Dear Dr. Millev,

Thank you for arranging the review of this manuscript. We are pleased that the referee looked favorably on the manuscript and recommended publication. In the revised manuscript, we have addressed all the issues raised by the referee, as explained in detail below. We trust the manuscript will now be judged suitable for publication.

Best,

Charles Stahl and Rahul Nandkishore

In what follows, the referee report is in blue and our response is in black.

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Report of the Referee -- BD14043/Stahl  
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In this paper, the authors present several 3D lattice models realizing   
a self-correcting quantum memory. In these models the quantum memory   
is protected by a 1-form symmetry. One of the main points of the   
manuscript is to shed light on a previous construction of a   
self-correcting quantum memory by Roberts and Bartlett that involved   
an SPT phase protected by a 1-form symmetry. The paper argues that the   
crucial ingredient in all of these constructions is the 1-form   
symmetry, and not the SPT character of 3D state.   
  
The models presented by the paper are illuminating, and the arguments   
are convincing. I also think the paper is clearly written and that it   
clarifies several aspects of the Roberts and Bartlett construction.   
For all of these reasons, I recommend that the paper be published in   
Physical Review B.

We thank the referee for this favorable assessment.   
  
I have two comments/suggestions that should be considered before   
publication:   
  
1. In the second model discussed in section III, the 1-form symmetry   
is not “on-site” in the sense discussed e.g. in arXiv:1812.02517. As   
far as I can tell, the same statement is also true for the model   
discussed by Roberts and Bartlett. In contrast, the Walker-Wang model   
in section II has an “on-site” higher form symmetry. I’m not sure   
whether the notion of an “on-site” higher form symmetry is as   
well-accepted as for conventional symmetries, but it may be worth   
pointing this out.   
  
2. I don’t understand the rules of the game for how to define 1-form   
symmetries in a lattice with a boundary. What are the restrictions (if   
any) on how the define the symmetry operators at the boundary? It may   
be useful to either clarify these rules in the paper, or point out   
that the issue is not understood. After all, the precise definition of   
the symmetry operators at the boundary seems to play an essential role   
in all of these constructions.

We appreciate these suggestions and have updated the manuscript in response, adding clarifying comments to the text and discussion. It is true that the symmetry in our second model is not "on-site", and we have pointed this out in the text. The failure to be "on-site" directly comes from the boundary action, so a complete answer to the second point raised by the referee would also clarify the first. We don't have a complete answer as to what the `rules of the game’ are for higher form symmetries, and we have noted this in the discussion. At the same time, this issue does not seem pertinent to the present work, since the symmetries we consider are no more constraining than un-decorated 1-form symmetries, so we have simply noted this point as a matter that may be of interest to future investigations.

We trust the manuscript will now be judged suitable for publication.

Sincerely,

Charles Stahl and Rahul Nandkishore