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Non-local order parameter for topological phase transition in the quantum toric code

M H Zarei

Department of Physics, School of Science, Shiraz University, Shiraz, Iran

E-mail: mzarei92@shirazu.ac.ir

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Abstract

It has been known that by encoding the Boltzmann weights of a classical Ising model in the amplitudes of the wave function of the ground state of the toric code model, the classical phase transition in Ising model is mapped to a topological phase transition in a perturbed toric code model. Since such topological phase transitions cannot be characterized by any local order parameter, it will be an important challenge to find an order parameter which describes the above topological phase transition. In this paper, using a simple technic based on mapping between classical Ising model and the ground state of the toric code model, we find a non-local order parameter which well reveals the topological nature of the above phase transition. We show that such an order parameter is, in fact, a kind of string order parameter which has been recently introduced for some topological phase transitions.

Keywords: topological phase transition, quantum toric code, non-local order parameter, Ising model

For full article, refer to the Persian section