e.g. flow in aneurysms. One of the key components in such flows, especially for the evaluation of rupture risk is the stress at the aneurysm wall. Contrary to classical numerical methods, the lattice Boltzmann method allows for strictly local evaluation of the stress tensor, via the non-equilibrium part of the distribution function, at the discrete grid-points. The aneurysm walls do not always fall exactly on a simulation

grid-point. This brings up the following question: How should one approximate the stress on the walls?

The topic of the present work will be to provide answers to that question. Once the proposer evaluations strategy has been devised, it will be implemented in the in-house solver ALBORZ and validated for ideal geometries.



Illustration of medical flows simulations conducted with ALBORZ

[1] Hosseini, S.A., Berg, P., Huang, F., Roloff, C., Janiga, G. and Thévenin, D., 2021. Central moments multiple relaxation time LBM for hemodynamic simulations in intracranial aneurysms: An in-vitro validation study using PIV and PC-MRI. *Computers in Biology and Medicine*, *131*, p.104251.
[2] Krüger, T., Varnik, F. and Raabe, D., 2009. Shear stress in lattice Boltzmann simulations. *Physical Review E*, *79*(4), p.046704.

[3] Matyka, M., Koza, Z. and Mirosław, Ł., 2013. Wall orientation and shear stress in the lattice Boltzmann model. *Computers & Fluids*, 73, pp.115-123.

Tasks:

- Familiarization with basic concepts of the lattice Boltzmann method
- Getting familiar with the in-house solver ALBORZ
- Implementing function to evaluate WSS in said code
- Validation and evaluation of error via simple ideal geometries

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Start: ASAP End: TBD