Probing Critical Surfaces in Momentum Space Using Real-Space Entanglement Entropy: Bose versus Fermi

KUN YANG, Department of Physics and National High Magnetic Field Laboratory, Florida State University, HSIN-HUA LAI, Department of Physics and Astronomy, Rice University — A co-dimension one critical surface in the momentum space can be either a familiar Fermi surface, which separates occupied states from empty ones in the non-interacting fermion case, or a novel Bose surface, where gapless bosonic excitations are anchored. Their presence gives rise to logarithmic violation of entanglement entropy area law. When they are convex, we show that the shape of these critical surfaces can be determined by inspecting the leading logarithmic term of real space entanglement entropy. The fundamental difference between a Fermi surface and a Bose surface is revealed by the fact that the logarithmic terms in entanglement entropies differ by a factor of two: \( S_{log}^{Bose} = 2S_{log}^{Fermi} \), even when they have identical geometry. Our method has remarkable similarity with determining Fermi surface shape using quantum oscillation. We also discuss possible probes of concave critical surfaces in momentum space.

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