Gauge theory and nematic order : the rich landscape of orientational phase transition

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Propositions

accompanying the thesis

Gauge Theory and Nematic Order
The rich landscape of orientational phase transition

I

Gauge theories are not an alternative but in fact a rather necessary route to study the statistical physics of liquid crystals.

Chapter 3 and chapter 4 of this thesis

II

The most symmetric nematic orders are subjected to extremely large fluctuations, and thus are difficult to stabilize.

Chapter 3 of this thesis

III

A symmetry can spontaneously break down to any of its subgroups. The associated phase transitions are in general of different nature.

Chapter 5 of this thesis

IV

Although phase transitions are in principle allowed for any two symmetries related via a subgroup relation, suitable tuning parameters are needed to realize such transitions.

Chapter 5 of this thesis

V

Many physicists believe that superconducting phases break the local gauge symmetry. However, as described by Elitzur's theorem, gauge symmetries cannot break spontaneously. Superconducting phases in fact break the gauged global U(1) symmetry.

S. Elitzur, Phys. Rev. D **12**, 3978 (1975).

VI

Gauge symmetry is not a symmetry but a redundancy in the description of a physical system (see, e.g., Wen's *Quantum Field Theory of Many-Body Systems* for reference), and can be introduced as an auxiliary tool to facilitate the calculations and/or to incorporate the effects of interactions.

X.-G. Wen, Quantum Field Theory of Many-Body Systems,
Oxford University Press, 2007.

VII

The classification of topological defects in liquid crystals has been subjected to extensive discussions since 1970s (see the reference). The dynamical properties of these defects, such as their creation, annihilation, motion and interplay with each other, however, have been largely ignored.

M. Kleman and J. Friedel, Rev. Mod. Phys. **80**, 61 (2008).

VIII

The results of Beekman *et al.* indicate that condensates of topological defects can be a real form of matter.

A. J. Beekman *et al.*, arXiv:1603.04254.

IX

Nematic phases have a great potential in the quest to explore the physics of non-Abelian topological order.

X

A lack of substance demands wrapping.

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