Surface Code Quantum Computation (WS 17/18)

Start:
Monday, 09.10.2017 at 10.30 in room 25.32.03.51
(Lecture time and day can be discussed/shifted if necessary)

Summary:
This lecture covers advanced concepts in Quantum Information Theory. Previous attendance of the lectures “Theoretical Quantum Optics and Quantum Information” and “Quantum Error Correction” are helpful but not mandatory. The lecture starts with concepts of quantum error correction. We will introduce the stabilizer formalism and discuss the toric code as well as more general surface codes. In the main part of the lecture we will show how to do universal quantum computation with the surface code. Possible physical implementations of such topological quantum computers will be discussed.

The concept of (non-abelian) anyons, fusion rules and braiding of anyons will be introduced. As an example of a universal topological quantum computation scheme with non-abelian anyons we will discuss the Fibonacci anyon model.

Lectures: Mondays
10.30-12.30, room: 25.32.03.51
and (sometimes) Fridays,
10:30-12:30, room: 25.32.03.51

Exercises: Fridays (after announcement),
10.30-12.30, room: 25.32.03.51

Further information: www.thphy.uni-duesseldorf.de/~ls3/teaching.html
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Content:
1. Concepts of Quantum Computation (previous lecture)

2. Quantum Error Correction
   a. Basic concepts: (previous lecture)
      i. Encoding/decoding
      ii. Logical qubits and logical operations
   b. The repetition code, Shor code (previous lecture)
   c. Stabilizer codes (previous lecture)
   d. Topological codes:
      i. Toric code
      ii. General surface codes

3. Surface code quantum computation
   a. Logical qubits in the surface code array
      i. Initialization
      ii. Measurement
   b. Universal set quantum gates

4. Topological quantum computation
   a. Anyons and their statistics
   b. Braiding and fusion rules
   c. Fibonacci Anyons
   d. Towards universal topological quantum computation

Literature: