# Modeling Slips

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The travel money was used for several short-term visits from Oxford to Durham during the periods 20-11-2017 to 25-11-2017, 20-3-2018 to 24-3-2018, 19-9-2018 to 24-8-2018 and 11-9-2018 to 13-9-2018. During the trips, I visited the group led by Dr H. Kusumaatmaja at Durham University as well as the group of Dr C. Semprebon at Newcastle University. There, we discussed the recently developed multicomponent Lattice Boltzmann code [1, 2] which includes tunable contact angles of sessile drops. This allows for the modelling of droplet dynamics on lubricated slippery interfaces, *Slips*, [3] which requires the modelling of multiple interfaces between different phases and a tunable solid-liquid interaction to be included in the simulations. These trips helped me to understand and use the multi-phase lattice Boltzmann code.

During the visits, we implemented multiple additional features in the lattice Boltzmann code. We mostly focused on a boundary scheme necessary to simulate microfluidic systems [4] and a wetting condition based on a cubic wetting potential [5], that improves the stability of the simulation significantly for large contact angles, *i.e.* higher than 150 degrees (see **Fig. 1**). This new wetting potential allows us to reach contact angles approaching 180 degrees which is necessary to simulate superhydrophobic surfaces. I plan to use this code in the future to investigate droplet dynamics on patterened lubricated interfaces. Furthermore, I plan to investigate droplet impacts on textured lubricated surfaces and liquid pools.

We also realised a Cuda scheme which utilises the graphics card of the computer to improve simulation time significantly. We found that, by using GPU calculations, we can improve the computing time for large systems substantially. This is a requirement to model the multiple interfaces present in droplet dynamics on lubricated slippery interfaces successfully. Lastly, the visits also provided an opportunity for me to give group seminars at Durham University and Newcastle University.

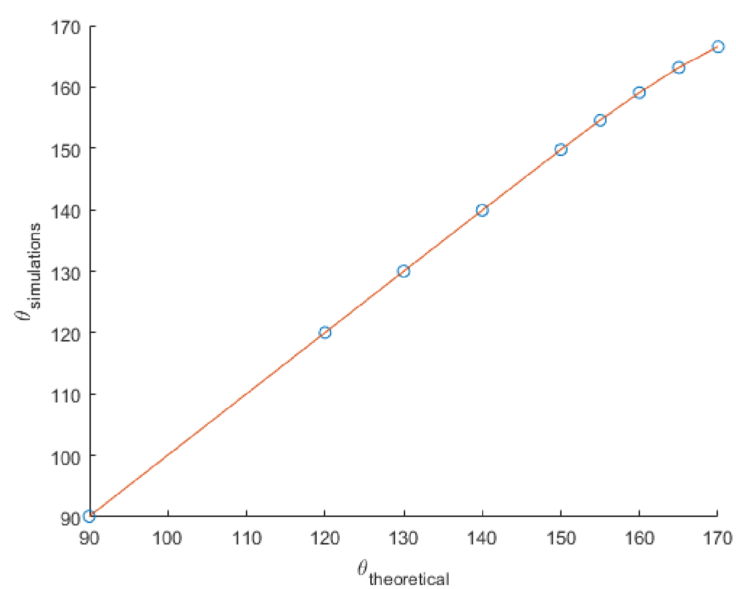


**FIG. 1:** Simulation results for the contact angle of a sessile drop implemented with a cubic wetting potential. The measured contact angle remains in good agreement with the theoretical value, up to contact angles of 165 degrees. The spurious velocities stay around or below $1 * 10^-4$ order of magnitude for these high contact angles, which can be neglectable compared to the bulk velocities.

[1] Moritz Wöhrwag, Ciro Semprebon, A Mazloomi Moqaddam, Ilya Karlin, and Halim Kusumaatmaja. Ternary free-energy entropic lattice boltzmann model with a high density ratio. *Physical Review Letters*, 120(23):234501, 2018.

[2] Ciro Semprebon, Timm Krüger, and Halim Kusumaatmaja. Ternary free-energy lattice boltzmann model with tunable surface tensions and contact angles. *Physical Review E*, 93(3):033305, 2016.

[3] Muhammad Subkhi Sadullah, Ciro Semprebon, and Halim Kusumaatmaja. Drop dynamics on liquid infused surfaces: The role of the lubricant ridge. *Langmuir*, 2018.

[4] Qin Lou, Zhaoli Guo, and Baochang Shi. Evaluation of outflow boundary conditions for two-phase lattice boltzmann equation. *Physical review E*, 87(6):063301, 2013.

[5] S Dong. Wall-bounded multiphase flows of n immiscible incompressible fluids: Consistency and contact-angle boundary condition. *Journal of Computational Physics*, 338:21–67, 2017.