Field-driven Pattern Formation in Nematic Liquid Crystals: Mesoscopic Simulations of Electroconvection

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Abstract

As an environment of rich pattern formation, electroconvection (EC) of nematic liquid crystals (LCs) is studied via fully nonlinear simulation for the first time. Previously, EC is mostly studied by experiments or by linear/weakly nonlinear hydrodynamic theory, of its instability criteria. While the negative dielectric LCs are used in most EC analytic and experimental investigations, EC with positive dielectric LC is only limited to experiments due to its more complex nonlinear behavior. In this work we take a step beyond the existing weakly nonlinear EC research by using a fully nonlinear particle-based simulation.

To investigate the distinct dynamics of positive and negative dielectric LCs, we modify the molecular potential in the LC stochastic rotational model (LC SRD)[1] to incorporate the dielectric characteristics and the field-particle interaction. As results, different convection patterns known in EC experiments are observed in our simulations, for which those patterns appear orderly as a function of external field strength. The simulated director and flow fields correspond each others well as found in experiments.For the positive dielectric LC, we discovered a net directional flows[2] accompanying the traveling EC rolls. This numerical model and its hydrodynamic analysis could be used for precise flow control in micro-scale, such as nematic colloidal transportation in microfluidics.

【結果と考察】

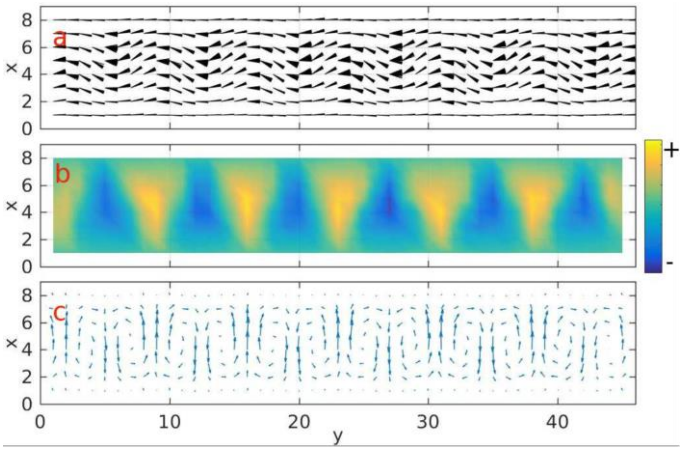

Figure. The typical EC with negative dielectric LCs is shown here. Panel a is the x-y projection of the directors, while panel c is the x-y projection of the flows. The middle panel b shows the bound charges

seen in the x-y plane, for which it is calculated according to Poisson’s equation for dielectric materials.

【参考文献】

(1) K.-W. Lee and M. G. Mazza, J. Chem. Phys., 2015, 142, 164110.

(2) K.-W. Lee and Thorsten Poeschel, RSC Advances, 2017, 7, 42218