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Oscillations of a viscous drop under spherical-belt constraint

JOSHUA BOSTWICK, PAUL STEEN, Cornell University — The motion of constrained liquid-gas interfaces is important in a variety of applications. We study the linear oscillations of a viscous liquid drop immersed in an immiscible fluid and constrained by an axisymmetric spherical "belt." The belt is a rigid spherical band delimited by two latitudinal circles. Unlike the unconstrained(Rayleigh) problem, the liquid boundary is the union of a surface of support and two disconnected free surfaces, the latter coupled by the incompressibility condition and allowed to "communicate" across the constraint. A modified set of shear boundary conditions is introduced to address the transition from free to supported surfaces along the drop interface. This formalism allows mode shapes with discontinuous contact angle across a pinned circle-of-contact constraint, a limiting case which is consistent with observation. As the size of the constraint increases from a pinned circle of contact, the mode shapes are shown to qualitatively change their character by increasing the number of nodes of the corresponding eigenfunction, while preserving the numerical ordering of the eigenfrequencies at a critical belt size.

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