Knotted defects in nematic liquid crystals

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We present a theoretical and computational investigation into the topological properties of knotted and linked line defects in nematics. We classify the number of topologically distinct field configurations one can associate to a given link, finding it equal to a well-known invariant - the determinant of the knot or link. Using the Pontryagin-Thom construction these distinct textures are understood in terms of Skyrmion tubes entangling the knot. We show the existence of metastable states containing such knotted and linked defects in cholesterics by numerical relaxation of the Landau-de Gennes free energy, finding knots whose size is comparable to the pitch length. We also present a set of robust topological rules for the resolution of disclination crossings based on the preservation of an induced orientation on defect lines.

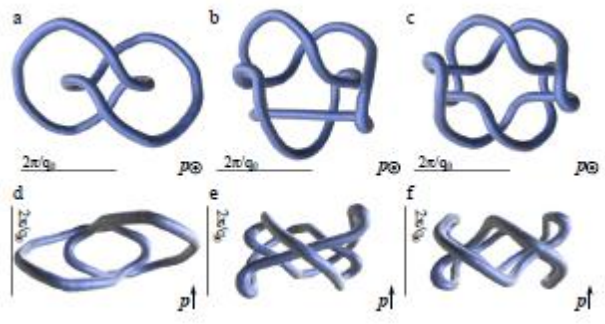

Figure 1: Images of stable knotted line defects in a cholesteric, found by numerical relaxation of the Landau-de Gennes free energy. Black lines indicate one pitch length. a, b & c are views along the pitch axis of a Hopf link, trefoil knot and Solomon's knot; d, e & f are views perpendicular to the pitch axis of the same knots.