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Thread amplitudes and frequencies in a fluid mechanical 'sewing machine' STEPHEN W. MORRIS, Dept. of Physics, University of Toronto, J.H.P. DAWES, JOHN LISTER, STUART DALZIEL, DAMTP, University of Cambridge — A viscous thread falling on a surface exhibits the famous rope- coiling effect, in which the thread buckles to form loops. If the surface is replaced by a belt moving at speed U, the rotational symmetry of the buckling instability is broken and a wealth of interesting states are observed (1). We experimentally studied this fluid mechanical 'sewing machine' in a new, more precise apparatus. As U is reduced, the stretched thread bifurcates into a meandering state in which the thread displacements are only transverse to the motion of the belt. We measured the amplitudes A and frequency ω of the meandering close to the bifurcation. For small U, single- frequency meandering bifurcates to a two-frequency 'figure 8' state, which contains a significant 2ω component and parallel as well as transverse displacements. This eventually reverts to single-frequency coiling at smaller U. More complex, highly hysteretic states with additional harmonics are observed for larger nozzle heights. We propose to understand this zoology in terms of the generic amplitude equations appropriate for resonant interactions between three oscillatory modes with frequencies ω, 2ω and 3ω. The form of the amplitude equations captures both the axisymmetry of the $U = 0$ coiling state and the symmetry-breaking effects induced by the moving belt.
(1) Chiu-Webster and Lister, J. Fluid Mech., in press.

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