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# Critical properties at the Anderson transition in the two-dimensional $Z_2$ quantum spin-Hall system

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The quantum spin-Hall (QSH) effect occurs in a new kind of a topological insulator characterized by the $Z_2$ topological number. Since QSH system possesses time-reversal symmetry and broken spin-rotation symmetry, this system is expected to belong to the symplectic class if taking account of symmetries but ignoring the topological nature. Recently, it is discussed that the Anderson transition of the QSH system belongs to the different universality class by reflecting the topological nature.

In this work, we investigate various critical properties at the Anderson transition of the QSH system in two-dimensions (2D) by using the network model. By applying the finite size-scaling analysis for the localization length, it is found that the critical exponent $\nu$ characterizing the divergence of the localization length at the critical point is identified with that of the ordinary symplectic class in 2D.

We also investigate bulk and boundary multifractality in the QSH system, which characterizes scale-invariant nature of wave functions at criticality in the bulk and near the boundary, respectively. We found that bulk multifractality in the QSH system is same as that of the ordinary symplectic class in 2D. When open boundaries are imposed on the QSH system, there exist two kinds of critical points depending on whether a boundary induces edge states in the adjacent insulating phase. It is found that boundary multifractality at the critical point of the metal - ordinary insulator (absence of edge states) transition is also same as that of the ordinary symplectic class. On the other hand, boundary multifractality at the critical point of the metal-topological insulator (presence of edge states) transition is completely different from that of the ordinary symplectic class. Therefore, boundary multifractality observed at the latter critical point is considered to be a new boundary critical phenomenon in the symplectic class, reflecting the presence of topologically non-trivial edge states in the adjacent insulating phase.