Jacques Magnaudet (IMFT, France): The hard life of air bubbles crossing a fluid/fluid interface.

We investigate the dynamics of isolated air bubbles crossing the horizontal interface separating two Newtonian immiscible liquids initially at rest by means of experiments and DNS. High-speed video imaging is used to obtain a detailed evolution of the various interfaces involved in the system. The size of the bubbles and the viscosity contrast between the two liquids are varied by more than one and four orders of magnitude, respectively, making it possible to obtain bubble shapes ranging from spherical to toroidal. A variety of flow regimes is observed, including that of small bubbles remaining trapped at the fluid–fluid interface in a film-drainage configuration. In most cases, the bubble succeeds in crossing the interface without being stopped near its undisturbed position and, during a certain period of time, tows a significant column of lower fluid which sometimes exhibits a complex dynamics as it lengthens in the upper fluid. Direct numerical simulations of several selected experimental situations are performed with a code employing a volume-of-fluid type formulation of the incompressible Navier–Stokes equations. Comparisons between experimental and numerical results confirm the reliability of the computational approach in most situations but also points out the need for improvements to capture some subtle but important physical processes, most notably those related to film drainage. Influence of the physical parameters highlighted by experiments and computations, especially that of the density and viscosity contrasts between the two fluids and of the various interfacial tensions, is discussed and analysed in the light of simple models.