MUTUAL ATTRACTIONS OF FLOATING OBJECTS: AN IDEALIZED EXAMPLE

During the 17th Century Edme Mariotte observed that objects floating on a liquid surface can attract or repel each other, and he attempted (without success!) to develop physical laws describing the phenomenon. Initial steps toward a consistent theory appeared with Laplace, who in 1806 examined the configuration of two infinite vertical parallel plates of possibly differing materials, partially immersed in an infinite liquid bath and rigidly constrained. This can be viewed as an instantaneous snapshot of an idealized special case of the Mariotte observations. Using the then novel concept of surface tension, Laplace identified particular choices of materials and of plate separation, for which the plates would either attract or repel each other.

The present work returns to that two-plate configuration from a more geometrical point of view, and yields characterization of all modes of behavior that can occur. The results lead to algorithms for evaluating the forces with arbitrary precision, and embrace also some surprises, notably a remarkable variety of occurring behavior patterns despite the relatively few relevant parameters. A striking limiting discontinuity appears as the plates approach each other.

All results described are exact consequences of the underlying (nonlinear) equations. No simplifying hypotheses are introduced; the conclusions appear as general laws relating physical parameters. A notable feature is that small configurational changes can have large observational consequences, and we may thus infer that easy answers in less restrictive circumstances should not be expected.