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Flexopolarization and Landau–de Gennes theory of modulated nematic phases

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Modulated nematic phases, such as the twist-bend nematic (NTB) and splaybend nematic (NSB) phases, experimentally discovered within the last 15 years, are among the most intriguing liquid crystal phases due to their potential practical applications. A possible mechanism underlying the stabilization of these phases is flexopolarization-induced softening of the bend elastic constant. To investigate this mechanism, we employ the helicity-mode expansion of both the alignment tensor field Q and the polarization field P, with the goal of identifying global minimizers of the minimal-coupling Landau–de Gennes theory with flexopolarization. This theoretical approach was first proposed by Longa and Trebin [1] and has successfully explained the stability [2,3] and field-induced behavior [4] of the NTB phase. The primary objective of the present study is to identify all classes of phase diagrams exhibiting at most one-dimensional periodic structures that can be predicted by this theory. The helicity-mode expansion is utilized to systematically control approximations when modeling these structures. The most significant new result is the simultaneous identification of both the NTB and NSB phases within a single phase diagram, along with the characterization of possible phase transitions between these and other nematic phases.

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