Probing the structure of topological entanglement via selective partitioning

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The topological entanglement entropy (TEE), defined as the subleading term of bipartite entanglement entropy, provides a universal signature of topological order. However, as a single number, it does not reveal its internal structure of more complex systems, such as multi component fractional quantum Hall (FQH) systems.

We propose a protocol to resolve this structure of complex FQH systems by selectively partitioning different components at the entanglement cut. By imposing constraints on chosen components in a stepwise manner, we track how the subleading contribution to the entanglement entropy evolves as individual components are partitioned. This procedure defines a sequence of partition-induced changes of the TEE that depends on the order in which the constraints are applied. We show that in Abelian systems these changes are governed by the scaling dimensions of the operators implementing the constraints, while in non-Abelian systems they deviate from this behavior.

Building on recent experimental advances, we show that this partitioning structure can be accessed via Maxwell relations in quantum point contact (QPC) and quantum dot (QD) setups.