Fakultät für Mathematik und Physik

Submission to Physical Review X

Gottfried Wilhelm Leibniz Universität Hannover, Postfach 6009, 30060 Hannover

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Dear Madam/Sir,

Please find enclosed the following paper for consideration for publication in Physical Review X.

Title: Gauging defects in quantum spin systems

The goal of this work is to build a dynamical theory of defects for quantum spin systems. A kinematic theory for an indefinite number of defects is first introduced exploiting distinguishable Fock space. Dynamics are then incorporated by allowing the defects to become mobile via a microscopic Hamiltonian. This construction is extended to topologically ordered systems by restricting to the ground state eigenspace of Hamiltonians generalizing the golden chain. We illustrate the construction with the example of a spin chain with Vec(Z/2Z) fusion rules, employing generalized tube algebra techniques to model the defects in the chain. The resulting dynamical defect model is equivalent to the critical transverse Ising model.

We think that our work is of great interest to a broad audience since it establishes a new link between theoretical physics and mathematics. We strongly focus on creating a connection between the physical theory of quantum phases of matter and the mathematical concepts of category theory and tube algebras.

We pave the way for describing defects in spin chains in the presence of topological order. In the experimental realization of such a system it will not be possible to ensure the complete absence of impurities. Hence, a framework to theoretically make sense of defects is required. Moreover, defects can even enhance the computational power of the system when using them for topological quantum computation. Therefore, adding defects will be a mandatory step for constructing topological quantum computers to make them suitable for practical tasks.

We show that it is not enough to just face the physical side to achieve this goal but rather also incorporate purely mathematical concepts. This gives a starting point for a stronger collaboration between these two areas.

Sincerely,

Jacob C. Bridgeman, Alexander Hahn, Tobias J. Osborne, and Ramona Wolf

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Subject Areas:

- Quantum Information,
- Quantum Physics,
- Condensed Matter Physics (Strongly Correlated Materials)

Potential Referees:

- Benjamin J. Brown (University of Sydney, Sydney, Australia)
- Beni Yoshida (Perimeter Institute, Waterloo, Canada)
- Colleen Delaney (Indiana University, Bloomington, United States of America)