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Stagnation, folding, coiling, and breakup of viscous jets: a synthesis NEIL RIBE, Institut de Physique du Globe de Paris, 75005 Paris, MEHDI HABIBI, YASER RAHMANI, Institute for Advanced Studies in Basic Sciences, Zanjan 45195-1159, Iran, DANIEL BONN, Van der Waals-Zeeman Institute, University of Amsterdam, 1018 XE Amsterdam, The Netherlands — Using laboratory experiments and theoretical modeling, we have studied the dynamics of a thin jet of viscous fluid falling from a substantial height (tens of cm) onto a solid surface. Our experiments reveal surprisingly complex behavior as the viscosity decreases for a fixed flow rate. For the highest viscosities used, the jet coils at all heights for which it remains intact. As the viscosity decreases, one observes (1) chaotic alternation between coiling and planar folding; (2) alternation between coiling, folding, and axisymmetric stagnation-point flow; and (3) stagnation-point flow alone. In all cases, the jet breaks up via the Rayleigh instability if the fall height becomes sufficiently large. To understand these results theoretically, we have developed a mathematical model of a thin viscous jet that includes an exact representation of surface tension forces. The linearized forms of these equations that describe the stability of stagnation-point flow comprise three uncoupled subsets, corresponding respectively to planar folding, helical coiling, and the Rayleigh instability. We solve these equations numerically to determine phase diagrams for the different types of instability, and compare the results with our experimental observations.

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