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How to include the nonlinear Cox-Voinov law into sloshing dynamics? A weakly non linear approach FRANCESCO VIOLA, LFMI EPFL, PIERRE-THOMAS BRUN, MIT, FRANCOIS GALLAIRE, LFMI EPFL — Fluid sloshing in a glass is a common example of damped oscillator, with the frequency derived in the potential flow limit. The damping rate is then evaluated considering the viscous dissipation at the wall, in the bulk and at the free surface, respectively. This classical theoretical result however differs from what is often seen in the laboratory when the attenuation of gravity waves happens in a small basin. In particular, the damping rate is found to increase as the sloshing amplitude decreases. Here we show that this enhanced damping is due to capillary forces at the contact line between the liquid and the container. The angle θ_{d} made by the liquid interface with the container walls (contact angle) is modeled as a non-linear function of the interface speed U, (Cox-Voinov law $\theta_{\mathrm{d}}^3 \ \alpha$ U). We propose a multiple scale expansion scheme to consistently derive an amplitude equation using the Cox-Voinov law as boundary condition at the moving interface. The zero order problem reduces to the classical static meniscus problem, while the first order problem yields an eigenvalue problem defining the viscous sloshing modes. At an higher order, a compatibility condition has to be enforced, yielding an amplitude equation. Solving the later, we recover the expected increase of the damping rate as the sloshing amplitude decreases, an effect thus attributed to capillary effects.

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