

Geometry And Topology Of Liquid Crystals

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Abstract

Liquid crystals are a rich class of materials that exhibit intermediate order between simple liquids and crystals. Nematic liquid crystals are phases in which the molecules develop orientational order. Smectic liquid crystals develop, in addition, a periodic modulation in one direction. These phases resemble a uniformly-spaced stack of fluid layers, and the nonlinearities in their energy often play a crucial role in understanding their properties, even for very small deformations.

This mini-course will explore the role of topology and geometry in both nematic and smectic liquid crystals, focussing mainly on smectics. Using nematic liquid crystals as a starting point, I will discuss topological defects in smectic liquid crystals. In certain cases, extrema of the fully nonlinear smectic energy can be found corresponding to certain configurations of defects. This will lead us to study liquid-crystalline structures whose order is frustrated, leading to a ground state of defects. These defect-laden phases share a close but only partially-explored relationship to certain minimal surfaces.