Fachbereich 4
Produktionstechnik
Maschinenbau &
Verfahrenstechnik

CENTER OF
APPLIED SPACE TECHNOLOGY
AND MICROGRAVITY
ZARM

Fluids and Space Engineering Seminar

Date: Wednesday, April 24, 2019 at 13:00
Location: ZARM, Room 1730

Damping sloshing waves with confinement, foams, or contact angle hysteresis

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Figure 1 - Air/ethanol interface during a sloshing experiment in a Hele-Shaw cell of width 10 cm.

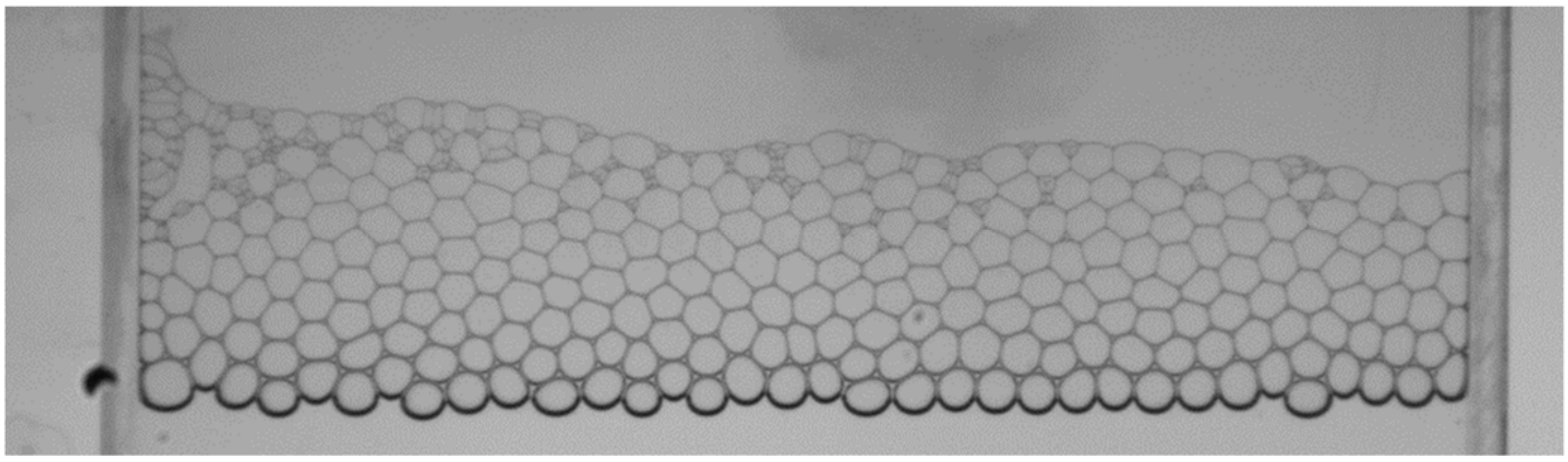

Figure 2 - Foam layer on top of a soap solution during a sloshing experiment.

We first consider sloshing in a confined geometry. Experimentally, we study the air/liquid interface motion of a liquid in a narrow rectangular cell shaken at different frequencies, and show that sloshing can then be suppressed for sufficiently viscous liquids. On the theoretical side, while the classical analysis of sloshing determines inviscid modes and plugs in dissipation afterwards, which is not fully consistent, we present a slender-body approach which enables to consider viscous dissipation at leading order. The resulting predictions are in excellent agreement with our measurements [Viola, Gallaire & Dollet, J. Fluid Mech. (2017)].

Second, we study sloshing in a cylindrical container of a liquid covered by a layer of foam. Foam damps sloshing efficiently, as beer drinkers know by experience. Moreover, due to the peculiar nature of foam/wall friction, namely the fact that the friction force depends nonlinearly on the sliding exponent, with a power law of exponent lower than one, we show that sloshing oscillations are damped in finite time, like solid friction, and unlike usual viscous dissipation. We rationalise this observation using multiple-scale analysis [Viola, Brun, Dollet & Gallaire, Phys. Fluids (2016)].

Third, we present preliminary results on the effect of contact line sliding motion on sloshing damping, which has heretofore remained elusive. To simplify the analysis, we have performed experiments on free decaying oscillations of a liquid column in a U-shaped tube. We show that like for foams, a strong nonlinear dissipation, reminiscent of solid friction, can dominate the dynamics if contact angle hysteresis is strong enough.