M2 INTERNSHIP PROPOSAL

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Thesis possibility after internship: **YES**
Funding: **YES** If YES, which type of funding: **ERC**

Impact of bacterial motility on the accumulation of biosurfactants at air-water interfaces

Evaporation from bare soils is a key hydrological process which returns a fifth of terrestrial precipitations directly to the atmosphere. This macroscopic phenomenon is governed at the microscale by **capillary flows** along water films between the top of the soil and the water at depth. The stability of these films is crucial to have an effective drying and it is highly sensitive to the **physico-chemistry** of the soil such as the **surface tension** at air-water interfaces or the **contact angle** of the aqueous phase with grains [1].
In soil, bacteria abound, with ~ 10^{10} bacteria per gram of top soil. Many of them release surface active components – surfactants – in their surroundings which can strongly decrease the surface tension at air-water interfaces (Fig.1) and change the contact angle [2]. To date, however, little is known about the potential impact of these bacteria on drying dynamics. **How do surfactants accumulate at drying interfaces? Does bacterial behavior, in particular motility by swimming, modify this accumulation dynamics? What are the consequences on the interface behavior inside the soil pores?**

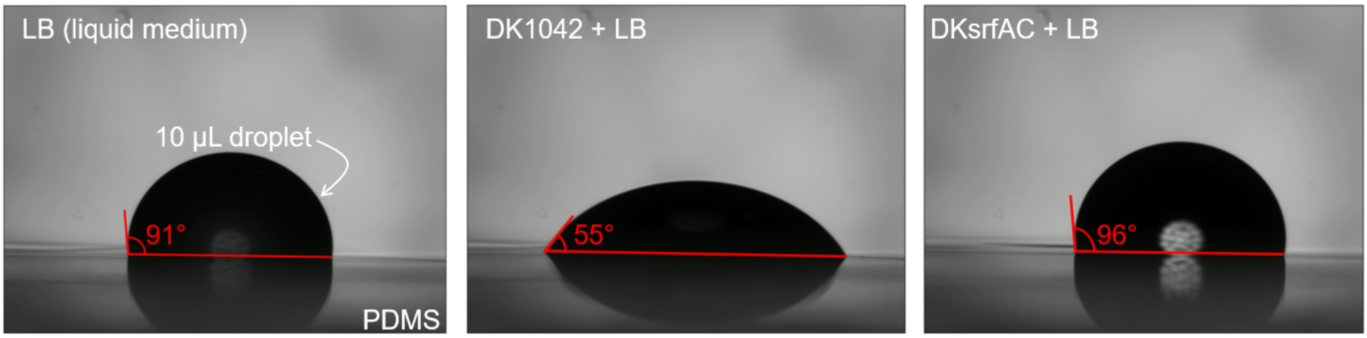

Fig. 1: Measurements of contact angles between a hydrophobic substrate (PDMS) and a 10 µL droplet of the filtrated broth after 127h of culture in LB. The contact angle measured with a wild type B.subtilis strain (photograph in the middle) is much smaller than for pure liquid medium (photograph on the left) or for a B.subtilis strain which cannot produce surfactants (photograph on the right).

We started investigating these questions at the level of the single pore with the PhD project of Nathan Chapelle. We have already started developing an **original experimental setup to follow the deformation of a single air-water interface which is put under evaporative forcing in the presence of surfactants, and validated our choice of model bacteria, *B.subtilis***. The goal of this internship is to get familiar with this setup and to shed light on the role of **different bacteria phenotypes** (in particular motile vs non-motile) on **the repartition of bacteria and surfactants in the bulk and at this air-water interface**. To do so, the intern will use microfluidic chips to mimic one pore of the soil, with an air-water interface present. Using optical microscopy techniques, he will **track individual bacteria** and characterize their behavior during evaporation from the interface. These results will be linked to changes in interface dynamics.

We are looking for a highly motivated student with a keen interest in the field of **biophysics** for this **experimental internship**. The internship candidates should have a background **in biophysics, physics, mechanical or chemical engineering, or microbiology with solid physics knowledge**.

References:
[1] D. Or *et al.*, "Advances in Soil Evaporation Physics - A Review," Vadose Zone Journal, 12(4) 2013.
[2] J Q Yang *et al.*, "Evidence for biosurfactant-induced flow in corners and bacterial spreading in unsaturated porous media", PNAS, 118(38), 2021.