

S E M I N A R

Encoding topological qubits using higher lattice gauge theory model

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Venues: Online and Physics Seminar Room, Stellenbosch University

ABSTRACT

The concept of fault-tolerant topological qubits originates from Alexei Kitaev, who proposed a 2+1D lattice gauge theory model based on finite 1-groups. Building on this theoretical foundation, Microsoft, a major player in the technology industry, announced on 18 February 2025 the development of the first stable and robust topological qubits based on Majorana quasiparticles. This is an impressive accomplishment, but there are still many technical challenges to overcome before the realisation of topological quantum computers. These challenges include the development of advanced mathematical models to manipulate topological states.

In this talk, we generalize the Kitaev model into a 3+1D higher lattice gauge theory model based on the representations of finite 2-groups described by a category of crossed modules on a lattice model described by path 2-groupoids. We define an exactly solvable topological Hamiltonian schema based on these lattice gauge representations. We then construct the corresponding ground states, which encode quantum information, and show that these ground states are topological invariants.

BIOGRAPHY



Dr Latévi Mohamed Lawson is a distinguished mathematical physicist with expertise in theoretical, mathematical and computational aspects of quantum sciences. He obtained his PhD in Theoretical Physics from the Institute of Mathematics and Physical Sciences (IMSP) in Benin in 2018.

Following his doctorate, he served as an assistant lecturer of physics at the University of Lomé in Togo. He also contributed to the academic community as a reviewer for several reputable journals. In October 2020, he joined the African Institute for Mathematical Sciences (AIMS) in Ghana, where he has been active as both a teaching assistant and postdoctoral researcher.

In 2024, Dr Lawson expanded his research by joining the Theoretical Division for Non-Hermitian Topological Phenomena as a visiting researcher at the Max Planck Institute for the Science of Light in Germany.

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