

Project 5.6. Shallow quantum circuits and random walks in compact groups

Supervisor: Prof. Adam Sawicki

Institute: Center for Theoretical Physics PAS

WWW: www.cft.edu.pl

Background:

In quantum computers information is encoded into quantum states and transformations between different states are realised by the quantum evolution. A basic task of a quantum computer is to evolve an initial quantum state to a target state. A priori the target state can be arbitrary (it depends on a problem we want solve using our quantum computer). A quantum computer that allows reaching any final state is called universal. In typical quantum architectures the evolution is realised by a quantum circuit that is build of quantum gates. Quantum gates can act on a single qubit (1-qubit or 1-local gates) or on several qubits (k-qubit or k-local gates). Given a transformation U which realises desired evolution and a universal set of gates S there will be many quantum circuits with a different arrangement and number of quantum gates that realise U . Moreover, the number of gates can also depend on a choice of a universal set, i.e. some universal sets of gates (we will call them efficient) can result with much shorter circuits than other ones. Practical realisations of quantum computers are constricted by noise and decoherence that affect large-scale quantum systems. Taking into account these destructive effects it is crucial that we find circuits with the lowest number of gates, aka circuits with the lowest depth.

Aim:

The subject of this project is to develop quantitative methods to identify the sets of quantum gates that give shallow quantum circuits.

Requirements:

- basics of programming.
- basics of quantum mechanics.
- advanced knowledge of representation theory of compact Lie groups.