Active nematic droplets:
from simple defect dynamics to nematic turbulence

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In confined active anisotropic soft mater, the interplay of ordering, elasticity, chirality, confinement, surface anchoring, external fields, flows, and activity leads to numerous complex static and dynamic structures. In frustrated passive systems, orientational ordering fields may include stable and metastable singular topological defects as well as nonsingular solitonic deformations. Increasing interest in active systems stimulated us to model the topology of three-dimensional extensile activity-driven nematodynamics where spherical confinement provides a topological constraint [1, 2]. To perform numerical simulations of active nematodynamics, we used a simple mesoscopic modeling of active nematic fluids [3]. It reasonably well describes experiments in thin layers and shells with active complex fluids that are mostly biological systems driven by internal conversion of stored chemical energy into motion [3, 4]. We demonstrate that stationary dynamic structures exist only at low activity and that as activity increases, they transform from stationary to chaotic 3D motions—active nematic turbulence. The time evolution in such a system can be defined by a specific confinement defined by a series of elementary topological events in which nematic disclinations divide, merge, annihilate, and crossover. I will focus to homeotropic anchoring, no-slip surface, and for selected activities illustrate our findings by simulated dynamics of nematic disclinations & flows accompanied by simulated optical microscopy. The recently introduced machine learning approach to active nematics [5] could benefit from our simple confined system as a test bed.

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