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A Long-wavelength Model of Viscous Entrainment

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When a large air bubble rises in syrup, it often leaves behind a thin trailing tendril in which air is entrained into the syrup. This is a familiar example of how viscous entrainment can create a long and slender structure on a liquid surface. We derive a simplified model of viscous entrainment in the limit when the entrained fluid is far less viscous than the entraining fluid. Results suggest there exists a class of macroscopic conditions which allow local, scale-invariant entrainment dynamics, thus raising the possibility of that infinitely thin liquid spouts in the continuum model are realizable in practice.

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