Qeios

Peer Review

# Review of: "Improving Stabilizer Approximation with Quantum Strategy"

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This review is for Preprint v1.

Grammar and spelling:

1. Section I, paragraph 1: we wouldn't be so luck to obtain > lucky/in luck
2. Section I, last paragraph: gives us a clue as how to > as to/as for
3. Section IV A, below eq. 15: have difficulty to select > difficulty in selecting
4. Section IV B, below eq. 21: not so satisfiable > satisfying
5. Summary, first sentence: approximation for groundstates > ground states

Writing:

1. It'd be easier for the readers to add in some in-article references, e.g., referring to eq. 4 in some discussion in Section III.
2. It may be better if, given a stabilized state, how the energy is actually calculated is shown.
3. What is done around eq. 22 and 23 is not very clear: For example, I'm not really sure how "we gauge $X_1$ and $Z_1$ as before, and discard $Z_1'$, say, by choosing $X_1'$ as the first stabilizer" leads to eq. 22. Also, does, for example, the operator $Z_2$ in eq. 22 refer to $I_1 \otimes Z_2$? If so, this can be a bit confusing.

Comments on the research:

1. This work seems to me more of an application and continuation of Ref. 9 (Stabilizer ground states for simulating quantum many-body physics), in particular Section III D of Ref. 9, where local rotations are performed, and Section 3.1 of Ref. 15 (Classical Verification of Quantum Proofs). How certain results from these two works are applied should be made clearer.

 doi.org/10.32388/ICJ8B7 

2. It's fine to say this work is inspired by the optimal quantum strategy for the CHSH game, but I feel it weird to think of this approach as bringing in "quantumness," as phrased in the introduction, because $H$ and $\tilde{H}$ can be regarded as Pauli Z and X in a different frame - In classical mechanics, similar transformations are also performed to solve problems, e.g., finding the normal modes of coupled oscillators.
3. Calling the process "gauging" may be associated with gauge theory, which may cause confusion. If the author intends to keep using this term, then this may need to be clarified.
4. Right after eq. 14, it's said "it is not difficult to check that... (the two stabilizers)... indeed stabilize $|\Phi'\rangle$" I don't really understand this sentence because to me $|\Phi'\rangle$ should be stabilized by construction. What's left to check?
5. Section IV C: What is the parameter to achieve that energy? And it'd be better if a diagram or table is shown.
6. Section IV C: Rotation around the y-axis seems quite restrictive. Also, this, as said above, doesn't seem different from the proposal from Ref. 9.

In brief, being a short note, this work is satisfactory, but certain parts need some revision as commented above.

## Declarations

**Potential competing interests:** No potential competing interests to declare.