# A set of Majorana zero modes on the triangular lattice in the coexistence phase of superconductivity and noncollinear magnetic order

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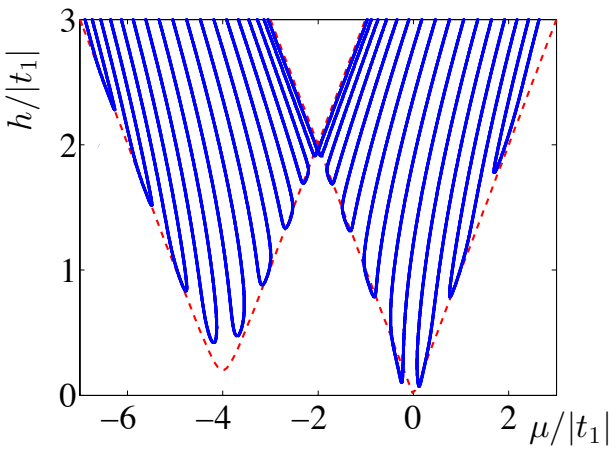


Diagram in variables exchange field ($h$) and chemical potential ($\mu$) determining the conditions of implementing the Majorana zero modes (solid lines). Dashed lines show topologically nontrivial phases.

In the last years the promising systems, such as superfluid quantum liquids[1] and topological superconductors[2] have been discussed in which the implementation of the Majorana zero modes on the edges is possible.

Recently, it has been shown[3] that the Majorana modes can arise due to the influence between superconductivity and spin density wave, including noncollinear magnetic structures[4]. It is demonstrated in Ref.[4] that the Majorana modes are realized on the edges of the triangular lattice, folded on a cylinder, in the case when the Fermi contour crosses the nodes of the chiral $d_{x^2-y^2} + id_{xy}$ superconducting order parameter with regard to noncollinear magnetic ordering ($3 \times 1$ structure).

In the present work, we show that the conditions of implementing the Majorana zero modes in such systems are significantly broader. In the figure the set of curves in variables $h$ (exchange field) and $\mu$ (chemical potential) is presented for which the excitation energy is zero leading to the appearance of the Majorana modes. The 1D chain from the cylinder of length 30 lattice parameters with the wave number $k_2 = 0$ (in the units of the reciprocal vector) is considered. The amplitude of the superconducting order parameter is $\Delta = 0.1|t_1|$ ($t_1$ is hopping parameter). The dashed lines determine the borders of the topologically nontrivial phases. On these borders the energy spectrum of the lattice, folded on a torus, has an odd number of gapless points at $k_2 = 0$.

The conditions of realization of the Majorana modes on the 2D triangular lattice with open boundaries are determined. The possibility of homogeneous coexistence of chiral superconductivity and noncollinear magnetic order in the model is also analyzed.

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