Disclinations, Hedgehogs, and Other Structures in Flowing Liquid Crystals

Hakam Agha[1,2], Kyle Baldwin[1], Babak V. Hokmabad[1], Corinna C. Maass[1], and Christian Bahr[1]*

[1] *Max Planck Institute for Dynamics and Self-Organization, Göttingen (DE)*

[2] *Present Address: LC Nano Group, University of Luxembourg, Luxembourg (LU)*

We report new results concerning the influence of anchoring, electric field, and flow on the director field and topological defect structures in nematic liquid crystals employing two experimental systems: microfluidic channels and self-propelling nematic droplets.

Recently, we reported a method to connect and disconnect nematic disclination lines in microfluidic channels [1]. Here, we report a more fundamental study of structural trans-formations of disclination lines in microchannels. In particular, we show how the interplay between anchoring, flow, and electric field can be used to switch between different con-figurations corresponding to wedge, linear twist, and zigzag-shaped twist disclination lines.

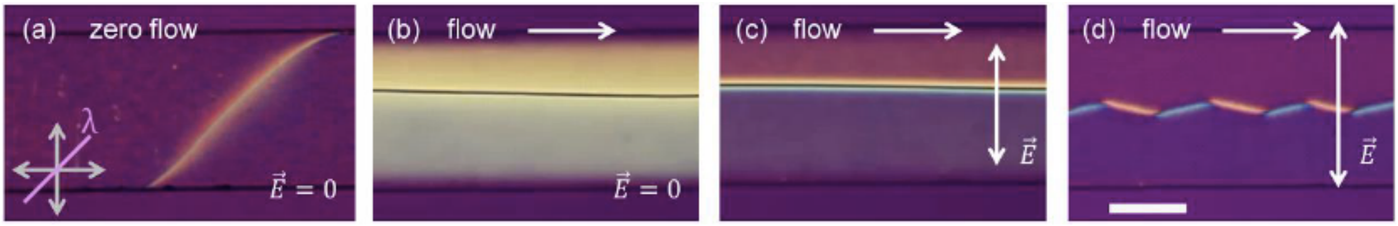

Figure 1: Micrographs showing structural transformations in microfluidic channels. (a) Wedge disclination. (b) Flow-stabilized twist disclination. (c) Twist disclination spatially quenched by electric field. (d) Field-induced zigzag-shaped twist disclination. Scale bar corresponds to 100 µm.

The second system under investigation consists of nematic droplets in aqueous surfactant solutions which show a self-propelled motion under certain conditions [2, 3]. The Marangoni flow in the droplet surface, which causes the self-propelled motion, leads also to a convective flow within the moving droplet. Here, we study the effect of the internal convection on the director field in the nematic droplet. An obvious effect is the shift of the central point defect (radial hedgehog) towards the droplet surface. Comparison between experimental micrographs and calculated micrographs based on model director fields reveal additional structural features resulting from the internal convection. We report also first results concerning the internal structure of self-propelling nematic shells.

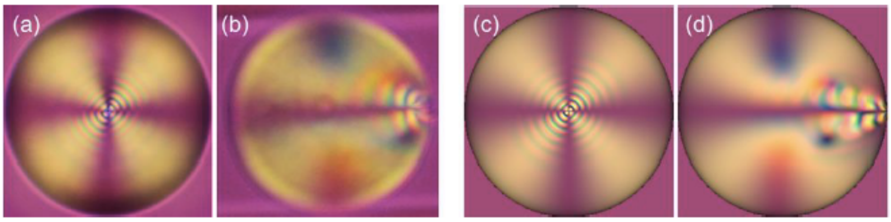

Figure 1: (a), (b) Experimental micrographs (crossed polarizers with diagonal λ plate) of a 5CB droplet (diameter 46 µm) in the resting (a) and self-propelling (b, motion from left to right) state. (c), (d) Calculated micrographs (Jones matrix method) for model director fields. While the resting droplet possesses a simple radial hedgehog defect, the active droplet shows a shifted hedgehog and additional deformations in the director field.

References

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**Corresponding author e-mail: christian.bahr@ds.mpg.de.*