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Topological characterization of phase transitions

In this work we study phase transitions from the point of view of topology. Topological invariants (of index-theory type) can characterize phases of matter for some of quantum, as well as classical systems. A paradigmatic example is given by the (classical) Ising model, for which the phase transition can be characterized in terms of basis projections and related $\mathbb{Z}_2$-index, as shown by H. Araki and D. Evans (1983). In joint work with S. Tabban and A.F. Reyes-Lega, we have established an alternative characterization of the phase transition in terms of the $\mathbb{Z}_2$-index that naturally arises in the context of the Shale-Stinespring theorem. This approach allows us to make an explicit connection between the current approaches to topological quantum matter (based on the study of topological invariants) and the operator-algebraic approach of Araki and Evans.

On the other hand, for some kind of topological systems it is possible to express the relevant invariants through local formulas (i.e Chern numbers) using K-theory elements. Recently, Kauffman et al. (2016) have proposed a formula of this type for theories in the frame of Clifford algebras using quaternionic K-theory. We verify the validity of this local index formula for the particular case of the Ising model, taking into account the connection with the CAR and Clifford algebras.