Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Topological transition caused by reconstruction of zero-mode Majorana fermions in XYZ spin chain TAKANORI SUGIMOTO, Tokyo University of Science, SAYED AKBAR JAFARI, Sharif University of Technology, TAKAMI TOHYAMA, Tokyo University of Science — Kitaev chain model has attracted much attention as a possible play-ground of topologically-protected quantum computation (TPQC), based on zero-energy modes of Majorana fermions (ZM2Fs). This model can be realized in a 1/2-spin chain compound, which has an anisotropic XY exchange interaction between nearest-neighbor sites. However, real materials also have a non-zero Ising interaction necessarily. Here, we theoretically study effects of the Ising interaction in a XYZ spin chain, where a fully anisotropic exchange is introduced in neighboring bonds. The existence of ZM2Fs can be clarified with energy gaps of ground states between different $Z_2 \times Z_2 \times Z_2$ sectors, defined by $Q^\alpha = \prod_i (2S_i^\alpha) = \pm 1$ where $\alpha = x, y, z$. By calculating the energy gaps with variational matrix-product state method, we find a topological transition, where a ZM2F in Q^α sectors changes into that in other Q^β sectors. Thus, we conclude that the transition originates from a reconstruction, namely a global $SU(2)$ rotation, of the ZM2F. Our results are helpful not only for understanding effects of possible Ising interactions in real compounds but also for important knowledge on stability of TPQCs.

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Date submitted: 10 Nov 2016