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Quark-hadron continuity beyond Ginzburg-Landau paradigm

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Quark-hadron continuity [1] is a scenario that hadronic matter is continuously connected to color superconductor without phase transitions as the baryon chemical potential increases. This scenario is based on Landau's classification of phases since they have the same symmetry breaking pattern. We address the question whether this continuity is true as quantum phases of matter, which requires the treatment beyond Ginzburg-Landau description [2,3]. To examine the topological nature of color superconductor, we derive a dual effective theory for U(1) Nambu-Goldstone (NG) bosons and vortices of the color-flavor locked phase, and discuss the fate of emergent higher-form symmetries. The theory has the form of a topological BF theory coupled to NG bosons, and fractional statistics of test quarks and vortices arises as a result of an emergent Z3 two-form symmetry. We find that this symmetry is not spontaneously broken, indicating that quark-hadron continuity is still a consistent scenario.

[1] T. Schafer and F. Wilczek, Phys.Rev.Lett. 82 (1999) 3956-3959.

[2] Y. Hirono, Y. Tanizaki, Phys. Rev. Lett., in press [arXiv:1811.10608]

[3] Y. Hirono, Y. Tanizaki, [arXiv:1904.08570]

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