

Abstract Submitted
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Liquid supercoiling NEIL RIBE, Laboratoire FAST, Orsay, France, MEHDI HABIBI, HOSSEIN HOSSEINI, MOHAMMAD HASSAN KHATAMI, Institute for Advanced Studies in Basic Sciences, Zanjan, Iran — Supercoiling is defined as the large-scale secondary coiling of a slender body that is already coiled at a smaller scale (e.g., telephone cords and DNA strands). We demonstrate experimentally a novel fluid-mechanical form of supercoiling that occurs in the context of the familiar “liquid rope coiling” instability of a thin thread of viscous fluid falling onto a rigid surface. Under appropriate conditions, the coiling instability generates a tall pile of coils in the form of a hollow cylindrical column, which in turn becomes unstable to a secondary coiling instability with a frequency $\approx 10\%$ of the primary one. To place this phenomenon in a broader context, we determine experimentally the phase diagram for the different possible behaviors of the thread (stagnation flow, simple coiling, rotatory folding, periodic column collapse, supercoiling) in the space of the fluid viscosity, the flow rate, and the fall height. We formulate a mathematical model for supercoiling by combining a thin-shell description of the column wall with a slender-thread description of the column as a whole. This leads to a set of coupled ordinary differential equations in one space dimension (the arclength along the axis of the coiling column) that we solve numerically using a continuation method. A comparison of the predicted and observed frequencies of secondary coiling will be shown.

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