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Chaotic elastic filament in periodically driven Stokes flow VIPIN AGRAWAL, DHRUBADITYA MITRA, Nordic institute for theoretical physics, DHRUBA'S GROUP TEAM — We numerically study the dynamics of a free elastic filament in a periodically driven (period T) Stokes flow in the absence of inertia and Brownian motion. We use a bead-spring model with particle-particle interaction. We find that the dynamics depends on the elasto-viscous number, $\mu = \frac{8\pi\eta S L^4}{B}$ (where η is viscosity, S is shear rate of the fluid, L is length, and B is bending rigidity of the filament)– the dimensionless ratio of viscous and elastic stress. For small μ, the filament remains straight. As μ increases, we observe buckling, the appearance of two-period, and complex and even chaotic behavior.
To understand the dynamics of the non-autonomous system for small and intermediate μ, we consider the map obtained by integrating the dynamical equations over exactly one period. We calculate the fixed points and some of the periodic orbits of this map and their stability. We further characterize the chaotic state at large μ in terms of the space-time correlation function of the curvature as a function of arc-length. We also calculate the phase-portrait of the time series of velocity at a fixed Eulerian point. For large μ, the phase portrait converges to an attractor with a fractal (non-integer) dimension.

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