Coating with colloids by receding contact lines

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The aim of many coating processes is to deposit a uniform, thick ans as regular as possible on a large glass surface. One of the possibilities for such a deposit is to leave colloids behind a receding contact line under evaporation. But such deposits are usually inhomogeneous, as in the famous example of the coffee stain. Several behavior can occur, such as stick-slip motion of the contact line. Those problems are mainly due to the fact that evaporation is not homogeneous along the liquid interface, but has singularities at the contact line. We are thus investigating the interaction between evaporation singularity, and hydrodynamics.

As we wanted to understand the effect of those singularities, we started from a simple case : a drying droplet of pure liquid drying on an non wetting substrate. Starting from Stokes equation and mass conservation, we found an non linear third order differential equation, that was impossible for us to solve analytically.

Therefore, we studied this equation using two different methods. The first one is numerical computation, which gives us a profile for the droplet. The second one is a combination of various approximations and the introduction of cut-off length, which leads us to an analytical approximated solution. We then compare the analytical solution and numerical solution to verify that our model fits the simulation. In the end, it enables us to write an analog to the Tanner law that takes into account evaporation. In a third part, we study

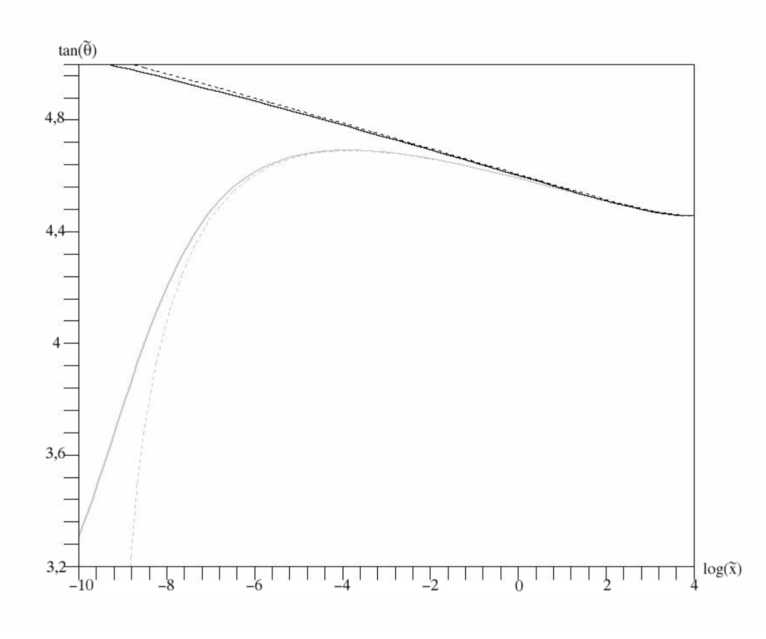

Fig. 1 – Numerical simulations (dashed lines) compared to analytical ones (solid lines) in the case of evaporation (grey curves) or without evaporation (black curves)

the analytical solution to extract a non dimensional number that represents the importance of evaporation singularities, and use this solution to calculate the evolution of both radius of the droplet and contact angle during its drying. We can then conclude investigating the profile of a particle deposit in this ideal case, where no pinning is occurring.

Références

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