Morphogenesis and Topological Evolution of Nematic Colloids under Strong Homeotropic Anchoring

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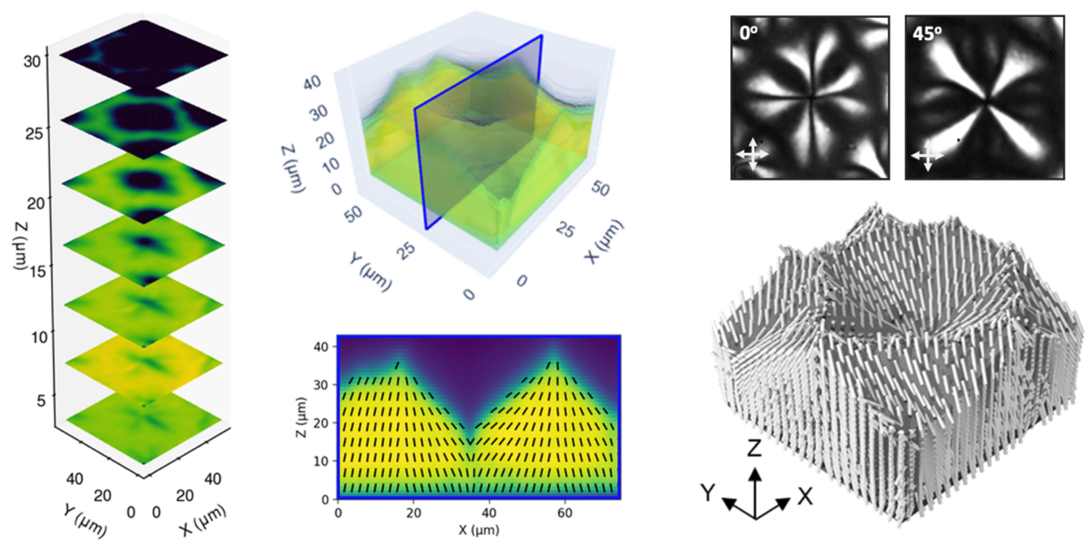
While various LC phases and topological structures have been identified, their 3D structures and dynamics (i.e., time-dependent morphogenesis and topological evolution) remain largely unexplored due to the sub-diffraction length scale and sub-millisecond timescale characteristic of conventional molecular LCs. Here, we present capturing the stepwise morphogenesis of a nematic colloidal suspension of Eu^{3+}-doped $LaPO_4$, evolving from typical tactoids into striking flower-shaped singularities [1], in remarkable coincidence with a theoretical prediction by P-G de Gennes a half-century ago [2]. Using 3D orientational tomography based on polarized photoluminescence of Eu^{3+} dopants [3,4], we perform volumetric mapping of LC directors (topology) and domain interfaces (topography). This technique reveals the complete morphogenesis process, driven by a previously unpredicted homeotropic anchoring of nanorods on the substrate, which exerts conflicting boundary conditions against planar anchoring at the opposite Iso–Nem interface. Our theoretical simulation quantitatively rationalizes how the balance between strong elastic volume energy and weaker surface tension of the nematic colloids drives the observed morphogenesis. This work offers a new perspective on previously unexplored LC dynamics and provides insights into tuning topological structures via the physico-chemical properties of their building blocks.



References

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