DMR MRSEC 1420382

2020

Topological structure and dynamics of three-dimensional active nematics

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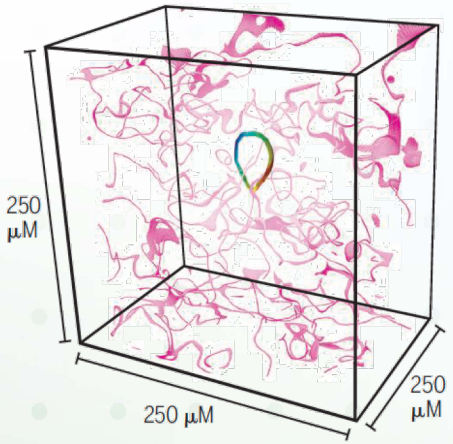
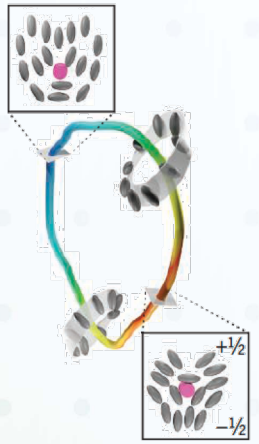
Topological structures are effective descriptors of the nonequilibrium dynamics of diverse many-body systems. For example, motile, point-like topological defects capture the salient features of two-dimensional active liquid crystals composed of energy-consuming anisotropic units. Here, force-generating microtubule bundles are dispersed in a passive colloidal liquid crystal to form a three-dimensional active nematic. Light-sheet microscopy revealed the temporal evolution of the millimeter-scale structure of these active nematics with single-bundle resolution. The primary topological excitations are extended, charge-neutral disclination loops that undergo complex dynamics and recombination events. This work suggests a framework for analyzing the nonequilibrium dynamics of bulk anisotropic systems as diverse as driven complex fluids, active metamaterials, biological tissues, and collections of robots or organisms.



Deformations in 3D LCs
Duclos et al. used high-resolution microscopy to image the director field. They located the extended defects (the linear structures) formed by internally driven bending instabilities.



Defect connections
The wedge-twist loop connects $+\frac{1}{2}$ and $-\frac{1}{2}$ defects like a Möbius strip. This smooth evolution can only occur in 3D materials and not in thin films.

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