Symmetry-protected topological phases of alkaline-earth cold fermionic atoms in one dimension

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Résumé

We investigate the existence of symmetry-protected topological phases in one-dimensional alkaline-earth cold fermionic atoms with general half-integer nuclear spin I at half filling. In this respect, some orbital degrees of freedom are required. They can be introduced by considering either the metastable excited state of alkaline-earth atoms or the p-band of the optical lattice. Using complementary techniques, we show that SU(2) Haldane topological phases are stabilised from these orbital degrees of freedom. On top of these phases, we find the emergence of topological phases with enlarged SU(2I+1) symmetry which depend only on the nuclear spin degrees of freedom. The main physical properties of the latter phases are further studied using a matrix-product state approach. On the one hand, we find that these phases are symmetry-protected topological phases, with respect to inversion symmetry, when I=1/2,5/2,9/2,..., which is directly relevant to ytterbium and strontium cold fermions. On the other hand, for the other values of I(=half-odd integer), these topological phases are stabilised only in the presence of exact SU(2I+1)-symmetry.

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