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Nematic Liquid Crystals - from Maier-Saupe to continuum theories.

We review the mean-field Maier-Saupe and continuum Landau-de Gennes theories for nematic liquid crystals. Using a maximum principle approach, we show that the Landau-de Gennes predictions are not consistent with the Maier-Saupe predictions in low-temperature regimes. We define a continuum energy functional that effectively interpolates between the Maier-Saupe energy and the Landau-de Gennes energy functional and can describe both spatially homogeneous and inhomogeneous systems. A key part of this definition is a thermotropic bulk potential which blows up whenever the Landau-de Gennes order parameter is inconsistent with the Maier-Saupe description. As a consequence, minimizers of this continuum energy functional are consistent with the Maier-Saupe predictions in all temperature regimes. We study the qualitative properties of these energy minimizers and also discuss phase transitions within this model.

Joint work with John Ball.