Non-magnetic disorder effects on 3-dimensional $Z_2$ quantum spin Hall systems

RYUICHI SHINDOU, RIKEN (the Institute of Physical and Chemical Research), SHUICHI MURAKAMI, Tokyo Institute of Technology — Motivated by the recent discovery of the $Z_2$ quantum spin Hall insulator (QSHI) in the antimony doped bismuth, we have studied the non-magnetic disorder effects onto the quantum critical point (QCP) which always exists between an ordinary insulator and the $Z_2$ QSHI. Namely, intervening the topologically distinct states of matter, such QCP should be generally stable against any perturbations (i.e. disorders), as far as the time-reversal symmetry is preserved. In this talk, I will present a possible microscopic mechanism of this stability, based on simple weak-localization calculations. Specifically, at the QCP between the topological insulator and an ordinary insulator, so-called the parity degree of freedom also becomes the conserved quantity, in addition to the usual charge. As a result of this, the diffuson near the QCP consists of the two quasi-degenerate dominant contributions having the diffusion poles; one contributes to the usual charge diffusion, while the other is ascribed to the parity diffusion. In terms of these two quasi-degenerate low-energy modes, I will construct a possible microscopic picture for the stability of the QCP against non-magnetic disorders.

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