The dynamics of bouncing drops, infinite liquid bridges, and flap-type wave energy converters

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Abstract

This talk concerns three problems that involve the interaction of a fluid with a structure.

The first problem is that of an infinite liquid bridge, which is the capillary surface that is formed when an object is dipped into a large bath of an incompressible liquid and slowly withdrawn. Two models of the motion of the liquid bridge over the object's surface are used to examine the stability of the liquid bridge. It is demonstrated that the classical treatment of this problem is missing an important piece of physics, "contact angle hysteresis", which is shown to have a stablising effect on the liquid bridge.

The second problem is that of a three-dimensional liquid drop deposited on an inclined substrate, vibrating vertically. The set of governing equations is expanded in an asymptotic series up to the second order; the small parameter is the ratio of vibration-induced inertia to surface tension. It is shown that, if the amplitude of the substrate's oscillations exceeds a certain threshold value, drops climb uphill (against gravity).

The third problem considers the hydrodynamic equation of motion (EOM) of a flap-type wave energy converter (WEC). The EOM is a second order integro-differential equation whose coefficients are determined using linear wave theory and experimental wave tank testing. The importance of these coefficients is examined with respect to model-prototype correlation and hydrodynamic power.