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Phase transitions and order parameters of complex liquid crystalline ordered systems KE LIU, JAAKKO NISSINEN, ROBERT-JAN SLAGER, Instituut-Lorentz for Theoretical Physics, Universiteit Leiden, KAI WU, Stanford Institute for Materials and Energy Sciences, Stanford University, JAN ZAANEN, Instituut-Lorentz for Theoretical Physics, Universiteit Leiden — Liquid crystalline states of matter possess rich phase diagrams, exotic topological defects and unique responses to external fields. Traditionally the focus has been on liquid crystal phases with uniaxial $D_{\infty h}$ symmetry and biaxial D_{2h} symmetry. However, in full generality liquid crystalline orders are associated with breaking the $O(3)$ rotational symmetry to any point group symmetry $G \subset O(3)$. We present a general theory for arbitrary three dimensional point group symmetries that allows to derive order parameters and investigate phase transitions of liquid crystalline states. The theory is constructed on symmetry grounds, and adapts to the description of both thermal and quantum liquid crystal systems. The realization of the model in experimental systems are also discussed.

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