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Mathematical Models for Chromonic Liquid Crystals

Inteviene
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Abstract

Chromonic liquid crystals are lyotropic materials which are attracting growing interest for their adapatbility to living systems. To describe their elastic properties, the classical Oseen-Frank theory requires anomalously small twist constants and (comparatively) large saddle-splay constants, so large as to violate one of Ericksen's inequalities, which guarantee that the Oseen-Frank stored-energy density is bounded below. This talk will show that, while such a violation does not prevent the existence and stability of equilibrium distortions in problems with fixed geometric confinement, the study of free-boundary problems for droplets reveales a number of paradoxical consequences. Minimizing sequences driving the total energy to negative infinity are constructed by employing ever growing needle-shaped tactoids incorporating a diverging twist. To overcome these difficulties, we propose a novel elastic theory that extends for chromonics the classical Oseen-Frank stored energy by adding a quartic twist term. The total energy of droplets is bounded below in the quartic twist theory, so that the known paradoxes are ruled out. The quartic term introduces a phenomenological length ain the theory; this affects the equilibrium of chromonics confined within capillary tubes. However, available experimental data for chromonics confined to cylindrical cavities with degenerate planar anchoring on their lateral boundary can be explained equally well by both competing theories. We then identify a means to differentiate these theories both qualitatively and quantitatively. They are shown to predict quite different core defects for the twisted hedgehogs that chromonics generate when confined to a fixed spherical cavity with homeotropic anchoring. In the quartic twist theory, the defect core is estimated to be nearly one order of magnitude larger (tens of microns) than in the other and, correspondingly, the director field lines describe Archimedean spirals instead of logarithmic ones.

Seminario

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