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Nuclear spin-induced localization of the edge states in two-dimensional topological insulators PETER STANO, CHEN-HSUAN HSU, RIKEN Center for Emergent Matter Science, Japan, JELENA KLINOVAJA, DANIEL LOSS, Department of Physics, University of Basel, Switzerland — We investigate the influence of nuclear spins on the transport properties of the helical edge states in two-dimensional topological insulators. The nuclear spins couple to the edge-state electrons through the hyperfine interaction, and cause spin-flip backscattering between the edge-state electrons. In a system with long edges, the edge states are localized due to disordered nuclear spins below the localization temperature. On the other hand, the edge states mediate anisotropic RKKY interaction, which induces a cycloidal nuclear spin order below the transition temperature. At zero temperature, where the nuclear spins are completely ordered, the nuclei-induced backscattering is suppressed in clean systems. However, we demonstrate that other backscattering processes can be caused by magnons at finite temperature, and charge impurities in the presence of the Overhauser field, which is induced by the ordered nuclei. The coexistence of the charge impurities and the Overhauser field leads to Anderson-type localization of the edge states, whereas the magnon-mediated backscattering depends on the magnon energy. We provide the RG analysis for the backscattering mechanisms caused by disordered nuclei, magnons, and the coexistence of charge impurities and an Overhauser field.

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