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The entanglement entropy and the Berry phase in solid states[1]
SHINSEI RYU, KITP, UCSB, YASUHIRO HATSUGAI, Dept. of Appl. Phys., Univ. of Tokyo — The entanglement entropy (von-Neumann entropy) has been used to characterize the quantum entanglement of many-body ground states in strongly correlated systems. In this talk, we try to establish a connection between the lower bound of the von-Neumann entropy and the Berry phase defined for quantum ground states. As an example, a family of 1D Hamiltonians with two bands separated by a finite gap is investigated. We argue that when the Berry phase (Zak's phase) of the occupied band is equal to $\pm\pi \times$ (odd integer) and when the ground state respects a discrete unitary particle-hole symmetry (chiral symmetry), the entanglement entropy in the thermodynamic limit is at least larger than $\ln 2$ (per boundary), i.e., the entanglement entropy that corresponds to a maximally entangled pair of two spins. We also discuss it is related to vanishing of the expectation value of a certain non-local operator which creates a kink in 1D systems.

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