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Calculation of the ground and exited states of the Ising model using Quantum Approximate Optimization Algorithm(QAOA)

H Davoodi Yeganeh*, M Mahdian, and R Mohammadi Aghdaragh

Department of theoretical and astrophysics, Faculty of Physics, University of Tabriz, Tabriz, Iran

E-mail: h.yeganeh@tabrizu.ac.ir

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Abstract

The one-dimensional quantum Ising model is used to describe many physical systems, therefore the calculation of ground and excited state energies of Ising model that has many applications in statistical mechanics, has been paid attention. We obtain the ground and excited states of this model by using the Quantum Approximate Optimization Algorithm(QAOA), which is a kind of hybrid quantum-classical algorithms. For this purpose, first, we find the ground state with quantum approximate optimization algorithm, then we generalize this algorithm by adding an overlap term to obtain excited states. We calculated ground state energy and excited states energies for different coupling coefficients which is compatible with exact calculation.

Keywords: the one-dimensional Ising model, ground and exited states, Quantum Approximate Optimization Algorithm(QAOA), hybrid quantum-classical algorithm

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