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Chiral liquid crystals: the vestigial chiral phases of T, O, I matter¹ JAAKKO NISSINEN, KE LIU, ROBERT-JAN SLAGER, Lorentz Institute for Theoretical Physics, Leiden University, the Netherlands, KAI WU, Stanford Institute for Materials and Energy Sciences, SLAC National Accelerator Laboratory and Stanford University, USA, JAN ZAANEN, Lorentz Institute for Theoretical Physics, Leiden University, the Netherlands — We show how chiral order develops in vestigial isotropic phases of T, O and I liquid crystalline systems in three dimensions. The liquid crystal phases are realized in a lattice model of orientational degrees of freedom with point group symmetries $G \subset O(3)$, represented as O(3)-rotors coupled to G gauge fields. The model incorporates also disclinations via the gauge fields, features an ordered nematic phase with unbroken G rotations at low temperatures and a high temperature isotropic liquid phase. We observe an intermediate phase with spontaneous chirality but isotropic SO(3) symmetry (a liquid) for the gauge groups T, O, and I, the proper symmetry groups of the tetrahedron, cube and icosahedron, respectively. For the other subgroups of SO(3), $C_{n<\infty}$ and $D_{n<\infty}$, there is generically only a single phase transition from the nematic phase to the isotropic liquid. We discuss the nature of the phase transitions and conditions under which the chiral phase is stabilized by the nematic order parameter fluctuations. The nature of the vestigial chiral phase is reminiscent of the so-called Ising nematic phase in iron based superconductors.

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