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Entanglement signatures of emergent Dirac fermions: kagome spin liquid and quantum criticality (I)

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Quantum spin liquids (QSL) are exotic phases of matter that host fractionalized excitations. It is difficult for local probes to characterize QSL, whereas quantum entanglement can serve as a powerful diagnostic tool due to its non-locality. The kagome antiferromagnetic Heisenberg model is one of the most studied and experimentally relevant models for QSL, but its solution remains under debate. Here, we perform a numerical Aharonov-Bohm experiment on this model and uncover universal features of the entanglement entropy. By means of the density-matrix renormalization group, we reveal the entanglement signatures of emergent Dirac spinons, which are the fractionalized excitations of the QSL. This scheme provides qualitative insights into the nature of kagome QSL, and can be used to study other quantum states of matter. As a concrete example, we also benchmark our methods on an interacting quantum critical point between a Dirac semimetal and a charge ordered phase.

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