Momentum polarization: an entanglement measure of topological spin and chiral central charge

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http://arxiv.org/abs/1212.6951 [2]

Topologically ordered states are quantum states of matter with topological ground state degeneracy and quasi-particles carrying fractional quantum numbers and fractional statistics. The topological spin $\theta_a=2\pi h_a$ is an important property of a topological quasi-particle, which is the Berry phase obtained in the adiabatic self-rotation of the quasi-particle by 2π. For chiral topological states with robust chiral edge states, another fundamental topological property is the edge state chiral central charge c. In this paper we propose a new approach to compute the topological spin and chiral central charge in lattice models by defining a new quantity named as the momentum polarization. Momentum polarization is defined on the cylinder geometry as a universal subleading term in the average value of a "partial translation operator". We show that the momentum polarization is a quantum entanglement property which can be computed from the reduced density matrix, and our analytic derivation based on edge conformal field theory shows that the momentum polarization measures the combination $h_a-\frac{c}{24}$ of topological spin and central charge. Numerical results are obtained for two example systems, the non-Abelian phase of the honeycomb lattice Kitaev model, and the $\nu=1/2$ Laughlin state of a fractional Chern insulator described by a variational Monte Carlo wavefunction. The numerical results verifies the analytic formula with high accuracy, and further suggests that this result remains robust even when the edge states cannot be described by a conformal field theory. Our result provides a new efficient approach to characterize and identify topological states of matter from finite size numerics.

- AQUTE [3]
- 04.25.+l Entanglement in solid state systems, Luttinger liquids, etc. [4]
- Result [5]
- 04.60.+s Entanglement in mesoscopic/macroscopic systems [6]
- 04.70.+m Multi-particle/multi-photon entanglement [7]

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