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Local gauge invariance and spin superconductivity in materials magnetic described by the two-dimensional compass model with Heisenberg interactions

Leonardo S Lima
Centro Federal de Educação Tecnológica de Minas Gerais, Brazil

The local spontaneous symmetry breaking is a general phenomenon in condensed matter physics. It is characterized by the fact that the action has a local symmetry but the quantum theory, instead of having a unique vacuum state which respects this symmetry, has a family of degenerate vacua that transform into each other under the action of the symmetry group. A simple example is given by a ferromagnetic model in which the act governing its microscopic dynamics is invariant under spatial rotations. A kind of local gauge invariance or spontaneous breaking of U(1) gauge symmetry is realized in nature in the phenomenon of superconductivity. We have proposed a Meissner mechanism for the spin transport in quantum spin systems that to have various applications in spintronics. Besides, we study about the behavior of the AC spin conductivity in the neighborhood of a quantum phase transition in a frustrated spin model such as the antiferromagnet in the compass lattice with single ion anisotropy at T=0. Our results show the curve of conductivity varying strongly with the behavior of the critical anisotropy Dc and J2. Katukuri *et al.* have shown that individual layers of Ba_2IrO_4 provided a good realization of the quantum compass model on the square lattice. Zhang *et al.* have used the Heisenberg model with compass interactions to study the compound Sr_2IrO_4 and pointed out that it has a close resemblance to the cuprate superconductors such as La_2CuO_4 and that many interesting phenomena common to the cuprates are also found in Sr_2IrO_4.

~~khkim@kaeri.re.kr~~