# Alcoholic droplets spinning towards chaos while they approach their death

The ephemeral life of a sessile droplet evaporating is typically dull and boring, but when small amounts of alcohol are added, their life becomes a total mess. In the absence of alcohol, a water droplet develops an evaporating-driven flow dominated by a capillary effect which is typically responsible for the well-known coffee-stain effect [1], characterized by radial symmetry (see Figure 1 Left). However, when a small amount of ethanol is added, the flow loses its radial symmetry and becomes tremendously complex (see Figure 1 Right). The reason for the complexity is the development of surface tension gradients at the interface of the droplet due to the presence of ethanol, which has a strong effect on it.
In this project you will make experimental measurements of such complex flow using a three-dimensional particle tracking technique for ethanol/water droplets at different concentrations. The results will be compared with three-dimensional (non-asymmetrical) numerical simulations developed by Christian Diddens [2],which will also be supervisor.
The final aim of the project is to compute how "complex" the flow becomes: **does the alcoholic droplet spins down towards its death in a chaotic flow?.**

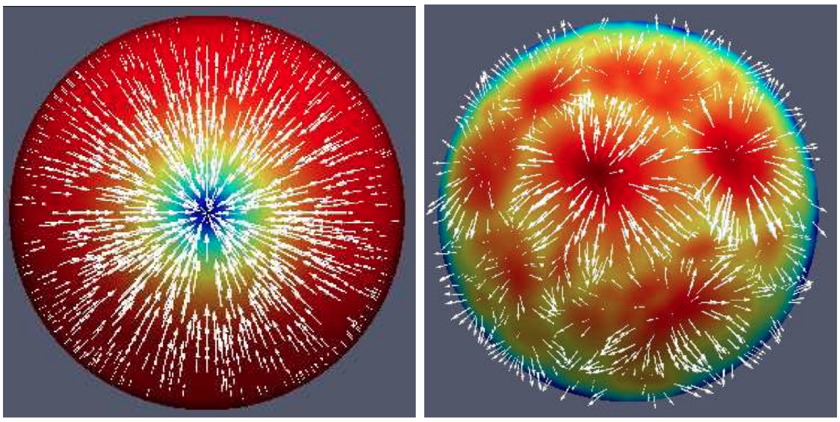

Figure 1: Three-dimensional simulations of an evaporating water droplet with different contents of ethanol. The arrows denote the interfacial flow field and the colors the local ethanol concentration field (red is high, blue is low, different scale in each case). Left: Water droplet with low ethanol concentration. Right: Water droplet with high ethanol concentration.

| **Supervision** | **Contact** | **Role** |
|---|---|---|
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[1] RD Deegan, O Bakajin, TF Dupont, G Huber, Sidney R Nagel, and T Witten. Capillary flow as the cause of ring stains from dried liquid drops. *Nature*, 1997.

[2] C. Diddens, H. Tan, P. Lv, M. Versluis, J. G. M. Kuerten, X. Zhang, and D. Lohse. Evaporating pure, binary and ternary droplets: thermal effects and axial symmetry breaking. *J. Fluid Mech.*, 823:470–497, 2017.