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Dynamical instability of viscoelastic fluids driven by steady roll-mills BIN LIU, MICHAEL SHELLEY, Courant Institute, New York University, JUN ZHANG, Department of Physics and Courant Institute, New York University — A layer of viscoelastic fluid, made of a polymeric solution, is driven from beneath by 16 rotating disks – rollers – on a square lattice. Each adjacent pair of rollers rotate in opposite directions at constant speed. We focus on the region near the free-surface of the fluid, where the dynamics is roughly two-dimensional. A set of stagnation points are thus created between the rollers, and divides the driven fluid into 16 cells. When the strain rate due to the local flow geometry is small compared to the relaxation time of the fluid, the fluid behaves like a Newtonian one, giving rise to fluid cells of equal size located above each individual roller. As the forcing increases, symmetries are broken, and the cells start differentiating in size. We observe experimentally that when the forcing is great enough, the asymmetric flow pattern becomes unsteady, and the stagnation points oscillate spontaneously. We show that the oscillatory frequency depends on the Weissenberg number Wi, characterizing the ratio of the forcing time scale to the relaxation time of the fluid.

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