CCSU

DEPARTMENT OF MATHEMATICAL SCIENCES

COLLOQUIUM

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3:00 – 4:00 PM
Maria Sanford, Room 101

PREPARATION OF 3-QUBIT STATES

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Joint work with Nelson Castaneda and Roger Vogeler

Abstract: A classical computer with 3 bits has 8 states, they are [000>, [001>, [010>, [011>, [100>, [101>, [110> and [111>. With a few gates it is easy to change from any state to another. A quantum computer with three quantum bits (three qubits) has infinitely many possible states. More precisely, the possible states are

$$z_1[000> + z_2\ [001> + z_3\ [010> + z_4\ [011> + z_5\ [100> + z_6\ \ [101> + z_7\ [110> + z_8\ [111>$$

where the z_k are complex number satisfying $\sum_{k=1}^{8} |z_k|^2=1$. The z_k's are called the amplitudes. Gates that only act on one of the three qubits are called local gates, and gates that interact with more than one qubit are called non-local gates. The controlled-Z gates act on two qubits and it is known that any circuit can be built using local gates and controlled-Z gates. We say that a circuit prepares a particular qubit state if this circuit takes the qubit [000> to the given qubit state.

In contrast with a classical computer, the problem of finding optimal circuits (circuits that use the least number of controlled-Z gates) that takes any qubit state into another is so difficult that even for a quantum computer with only three qubits, the problem remains open.

We call a pure qubit state real if all its amplitudes are real numbers. In this talk we show that any real 3-qubit state can be prepared using local gates represented with real numbers and at most four controlled-Z gates. We conjecture that four is optimal. We also present an algorithm---different from the 2008 algorithm given by Znidaric, Giraud and Georgeot---that prepares any 3-qubit state using local gates and at most three controlled-Z gates. Videos showing how our method works for two- and three-qubit states can be found at https://youtu.be/LIdYSs-rE-o and https://youtu.be/Kne0Vq7gyzQ.

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For further information: gotchevi@ccsu.edu; 860-832-2839; https://web.ccsu.edu/colloquium/