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RETRACTION OF LEVITATING DROPS

Kindness Isukwem[1,2], Elie Hachem[1], Anselmo Pereira[1]
[1]Mines Paris, PSL University, Centre for material forming (CEMEF), Sophia Antipolis, France
[2]Mathematics Department, University of British Columbia, Vancouver, Canada

ABSTRACT

This theoretical and numerical study focuses on the physical mechanisms driving the retraction of levitating Newtonian micrometric/millimetric/centimetric drops surrounded by air and under zero-gravity conditions. The drops present a pancake-like initial shape, gradually converging towards a spherical one under surface tension effects. Three drop retraction regimes are observed: capillary-inertial; mixed capillary-inertio-viscous; and capillary-viscous. In the first regime, the retraction is essentially driven by a competition between capillary pressure and inertial stresses, which induces a complex flow with equivalent shear, uniaxial and biaxial components. As the viscous stress becomes comparable to the capillary and the inertial stresses, the second regime emerges while shear-based deformations tend to vanish. Lastly, the third regime is dominated by a balance between capillary and viscous stresses, essentially exhibiting axial deformation. These physical features are underlined through multiphase three-dimensional numerical simulations and analysed in light of retraction dynamics, energy transfer and scaling laws. Our results are rationalised in a two-dimensional diagram linking the drop retraction time with the observed retraction regimes through a single dimensionless parameter combining capillary, inertial, viscous and geometrical effects, i.e., the retraction number.