Dynamic receding contact angles: SPH simulations vs. experiments

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The spreading of rain drops on leaves, cleaning and coating processes or just taking a shower in the morning, in all these examples liquids spread and recede on surfaces. These processes are well understood in the case of simple liquids on hard and flat substrates. However, essentially none of the above mentioned examples fulfils the assumptions of the existing models.
In this presentation we compare in detail experimental results of receding contact angles with smoothed particle hydrodynamics (SPH) simulations. The experimental setup consists of a rotating drum with simple liquids and aqueous surfactant solutions [1] while the simulation calculates a simplified model thereof in which an infinite rigid plane is pulled out of the liquid.
SPH simulations introduce effective particles on a quasi-macroscopic scale. This allows a simulation approach on macroscopic length and time scales. Our simulation model uses an implicit pressure solver [2], reproduces viscosity, surface tension and dynamic contact angles of simple liquids on smooth surfaces with equilibrium contact angles in the order of 90º [3]. We additionally apply a force between rigid and fluid particles to reproduce the natural adhesion between the vertical plane and the fluid [4].
Comparisons of our simulation results with the experimental results show that the key features of the experiments are reproduced by the SPH simulation. Furthermore, we use hydrodynamic models [5] to fit our experimental and simulation results. We discuss possibilities and limitation of SPH simulations of dynamic wetting with respect to simple liquids and aqueous surfactant solutions.

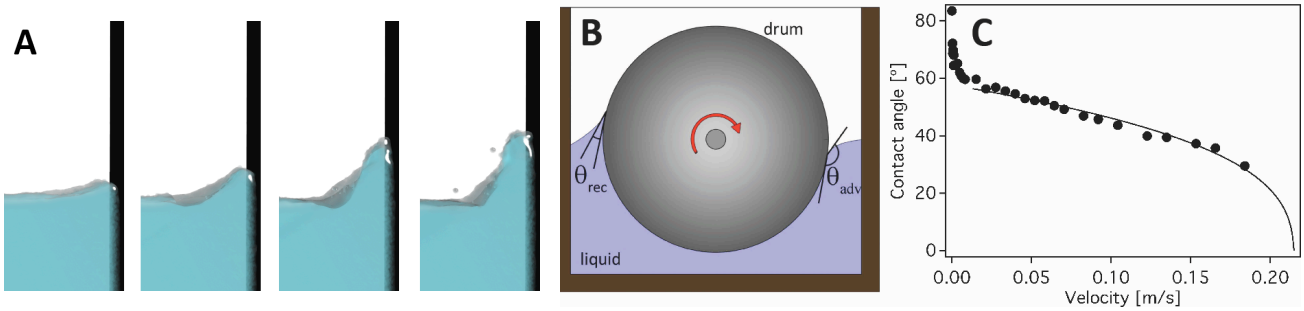

Figure 1: A) Snap shots of the simulation results for increasing dewetting speeds (from left to right). B) Sketch of the experimental setup. C) Experimental results for pure water on a PS coated drum in comparison to a fit to the model of ref [5].

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References

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